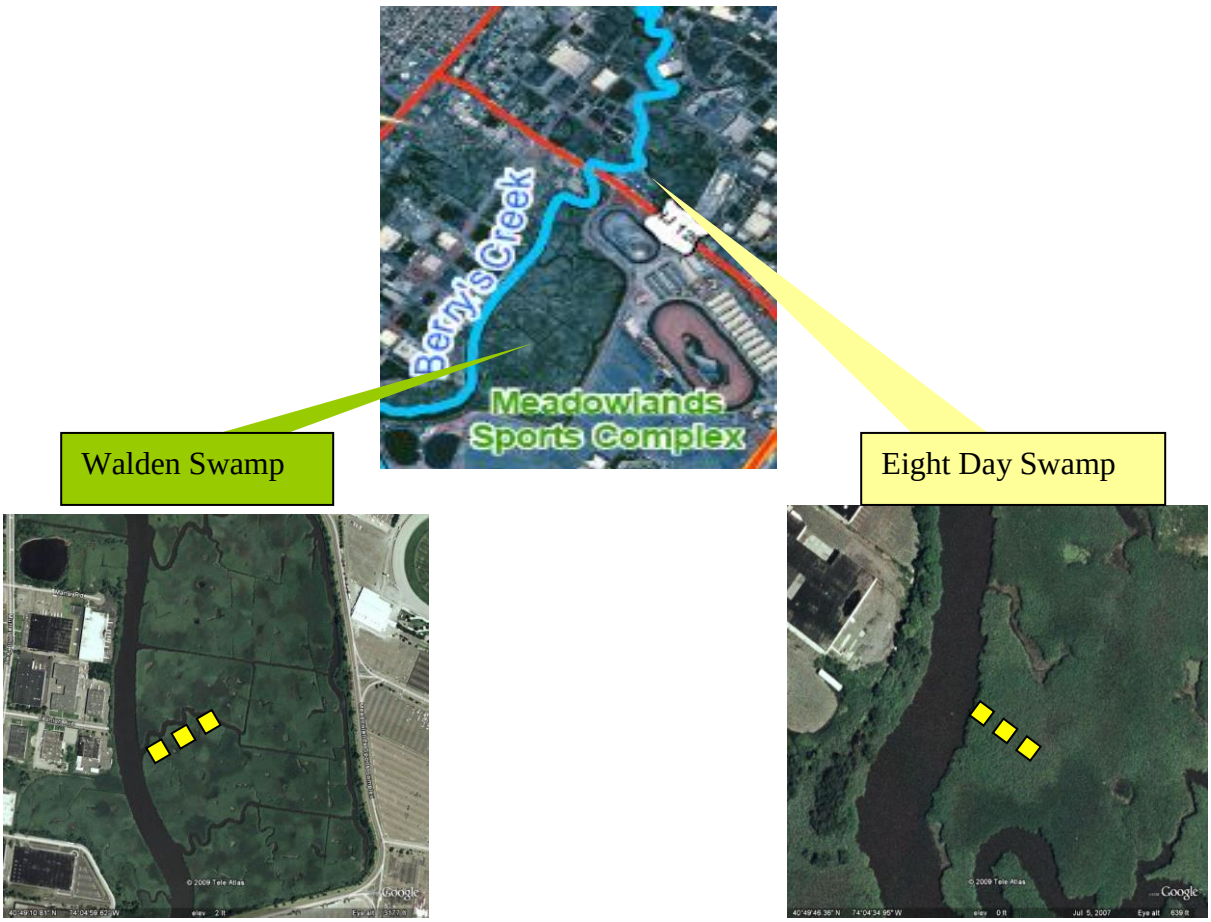
Measuring Elevation Change in Berry's Creek Marshes
Using Surface Elevation Tables (SETs) and Marker Horizons
Meadowlands Environmental Research Institute (Spring 2015)

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 of 2015. 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 six 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	4/27/2015	2188	5.99
WS-1, 2, 3	4/30/2009	5/7/2015	2198	6.02

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

Table 2: Average Elevation Change (mm) – Spring 2015 Sampling

Eight Day Swamp	
All Platforms	53.90
Std Error	3.09
EDS-1	53.0
Std Error	14.89
EDS-2	49.06
Std Error	7.05
EDS-3	59.6
Std Error	6.3
EDS-1 pos 2	80.9
EDS-1 pos 4	71.3
EDS-1 pos 6	14.4
EDS-1 pos 8	45.33
EDS-2 pos 2	46.44
EDS-2 pos 4	41.1
EDS-2 pos 6	69.67
EDS-2 pos 8	39.00
EDS-3 pos 1	49.7
EDS-3 pos 3	77.6
EDS-3 pos 5	59.4
EDS-3 pos 7	51.89

