Coastal Working Group

ERDC
Engineer Research and Development Center

Sediment Mobility Tool & Its Application

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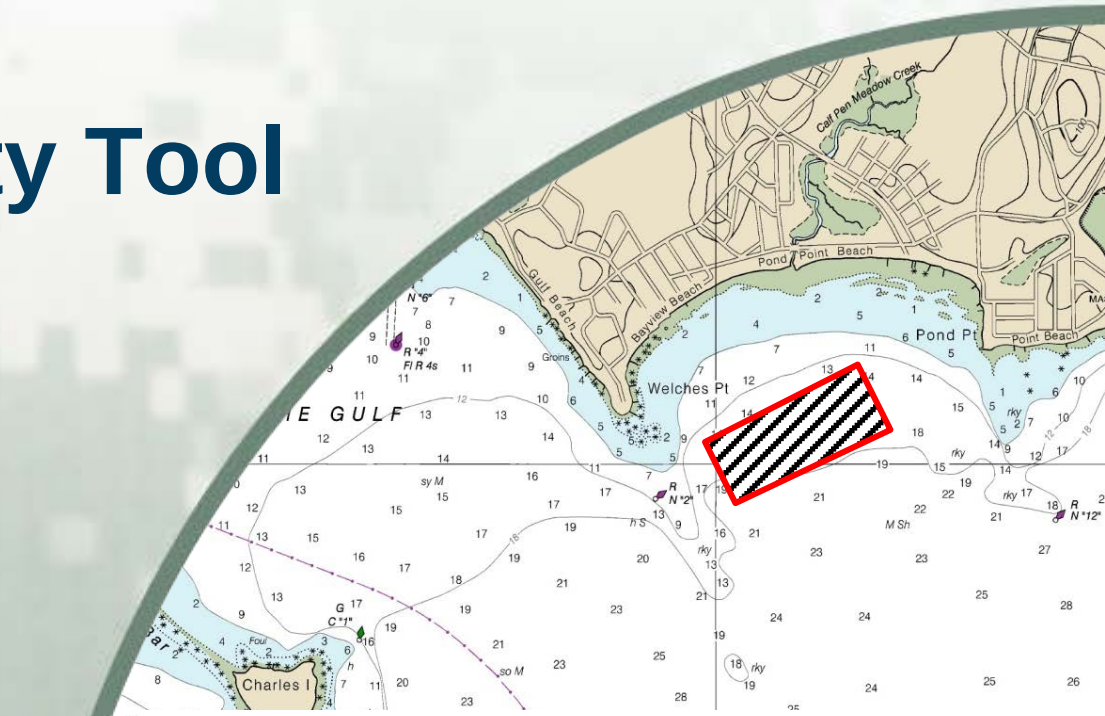

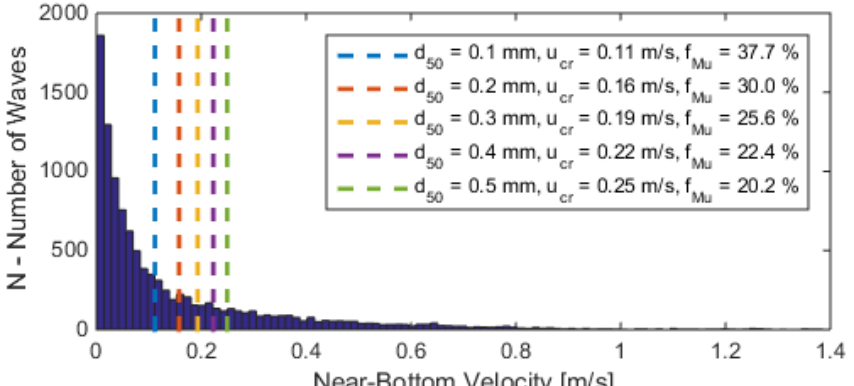

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Outline

- What is it?
- Why is it helpful?
- How does it work?
- How is it applied?
- How can I use it?
- Summary

Outline

- **What is it?**
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What is it?

