# Engineering with Nature: Breakwaters for the creation of Submerged Aquatic Vegetation (SAV) habitat


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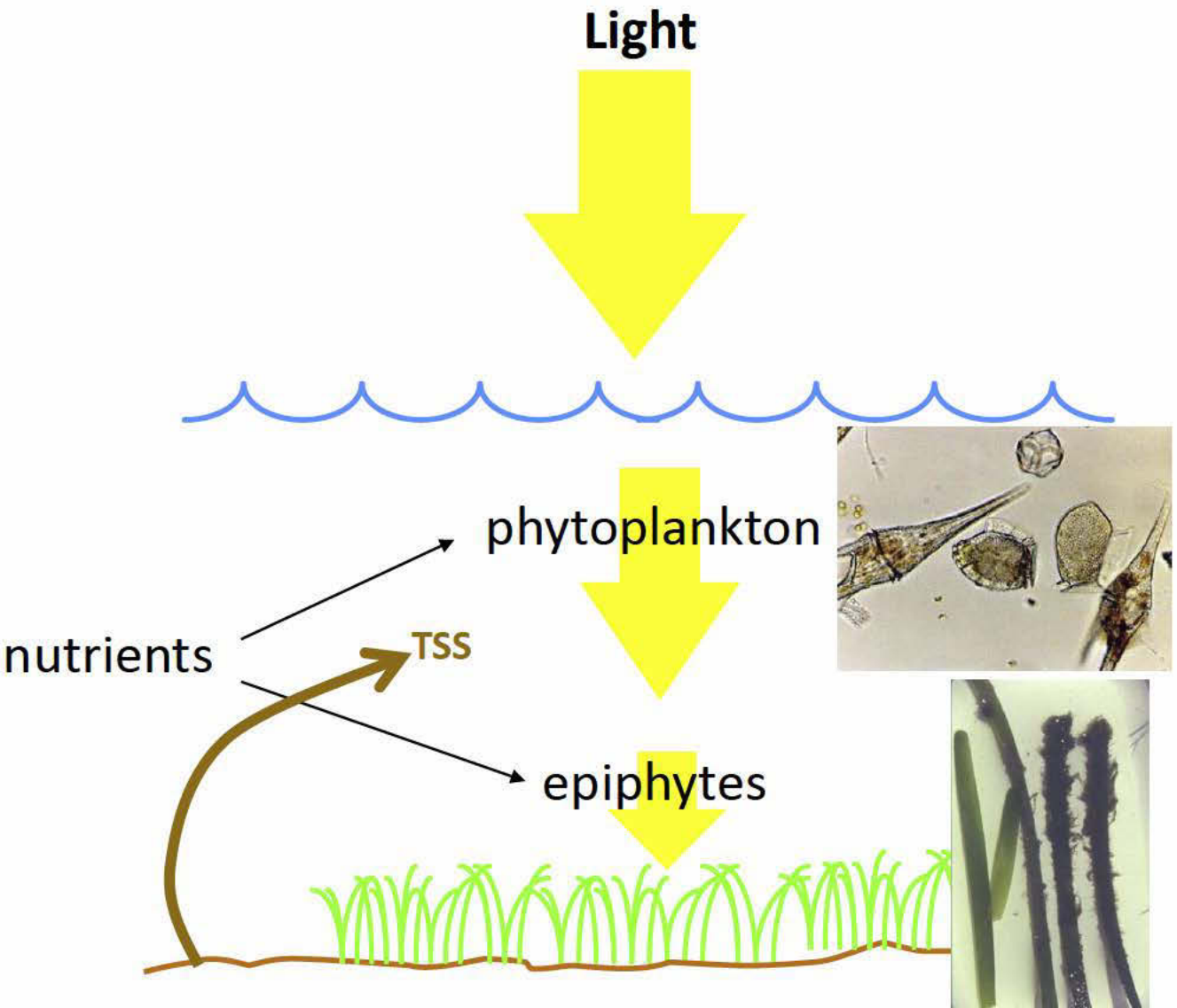
**SAV** – flowering, rooted aquatic (submersed) plants

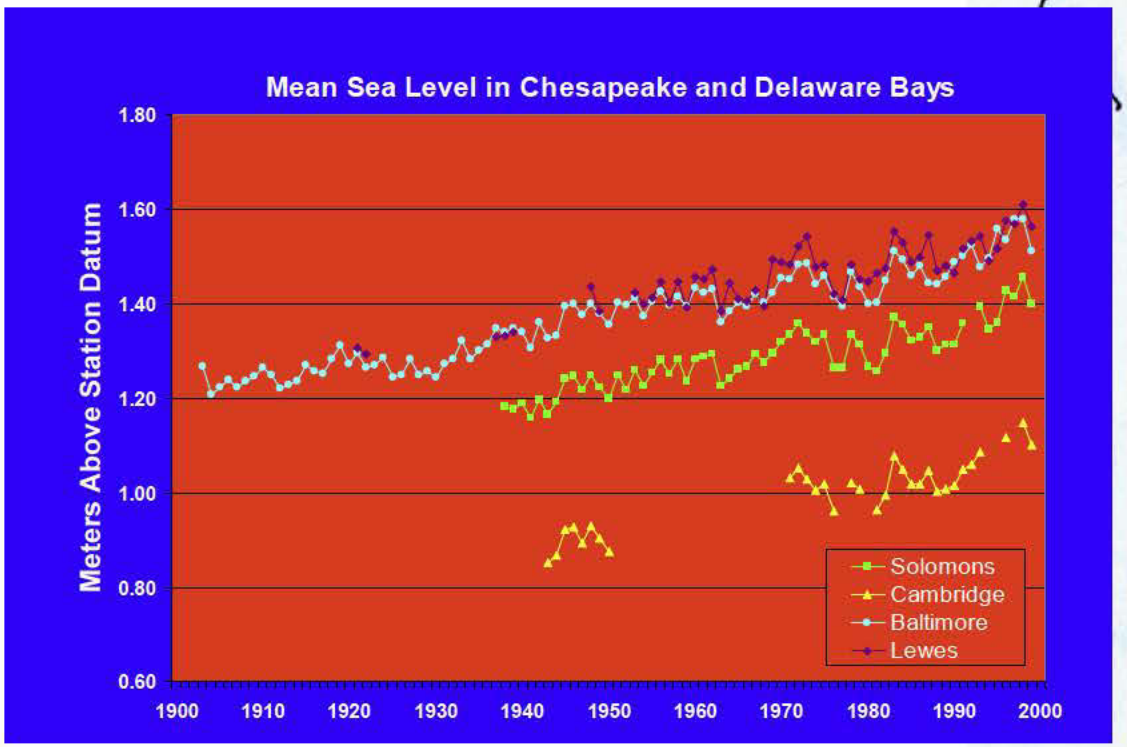
One of the most important estuarine habitats.

SAV have been disappearing at an alarming rate.