Walden Swamp	
All Platforms	77.86
Std Error	8.81
WS-1	77.8
Std Error	8.37
WS-2	93.17
Std Error	15.91
WS-3	62.6
Std Error	6.6
WS-1 pos 2	85.1
WS-1 pos 4	95.2
WS-1 pos 6	56.0
WS-1 pos 8	74.78
WS-2 pos 2	126.67
WS-2 pos 4	57.4
WS-2 pos 6	76.44
WS-2 pos 8	112.11
WS-3 pos 2	50.2
WS-3 pos 4	52.2
WS-3 pos 6	74.6
WS-3 pos 8	73.56

Table 2a: SETs Measurements – Spring 2015 sampling

Site	Marsh Type	Dominant Vegetation	Rate of Elevation Change (mm/yr)
Eight Day Swamp	High	Phragmites	8.99
Walden Swamp	High	Phragmites	12.93

Tables 2 and 2a are summaries of the changes in elevation measured at each location.

Table 2 contains the averages of elevation changes obtained at each of the three plots (EDS-1, EDS-2, EDS-3 for Eight Day Swamp and WS-1, WS-2, WS-3 for Walden Swamp) as well as at each of

the 4 orientation positions. The averages of measurements from all 108 platforms at each site are also included in Table 2. The average of all the platforms is then divided by the time elapsed since the initial date (Table 1) to derive the rate of elevation change in mm/yr (Table 2a). For the complete data set, please refer to Appendices at the end of this report.

Table 3: Average Accretion (mm) – Spring 2015 sampling

Eight Day Swamp	
All Platforms	43.33
Std Error	2.55
EDS-1	41.67
Std Error	7.50
EDS-2	48.33
Std Error	1.67
EDS-3	40.00
Std Error	2.50
EDS-1	
Plot A	40.0
Plot B	35.0
Plot C	50.0
EDS-2	
Plot A	45.0
Plot B	50.0
Plot C	50.0
EDS-3	
Plot A	35.0
Plot B	40.0
Plot C	45.0

Walden Swamp	
All Platforms	49.11
Std Error	5.60
WS-1	50.00
Std Error	12.50
WS-2	39.00
Std Error	5.86
WS-3	58.33
Std Error	12.50
WS-1	
Plot A	45.0
Plot B	65.0
Plot C	40.0
WS-2	
Plot A	30.0
Plot B	37.0
Plot C	50.0
WS-3	
Plot A	75.0
Plot B	50.0
Plot C	50.0

Table 3a: Feldspar Horizon Measurements – Spring 2015 sampling

Site	Positive Accretion (Percent)	Accretion Rate (mm/yr)
Eight Day Swamp	100	7.23
Walden Swamp	100	8.16

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 3a). Not all horizons produced recognizable accretion; it is possible that the feldspar cannot be found and will need to be replaced and a new data set generated. Where negligible material accumulated above the horizon, "NA 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 six 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 4: Elevation Rate and Accretion Rate – Spring 2009 to Spring 2015

Eight Day Swamp						
Days	0	378	736	1322	1819	2188
Sample Date	4/30/2009	5/13/2010	5/6/2011	12/12/2012	4/23/2014	4/27/2015
Elevation Rate mm/yr	0	19.07	18.67	14.40	11.64	8.99
Accretion Rate mm/yr	0	5.92	5.68	5.74	6.05	7.23

Walden Swamp						
Days	0	378	736	1310	1824	2198
Sample Date	4/30/2009	5/13/2010	5/6/2011	11/30/2012	4/28/2014	5/7/2015
Elevation Rate mm/yr	0	40.27	32.82	22.40	18.37	12.93
Accretion Rate mm/yr	0	3.77	8.40	9.38	7.92	8.16

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)

Table 5 shows both surface and subsurface processes that can affect both the elevation and accretion rates. Elevation is affected by the surface and subsurface processes while the accretion is only affected by the surface processes.

According to table 4, the elevation rates for both Eight Day Swamp and Walden Swamp are decreasing each year while the accretion rates remain constant. Eight Day Swamp has an average accretion rate of 6 mm/yr and Walden Swamp has an average of 8 mm/yr.

Conclusion

In the years to come, the rates of accretion and elevation change will continue to drop as seen in table 4 and then stabilize. These two sites are well over the initial readings taken in 2009, but it is still too early to form any real conclusions from the present data.

