

Sediment Mobility Tool for Nearshore Placements

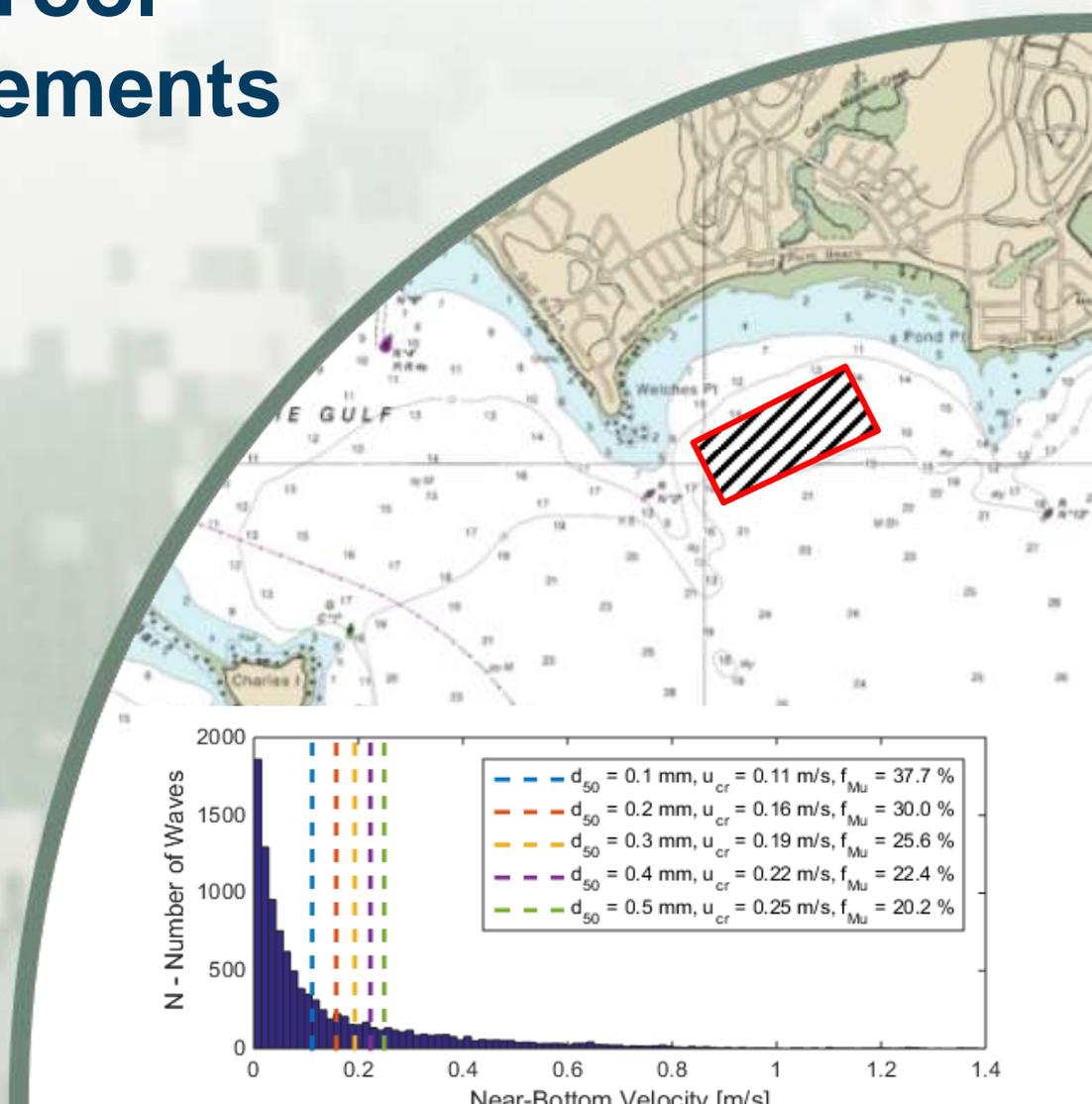
Brian C. McFall, PhD, PE

Katherine E. Brutsché, PhD

20 August 2015



US Army Corps
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Preliminary/Reconnaissance Tool

