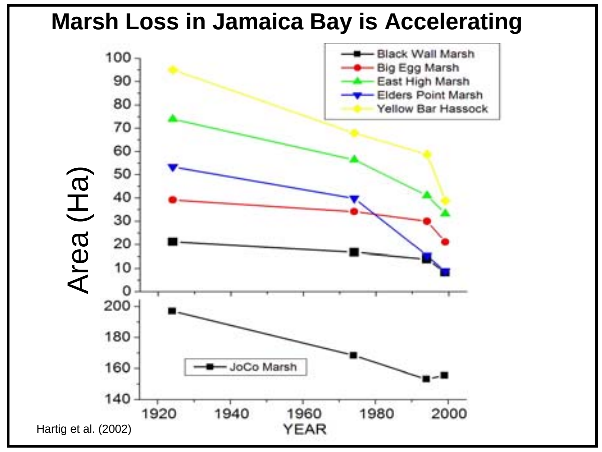
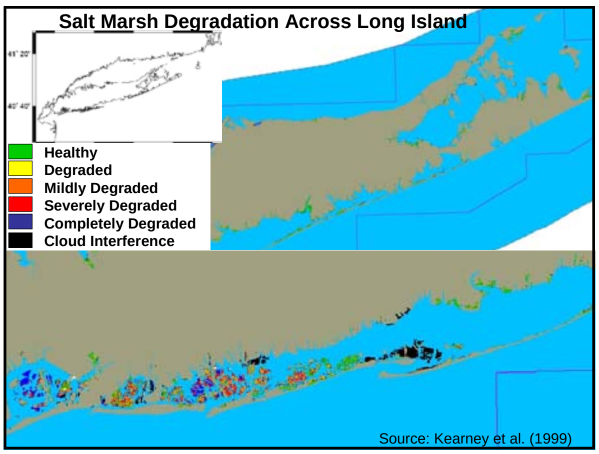
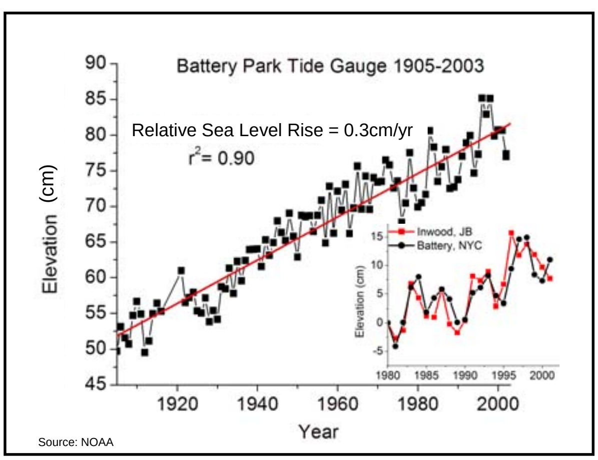
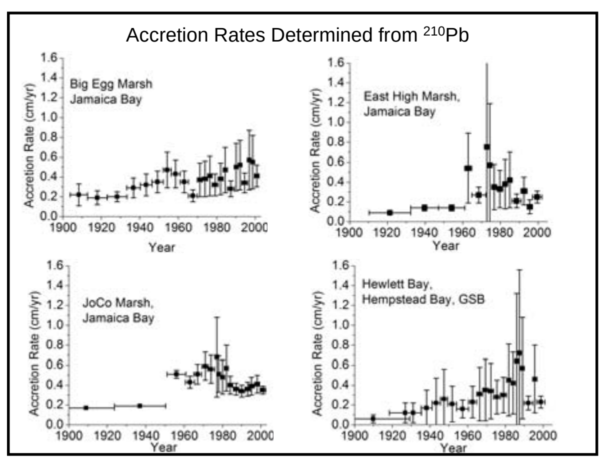




Hypothesis I

- Salt marsh loss occurs in environments where accretion rates do not keep pace with sea level rise.
- Marshes with the slowest accretion rates should have the fastest rates of marsh loss.

