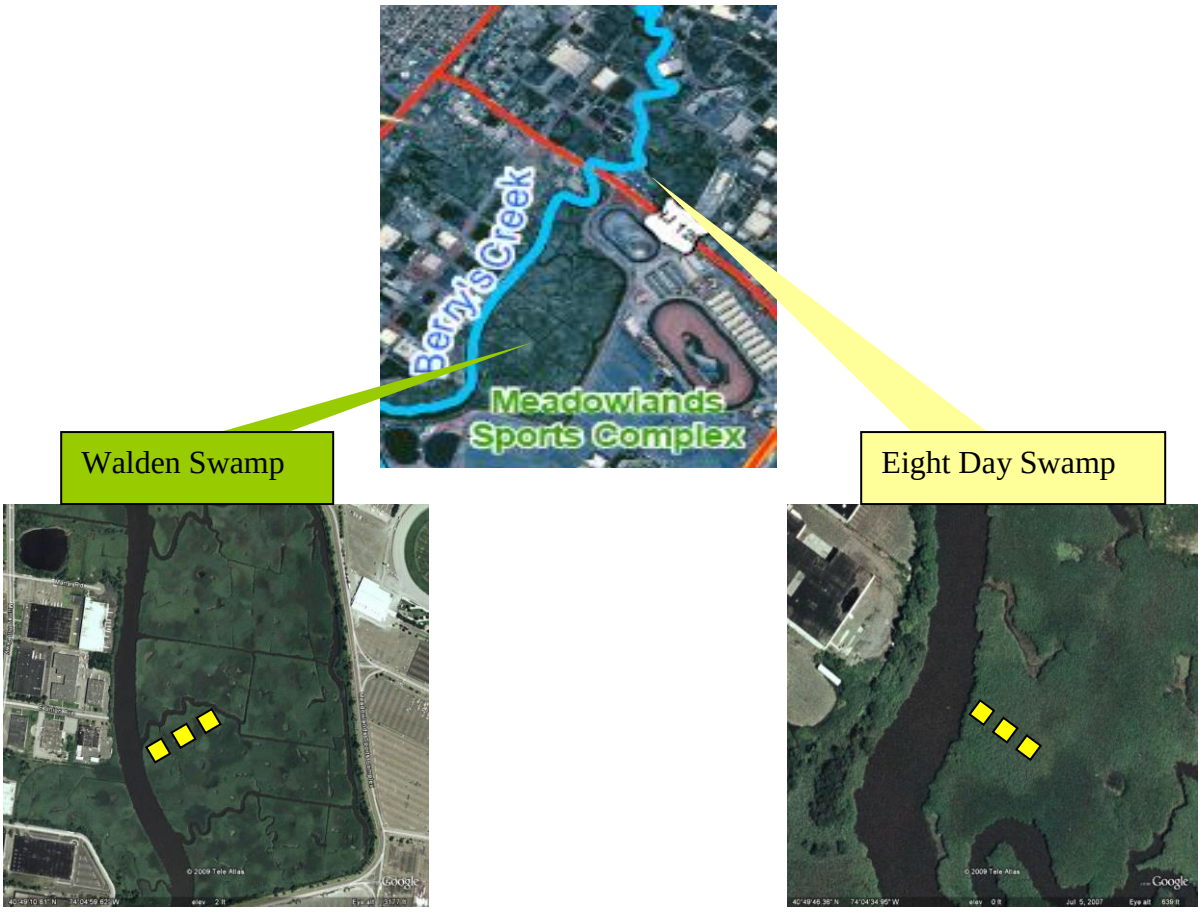
Measuring Elevation Change in Berry's Creek Marshes Using Surface Elevation Tables (SETs) and Marker Horizons

Meadowlands Environmental Research Institute (May 2011)

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 spring 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	5/6/2011	736	2.02
WS-1, 2, 3	4/30/2009	5/6/2011	736	2.02

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

Table 2: SETs Measurements – Spring 2011 sampling

Site	Marsh Type	Dominant Vegetation	Rate of Elevation Change (mm/yr)
Eight Day Swamp	High	Phragmites	18.7
Walden Swamp	High	Phragmites	32.8

