

# Transport of horseshoe crab eggs and sediment on a sandy foreshore in Delaware Bay

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# Egg Exhumation

Horseshoe crab eggs are the primary source of energy to some migratory shorebirds



Eggs released from sand matrix by bioturbation or wave and swash processes

# Delivery to Shorebirds



Physical agents such as wave breaking and swash processes play a more important role in exhumation and delivery of eggs when crabs spawn in fewer numbers.

# Biogenic and Terrigenous Sediment

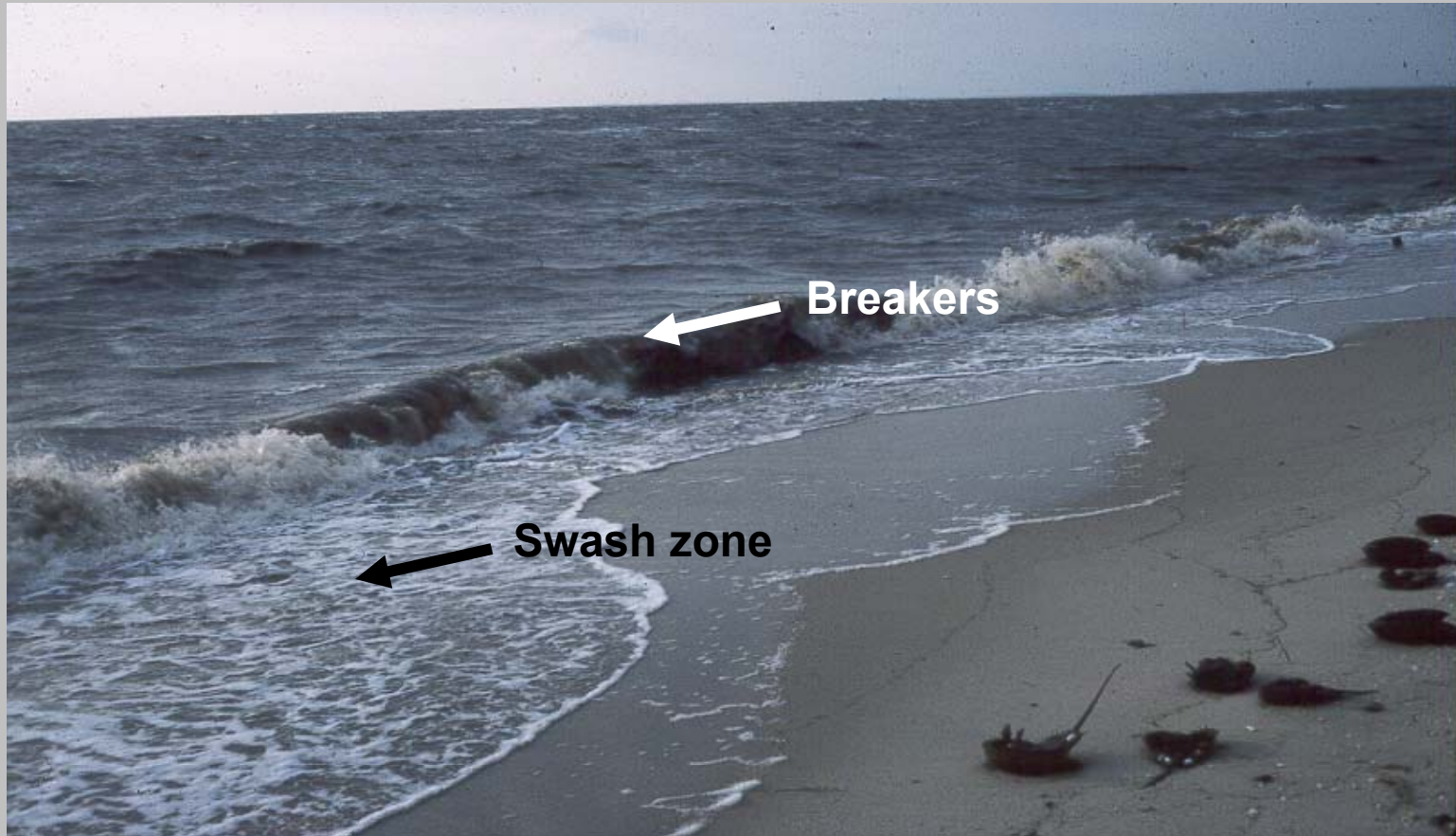


- **Passive, negatively buoyant particles**
- **Size varies from 1600 - 1800  $\mu\text{m}$**
- **3000- 4000 eggs per nest**
- **Density of eggs - 0.65 gm/ml**
- **Fall velocity of eggs - 0.21 cm s<sup>-1</sup>**