- Frequency of Sediment Mobility
- Single Depth or Range of Depths
- Matlab Script to Automate Process
- Applied to WIS, NACCS, or Other Wave Gauge Data



Why is it Helpful

- Answers:
 - ▶ Will the Berm Move?
 - ▶ Where Is Sediment Likely To Go?
- Ideal for:
 - ▶ Preliminary Siting of Nearshore Berms
 - ▶ Small Projects That Don't Warrant a Full Numerical Model



Application

- 2 Sites
- 3 Different Data Sets:
 - ▶ WIS (Duck)
 - ▶ NACCS (Milford)
 - ▶ U. Conn. Buoy (Milford)



User Defines:

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



Wave Theories

- Linear Wave Theory

- ▶ Bed Shear Stress
- ▶ Shield's Diagram

$$\tau_{cr} = \theta_{cr} g (\rho_s - \rho) d_{50}$$

$$\tau_m = \tau_c \left[1 + 1.2 \left(\frac{\tau_w}{\tau_c + \tau_w} \right)^{3.2} \right]$$

$$\tau_{max} = [(\tau_m + \tau_w \cos \phi)^2 + (\tau_w \sin \phi)^2]^{1/2}$$

- Nonlinear Stream Function Wave Theory

- ▶ Near-bed Velocity
- ▶ Critical Velocity by Hallermeier (1980) & Komar and Miller (1974)

$$u_{cr} = \sqrt{8 g \gamma d_{50}} \quad d_{50} \leq 2.0 \text{ mm}$$

$$u_{\max \text{ crest}} = \left(\frac{H}{T} \right) \left(\frac{h}{L_o} \right)^{-0.579} \exp \left[0.289 - 0.491 \left(\frac{H}{h} \right) - 2.97 \left(\frac{h}{L_o} \right) \right]$$

