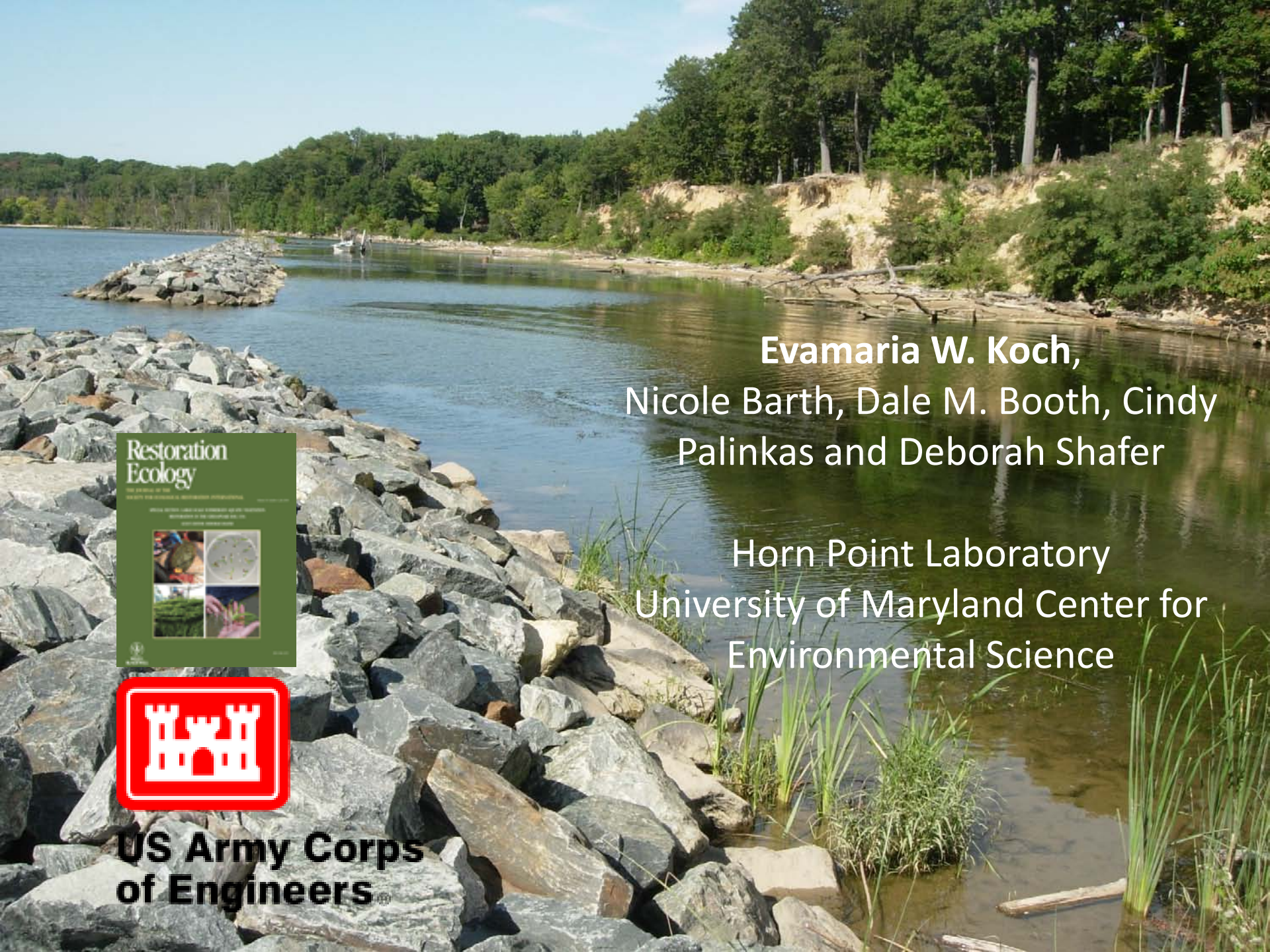
Engineering with Nature: Breakwaters for the creation of Submerged Aquatic Vegetation (SAV) habitat



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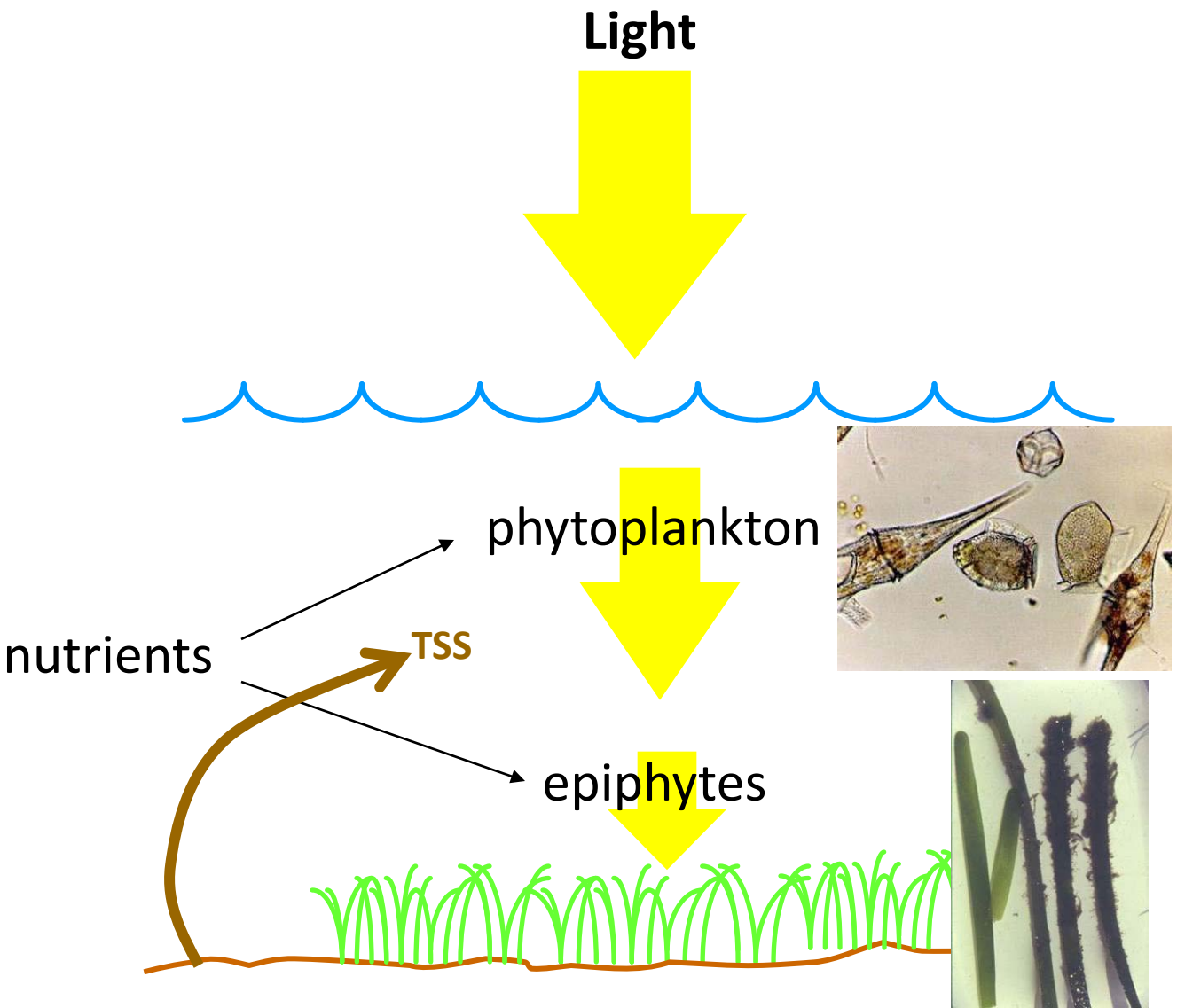
SAV – flowering, rooted aquatic (submersed) plants