- Tool Predicts:
  - ► Frequency of Sediment Mobility
  - ► Onshore/Offshore Migration
  - ► Axis of Wave Dominated Transport
- Single Depth or Range of Depths
- Matlab Script to Automate Process
- Applied to WIS, NACCS, or Other Wave Gauge Data

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- What is it?
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Why is it helpful?

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

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How does it work?

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

$$\tau_{cr} = \theta_{cr}\, g\, (\rho_s - \rho)\, d_{50} \qquad \tau_m = \tau_c \left[1 + 1.2 \left(\frac{\tau_w}{\tau_c + \tau_w}\right)^{3.2}\right]$$

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

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

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

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

How Does It Work?

- Onshore/Offshore Migration:
  - Dean's Number

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

> 7.2, Offshore Migration

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

- Axis of Wave Dominated Transport:
  - Wave Rose

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Where Has It Been Applied?

- Been Applied To:
  - Duck, NC (WIS data)
  - Milford, CT (NACCS & U.Conn. Buoy)

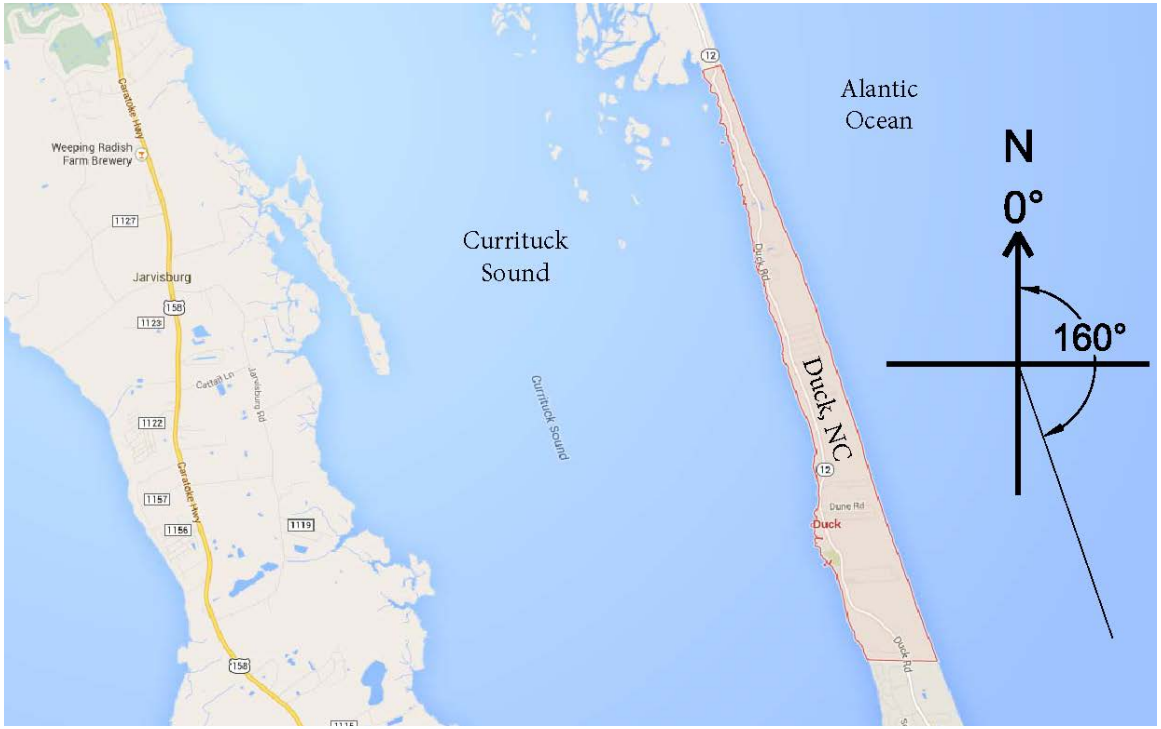
- Will be Applied Next FY:
  - Vilano Beach, FL
  - Amelia Island, FL
  - Burns Waterway Harbor, IN
  - Illinois Beach State Park, IL

How Is It Applied?