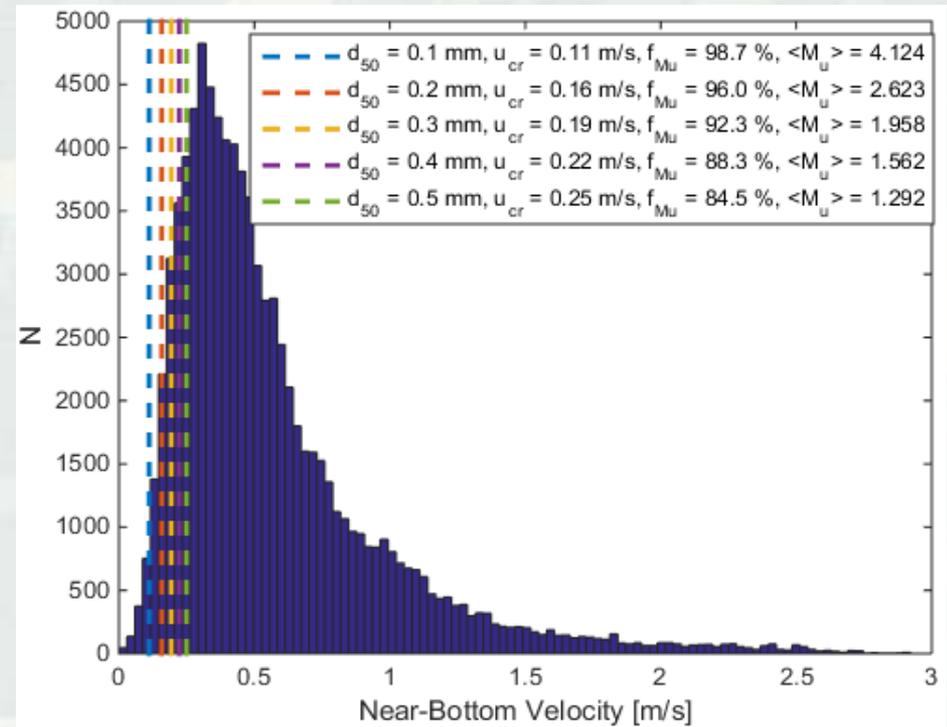
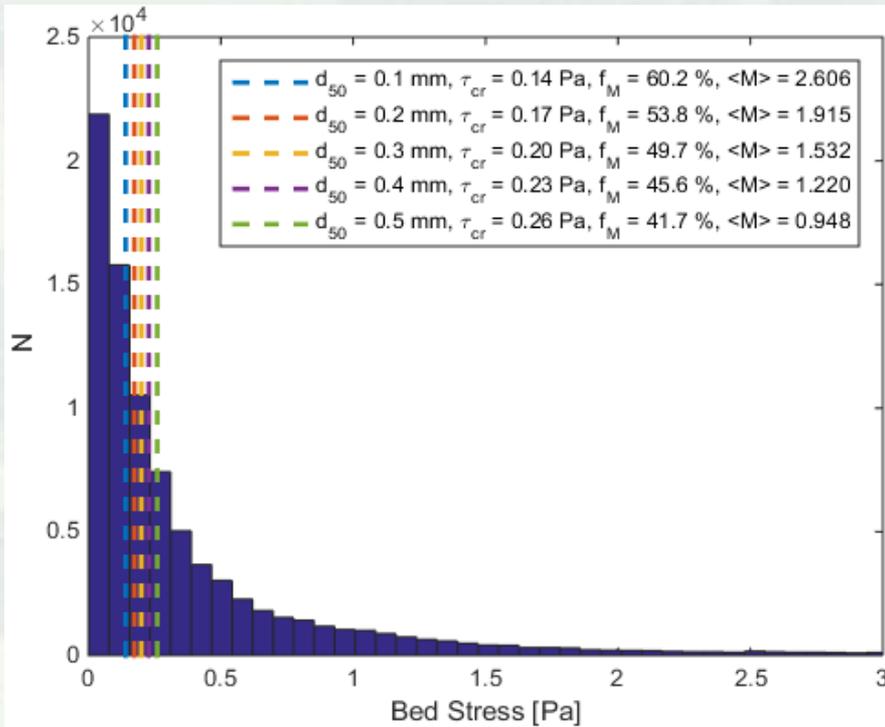


