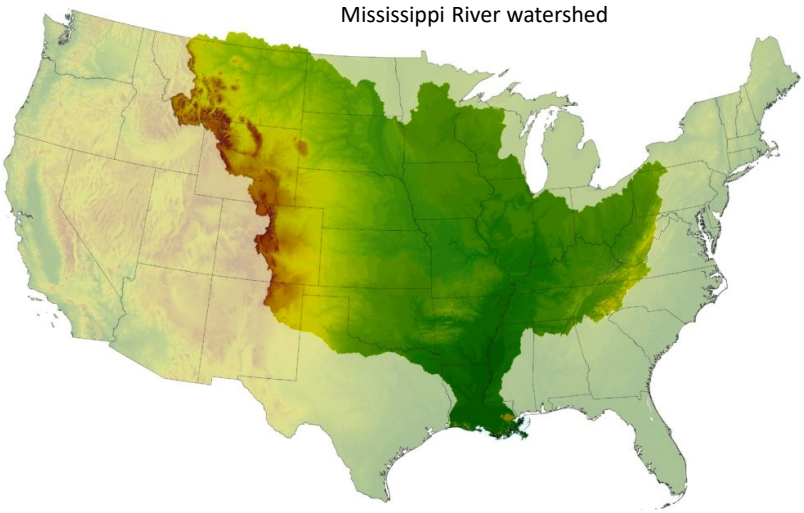
1

Louisiana coastal wetlands

Louisiana contains:

- ~40% of the coastal wetlands within the 48 conterminous United States
- 80% of the coastal wetland losses

Louisiana has lost 4,900 km^2 of land since 1930



2

Problems for Louisiana coastal wetlands

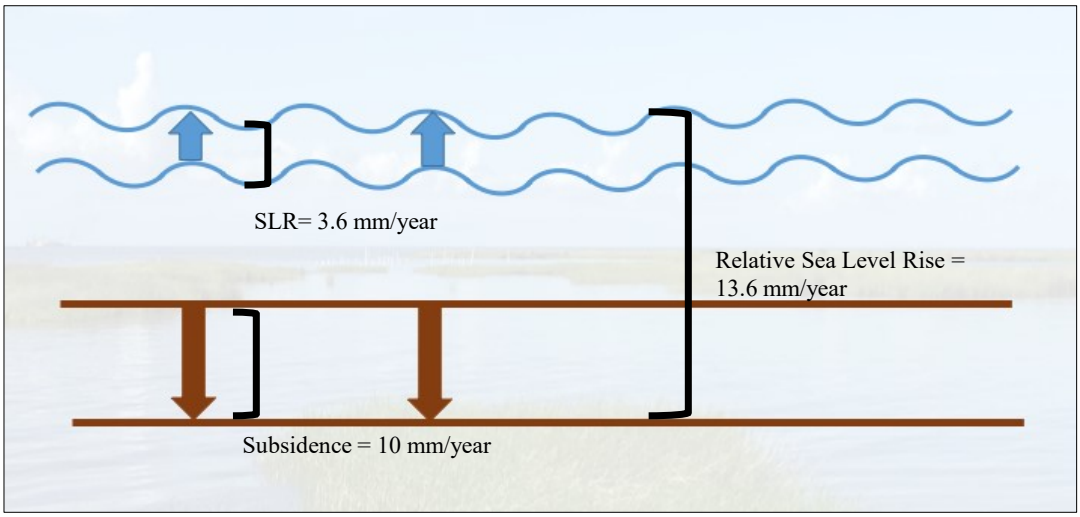


Image modified from Vaccare (2019)

