NJ Tidal Marshes, *Phragmites*, and Sea Level Rise

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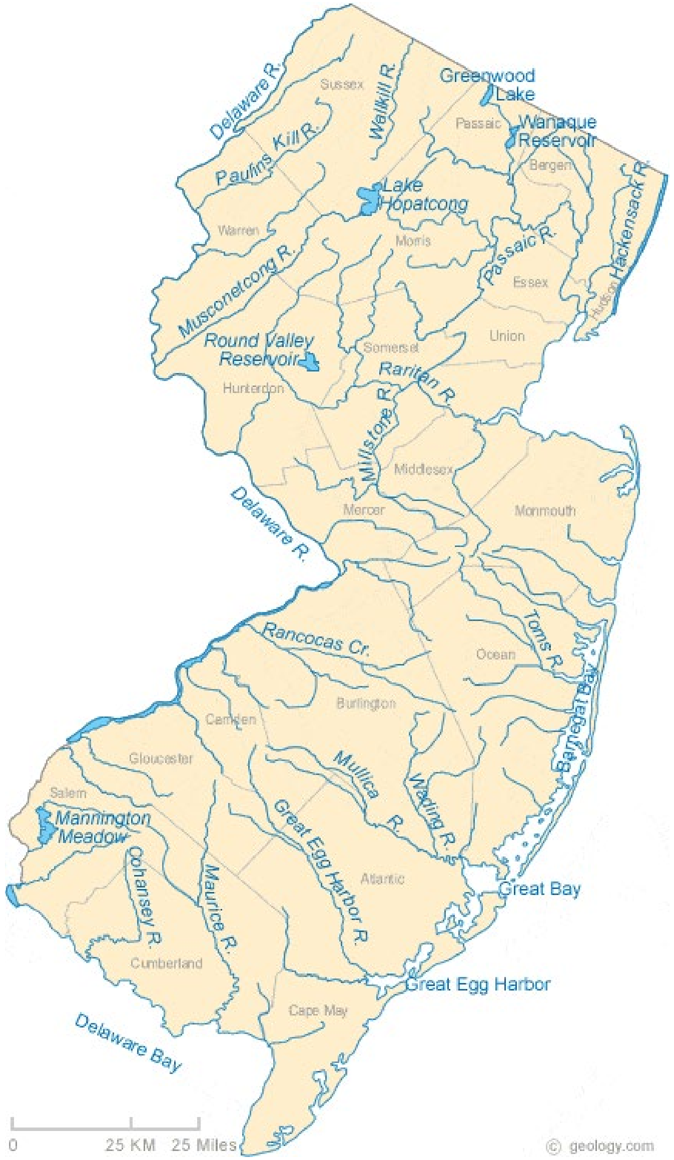
MARSHES

- RATE OF SLR IN NJ IN 2019 was 5-6 MM/YR
- WILL THEY KEEP UP WITH SLR BY ELEVATING OR MIGRATING INLAND?
- MANY DON’T GET ENOUGH SEDIMENT
- MANY IN DEVELOPED PART OF STATE DO NOT HAVE OPEN SPACE BEHIND THEM – “COASTAL SQUEEZE”
- INFORMATION FROM DELAWARE BAY, BARNEGAT BAY, MEADOWLANDS,
- EVALUTE POTENTIAL REMEDIES



Symptoms of a marsh in trouble

Sea level rise affecting marshes

Mostly marsh with some water

Becomes….

Mostly water with some marsh

Becomes…
Open water – no marsh

MARSHES

- WILL THEY KEEP UP WITH SEA LEVEL RISE BY GETTING MORE SEDIMENT TO ELEVATE OR BY MIGRATING INLAND, **IF** THERE IS OPEN SPACE UPLAND
- MANY MARSHES DON'T GET ENOUGH SEDIMENTS
- MANY MARSHES IN DEVELOPED PART OF THE STATE DO NOT HAVE OPEN SPACE BEHIND THEM – "COASTAL SQUEEZE"

Moving Forward to Save the Westport Rivers' Salt Marshes

If this marsh loss continues at the accelerated rate observed between 2012 and 2016, the marsh islands studied could disappear in 15 to 58 years (average 33 years). Reducing nitrogen pollution to the Westport Rivers will help salt marshes grow stronger, healthier root systems and enhance the stability of the marsh islands. Implementing nitrogen reduction recommendations, particularly for residential septic systems, should help improve the health and survival of the rivers' salt marsh islands.

