Restoring and Sustaining Ecological Function in Coastal Marshes Affected by Sea Level Rise – WU Reasoning

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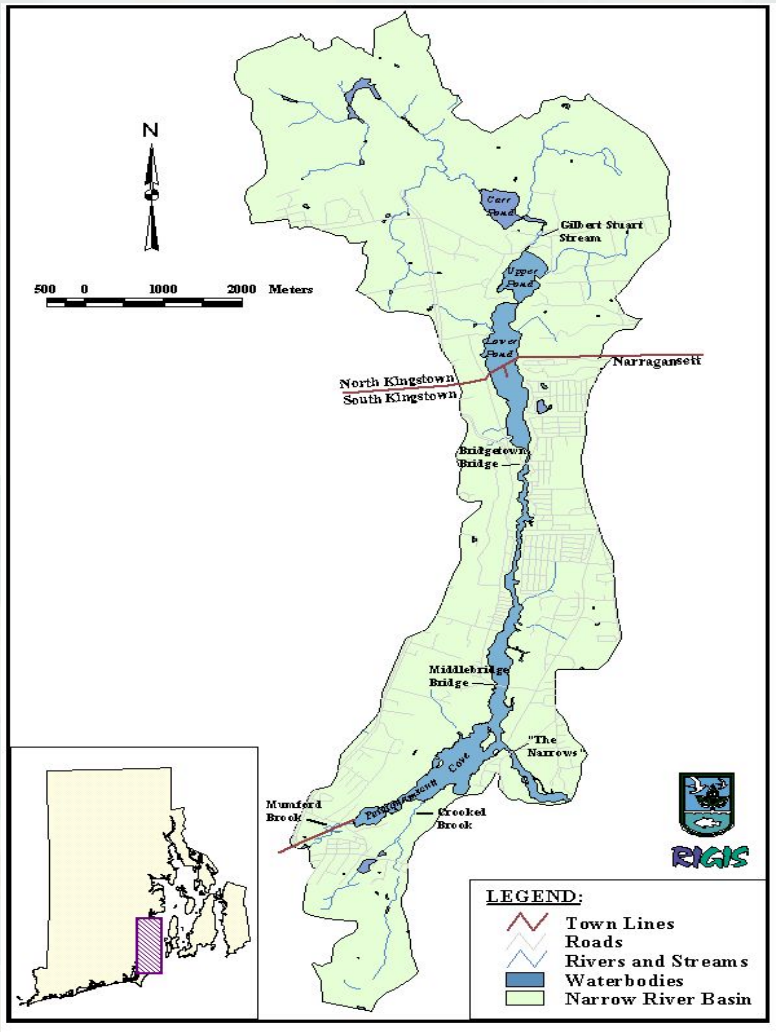
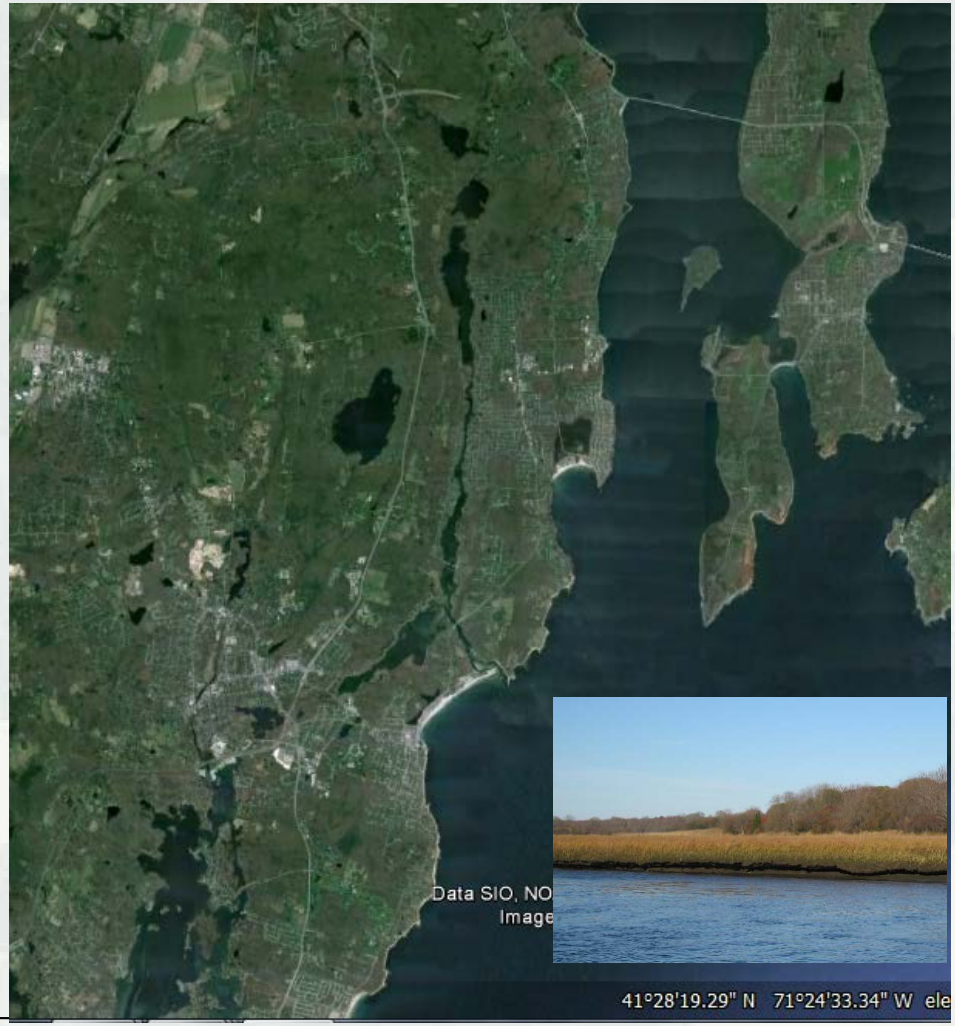
SON: Techniques and Methods for Salt Marsh Restoration to Account for Sea Level Rise