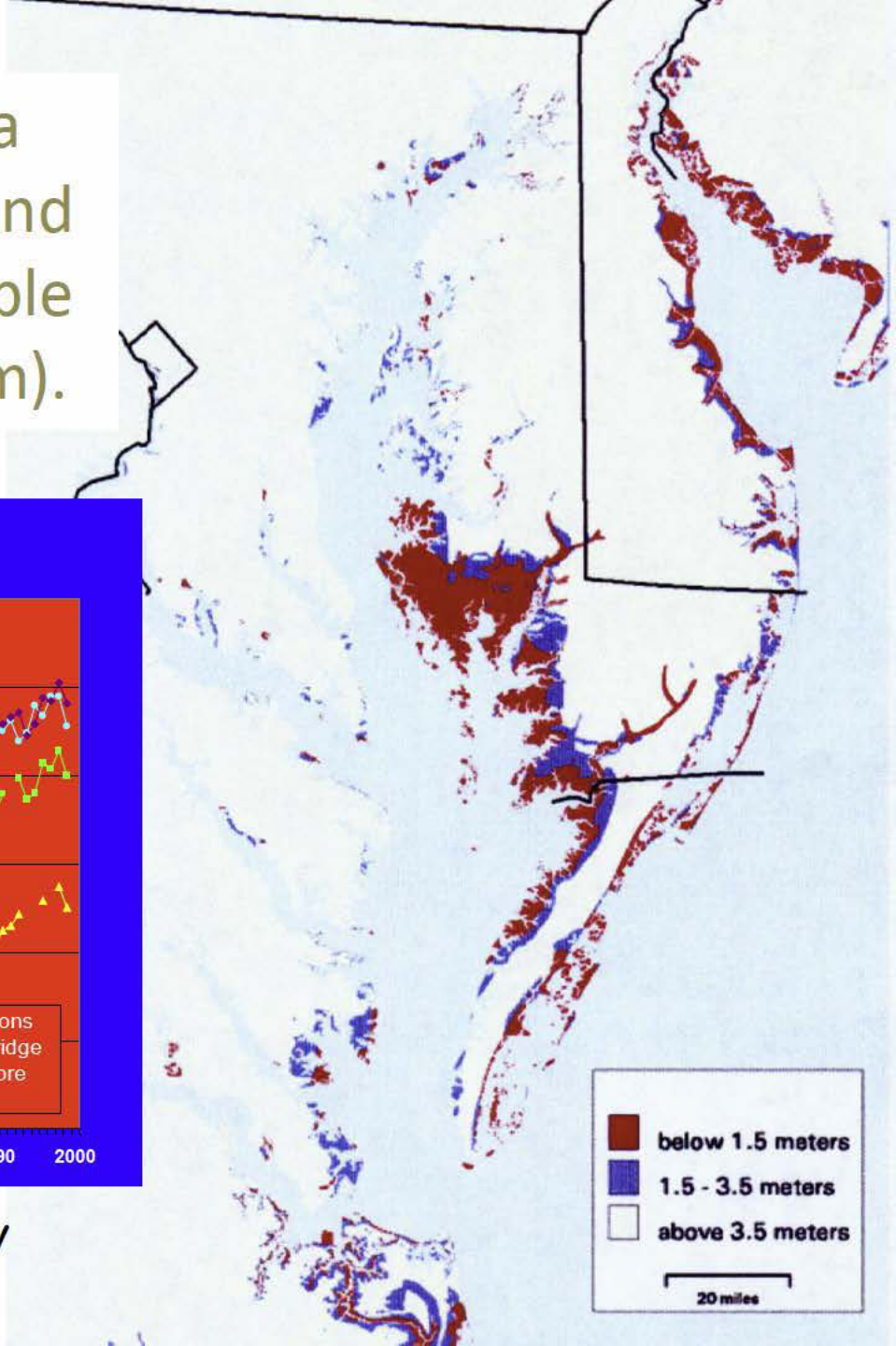
**Causes:** eutrophication = lack of light.



In the Chesapeake Bay area rate of sea level rise is high and many areas are very vulnerable to flooding (elevation < 1.5 m).




Sea-level rise between 2.5-3.6 mm/y
(Hicks et al., 1983, Davis, 1987)



# As a result, shoreline retreat is high and shoreline protection is becoming more and more common.

24% of shorelines in Chesapeake Bay are engineered
(Berman et al., 2000)

# The viability of LIVING SHORELINES (mixture of structural and non-structural defense) needs to be considered in all new projects.

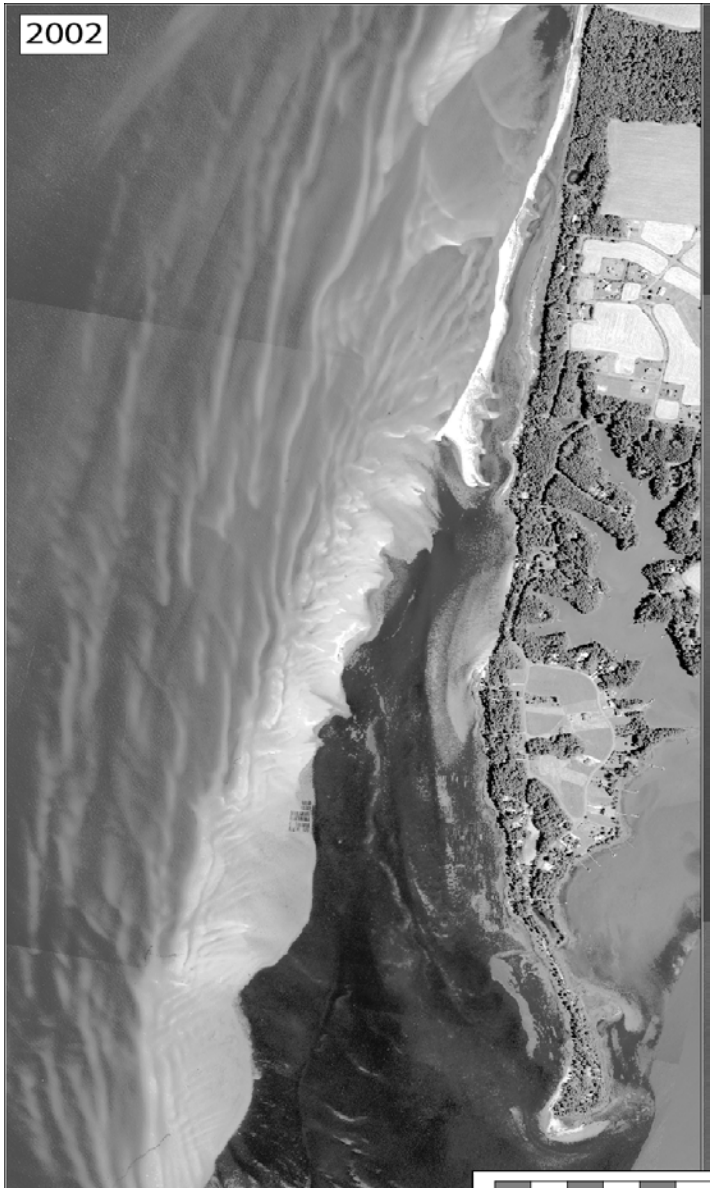
Living shorelines focus on marshes; how about SAV?

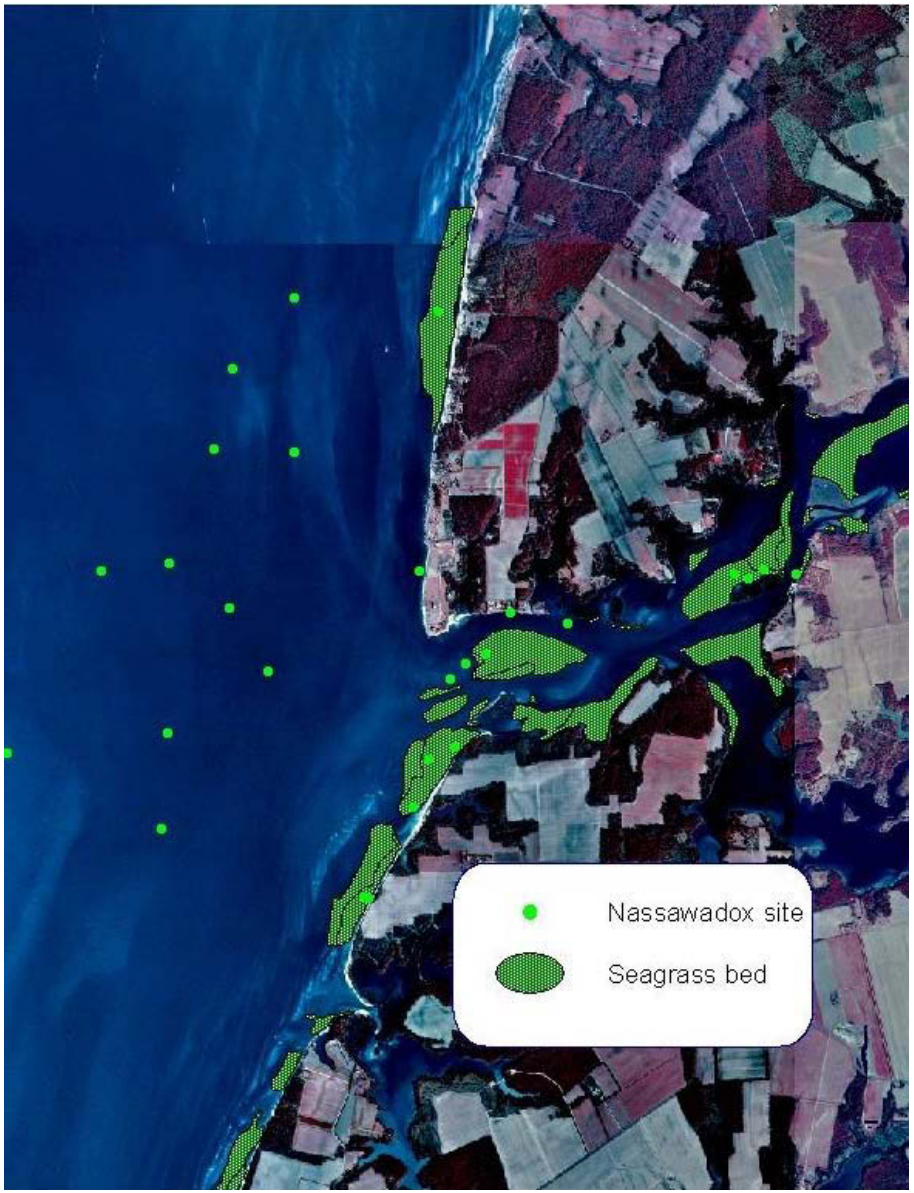
# What is the best way to protect shorelines while creating SAV habitat?

