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

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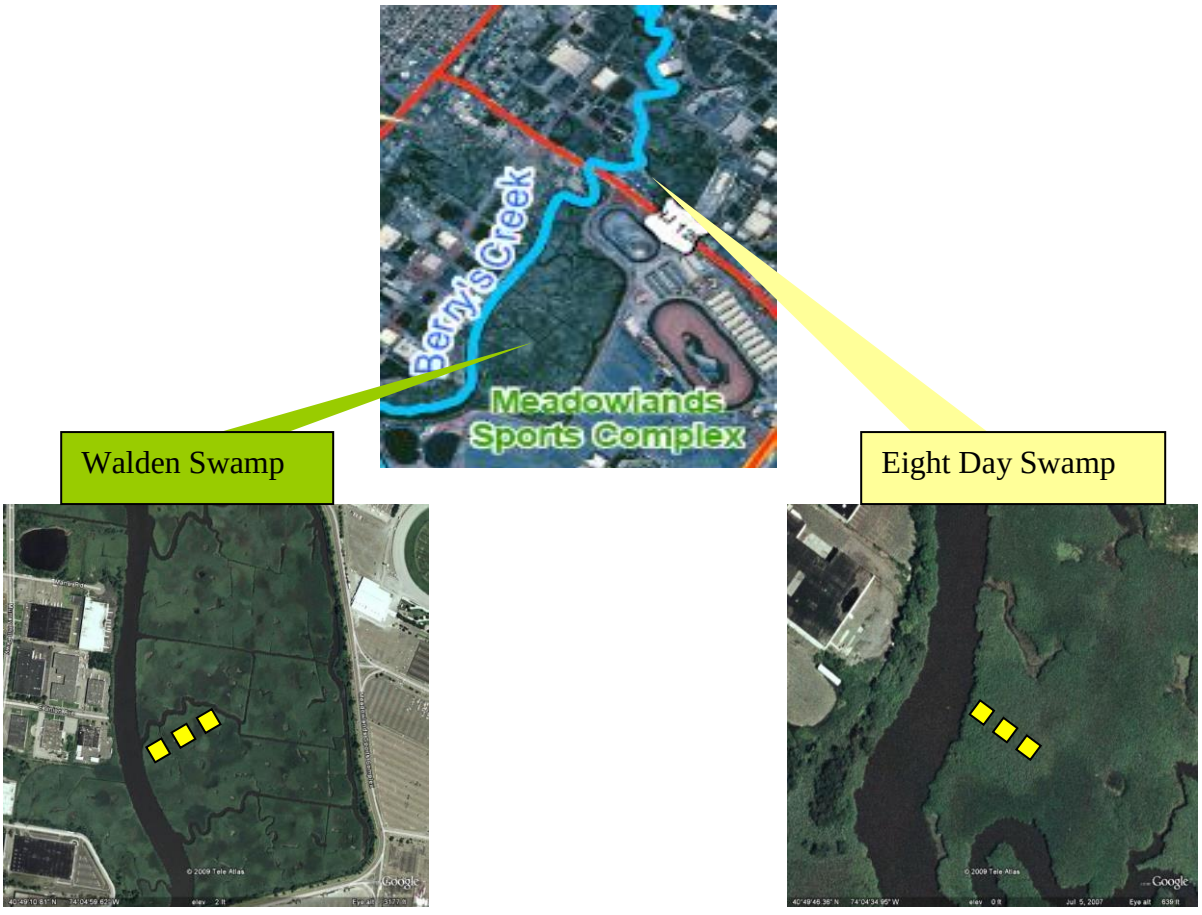
The SET (Sediment Elevation Table) provides a constant plane in space from which the distance to the sediment surface can be measured by means of pins lowered to the marsh surface (USGS 2010). Benchmark rods were established, marker horizons of feldspar were emplaced and baseline readings were taken at two locations in the Berry's Creek watershed during the spring of 2009. Each site was revisited and readings were taken in the spring and fall of 2010 and the spring and fall of 2011. This report is a summary of those measurements.

Figure 1: Study Area



At each site, three replicate plots have been installed. At each plot, nine pins are lowered to the marsh surface. Readings are taken in each of four orientations resulting in a total of 108 measurements. 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. To obtain a yearly rate, this value is be divided by the number of days that have elapsed between establishment of

the benchmark and the subsequent reading. Approximately two years elapsed between the readings summarized in this report (Table 1).

