Measuring Elevation Change in Meadowlands Marshes Using Surface Elevation Tables (SETs) and Marker Horizons

Meadowlands Research and Restoration Institute (December, 2024)

Introduction

Sediment Elevation Tables (SET) provide a constant plane in space from which the change in marsh surface elevation can be measured. Benchmark rods and marker horizons of feldspar were established at five sites in the lower Hackensack River Meadowlands during August of 2008. The five sites being monitored are Riverbend High Marsh (RBH), Riverbend Mixed Marsh (RBM), Sawmill (SM), Lyndhurst Riverside (LR), and Secaucus High School (SHS). Each site is measured annually, except in the year 2009. This Report is a summary of the marsh elevation change up to today. (Fall 2024)

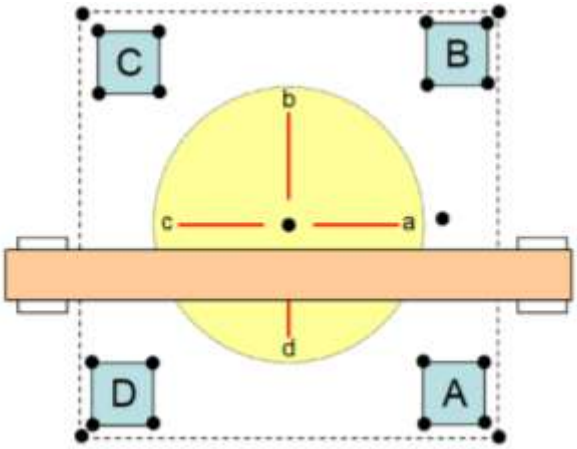
Figure 1: Location of the SET sites

Methods:

Three replicate plots are installed at each of the five sites. At each plot within a site, a total of 36 measurements are made covering the four cardinal directions, which gives a total of 108 measurements per site. Every year, measurements in each site are compared to the previous year and this constitutes a data point. To obtain the rate of elevation change, the last data point value is divided by the number of years elapsed between the establishment of the site. Time elapsed between readings is summarized in this report (Table 1).

Diagram of the SET benchmark plot:

The four outside corners, A, B, C, and D represent feldspar horizon markers. The yellow circle inside with a, b, c, and d are the four cardinal directions in which the measurements are taken.



Locations were chosen to span several miles of tidal wetlands and represent different vegetation and marsh regimes. The five sites selected include a restored *Spartina alterniflora* low marsh (Secaucus High School, SHS), a *Spartina alterniflora* low marsh (Saw Mill, SM), a *Spartina patens* dominated high marsh (Riverbend-Patens, RBP), a mixed *Spartina patens* and *Phragmites australis* high marsh (Riverbend Mixed, RBM) and a *Phragmites australis* dominated high marsh (Lyndhurst Riverside, LR). At each site, three replicate plots were installed. At each plot, nine pins are lowered to the marsh surface. Readings are taken in each of four directions resulting in a total of 108 measurements for each of the 5 sites. At the time of each subsequent reading, results obtained from each pin are compared. The average of the resulting differences becomes one data point that represents the level of the marsh surface elevation.

Table 1: Time Elapsed Between SET installation the latest sampling

Location	Initial Date	Most Recent Date	Days	Years
Riverbend Patens/Mixed Marsh	8/26/2008	12/5/2024	5945	16.29
SawMill Creek (SMC)	8/28/2008	12/3/2024	5941	16.28
Lyndhurst Riverside (LR)	8/29/2008	12/3/2024	5940	16.27
Secaucus HS (SHS)	8/28/2008	12/23/2024	5961	16.33

Table 2 Averages of elevation changes obtained at each of the five sites. The average of all the plots is then divided by the time elapsed since the initial date (Table 1) to obtain the rate of elevation change in mm/yr (Table 2a).

