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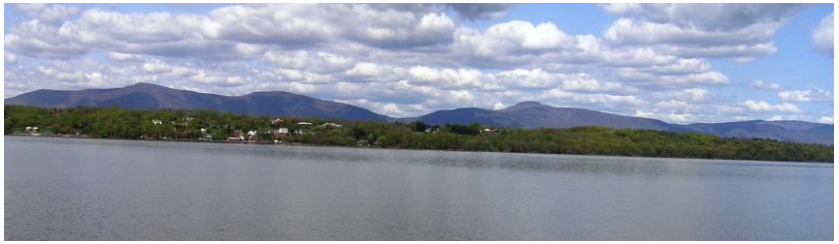


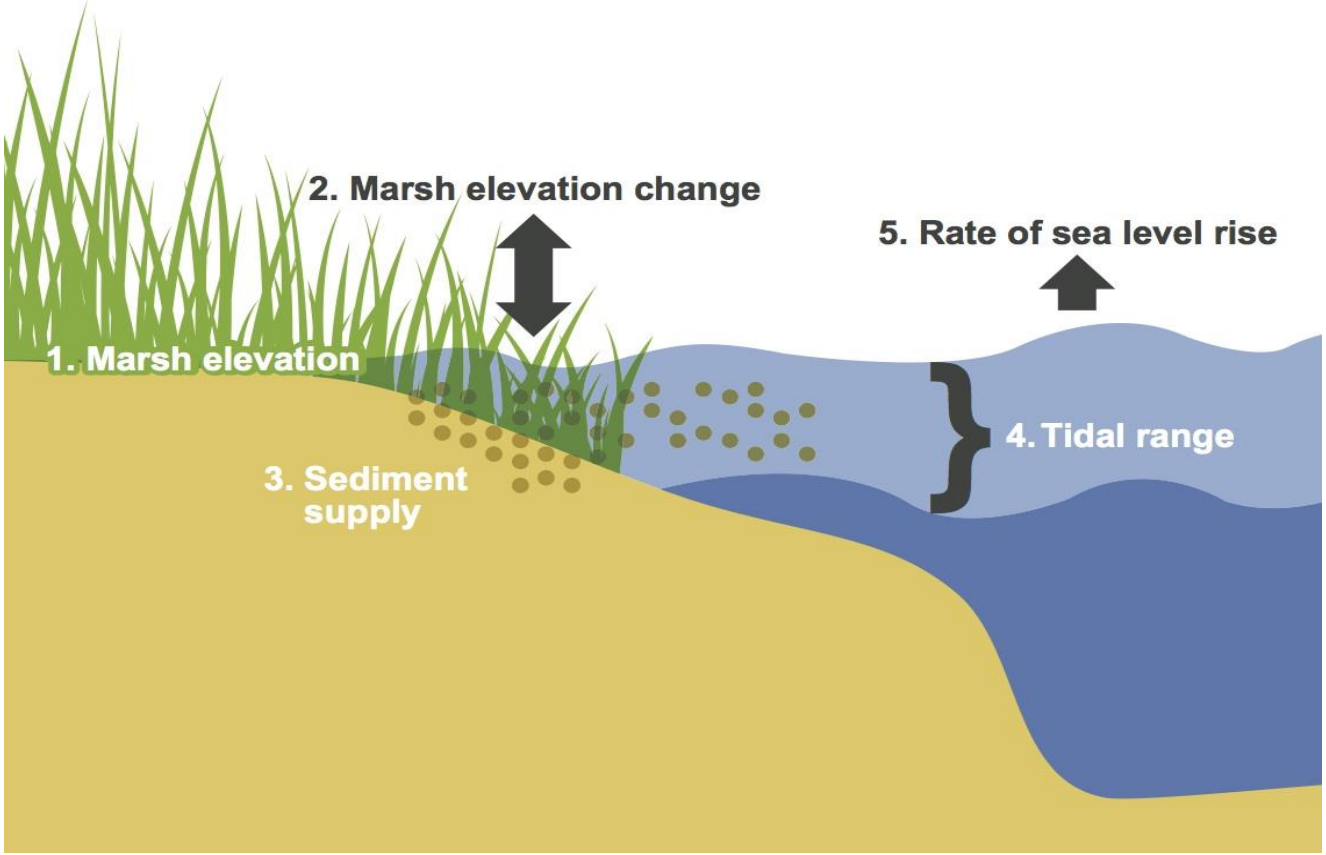
Monitoring Hudson River Tidal Wetlands for Climate Change Resilience