For low-elevation marshes that are most susceptible to sea level rise, the town of Westport could explore the possibility of thin layer placement, a relatively new and somewhat experimental technology that artificially increases marsh height by placing new sediment on top of the existing marsh. This approach has had variable success in other places and needs further testing before widespread application is considered.

REFERENCES

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HABITAT – DELAWARE BAY 1778-2015 -HORIZONTAL

Study	Time period	Geographic area	Total Loss (acres)	Total Gains (acres)	Net Change	Annualized loss rate
PDE 2017	1996-2010	Delaware Bay	2,700	-	-1.8%	-0.13%
Smith et al. 2017	1931-2015	Delaware Bay, NJ	19,501	6,958	-15%	-0.18%
Carr et al. 2018	1778-1918	Delaware Bay	18,780		-8.2%*	-0.05%
Carr et al. 2018	1918-2011	Delaware Bay	36,572		-17.3%*	-0.19%
Carr et al. 2018	1975-2011	Delaware Bay	12,009		-6.4%*	-0.17%
Watson et al. 2019	1974-2015	NJ MACWA sites	3,108	2,446	-4.4%	-0.11%

Less loss than expected since considerable erosion seen. Marsh migrating upland into forests

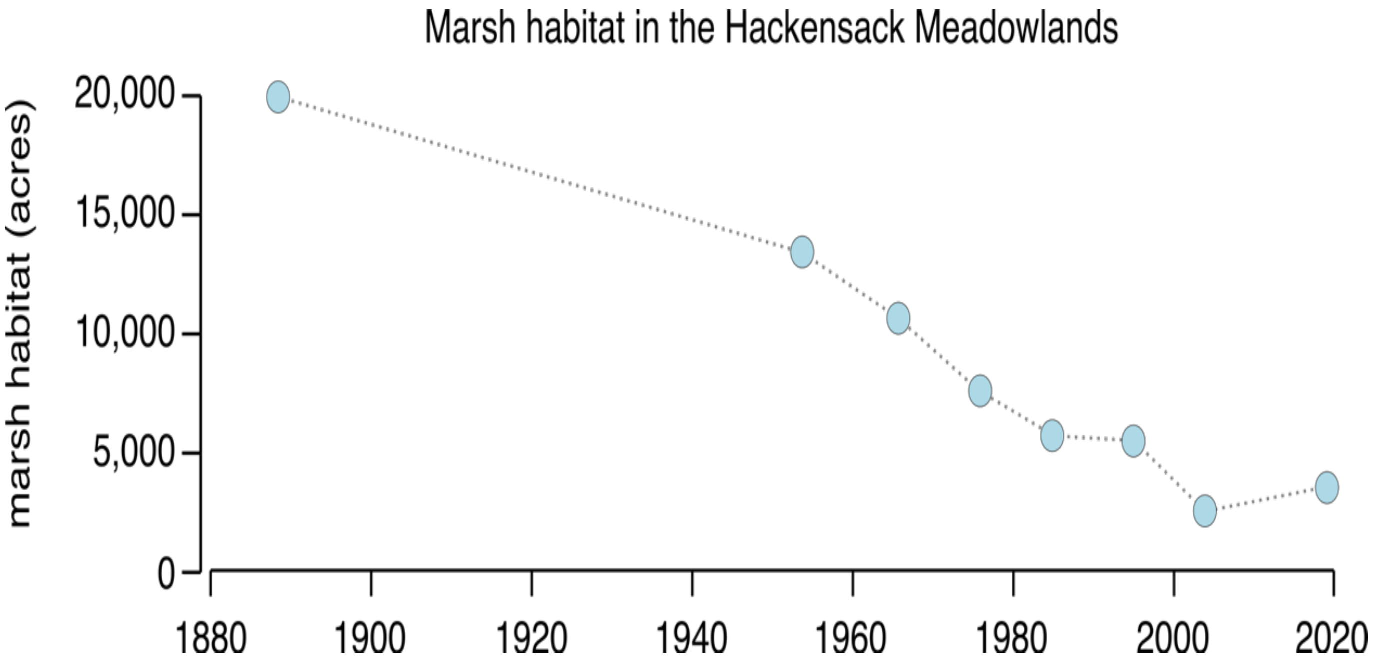
HABITAT- BARNEGAT BAY 1972-2012

Year	Tidal wetlands	Net loss*	Annualized loss rate	Source
1972	25,877 acres	-		Lathrop & Bognar 2001
1984	25,647 acres	-0.88%	1972-1984: 0.07% yr^{-1}	Lathrop & Bognar 2001
1995	24,564 acres	-1.3%	1984-1995: 0.38% yr^{-1}	Lathrop & Bognar 2001
2007	23,033 acres	-11.0%	1995-2007: 0.52% yr^{-1}	BBP 2016
2012	22,795 acres	-11.9%	2007-2012: 0.21% yr^{-1}	BBP 2016

HORIZONTAL EXTENT: MEADOWLANDS HABITAT

- Centuries of filling marshes for towns, industrial sites, garbage dumps.

Although SLR is undoubtedly affecting the marshes, estimating losses is difficult due to development that continues to reduce wetland acreage and restoration efforts which have increased wetland acreage.

