Oregon Regional Sediment Model

Port Orford, Oregon

Jarod Norton
MCR/RSM Project Manager
Kate Groth
Coastal Project Manager

Special thanks to:

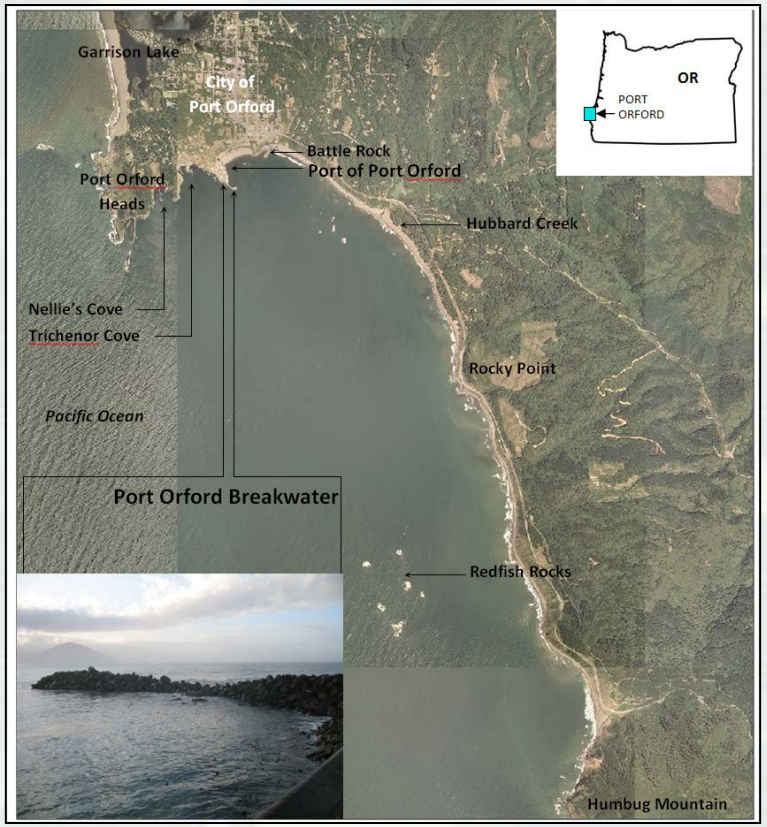
Rod Moritz, Coastal Engineer/Technical Manager
Honghai Li, ERDC
Tahirih Lackey, ERDC

June 18, 2015

US Army Corps of Engineers
BUILDING STRONG®

Port of Port Orford

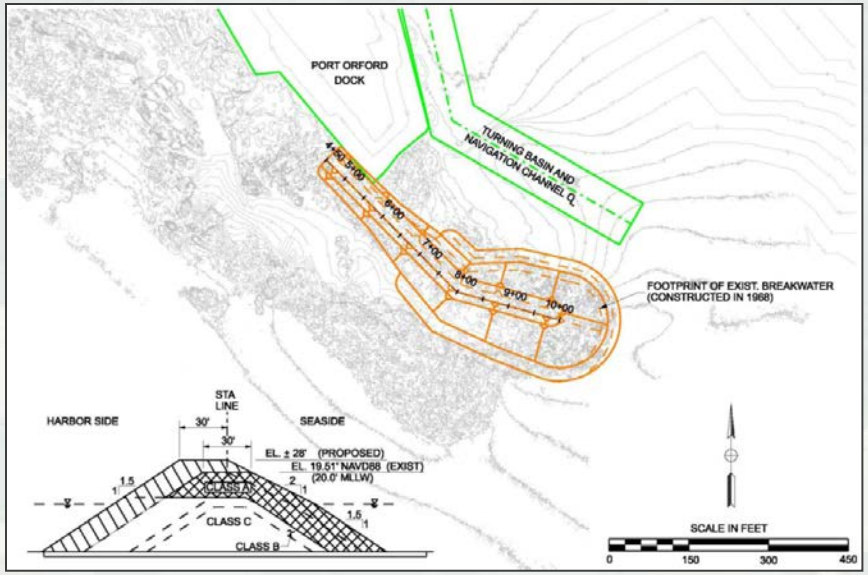
- Unique dolly dock –hoist vessels in and out of water onto dock.
- 1969 constructed 550’ breakwater extension to provide wave protection for deepwater dock; 1970 shoaling began and Corps authorized to conduct maintenance dredging.
- Breakwater has sustained a mid-section breach, ~1/2 length is damaged, unraveling.
- 2011 conducted a major maintenance report (MMR)



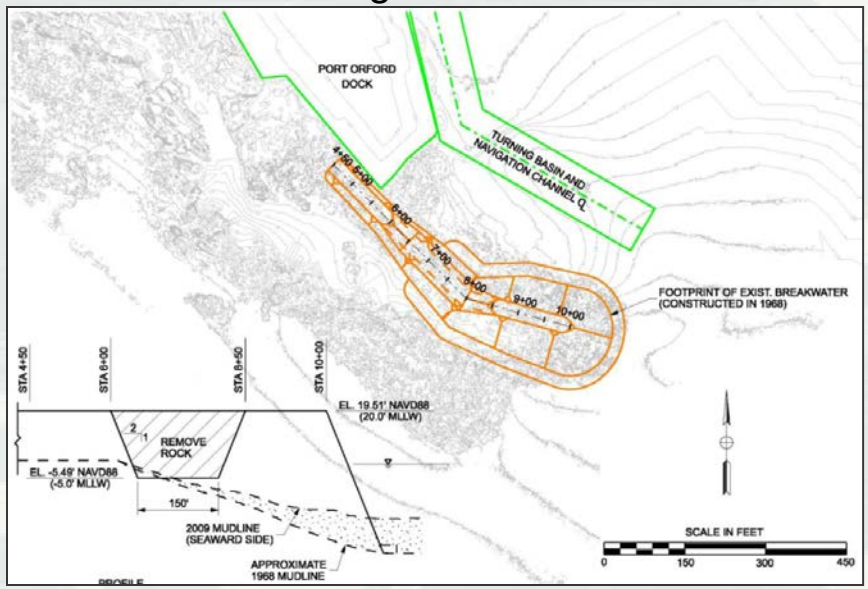
PORTLAND DISTRICT
BUILDING STRONG®

Major Maintenance Report

- Cross – Sectional Modification
- Recommended Alternative
- Wave heights 53% of pre-project condition
- No reduction in dredging need
- In RSM considered modified BW



- Mid-Section Modification
- Least cost alternative (life-cycle)
- Increased wave heights 45% relative to existing condition
- Re-directed wave-induced transport away from wharf face = potential for reduced shoaling.



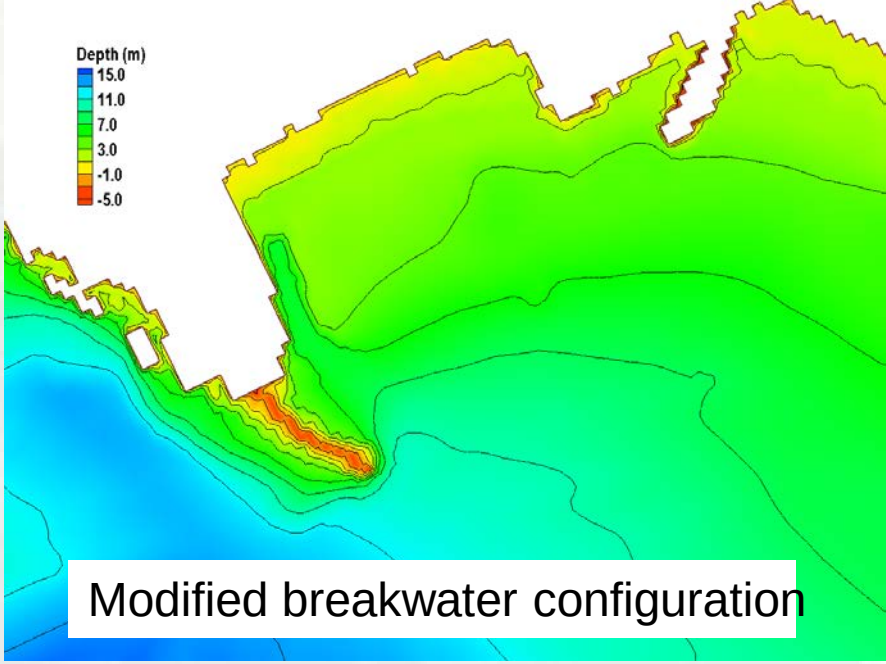
Regional Sediment Model Objectives

- Reduce risk associated with notch alternative
- Determine sources of sediment responsible for channel infilling
- Define littoral sediment transport pathways that affect shoaling
- Determine if opportunity to alter breakwater to reduce long term dredging need. May meet customer needs with initial upfront costs, but save on life cycle costs of dredging.