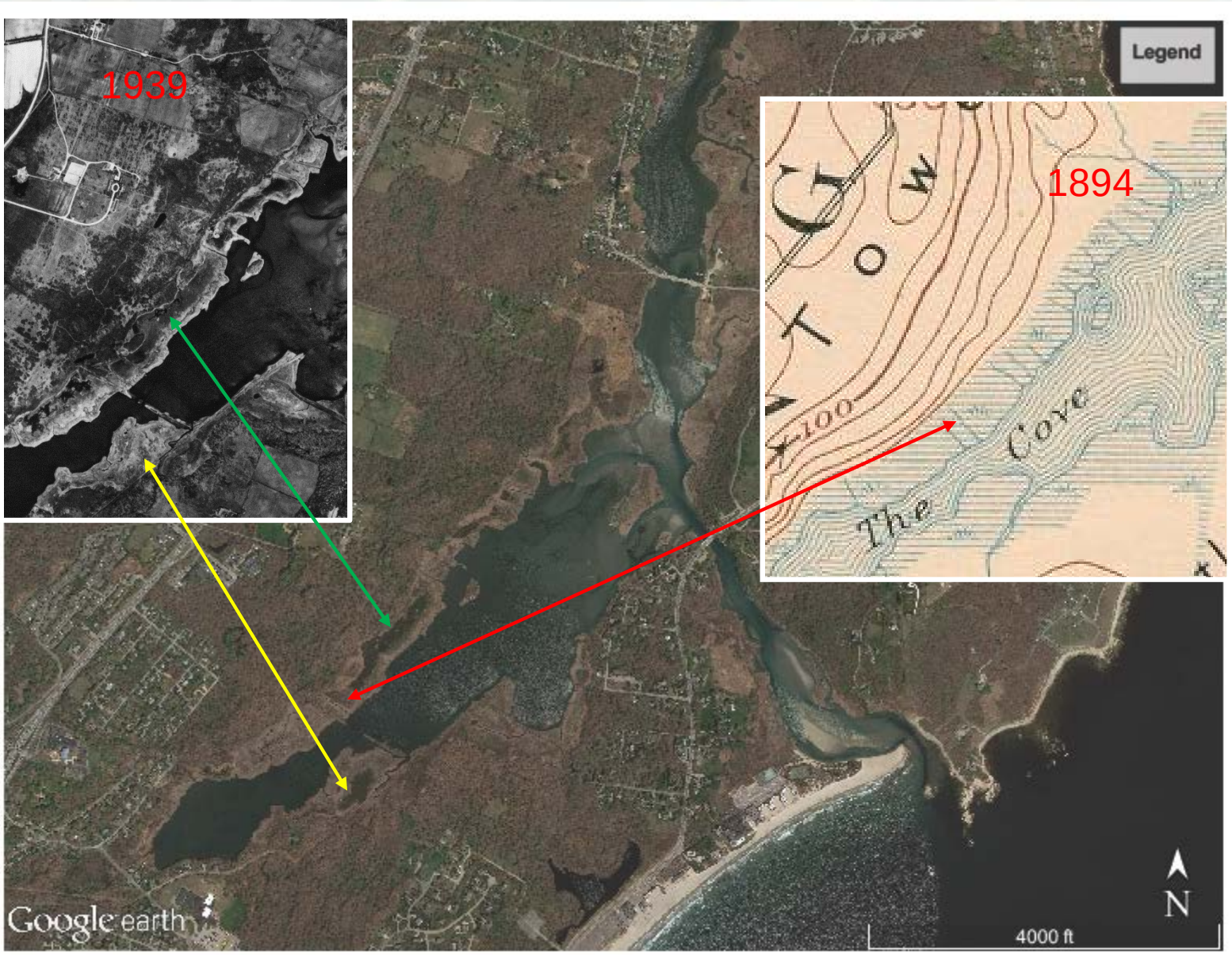
- Three questions:
  - Is there a problem?
  - How do we define the problem for a particular site?
  - Are we addressing the right problem the right way for the site?