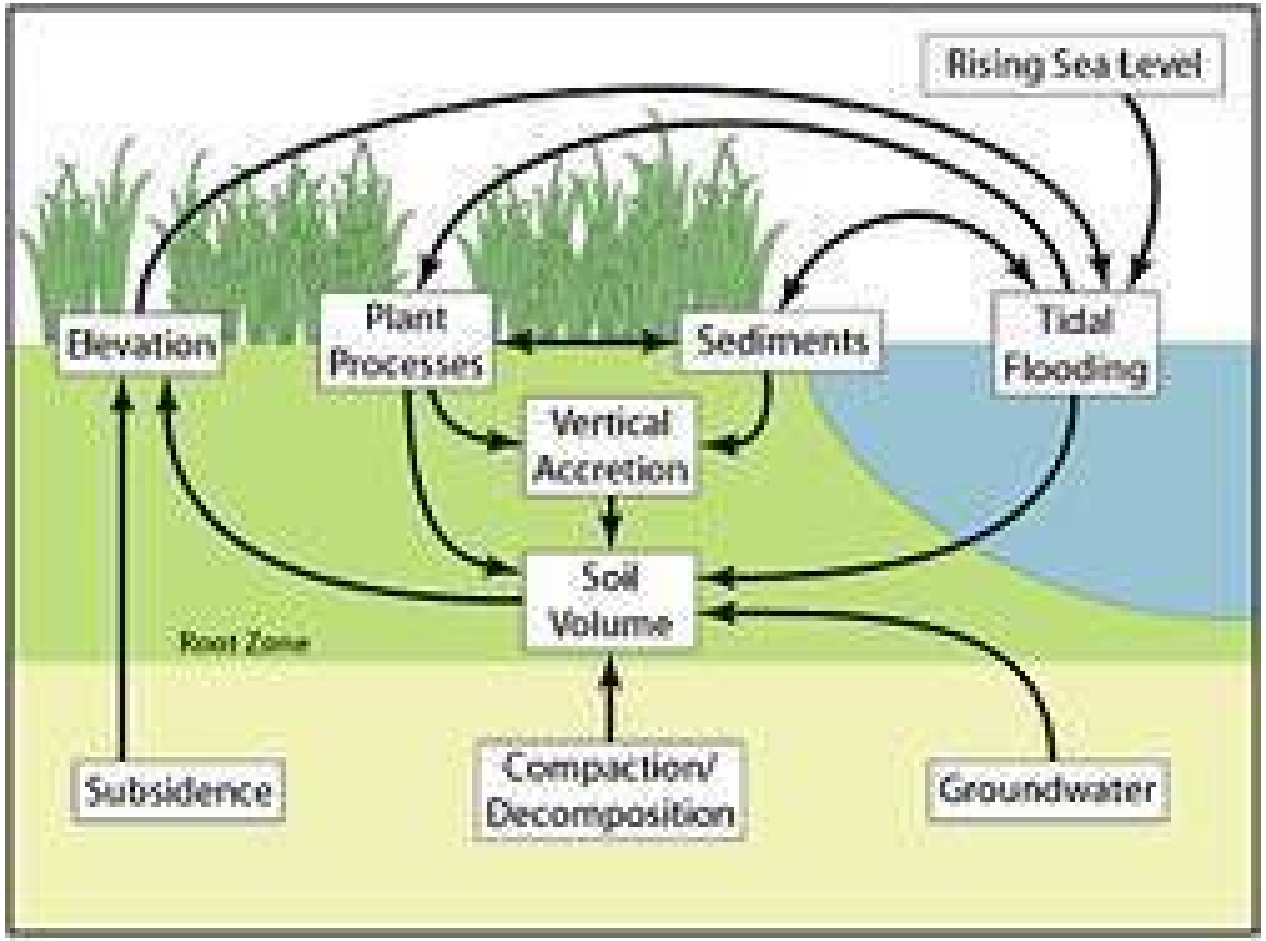


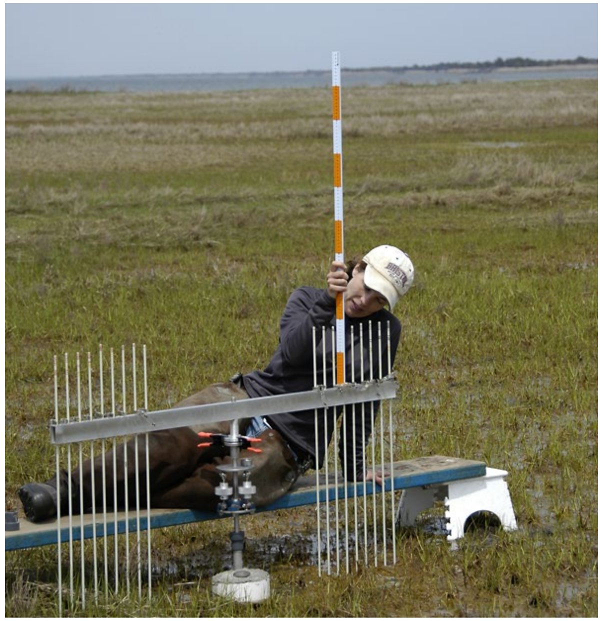
Gandy’s Beach – Delaware Bay

