Blue Carbon Development and Microbial Community Structure in Restored Marshes of the Chenier Plain, Louisiana

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Introduction

- Salt marshes can have high rates of carbon (C) accumulation due to high primary productivity, relatively slow organic matter decay, and sedimentation[3,5]
- Salt marsh C accumulation rates (CAR) average 242 g C m^{-2} yr^{-1}, higher than other coastal and terrestrial forest ecosystems[1,4]
- Restoration and creation are frequently used to mitigate for salt marsh degradation and loss of natural functions, such as C sequestration and microbial processes[3]
- Created and restored wetlands may accumulate and store labile and refractory C depending on[3,5]:
  - *vegetation composition, porewater chemistry, soil texture, mineral sediment accumulation, hydrology, and tidal elevation*
- Microbial community development and the relationship with soil C development in created marshes is relatively unknown

Study Sites

- The goal of this study is to examine C accumulation and microbial diversity in a 32-year chronosequence of 6 created wetlands and 2 adjacent natural salt marshes in Sabine National Wildlife Refuge in southwest Louisiana (Figure 1)

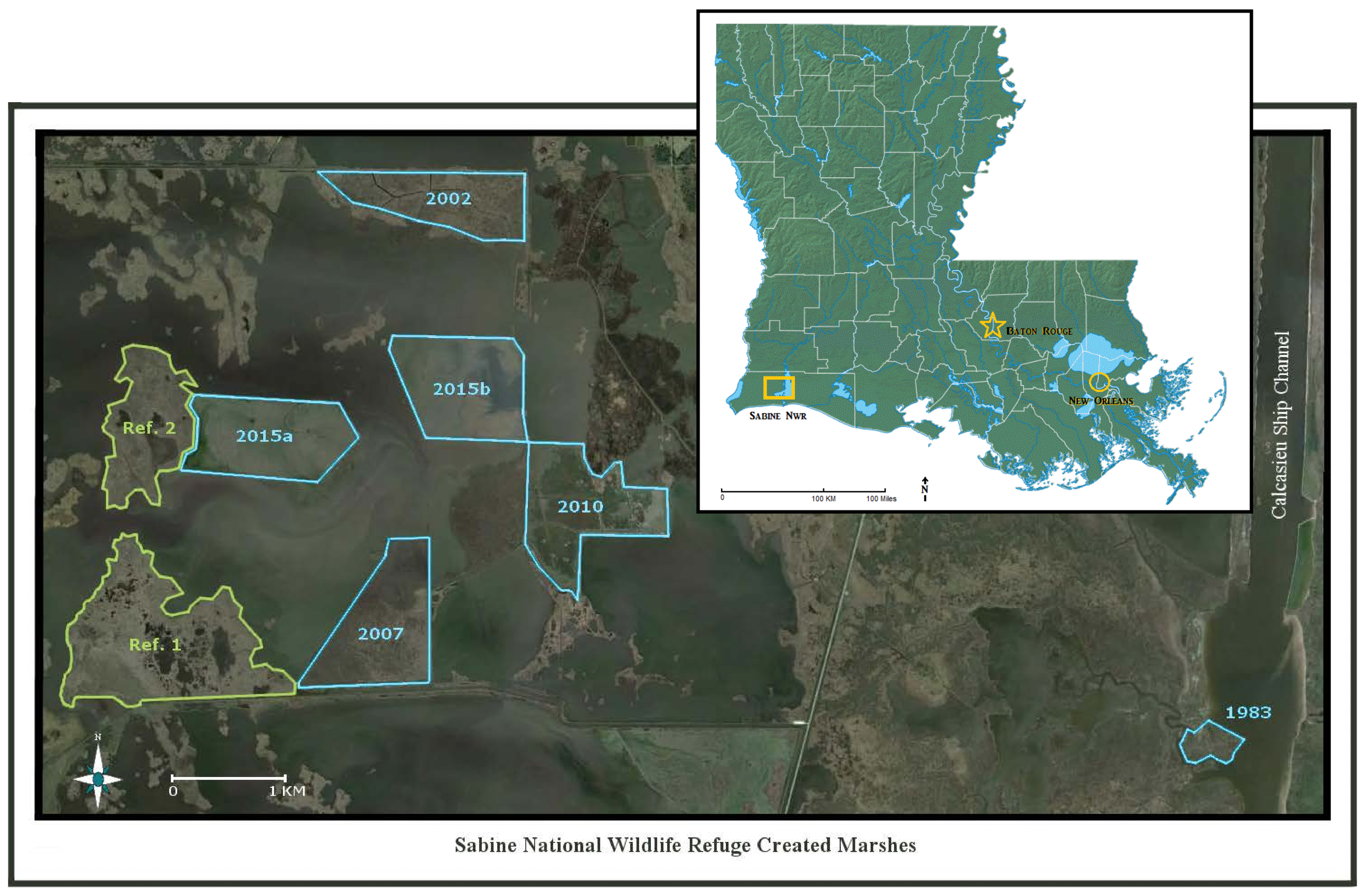