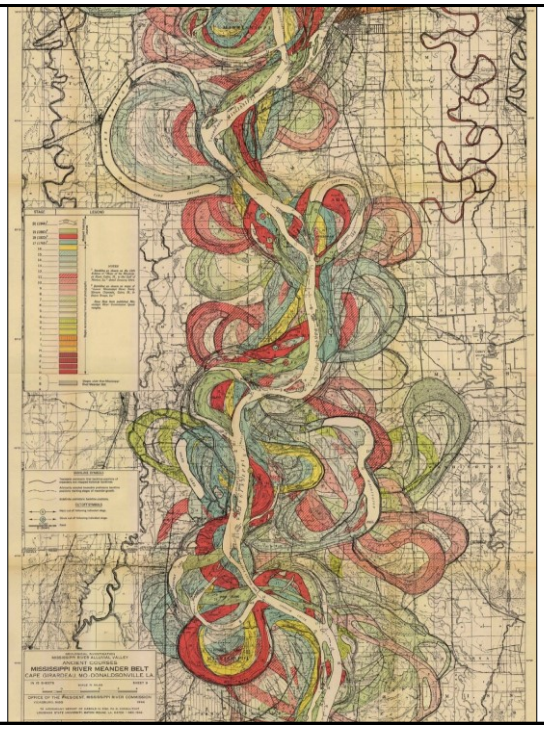
3

Anthropogenic causes of land loss in Louisiana after 1930

1. Leveeing of the Mississippi River

2. Dredging of canals for oil and gas extraction

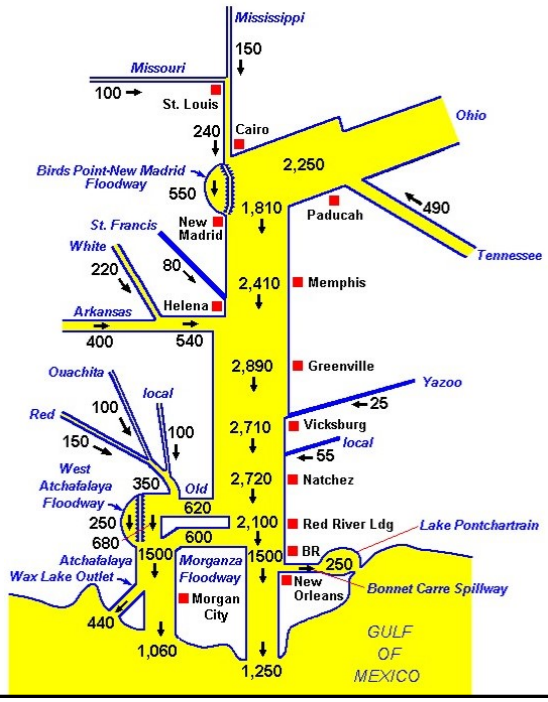
4



Fisk USACE

5

Engineered Mississippi River



U.S. Army Corps of Engineers

6

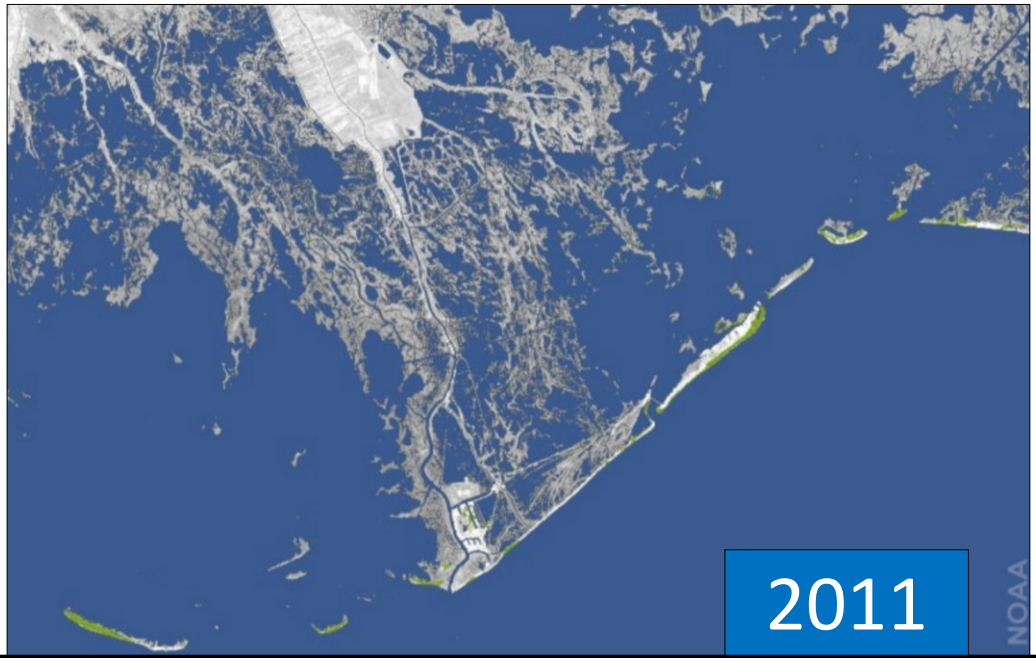
Dredging canals for oil and gas extraction

