Elevation Change in Berry's Creek Marshes Using Surface Elevation Tables (SETs) and Marker Horizons

Meadowlands Research & Restoration Institute (Fall 2023)

Introduction

Sediment Elevation Tables (SET) provide a constant plane in space from which the change in marsh surface elevation can be measured (USGS 2010). Benchmark rods and marker horizons of feldspar have been established at five sites. The five sites being monitored are Eight Day Swamp (EDS) and Walden Swamp (WS) established in the spring of 2009, Tollgate Marsh (TM) established in the Fall of 2018, and Ackerman Marsh (ACK) and Never Touch Creek (NTC) added in 2021. Each site is measured annually. This report is a summary of the marsh elevation change up to the Fall of 2023.

Figure 1: Images: Location of each SET site

Eight Day Swamp
40°49' 46.4"N 74°4' 35"W

Never Touch Creek
40°50' 7.5"N 74°4' 43"W

Ackerman Creek
40°49' 35"N 74°5' 12"W

Walden Swamp
40°49' 8.1"N 74°5' 9.4"W

Toll Gate Marsh
40°48' 27"N 74°5' 10.4"W

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 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 a yearly rate, 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)."

Figure 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 directions in which the pin measurements are taken."

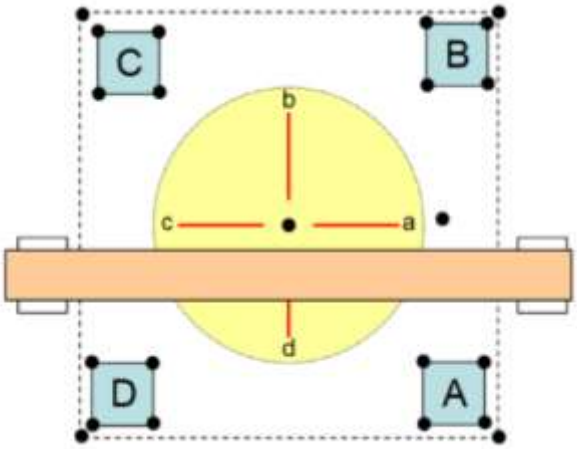

Table 1: Time Elapsed Between SET installation and the latest sampling

Location	Initial Date	Last sampling date	Days since installation	Years since installation
EDS - 1, 2, 3	4/30/2009	12/7/2023	5334	14.6
WS - 1, 2, 3	4/30/2009	12/5/2023	5332	14.6
TM - 1, 2, 3	11/30/2018	12/4/2023	1830	5.0
NTC - 1, 2, 3	6/23/2021	11/20/2023	880	2.4
ACK - 1, 2, 3	5/20/2021	11/13/2023	907	2.5

"Table 2 contains the averages of elevation changes obtained at each of the five sites since the first measurement was taken. The averages of measurements from all plots at each site are included in Table 2. The

average of all the plots is then divided by the time elapsed since the initial measurement date (Table 1) to derive the rate of elevation change in mm/yr (Table 2a)."

Table 2: Average Elevation Change (mm) up to Fall of 2023.

Eight Day Swamp (EDS)	
All Plots (mm)	112.05
Std Error	8.57
Plot 1 (mm)	123.36
SE	15.24
Plot 2 (mm)	95.25
SE	6.84
Plot 3 (mm)	117.53
SE	3.9
EDS-1 pos 2	139.78
EDS-1 pos 4	145.89
EDS-1 pos 6	78.89
EDS-1 pos 8	128.89
EDS-2 pos 2	88.22
EDS-2 pos 4	88.56
EDS-2 pos 6	115.78
EDS-2 pos 8	88.44
EDS-3 pos 1	109.67
EDS-3 pos 3	127
EDS-3 pos 5	120.56
EDS-3 pos 7	112.89
Elevation rate mm/yr	
7.67	