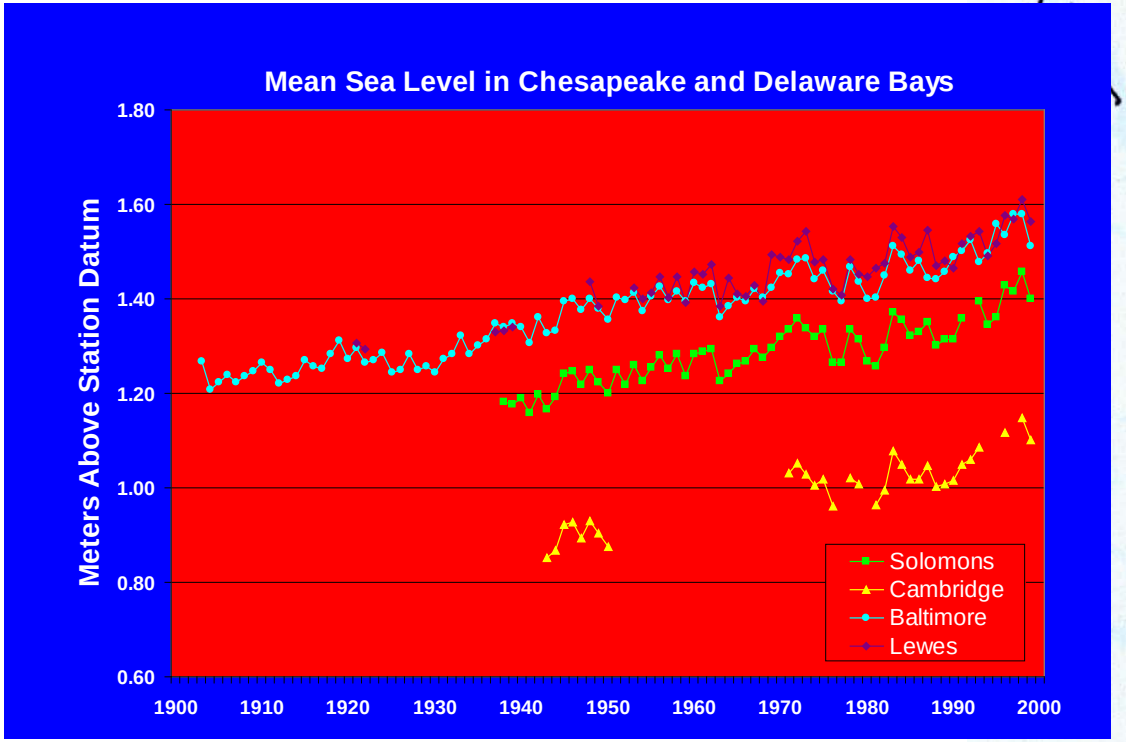
One of the most important estuarine habitats.

SAV have been disappearing at an alarming rate.

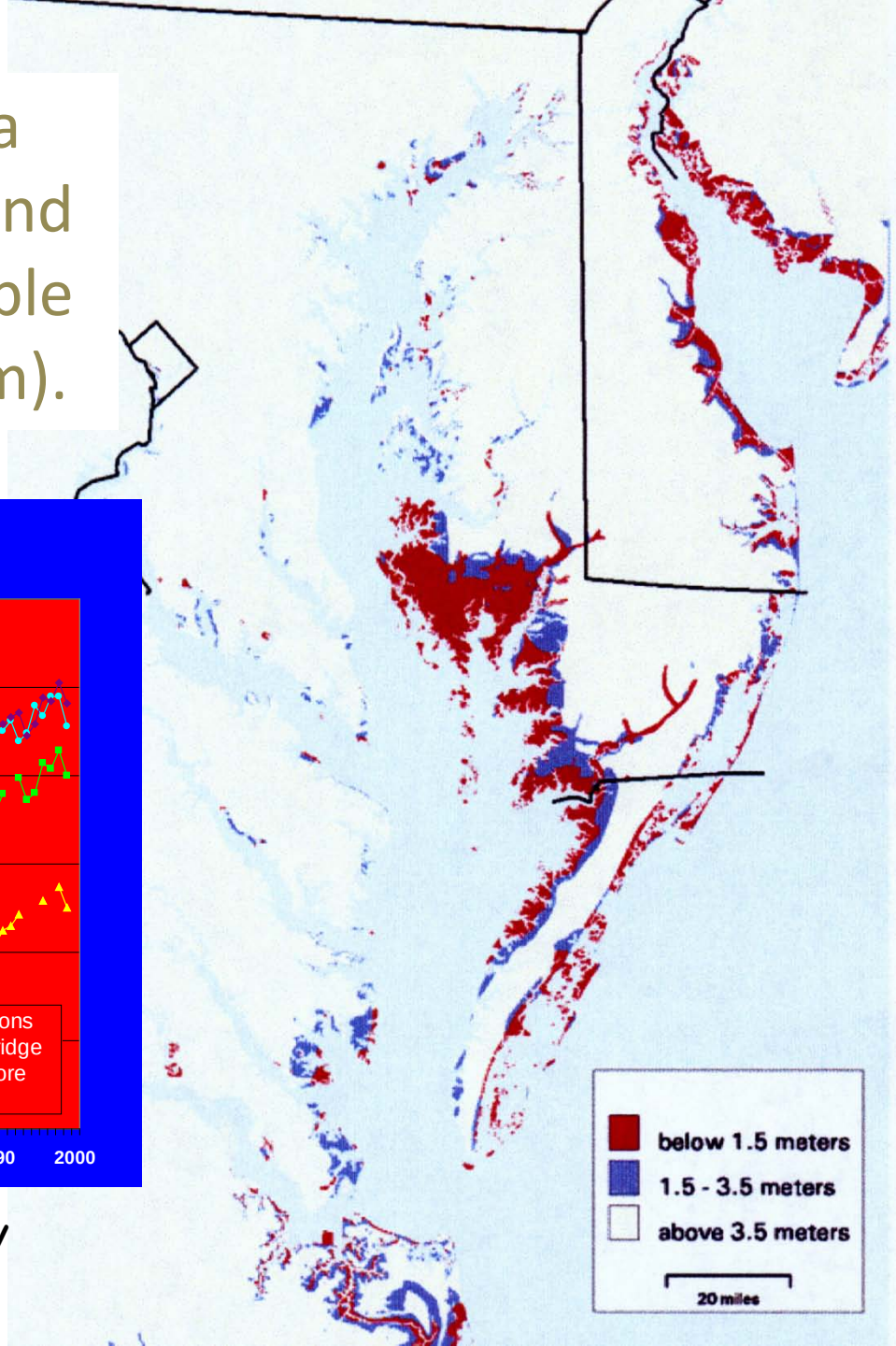
Causes: eutrophication = lack of light.



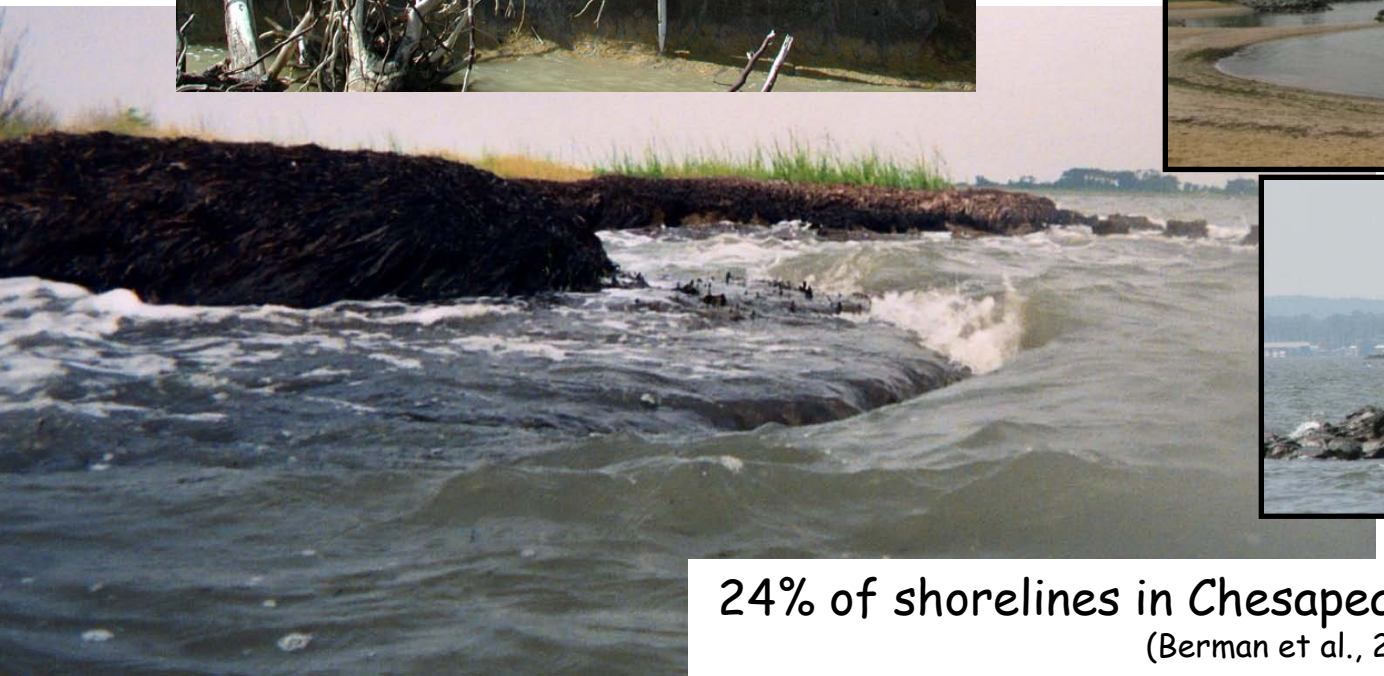
In the Chesapeake Bay area rate of sea level rise is high and many areas are very vulnerable to flooding (elevation < 1.5 m).



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.