7

Historical land loss in coastal Louisiana

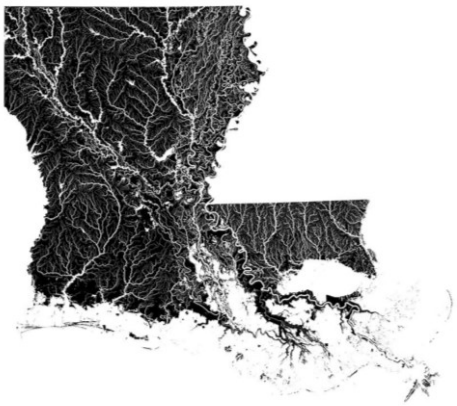
8

Historical land loss in coastal Louisiana



9

Why does this matter?



10

Importance of Louisiana coastal wetlands

Image from CPRA

11

Ecosystem Services

- Storm mitigation
- Storm surge reduction
- Atmospheric CO_2 reduction
- Habitats for fish and other coastal species

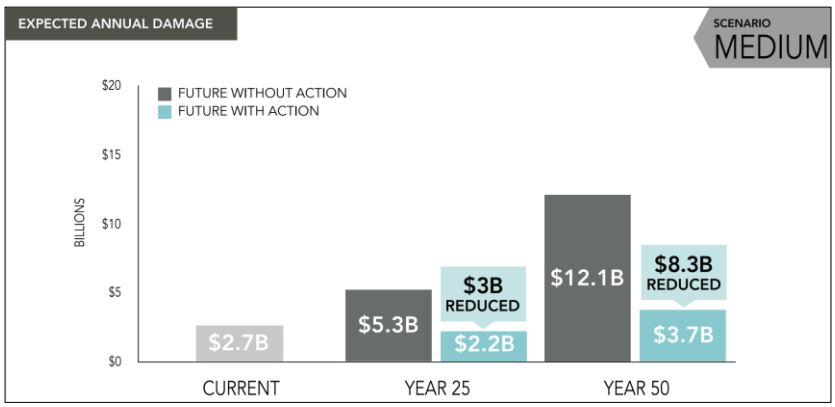
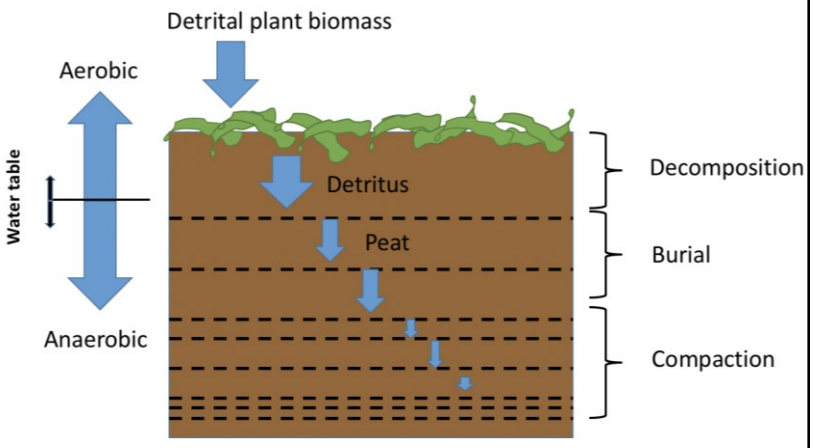