Site 1: Duck, NC

- $h = 8 \text{ m}$
- WIS Station 63218
- $0.1 \leq d_{50} \leq 0.5 \text{ mm}$



Site 1: Duck, NC

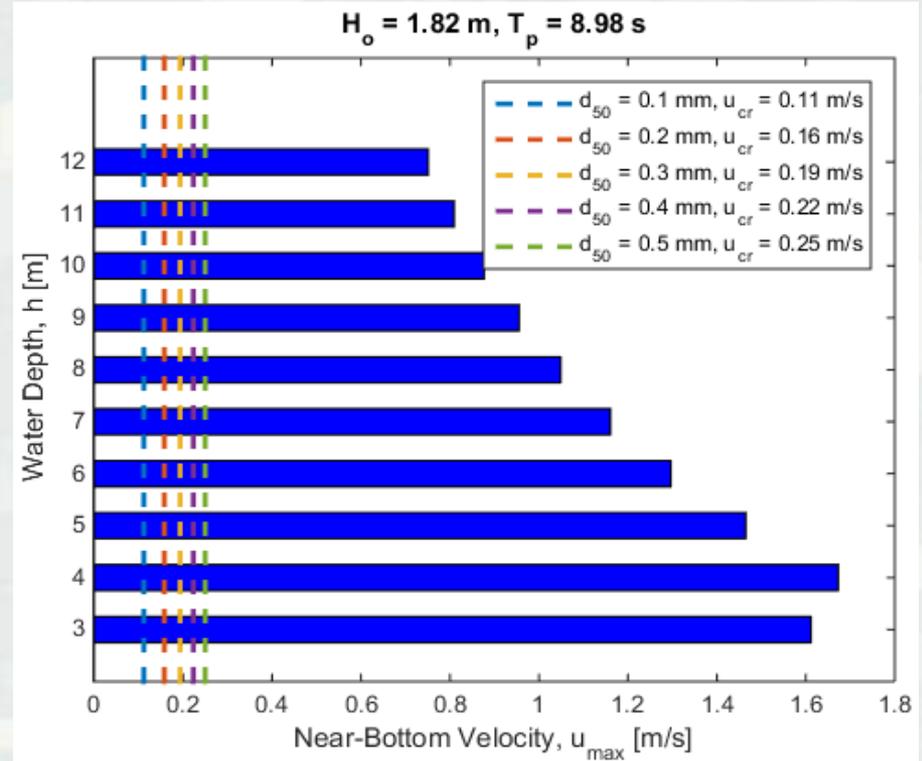
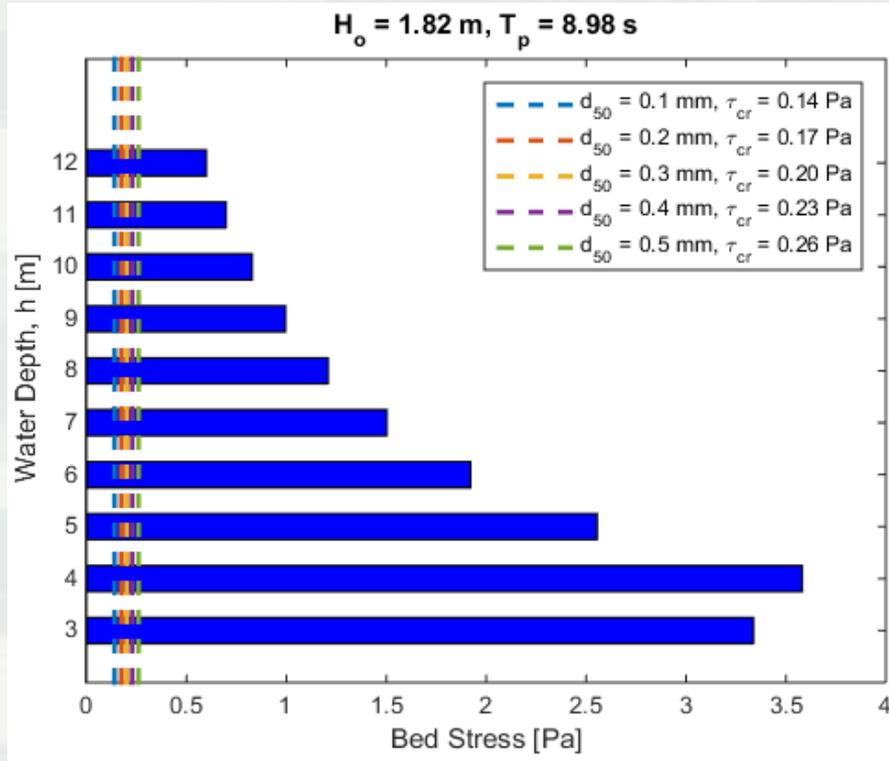