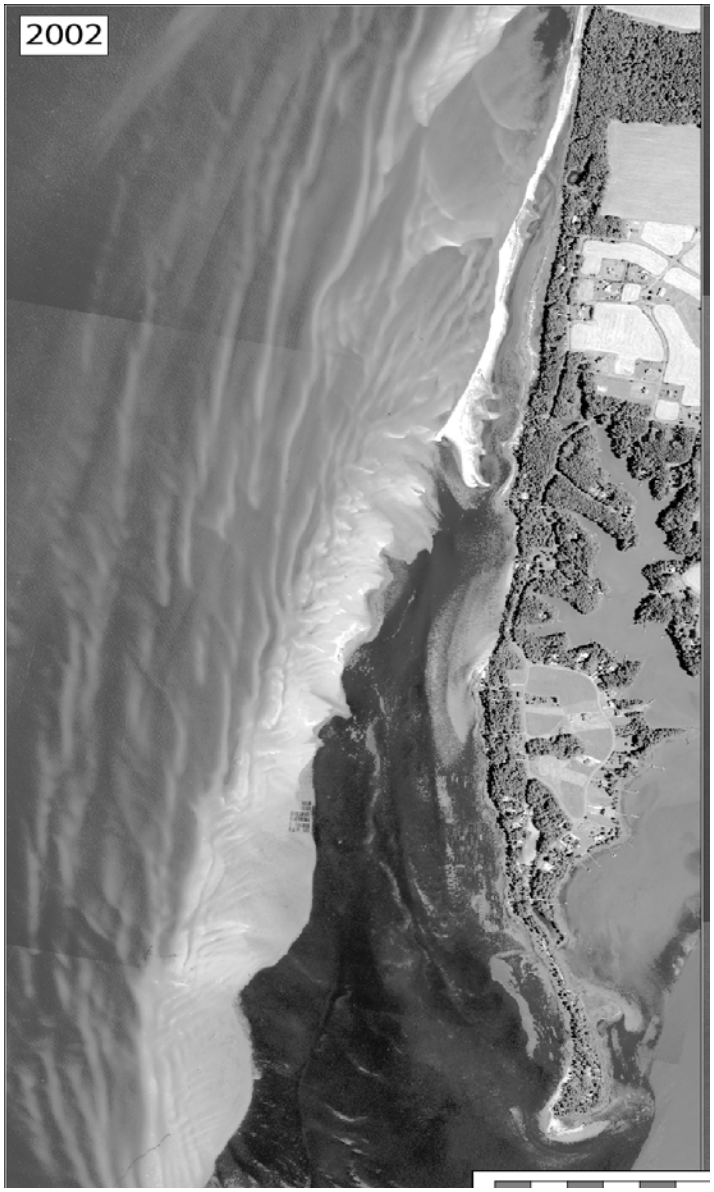
Living shorelines focus on marshes; how about SAV?

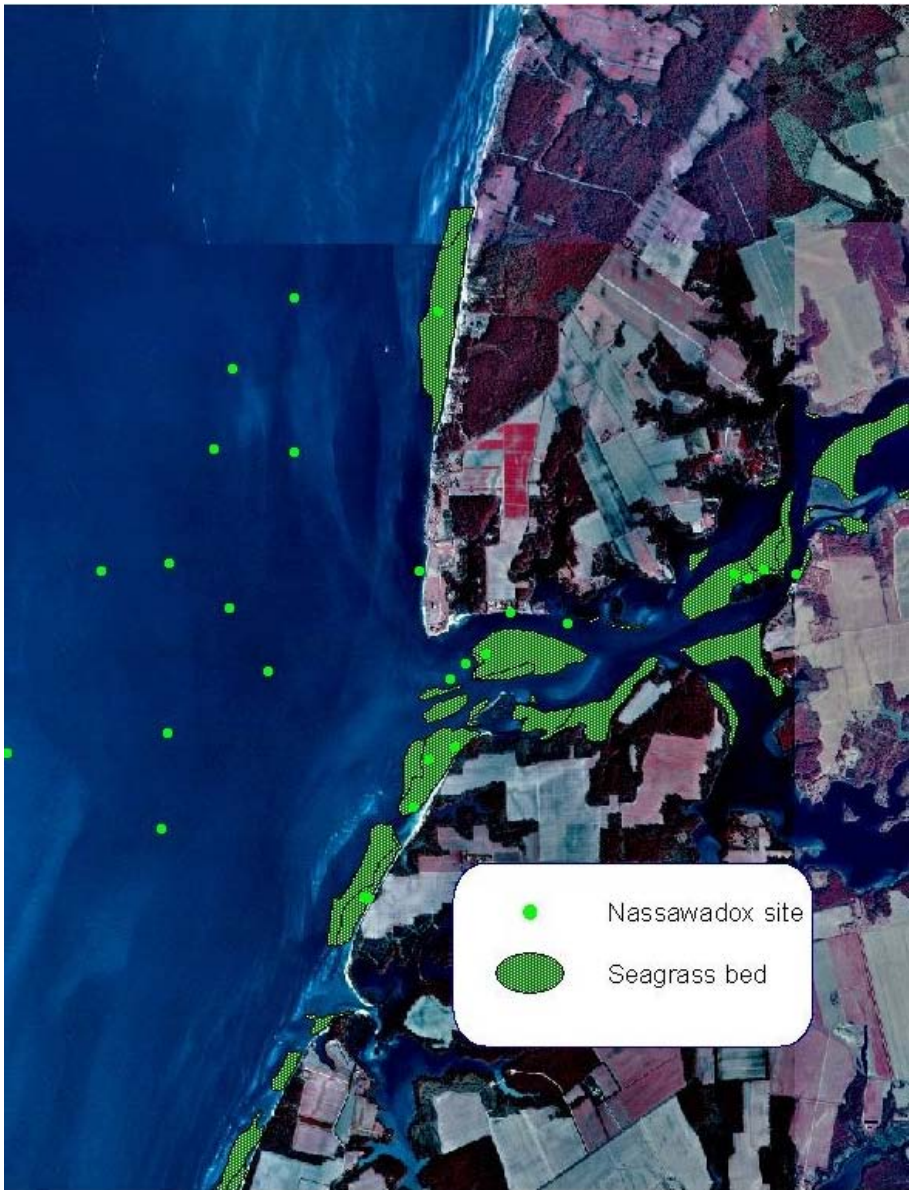
What is the best way to protect shorelines while creating SAV habitat?