SAV need
submersed habitats
= breakwaters

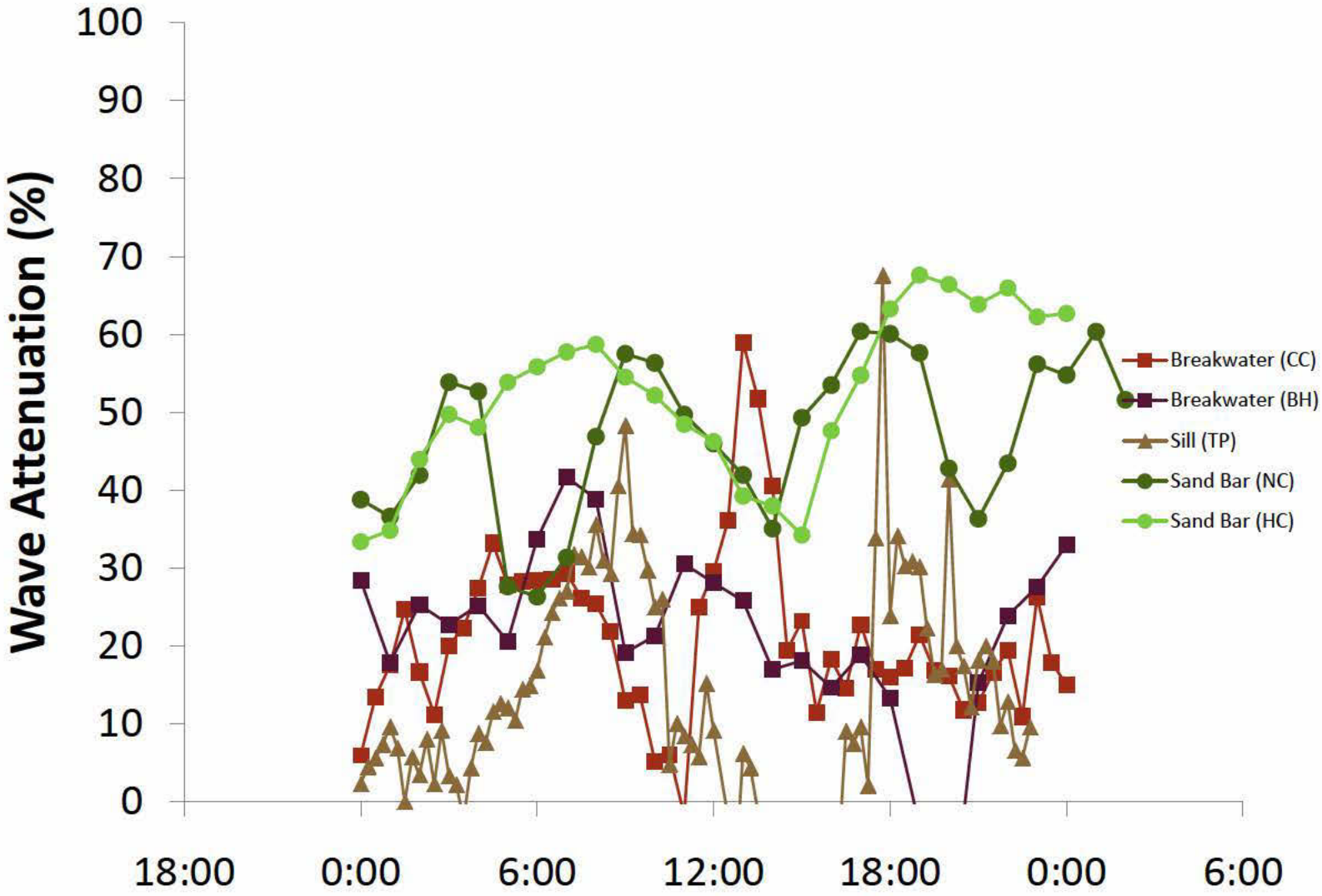
but not all breakwaters have SAV…

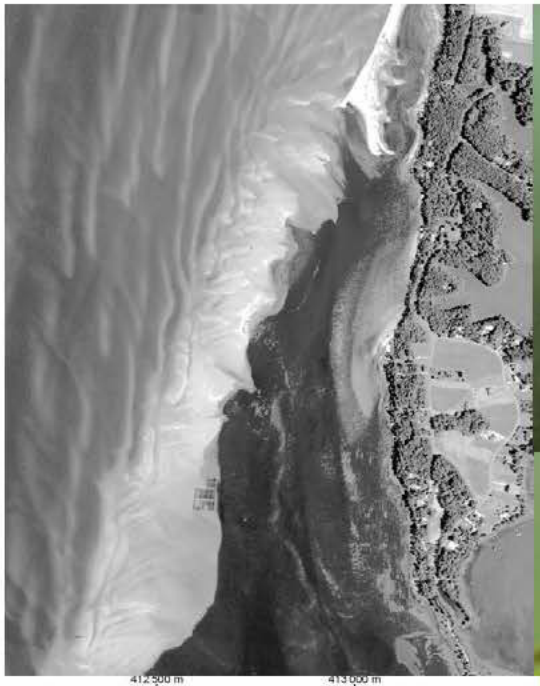
# What do sandbars have that breakwaters don't?