$$M = \left(\frac{\tau_{max} - \tau_{cr}}{\tau_{cr}} \right)$$

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



Site 1: Duck, NC

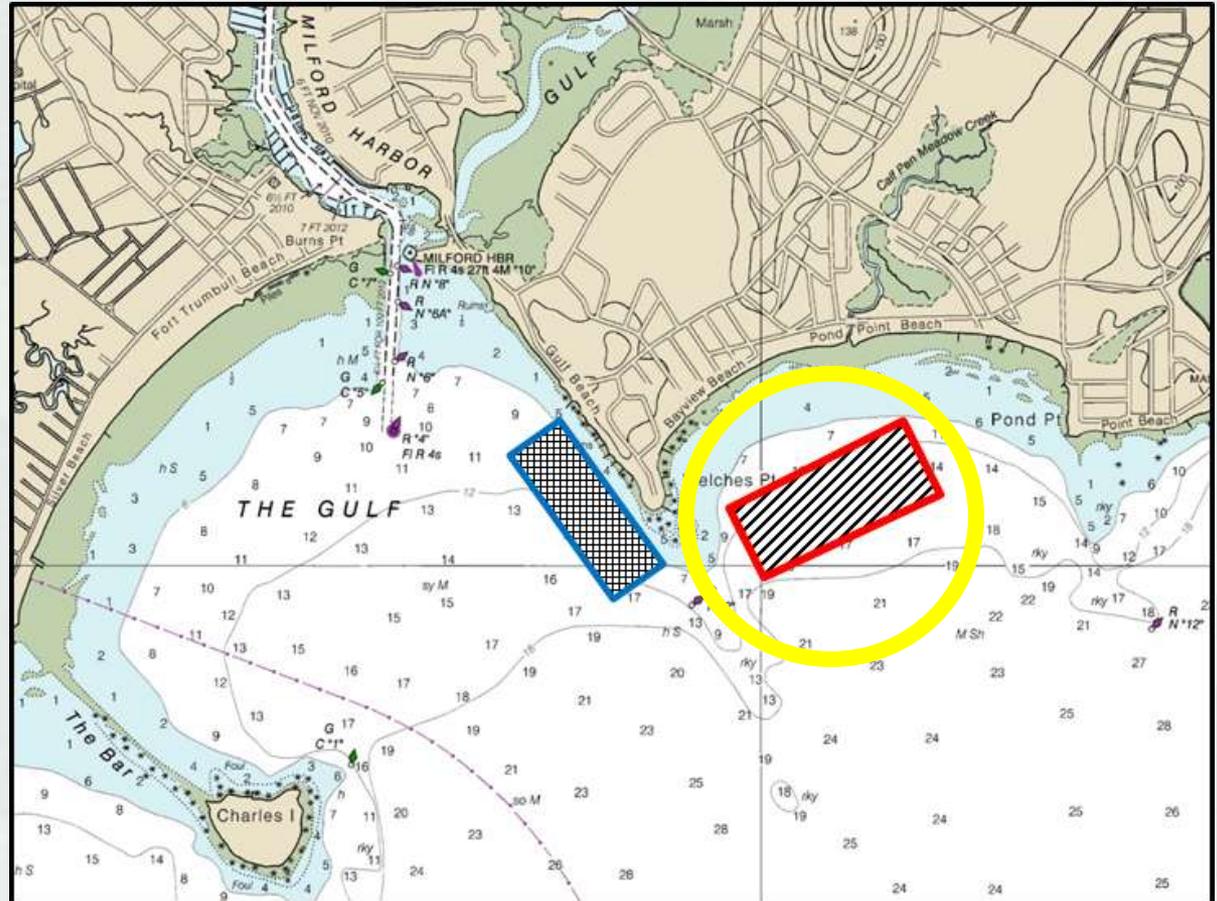