Table 1: Time Elapsed Between Readings

Location	Initial Date	Subsequent Date	Days	Years
EDS-1, 2, 3	4/30/2009	11/21/2011	934	2.56
WS-1, 2, 3	4/30/2009	12/1/2011	945	2.60

Table 1 provides the dates for each reading and the time elapsed in days and years.

Table 2: SETs Measurements – Fall 2011 sampling

Site	Marsh Type	Dominant Vegetation	Rate of Elevation Change (mm/yr)
Eight Day Swamp	High	Phragmites	15.6
Walden Swamp	High	Phragmites	31.9

Table 2A: Average Elevation Change (mm) – Fall 2011 Sampling

Eight Day Swamp	
All Platforms	39.92
Std Error	4.68
EDS-1	43.5
Std Error	12.61
EDS-2	30.64
Std Error	10.21
EDS-3	45.6
Std Error	2.6
EDS-1 pos 2	48.2
EDS-1 pos 4	63.3
EDS-1 pos 6	6.8
EDS-1 pos 8	55.56
EDS-2 pos 2	18.00
EDS-2 pos 4	25.00
EDS-2 pos 6	60.89
EDS-2 pos 8	18.67
EDS-3 pos 1	38.9
EDS-3 pos 3	44.6
EDS-3 pos 5	50.8
EDS-3 pos 7	48.33

Walden Swamp	
All Platforms	82.70
Std Error	14.02
WS-1	76.1
Std Error	2.32
WS-2	109.6
Std Error	7.37
WS-3	62.4
Std Error	5.3
WS-1 pos 2	82.6
WS-1 pos 4	75.4
WS-1 pos 6	71.6
WS-1 pos 8	74.7
WS-2 pos 2	112.8
WS-2 pos 4	104.1
WS-2 pos 6	93.33
WS-2 pos 8	128.2
WS-3 pos 2	62.4
WS-3 pos 4	60.1
WS-3 pos 6	76.6
WS-3 pos 8	50.7

The above two tables, Tables 2 and 2A, are summaries of the changes in elevation measured at each location. The complete data set is found in Appendices at the end of the report.

Table 3: Feldspar Horizon Measurements – Fall 2011 sampling

Site	Positive Accretion (Percent)	Accretion Rate (mm/yr)
Eight Day Swamp	100	8.30
Walden Swamp	100	12.60

Table 3a: Average Accretion (mm) – Fall 2011 sampling

Eight Day Swamp	
All Platforms	21.3
Std Error	2.50
EDS-1	26.33
Std Error	1.0
EDS-2	19.0
Std Error	2.1
EDS-3	18.7
Std Error	3.0
EDS-1	
Plot A	25.0
Plot B	28.0
Plot C	26.0
EDS-2	
Plot A	20.0
Plot B	15.0
Plot C	22.0
EDS-3	
Plot A	20.0
Plot B	14.0
Plot C	22.0

Walden Swamp	
All Platforms	32.6
Std Error	3.86
WS-1	35.0
Std Error	0.0
WS-2	37.7
Std Error	3.93
WS-3	25.0
Std Error	3.0
WS-1	
Plot A	35.0
Plot B	35.0
Plot C	35.0
WS-2	
Plot A	43.0
Plot B	40.0
Plot C	30.0
WS-3	
Plot A	28.0
Plot B	22.0
Plot C	25.0

Tables 3 and 3a are summaries of the accretion measured by use of feldspar horizons emplaced at each benchmark location

Feldspar horizons were emplaced inside three corners of each benchmark 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 associated with each marsh; the average of all readings produces a summary value (Table 3). Not all horizons produced recognizable accretion; it is possible that the feldspar can not be found and will need to be replaced and a new data set generated. Where

negligible material accumulated above the horizon, "0.0 accretion" is designated. All recoverable values are included in the calculation for accretion rate.

To obtain a yearly rate, this value is divided by the number of days that have elapsed between establishment of the benchmark and the subsequent reading. Approximately two and a half years elapsed between the readings summarized in this report. Table 3 provides the dates for each reading and the time elapsed in days and years.