Image from CPRA

12

Carbon sequestration

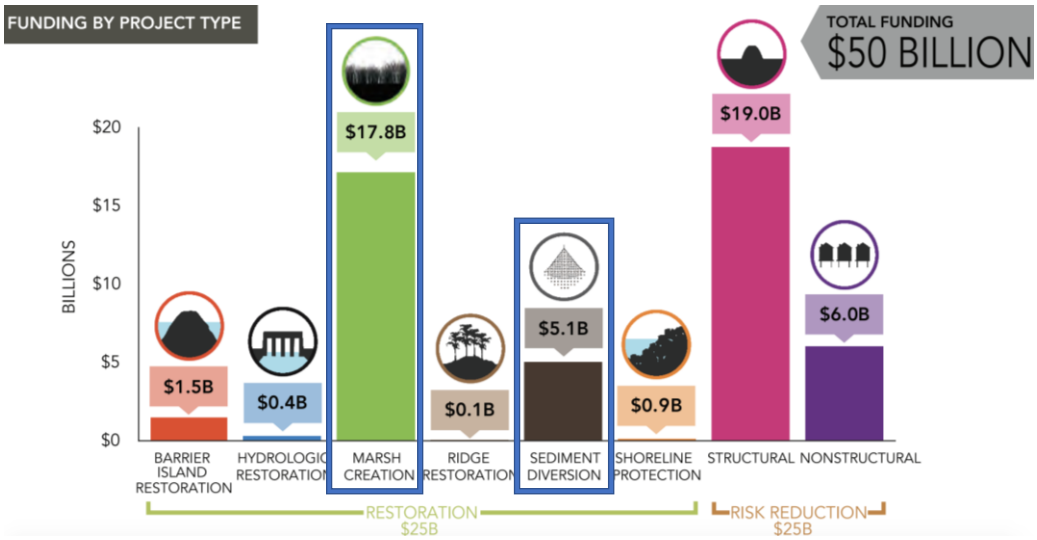
- Carbon in organic material can be stored in marsh soil for long periods of time
- Amount of carbon in wetland soils is substantial
- Annual carbon lost through marsh deterioration in Louisiana alone is 2.3 million metric tons C



Organic matter burial over time
(modified from Reddy and White, 2008)

