Evaluating Sediment Mobility for Nearshore Placement

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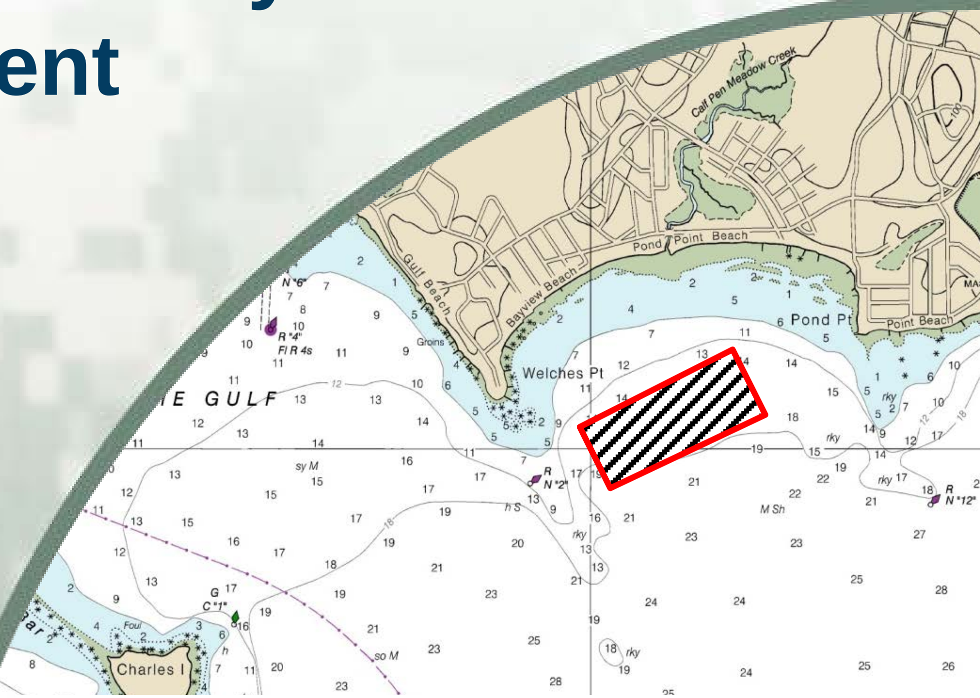

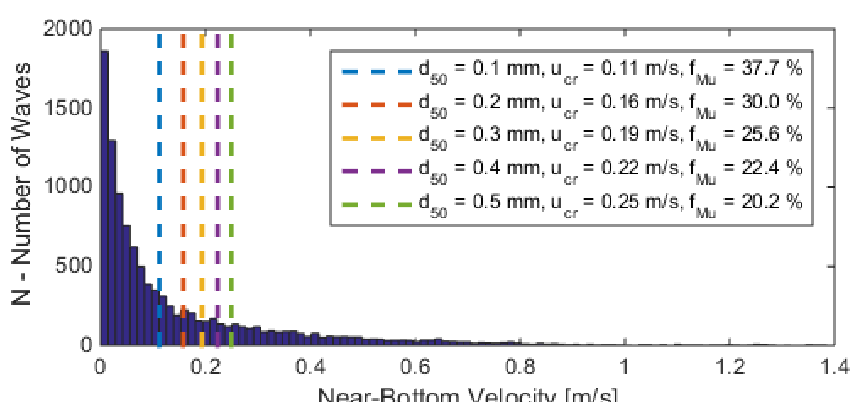

Engineer Research and Development Center

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Sediment Mobility Tool

- 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

- Frequency of Mobility:
  - Linear Wave Theory (Bed Shear Stress)

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

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

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

  - Nonlinear Stream Function Wave Theory (Near-bed Velocity)