Narrow River





Narrow River – 1939 - 2016



What Should a Marsh Look Like?

Ditched – a lot of salt meadow

Unditched – a lot of short *S. alterniflora*

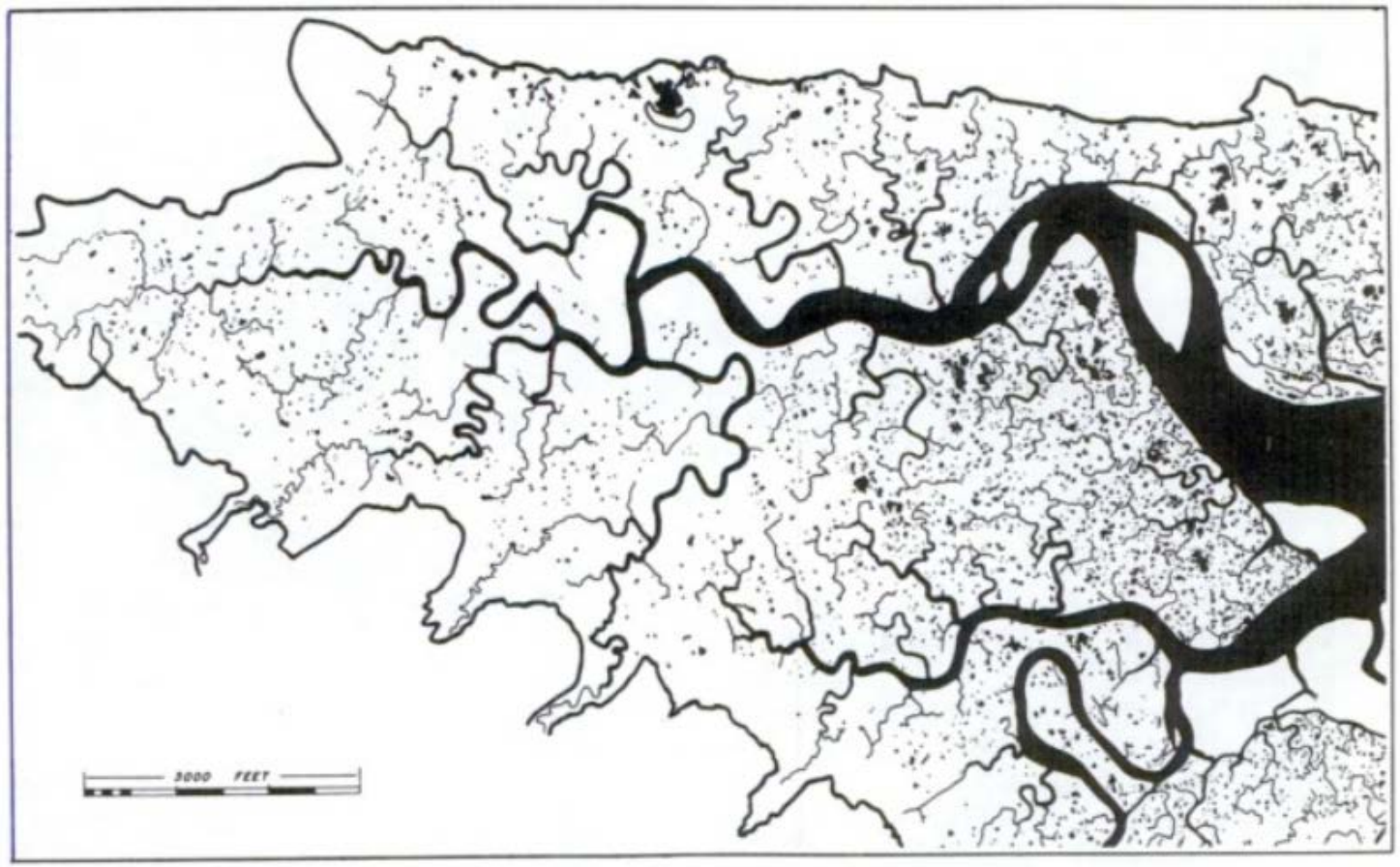


Figure 13. Dark areas represent the distribution of pond holes or pannes and tidal creeks on the high marsh at Barnstable, Cape Cod (Redfield 1972). The marsh on the left and in the foreground where