SAV need
submersed habitats
= breakwaters

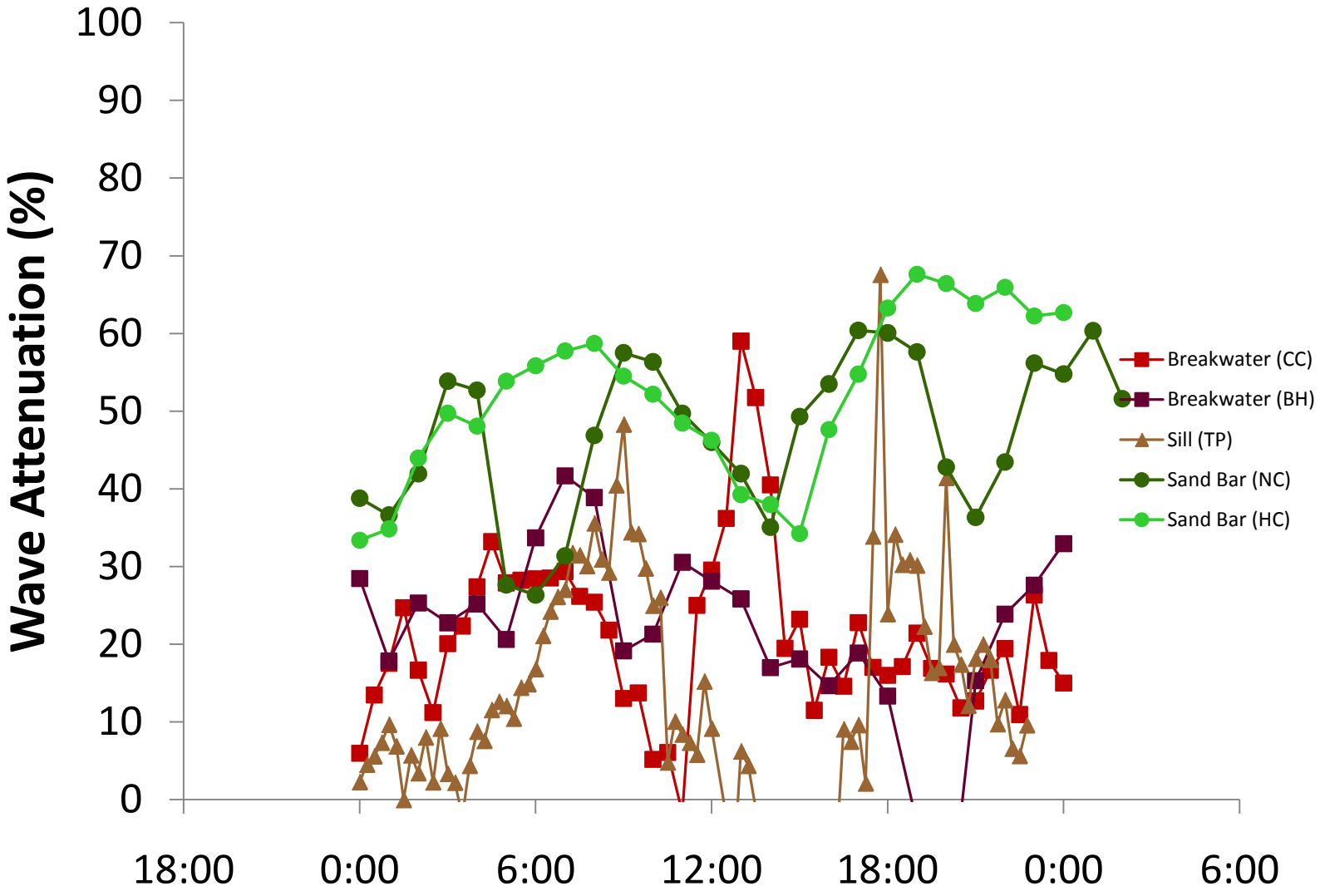
but not all breakwaters have SAV…

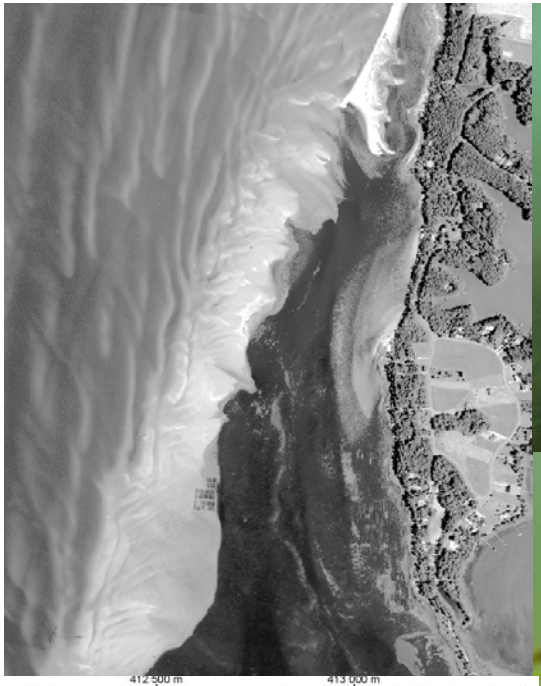
What do sandbars have that breakwaters don't?

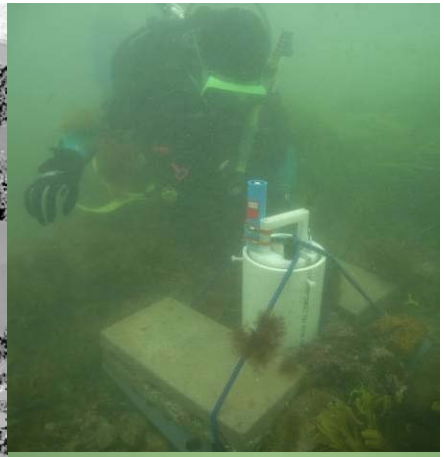


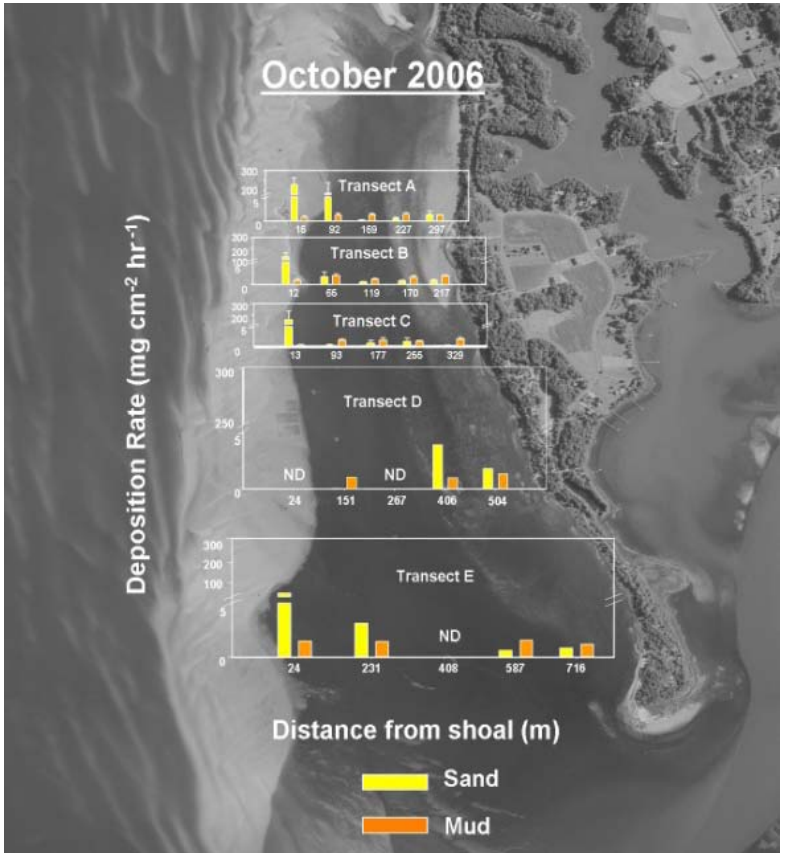


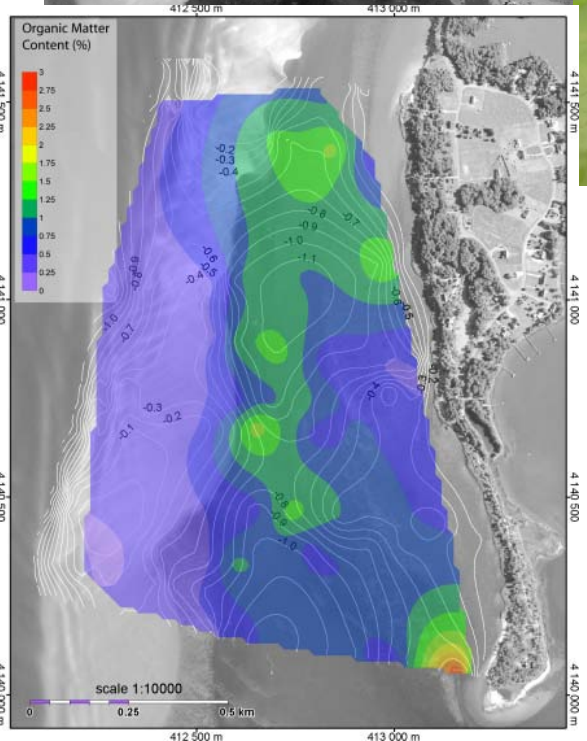
What do sandbars have that breakwaters don't?