Sarah H. Fernald, Research Coordinator

Hudson River National Estuarine Research Reserve

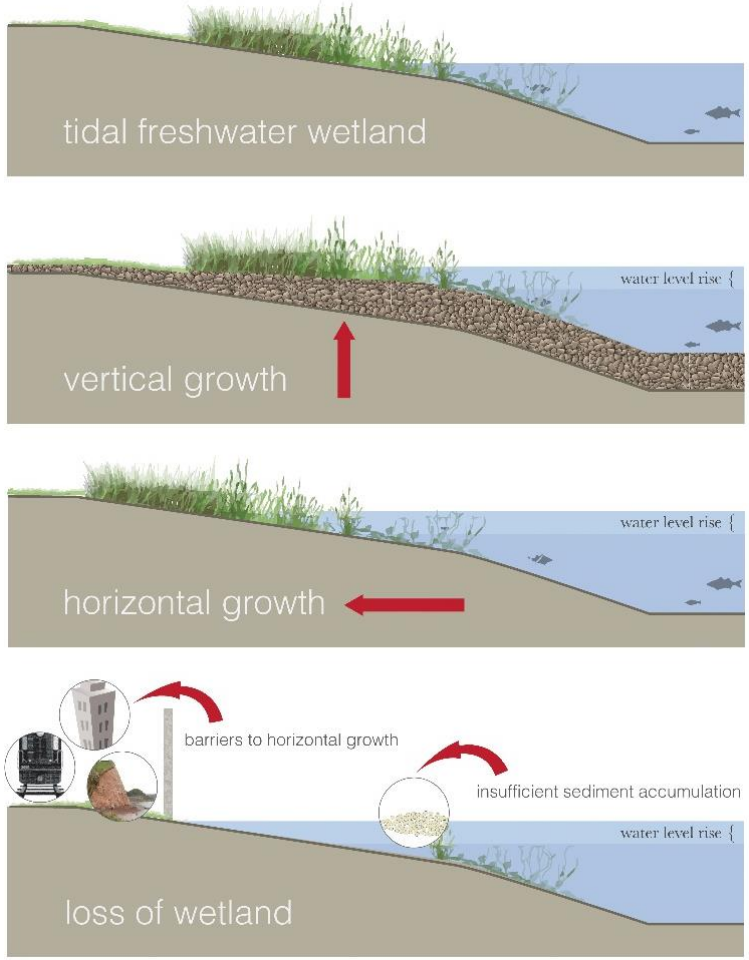
May 8, 2019

5 Indicators of Marsh Resilience to Sea Level Rise



Tidal Wetlands and Rising Waters

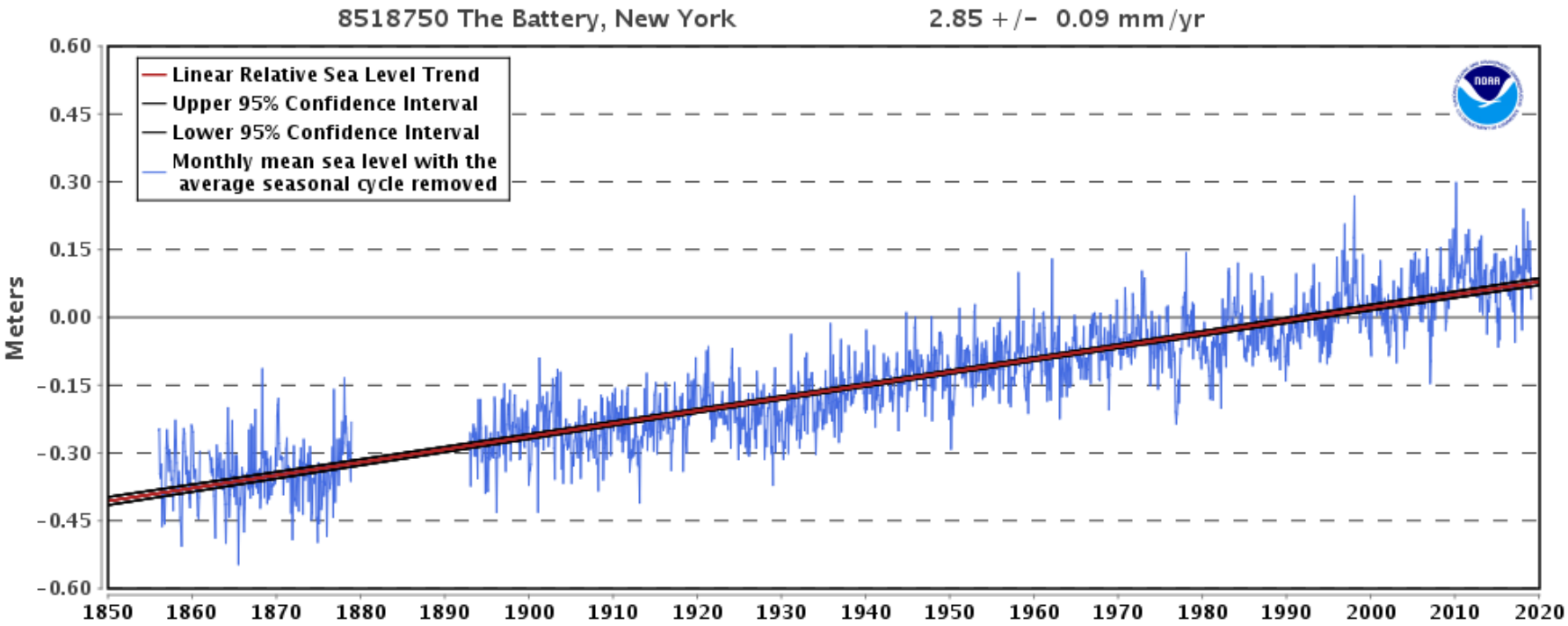
- Vegetation in the intertidal zone
- Tides deposit sediment (vertical growth)
- Pathways for inland marsh migration (horizontal growth)
- Barriers to horizontal growth and insufficient vertical growth lead to loss of wetlands with sea level rise