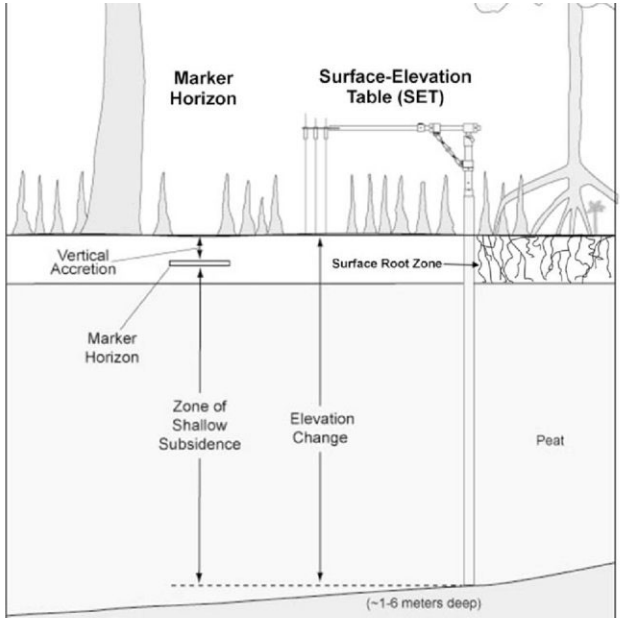
Great Bay – South of Barnegat Bay – 30 yrs