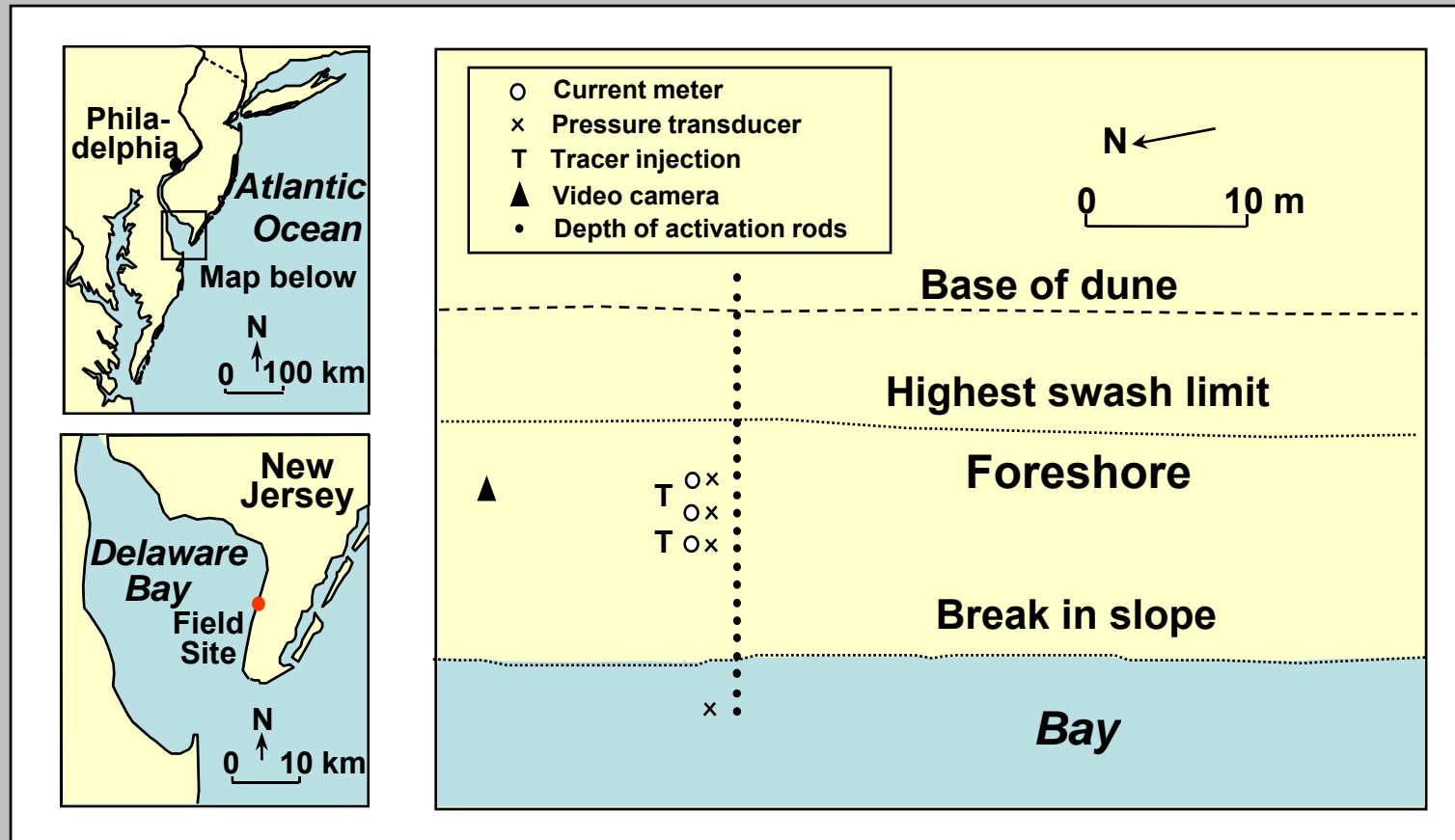
- **Predominantly medium to coarse sand  $\approx 480 - 700 \mu\text{m}$**
- **Small percentage of fine sands  $\approx 20\%$  on upper foreshore**
- **Density of quartz - 2.65 gm/cc**
- **Fall velocity of fine to very fine sand (0.25 - 0.19 cm s<sup>-1</sup>)**

# Purpose



How are horseshoe crab eggs and sediment transported in the swash zone?