Table 2: Average Elevation Change (mm) - Fall of 2024

Riverbend High Marsh (RBP)	
All Pipes	85.61
SE pipes	4.67
Platform 1	91.37
SE	4.56
Platform 2	76.37
SE	3.26
Platform 3	89.09
SE	3.73
RB-1 pos 1	88.07
RB-1 pos 3	98.96
RB-1 pos 5	98.51
RB-1 pos 7	79.96
RB-2 pos 1	68.96
RB-2 pos 3	77.40
RB-2 pos 5	74.51
RB-2 pos 7	84.62
RB-3 pos 1	81.07
RB-3 pos 3	92.51
RB-3 pos 5	85.07
RB-3 pos 7	97.73
Elevation rate mm/yr	
5.26	

Riverbend Mixed Marsh (RBM)	
All Plots (mm)	86.31
Std Error	12.97
Plot 1 (mm)	62.01
SE	9.66
Plot 2 (mm)	90.59
SE	9.01
Plot 3 (mm)	106.32
SE	8.52
RB4 pos1	90.84
RB4 pos3	55.18
RB4 pos5	50.40
RB4 pos7	51.62
RB5 pos2	91.07
RB5 pos4	86.29
RB5 pos6	70.73
RB5 pos8	114.29
RB6 pos2	95.40
RB6 pos4	106.29
RB6 pos6	130.40
RB6 pos8	93.18
Elevation rate mm/yr	
5.30	

Sawmill Creek (SMC)	
All Plots (mm)	89.02
Std Error	2.68
SM-1 (mm)	93.00
Std Error	10.27
SM-2 (mm)	83.92
Std Error	6.71
SM-3 (mm)	90.14
Std Error	6.43
SM-1 pos 2	62.33
SM-1 pos 4	100.78
SM-1 pos 6	103.33
SM-1 pos 8	105.56
SM-2 pos 1	80.67
SM-2 pos 3	92.11
SM-2 pos 5	66.44
SM-2 pos 7	96.44
SM-3 pos 1	98.44
SM-3 pos 3	82.67
SM-3 pos 5	76.11
SM-3 pos 7	103.33
Elevation rate (mm/yr)	
5.47	

Lyndhurst Riverside (LR)	
All Plots (mm)	72.75
Std Error	7.81
SM-1 (mm)	57.25
Std Error	12.83
SM-2 (mm)	82.22
Std Error	12.96
SM-3 (mm)	78.78
Std Error	20.07
LR-1 pos 1	37.44
LR-1 pos 3	42.44
LR-1 pos 5	94.11
LR-1 pos 7	55.00
LR-2 pos 1	104.44
LR-2 pos 3	47.89
LR-2 pos 5	76.67
LR-2 pos 7	99.89
LR-3 pos 1	30.22
LR-3 pos 3	105.89
LR-3 pos 5	117.00
LR-3 pos 7	62.00
Elevation rate mm/yr	
4.47	

Secaucus HS (SHS)	
All Plots (mm)	111.06
Std Error	14.60
SM-1 (mm)	140.19
Std Error	12.21
SM-2 (mm)	98.25
Std Error	19.78
SM-3 (mm)	94.72
Std Error	8.57
SM-1 pos 2	147.11
SM-1 pos 4	153.89
SM-1 pos 6	155.78
SM-1 pos 8	104.00
SM-2 pos 1	108.67
SM-2 pos 3	146.44
SM-2 pos 5	85.44
SM-2 pos 7	52.44
SM-3 pos 1	114.11
SM-3 pos 3	101.78
SM-3 pos 5	74.22
SM-3 pos 7	88.78
Elevation rate mm/yr	
8.09	

Table 2a: SETs Elevation Rates, Locations and Marsh type - Fall 2024 sampling

Hackensack River Sites	Marsh Type	Dominant Vegetation	Rate of Elevation Change from 2008 to 2024 (mm/yr)
Riverbend Patens (RBP)	High Marsh	*Spartina Patens*	5.26
Riverbend Mixed marsh (RBM)	High Marsh	*Phragmites australis / spartina patens*	5.30
SawMill Creek (SMC)	High Marsh	*Spartina alterniflora*	5.47
Lyndhurst Riverside (LR)	High Marsh	*Phragmites australis*	4.47
Secaucus HS (SHS)	Low Marsh	*Spartina alterniflora*	8.09

Feldspar horizons were placed inside three corners of each plot. The sediment between the white feldspar marker and the horizon is measured. One reading is taken at each of the three corners resulting in a total of nine values per site. The average of all readings is shown in Table 3. All recoverable values are included in the calculation for accretion rate. To obtain a yearly rate, total accretion is divided by the number of years that have elapsed between establishment of the benchmark and the latest reading. Fourteen years elapsed between the readings summarized in this report. Table 1 provides the dates for each reading and the time elapsed in days and years.