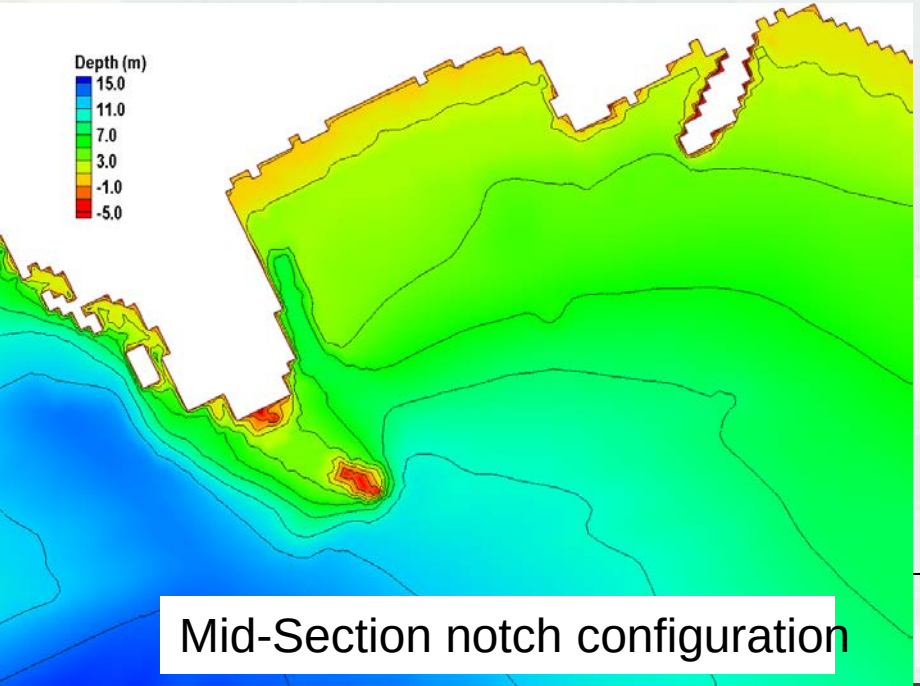
RSM Approach

- Reduce Risk by further modeling of 3 alternatives: Modified Breakwater, Mid-section Notch, and removal of Breakwater in both Summer and winter conditions
- Conform MIKE 21 data to CMS model framework
- Apply CMS and Bouss-2D models
- Set-up PTM model for Port Orford using CMS forcing data
- Apply PTM mode to forecast shoaling pathways -Present Condition (Modified Breakwater), Alternative Condition 1 (mid-section notch breakwater), and Alternative Condition 2 (removed breakwater)
- Forecast shoaling for 3 alternatives under 2 seasonal conditions

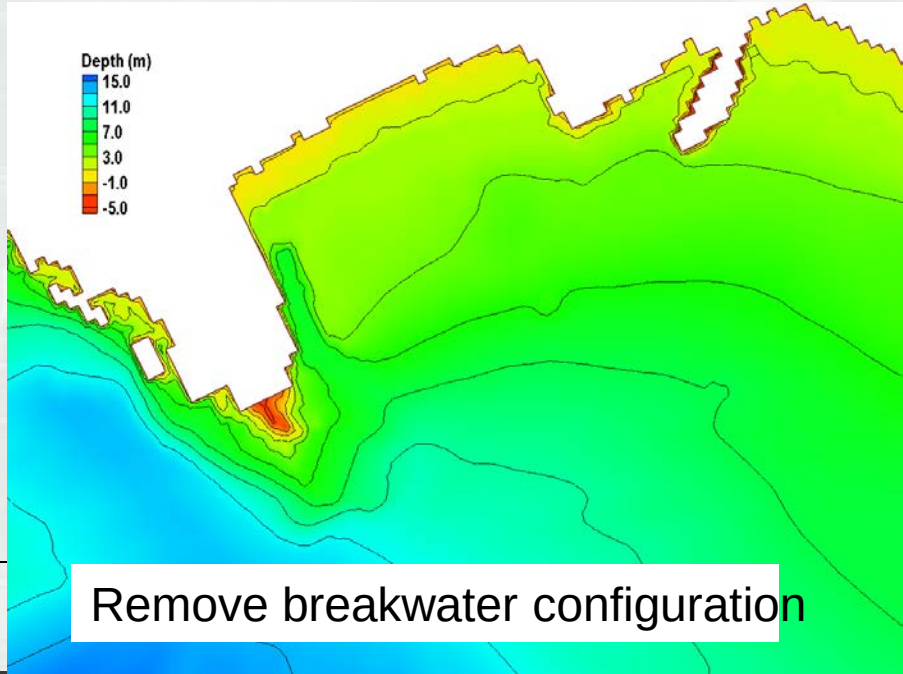
Configurations



Modified breakwater configuration



Mid-Section notch configuration



Remove breakwater configuration

Sediment Transport Method:

Particle Tracking Model (PTM)

PTM is a Lagrangian particle tracker that models transport processes (advection, diffusion, deposition, etc) for representative parcels to determine constituent (sediment, contaminants, biologicals, etc) fate.

Probability of Entrainment

- For sand class sediment size, transport in Port Orford should primarily be bedload transport. The ability of PTM to model bedload transport is limited.
- PTM calculates a probability of entrainment based on critical shear stress, wave bed shear stress, current bed shear stress, etc. In wave dominated environments, the model may over predict sediment movement.
- To address this issue within the scope of this work, a range of particle entrainment values were considered: 10%-100% of the calculated value. The 10% value comes from multiple model runs and collaboration with additional ERDC researchers .

PTM Simulation Details

- Two Hydrodynamic Periods
  - ► November/December (40 days)
  - ► June (29 days)
- Three Configurations
  - ► Midway Notch
  - ► Modified Breakwater
  - ► Remove Breakwater

- Probability of Entrainment (10%-100%)

Source Locations

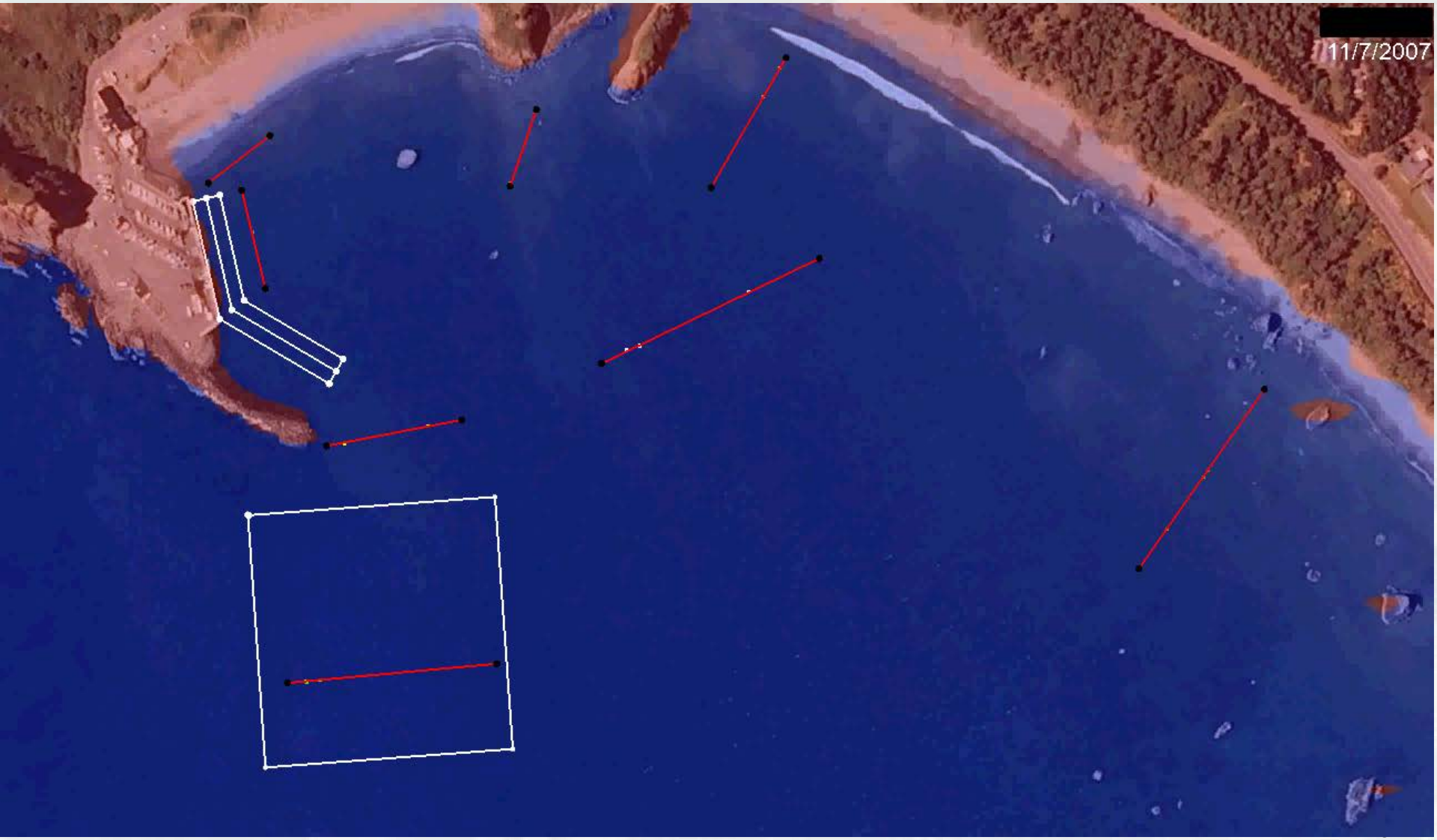
- Sediment sources locations were determined through consultation by:
  - ERDC Team
  - Portland District
  - Port of Port Orford
- Sources are erosion sources (particles are initially at the bed)