# Study Area

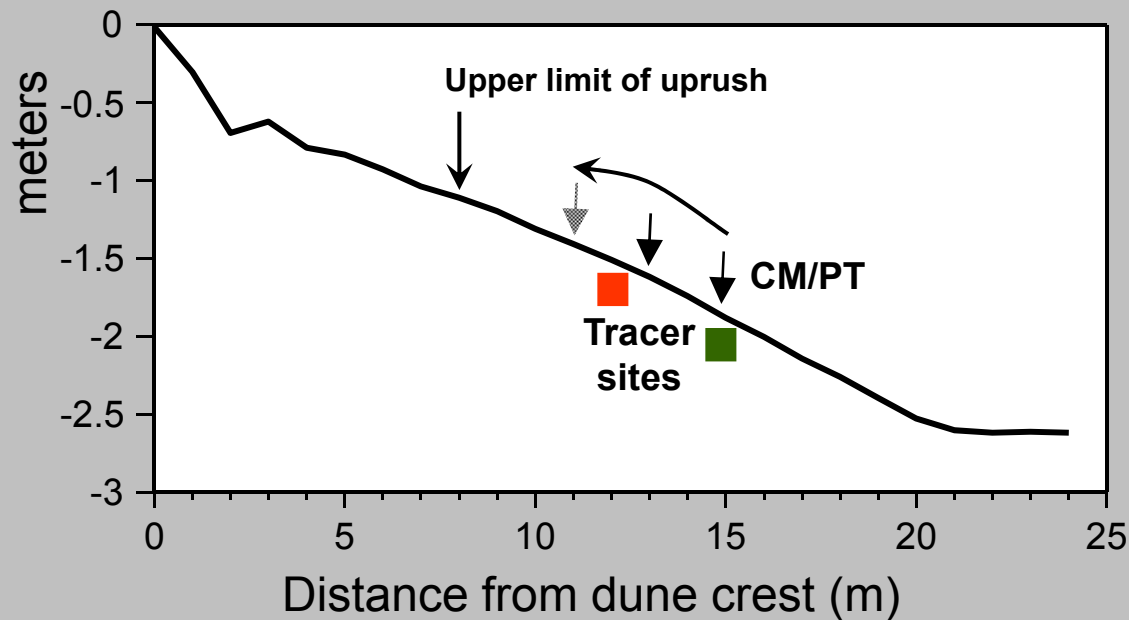


Measurements of waves, flow velocities, and exhumation and transport of eggs and terrigenous sediment via tracer over tidal cycle

# Tracer Deployment



- 9 kg sand tracer/site  
   $\approx$  400,000 eggs/site
- Lower - Green
- Upper - Red