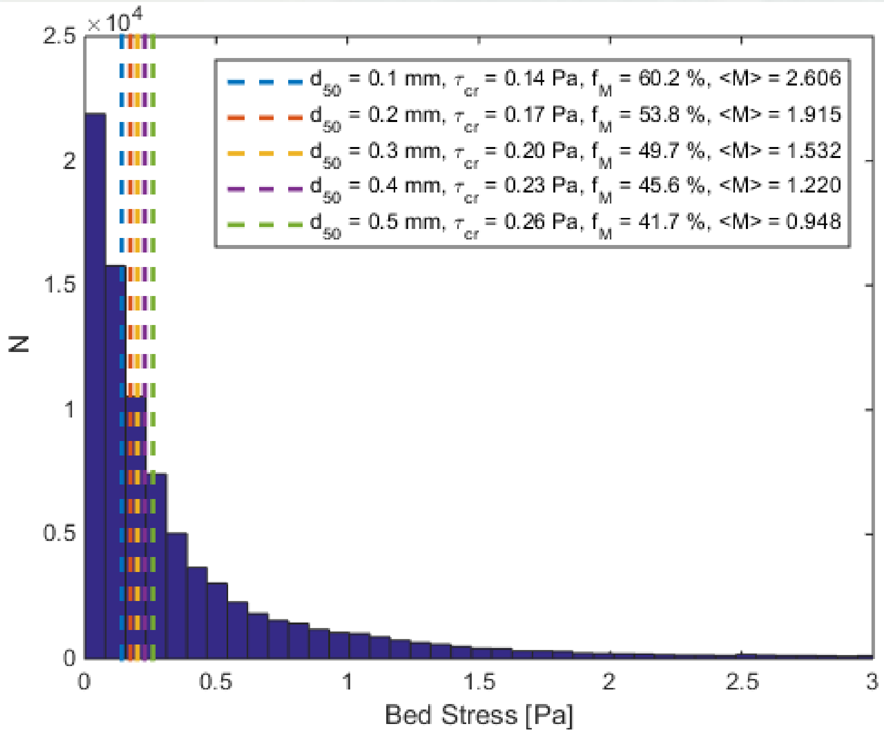
$$u_{cr} = \sqrt{8\, g\, \gamma\, d_{50}} \qquad d_{50} \le 2.0\, mm$$

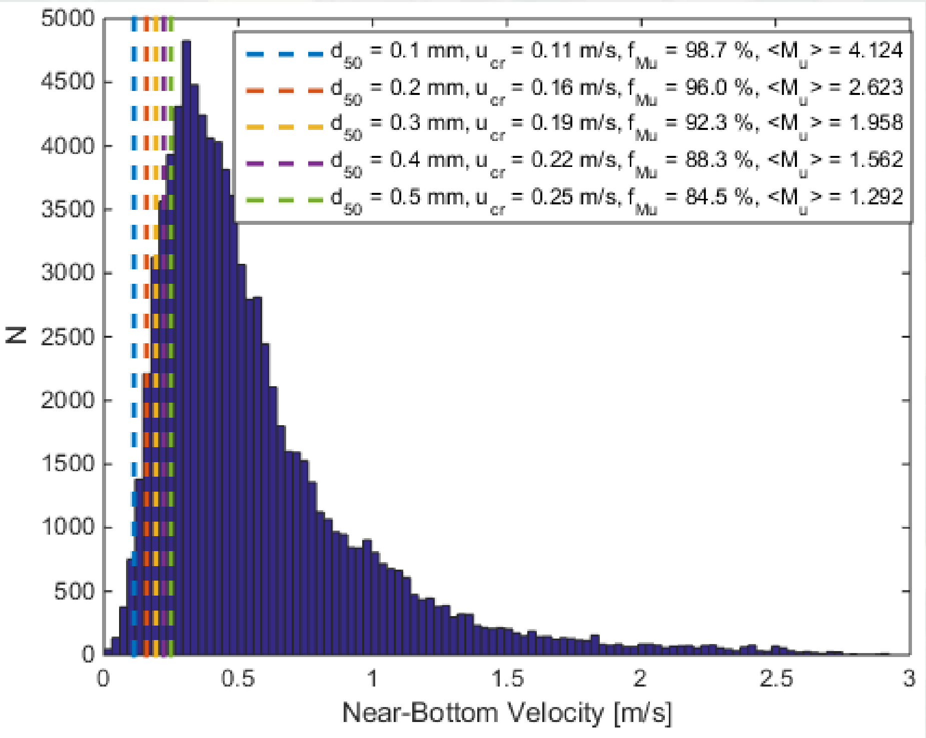
$$u_{\max\, crest} = \left(\frac{H}{T}\right)\left(\frac{h}{L_o}\right)^{-0.579} \exp\left[0.289 - 0.491\left(\frac{H}{h}\right) - 2.97\left(\frac{h}{L_o}\right)\right]$$

