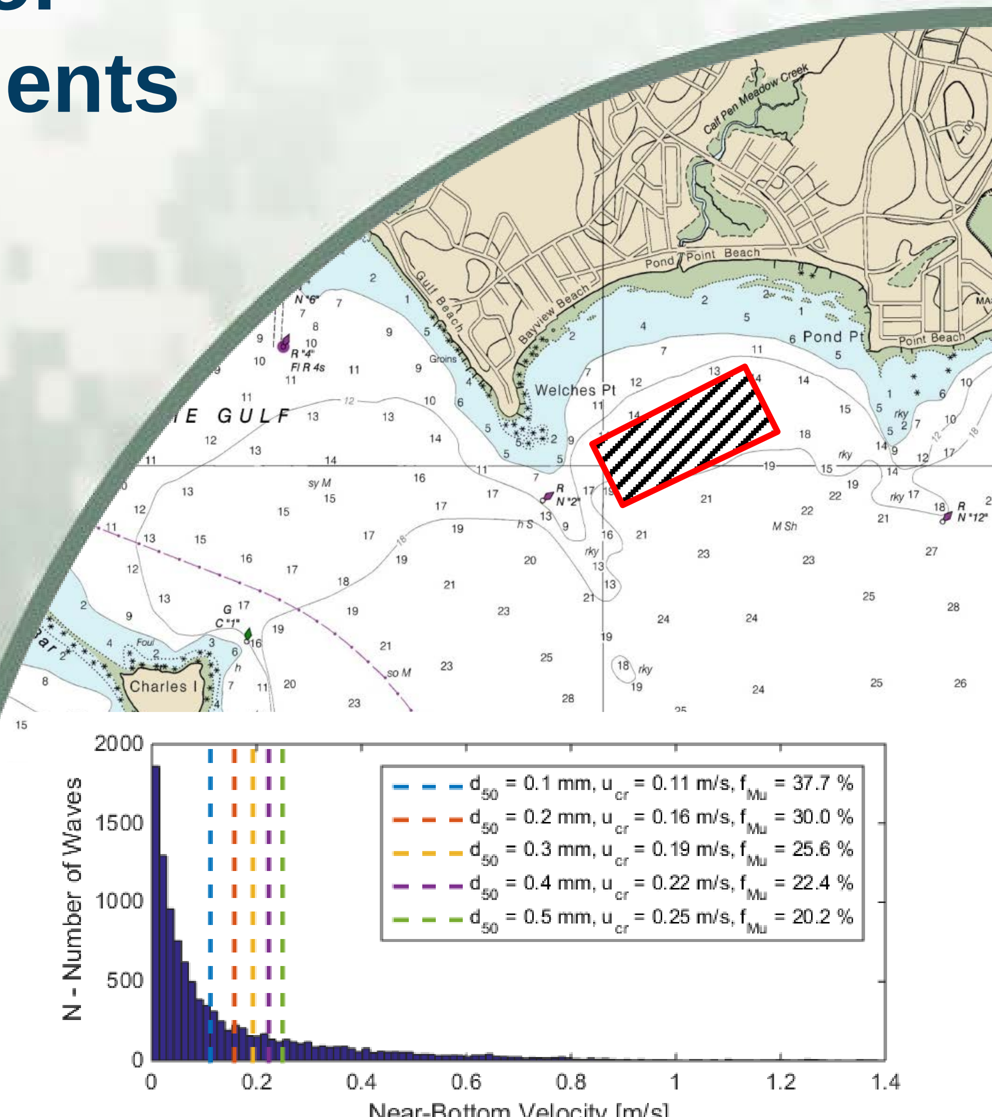
ERDC
Engineer Research and Development Center

Sediment Mobility Tool for Nearshore Placements

Brian C. McFall, PhD, PE

Katherine E. Brutsché, PhD

20 August 2015



US Army Corps of Engineers®

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)

