Assessing Salt Marsh Recovery Utilizing Improved Computer-Aided Tomography Technology (CTT)

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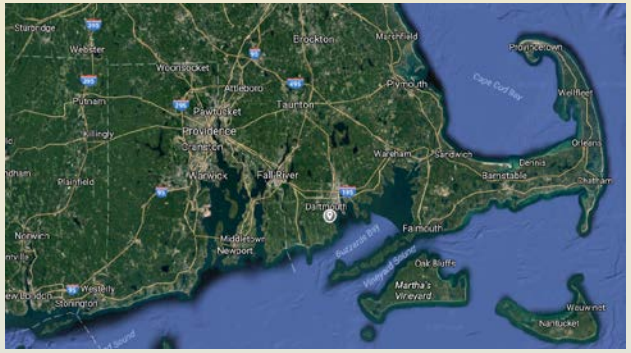
Abstract

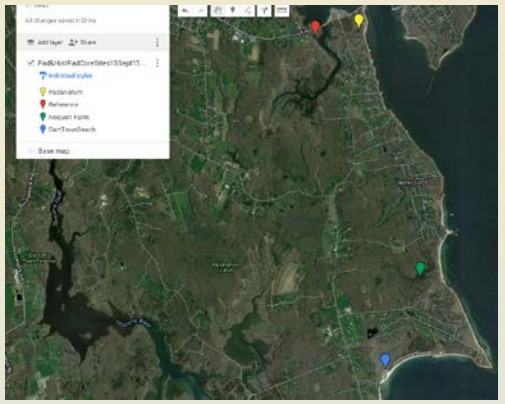
CERF 2017 Abstract: Assessing saltmarsh recovery utilizing improved computer-aided tomography technology (CTT)

In 2001 the Padanaram marsh, a small 7.2 acre marsh in Dartmouth, MA, was chosen as a Tidal Hydrology Restoration site. The site was initially characterized as a brackish mostly freshwater deteriorating marsh by O'Reilly and Turek. Then in May 2003 the seawater input to this marsh was increased by replacing the old 30 cm diameter culvert with a 100 cm by 132 cm culvert, which increased the maximum seawater input by approximately 60 times. Within 2 years aboveground *Phragmites australis*, which dominated the eastern shores of this marsh, completely disappeared. Today, almost 15 years later, this marsh is dominated by native saltmarsh species such as *Spartina alterniflora*.

We applied computer-aided tomography technology (CTT) to investigate the belowground portions of this recovering marsh and compared these results with nearby reference marshes. Results in 2015 indicated that the first chosen reference marsh was not suitable for comparison to this recovering marsh because these marshes were so statistically different in biological and physical composition. The next year we chose another reference marsh, Meadow Shores, which bracketed the recovering marsh with respect to soil wet bulk density and other components of the CTT budgets. Based upon these results, we compared the reference versus the recovery marshes and speculated on the possible future of the recovery marsh. We believe this study demonstrates CTT is a powerful tool for assessing belowground saltmarsh condition, including recovery investigations.

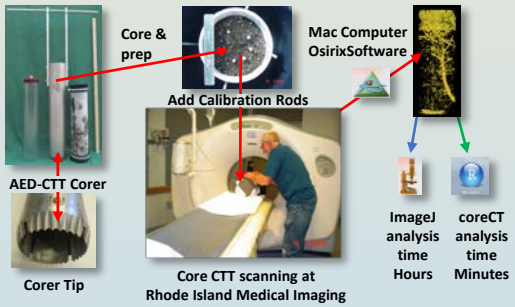
Approximate position location of Padanaram Marsh off Apponagansett Bay in Dartmouth, Mass





Methods

CTT Methods of Collection, Preparation, CT scanning and Analysis of Belowground Marsh Cores



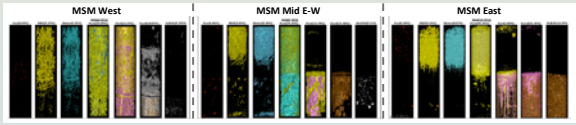
2015 Comparison between Padanaram & Reference Marshes for CT Components