Vertical Position – Surface Elevation Tables - SETs

Measure accretion of new sediments, elevation from plant processes below ground, and subsidence/compaction







SET stations in Delaware Bay (Quirk; Watson; Haaf).

	vegetation	salinity	accretion rate mm yr^{-1}	subsidence rate mm yr^{-1}	elevation change mm yr^{-1}
Crosswicks Cr 1	Zizania aquatica, Peltandra virginica, Nuphar advena	0.10	13.5	-9.41	4.11
Crosswicks Cr 2			8.35	-3.83	4.52
Crosswicks Cr 3			9.98	-6.59	3.40
Dividing Cr 1	S. alterniflora, S. patens, D. spicata	17	8.16	-3.03	5.13
Dividing Cr 2			10.1	-3.82	6.28
Dividing Cr 3			6.01	0.89	6.89
Maurice 1	S. alterniflora, S. patens, D. spicata	11	7.70	-6.54	1.16
Maurice 2			3.72	0.05	3.77
Maurice 3			6.81	-1.6	5.21
Dennis Cr 1	S. alterniflora, S. patens, D. spicata	16	6.99	+0.99	5.85
Dennis Cr 2			3.78	-4.12	0.74
Dennis Cr 3			5.06	-3.40	1.46

SETs in Barnegat Bay (Quirk, Maxwell-Doyle)

NET ACCRETION ↓

Reedy Creek 1*	**S. alterniflora**	**20**	**4.75**	**0.46**	**5.21**	★
Reedy Creek 2*		20	6.72	-0.95	5.77	★
Reedy Creek 3*		20	4.52	-2.28	2.24	
Island Beach 1*	S. alterniflora	27	2.91	-2.28	0.62	
Island Beach 2*		27	3.63	-5.6	-1.96	
Island Beach 3*		27	2.57	-1.24	1.32	
Horse Point 1*	S. alterniflora	26	5.87	-1.95	3.92	
Horse Point 2*		26	5.86	-1.47	4.40	
Horse Point 3*		26	5.39	-1.22	4.17	

VERTICAL CHANGES –(SLR CURRENTLY 5-6 MM/YR) MARSH ELEVATION (SETs) IN MEADOWLANDS (MERI)

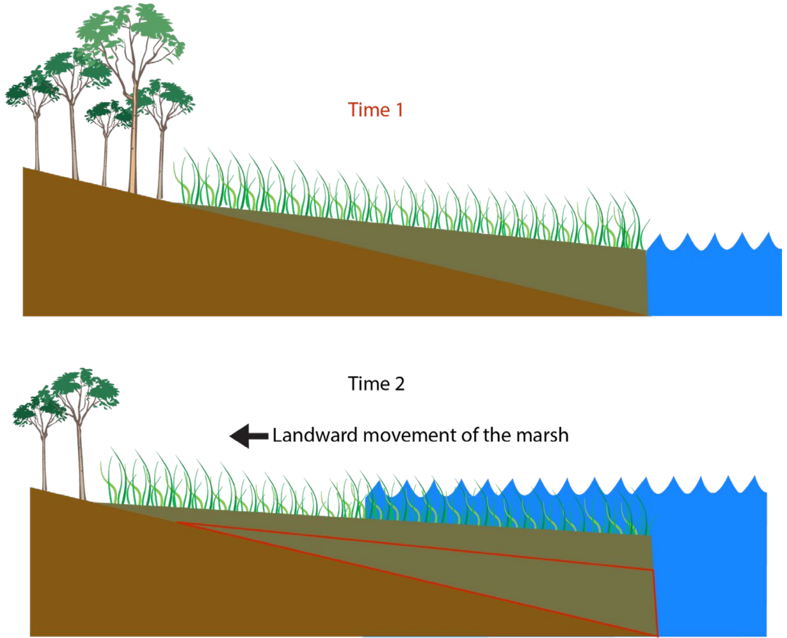
Location	vegetation	salinity	accretion rate mm yr^{-1}	subsidence rate mm yr^{-1}	elevation change mm yr^{-1}
Lyndhurst	S. patens	11.5	3.61	0.58	3.03
Riverbed	S. patens	11.5	5.36	0.36	5.00
Riverbend	P. australis S. patems	15.5	5.21	1.11	4.10
Saw Mill	S. alterniflora	13.5	7.80	3.60	4.20
Secaucus	S. alterniflora	7.5	5.52	1.97	3.56
Walden Swamp	P. australis	4.5	5.45	-6.3	11.75
Eight-day swamp	P. australis	4.0	6.45	-1.72	8.17