Table 4: Rate and Accretion values – Spring 2009 to Fall 2011

Eight Day Swamp					
Days	0	378	566	736	935
Sample Date	4/30/2009	5/13/2010	11/17/2010	5/6/2011	11/21/2011
Elevation Rate mm/yr	0.00	19.07	25.24	18.67	15.60
Accretion Rate mm/yr	0.00	5.92	7.20	5.68	8.30

Walden Swamp					
Days	0	378	566	736	945
Sample Date	4/30/2009	5/13/2010	11/17/2010	5/6/2011	12/1/2011
Elevation Rate mm/yr	0.00	40.27	41.21	32.82	31.94
Accretion Rate mm/yr	0.00	3.77	12.20	8.40	12.60

Table 4 shows the yearly accretion and elevation rate for every sampling event.

Table 5: Marsh Processes (USGS 2010)

SURFACE PROCESSES:
1) Sediment deposition
2) Sediment erosion
SUBSURFACE PROCESSES:
3) Root Growth
4) Decomposition
5) Porewater Flux
6) Compaction

Table 5 explains both surface and subsurface interactions (USGS, 2010).

Discussion

While it is tempting to draw conclusions from this data set, one must acknowledge that marsh sediment processes take place slowly over long periods of time; to quote Jim Lynch, USGS SETs methodology expert, "…It will take a long time to get enough data to see what's going on."(2010, personal communication)

According to table 4, both Eight Day Swamp and Walden Swamp are slowly decreasing in elevation rate. Although the accretion rates are significant at 8.30 and 12.60 mm/yr, the elevation rates are still decreasing.

Seasonally, one can see that the accretion rates are higher in the fall due to root growth and decomposition of plant material from the summer months. The rates are relatively lower in the spring because of the winter months of ice and sediment compaction.

Conclusion

We expect to see a cycle within our data. During the fall sampling, the rate and accretion will remain at a relatively high amount due to swelling of the marsh surface from root growth and water storage in the subsurface. Cahoon et al., (1995) proposed changes in water storage and in the volume of the root zone related to seasonal patterns of plant production as an explanation for elevation change in a Louisiana marsh. However, during the spring sampling, we expect to see lower values for both the elevation rate and accretion rate due to the loss of decomposed matter and possible sediment impaction from ice on the surface.

References

Cahoon, D., Reed, D., Day, J Jr. 1995. Estimating shallow subsidence in microtidal salt marshes of the southeastern United States: Kaye and Barghoorn revisited. Marine Geology 128, 1-9.

Lynch, J. 2010. USGS Patuxent Wildlife Research Center, Personal Communication.

USGS 2010. SET Concepts and Theory, url: http://www.pwrc.usgs.gov/set/theory.html#mh Patuxent Wildlife Research Center.

Weis, P., Barrett, K, Proctor, T., and Bopp, R. 2005. Studies of a contaminated brackish marsh in the Hackensack Meadowlands of northeastern New Jersey: An assessment of natural recovery. Marine Pollution Bulletin 50, 1405–1415.

Appendix 1: Eight Day Swamp Surface Elevation Table Readings (mm)