Analysis Traps

- A series of traps were developed for analysis purposes.
- Trap height is approximately half the depth.
- Traps are designed as closed traps (when a particle enters trap, it is counted and transport calculations for the particle ceases)

Results

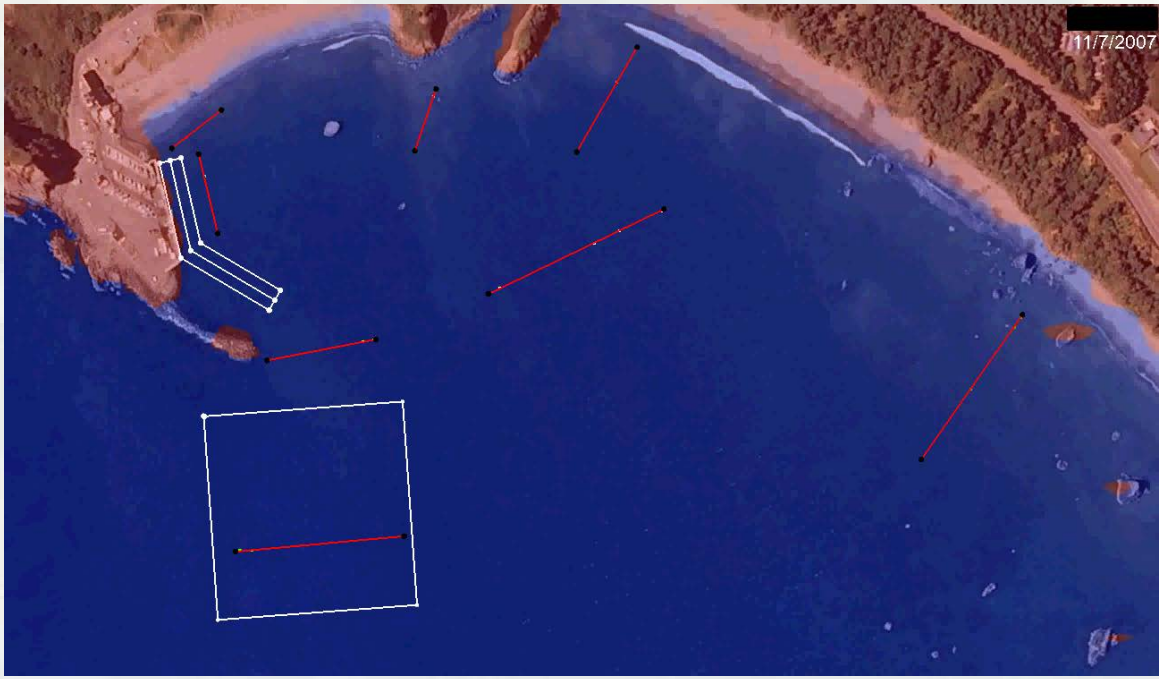
Sediment Transport Animation
Modified Breakwater, Nov/Dec 2007
(particles are color coded based on initial position)



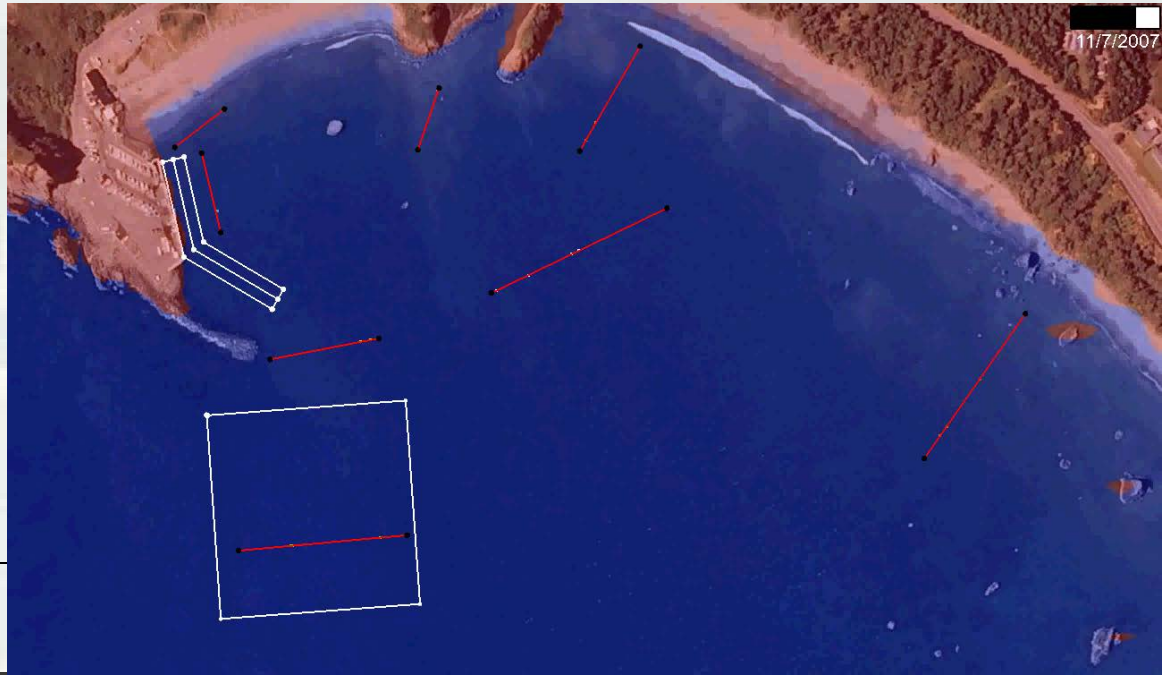
Comparison: Mid-Notch and Breakwater Removal Alternatives

