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 µm
- 3000- 4000 eggs per nest
- Density of eggs - 0.65 gm/ml
- Fall velocity of eggs - 0.21 cm s\(^{-1}\)

- Predominantly medium to coarse sand ≈ 480 – 700 µm
- Small percentage of fine sands ≈ 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\(^{-1}\))
How are horseshoe crab eggs and sediment transported in the swash zone?
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

Graph showing energy density over time and frequency.
Net Change and Sediment Activation

Zone of highest wave breaking & step migration

Distance from dune crest (m)

Net change
Activation depth

Injection sites
Time Periods of Egg Recovery

1. Green eggs - <3%; Red eggs – <3%  
   9:00-9:15  
   Uprush limit  
   Tracer sites

2. Green eggs - 95%; Red eggs – 95%  
   9:35-10:05  
   Uprush limit  
   Tracer sites

3. Green eggs - <3%; Red eggs – <3%  
   12:39-12:59  
   Uprush limit  
   Tracer sites

Distance from dune crest (m)
Backwash Trap Samples

- Green Egg
- Green Sand
- Red Egg
- Red Sand
- Sediment
- Average backwash velocity (15 m)
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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