fewer of these features are found is older accord to ^{14}C dating.

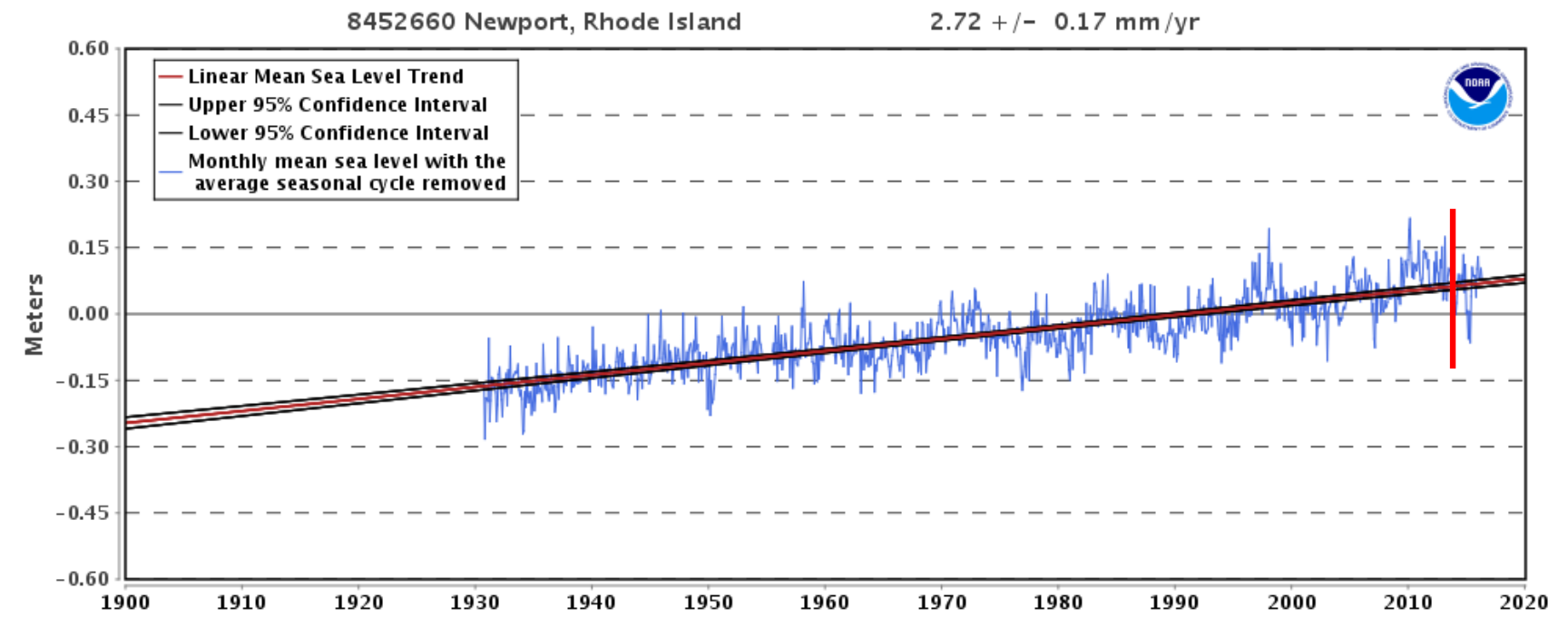
Redfield, A.C. 1972. Development of a New England salt marsh. Ecological monographs, 42:201-237. in Nixon, S.W. 1982. The Ecology of New England High Salt Marshes: A Community Profile. FWS/OBS-81-55. U.S. Fish and Wildlife Service. Office of Biological Services, Washington, D.C. 70 pp.