Site 1: Duck, NC

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

Site 1: Duck, NC

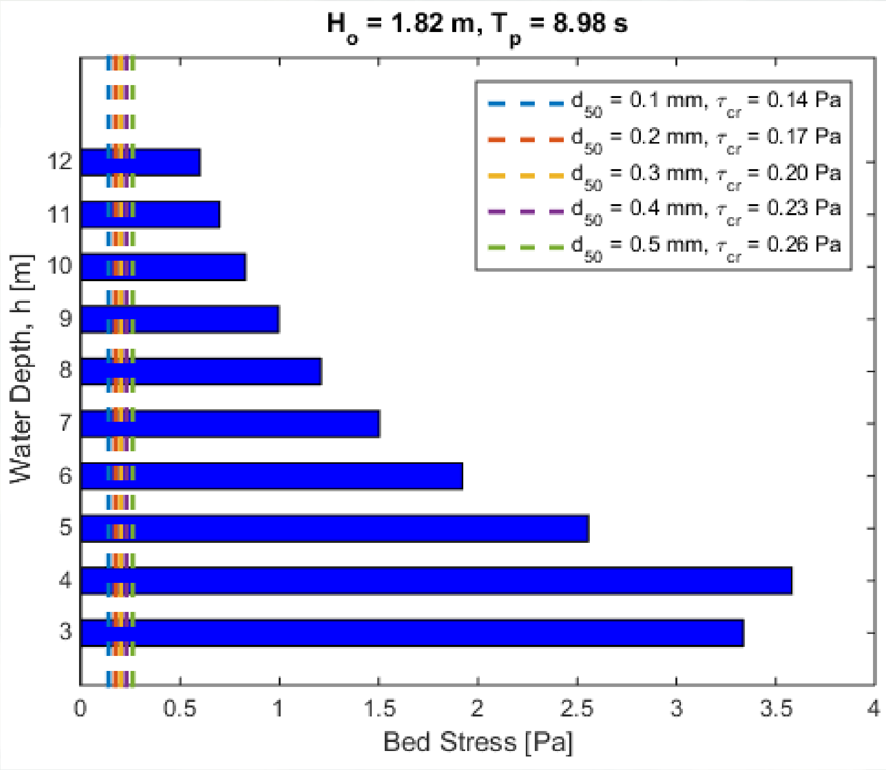


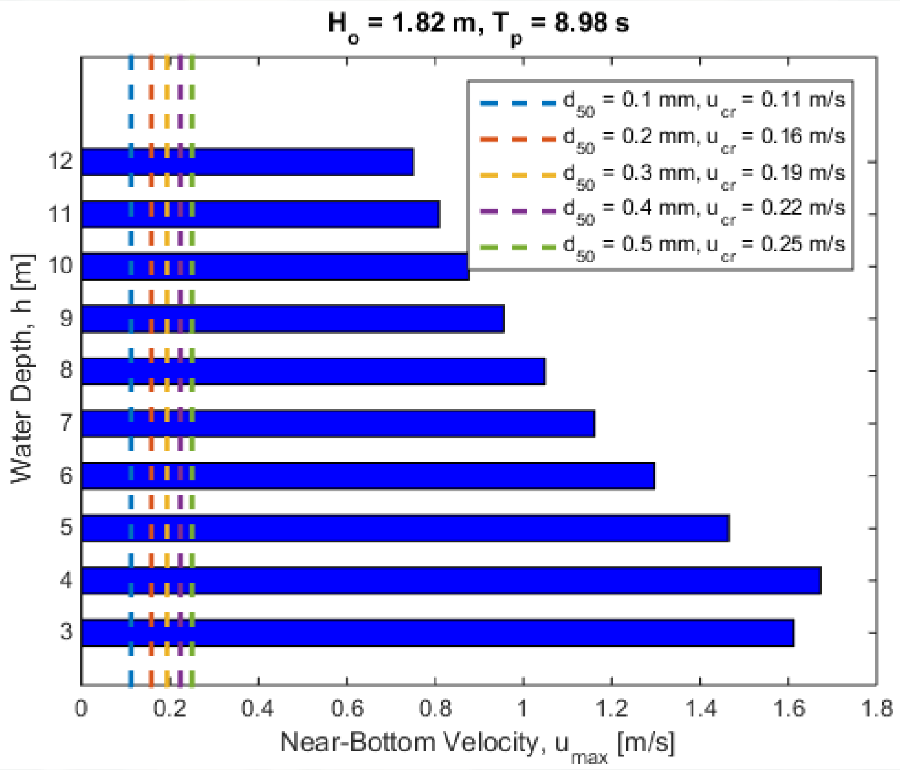