Table 3: Average Accretion Tables (mm) - Fall 2024 sampling

Riverbend Patens (RBP)	
All Plots (mm)	76.67
Std Error	1.67
SM-1 (mm)	75.00
Std Error	0.00
SM-2 (mm)	80.00
Std Error	0.00
SM-3 (mm)	75.00
Std Error	0.00
RB-1	
A (mm)	75.0
B (mm)	75.0
C (mm)	75.0
RB-2	
A (mm)	80.0
B (mm)	80.0
C (mm)	80.0
RB-3	
A (mm)	75.0
B (mm)	75.0
C (mm)	75.0

Riverbend Mixed marsh (RBM)	
All Plots (mm)	80.00
Std Error	2.89
WS-1 (mm)	85.00
Std Error	0.00
WS-2 (mm)	80.00
Std Error	0.00
WS-3 (mm)	75.00
Std Error	0.00
RB-4	
A (mm)	85.0
B (mm)	85.0
C (mm)	85.0
RB-5	
A (mm)	80.0
B (mm)	80.0
C (mm)	80.0
RB-6	
A (mm)	75.0
B (mm)	75.0
C (mm)	75.0

SawMill Creek (SMC)	
All Plots (mm)	91.11
Std Error	6.41
TM-1 (mm)	98.33
Std Error	0.00
TM-2 (mm)	96.67
Std Error	0.00
TM-3 (mm)	78.33
Std Error	0.00
SMC-1	
A (mm)	100.0
B (mm)	95.0
C (mm)	100.0
SMC-2	
A (mm)	95.0
B (mm)	100.0
C (mm)	95.0
SMC-3	
A (mm)	80.0
B (mm)	75.0
C (mm)	80.0

Lyndhurst Riverside (LR)	
All Plots (mm)	52.78
Std Error	4.78
SM-1 (mm)	48.33
Std Error	1.67
SM-2 (mm)	62.33
Std Error	1.45
SM-3 (mm)	47.67
Std Error	1.45
LR-1	
A (mm)	50.0
B (mm)	45.0
C (mm)	50.0
LR-2	
A (mm)	62.0
B (mm)	60.0
C (mm)	65.0
LR-3	
A (mm)	48.0
B (mm)	50.0
C (mm)	45.0

Secaucus HS (SHS)	
All Plots (mm)	91.11
Std Error	12.56
SM-1 (mm)	111.67
Std Error	1.67
SM-2 (mm)	93.33
Std Error	1.67
SM-3 (mm)	68.33
Std Error	1.67
SHS-1	
A (mm)	115.0
B (mm)	110.0
C (mm)	110.0
SHS-2	
A (mm)	95.0
B (mm)	90.0
C (mm)	95.0
SHS-3	
A (mm)	70.0
B (mm)	65.0
C (mm)	70.0

Table 3a: Average Accretion Rate - Fall 2024 sampling

Location	Accretion Rate (mm/yr)
Riverbend Patens (RBP)	4.7
Riverbend Mixed marsh (RBM)	4.9
SawMill Creek (SMC)	5.6
Lyndhurst Riverside (LR)	3.24
Secaucus HS (SHS)	5.58

Table 4: Summary of Elevation and Accretion rate up to the Fall of 2024.
Eight Day Swamp, Walden Swamp, Tollgate Marsh, Lyndhurst Riverside and Secaucus High School

Riverbend Patens															
Days	**0**	**632**	**980**	**1555**	**2065**	**2430**	**2795**	**3137**	**3585**	**4045**	**4468**	**4811**	**5200**	**5546**	**5945**
Sample Date	**8/26/2008**	**5/20/2010**	**5/3/2011**	**11/28/2012**	**4/22/2014**	**4/22/2015**	**4/21/2016**	**3/29/2017**	**6/20/2018**	**9/23/2019**	**11/19/2020**	**10/28/2021**	**11/21/2022**	**11/2/2023**	**12/5/2024**
Elevation Rate mm/yr	0.00	2.48	6.02	5.92	3.68	4.18	3.02	4.18	4.00	5.00	3.69	5.04	5.05	5.22	5.25
Accretion Rate mm/yr	0.00	0.00	5.69	6.39	5.03	5.67	6.31	3.81	5.75	5.36	5.04	6.41	4.45	4.17	4.71