Walden Swamp (WS)	
All Plots (mm)	165.59
Std Error	23.11
Plot 1 (mm)	154.32
SE	6.77
Plot 2 (mm)	210.04
SE	3.48
Plot 3 (mm)	132.4
SE	4.68
WS-1 pos 2	168.18
WS-1 pos 4	162.51
WS-1 pos 6	138.4
WS-1 pos 8	148.18
WS-2 pos 2	215.96
WS-2 pos 4	201.96
WS-2 pos 6	206.51
WS-2 pos 8	215.73
WS-3 pos 2	123.29
WS-3 pos 4	125.4
WS-3 pos 6	141.18
WS-3 pos 8	139.73
Elevation rate mm/yr	
12.18	

Tollgate Marsh (TM)	
All Plots (mm)	28.38
Std Error	7.26
SM-1 (mm)	17.36
Std Error	10.32
SM-2 (mm)	25.69
Std Error	5.98
SM-3 (mm)	42.08
Std Error	3.06
EDS-1 pos 2	14.33
EDS-1 pos 4	7.67
EDS-1 pos 6	47.11
EDS-1 pos 8	0.33
EDS-1 pos 2	19.44
EDS-1 pos 4	15.44
EDS-1 pos 6	25.33
EDS-1 pos 8	42.56
EDS-3 pos 1	49
EDS-3 pos 3	39.89
EDS-3 pos 5	34.78
EDS-3 pos 7	44.67
Elevation rate (mm/yr)	
7.09	

Never Touch Creek (NTC)	
All Plots (mm)	28.68
Std Error	1.23
SM-1 (mm)	28.72
Std Error	3.31
SM-2 (mm)	26.53
Std Error	5.37
SM-3 (mm)	30.78
Std Error	2.32
EDS-1 pos 2	23.11
EDS-1 pos 4	23.67
EDS-1 pos 6	37
EDS-1 pos 8	31.11
EDS-1 pos 2	30.89
EDS-1 pos 4	32.67
EDS-1 pos 6	32.11
EDS-1 pos 8	10.44
EDS-3 pos 1	34.56
EDS-3 pos 3	24
EDS-3 pos 5	32.11
EDS-3 pos 7	32.44
Elevation rate mm/yr	
19.75	

Ackerman Marsh (ACK)	
All Plots (mm)	41.5
Std Error	9.69
SM-1 (mm)	25.39
Std Error	8.25
SM-2 (mm)	40.22
Std Error	5.97
SM-3 (mm)	58.89
Std Error	6.23
EDS-1 pos 2	24.56
EDS-1 pos 4	29.33
EDS-1 pos 6	43.78
EDS-1 pos 8	3.89
EDS-1 pos 2	38.56
EDS-1 pos 4	37.56
EDS-1 pos 6	28.11
EDS-1 pos 8	56.67
EDS-3 pos 1	54.78
EDS-3 pos 3	77.33
EDS-3 pos 5	50.11
EDS-3 pos 7	53.33
Elevation rate mm/yr	
16.70	

Table 2a: Summary of Elevation change and marsh type

Site	Marsh Type	Dominant Vegetation	Rate of Elevation Change (mm/yr)
Eight Day Swamp	High	Phragmites	7.67
Walden Swamp	High	Phragmites	12.18
Tollgate Marsh	High	Phragmites	7.09
Never Touch Creek	High	Phragmites	19.75
Ackerman Marsh	Low	Phragmites	16.70

"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. Between three and 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 2023 sampling