Graphic: Cary Institute of Ecosystem Studies, L. Tumblety

The Battery Tide Station

The Turkey Point Tide Station



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Range	Mid-year	Difference	Over 14 Years in m
2000-2004	2002	Baseline	0.01
2014-2018	2016	Recent -	0.08
		Difference	0.07 meters
	14	years	2.65 inches

Range	Mid-year	Difference Over 14 Years in m	
2000-2004	2002	Baseline	0.01
2014-2018	2016	Recent -	0.08
		Difference	0.07 meters
	14 years		2.65 inches

(b) New York City/Lower Hudson Region

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection
2020s	2 inches	4 inches	6 inches	8 inches	10 inches
2050s	8 inches	11 inches	16 inches	21 inches	30 inches
2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	22 inches	36 inches	50 inches	75 inches

From https://www.dec.ny.gov/regulations/103877.html

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2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	22 inches	36 inches	50 inches	75 inches

From https://www.dec.ny.gov/regulations/103877.html

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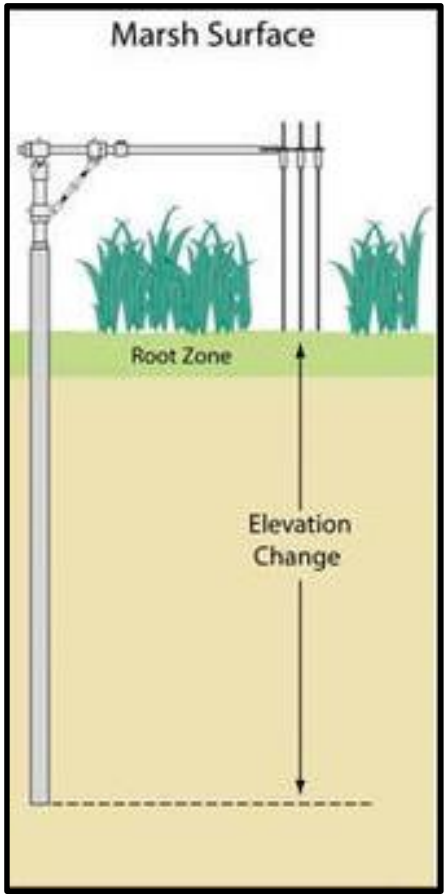
Surface Elevation Table (SET)