Significant Wave Height and Period

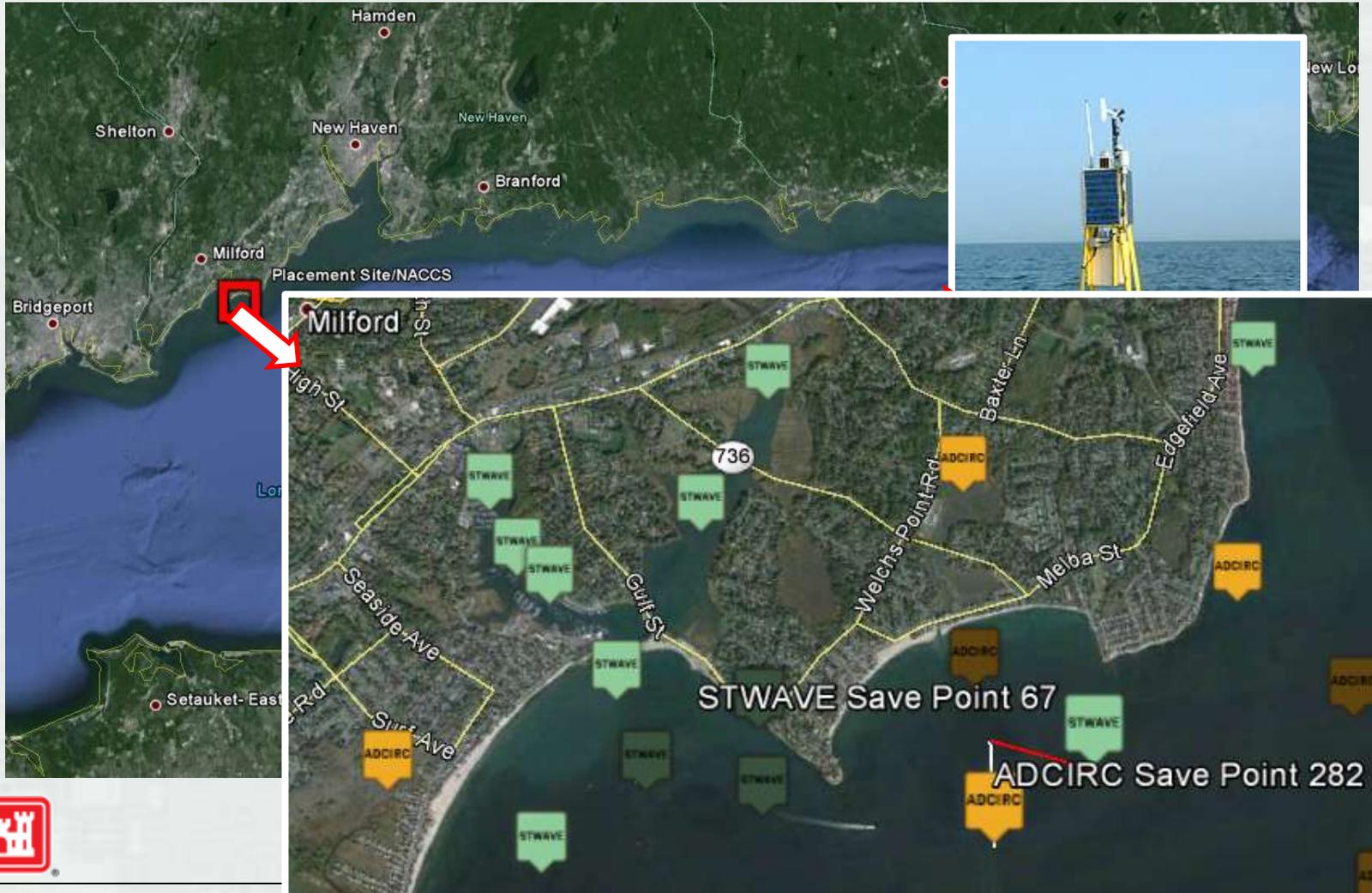


Site 2: Milford, CT

- Milford, CT
- 20,000 cy
- $d_{50}=0.21$ mm
- $0.1 \leq d \leq 0.5$ mm



Wave & Current Info