Eight Day Swamp (EDS)		Walden Swamp (WS)		Tollgate Marsh Accretion (TM)		Never Touch Creek Accretion (NTC)		Ackerman Marsh Accretion (ACK)	
All Plots (mm)	83.33	All Plots (mm)	85.00	All Plots (mm)	50.00	All Plots (mm)	30.00	All Plots (mm)	25.56
Std Error	0.96	Std Error	2.89	Std Error	2.89	Std Error	-	Std Error	2.42
SM-1 (mm)	83.33	WS-1 (mm)	85.00	TM-1 (mm)	45.00	SM-1 (mm)	30.00	SM-1 (mm)	30.00
Std Error	2.50	Std Error	-	Std Error	-	Std Error	-	Std Error	-
SM-2 (mm)	81.67	WS-2 (mm)	90.00	TM-2 (mm)	55.00	SM-2 (mm)	30.00	SM-2 (mm)	25.00
Std Error	1.67	Std Error	-	Std Error	-	Std Error	-	Std Error	-
SM-3 (mm)	85.00	WS-3 (mm)	80.00	TM-3 (mm)	50.00	SM-3 (mm)	30.00	SM-3 (mm)	21.67
Std Error	0.00	Std Error	-	Std Error	-	Std Error	-	Std Error	-
EDS-1		WS-1		TM-1		NTC-1		ACK-1	
A (mm)	85.0	A (mm)	85.0	A (mm)	45.0	A (mm)	30.0	A (mm)	30.0
B (mm)	80.0	B (mm)	85.0	B (mm)	45.0	B (mm)	30.0	B (mm)	30.0
C (mm)	85.0	C (mm)	85.0	C (mm)	45.0	C (mm)	30.0	C (mm)	30.0
EDS-2		WS-2		TM-2		NTC-2		ACK-2	
A (mm)	85.0	A (mm)	90.0	A (mm)	55.0	A (mm)	30.0	A (mm)	25.0
B (mm)	80.0	B (mm)	90.0	B (mm)	55.0	B (mm)	30.0	B (mm)	25.0
C (mm)	80.0	C (mm)	90.0	C (mm)	55.0	C (mm)	30.0	C (mm)	25.0
EDS-3		WS-3		TM-3		NTC-3		ACK-3	
A (mm)	85.0	A (mm)	80.0	A (mm)	50.0	A (mm)	30.0	A (mm)	20.0
B (mm)	85.0	B (mm)	80.0	B (mm)	50.0	B (mm)	30.0	B (mm)	20.0
C (mm)	85.0	C (mm)	80.0	C (mm)	50.0	C (mm)	30.0	C (mm)	25.0

Table 2a: Average Accretion Rate (mm/yr) since the initial measurement - Fall 2023 sampling

Site	Accretion Rate (mm/yr)
Eight Day Swamp (EDS)	5.7
Walden Swamp (WS)	5.82
Tollgate Marsh Accretion (TM)	9.97
Never Touch Creek Accretion (NTC)	12.4
Ackerman Marsh Accretion (ACK)	10.3

Table 4: Summary of Elevation and Accretion rate up to the Fall of 2023.
Eight Day Swamp, Walden Swamp, Tollgate Marsh, Never Touch Creek Marsh and Ackerman Marsh

Eight Day Swamp													
Days	0	378	736	1322	1819	2188	3115	3515	3827	4249	4590	4949	5334
Sample Date	4/30/2009	5/13/2010	5/6/2011	12/12/2012	4/23/2014	4/27/2015	11/9/2017	12/14/2018	10/22/2019	12/17/2020	11/23/2021	11/17/2022	12/7/2023
Elevation Rate mm/yr	0	19.07	18.67	14.40	11.64	8.99	7.30	7.33	8.16	7.09	8.08	7.87	7.67
Accretion Rate mm/yr	0	5.92	5.68	5.74	6.05	7.23	3.93	5.45	6.45	5.11	6.23	5.41	5.70

Walden Swamp													
Days	0	378	736	1310	1824	2198	3120	3501	3807	4247	4589	4963	5332
Sample Date	4/30/2009	5/13/2010	5/6/2011	11/30/2012	4/28/2014	5/7/2015	11/14/2017	11/30/2018	10/2/2019	12/15/2020	11/22/2021	12/1/2022	12/5/2023
Elevation Rate mm/yr	0	40.27	32.82	22.40	18.37	12.93	10.19	12.35	11.75	10.59	11.27	11.30	11.34
Accretion Rate mm/yr	0	3.77	8.40	9.38	7.92	8.16	5.91	5.93	5.45	-	7.72	5.27	5.82