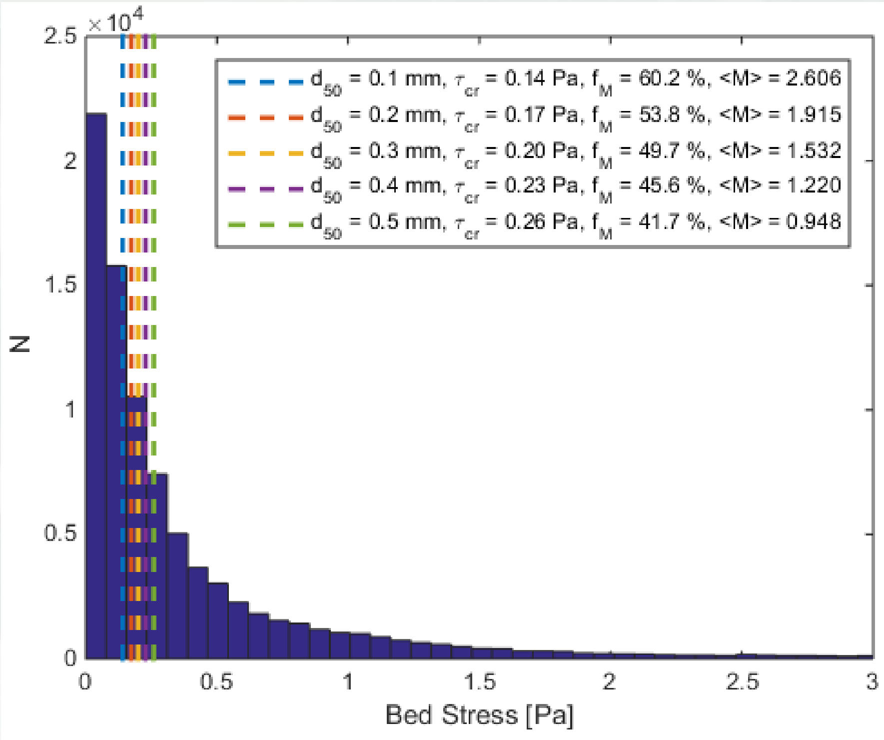
$$u_{cr} = \sqrt{8\, g\, \gamma\, d_{50}} \qquad d_{50} \leq 2.0\, mm$$

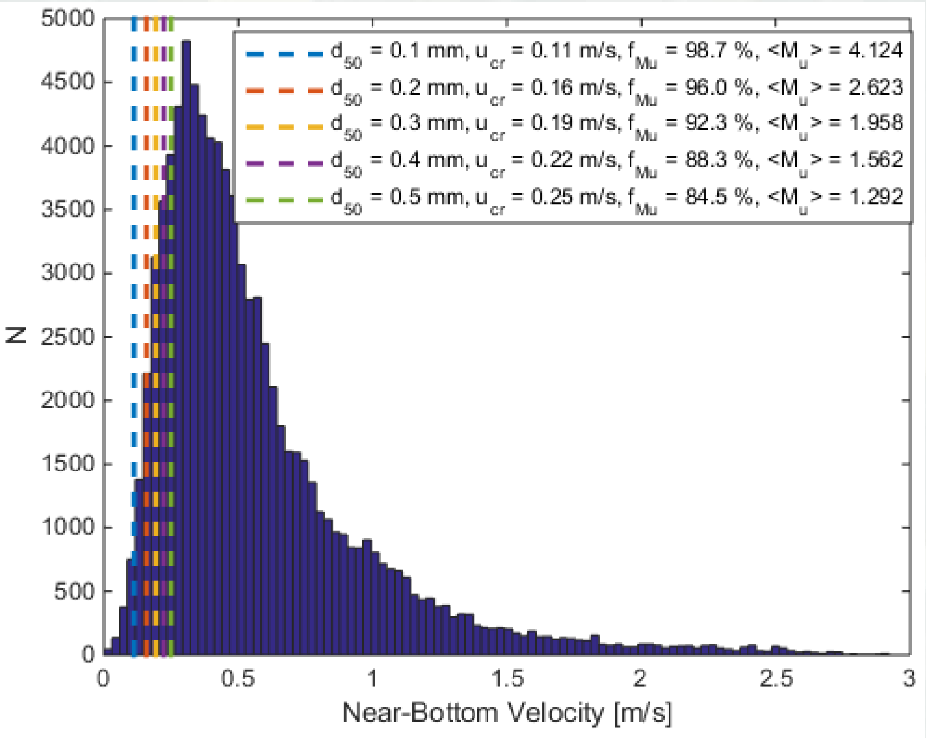
$$u_{\max crest} = \left(\frac{H}{T}\right)\left(\frac{h}{L_o}\right)^{-0.579} \exp\left[0.289 - 0.491\left(\frac{H}{h}\right) - 2.97\left(\frac{h}{L_o}\right)\right]$$