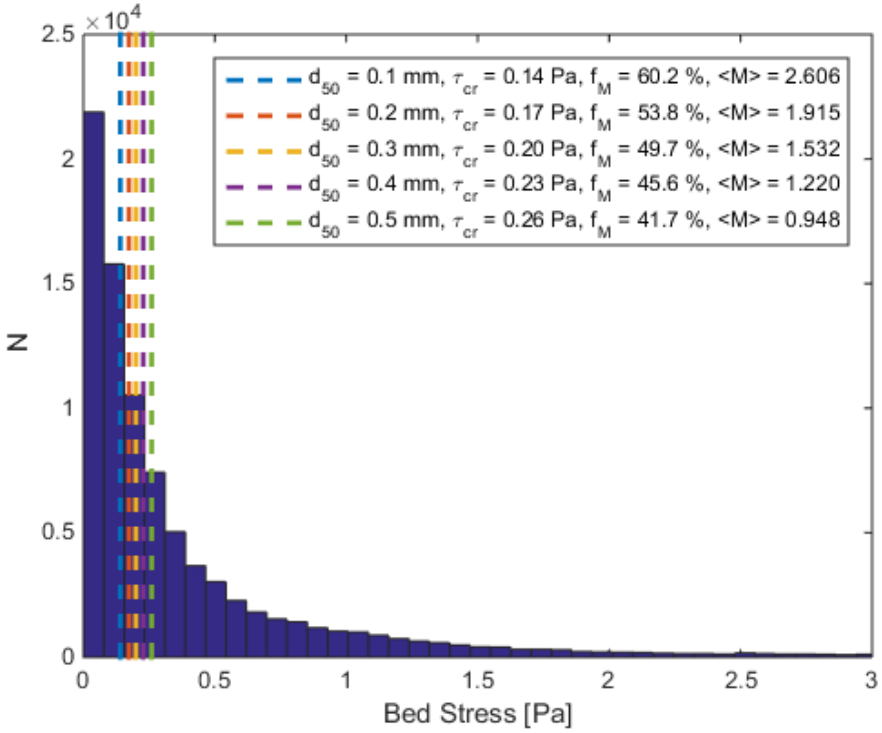
- User Defines:
  - Data Source
  - Offshore Water Depth of Data Source
  - Shoreline Orientation
  - Median Grain Size
  - Current Velocity 1 m above the Bed