- Two total load traps
- Trapping over one tide
- 110 swash cycles

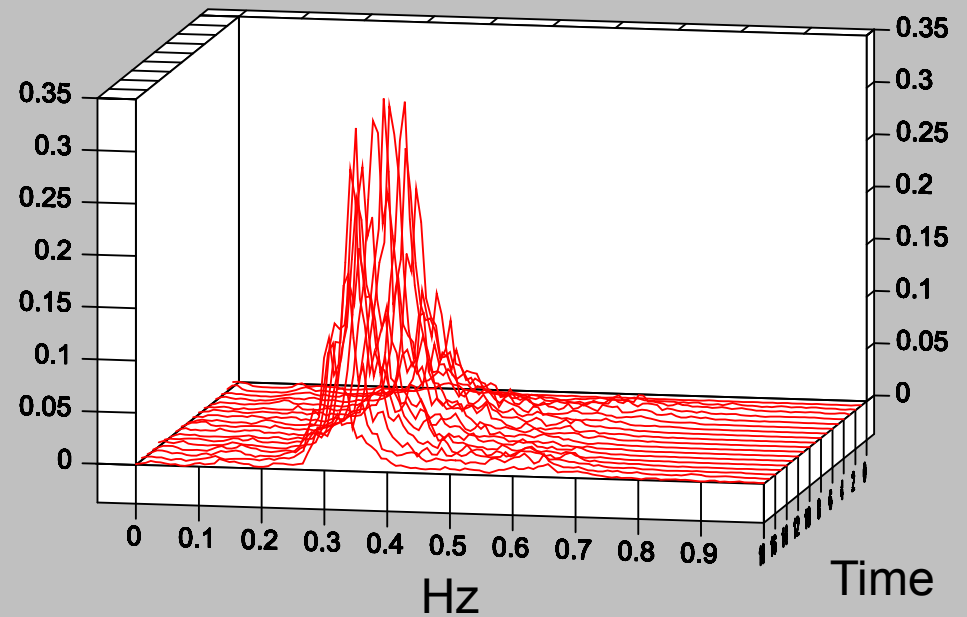
# Wave Characteristics