Tollgate Marsh						
Days	0.00	305.00	740.00	1088.00	1462.00	1830.00
Sample Date	11/30/2018	10/1/2019	12/9/2020	11/22/2021	12/1/2022	12/4/2023
Elevation Rate mm/yr	0.00	-8.63	0.60	6.22	7.11	5.68
Accretion Rate mm/yr	0.00	1.99	13.70	10.06	11.65	9.97

Never Touch Creek Marsh				
Days	0	175	530	880
Sample Date	6/23/2021	12/15/2021	12/5/2022	11/20/2023
Elevation Rate mm/yr	0.0	35.1	19.0	11.9
Accretion Rate mm/yr	0.0	0.0	21.8	12.4

Ackerman Marsh (ACK)				
Days	0	193	538	907
Sample Date	5/20/2021	11/29/2021	11/9/2022	11/13/2023
Elevation Rate mm/yr	0.0	66.1	20.2	16.7
Accretion Rate mm/yr	0.0	0.0	14.5	10.3

Discussion

The data provided suggests that the age of the monitoring sites plays a significant role in the rate of accretion (the accumulation of sediments) and elevation change at those sites.

For sites older than 8 years, the accretion and elevation change are moderate, with a relatively low variability. The accretion rate ranges from 5 to 6 mm per year, while the elevation change ranges from 7 to 10 mm per year.

On the other hand, sites with less than 8 years of monitoring exhibit high variability in the rates of accretion and elevation change. The accretion rates range from 2 to 21 mm per year, and the elevation change ranges from 8

to 66 mm per year. This variability suggests that these sites may be undergoing more dynamic changes compared to the older sites.

Interestingly, at the older sites (more than 8 years of monitoring), there were no significant differences in accretion and elevation between 2023 and the preceding six years. This stability in sediment accumulation and elevation suggests a relatively consistent environment.

In contrast, at sites with less than 6 years of monitoring, the data indicates that the accretion and elevation results in 2023 were smaller compared to the previous year. This suggests a potential declining trend in sediment accumulation and elevation change at these sites, although a longer monitoring period would provide a clearer understanding of the overall trend.

Conclusion

Based on the data provided, it is evident that there are variations in the rates of elevation change and accretion between different monitoring sites.

The Eight Day Swamp recorded an annual elevation change of 7.67 mm and an accretion rate of 5.70 mm per year. Walden Swamp showed a slightly higher annual elevation change of 11.34 mm and an accretion rate of 5.82 mm per year. These results indicate that Walden Swamp experienced a more significant increase in elevation compared to Eight Day Swamp, while the accretion rates were relatively similar for both sites.

Tollgate Marsh, on the other hand, exhibited a lower annual elevation change of 5.68 mm per year. However, it had a relatively higher accretion rate of 9.97 mm per year. This suggests that Tollgate Marsh experienced less significant changes in elevation but had a higher accumulation of sediments compared to the other two sites.

The two recently installed SET plots, Ackerman Marsh and Never Touch Creek Marsh, showed higher rates of elevation change and accretion. Never Touch Creek Marsh recorded an annual elevation change of 11.9 mm and an accretion rate of 12.4 mm per year, indicating significant changes in elevation and sediment accumulation. Ackerman Marsh had an even higher annual elevation change of 16.7 mm per year, suggesting more substantial changes in elevation, while its accretion rate was measured at 10.3 mm per year.

These findings demonstrate the variation in elevation change and sediment accumulation rates among different monitoring sites. The differences may be attributed to various factors, including the hydrological dynamics, sediment transport, and environmental conditions specific to each site.

It is crucial to continue monitoring these sites over a more extended period to determine if these observed rates remain consistent or if they indicate long-term trends. Additionally, monitoring sites with shorter durations, such as the two recently installed SET plots, provide valuable insights into the initial changes that occur in these ecosystems. However, further monitoring and analysis would be necessary to fully understand the implications and significance of these findings.