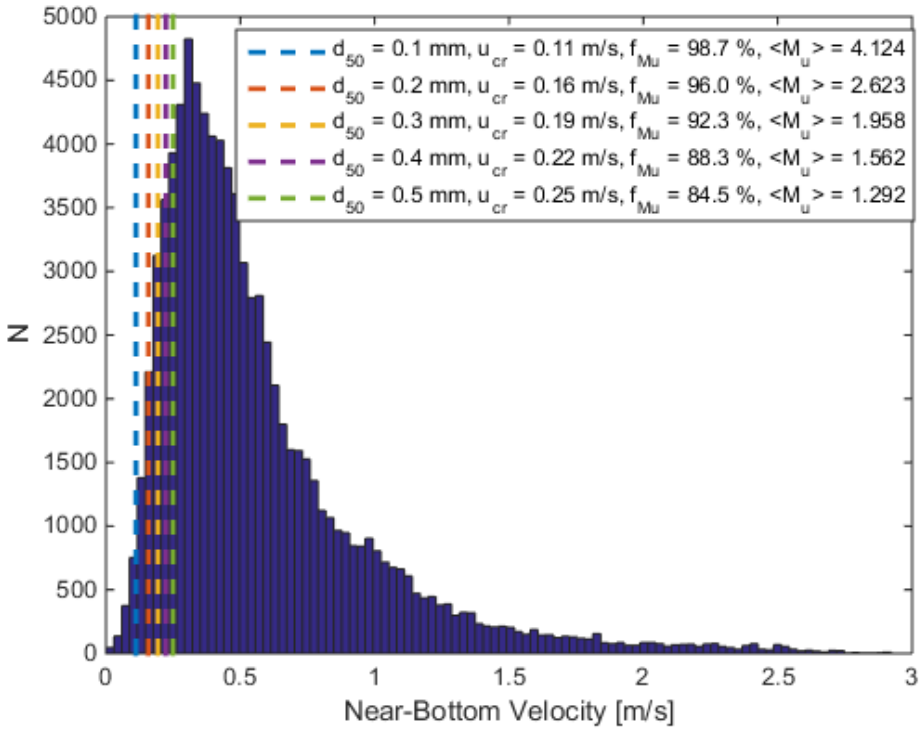
Site 1: Duck, NC

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



Site 1: Duck, NC

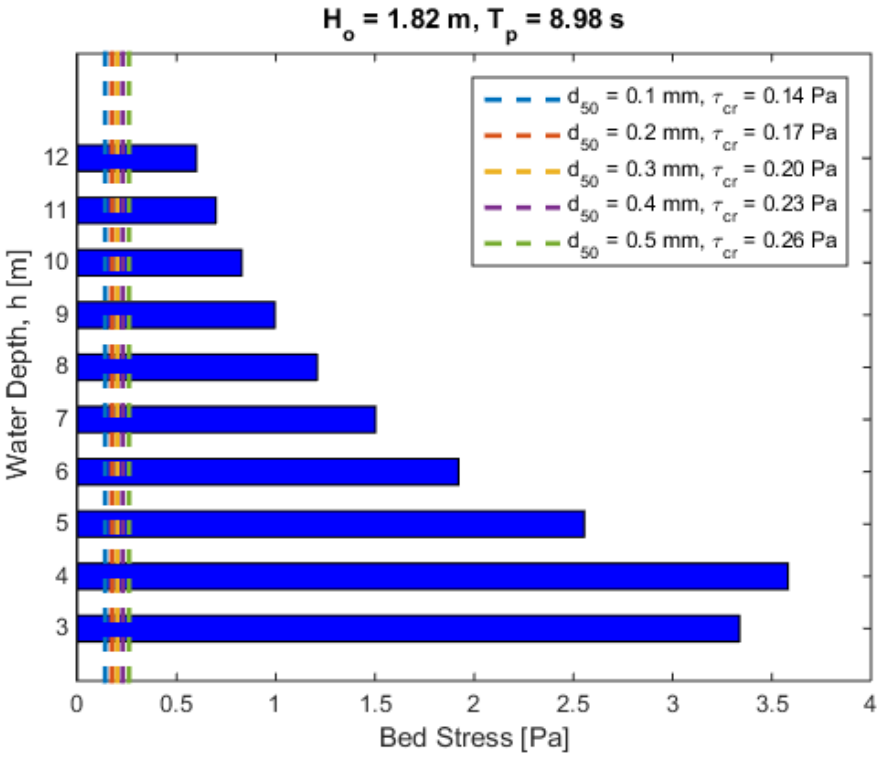


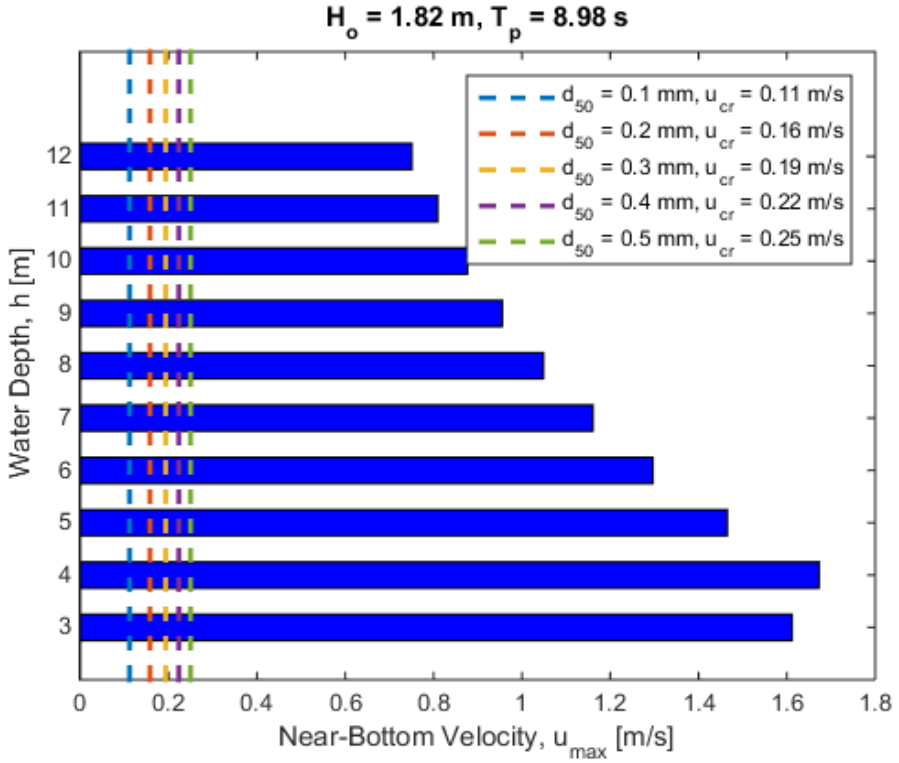