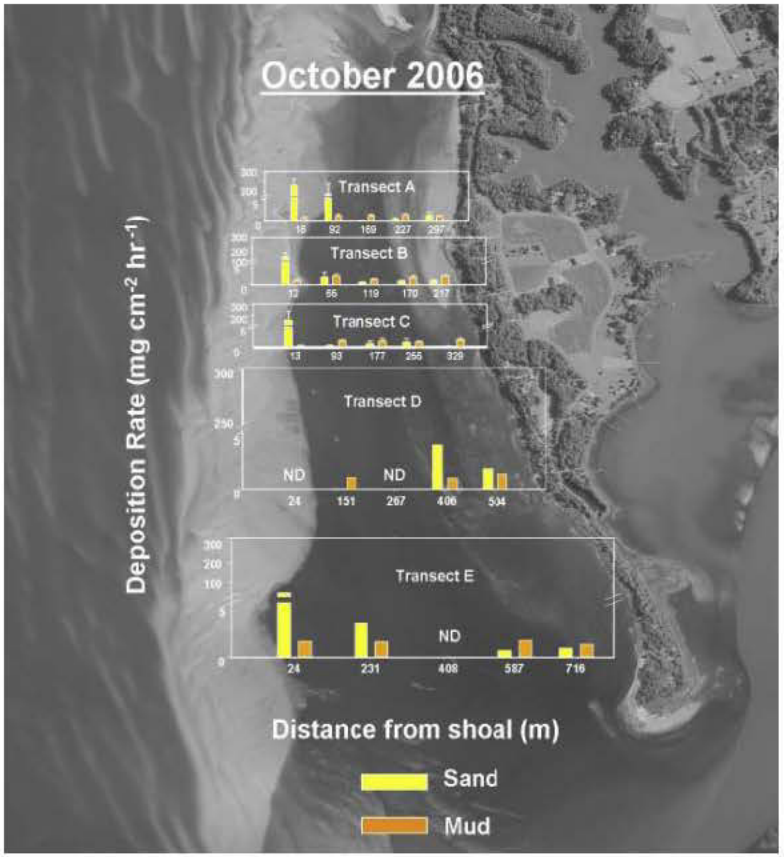


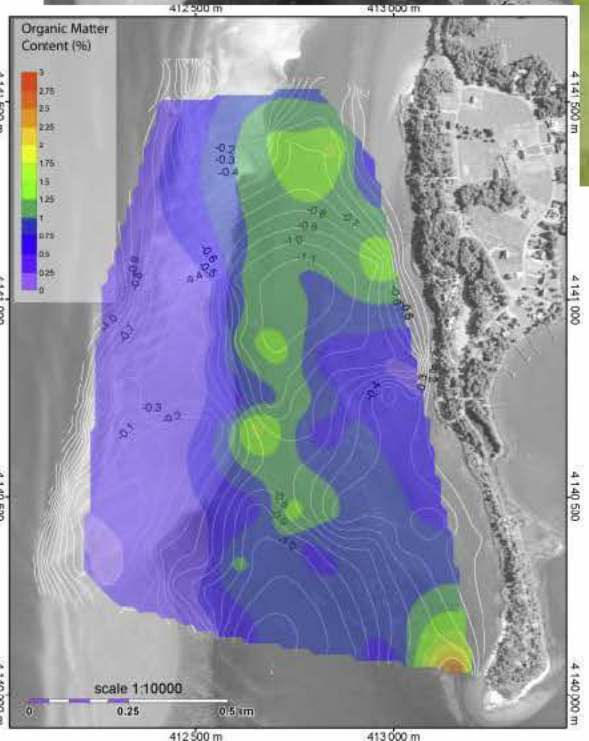



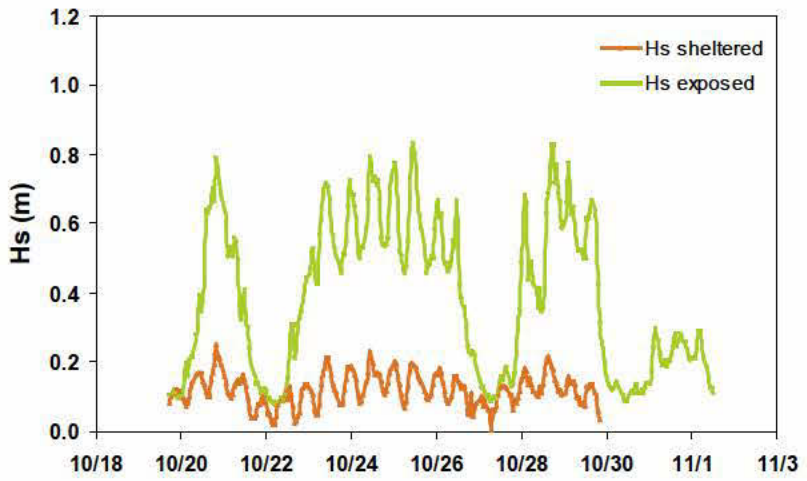
# What do sandbars have that breakwaters don't?

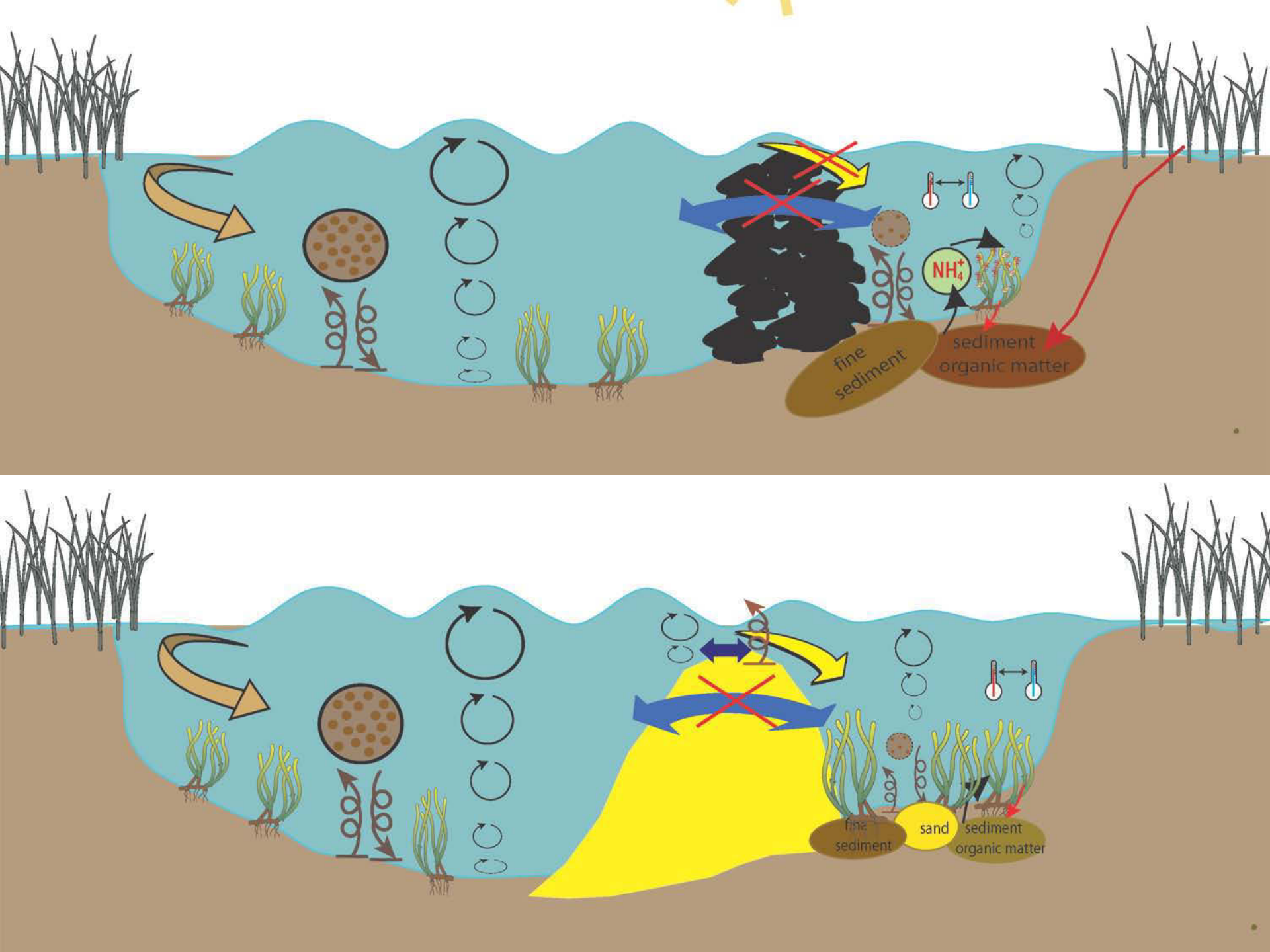




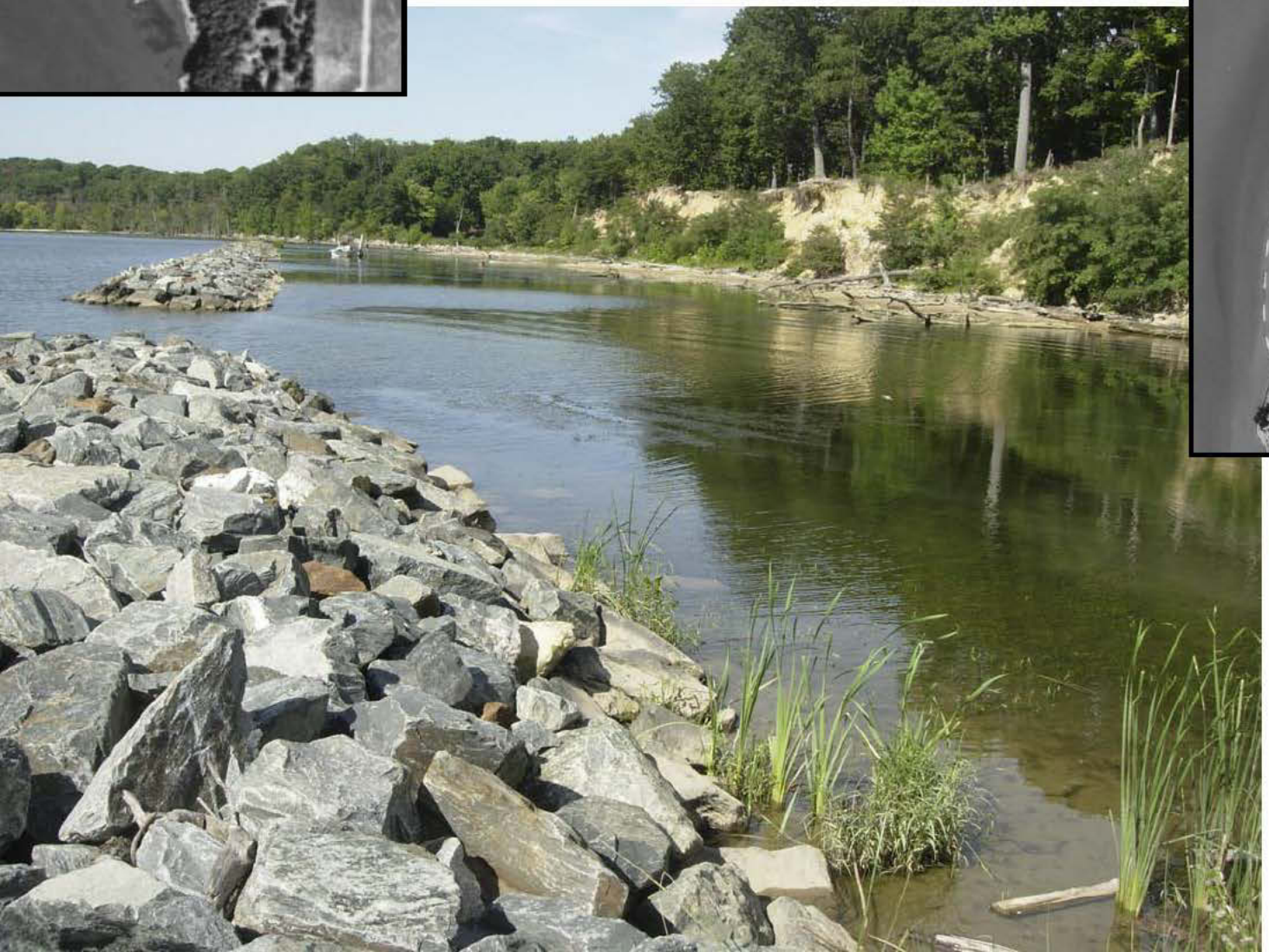

October 2006
Deposition Rate (mg cm-2 hr-1)
Transect A
Transect B
Transect C
Transect D
Transect E
ND
Distance from shoal (m)
Sand
Mud