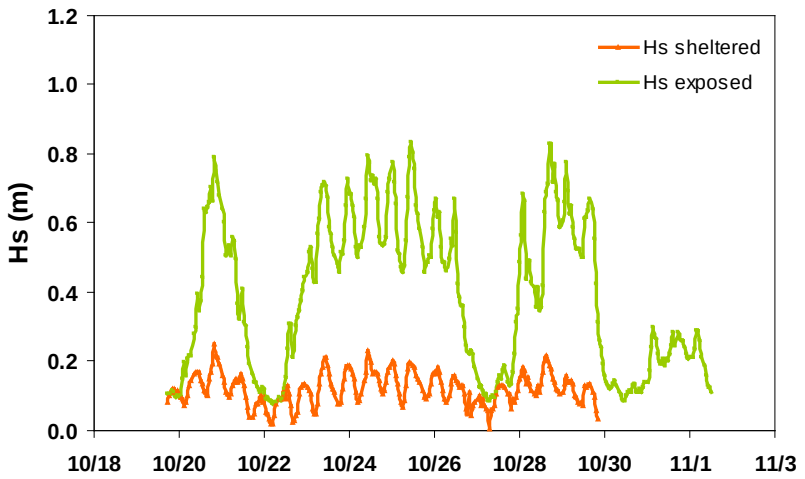


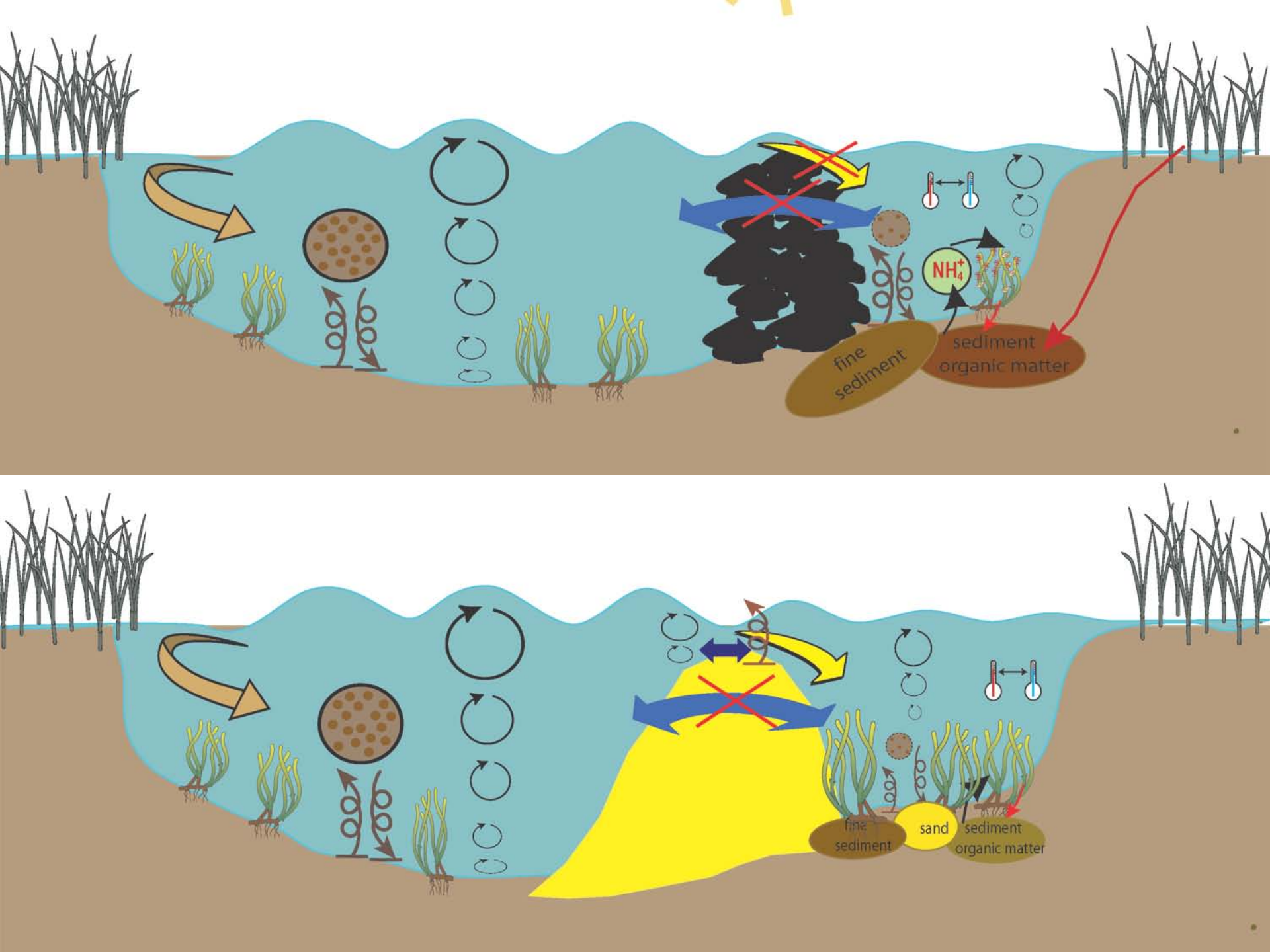




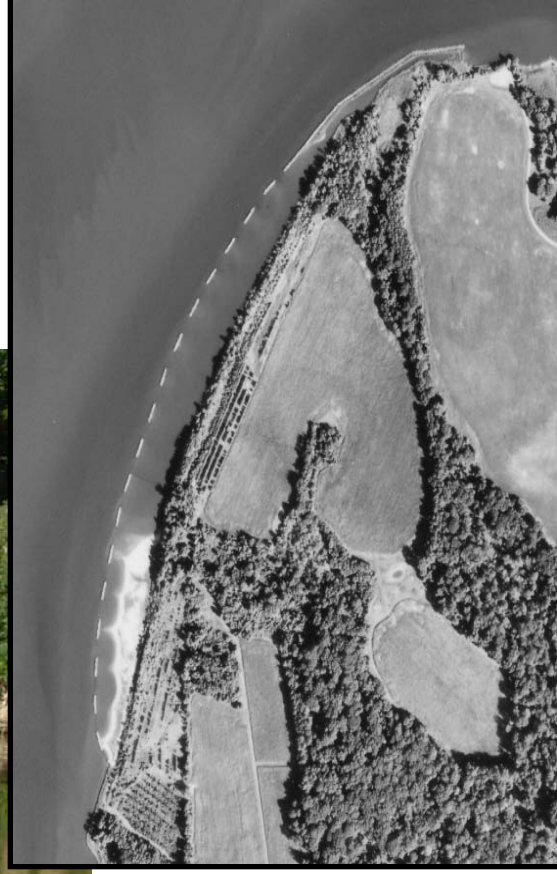

October 2006
Deposition Rate (mg cm-2 hr-1)
Transect A
Transect B
Transect C
Transect D
Transect E
ND
Distance from shoal (m)
Sand
Mud


Organic Matter Content (%)
scale 1:10000
412 500 m
413 000 m
4 141 500 m
4 141 000
4 140 500
4 140 000 m

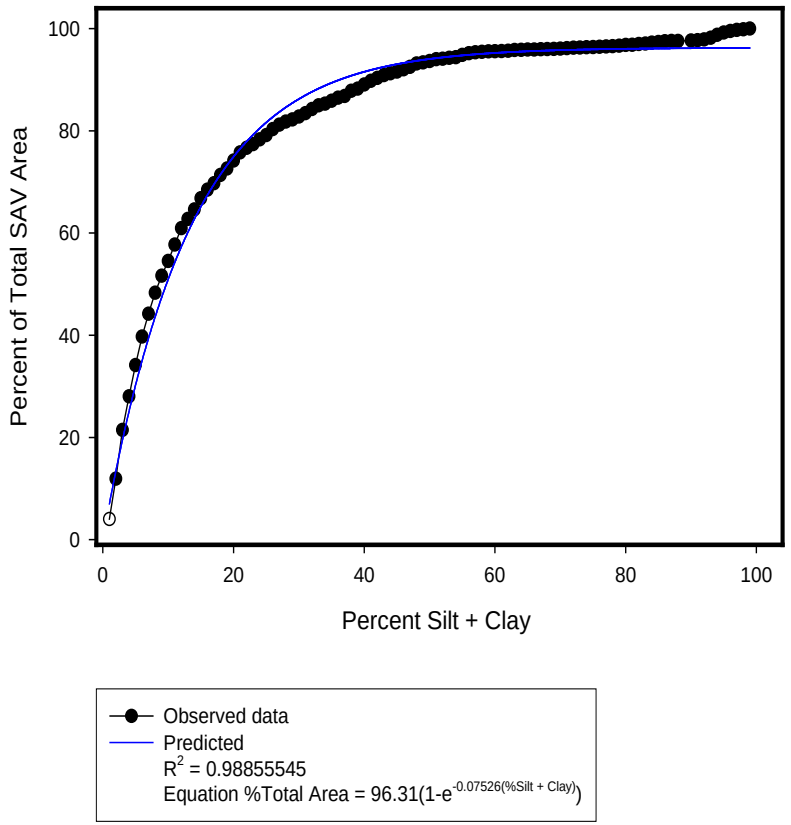

Hs sheltered
Hs exposed
Hs (m)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10/18
10/20
10/22
10/24
10/26
10/28
10/30
11/1
11/3

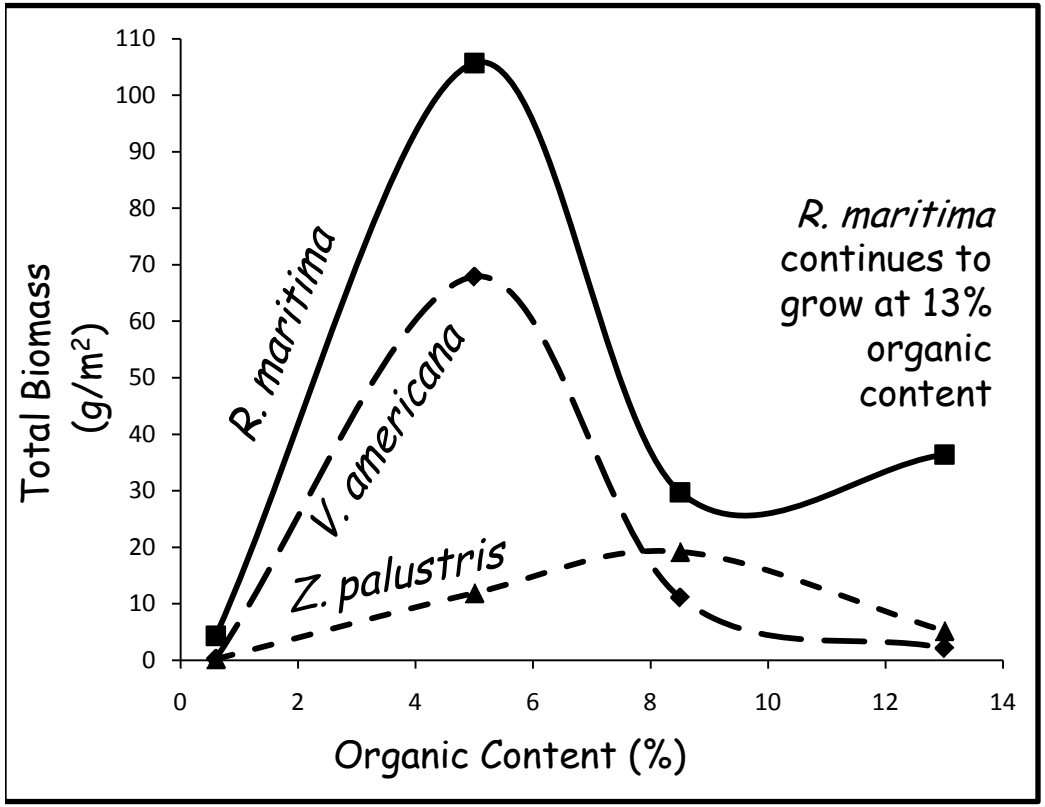

NH_4^+
fine sediment
sediment organic matter
fine sediment
sand
sediment organic matter

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.