Site 1: Duck, NC

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

Site 1: Duck, NC

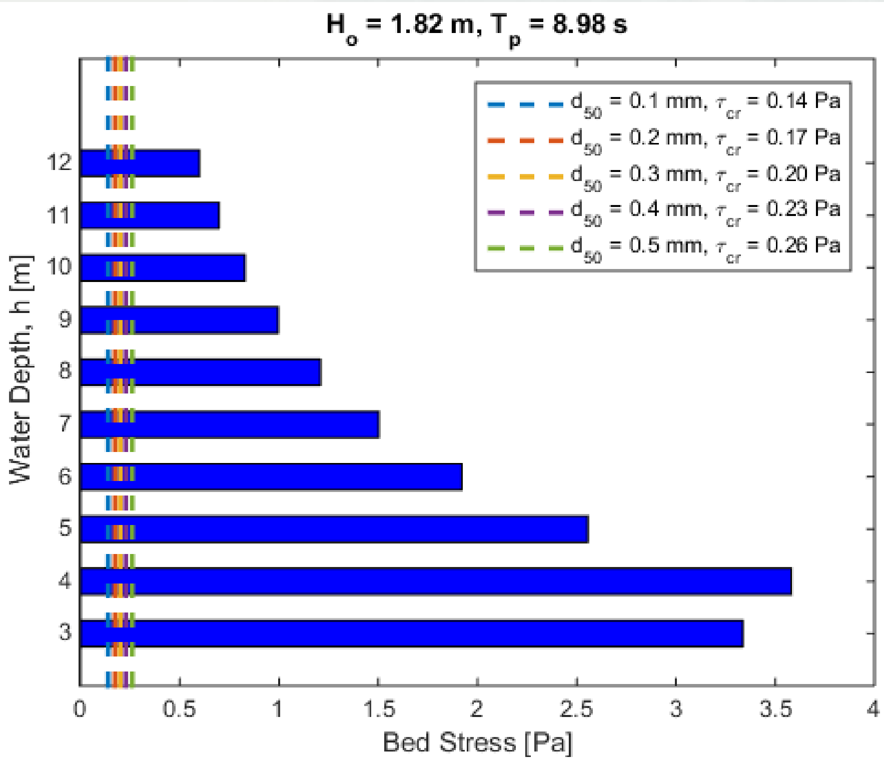


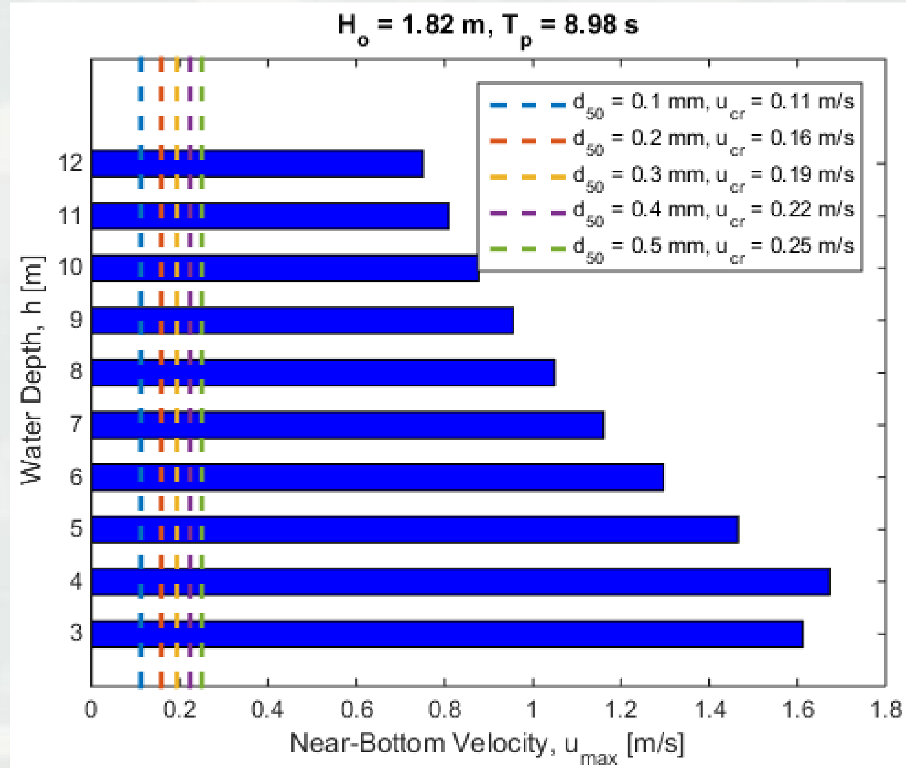