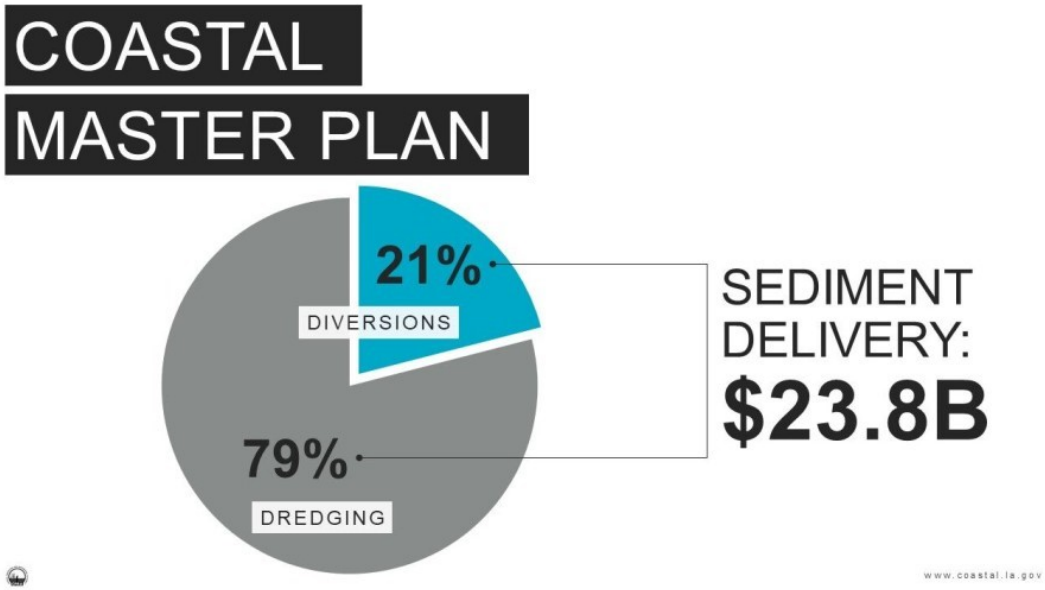
13

Restoration efforts



CPRA 2017 Coastal Master Plan

14



CPRA 2017 Coastal Master Plan

15

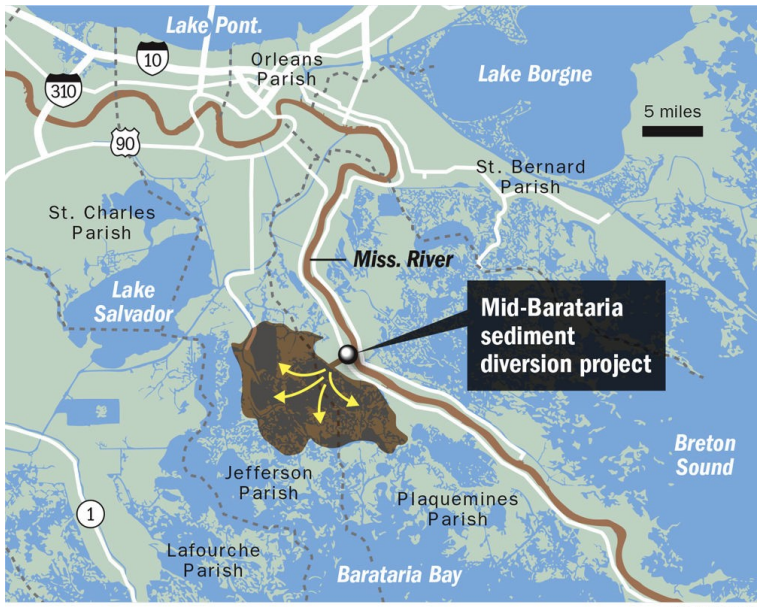
Marsh creation

16

Marsh creation

17

Sediment diversions



Advocate map

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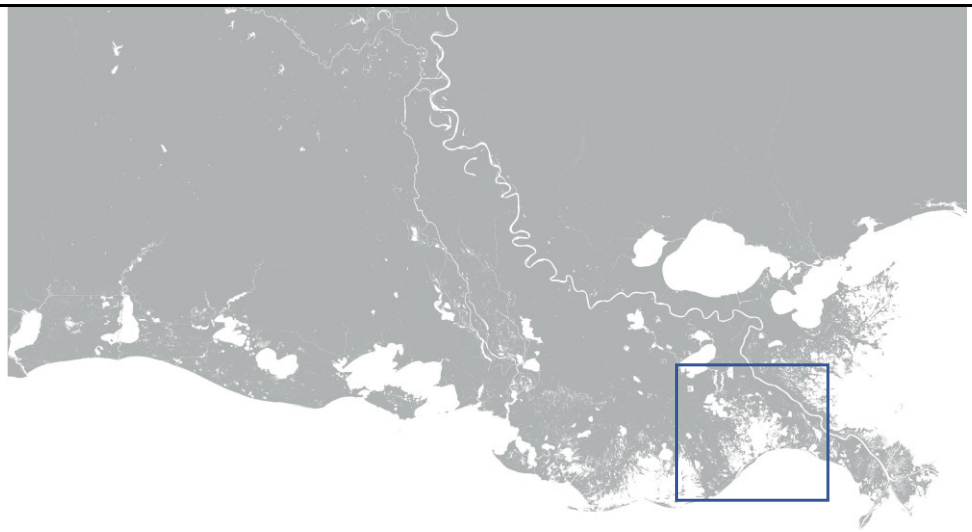
Objectives:

1. Compare soil properties to control marsh
2. Compare soil properties to initial study conducted in 2016
3. Estimate trajectories of marsh soil properties to reach ≥95% of natural marsh

19

Where is Barataria Bay?