Sed. Mobility

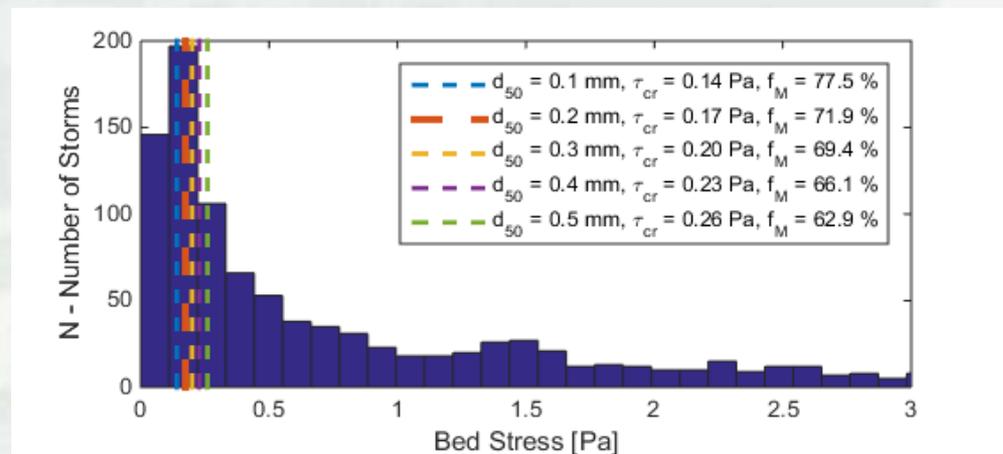
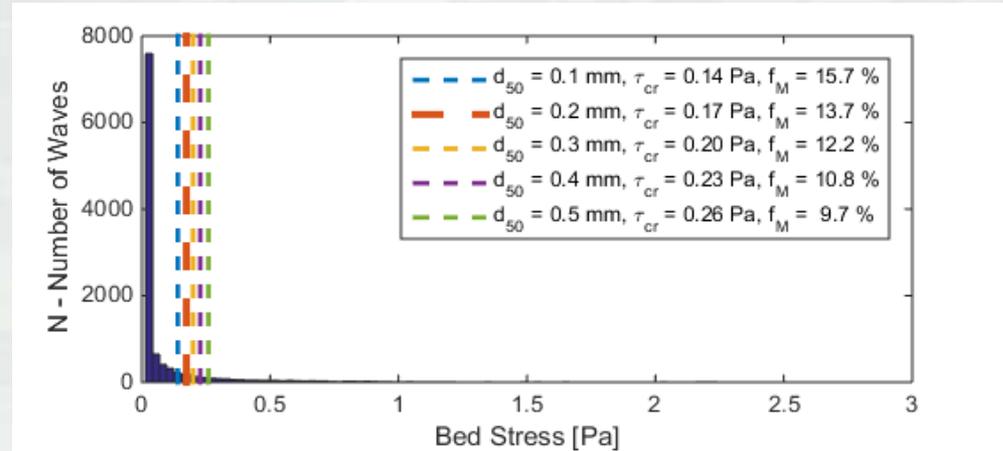
$$d_{50} = 0.21\text{mm}$$

Typical Waves:

$$f_M = 13.6\%$$

Storm Waves:

$$f_M = 71.4\%$$



Sed. Migration Direction

- Dean's Number

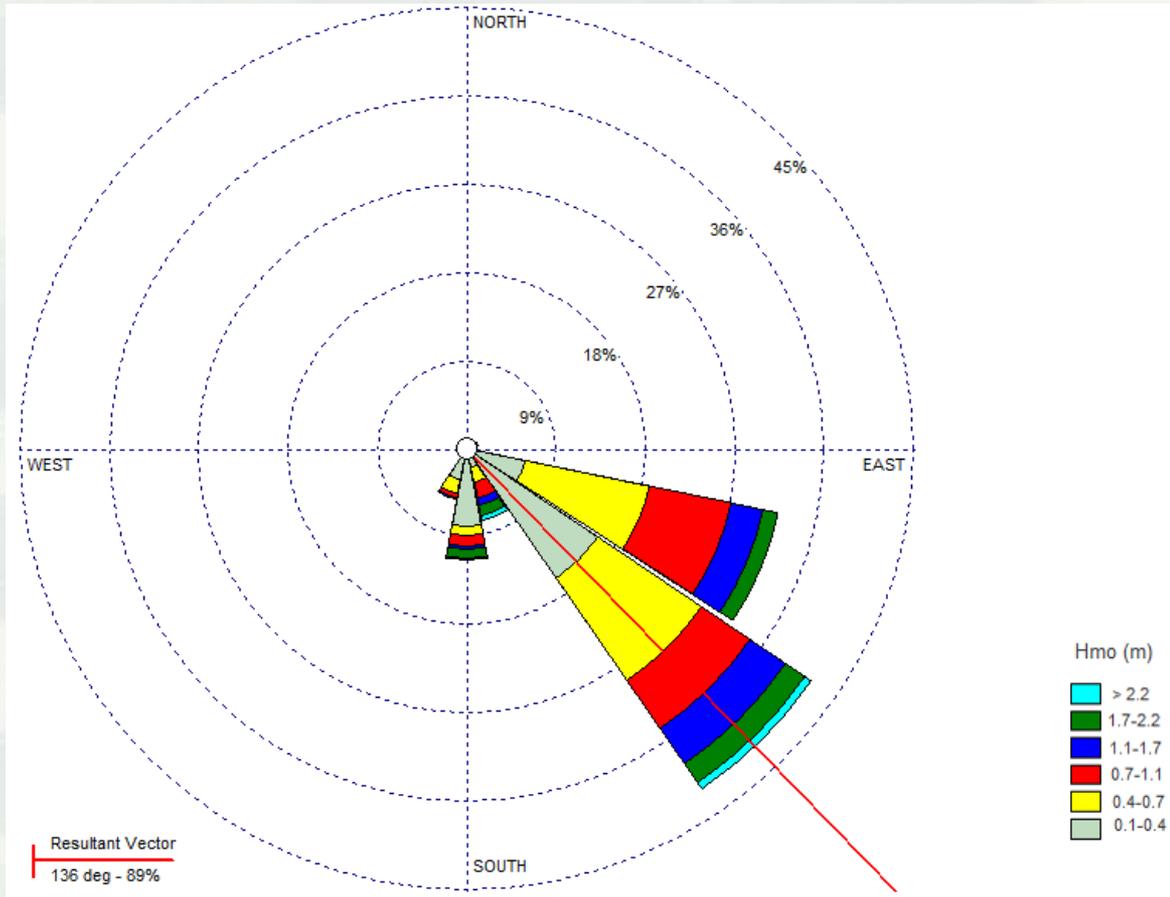
$$D = \frac{H_0}{\omega T} > 7.2, \text{ Offshore Migration}$$

$$< 7.2, \text{ Onshore Migration} \quad (\text{Larson \& Kraus, 1992})$$

d (mm)	Typical Waves	Storm Events
	Predicted Sediment Migration	Predicted Sediment Migration
0.1	83% Offshore	97% Offshore
0.2	60% Onshore	52% Offshore
0.21	63% Onshore	52% Onshore
0.3	84% Onshore	74% Onshore
0.4	96% Onshore	91% Onshore
0.5	99% Onshore	99% Onshore



Storm Wave Direction



- Storm waves
- Resultant: 136°
- Accretion Towards Northwest



Conclusions

- Works with Various Data Sets
- Estimates
 - ▶ Frequency of mobility
 - ▶ On/Offshore migration direction
 - ▶ Dominant axis of wave dominated migration
- Preliminary tool to make educated decisions with little data



Thank you!



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Full Summary

d ₅₀ (mm)	Typical Waves		Storm Events	
	Frequency of Mobilization	Predicted Sediment Migration	Frequency of Mobilization	Predicted Sediment Migration
0.1	16 – 38%	83% Offshore	78 – 96%	97% Offshore
0.2	14 – 30%	60% Onshore	72 – 95%	52% Offshore
0.21	14 – 30%	63% Onshore	71 – 94%	52% Onshore
0.3	12 – 26%	84% Onshore	69 – 93%	74% Onshore
0.4	11 – 22%	96% Onshore	66 – 91%	91% Onshore
0.5	10 – 20%	99% Onshore	62 – 89%	99% Onshore