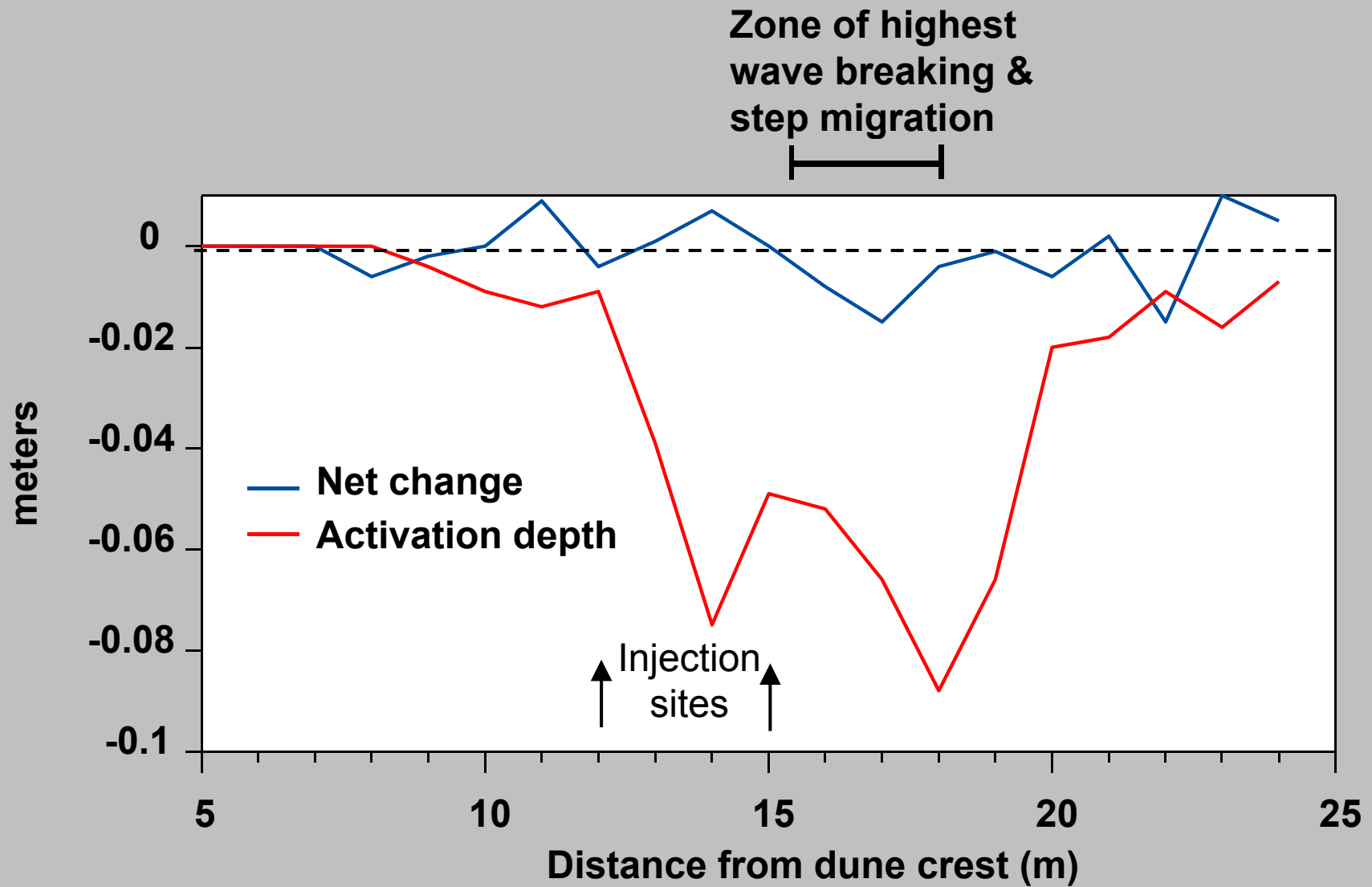
Winds nearly directly onshore  
Significant wave height 0.28 m  
Wave period 3.0 s