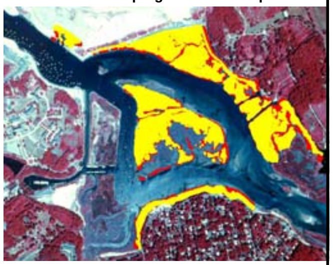


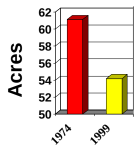


NYSDEC GIS Methodology

- Aerial photographs were taken in 1974 and again in 1998, 1991, or 2001.
- Photographs were taken within 2 hrs of low tide.
- Photographs were georeferenced to 1994 NY State Digital Orthophotos, NAD (1983).
- Vector polygons, representing the tidal wetland boundaries were digitized over the images and analyzed for trends in ArcView 3.2 with an accuracy of ~ 1 meter.

1974 - 1999 Nissequogue River Comparison



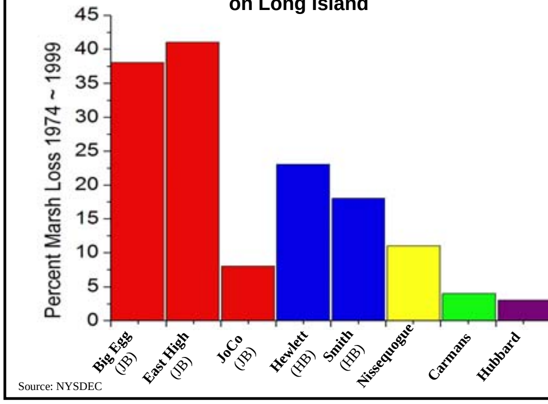


1974 : 61.14 acres
1999 : 54.18 acres

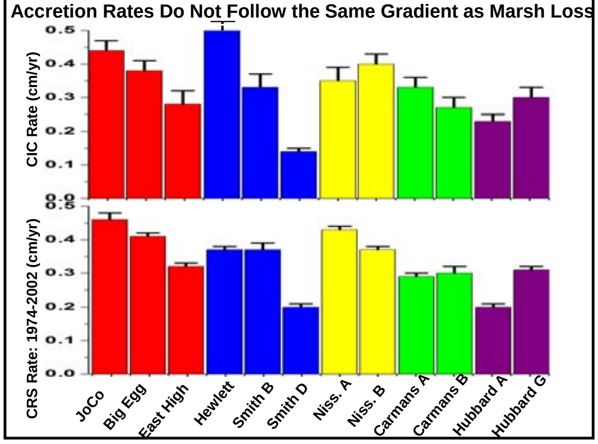
-6.96 acres

= 11.4% lost
= 0.5% lost/year
= 0.28 acres/yr

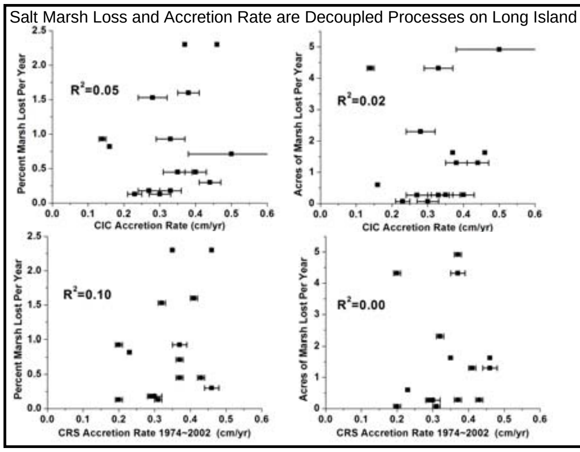
Marsh Loss typically follows a West-East Gradient on Long Island



Accretion Rates Do Not Follow the Same Gradient as Marsh Loss



Salt Marsh Loss and Accretion Rate are Decoupled Processes on Long Island



Findings I

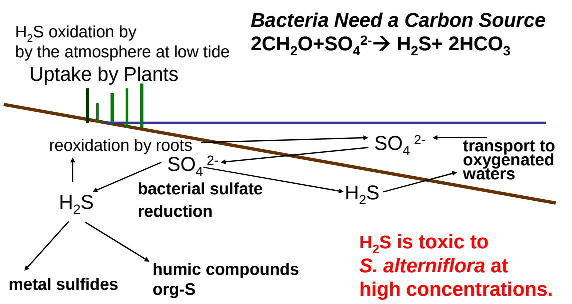
- Salt marsh loss and accretion rates are independent processes Long Island and New York City salt marshes. This suggests that the primary cause of marsh loss in these settings is not an inability of the marshes to keep pace with rates of sea level rise.
- Instead, marsh loss rates on Long Island appear to follow the gradient in population density.