$$M = \overline{\left(\frac{\tau_{max} - \tau_{cr}}{\tau_{cr}}\right)}$$

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

Site 1: Duck, NC

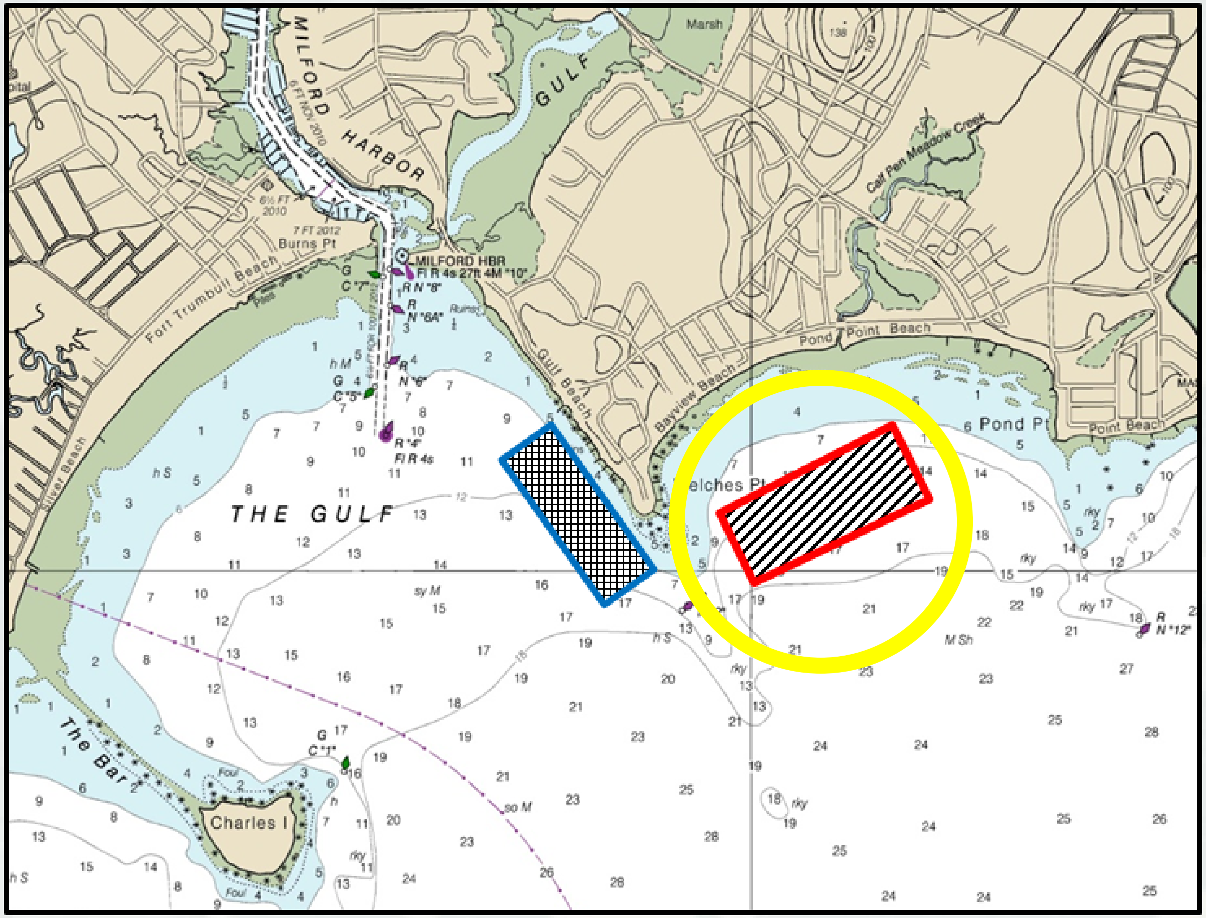