Nov/Dec Hydrodynamics,
100% Entrainment Probability

Mid-Notch Configuration



Breakwater Removal Configuration

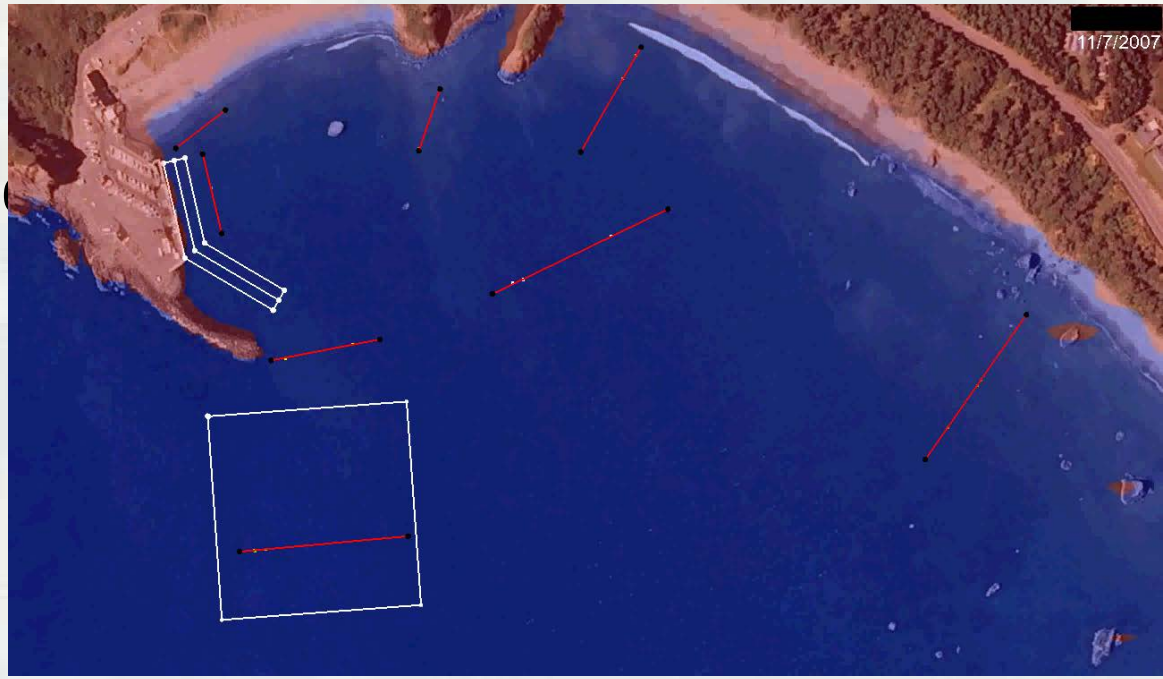


U.S.ARMY

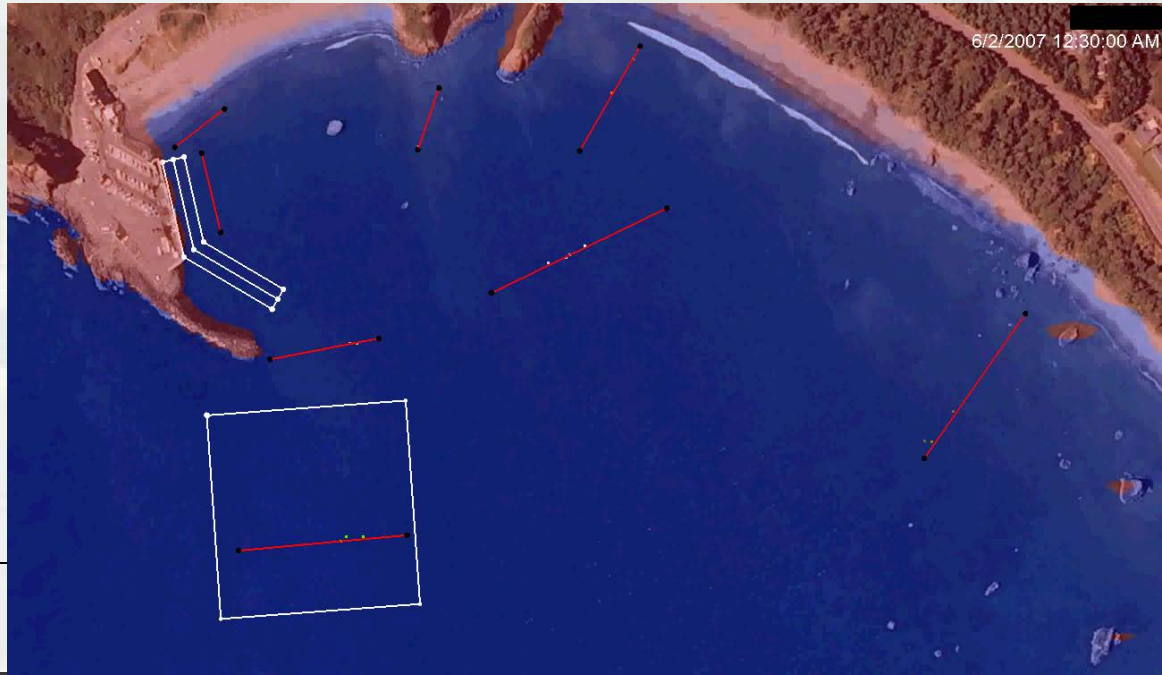
Comparison:
Hydrodynamic Time Perio

Modified Configuration
100% Entrainment Probability

Nov/Dec



June

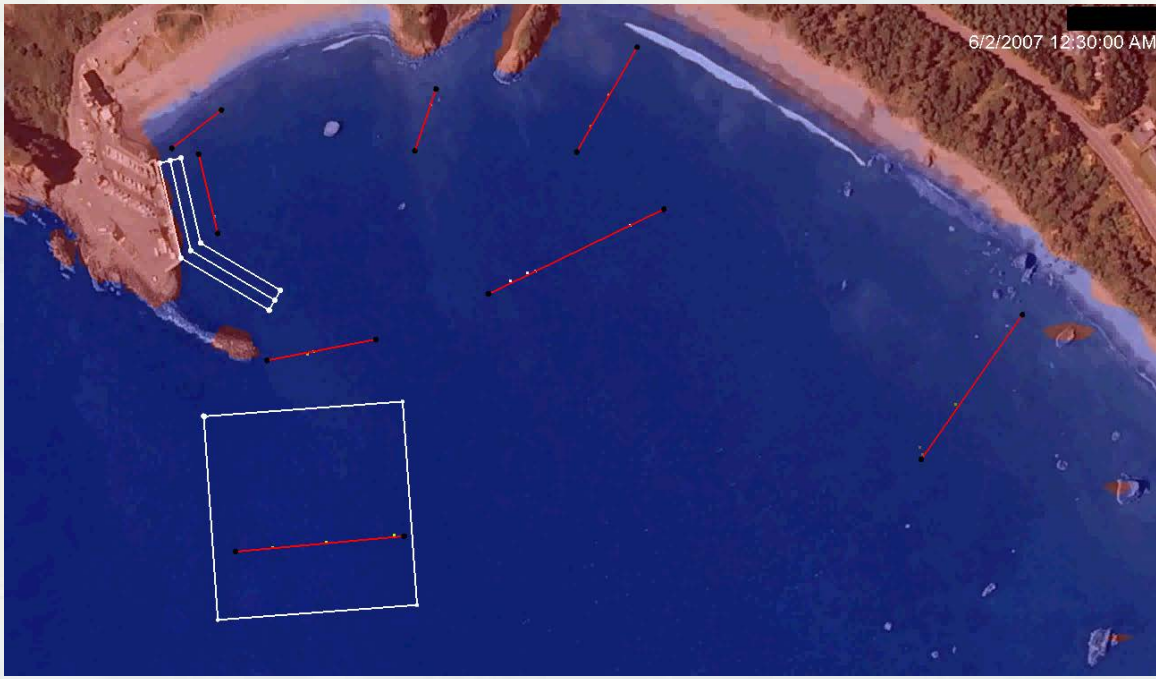


U.S.ARMY

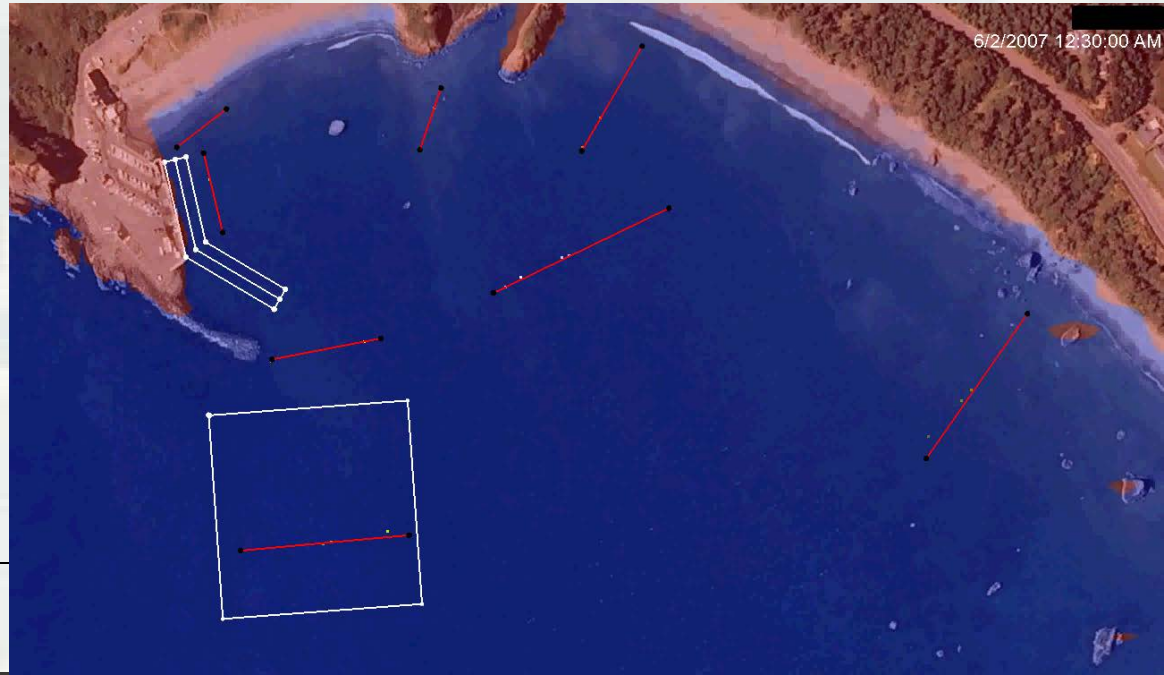