Google earth
3000 ft

Northeast Sea Level Rise

- Hotspot of accelerated sea level rise on the Atlantic coast of North America (Sallenger, Doran, & Howd, 2012)

Newport, RI Sea Level Trend



The mean sea level trend is 2.72 millimeters/year with a 95% confidence interval of +/- 0.17 mm/yr based on monthly mean sea level data from 1930 to 2015 which is equivalent to a change of 0.89 feet in 100 years.

When we ran this on 1/31/2014 it was 2.58 mm/yr and 0.85 ft in 100 years.

Accretion Rates – Nixon 1982

- "It is hard to know if this suggests a natural upper limit of about 10 to 12 mm/yr beyond which marshes cannot, on the average, keep pace. The more correct conclusion may be that, given an adequate sediment supply, the marsh grasses themselves are capable of dealing with very rapid rates of sea level rise."

Nixon, S.W. 1982. The Ecology of New England High Salt Marshes: A Community Profile. FWS/OBS-81-55. U.S. Fish and Wildlife Service. Office of Biological Services, Washington, D.C. 70 pp.

Nature Article Findings

- "There are relatively few examples of marsh loss in the historical record that are directly attributable to sea-level rise because feedbacks between flooding, plant growth and elevation change tend to stabilize submerging wetlands."

Kirwan & Megonigal, Nature, Vol. 504, 2013

Marshes Are Changing

- If it’s not just sea level rise, what is it?

Nature Article Findings

- "Regions of the world with drastic wetland deterioration occur mainly in areas in which humans have accelerated subsidence rates and/or decreased sediment delivery rates to the coast (for example, coastal Louisiana, the Venice Lagoon and Chesapeake Bay)."

- the present and future are characterized by higher atmospheric carbon dioxide concentration, plant-available nitrogen, temperature and introductions of new plant and animal species, all of which influence the major natural feedback processes that stabilize tidal wetland ecosystems.