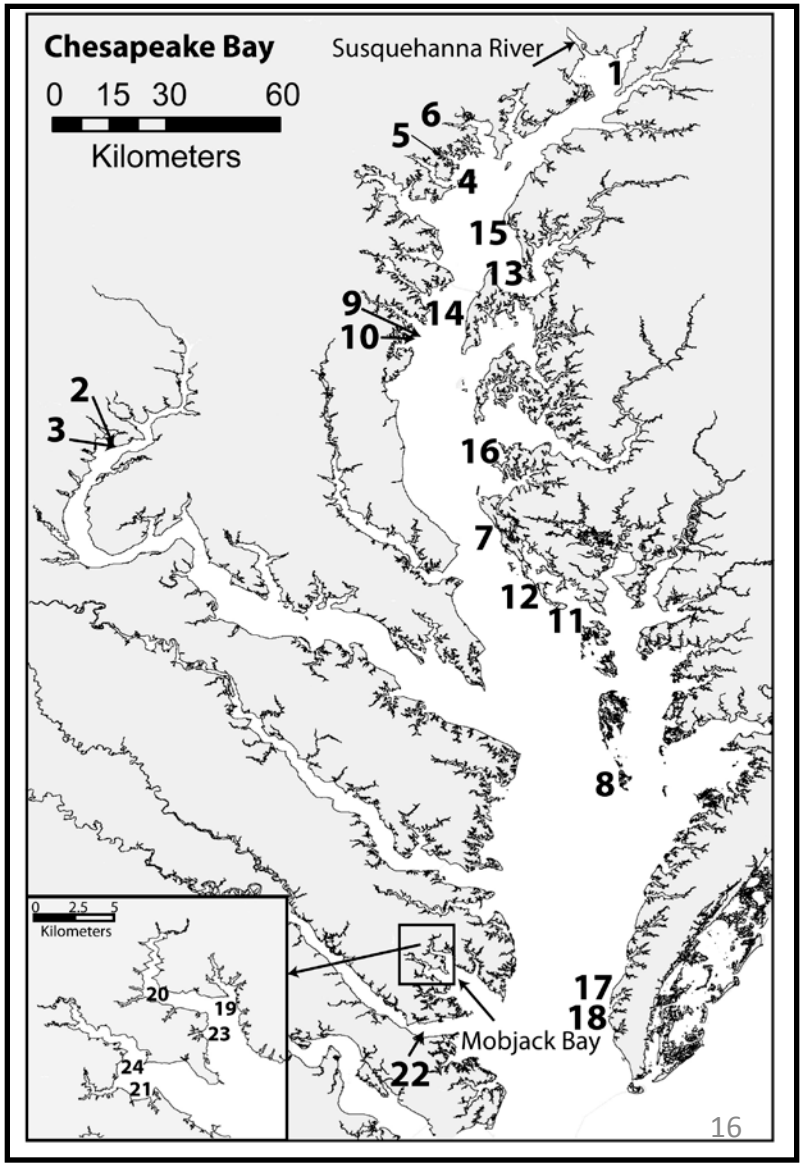




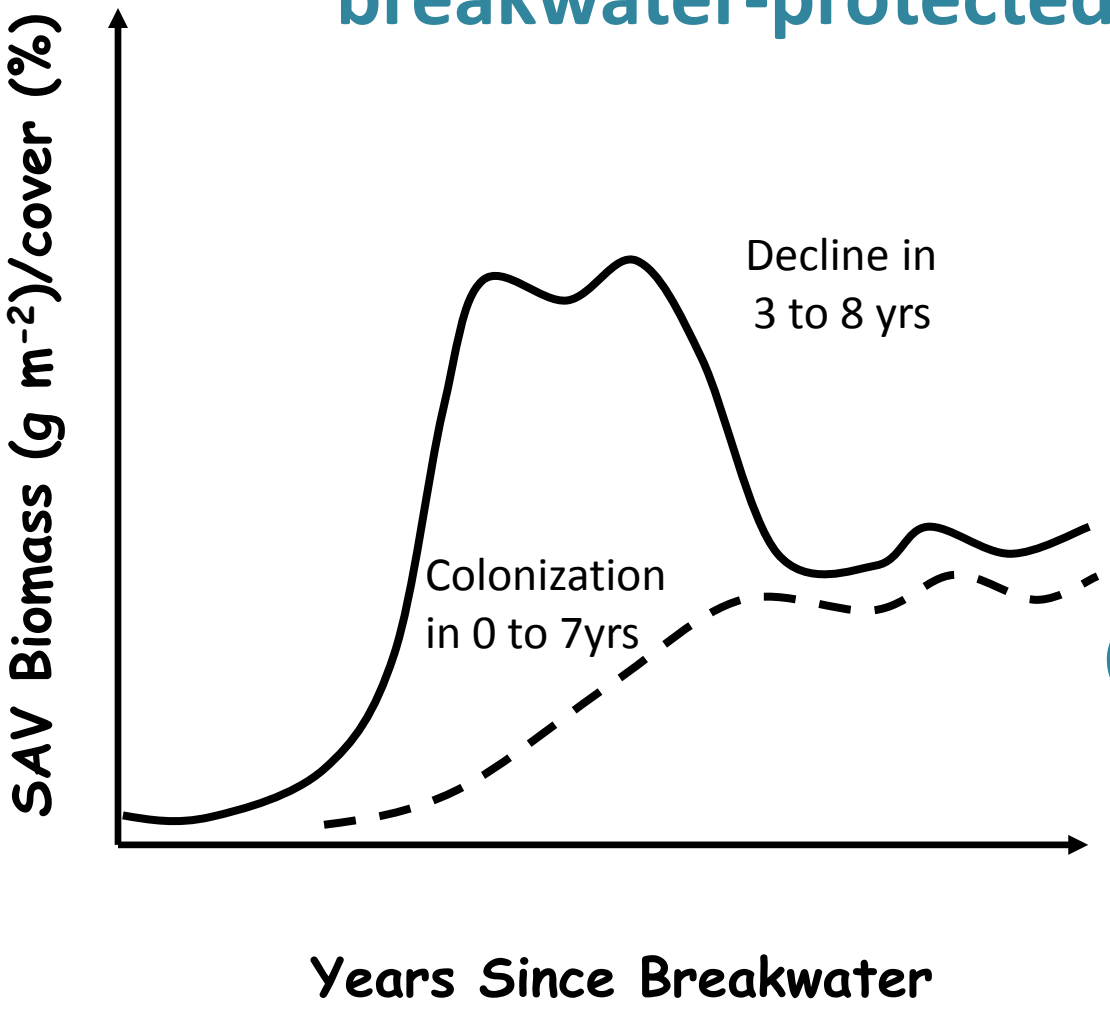
Sufficient water depth and a fine equilibrium of sand input is necessary for the successful colonization of SAV in breakwater-protected areas.

24 breakwaters in Chesapeake Bay

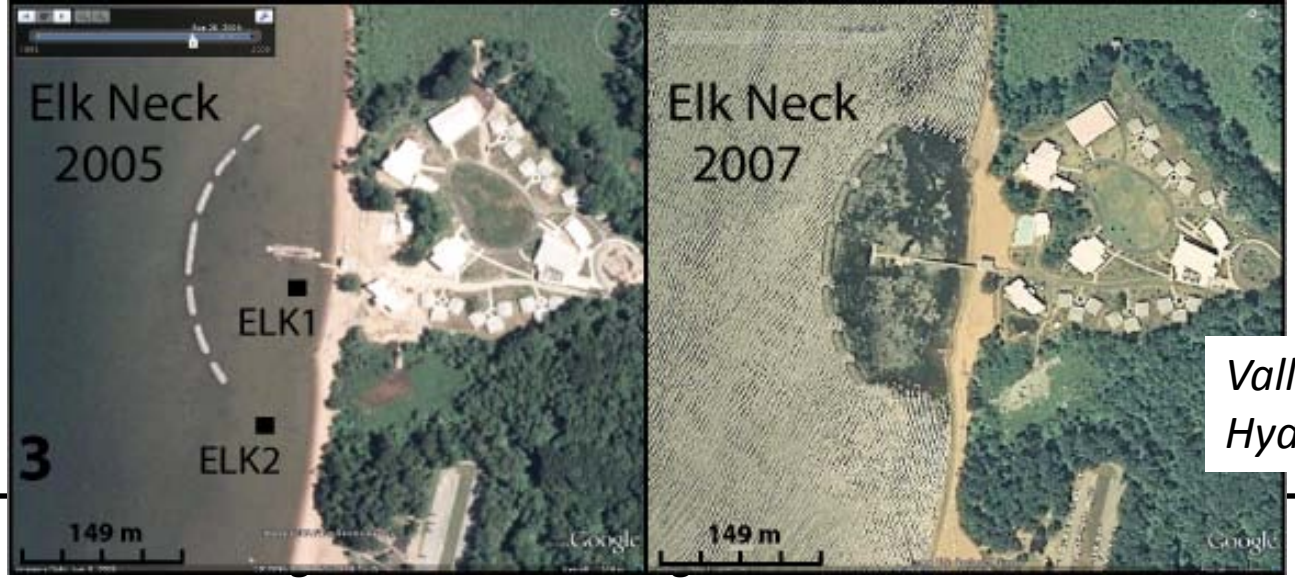
- SAV-vegetated
  (currently or in the last 20 y)
- ages from 0 to 20 yrs