	Gas	Water	Peat	Part	Sand	Shell	Living R&R (cm³)
Ref15-1	0.003	1.256	71.007	12.104	0.502	0.046	183.830
Ref15-2	0.001	2.896	82.611	7.309	0.108	0.008	100.358
Ref15-3	0.006	2.848	82.468	7.369	0.054	0.006	87.870
Ref15-4	0.015	4.663	84.446	6.357	0.224	0.031	141.494
Ref15-5	0.029	4.474	76.103	9.189	0.298	0.221	154.452
Pad15-1	0.038	1.691	31.495	24.332	37.564	3.605	14.931
Pad15-2	0.066	2.062	21.583	18.302	50.356	4.866	30.033
Pad15-3	0.017	0.611	8.475	13.644	67.506	8.167	23.548
Pad15-4	0.017	0.841	12.741	13.362	65.597	7.678	22.286
Pad15-5	0.028	0.751	11.406	13.727	63.157	9.250	27.176
Historic	0.087	2.182	55.326	30.225	4.067	0.225	30.078
T-Test vs Historic	0.14704	0.00104	0.00000	0.01427	0.00001	0.00026	0.01101

Conclusion: Since all CT components except gas were statistically different between the Padanaram & this Reference Marsh, we concluded that this Reference was not a suitable marsh to compare to the Padanaram. Consequently, we looked for another reference marsh and finally decided that the Meadow Shores Marsh (MSM) might be a more appropriate marsh to compare and now we believe the following slides verify this decision.

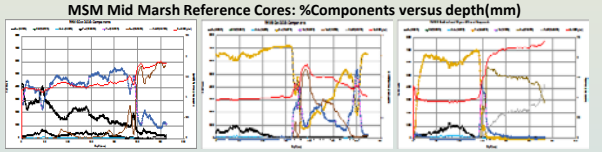
Comparison of Control and Recovery cores at Mid Marshes: Note sand in recovery core sets appears more abundant; however, it is layered from episodic events. There are *Phragmites australis* R&R fragments at the bottom of the recovery cores.

Mid Marsh Reference Cores

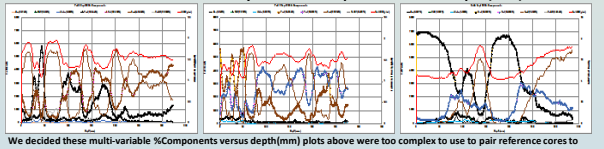


"Mid Marsh" Recovery Cores

MSM Mid Marsh Reference Cores: %Components versus depth(mm)



PAD "Mid Marsh" Recovery Cores: %Components versus depth(mm)

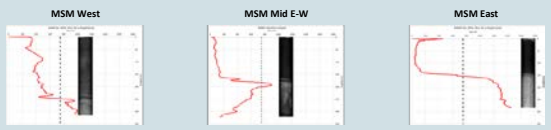


We decided these multi-variable %Components versus depth(mm) plots above were too complex to use to pair reference cores to recovering marsh cores for the low, mid and high marsh positions; therefore, we decided to use just one variable, Soil HU (which is directly related to wet soil bulk density) versus depth profiles as shown in the next slide to make these comparisons.

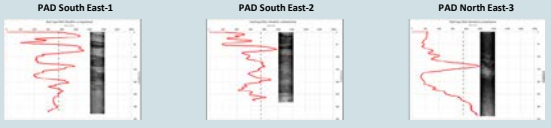
Results

We determined that Plots of Houndsfield units (HU, which are directly related to Soil Wet Bulk Density) versus Soil Depth might be the simplest and most direct approach to compare reference and recovery marsh differences.