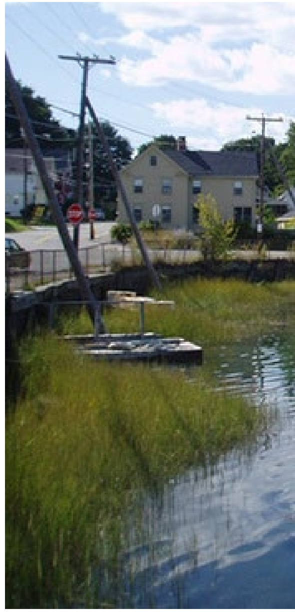
WHAT CAN BE DONE?

- 1. MIGRATION PATHWAYS
- 2. PHRAGMITES MANAGEMENT
- 3. SEDIMENT MANIPULATION
- 4. “LIVING SHORELINES”

OPEN SPACE UPLAND "migration pathways"

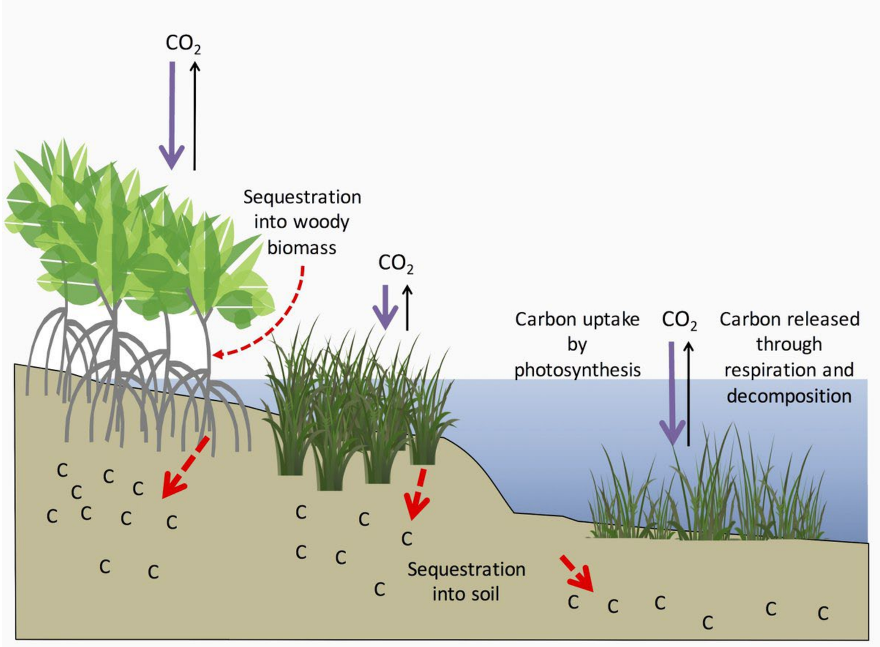
- Delaware Bay moving inland into coastal forests (causing "ghost forests"). Developed areas subject to "coastal squeeze."
- Protect land upland of marshes via transfer of property to public, acquisition of private property or conservation easements. Where appropriate, remove paved surfaces and reclaim areas for potential salt marsh migration
- Local towns and municipalities in charge of land use – political and social issues