Significant Wave Height and Period

Site 2: Milford, CT

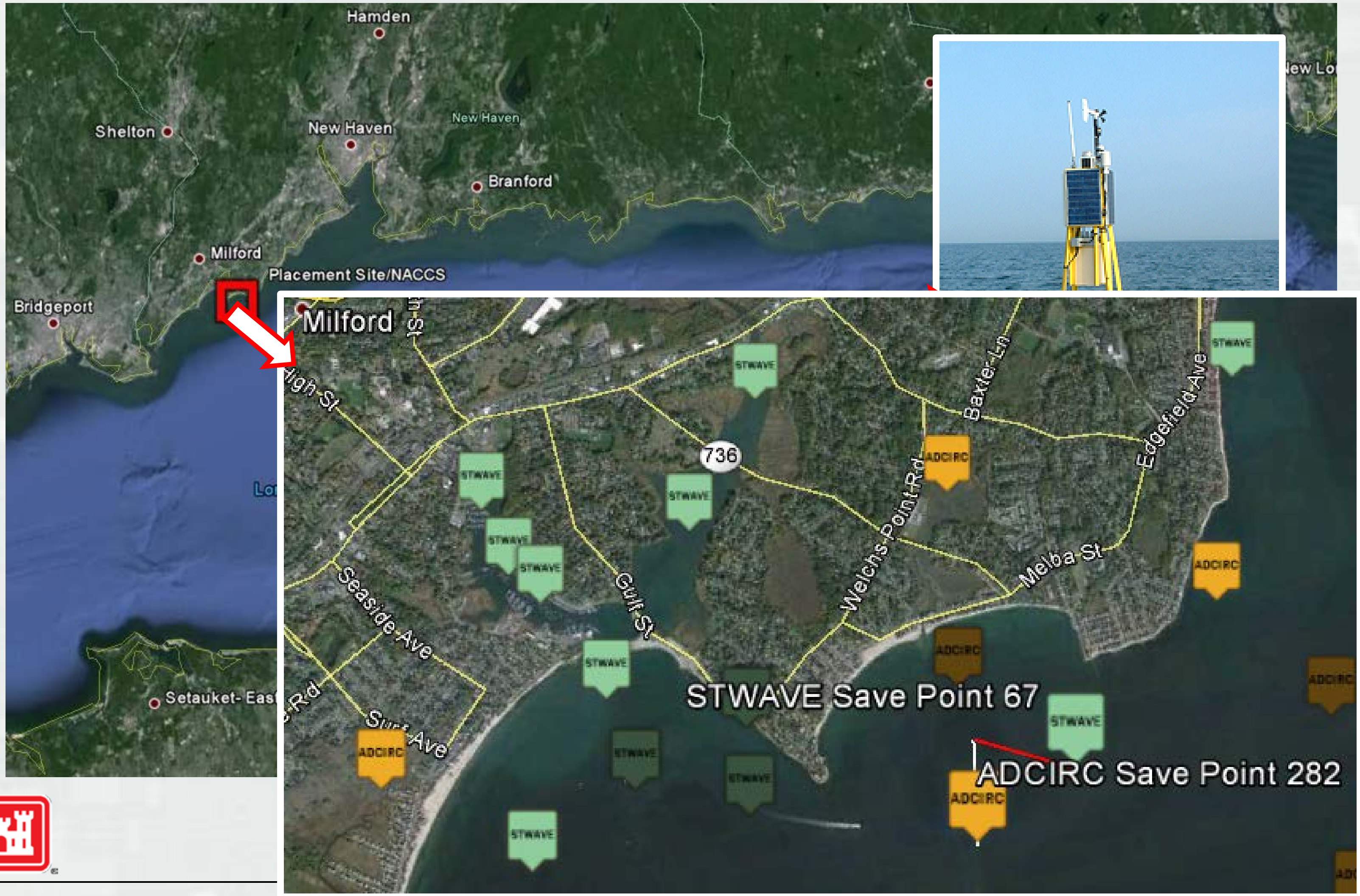
- Milford, CT
- 20,000 cy
- d_{50}=0.21 mm
- 0.1 ≤ d ≤0.5mm