$$M = \overline{\left(\frac{\tau_{max} - \tau_{cr}}{\tau_{cr}}\right)}$$

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

Site 1: Duck, NC

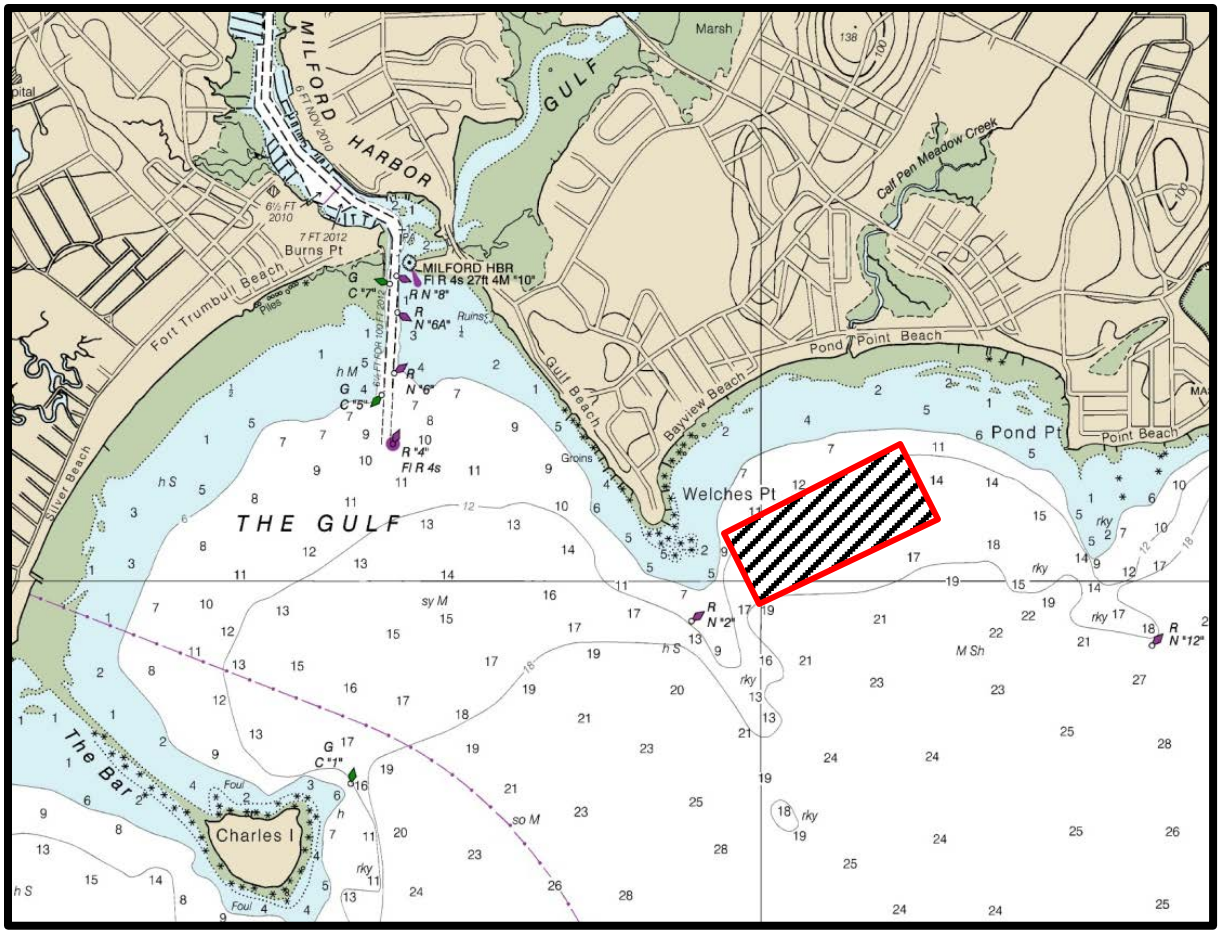