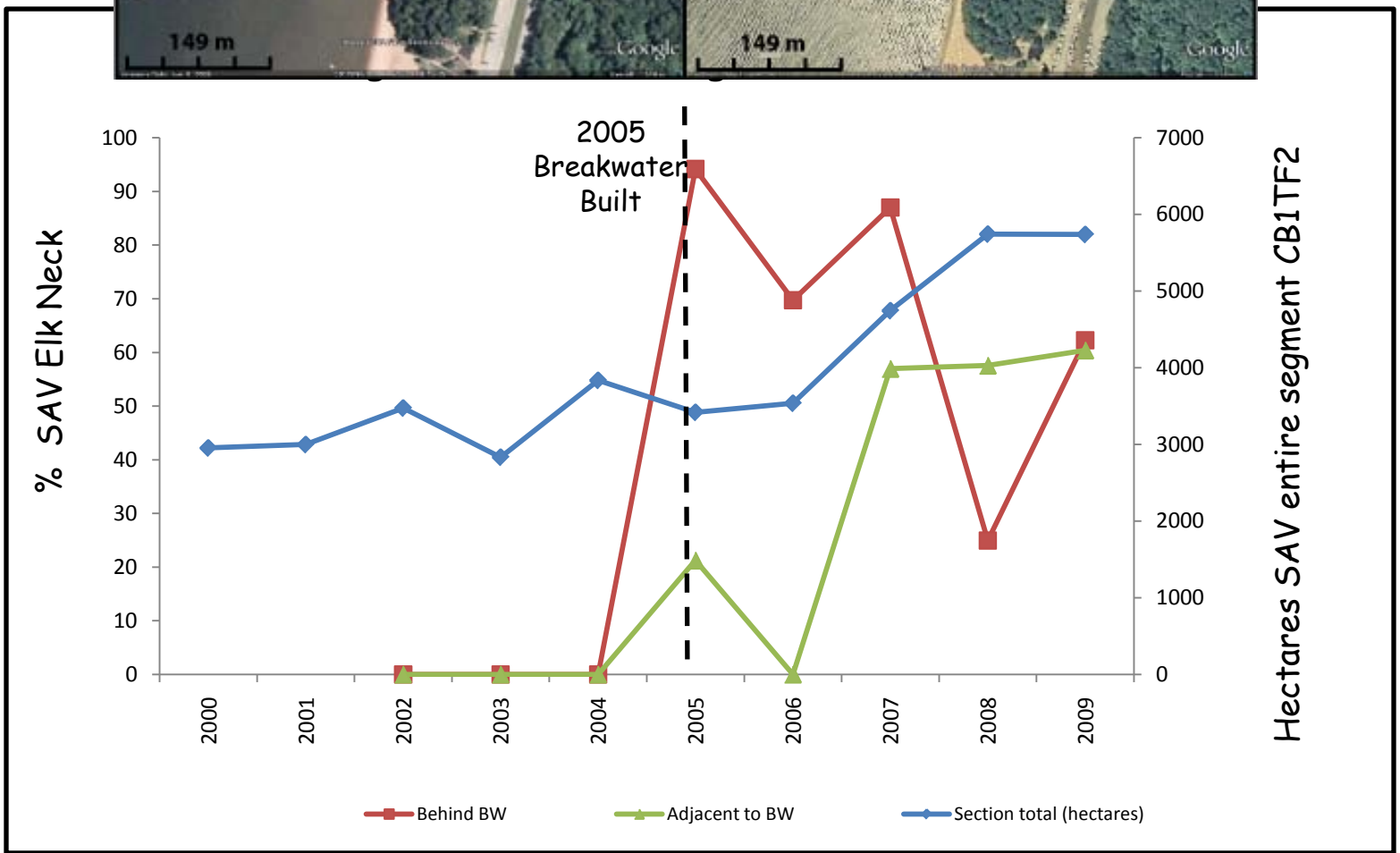
Initial colonization of SAV in breakwater-protected areas



growth stabilizes at sub-optimal levels (patchy vegetation)