Comparison: Breakwater Configuration

June Hydrodynamic Period
100% Entrainment Probability

Mid-Notch Configuration



Breakwater Removal Configuration

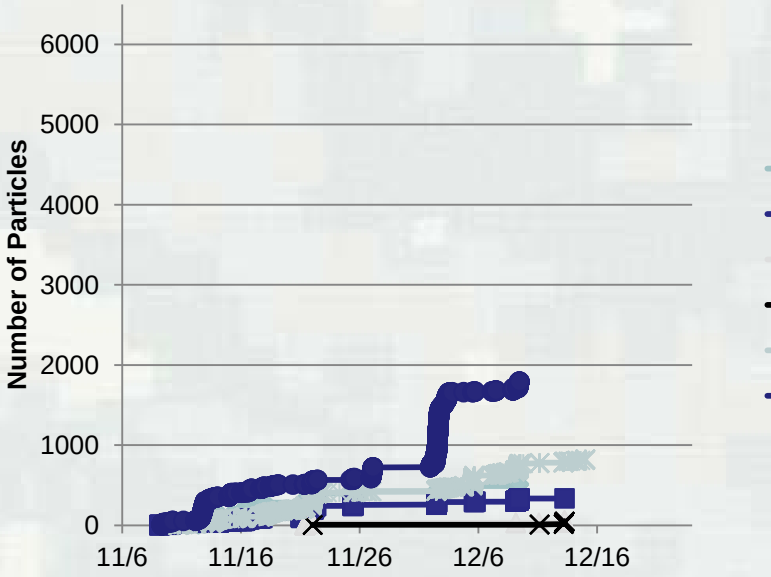


U.S.ARMY

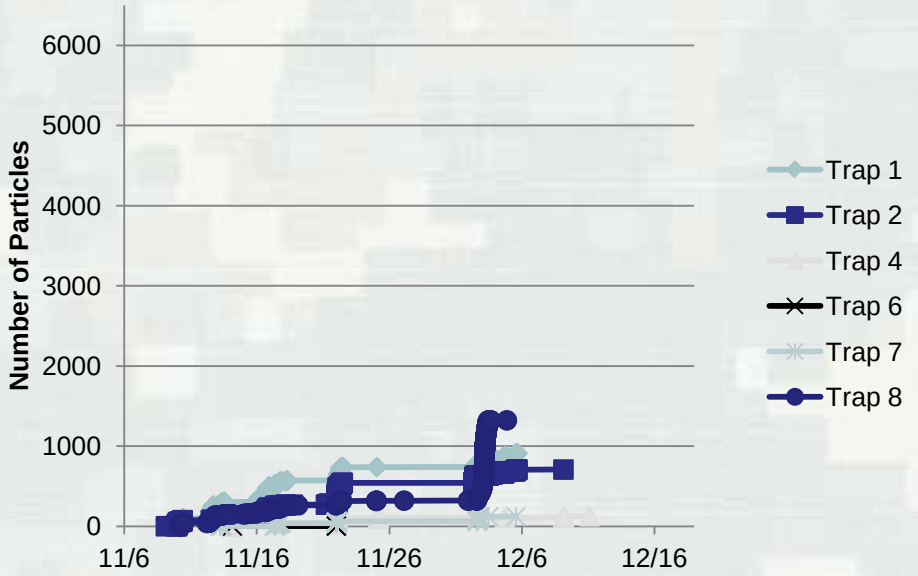
Analysis

Comparison (Nov/Dec) 100%

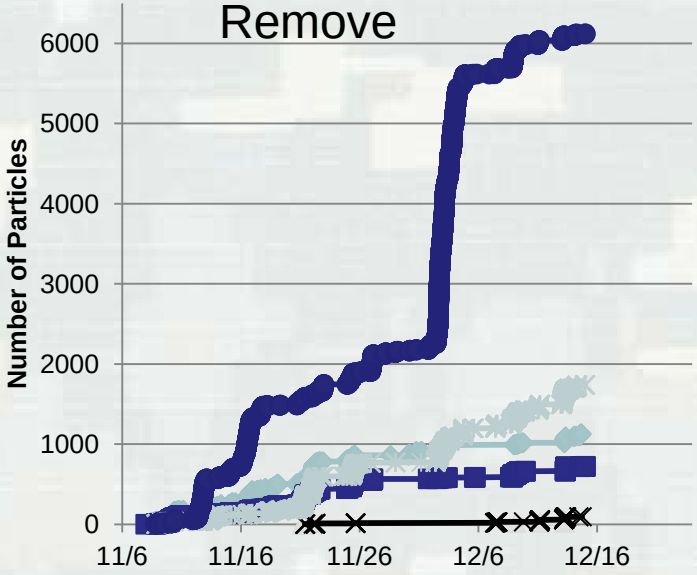
Mid-Notch

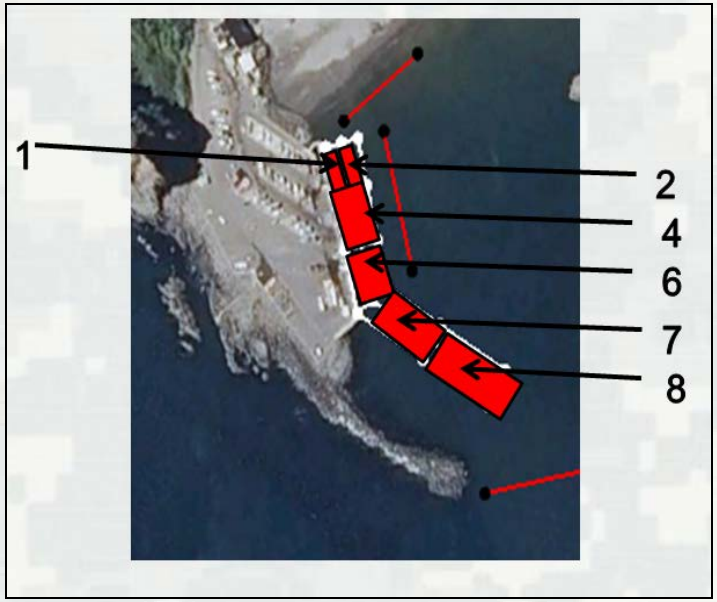


Modified Breakwater

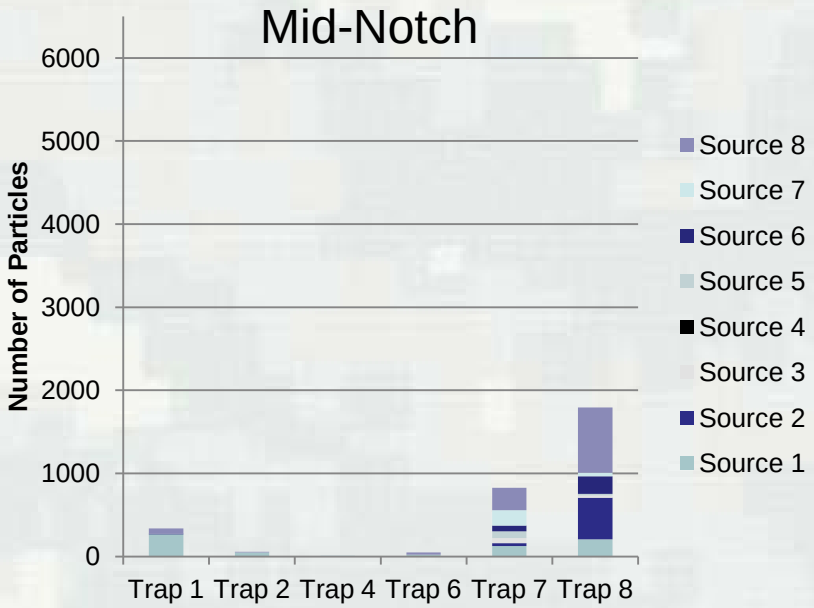