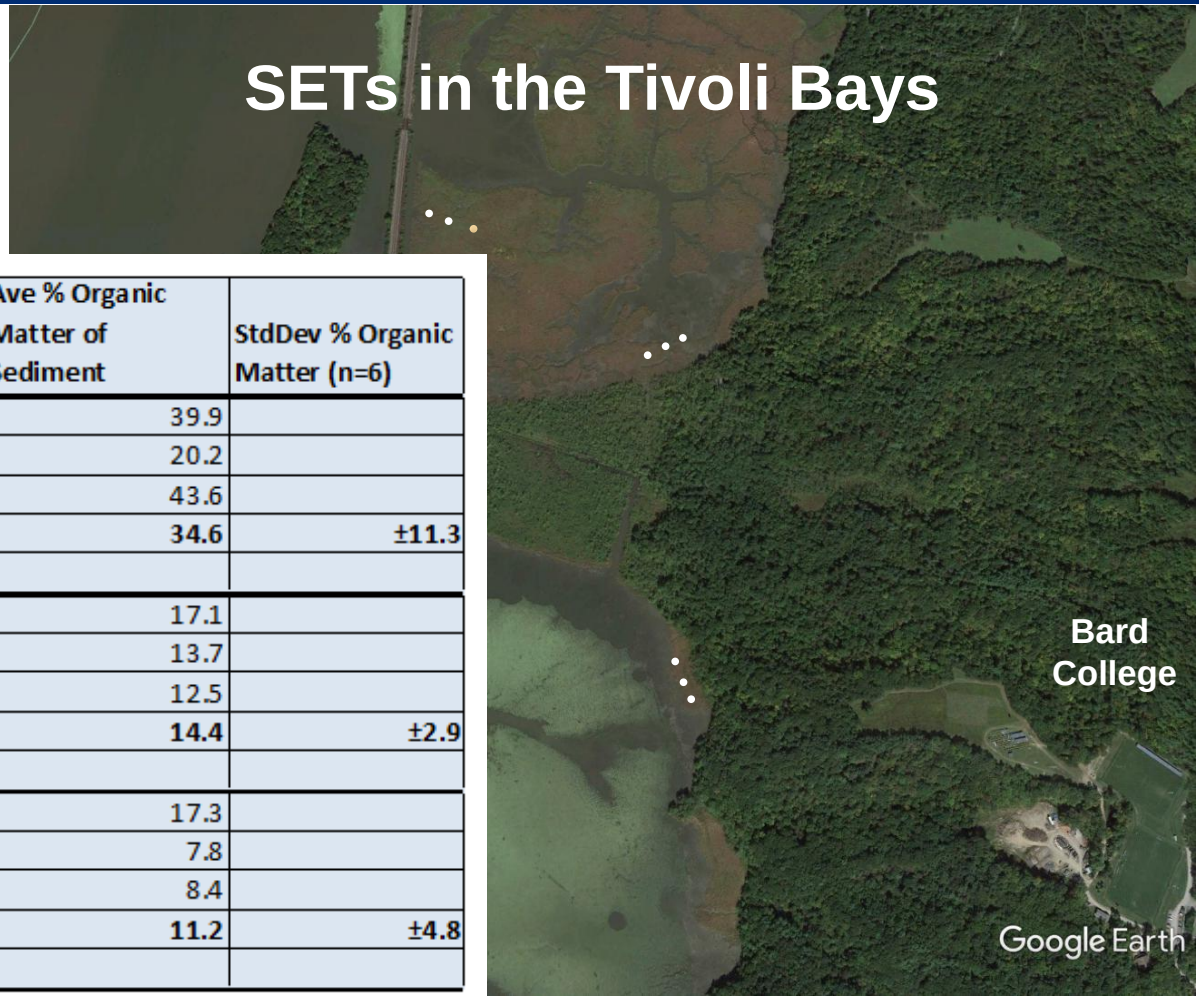
USGS

Photo: Narragansett Bay National Estuarine Research Reserve

Photo: HRNERR Tivoli Bays

SETs in the Tivoli Bays

Site Code	Ave Pin Slope (mm/year)	Ave Pin R^2	Ave % Organic Matter of Sediment	StdDev % Organic Matter (n=6)
OTN-7A	21.4	0.7658	39.9	
OTN-7B	5.4	0.3890	20.2	
OTN-7C	6.1	0.4310	43.6	
AVE	**10.9**	**0.5286**	**34.6**	**±11.3**
ITN-7A	6.0	0.3126	17.1	
ITN-7B	6.9	0.4146	13.7	
ITN-7C	2.1	0.2117	12.5	
AVE	**5.0**	**0.3130**	**14.4**	**±2.9**
TSB-7A	9.6	0.6100	17.3	
TSB-7B	11.3	0.7389	7.8	
TSB-7C	17.8	0.7021	8.4	
AVE	**12.9**	**0.6837**	**11.2**	**±4.8**