Are there biological or chemical mechanisms for salt marsh loss?

- Sulfide (H_2S) is toxic to *S. alterniflora* at high concentrations.
- *S. alterniflora* has the ability to oxygenate its roots, thereby detoxifying sulfide. However, these abilities are limited.
- When *S. alterniflora* dies its roots collapse, which can lead to an irrecoverable loss in marsh elevation.
- Sulfur cycling is closely coupled to organic matter inputs.

Selected Sources: DeLaune et al., (1994); Koch et al., (1990); Howarth, (1984); Berner (1980)

Sulfur cycling in a salt marsh



Hypothesis II

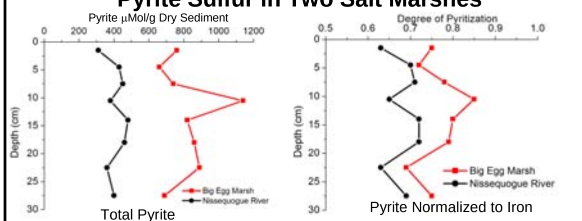
- **Marsh loss greatest in areas with elevated sulfide concentrations.**

•Pyrite (FeS_2) concentrations are a good indicator of seasonal porewater sulfide concentrations. The degree of pyritization (DOP) is an indicator of the capacity of marsh sediments to continue to sequester porewater sulfide.

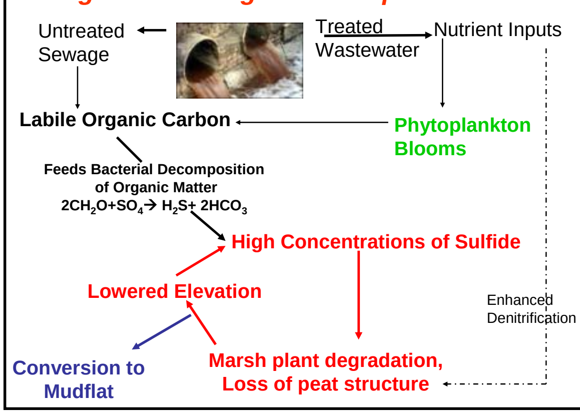
•Pyrite concentrations and DOP values are reported for two marshes, Big Egg Marsh in Jamaica Bay and the Nissequogue River marshes in central Long Island Sound. Both marshes are meso-tidal environments with tall form *S. alterniflora*. They differ in their levels of marsh loss.

Selected Sources: Howarth, (1984); Berner (1980), Kolker (2005)

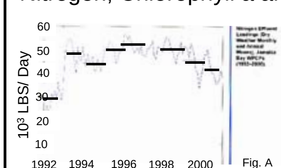
Pyrite Sulfur in Two Salt Marshes



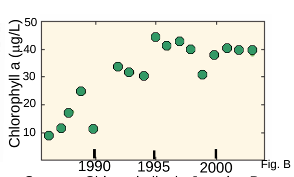
Organic Loading and the Spiral of Doom!



Nitrogen, Chlorophyll a and Marsh Loss In Jamaica Bay



Dry Weather Nitrogen Effluent to Jamaica Bay



Summer Chlorophyll a in Jamaica Bay

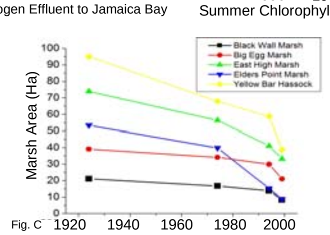


Fig. C

Sources: Fig A,B: NYCDEP
Fig. C: Hartig et al. (2002)

Findings II

- Big Egg Marsh in Jamaica Bay has elevated pyrite concentrations and a higher degree of pyritization relative to a stable site in the Nissequogue River. This suggests that Jamaica Bay salt marshes are regularly exposed to higher concentrations sulfide and less resilient to sulfide stress than Nissequogue River marshes.
- The positive feedback loop in the "Spiral of Doom" model may explain the chronology and geography of marsh loss in Jamaica Bay.
- While salt marsh loss in Jamaica Bay is probably the result of multiple processes, changing nitrogen dynamics and their subsequent impacts to sulfur cycling may best explain observed pattern marsh loss.
- Ongoing research seeks to fully test this model.