Fig. 1. Created and natural reference marshes in Sabine National Wildlife Refuge, LA.

Methods

Field Methods

- Soil cores were randomly collected in each created and natural marsh (n = 6)
- Feldspar marker horizons for short-term accretion and C accumulation (Figure 2)
- Environmental metrics - elevation, dominant vegetation, salinity, water level

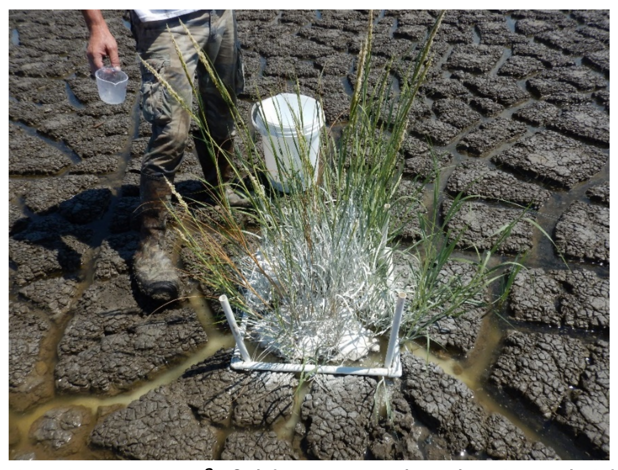

Fig. 2. A 50cm[2] feldspar marker horizon laid on a S. alterniflora clone in created marsh

Carbon Content and Accumulation

- Grain size analysis - hydrometer method
- Bulk density and loss-on-Ignition for organic matter content
- Radiometric dating (Cs-137 and Pb-210) used for natural marsh accumulation rates
- CN analysis

Microbial Diversity

- Fatty acid methyl esters (FAMEs) analysis

Statistical Analyses

- To examine differences in soil C concentration and density among marshes, we will use analysis of variance (ANOVA), and Tukey's range test to perform post-hoc comparisons using JMP SAS v.12 (SAS, Inc.)
- Stepwise regression model will be used to identify important explanatory variables influencing C accumulation rates (SAS, Inc.)
- PCA will be applied to investigate similarities within and between microbial communities in created and natural marshes (R Core Team, 2013)