SETs in Iona Island Marsh

SET	Ave rate of surface elevation change (mm/year)	Standard Deviation (mm/year)	R^2
Iona_1 Managed	5.2	2.31	0.52
Iona_2 Managed	7.2	1.92	0.64
Iona_3 Managed	6.5	2.64	0.57
Ave	**6.3**		**0.58**
Iona_4 Phragmites	10.2	4.40	0.57
Iona_5 Phragmites	12.1	3.02	0.60
Iona_6 Phragmites	18.2	2.47	0.79
Ave	**13.5**		**0.66**

NERRS System-Wide Monitoring Program: Sentinel Sites

Vegetation Transects

Water Level Station

Surface Elevation Tables

Vertical Control

Water Quality Stations

Marsh Resilience to Sea-level Rise (MARS) Index

- **10 metrics grouped into 5 categories**

Elevation change	SET data
% veg below MHW	Vegetation transect data
% veg in bottom 1/3	
Veg skewness	
Sed. Accretion current	Feldspar horizons or sediment cores
Sed. Accretion past	
Turbidity	Water Quality Station Data
Tidal range	
Long term SLR	NOAA Tide Station data
SLR anomaly	

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MARS Results from 17 Reserves

	Northeast			Mid-Atlantic				Southeast				Gulf	Pacific				
	NH	MA	RI	NY	DE	MD	VA	NC	SC-1	SC-2	FL	MS	WA	OR	CA-1	CA-2	CA-3
	Great Bay	Waquoit Bay	Narrangansett Bay	Hudson River	Delaware	Chesapeake Bay	Chesapeake Bay	North Carolina	NI-WB	ACE Basin	GTM	Grand Bay	Padilla Bay	South Slough	San Francisco Bay	Elkhorn Slough	Tijuana River
Elevation change	4.30	1.70	1.90	10.0	5.1	2.50	5.27	-3.36	2.61	2.00	2.30	4.12	no data	-0.20	2.80	1.05	no data
% veg below MHW	42.46	62.00	61.01	71	3	16.00	26.66	86.00	58.06	47.00	no data	58.00	40.00	34.00	0.00	27.91	2.00
% veg in bottom 1/3	8.88	14.00	5.57	46	59	8.00	7.85	19.00	25.51	44.00	no data	8.00	85.00	4.00	0.00	46.51	54.00
Veg skewness	-1.56	1.45	-0.13	0.09	-1.55	-1.31	-0.32	-0.42	-0.11	0.07	no data	1.90	2.13	-1.31	-0.17	0.69	0.61
Sed. Accretion current	2.68	no data	no data	16.9	19.7	31.00	8.27	no data	no data	no data	12.60	3.04	no data	1.40	3.10	3.78	no data
Sed. Accretion past	no data	no data	2.70	6.0	7.2	4.20	no data	no data	2.70	no data	no data	no data	4.50	1.60	3.90	3.80	no data
Turbidity	34.40	1.76	4.49	23.04	48.8	24.00	5.07	17.80	16.52	25.00	13.91	21.80	6.72	14.00	60.60	15.43	21.6
Tidal range	2.70	0.55	0.53	1.44	1.3	0.74	0.76	1.31	1.40	1.82	0.51	0.42	2.50	1.81	1.32	1.63	0.98
Long term SLR	1.76	2.83	2.74	2.84	3.41	3.72	4.60	2.10	3.16	3.07	2.50	3.20	1.07	0.84	1.92	1.16	2.08
SLR anomaly	no data	23.16	18.33	28.48	22.48	30.06	20.53	-0.50	-2.07	5.73	6.67	-1.48	-2.58	-7.14	-14.66	-5.84	-0.92

The range of values for all reserves were ranked from best (green) to worst (red).