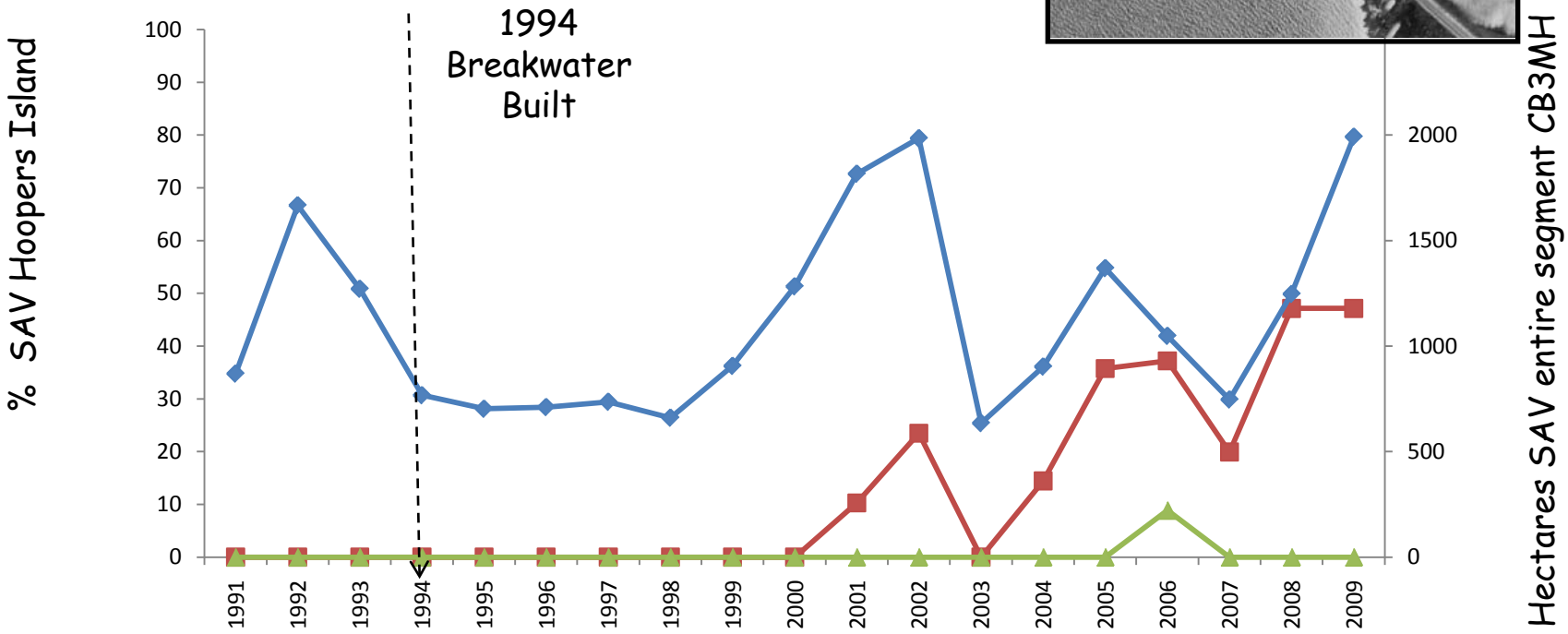


Vallisneria americana
Hydrilla verticilata

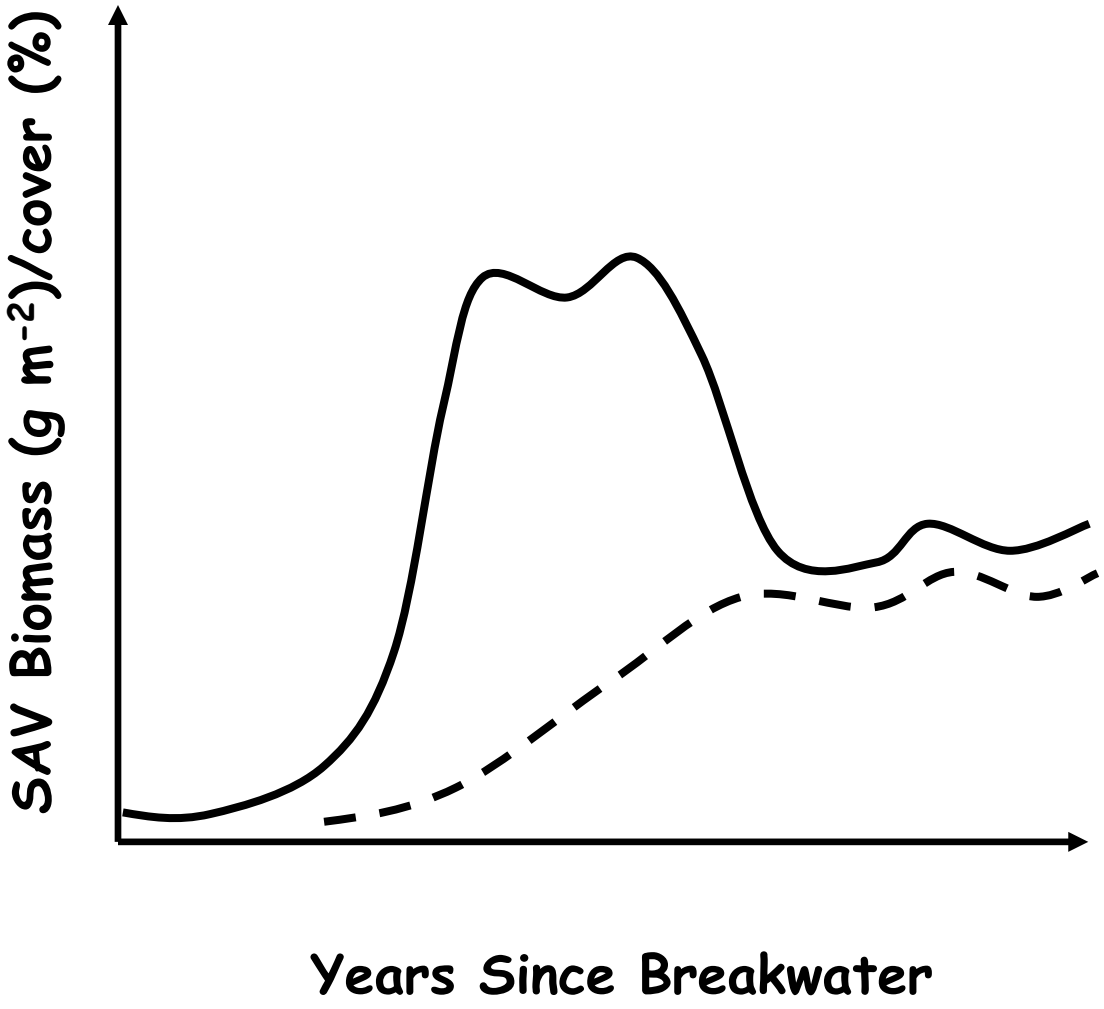


Ruppia maritima
Zostera marina

Segment SAV coverage vs. Hoopers Island

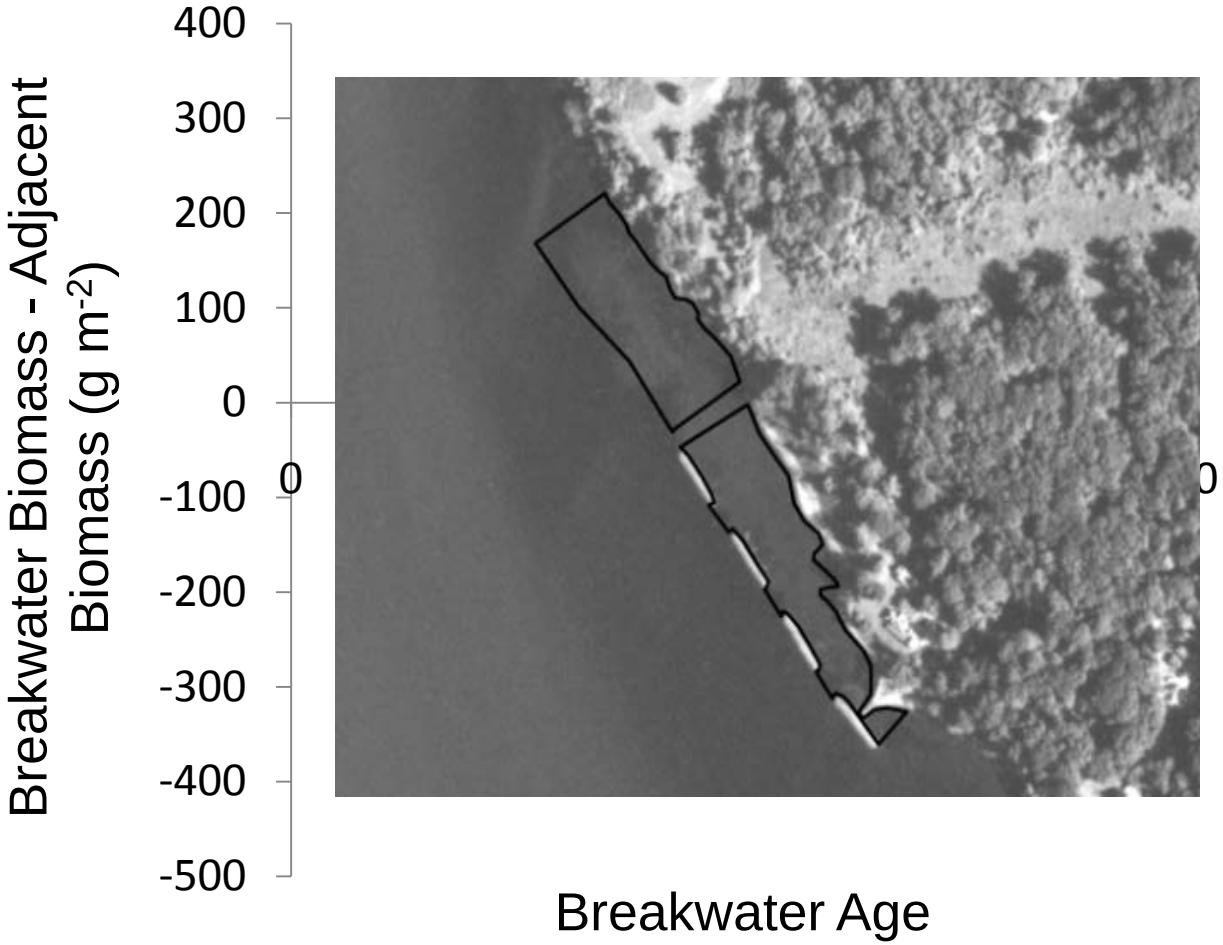


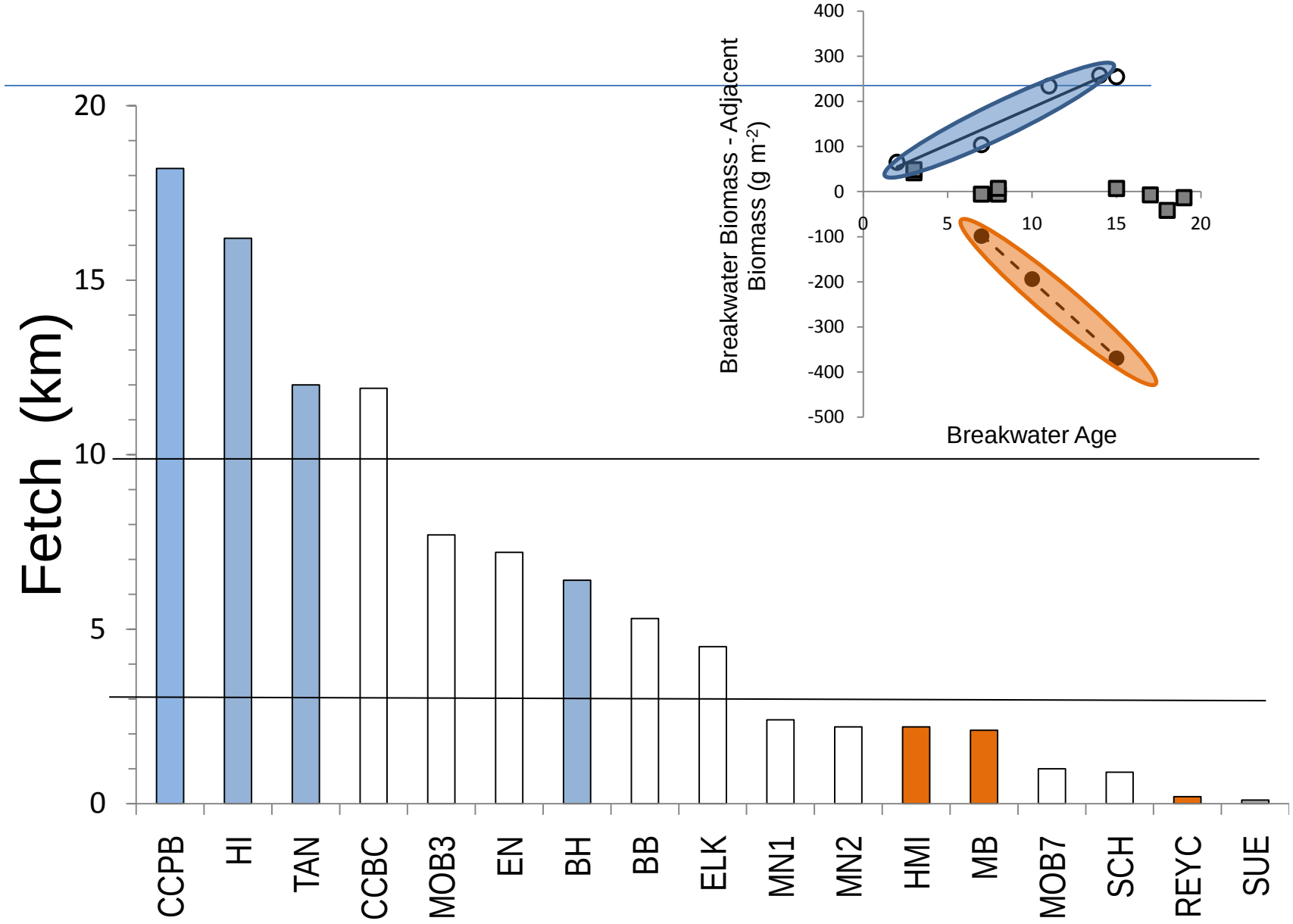
Initial colonization



- 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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