Results

***Figures 3 - 8.** Organic carbon content (%) by depth*

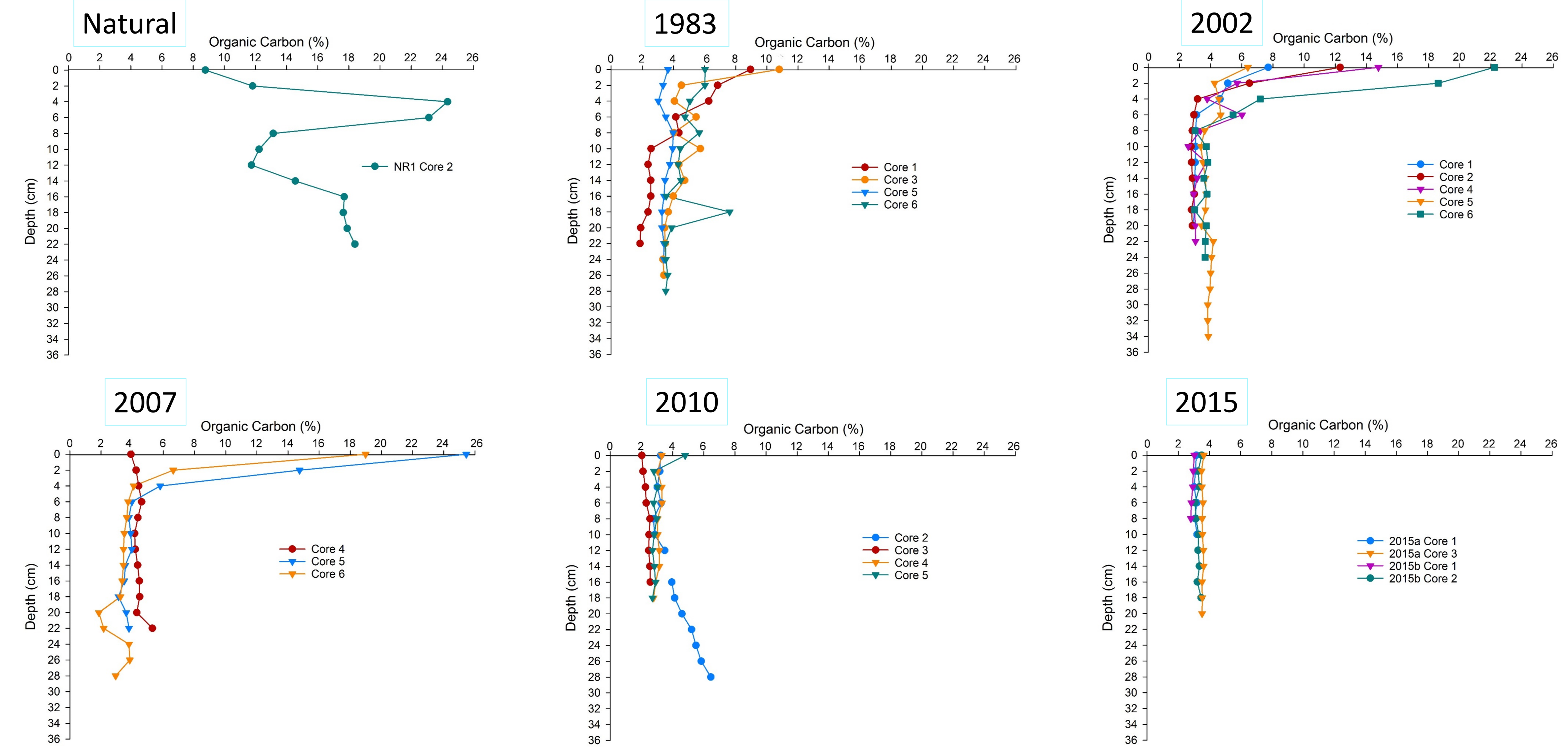

Table 1. Environmental parameters

Marsh	Elevation ± SE (cm, NAVD 88)	Dominant Veg.	Secondary Veg.
Natural	9.97 ± 4.5	*Spartina patens*	*Distichlis spicata*
1983	34.77 ± 4.4	*D. spicata*	*Spartina alterniflora*
2002	9.07 ± 4.4	*D. spicata*	*S. alterniflora*
2007	-3.61 ± 6.0	*S. alterniflora*	*D. spicata*
2010	13.97 ± 9.3	*S. alterniflora*	*Dead S. alterniflora*
2015	20.60 ± 6.5	*Bare ground*	*S. alterniflora*

Table 2. Bulk density (g/cm[3])

		Natural	1983	2002	2007	2010	2015
Depth (cm)	**4 - 6**	0.31	0.79	0.77	0.70	1.29	0.96
	8 - 10	0.23	0.89	1.12	1.43	0.73	0.90
	16 - 18	0.32	1.22	1.15	1.37	0.84	0.96

Table 3. Carbon content (%)