RISKY METRICS	1	7	7	3	2	4	4	3	4	2	3	3	3	4	1	3	2

MARS Results from 17 Reserves

	Northeast				Mid-Atlantic			Southeast				Gulf	Pacific				
	NH	MA	RI	NY	DE	MD	VA	NC	SC-1	SC-2	FL	MS	WA	OR	CA-1	CA-2	CA-3
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Elevation change	4.30	1.70	1.90	10.0	5.1	2.50	5.27	-3.36	2.61	2.00	2.30	4.12	no data	-0.20	2.80	1.05	no data
% veg below MHW	42.46	62.00	61.01	71	3	16.00	26.66	86.00	58.06	47.00	no data	58.00	40.00	34.00	0.00	27.91	2.00
% veg in bottom 1/3	8.88	14.00	5.57	46	59	8.00	7.85	19.00	25.51	44.00	no data	8.00	85.00	4.00	0.00	46.51	54.00
Veg skewness	-1.56	1.45	-0.13	0.09	-1.55	-1.31	-0.32	-0.42	-0.11	0.07	no data	1.90	2.13	-1.31	-0.17	0.69	0.61
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Sed. Accretion past	no data	no data	2.70	6.0	7.2	4.20	no data	no data	2.70	no data	no data	no data	4.50	1.60	3.90	3.80	no data
Turbidity	34.40	1.76	4.49	23.04	48.8	24.00	5.07	17.80	16.52	25.00	13.91	21.80	6.72	14.00	60.60	15.43	21.6
Tidal range	2.70	0.55	0.53	1.44	1.3	0.74	0.76	1.31	1.40	1.82	0.51	0.42	2.50	1.81	1.32	1.63	0.98
Long term SLR	1.76	2.83	2.74	2.84	3.41	3.72	4.60	2.10	3.16	3.07	2.50	3.20	1.07	0.84	1.92	1.16	2.08
SLR anomaly	no data	23.16	18.33	28.48	22.48	30.06	20.53	-0.50	-2.07	5.73	6.67	-1.48	-2.58	-7.14	-14.66	-5.84	-0.92

The range of values for all reserves were ranked from best (green) to worst (red).

	NH	MA	RI	NY												
RISKY METRICS	1	7	7	3	2	4	4	3	4	2	3	3	3	4	1	3	2


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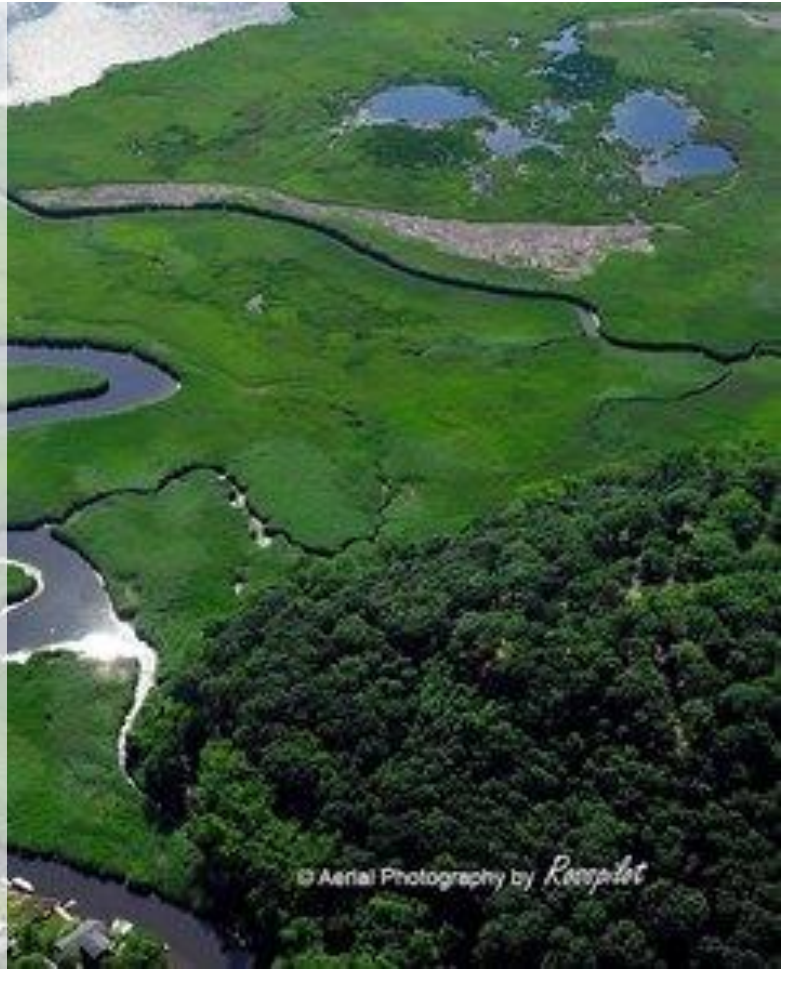
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Exploring Thin Layer Sediment Placement for Wetland Restoration in the Mid-Atlantic

A Workshop to Explore Questions, Resources, and Opportunities for Collaboration

Delaware NERR, April 2018

Thank You

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