Acknowledgements

- **Steve Goodbred**
- **Kirk Cochran**
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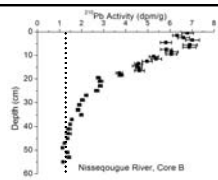
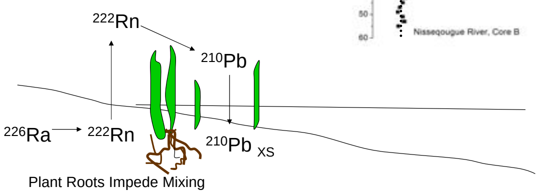
- **Vivien Gornitz**
- **Larry Swanson**
- **Jamaica Bay Science Board**
- **Marine Sciences Research Center**

Extra Slides

^{210}Pb Pathways in a Salt Marsh

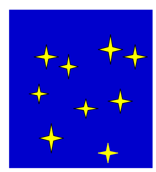




^{210}Pb ← ^{222}Rn ← ^{226}Ra
(Supported)

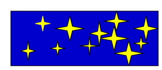
The Constant Rate of Supply Model

Isotope Dilution and Enrichment $Q_x = Q_0 e^{-\lambda t}$



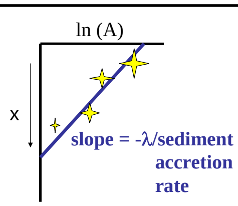
High sediment load dilutes the isotopic signal, fast marsh accretion rate.

Low sediment load yields an enriched isotopic signal, slow marsh accretion rate.

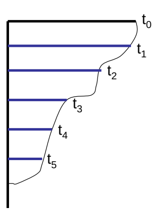


Q_x = $^{210}Pb_{xs}$ Inventory below depth x (dpm/cm^2)
Q_o = $^{210}Pb_{xs}$ Inventory in the core (dpm/cm^2)
λ = Radioactive decay constant (.693/22.3yr)
t = Age of Interval x (years)

Method 1: The Constant Initial Concentration (CIC) Model.
Assumes that sediment deposited at the surface always has the same activity of ^{210}Pb. Yields 1 accretion rate for a period of ~100yrs.



Method 2: The Constant Rate of Supply (CRS) Model.
Assumes that the ^{210}Pb to the marsh surface is time invariant, though the sediment flux may vary. It yields a chronology of accretion rates, which are reported for 1974~2002 in the present study.



5-5 Estimated Changes in the Effluent Derived Sulfur Flux to Jamaica Bay Salt Marshes

Time	Nitrogen Inputs (Kg/Day Dry Weather)	Nitrogen input (Moles/Day Dry Weather)	Moles Carbon produced/day [1]	Moles of Carbon that land on sediment surfaces	Amount of Carbon Respired by SO_4^{2-} reduction	Moles of Sulfide Produced [4]	Sulfur flux[5] (moles/m^2/day)	Sulfur Flux g/m^2/yr)
Early 1990s	1.4×10^4	9.7×10^5	3.2×10^6	2.6×10^6 [2a]	1.3×10^6 [3a]	6.4×10^6	1.3×10^{-2}	150
Mid-Late 1990s	2.3×10^4	1.6×10^6	5.4×10^6	4.3×10^6 [2a]	2.2×10^6 [3a]	1.1×10^7	2.1×10^{-2}	250
Early 1990s	1.4×10^4	9.7×10^5	3.2×10^6	3.2×10^6 [2b]	3.2×10^6 [3b]	1.6×10^6	3.2×10^{-2}	370
Mid-Late 1990s	2.3×10^4	1.6×10^6	5.4×10^6	5.4×10^6 [2b]	5.4×10^6 [3b]	2.7×10^6	5.3×10^{-1}	610

1Assumes that 1/2 nitrogen input is fixed to phytoplankton with a stoichiometry of 6.6C:1N.
2a Assumes that 80% of freshly produced phytoplankton are deposited on marsh surfaces
2b Assumes that 100% of all freshly produced phytoplankton are deposited on marsh surfaces
3a Assumes that 50% of all carbon is respired by SO_4^{2-} reduction
3b Assumes that all 100% of all carbon is respired byo SO_4^{2-}
4 Assumes that 2 carbons used for every 1 sulfur
5 Based on an area of 51 km2,