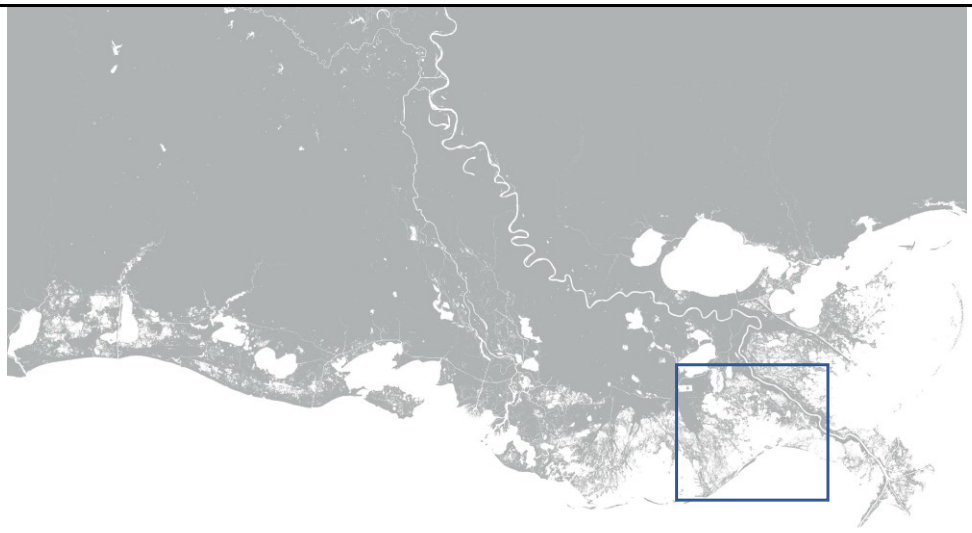
20



Louisiana Coastline in 1932

LSU Coastal Sustainability Studio

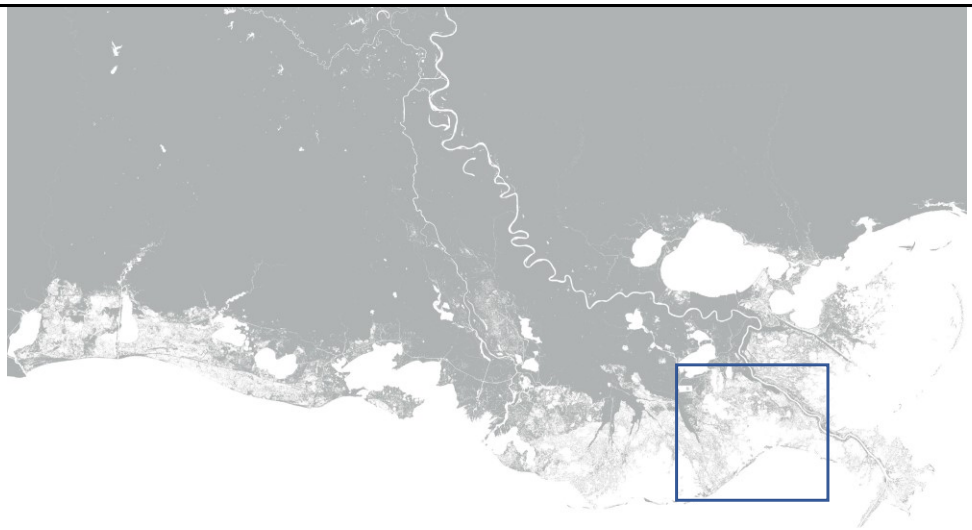
21



Louisiana Coastline in 2010

LSU Coastal Sustainability Studio

22

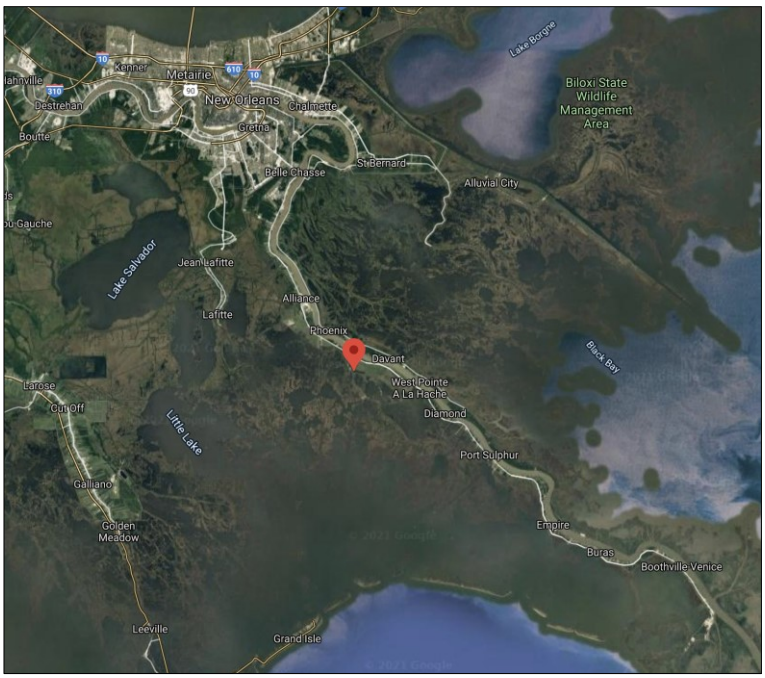


Louisiana Coastline in 2050 (projected)