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

Eight Day Swamp	
All Platforms	37.65
Std Error	5.17
EDS-1	42.2
Std Error	10.52
EDS-2	27.33
Std Error	5.57
EDS-3	43.4
Std Error	8.0
EDS-1 pos 2	42.1
EDS-1 pos 4	60.4
EDS-1 pos 6	12.8
EDS-1 pos 8	53.56
EDS-2 pos 2	25.11
EDS-2 pos 4	27.0
EDS-2 pos 6	42.11
EDS-2 pos 8	15.11
EDS-3 pos 1	24.7
EDS-3 pos 3	56.9
EDS-3 pos 5	56.6
EDS-3 pos 7	35.44

Walden Swamp	
All Platforms	66.18
Std Error	18.31
WS-1	44.8
Std Error	4.90
WS-2	102.61
Std Error	11.27
WS-3	51.1
Std Error	3.1
WS-1 pos 2	42.6
WS-1 pos 4	58.4
WS-1 pos 6	35.1
WS-1 pos 8	43.00
WS-2 pos 2	127.67
WS-2 pos 4	86.3
WS-2 pos 6	81.00
WS-2 pos 8	115.44
WS-3 pos 2	46.9
WS-3 pos 4	46.1
WS-3 pos 6	52.1
WS-3 pos 8	59.44

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 – Spring 2011 sampling

Site	Positive Accretion (Percent)	Accretion Rate (mm/yr)
Eight Day Swamp	100	5.9
Walden Swamp	100	8.0

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

Eight Day Swamp	
All Platforms	11.9
Std Error	2.8
EDS-1	10.0
Std Error	1.0
EDS-2	17.3
Std Error	3.9
EDS-3	8.3
Std Error	1.0
EDS-1	
Plot A	8.0
Plot B	10.0
Plot C	12.0
EDS-2	
Plot A	25.0
Plot B	12.0
Plot C	15.0
EDS-3	
Plot A	5.0
Plot B	7.0
Plot C	13.0

Walden Swamp	
All Platforms	16.1
Std Error	5.3
WS-1	26.7
Std Error	7.0
WS-2	11.3
Std Error	3.5
WS-3	10.3
Std Error	7.5
WS-1	
Plot A	26.0
Plot B	20.0
Plot C	34.0
WS-2	
Plot A	17.0
Plot B	12.0
Plot C	5.0
WS-3	
Plot A	20.0
Plot B	5.0
Plot C	6.0

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 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 Spring 2011

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

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

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)

Elevation change measured by the SET is influenced by both surface and subsurface processes occurring within the soil profile (USGS 2010, Table 5). The marker horizons reveal surface processes only. One can surmise the relative contribution of these processes by looking at the difference between the rates obtained by each. Table 4 shows that at both locations, the overall rate and accretion values decreased from the fall 2010 sampling. This decrease correlates with the low amount of root growth and decomposed matter present in the Spring Season due to the winter months.

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.