Riverbend Mixed															
Days	**0**	**632**	**980**	**1555**	**2065**	**2430**	**2795**	**3137**	**3585**	**4045**	**4468**	**4811**	**5200**	**5546**	**5945**
Sample Date	**8/26/2008**	**5/20/2010**	**5/3/2011**	**11/28/2012**	**4/22/2014**	**4/22/2015**	**4/21/2016**	**3/29/2017**	**6/20/2018**	**9/23/2019**	**11/19/2020**	**10/28/2021**	**11/21/2022**	**11/2/2023**	**12/5/2024**
Elevation Rate mm/yr	0.00	5.96	7.58	6.99	3.63	5.15	2.94	4.08	3.67	4.10	3.86	4.52	4.87	5.10	5.30
Accretion Rate mm/yr	0.00	0.00	7.80	6.31	5.05	7.18	8.59	3.75	5.88	5.21	4.81	6.15	5.73	5.37	4.91

Sawmill															
Days	**0**	**631**	**980**	**1566**	**2065**	**2430**	**2814**	**3136**	**3584**	**4047**	**4467**	**4828**	**5208**	**5606**	**5941**
Sample Date	**8/28/2008**	**5/21/2010**	**5/5/2011**	**12/11/2012**	**4/24/2014**	**4/24/2015**	**5/12/2016**	**3/30/2017**	**6/21/2018**	**9/27/2019**	**11/20/2020**	**11/16/2021**	**12/1/2022**	**1/3/2024**	**12/3/2024**
Elevation Rate mm/yr	0.00	-4.66	5.51	7.94	5.70	4.74	3.93	4.75	3.94	4.20	4.65	5.06	6.43	5.75	5.47
Accretion Rate mm/yr	0.00	0.00	13.80	11.10	9.90	9.70	7.40	8.50	8.50	7.80	-	6.55	7.55	5.86	5.60

Lyndhurst Reserve															
Days	**0**	**630**	**979**	**1557**	**2064**	**2429**	**2813**	**3135**	**3583**	**4044**	**4466**	**4829**	**5207**	**5577**	**5940**
Sample Date	**8/29/2008**	**5/21/2010**	**5/5/2011**	**12/3/2012**	**4/24/2014**	**4/24/2015**	**5/12/2016**	**3/30/2017**	**6/21/2018**	**9/25/2019**	**11/20/2020**	**11/18/2021**	**12/1/2022**	**12/6/2023**	**12/3/2024**
Elevation Rate mm/yr	0	8.79	6.38	7.53	3.65	3.18	1.91	1.85	2.44	3.03	2.48	3.95	4.05	4.10	4.47
Accretion Rate mm/yr	0	2.74	3.94	4.20	3.40	4.40	5.00	4.50	3.26	3.61	3.00	3.07	3.74	3.27	3.24

Secaucus HS															
Days	**0**	**609**	**984**	**1553**	**2066**	**2421**	**2801**	**3169**	**3585**	**4044**	**4470**	**4843**	**5199**	**5607**	**5961**
Sample Date	**8/28/2008**	**4/29/2010**	**5/9/2011**	**11/28/2012**	**4/25/2014**	**4/15/2015**	**4/29/2016**	**5/2/2017**	**6/22/2018**	**9/24/2019**	**11/23/2020**	**12/1/2021**	**11/22/2022**	**1/4/2024**	**12/23/2024**
Elevation Rate mm/yr	0.00	9.97	5.03	6.52	6.16	5.84	3.67	3.90	3.93	3.55	9.32	10.37	6.05	8.62	8.09
Accretion Rate mm/yr	0.00	10.00	4.40	6.70	8.90	7.90	5.90	6.90	5.83	5.52	4.99	5.11	5.50	5.75	5.58

Conclusion

In the Fall of 2024, Riverbend High Marsh, or Riverbend Patens, showed an annual elevation change of 5.2 mm/yr and an accretion rate of 4.7 mm/yr. Riverbend Mixed Marsh showed an annual elevation change of 5.3 mm/yr and an accretion rate of 4.9 mm/yr. Sawmill showed an annual elevation change of 5.5 mm/yr and an accretion rate of 5.6 mm/yr. Lyndhurst Riverside, showed an annual elevation change of 4.5 mm/yr and an accretion rate of 3.2 mm/yr. Secaucus High School showed an annual elevation change of 8.1 mm/yr and an accretion rate of 5.6 mm/yr.