LSU Coastal Sustainability Studio

23

Study Site



29°33’32.4” N 89°51’18.0” W; Google Earth

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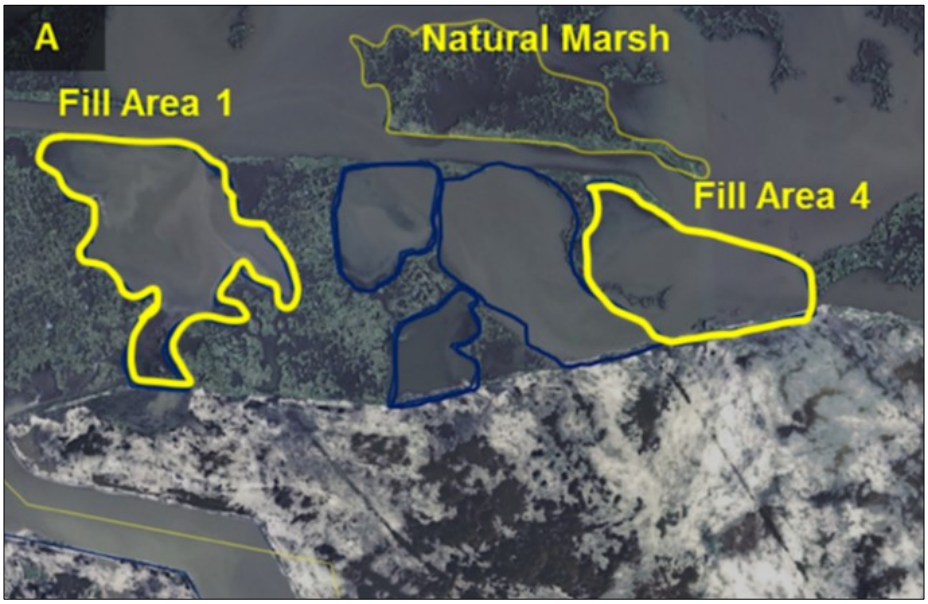
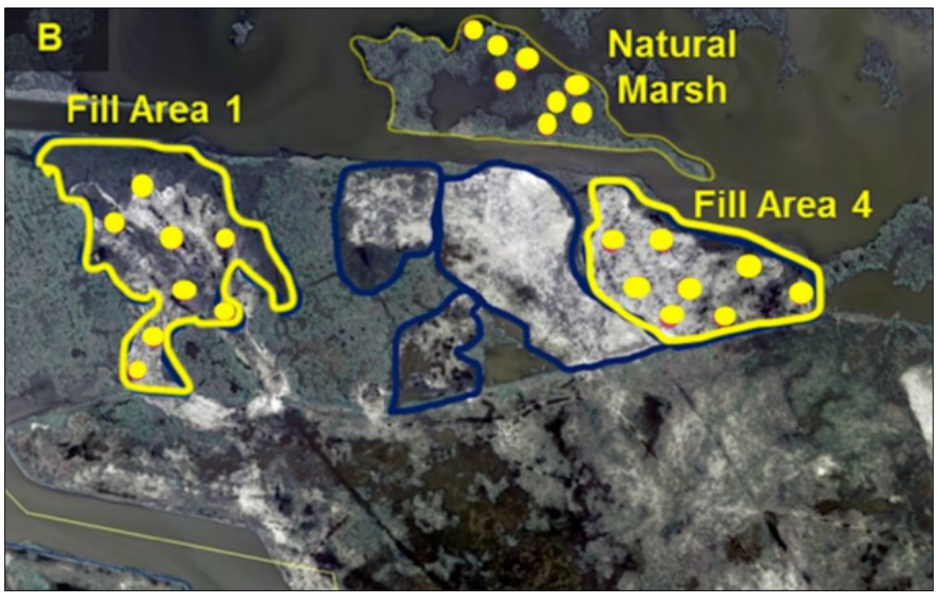
Study Site