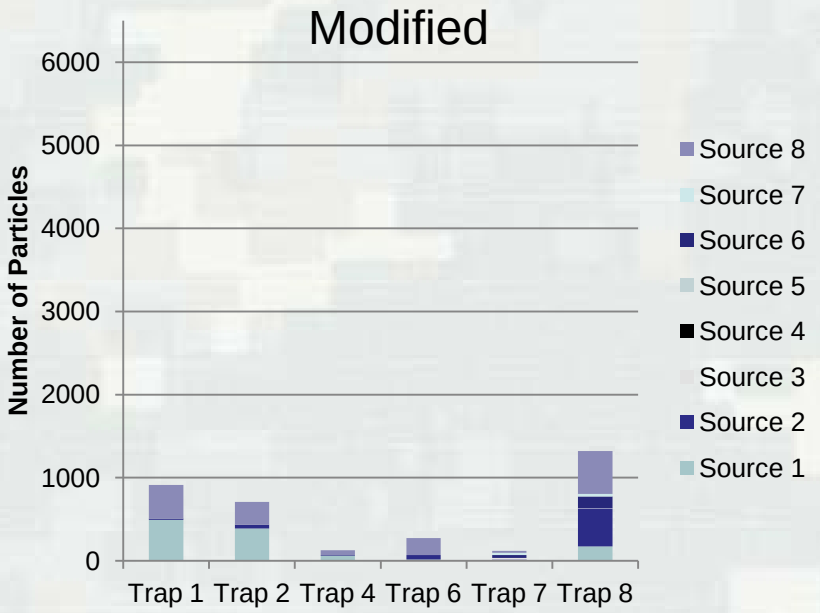
Remove

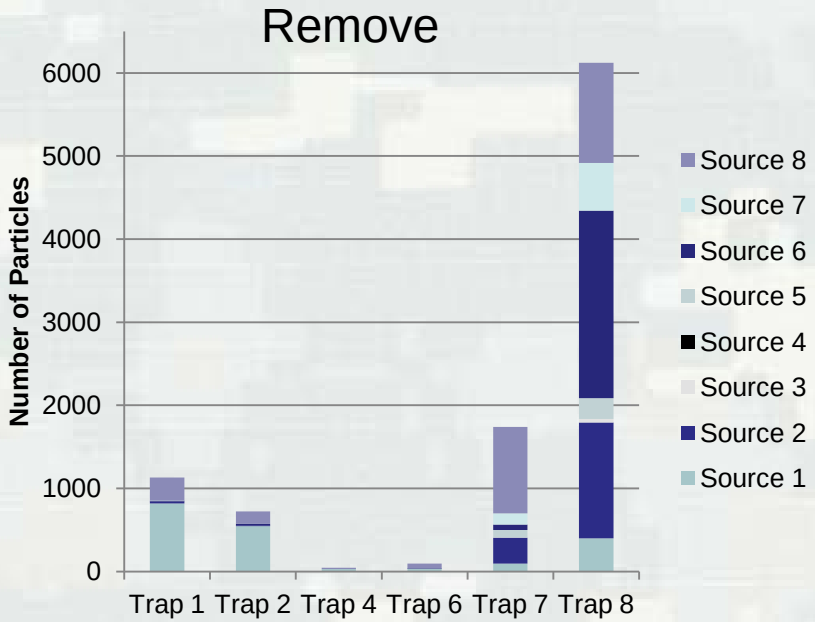


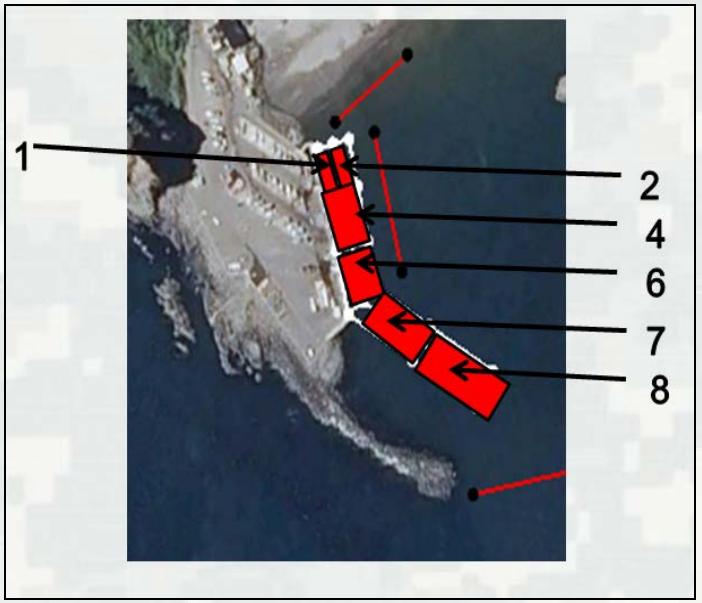


Comparison (Nov/Dec) 100%

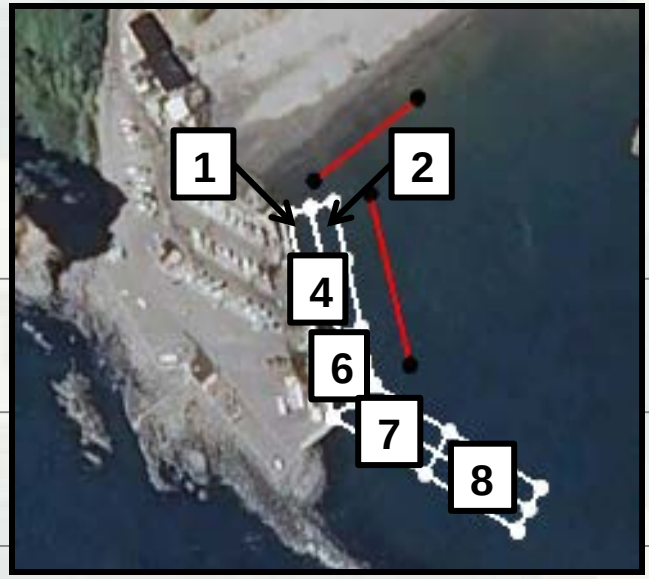




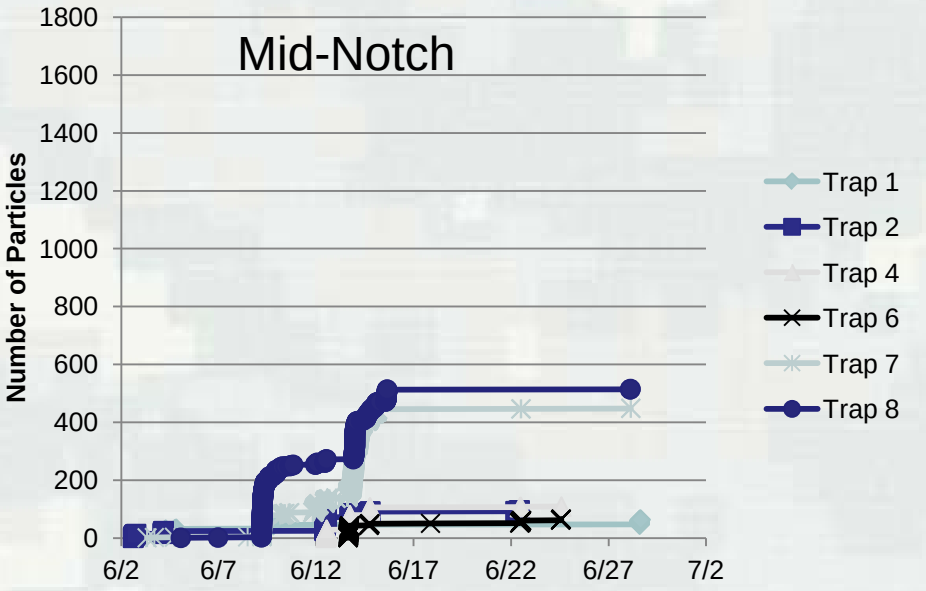


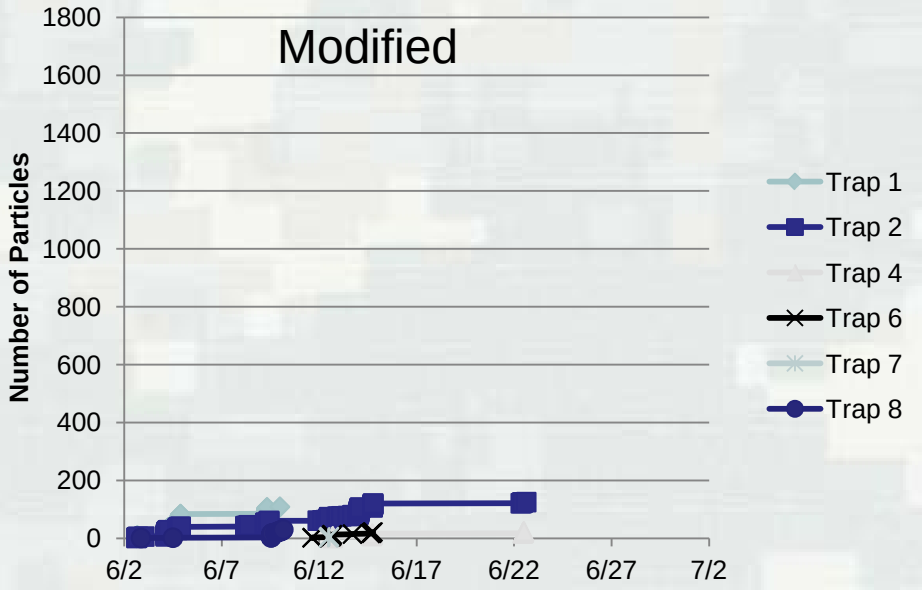


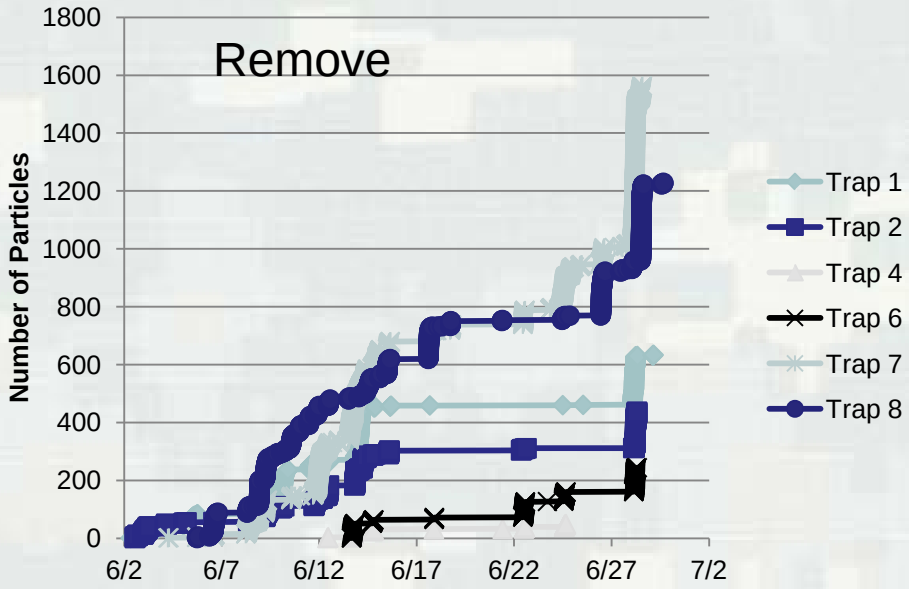
Breakwater Configuration Comparison of Channel Infill (Nov/Dec)