Wave energy over tidal cycle concentrated at the incident bay wave frequency for wind conditions

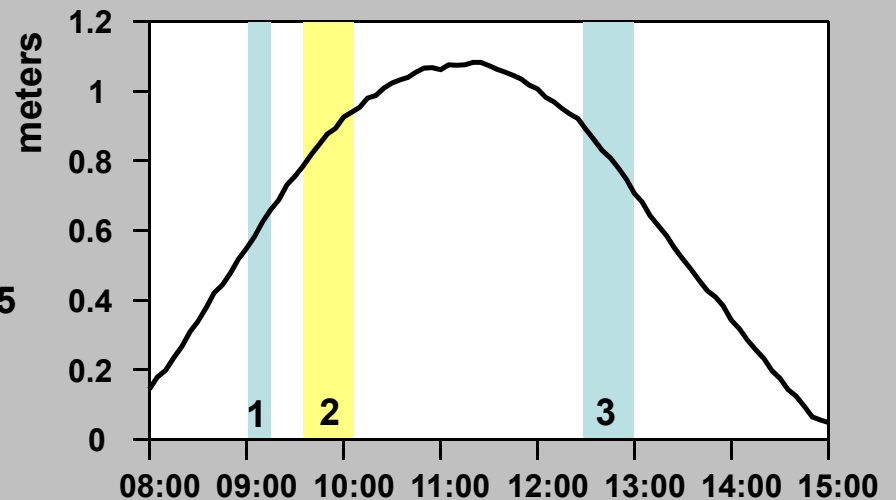
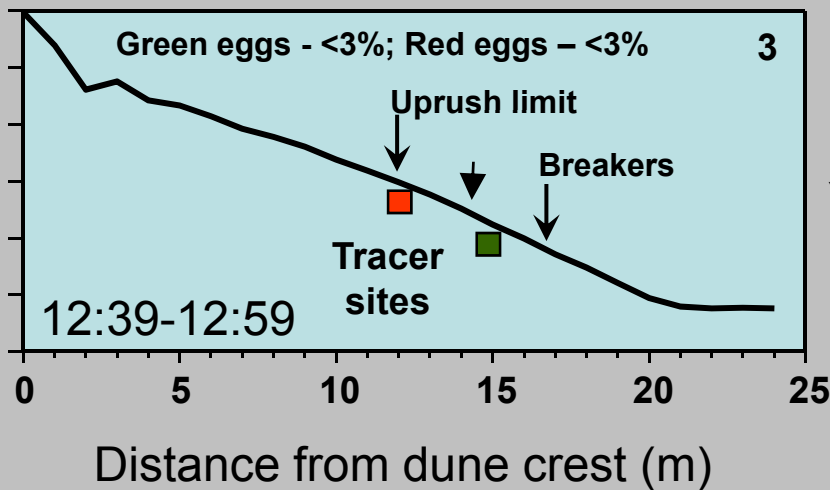
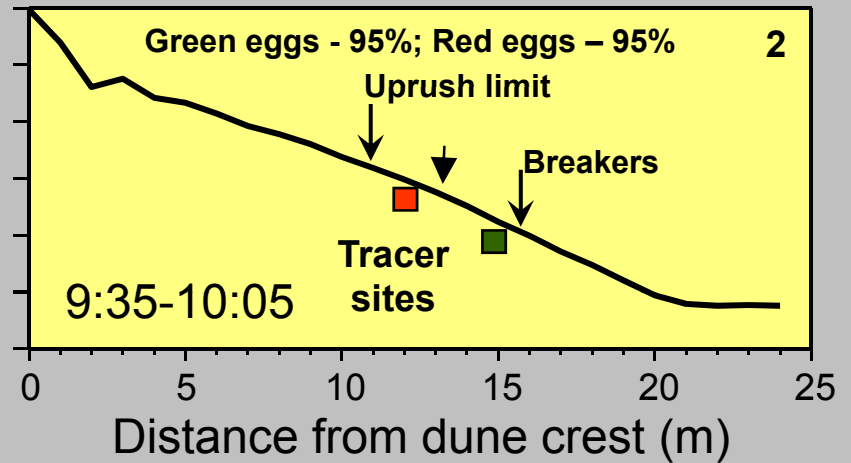
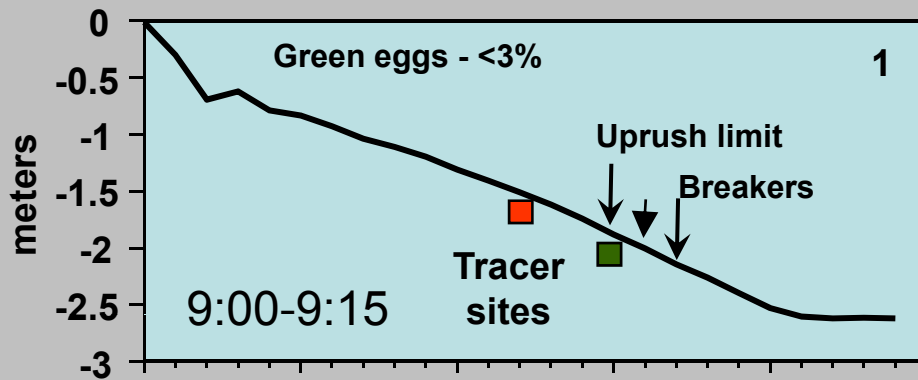
Energy density