$$M = \overline{\left(\frac{\tau_{max} - \tau_{cr}}{\tau_{cr}}\right)}$$

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

Site 1: Duck, NC

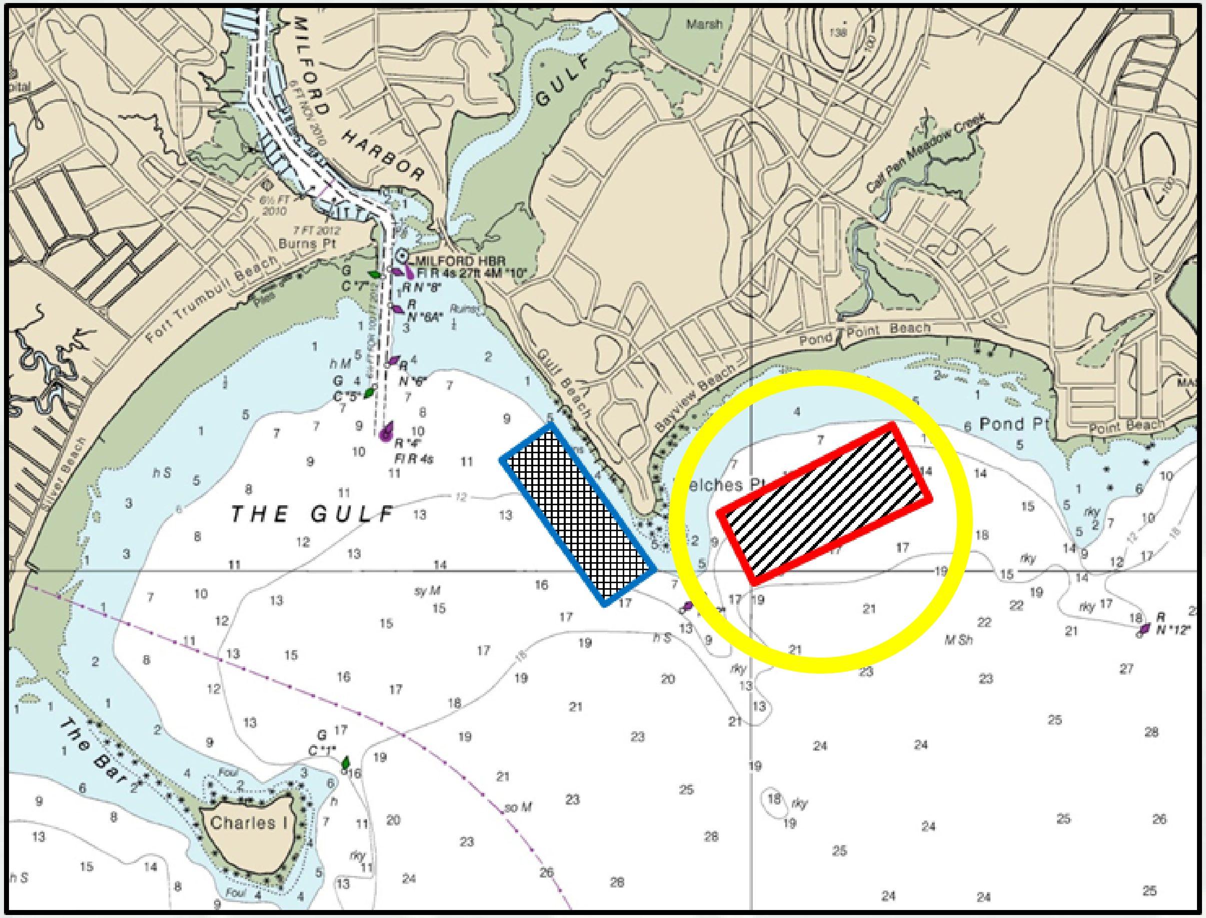