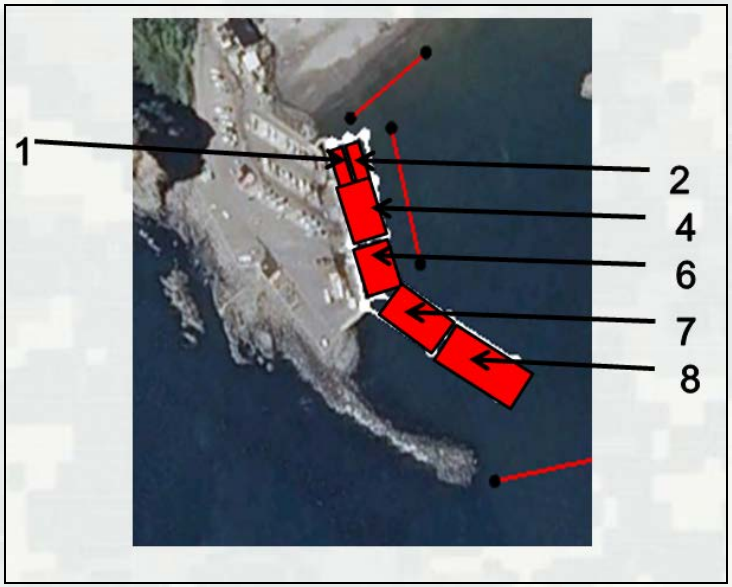


Comparison (June) 100%

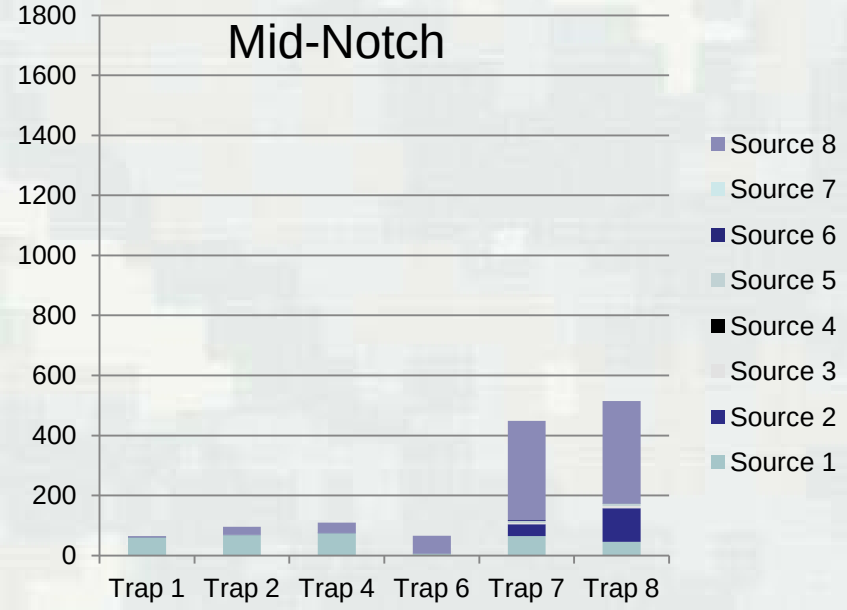


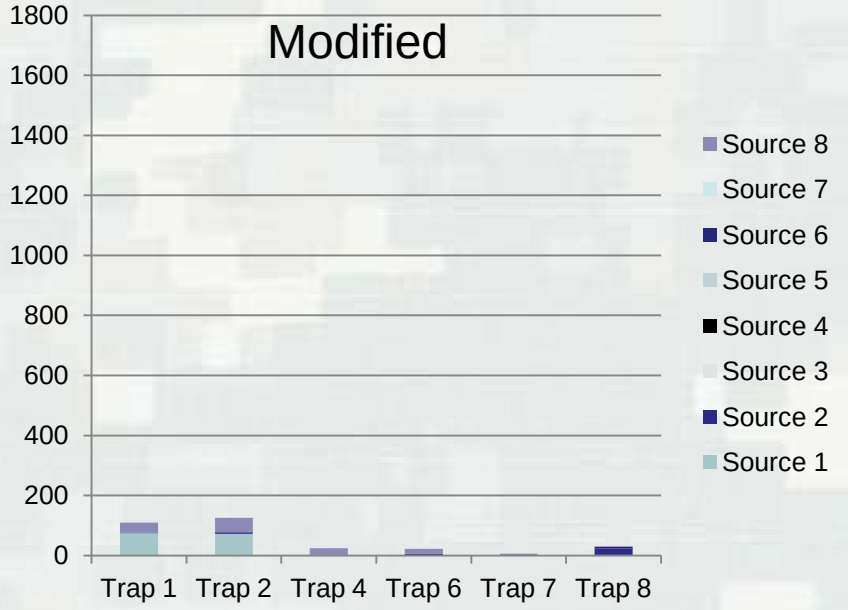


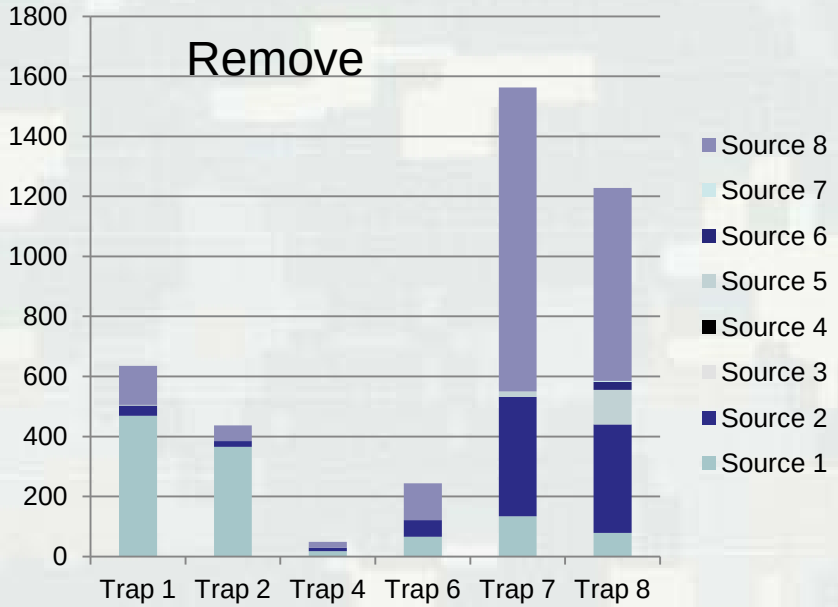


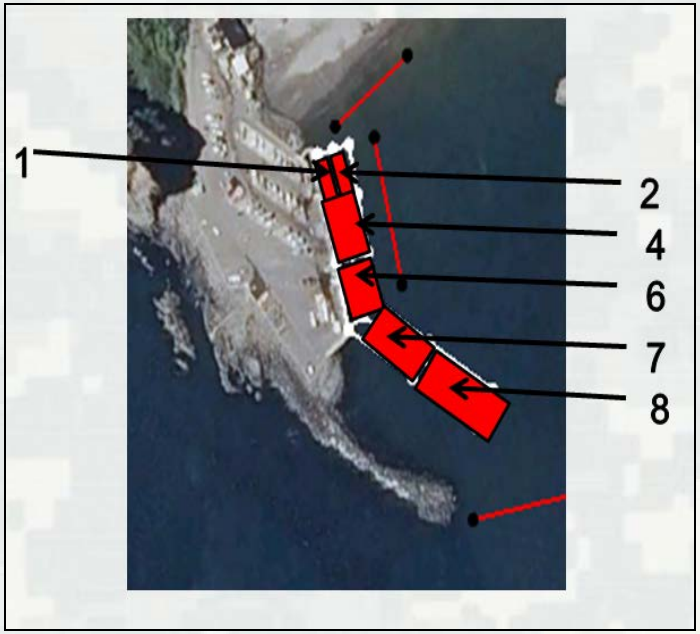


Comparison (June) 100%

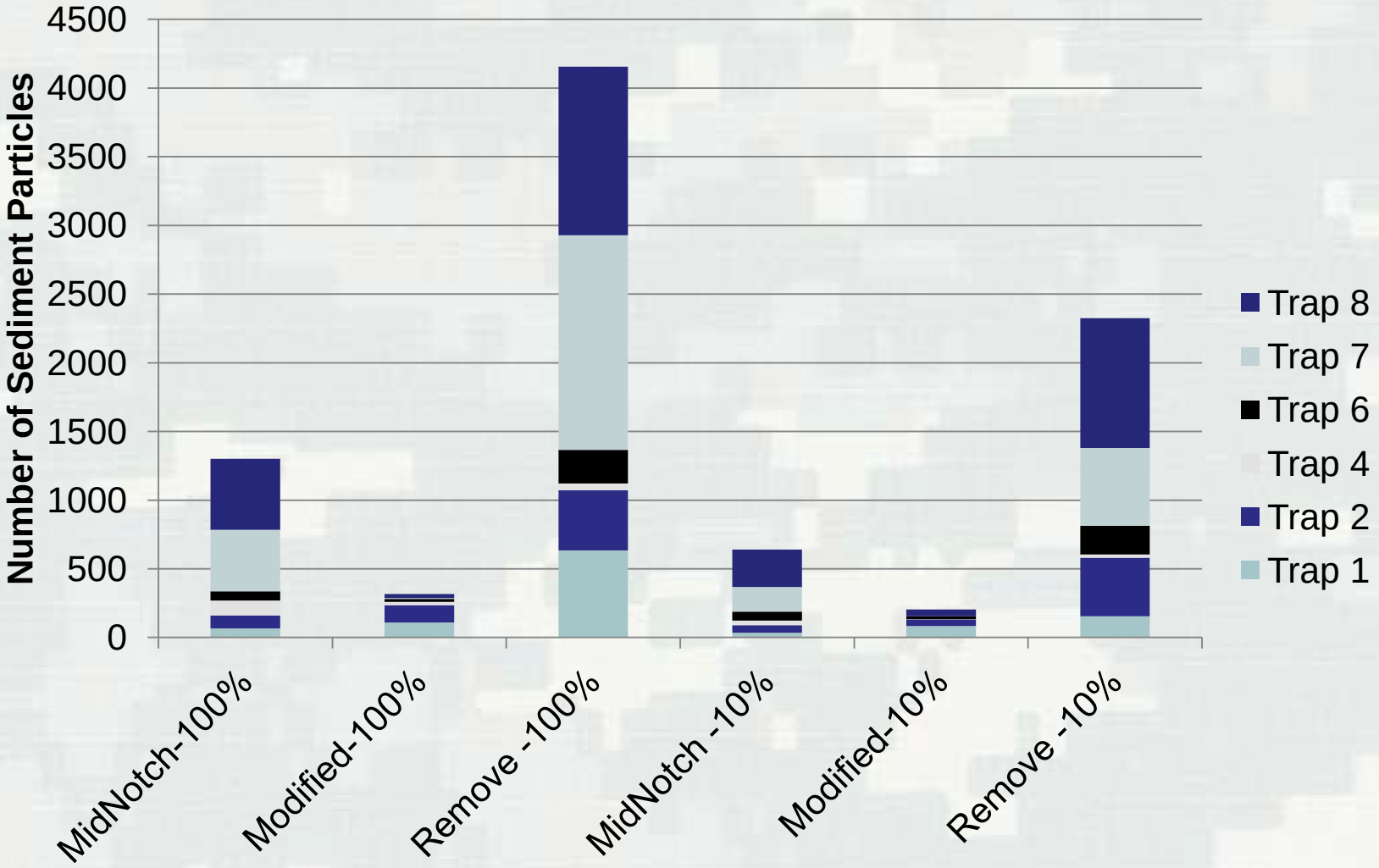








Breakwater Configuration Comparison of Channel Infill (June)



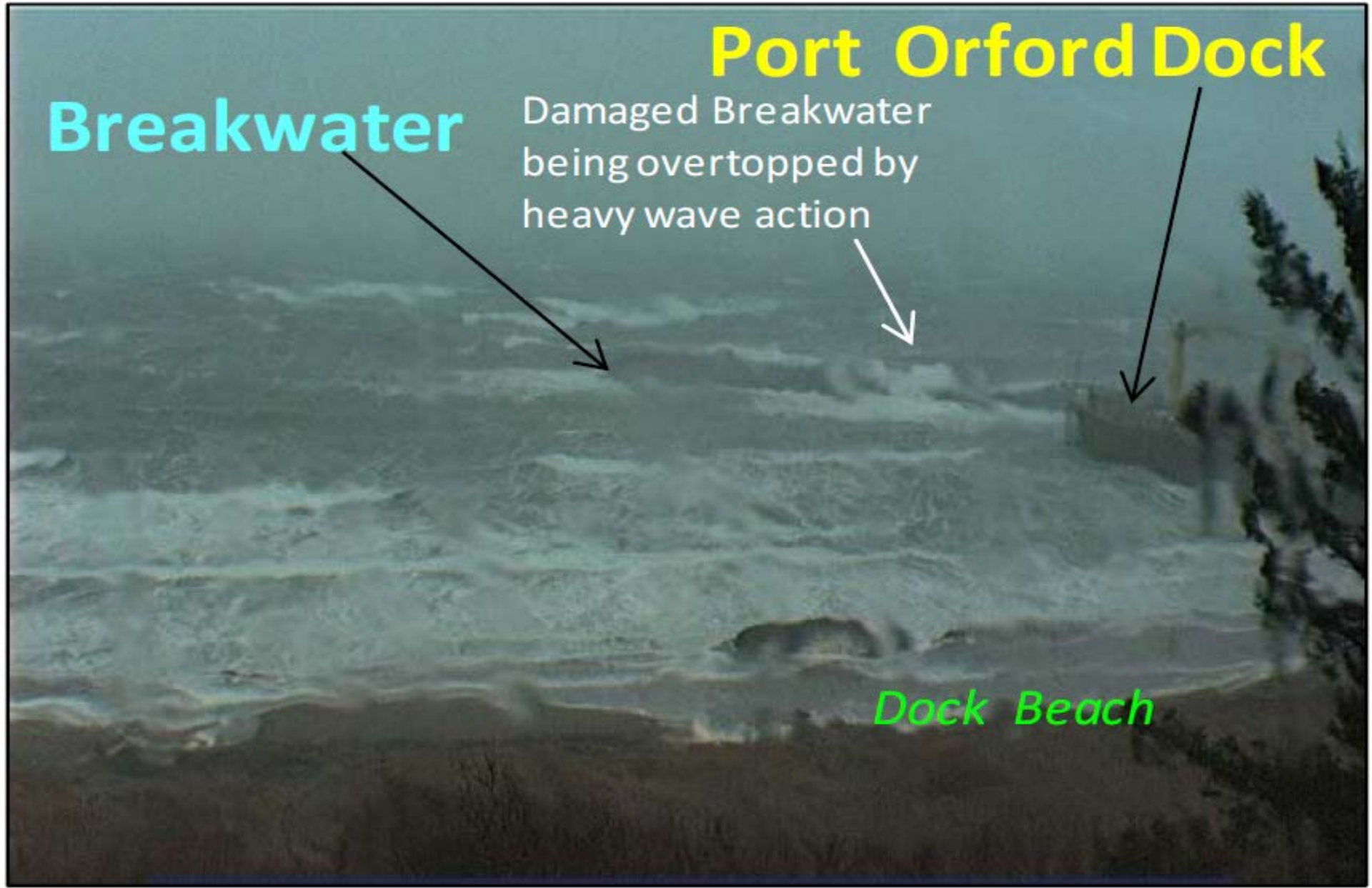
Observations

- Configuration comparisons show that the removal of the breakwater leads to more efficient sediment pathways to the channel
- Sediment from the placement site source has no pathway to the channel for the hydrodynamic periods modeled. It appears, based on trends from neighboring sources, material from the closest edge of the placement site would not contribute to channel infilling.
- The Fall (Nov/Dec) period appears to have greater transport of sediment, especially during the storm period
- The modified breakwater configuration has the least predicted sediment pathways to the channel

Lessons Learned

- Overall results show trends which can be utilized to understand the system. Bracketing of the probability of entrainment is a good technique for systems such as this where parameterization must occur yet data is insufficient.
- Risk of additional shoaling with no breakwater is greater than notched breakwater. Risk of shoaling with notched breakwater is greater than modified breakwater.
- District is moving forward with requesting funds to repair the breakwater with the modified option.

Questions?


Port Orford Dock
Breakwater
Damaged Breakwater being overtopped by heavy wave action
Dock Beach