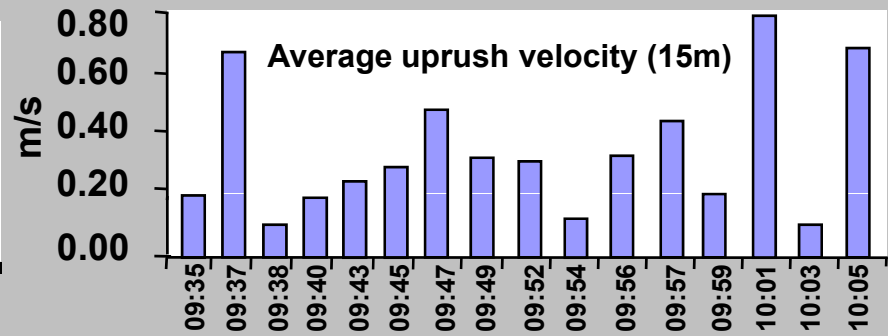
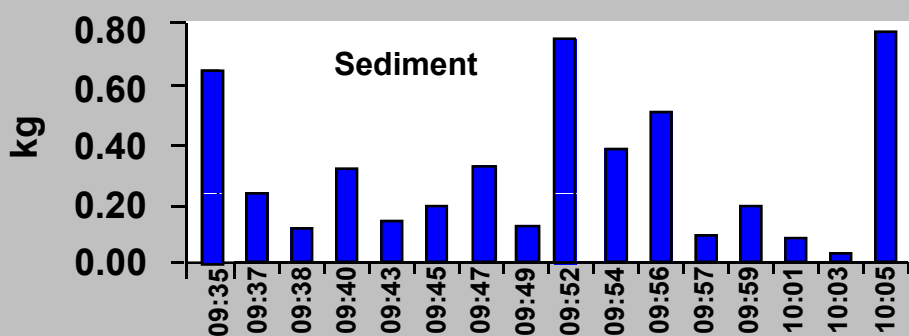
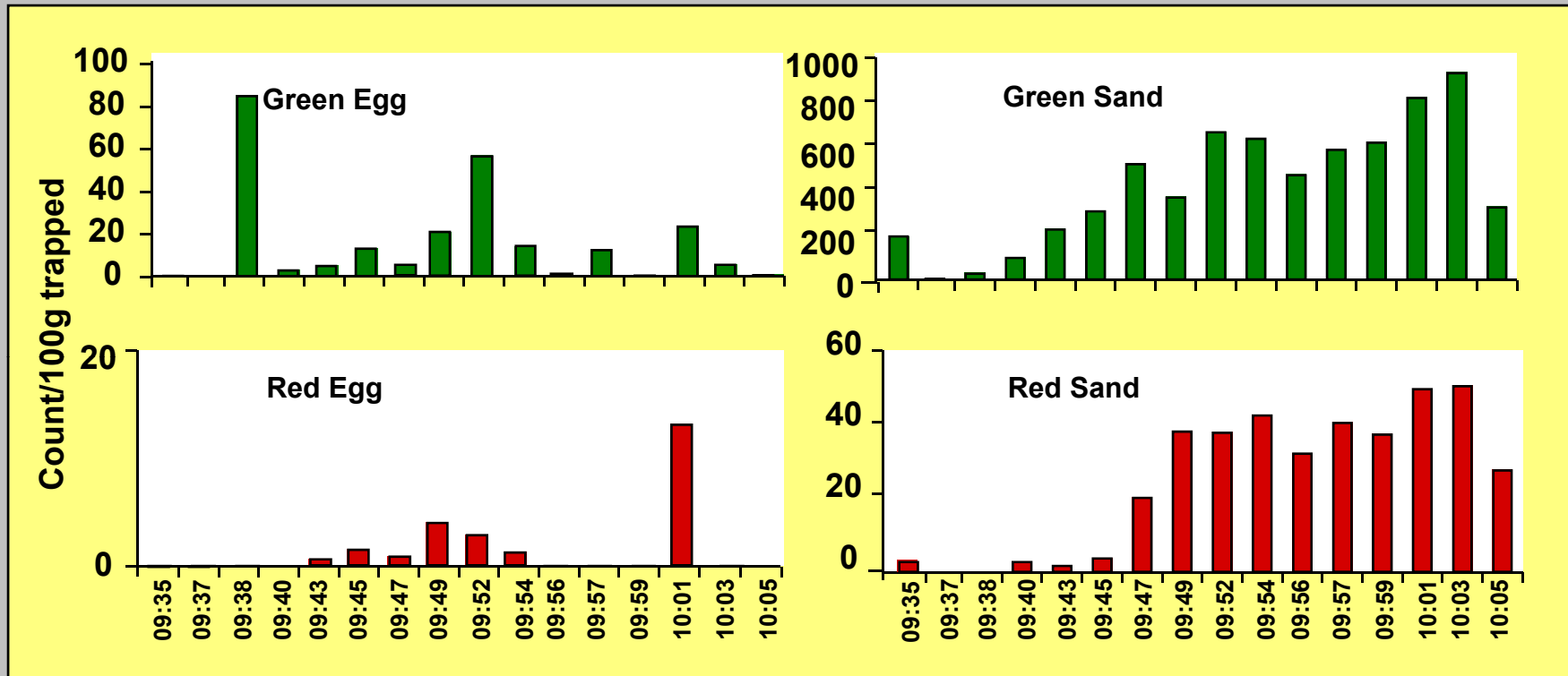
# Net Change and Sediment Activation