Significant Wave Height and Period

Site 2: Milford, CT

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



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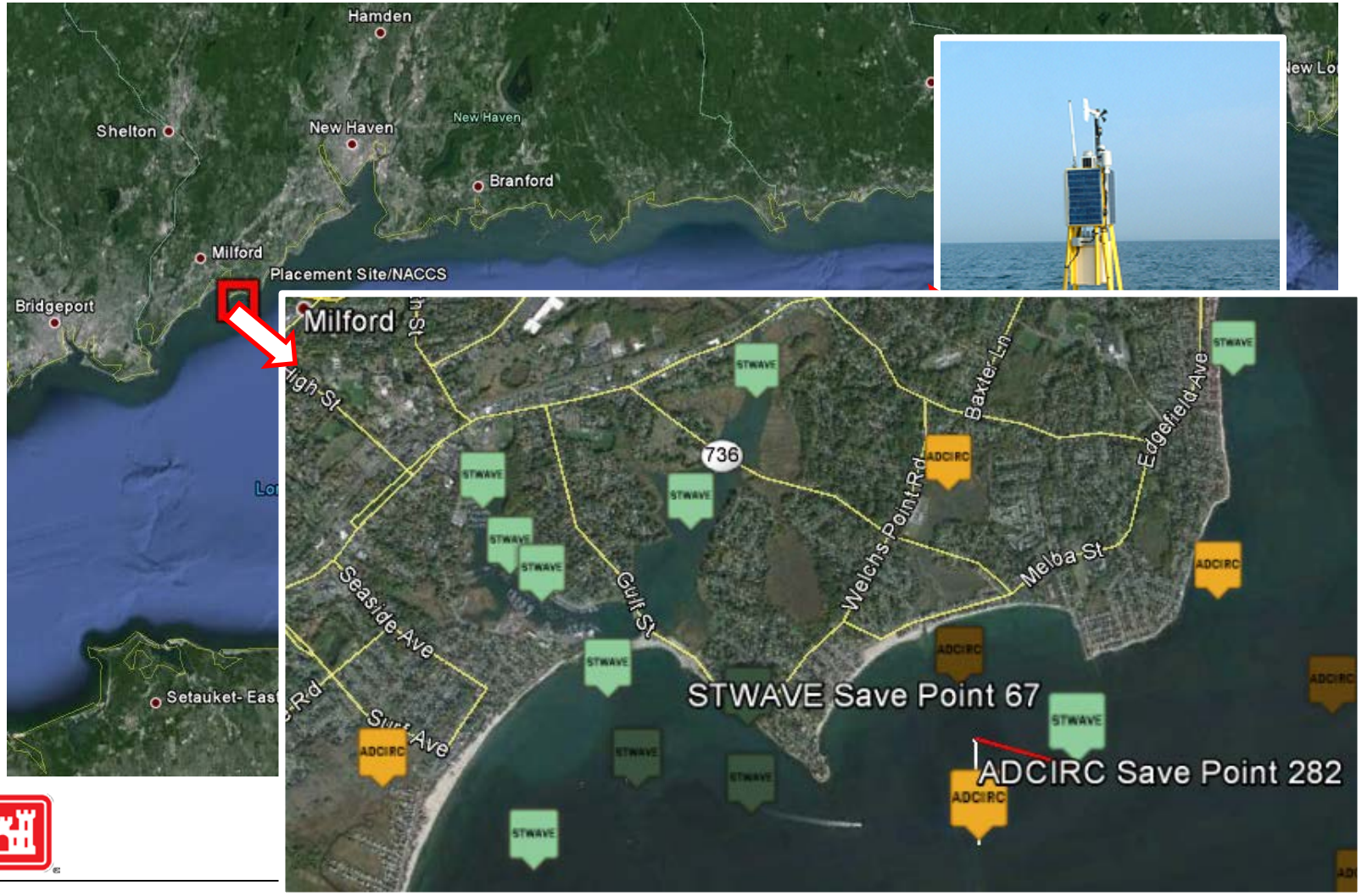
Wave & Current Info