		Natural	1983	2002	2007	2010	2015
Depth (cm)	**4 - 6**	24.34	4.60	4.65	4.77	2.90	3.44
	8 - 10	13.15	4.51	3.17	2.86	2.83	3.34
	16 - 18	17.70	3.37	3.26	3.77	3.08	3.38

Table 4. Preliminary carbon accumulation rates

Marsh	CAR (g C m^{-2} yr^{-1})
1983	115.22 ± 19.6
2002	131.19 ± 44.3
2007	151.48 ± 30.5
2010	75.57 ± 17.8
2015	0 ± 0

Fig. 9. Taking elevation measurements with Leica RTK GPS in created marsh

Fig. 10. Collecting a core in a newly created marsh (2015)

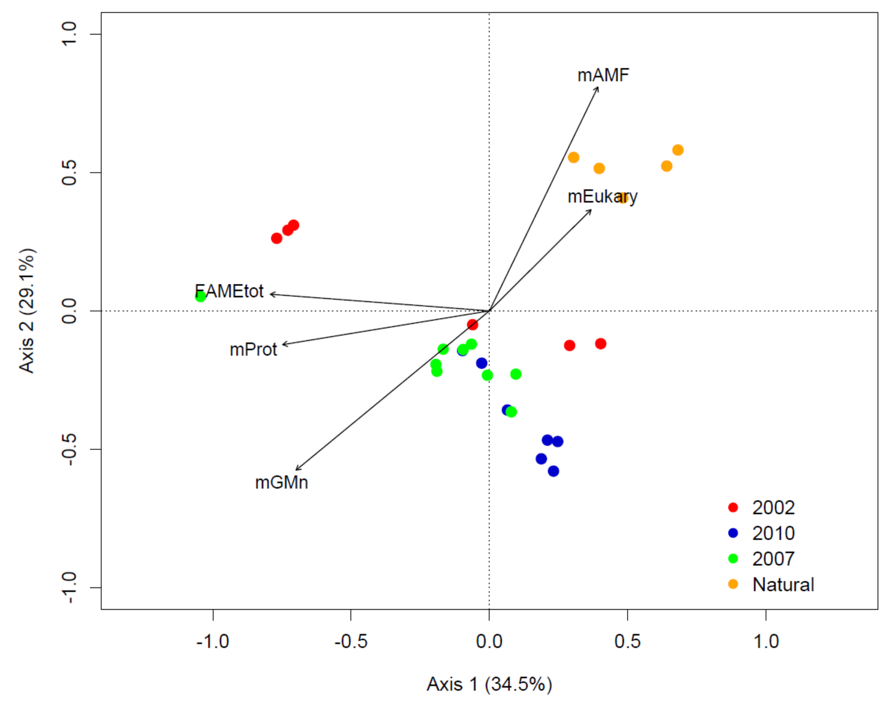

***Figure 11.** Ordination plot for relative abundance (mol%) of FAME profiles.* Greater distance between 2 points indicates greater dissimilarities. Vectors indicate greater correlations with biomarker groups (mAMF: arbuscular mycorrhizal bacteria; mEukary: Eukaryotes; mGMn: Gram negative bacteria; mProt: Protozoa; FAMEtot: absolute fatty acid abundance)

Conclusions

- Organic carbon content at the surface of created wetlands is extremely variable, ranging from 2 to 25% (Figures 3 – 8)
- Many marshes show significant decline of organic C with depth, with dredge sediment having a baseline C content of 3 – 4 %
- Environmental parameters differ between sites, and future analyses will identify important influences on variability in C content
- 32 years after creation, the bulk density of created wetlands is approximately 2.5x higher at the surface than adjacent natural marshes, with organic C content at the surface 19% of the natural marsh
- Newer created marshes have lower C accumulation rates than older created marshes (9+ years)
- C content and accumulation rates are preliminary and based on results from LOI[2]
- Preliminary outputs from FAME PCA analysis show differences between created and natural marsh microbial communities (Figure 9)

References

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Acknowledgements

This project is supported by Louisiana Sea Grant. We would like to thank R. DeLaune, B. Leonard of Sabine NWR, C. LeSieur, S. Matzke, M. Miller, A. Muench, and W. Quirk for assistance in research, planning, and in the field.