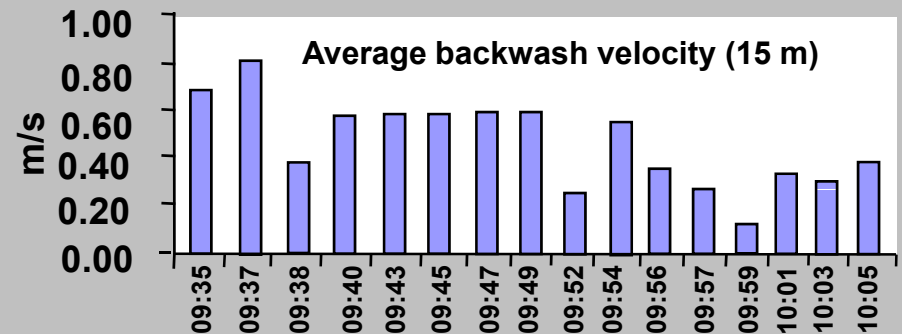
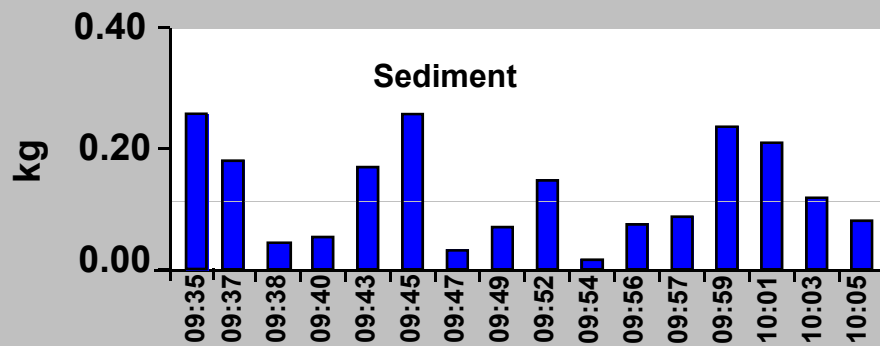
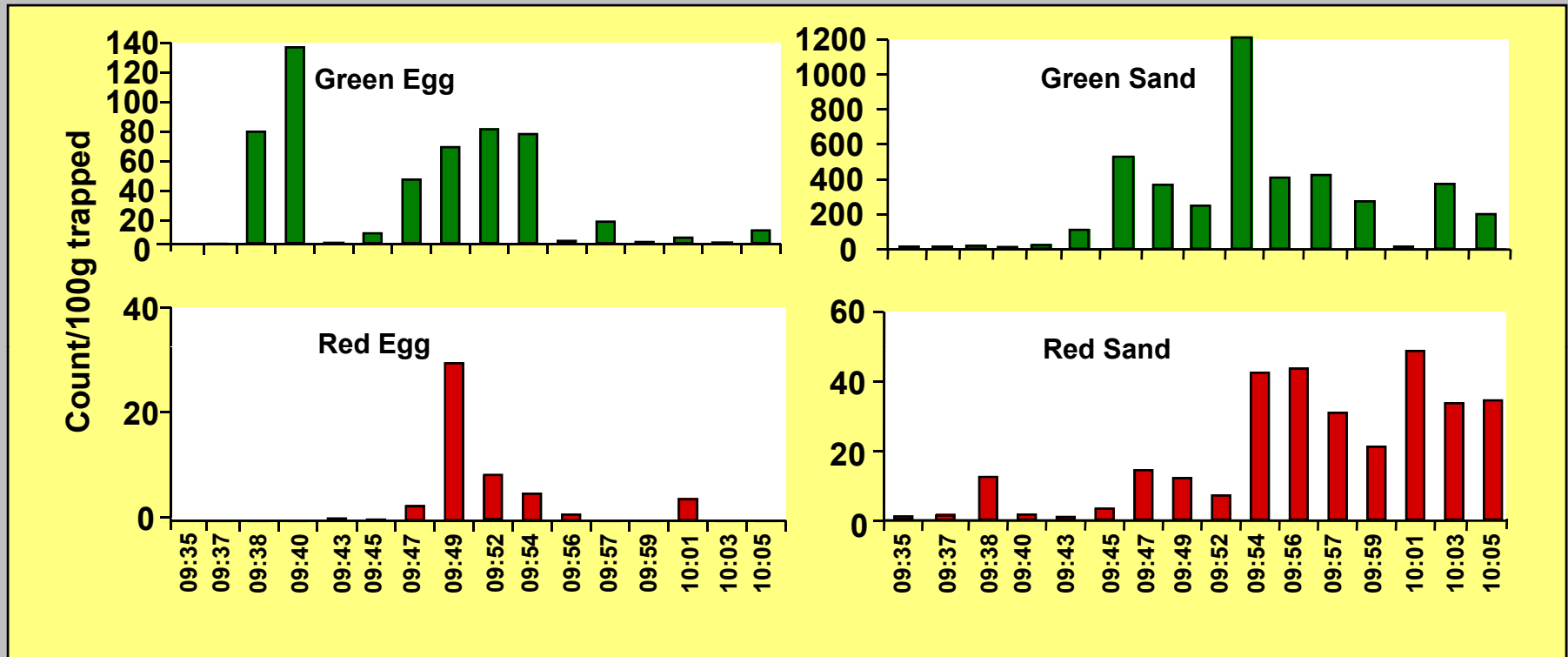
# Time Periods of Egg Recovery



# Uprush Trap Samples



# Backwash Trap Samples



# Preliminary Findings

- Terrigenous sediment tracer exhumed and transported when in contact with swash and breakers and remains in the active swash zone. Egg tracer does not remain resident in the active swash.
- Swash uprush velocities were lower as uprush propagates over backwash of previous swash cycle.
- Peaks in number of eggs trapped in the uprush attributed to large uprush excursions.
- Fewer eggs exhumed by swash in the region of maximum horseshoe crab spawning during spring tides.

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