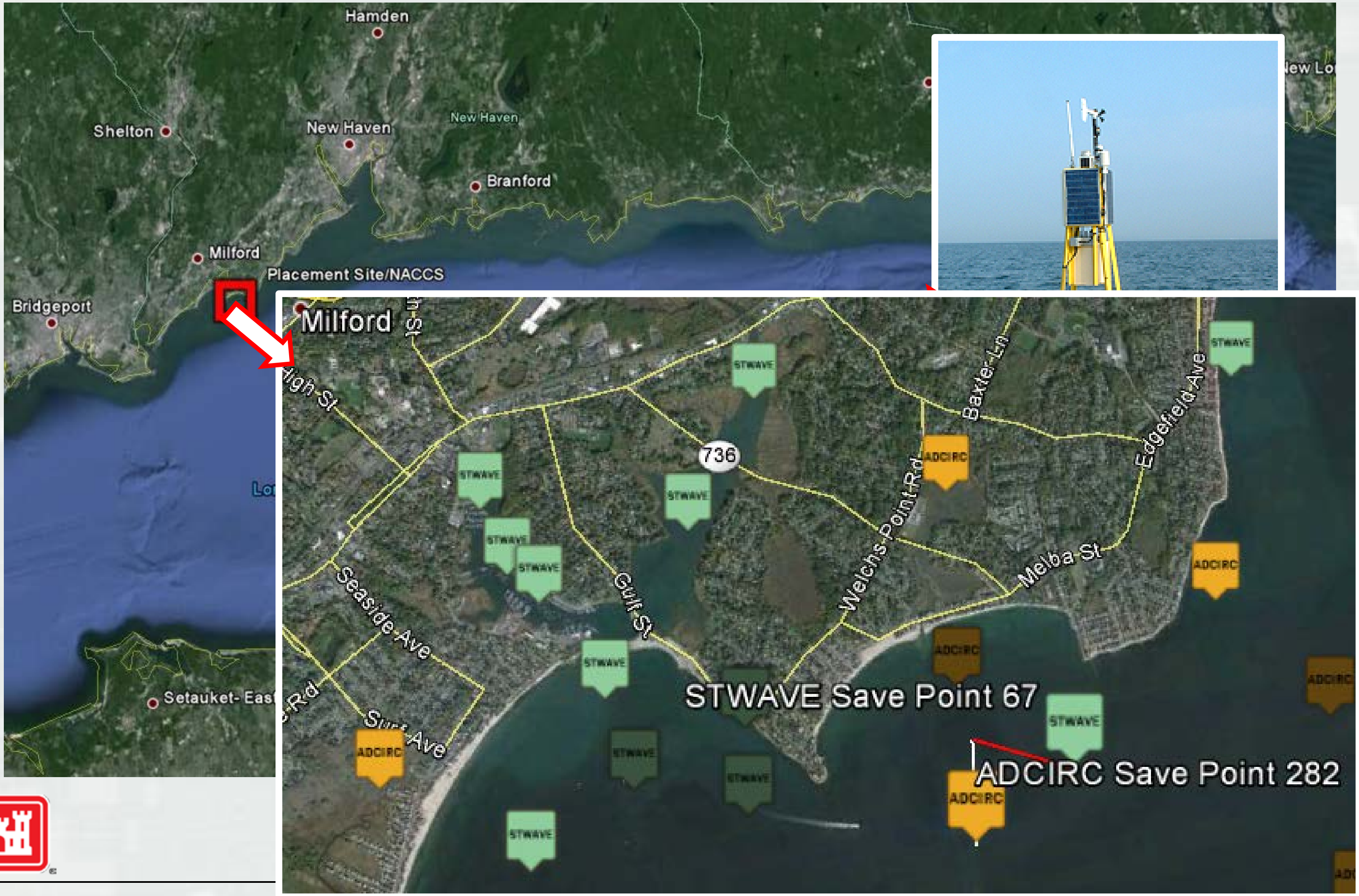
Significant Wave Height and Period

Site 2: Milford, CT

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