Organic Matter Content (%)
scale 1:10000
412 500 m
413 000 m

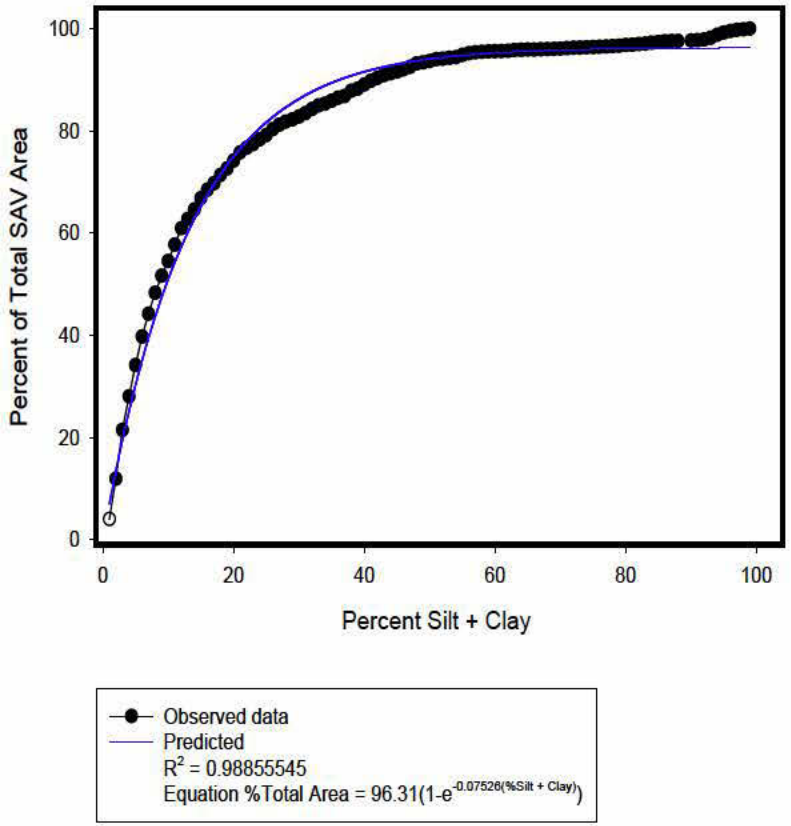

Hs (m)
Hs sheltered
Hs exposed
10/18
10/20
10/22
10/24
10/26
10/28
10/30
11/1
11/3

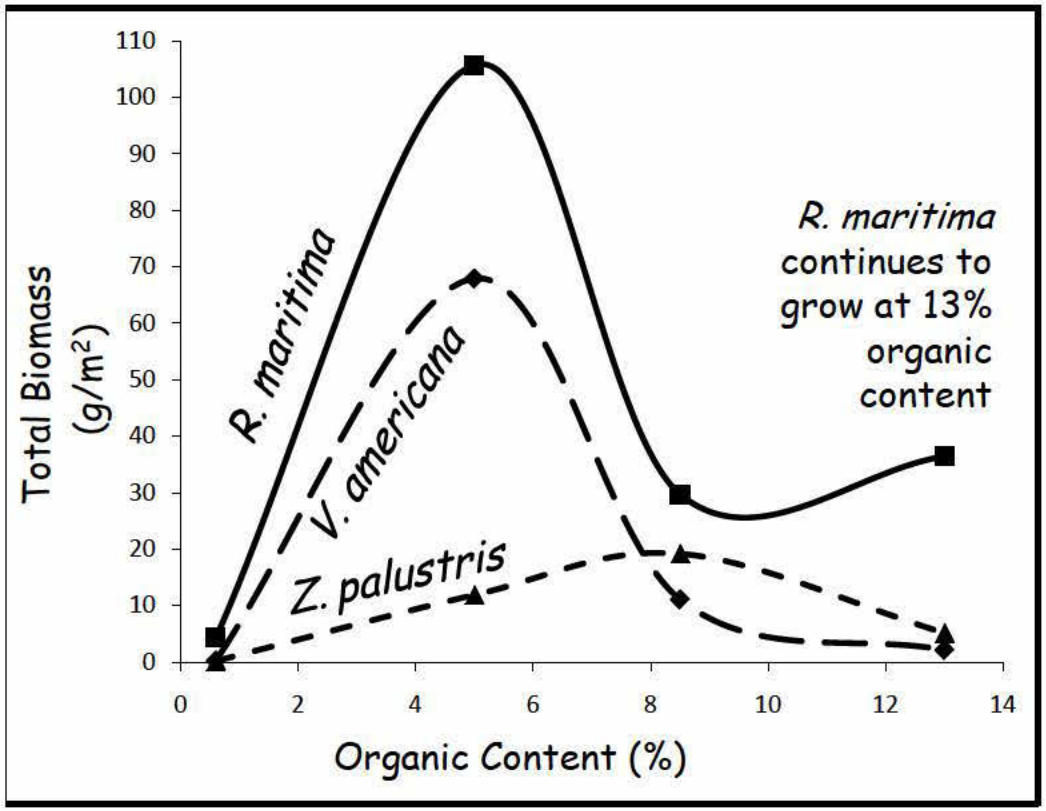

$NH_4^+$
fine sediment
sediment organic matter
fine sediment
sand
sediment organic matter

# Excessive sand input is also detrimental to SAV



# In order for breakwaters to be successful, sediments need to remain sandy (<35 silt + clay) and have low organic content (<5 or 8%) over time.

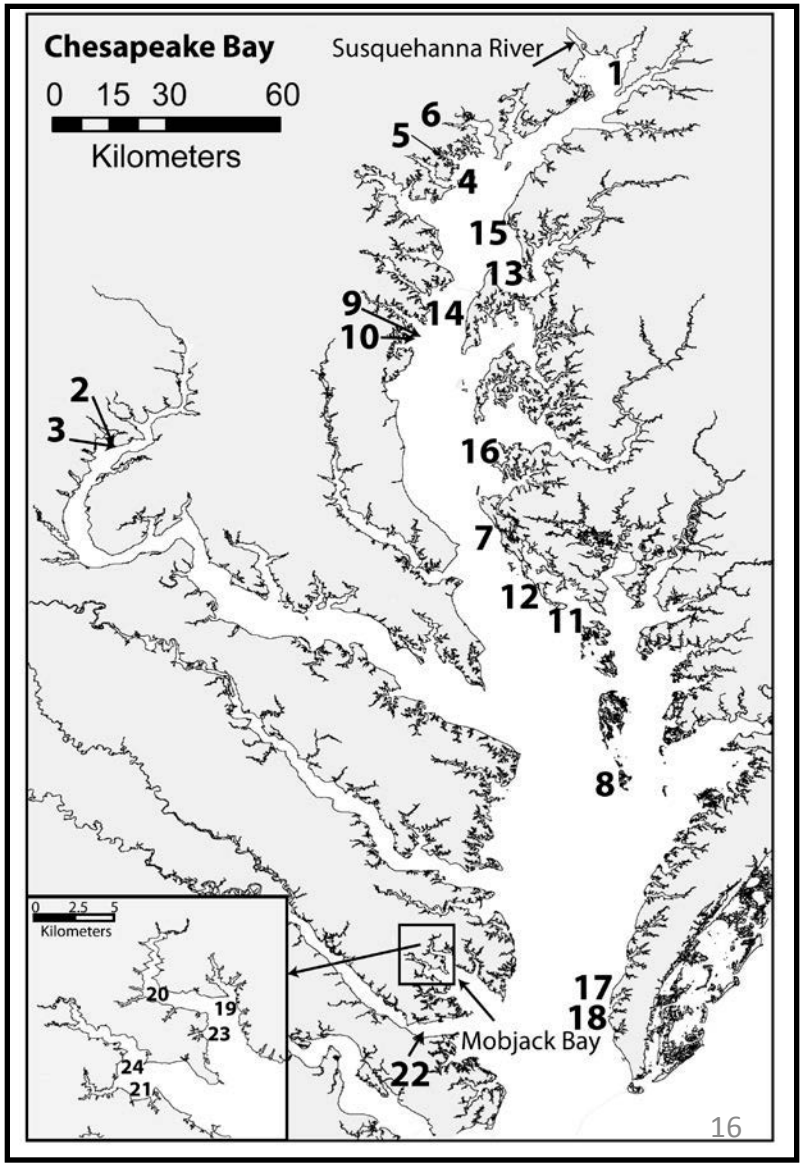


Sufficient water depth and a fine equilibrium of sand input is necessary for the successful colonization of SAV in breakwater-protected areas.