Kirwan & Megonigal, Nature, Vol. 504, 2013

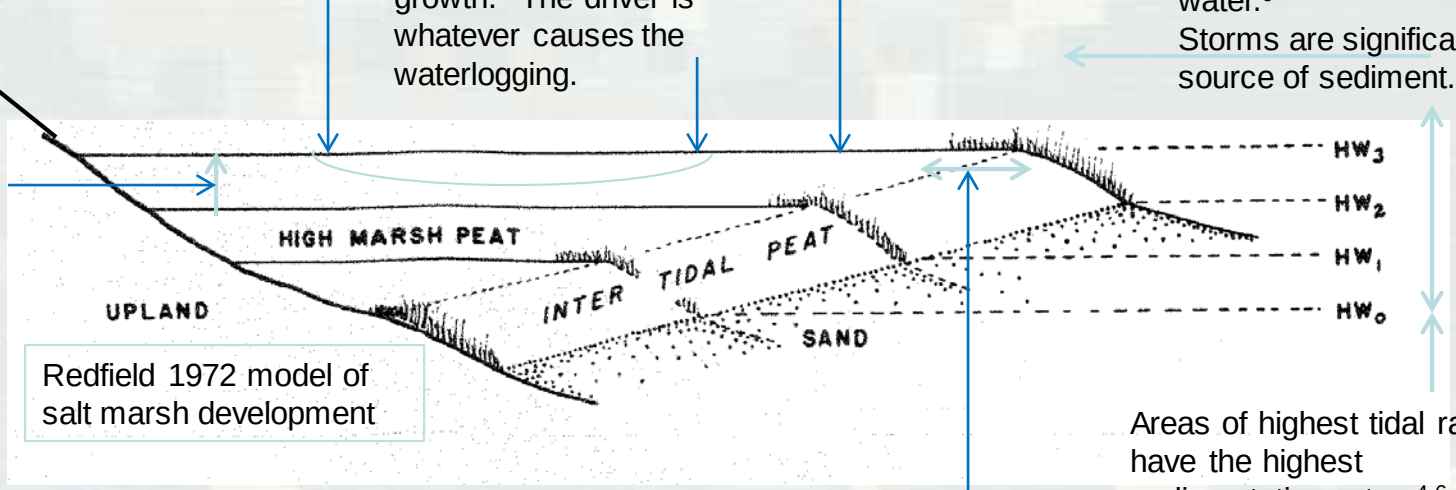
Upland sediment source – influenced by land use and sediment management practices

More than 60% of Barnstable marsh studied by Redfield in 1972 was short *S. alterniflora*.[1] With fertilization, *S. alterniflora* competitively displaces *S. patens*[2] and the alteration of hydrology caused by the change to *S. alterniflora* allows it to persist.[3]

Waterlogging decreases plant growth.[9] The driver is whatever causes the waterlogging.

Sediment deposition is limited by the availability of suspended sediment and the opportunity for it to be transported onto the marsh surface.[10]

Estuary sediment source
Suspended sediment concentration decreases with distance from open water.[6]
Storms are significant source of sediment.[6]



Redfield 1972 model of salt marsh development

High marsh must have sufficient inundation, sediment input (to maintain bulk density), and plant growth to accrete with SLR. High marshes have kept pace with up to 7 mm/yr in the short term.[5]

SLR – ~2.5 mm/yr

Areas of highest tidal range have the highest sedimentation rates.[4,6] Higher tide range correlates with higher primary productivity.[7] The amount of tidal energy (tide range) is important in determining the rate of marsh accretion.[8]

Creekbank levees cause bi-directional flow of soil water[3]

Timeline

BUILDING STRONG®

Invasive Species Increase	~1980
Farms Replaced by Forest & Homes	~1940s
Grid Ditching	~1930s
Dredging	~1800s
Gilbert Stuart Dam Constructed	1757
Farms Established	~1600s
RI First Settled	1636
Narrow River SMs Established	~600 yrs BP
Salt Water Enters Narrow River	~2,000 yrs BP
NE Salt Marshes Established	~3-4,000 yrs BP

Systemic Solutions

Dams and reservoirs now prevent about 20% of the global sediment load from reaching the coast.

Because mineral sediment availability is a primary driver of wetland building, changes in sediment delivery rates have large impacts on marsh sustainability. (Kirwan & Megonigal, Nature, Vol. 504, 2013)

Summary

- The drivers of salt marsh loss are complex
- There are potential adverse effects of placing dredged material on salt marshes
- Research and information is needed to guide decision making