PHRAGMITES MANAGEMENT

- *Phragmites* enables marshes to elevate faster and keep up with SLR (Windham & Lathrop 1999; Rooth & Stevenson 2000). Builds soils more effectively. Dense tall plants better buffer
- *Phragmites* better at sequestering nitrogen. (Windham and Ehrenfeld 2003)
- *Phragmites* better at sequestering CO_2 – “Blue Carbon” (Schafer et al. 2014, Duman and Schäfer 2017) which can help to mitigate climate change.
- So: leave some in place to help marsh survive SLR. Research how and where



Sediment manipulation

- Spray sediment onto marsh surface – **thin layer deposition**.
- Existing grass buried. Plants grow through the sediment eventually.
- Years for marsh to recover.
- How thick to make it? How soon before you have to do it again?

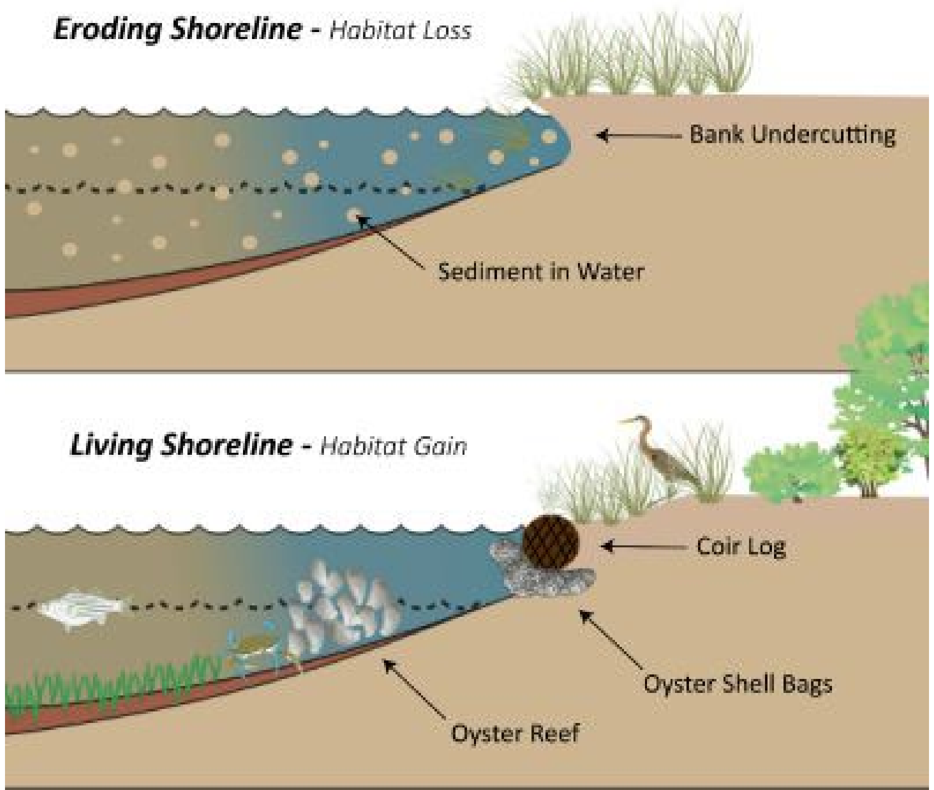
Runnels – thin channels

- When water pools on the surface, which will lead to death of grasses, dig thin channels to facilitate drainage into tidal creeks – need some slope

Runnel installation at Cape May NWR. Image courtesy Wood.

Erosion at Edges – Living Shorelines

From wave action, subsidence, SLR & insufficient sediment supply. Edge keeps moving inland



Living shoreline reduces erosion and is better storm protection than marsh alone or seawall

Conclusions

- 1. Marshes are at great risk from sea level rise. Must either elevate fast enough or migrate inland – few are elevating fast enough
- 2. “Natural” solutions – leaving some *Phragmites* in place; marsh migration pathways – require changes in policies, meets opposition, political and social issues
- 3. Engineering solutions – adding sediments, living shorelines etc. expensive, experimental, site-specific, and temporary. But both show promise.