# 24 breakwaters in Chesapeake Bay

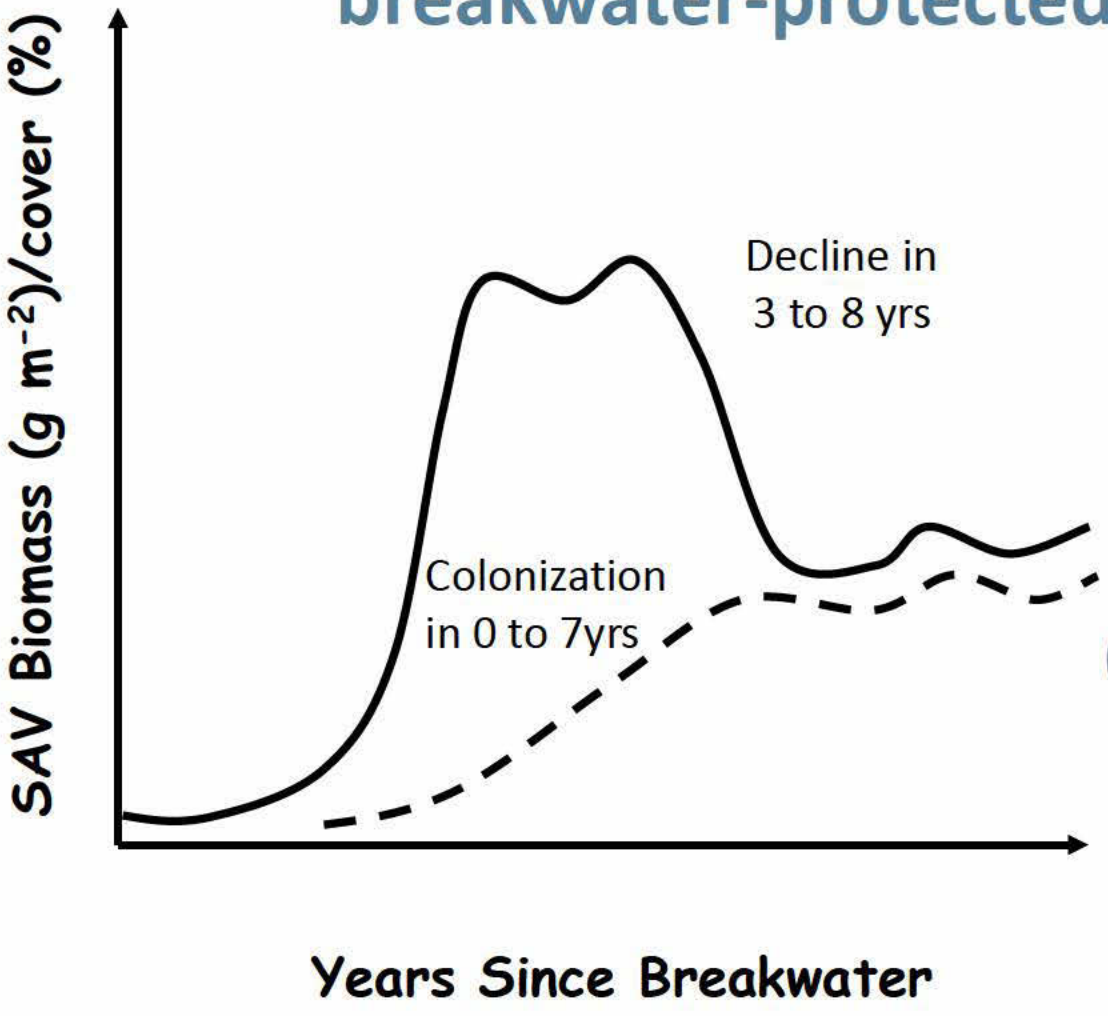
- SAV-vegetated
  (currently or in the last 20 y)
- ages from 0 to 20 yrs





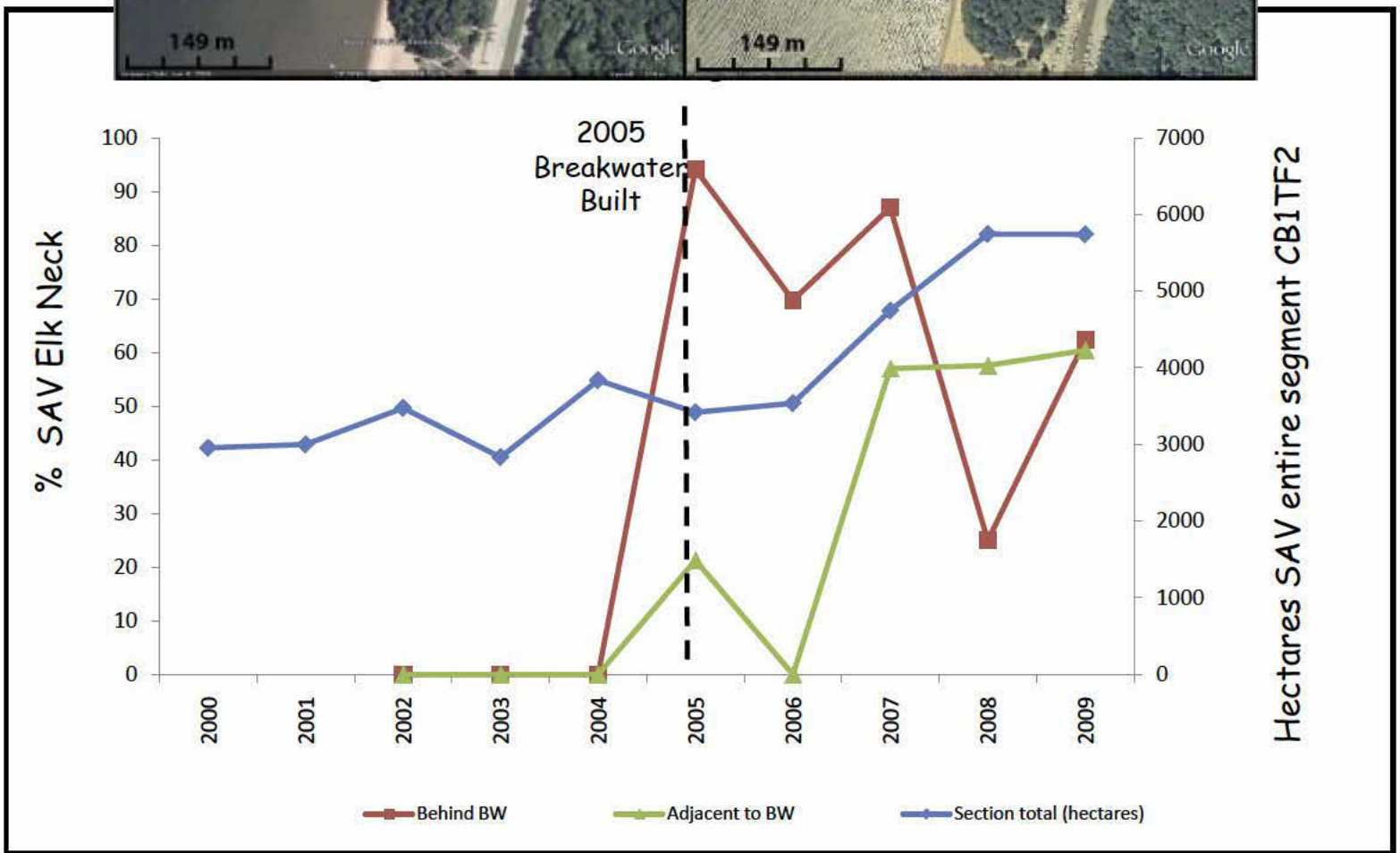


# Initial colonization of SAV in breakwater-protected areas

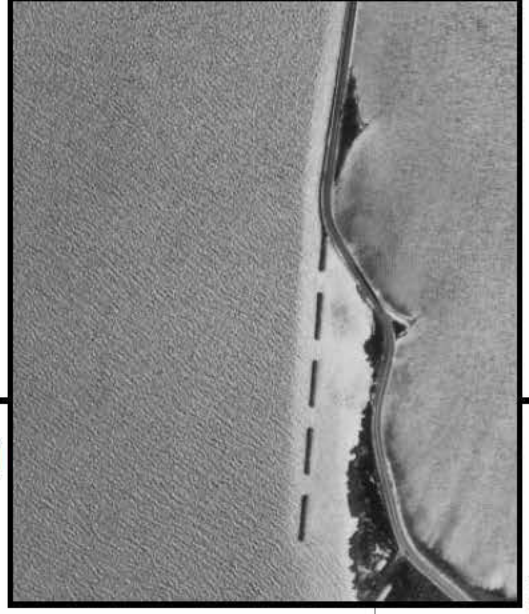



growth stabilizes at sub-optimal levels (patchy vegetation)