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

EDS-1					EDS-2					EDS-3				
Position	Pin	4/30/2009	5/6/2011	Difference	Position	Pin	4/30/2009	5/6/2011	Difference	Position	Pin	5/1/2009	5/6/2011	Difference
2	1	91	85	-6	2	1	56	85	29	1	1	64	112	48
	2	45	106	61		2	68	95	27		2	64	100	36
	3	42	102	60		3	71	98	27		3	111	115	4
	4	40	102	62		4	67	83	16		4	102	122	20
	5	83	102	19		5	85	81	-4		5	107	132	25
	6	65	100	35		6	65	105	40		6	113	128	15
	7	70	110	40		7	61	89	28		7	103	121	18
	8	65	126	61		8	70	101	31		8	101	123	22
	9	50	97	47		9	53	85	32		9	81	115	34
4	1	21	84	63	4	1	43	77	34	3	1	54	136	82
	2	21	95	74		2	65	92	27		2	90	130	40
	3	38	97	59		3	67	104	37		3	80	144	64
	4	50	104	54		4	65	86	21		4	56	134	78
	5	58	125	67		5	60	104	44		5	80	124	44
	6	48	99	51		6	75	95	20		6	75	121	46
	7	13	96	83		7	75	99	24		7	86	135	49
	8	60	106	46		8	68	86	18		8	76	146	70
	9	60	107	47		9	64	82	18		9	80	119	39
6	1	60	119	59	6	1	30	82	52	5	1	82	141	59
	2	118	114	-4		2	24	87	63		2	79	119	40
	3	134	111	-23		3	20	95	75		3	87	135	48
	4	105	103	-2		4	37	76	39		4	89	161	72
	5	123	102	-21		5	48	81	33		5	89	140	51
	6	123	114	-9		6	42	92	50		6	95	161	66
	7	52	116	64		7	49	70	21		7	97	155	58
	8	55	113	58		8	46	84	38		8	92	137	45
	9	112	105	-7		9	62	70	8		9	60	130	70
8	1	55	111	56	8	1	74	85	11	7	1	100	126	26
	2	60	105	45		2	62	75	13		2	98	115	17
	3	65	115	50		3	64	82	18		3	93	124	31
	4	64	115	51		4	51	76	25		4	78	135	57
	5	66	116	50		5	74	95	21		5	80	135	55
	6	62	123	61		6	76	78	2		6	80	120	40
	7	60	106	46		7	63	84	21		7	97	117	20
	8	58	118	60		8	62	80	18		8	80	123	43
	9	63	126	63		9	50	57	7		9	77	107	30

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

WS-1					WS-2						WS-3				
Position	Pin	4/30/2009	5/6/2011	Difference	Position	Pin	4/30/2009	5/6/2011	Difference	Position	Pin	4/30/2009	5/6/2011	35 mm offset	Difference
2	1	42	110	68	2	1	179	265	86	2	1	110	130	165	55
	2	53	95	42		2	156	255	99		2	96	102	137	41
	3	61	95	34		3	150	257	107		3	112	119	154	42
	4	121	112	-9		4	69	282	213		4	109	116	151	42
	5	25	108	83		5	223	265	42		5	94	113	148	54
	6	45	95	50		6	155	270	115		6	112	116	151	39
	7	50	93	43		7	123	271	148		7	90	115	150	60
	8	40	106	66		8	83	269	186		8	112	106	141	29
	9	100	106	6		9	117	270	153		9	97	122	157	60
4	1	51	111	60	4	1	176	217	41	4	1	112	104	139	27
	2	71	108	37		2	156	241	85		2	118	111	146	28
	3	87	123	36		3	172	245	73		3	115	121	156	41
	4	52	107	55		4	82	249	167		4	127	125	160	33
	5	63	115	52		5	192	253	61		5	101	111	146	45
	6	67	113	46		6	127	230	103		6	88	106	141	53
	7	41	106	65		7	175	239	64		7	98	114	149	51
	8	33	107	74		8	144	230	86		8	75	107	142	67
	9	12	113	101		9	157	254	97		9	80	115	150	70
6	1	43	103	60	6	1	230	230	0	6	1	106	126	161	55
	2	80	104	24		2	200	248	48		2	106	126	161	55
	3	87	111	24		3	155	255	100		3	98	119	154	56
	4	78	106	28		4	195	240	45		4	96	103	138	42
	5	95	122	27		5	115	256	141		5	96	91	126	30
	6	92	116	24		6	140	246	106		6	85	112	147	62
	7	80	126	46		7	118	241	123		7	96	116	151	55
	8	90	119	29		8	170	232	62		8	65	95	130	65
	9	70	124	54		9	150	254	104		9	71	85	120	49
8	1	73	111	38	8	1	172	245	73	8	1	68	96	131	63
	2	73	103	30		2	230	262	32		2	69	103	138	69
	3	81	114	33		3	170	250	80		3	78	136	171	93
	4	70	116	46		4	94	262	168		4	116	100	135	19
	5	80	109	29		5	120	263	143		5	52	103	138	86
	6	45	110	65		6	110	296	186		6	93	110	145	52
	7	50	116	66		7	136	261	125		7	164	132	167	3
	8	80	106	26		8	100	260	160		8	75	114	149	74
	9	55	109	54		9	195	267	72		9	95	136	171	76