BUILDING STRONG®

Innovative solutions for a safer, better world

Wave & Current Info



Sed. Mobility

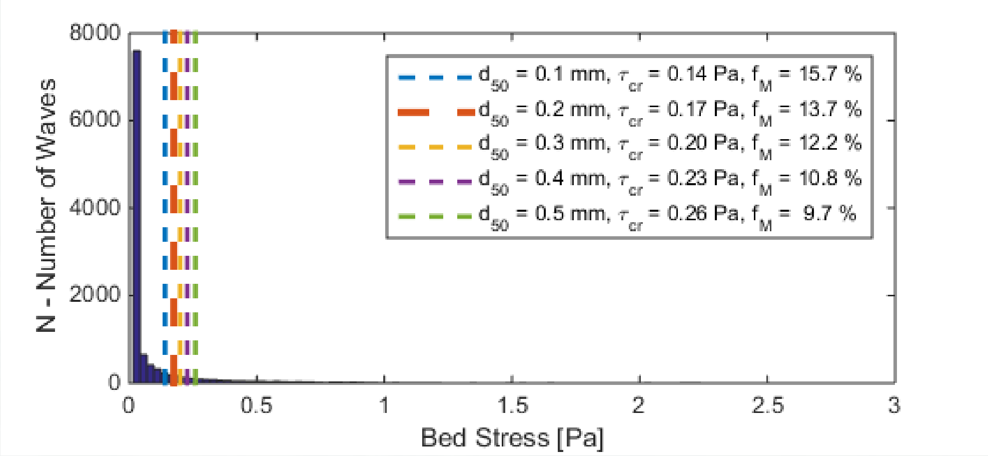
$d_{50} = 0.21mm$

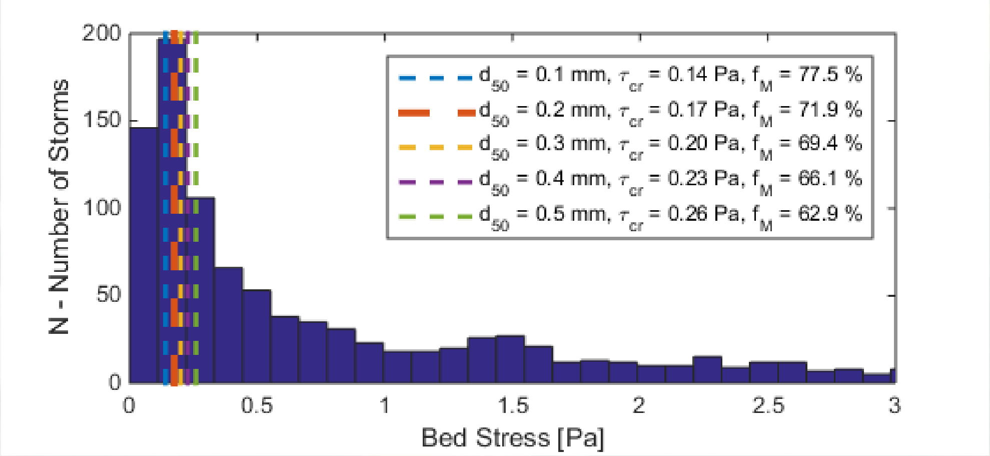
Typical Waves:

$f_M = 13.6\%$

Storm Waves:

$f_M = 71.4\%$





Sed. Migration Direction

- Dean's Number

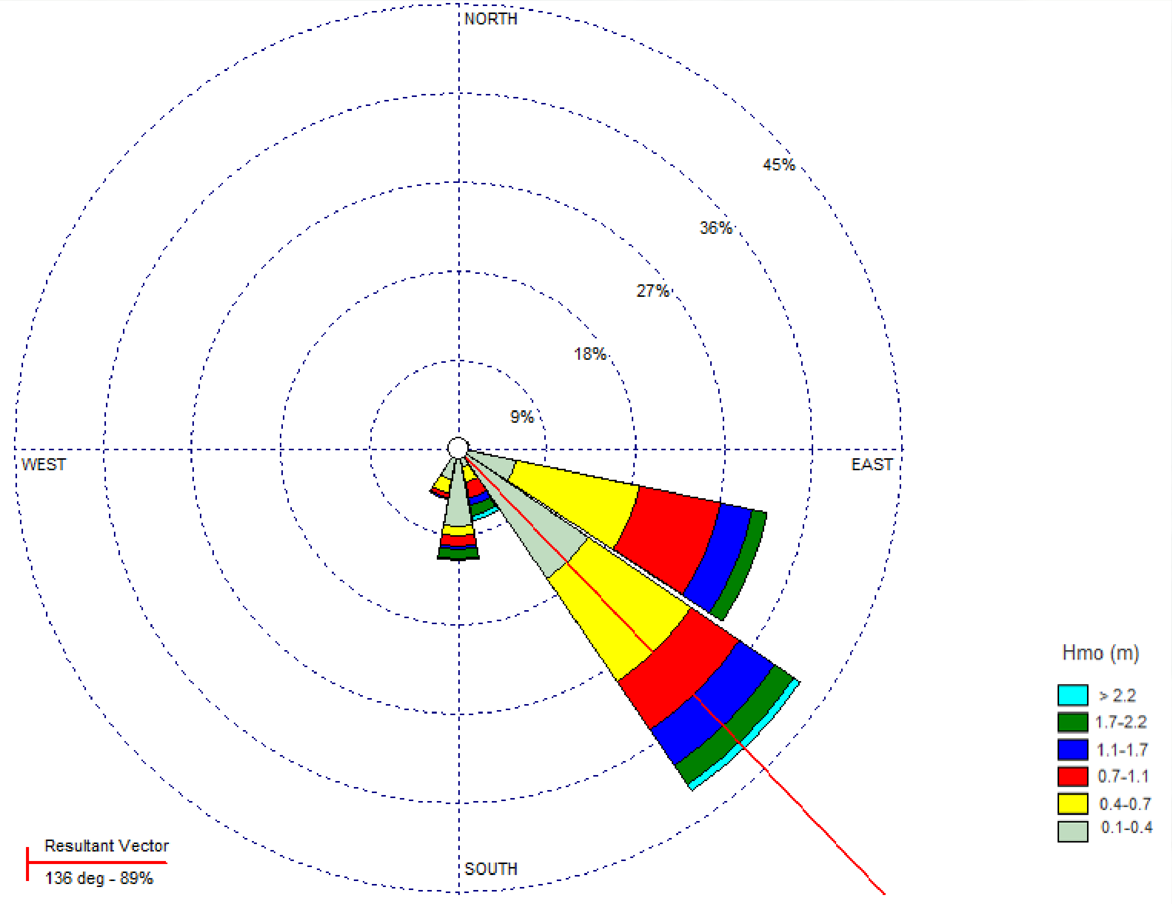
$$D = \frac{H_0}{\omega\, T}$$

> 7.2, Offshore Migration

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

	Typical Waves	**Storm Events**
d (mm)	**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!