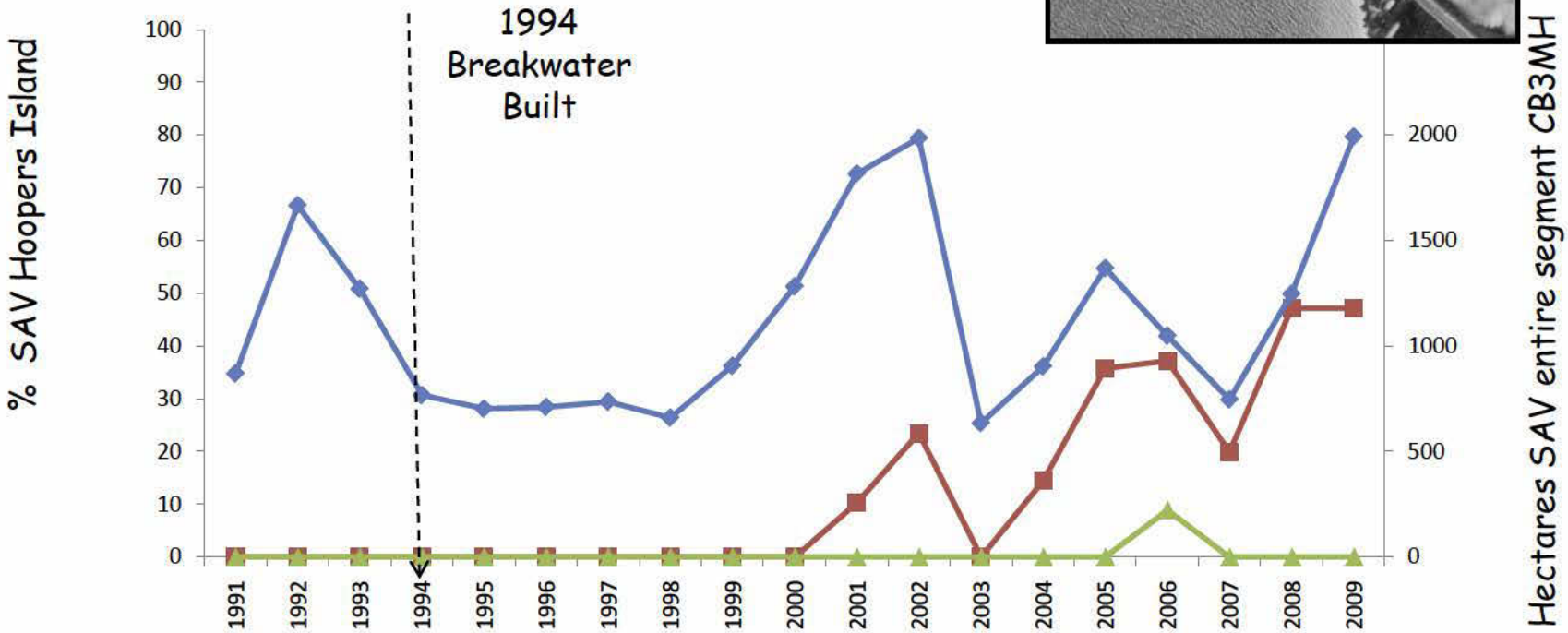

*Vallisneria americana*
*Hydrilla verticilata*



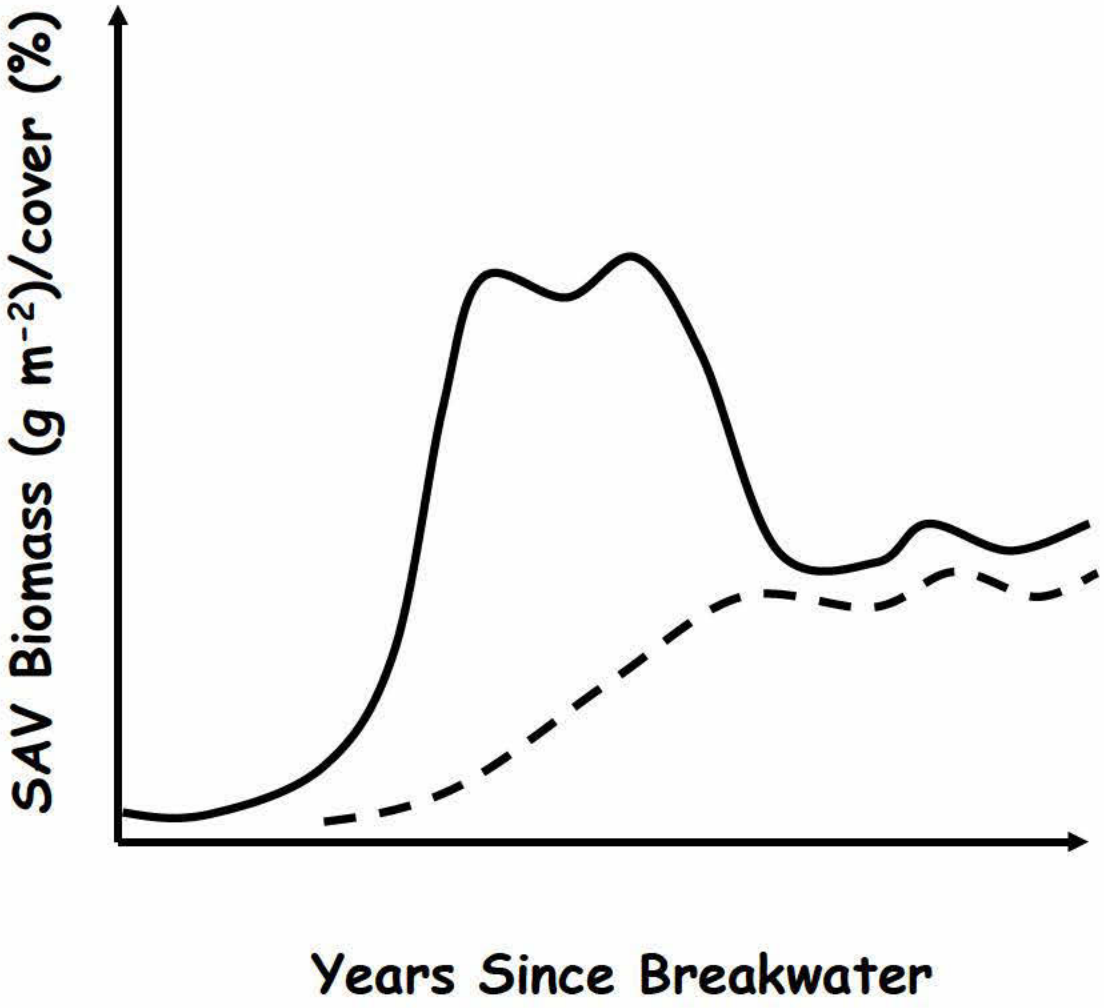
*Ruppia maritima*
*Zostera marina*



## Segment SAV coverage vs. Hoopers Island

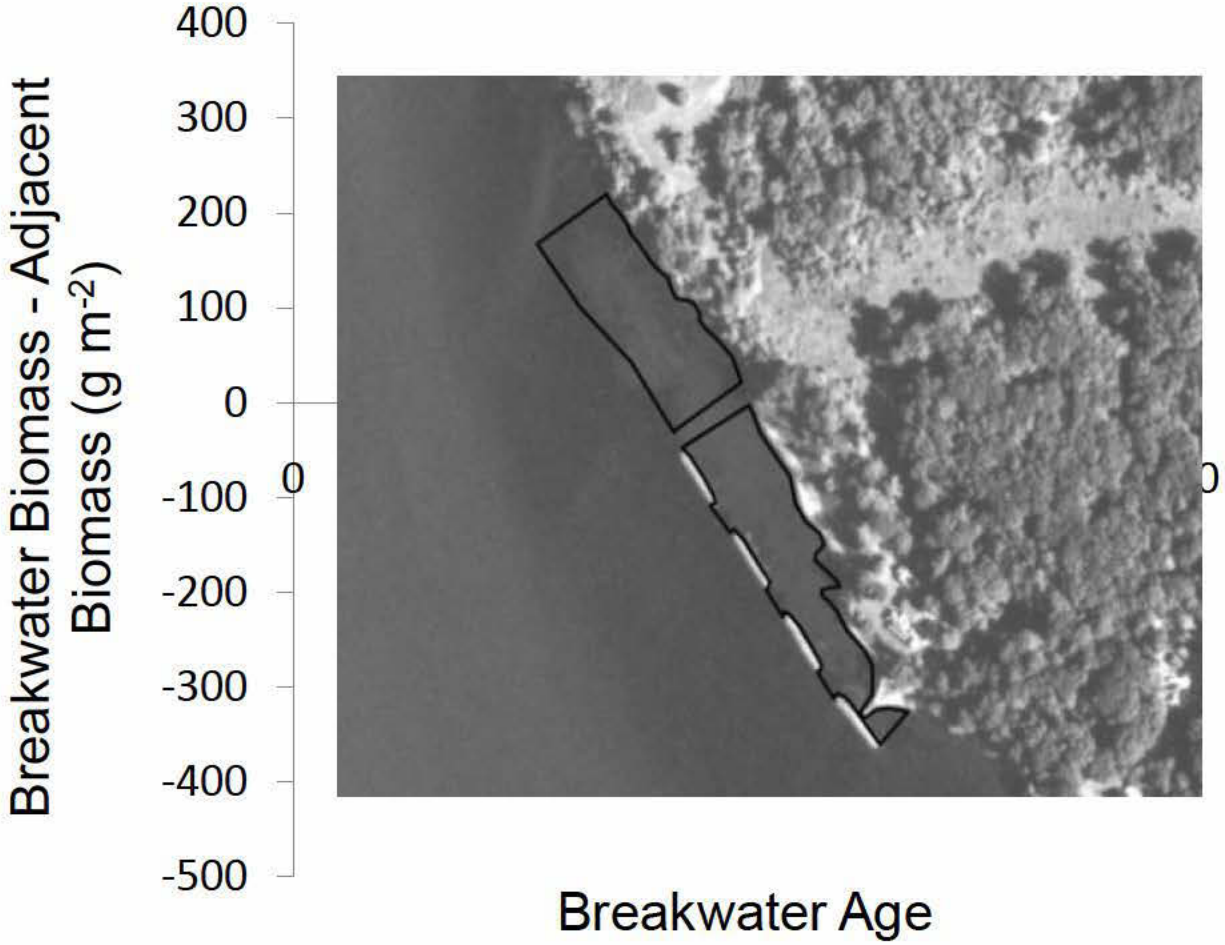


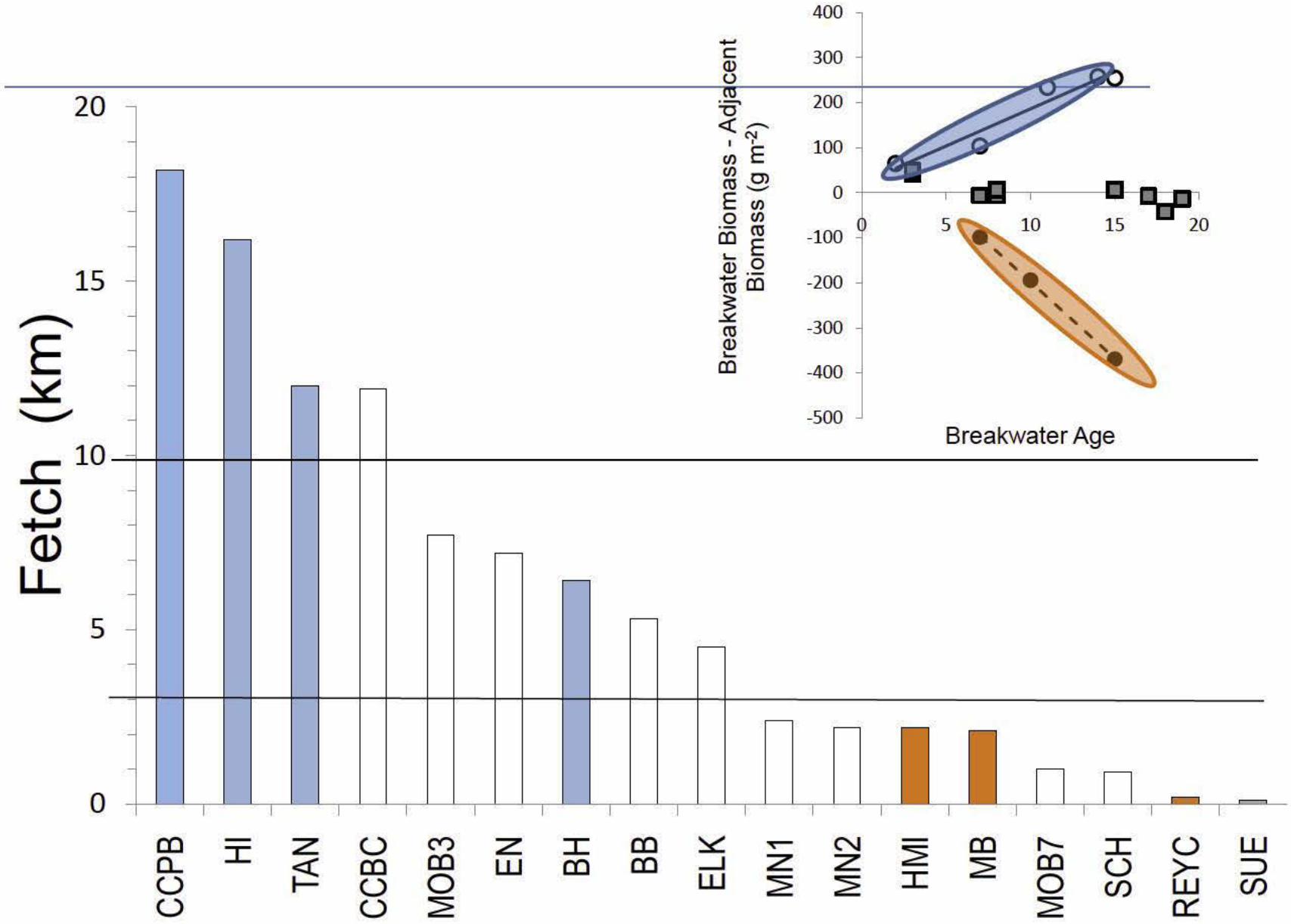
# Initial colonization




- does the biomass crash only occur in freshwater species?
- how can we sustain maximum SAV biomass in breakwater-protected areas?

# Long term growth and SAV biomass development in breakwater-protected areas




Fetch (km)
20
15
10
5
0
CCPB
HI
TAN
CCBC
MOB3
EN
BH
BB
ELK
MN1
MN2
HMI
MB
MOB7
SCH
REYC
SUE
Breakwater Biomass - Adjacent Biomass (g m-2)
400
300
200
100
0
-100
-200
-300
-400
-500
0
5
10
15
20
Breakwater Age

# Conclusions

Breakwaters can sustain SAV populations as long as some habitat requirements are met:

- **Water quality** – regional water quality needs to be good enough to support SAV growth
- **Water depth** – deep enough so SAV can remain submersed at low tide
- **Sediment** – needs to remain sandy (<35% silt+clay) with low organic matter (<5 to 8% organic matter) over time
- **Fetch** – breakwaters are most beneficial to SAV in long fetch areas (> 10 km)
- **Water flow** – some freshwater species have a minimum water flow requirement

# Management Recommendations
## breakwater construction for SAV conservation and/or restoration

Shoreline characteristics need to be considered:

- **Eroding Marshes** – a layer of sand* needs to be added to cover the marsh peat in the sub-tidal (*>2cm, Wicks et al. 2009)

- **Sandy Beach** – breakwater beneficial to SAV especially when fetch > 10 km

- **Cliffs** – base of cliff needs to be stabilized to reduce sediment input and shoaling breakwater-protected area

# Questions for Evamaria Koch?

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