Reference Cores



Recovery Cores



%Budget Comparisons between the Recovering and Reference marshes

Marsh Position	Core Site	Gas	R&R	Water	Peat&Part	Sand&Rock
Meadow Shores Reference Marsh						
Creek Edge	RHM5	0.026	4.183	0.471	92.846	2.474
Creek Edge	RHM7	0.098	2.308	0.184	97.245	0.165
Creek Edge	RHM8	0.210	2.735	0.445	96.133	0.007
Padanarum Recovering Marsh						
Creek Edge	PAD8	0.392	2.766	2.174	93.849	0.818
Creek Edge	PAD10	0.395	2.958	1.064	93.448	2.135
Creek Edge	PAD11	0.492	4.215	1.406	90.518	3.369
Ttest		0.003	0.404	0.023	0.146	0.146
Meadow Shores Reference Marsh						
Mid	RHM4	0.025	3.073	0.500	77.358	19.043
Mid	RHM9	0.056	2.851	0.493	83.116	13.484
Mid	RHM10	0.041	3.553	0.673	49.248	46.486
Padanarum Recovering Marsh						
Mid	PAD1	0.174	2.861	0.803	52.274	43.889
Mid	PAD2	0.143	2.293	0.802	62.909	33.853
Mid	PAD4	0.547	2.838	1.414	67.224	27.974
Ttest		0.100	0.040	0.045	0.286	0.292
Meadow Shores Reference Marsh						
High	RHM3	0.036	0.837	0.159	26.171	72.798
High	RHM6	0.033	1.774	1.243	29.838	67.112
High	RHMEX	0.030	2.067	0.398	20.849	76.657
Padanarum Recovering Marsh						
High	PAD5	0.139	1.696	0.665	24.308	73.192
High	PAD6	0.048	1.318	0.820	20.404	77.411
High	PAD7	0.242	3.335	0.411	33.488	62.419
Ttest		0.124	0.198	0.458	0.476	0.442
		Phrag Gas?				

At the Creek edge, the T-test indicates that there is significantly more gas and water in the recovery than the reference cores

In the mid marsh cores, the T-test indicates there is again significantly more water in the recovery than the reference cores; however, there are more Roots & Rhizomes in the reference than the recovery cores. The red colored recovery gas core is most likely a *Phragmites australis* Rhizome gas-filled fragment.

There were no significantly different components in the high marsh cores. Again, the red colored recovery gas core is most likely a *Phragmites australis* Rhizome gas-filled fragment.

Comparison between the Recovering and Reference marshes For Living R&R

Marsh Position	Core Site	Living R&R Vol(ml)
Meadow Shores Reference Marsh		
Creek Edge	RHM5	54.147
Creek Edge	RHM7	63.870
Creek Edge	RHM8	66.657
Padanarum Recovering Marsh		
Creek Edge	PAD8	22.929
Creek Edge	PAD10	32.539
Creek Edge	PAD11	50.804
Ttest		0.018
Meadow Shores Reference Marsh		
Mid	RHM4	50.521
Mid	RHM9	101.926
Mid	RHM10	109.780
Padanarum Recovering Marsh		
Mid	PAD1	24.186
Mid	PAD2	18.126
Mid	PAD4	36.527
Ttest		0.037
Meadow Shores Reference Marsh		
High	RHM3	11.148
High	RHM6	22.159
High	RHMEX	72.960
Padanarum Recovering Marsh		
High	PAD5	21.037
High	PAD6	8.327
High	PAD7	53.969
Ttest		0.240

For both the Creek Edge and the Mid-marsh cores the T-test indicates that there was more Living Roots & Rhizome Volume in the reference than the recovery cores.

There was no significant difference for Living R&R Volume in the high marsh cores.

Conclusions

- It was essential to find a suitable reference marsh such as the Meadow Shores Marsh (MSM), which bracketed the habitats (plant species & soil densities etc.) of the recovering Padanaram (PAD)salt marsh. Using Soil HU versus depth profiles seemed to be a reasonable way to pair reference cores to recovering marsh cores for the low, mid and high marsh positions.
- What can be speculated about the fate of the PAD marsh?
  - The higher % of both gas and water in the PAD creek banks (CB) cores suggests that these areas are decaying and drowning as sea-level (SLR) is rising.
  - Storm events have periodically occurred burying the recovery marsh with bands of sand and rock in the eastern marsh areas and even some of the CB stations. This process could speed up the time that these areas are filled in with sediment and no longer available for salt marsh plant growth.
  - The PAD higher elevation areas seem to be similar to the MSM high marsh reference areas; however, there appears to be few areas for the current PAD marsh to expand with further SLR.

CTT is a powerful tool for assessing below-ground salt marsh condition including recovery investigations.