Sed. Mobility

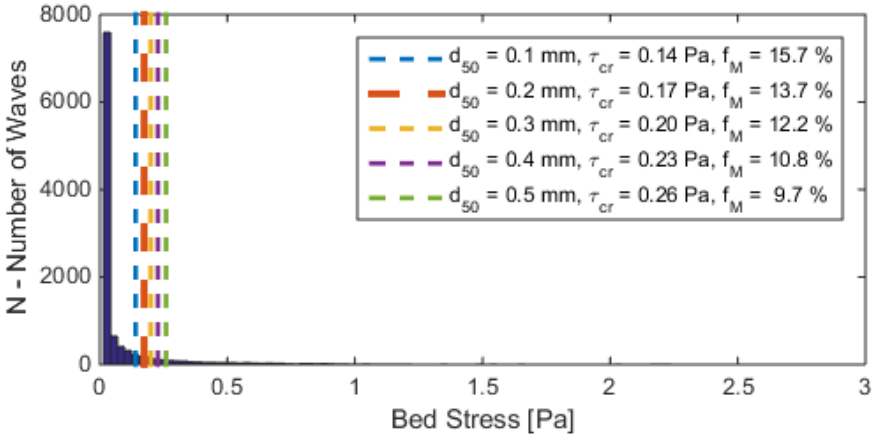
$d_{50} = 0.21mm$

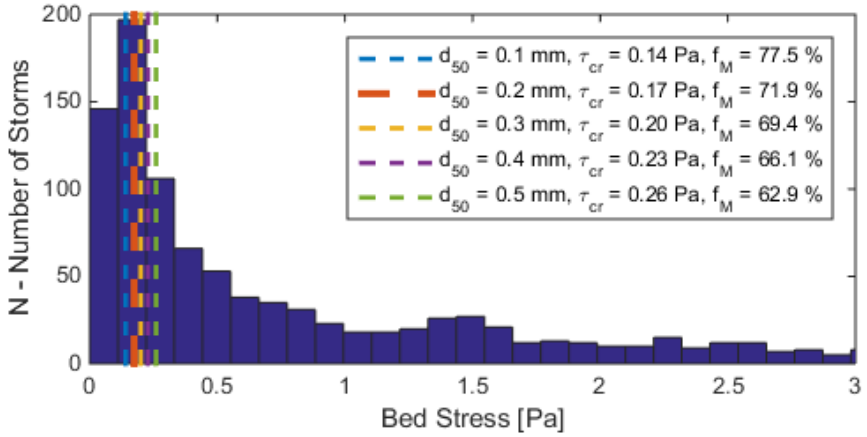
Typical Waves:

$f_M = 13.6\%$

Storm Waves:

$f_M = 71.4\%$





Sed. Migration Direction

- Dean's Number

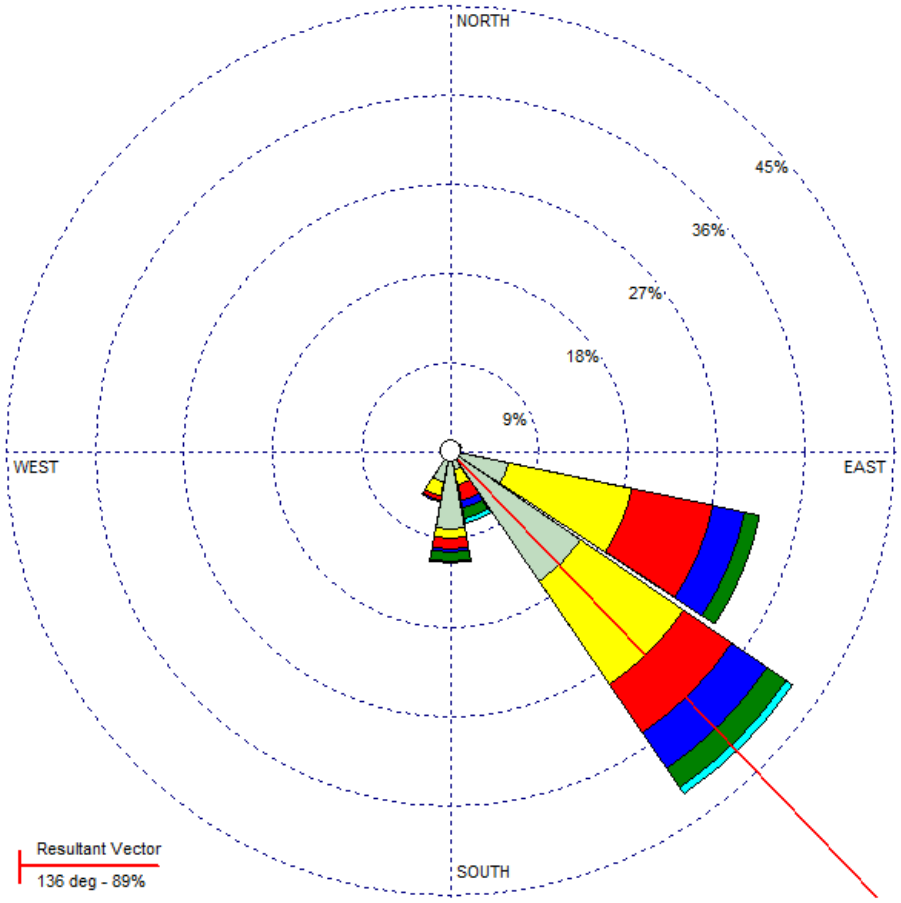
$$D = \frac{H_0}{\omega T}$$

> 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

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How Can I Use It?

- Currently:
  - ► Matlab Script
  - ► Run the Tool & Letter Report
    - Contract with ERDC ($10k)
    - DOTS Request (http://el.erdc.usace.army.mil/dots/)

- Future:
  - ► Working with OPJ to create a webtool

Summary

- What is it?
  - ► Tool Predicts:
    - Frequency of mobility
    - On/Offshore migration direction
    - Axis of wave dominated transport
- Why is it helpful?
  - ► Answers:
    - Will the Sediment Move?
    - Where Is the Sediment Likely To Go?

Summary

- How does it work?
  - ► Linear and Nonlinear Wave Theories
  - ► Critical Dean Number *(Larson & Kraus, 1992)*
- How can I use it?
  - ► Run Tool & Letter Report
    - Contract with ERDC
    - DOTS Request (http://el.erdc.usace.army.mil/dots/)
  - ► Future: Webtool

Conclusion

Powerful preliminary tool to make educated decisions with little data.

Thank you!

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