	EDS-1				EDS-2					EDS-3				
Position	Pin	4/30/2009	11/21/2011	Difference	Position	Pin	4/30/2009	11/21/2011	Difference	Position	Pin	5/1/2009	11/21/2011	Difference
2	1	91	111	20	2	1	56	82	26	1	1	64	135	71
	2	45	103	58		2	68	83	15		2	64	160	96
	3	42	96	54		3	71	85	14		3	111	131	20
	4	40	128	88		4	67	81	14		4	102	126	24
	5	83	131	48		5	85	80	-5		5	107	125	18
	6	65	105	40		6	65	86	21		6	113	137	24
	7	70	116	46		7	61	86	25		7	103	134	31
	8	65	88	23		8	70	95	25		8	101	119	18
	9	50	107	57		9	53	80	27		9	81	129	48
4	1	21	100	79	4	1	43	85	42	3	1	54	119	65
	2	21	105	84		2	65	82	17		2	90	116	26
	3	38	125	87		3	67	102	35		3	80	126	46
	4	50	100	50		4	65	87	22		4	56	128	72
	5	58	104	46		5	60	106	46		5	80	123	43
	6	48	110	62		6	75	96	21		6	75	112	37
	7	13	95	82		7	75	80	5		7	86	115	29
	8	60	109	49		8	68	87	19		8	76	125	49
	9	60	91	31		9	64	82	18		9	80	114	34
6	1	60	115	55	6	1	30	124	94	5	1	82	142	60
	2	118	107	-11		2	24	126	102		2	79	124	45
	3	134	95	-39		3	20	109	89		3	87	140	53
	4	105	120	15		4	37	126	89		4	89	140	51
	5	123	106	-17		5	48	96	48		5	89	133	44
	6	123	106	-17		6	42	76	34		6	95	129	34
	7	52	102	50		7	49	89	40		7	97	131	34
	8	55	98	43		8	46	81	35		8	92	149	57
	9	112	94	-18		9	62	79	17		9	60	139	79
8	1	55	110	55	8	1	74	82	8	7	1	100	140	40
	2	60	119	59		2	62	80	18		2	98	151	53
	3	65	107	42		3	64	87	23		3	93	115	22
	4	64	110	46		4	51	80	29		4	78	133	55
	5	66	140	74		5	74	100	26		5	80	140	60
	6	62	142	80		6	76	82	6		6	80	115	35
	7	60	114	54		7	63	81	18		7	97	136	39
	8	58	109	51		8	62	76	14		8	80	151	71
	9	63	102	39		9	50	76	26		9	77	137	60

Appendix 2: Walden Swamp Surface Elevation Table Readings (mm)

WS-1					WS-2							WS-3			
Position	Pin	4/30/2009	12/1/2011	Difference	Position	Pin	4/30/2009	12/1/2011	Difference	Position	Pin	4/30/2009	12/1/2011	35 mm offset	Difference
2	1	42	121	79	2	1	179	261	82	2	1	110	122	157	47
	2	53	132	79		2	156	256	100		2	96	134	169	73
	3	61	136	75		3	150	254	104		3	112	134	169	57
	4	121	160	39		4	69	266	197		4	109	129	164	55
	5	25	164	139		5	223	269	46		5	94	131	166	72
	6	45	146	101		6	155	272	117		6	112	134	169	57
	7	50	143	93		7	123	260	137		7	90	136	171	81
	8	40	151	111		8	83	232	149		8	112	141	176	64
	9	100	127	27		9	117	200	83		9	97	118	153	56
4	1	51	132	81	4	1	176	295	119	4	1	112	122	157	45
	2	71	109	38		2	156	255	99		2	118	120	155	37
	3	87	122	35		3	172	261	89		3	115	134	169	54
	4	52	123	71		4	82	258	176		4	127	149	184	57
	5	63	126	63		5	192	220	28		5	101	126	161	60
	6	67	144	77		6	127	251	124		6	88	132	167	79
	7	41	152	111		7	175	249	74		7	98	142	177	79
	8	33	110	77		8	144	270	126		8	75	105	140	65
	9	12	138	126		9	157	259	102		9	80	110	145	65
6	1	43	156	113	6	1	230	282	52	6	1	106	124	159	53
	2	80	152	72		2	200	259	59		2	106	123	158	52
	3	87	151	64		3	155	264	109		3	98	131	166	68
	4	78	149	71		4	195	289	94		4	96	139	174	78
	5	95	137	42		5	115	239	124		5	96	145	180	84
	6	92	146	54		6	140	223	83		6	85	132	167	82
	7	80	160	80		7	118	240	122		7	96	136	171	75
	8	90	165	75		8	170	266	96		8	65	137	172	107
	9	70	143	73		9	150	251	101		9	71	126	161	90
8	1	73	139	66	8	1	172	269	97	8	1	68	96	131	63
	2	73	129	56		2	230	286	56		2	69	119	154	85
	3	81	134	53		3	170	297	127		3	78	101	136	58
	4	70	127	57		4	94	270	176		4	116	95	130	14
	5	80	163	83		5	120	271	151		5	52	131	166	114
	6	45	147	102		6	110	297	187		6	93	122	157	64
	7	50	145	95		7	136	264	128		7	164	90	125	-39
	8	80	144	64		8	100	261	161		8	75	103	138	63
	9	55	151	96		9	195	266	71		9	95	94	129	34