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)

Plot	EDS-1				Plot	EDS-2				Plot	EDS-3			
Position	Pin	4/30/2009	4/27/2015	Difference	Position	Pin	4/30/2009	4/27/2015	Difference	Position	Pin	5/1/2009	4/27/2015	Difference
2	1	91	178	87	2	1	56	106	50	2	1	64	154	90
	2	45	168	123		2	68	104	36		2	64	138	74
	3	42	132	90		3	71	96	25		3	111	138	27
	4	40	131	91		4	67	129	62		4	102	149	47
	5	83	137	54		5	85	94	9		5	107	136	29
	6	65	135	70		6	65	126	61		6	113	157	44
	7	70	128	58		7	61	96	35		7	103	135	32
	8	65	134	69		8	70	136	66		8	101	145	44
	9	50	136	86		9	53	127	74		9	81	141	60
4	1	21	129	108	4	1	43	125	82	4	1	54	165	111
	2	21	112	91		2	65	110	45		2	90	157	67
	3	38	114	76		3	67	110	43		3	80	157	77
	4	50	102	52		4	65	112	47		4	56	145	89
	5	58	115	57		5	60	98	38		5	80	164	84
	6	48	114	66		6	75	100	25		6	75	153	78
	7	13	110	97		7	75	102	27		7	86	161	75
	8	60	111	51		8	68	101	33		8	76	144	68
	9	60	104	44		9	64	94	30		9	80	129	49
6	1	60	109	49	6	1	30	88	58	6	1	82	150	68
	2	118	124	6		2	24	86	62		2	79	149	70
	3	134	118	-16		3	20	116	96		3	87	143	56
	4	105	113	8		4	37	117	80		4	89	134	45
	5	123	110	-13		5	48	98	50		5	89	164	75
	6	123	105	-18		6	42	96	54		6	95	145	50
	7	52	116	64		7	49	127	78		7	97	135	38
	8	55	118	63		8	46	112	66		8	92	154	62
	9	112	99	-13		9	62	145	83		9	60	131	71
8	1	55	87	32	8	1	74	110	36	8	1	100	149	49
	2	60	101	41		2	62	104	42		2	98	139	41
	3	65	99	34		3	64	94	30		3	93	139	46
	4	64	95	31		4	51	111	60		4	78	146	68
	5	66	110	44		5	74	101	27		5	80	146	66
	6	62	130	68		6	76	99	23		6	80	127	47
	7	60	109	49		7	63	108	45		7	97	135	38
	8	58	120	62		8	62	95	33		8	80	137	57
	9	63	110	47		9	50	105	55		9	77	132	55

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

Plot	WS-1				Plot	WS-2				Plot		WS-3		35 mm	
Position	Pin	4/30/2009	5/7/2015	Difference	Position	Pin	4/30/2009	5/7/2015	Difference	Position	Pin	4/30/2009	5/7/2015	offset	Difference
2	1	42	147	105	2	1	179	298	119	1	1	110	135	170	60
	2	53	156	103		2	156	254	98		2	96	140	175	79
	3	61	161	100		3	150	263	113		3	112	110	145	33
	4	121	125	4		4	69	249	180		4	109	111	146	37
	5	25	153	128		5	223	291	68		5	94	100	135	41
	6	45	134	89		6	155	280	125		6	112	121	156	44
	7	50	137	87		7	123	234	111		7	90	110	145	55
	8	40	149	109		8	83	265	182		8	112	132	167	55
	9	100	141	41		9	117	261	144		9	97	110	145	48
4	1	51	155	104	4	1	176	227	51	3	1	112	135	170	58
	2	71	161	90		2	156	187	31		2	118	140	175	57
	3	87	134	47		3	172	237	65		3	115	110	145	30
	4	52	139	87		4	82	217	135		4	127	111	146	19
	5	63	122	59		5	192	198	6		5	101	100	135	34
	6	67	162	95		6	127	188	61		6	88	121	156	68
	7	41	164	123		7	175	213	38		7	98	110	145	47
	8	33	146	113		8	144	209	65		8	75	132	167	92
	9	12	151	139		9	157	222	65		9	80	110	145	65
6	1	43	140	97	6	1	230	215	-15	5	1	106	148	183	77
	2	80	130	50		2	200	276	76		2	106	153	188	82
	3	87	131	44		3	155	264	109		3	98	154	189	91
	4	78	160	82		4	195	240	45		4	96	124	159	63
	5	95	134	39		5	115	272	157		5	96	123	158	62
	6	92	135	43		6	140	250	110		6	85	140	175	90
	7	80	124	44		7	118	210	92		7	96	102	137	41
	8	90	130	40		8	170	215	45		8	65	107	142	77
	9	70	135	65		9	150	219	69		9	71	124	159	88
8	1	73	137	64	8	1	172	244	72	7	1	68	130	165	97
	2	73	130	57		2	230	271	41		2	69	125	160	91
	3	81	140	59		3	170	268	98		3	78	130	165	87
	4	70	140	70		4	94	260	166		4	116	126	161	45
	5	80	132	52		5	120	241	121		5	52	122	157	105
	6	45	154	109		6	110	244	134		6	93	128	163	70
	7	50	152	102		7	136	254	118		7	164	116	151	-13
	8	80	146	66		8	100	285	185		8	75	128	163	88
	9	55	149	94		9	195	269	74		9	95	152	187	92

*The 35 mm offset means it is 35 mm higher than the SET benchmark rods installation elevation and it is used in calculating the difference.