Wave & Current Info



Sed. Mobility

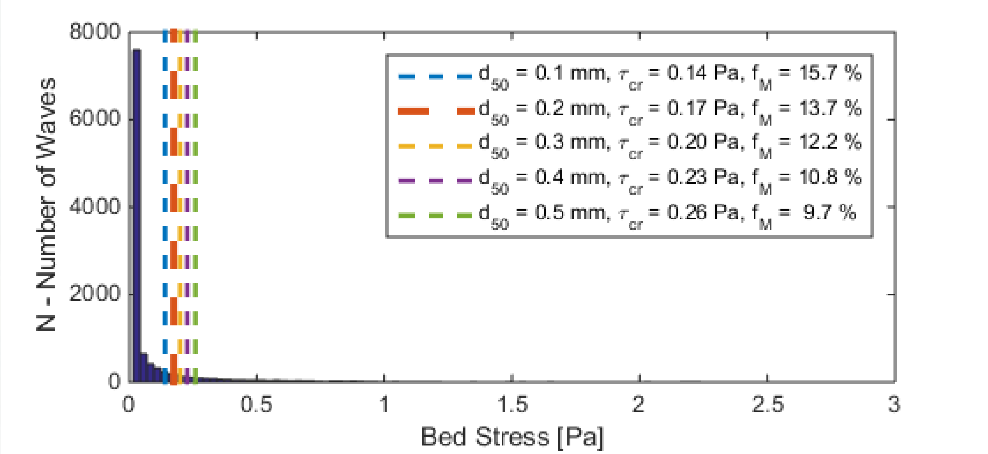
$d_{50} = 0.21mm$

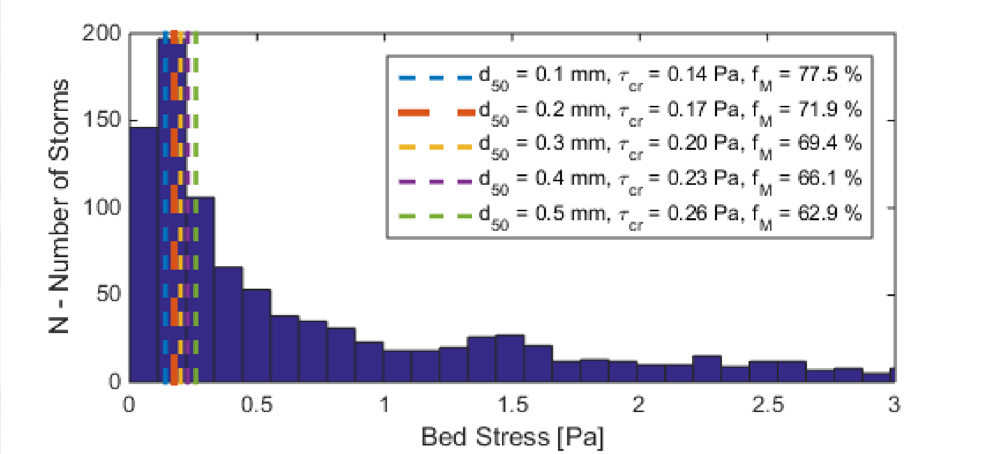
Typical Waves:

$f_M = 13.6\%$

Storm Waves:

$f_M = 71.4\%$





Sed. Migration Direction

- Dean's Number

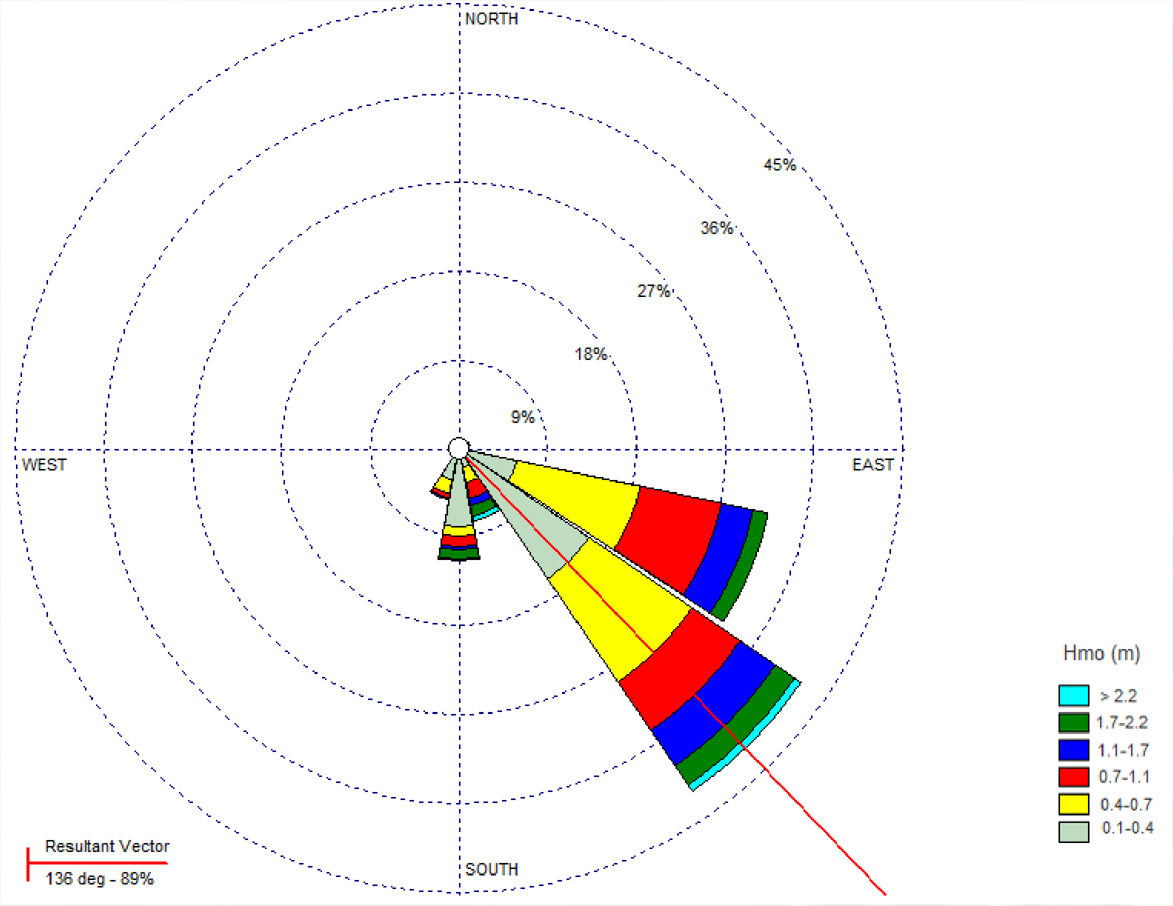
$$D = \frac{H_0}{\omega\, T}$$

> 7.2, Offshore Migration

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

d (mm)	Typical Waves Predicted Sediment Migration	Storm Events 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

- Answers:
  - ▶ Will the sediment move?
  - ▶ Where is likely to go?
- Estimates
  - ▶ Frequency of mobility
  - ▶ On/Offshore migration direction
  - ▶ Dominant axis of wave dominated transport
- Preliminary tool to make educated decisions with little data

Thank you!