LOSCO

25

Study Site



LOSCO

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Sampling

- Soil samples collected through push core
- 24 sampling locations
- 2 depths at each location
- 0-5 cm soil: newly accreted sediment
- 5-10 cm soil: original dredged material
- 48 total soil samples

August 11th, 2020

MCA-1

MCA-4

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Materials and Methods

- Physiochemical Soil Properties
- Soil Microbial Properties

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Importance of microbes

Organic Matter (total C, N, P; not available for plant uptake)

Microbial Activity (Microbial Biomass C and N, PMN, Enzyme activity)

Bioavailable Nutrients (NH_4^+, NO_3^-, SRP)

End products + energy

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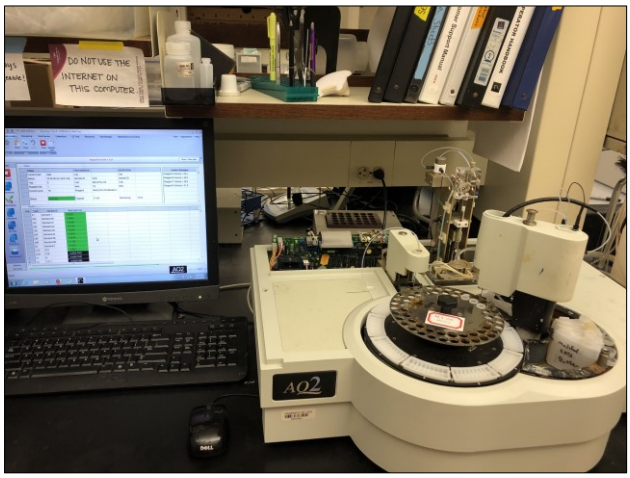
Soil Physiochemical Properties

- Percent Weight Organic Matter
- Total C, N, and P
- Moisture content and bulk density
- Extractable NH_4^+, NO_3^-, and soluble reactive phosphorus (SRP)

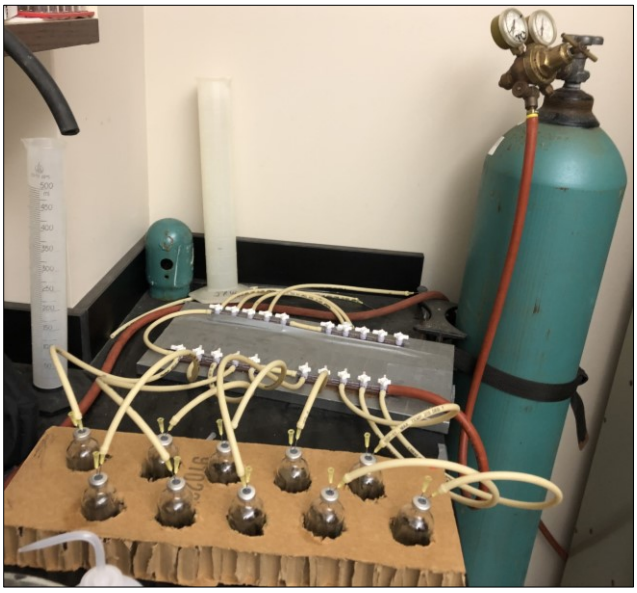


AQ2 with Extractable NH_4^+ results

30

Microbial Soil Properties

- Microbial Biomass C and N
- Enzyme activity
- Potentially Mineralizable N



Nitrogen injection for potentially mineralizable N determination

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Results

1. Comparison to natural marsh
2. Comparison to initial study from 2016
3. Estimation of created marsh soil property trajectories

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Comparison to the natural marsh

Soil Properties	Combined Depths Percent of Control	5-10 cm soil Percent of Control	0-5 cm soil Percent of Control
Percent Weight Organic Matter	19	10	29
Total Carbon	18	7.9	28
Total Nitrogen	14	4.7	24
Soil Moisture	48	33	63

33

Comparison to the natural marsh

Soil Properties	Combined Depths Percent of Control	5-10 cm soil Percent of Control	0-5 cm soil Percent of Control
Microbial Biomass Carbon	17	9.3	24
Microbial Biomass Nitrogen	25	3.8	47
Potentially Mineralizable Nitrogen	16	5.1	26
β-Glucosidase Enzyme Activity	17	14	21

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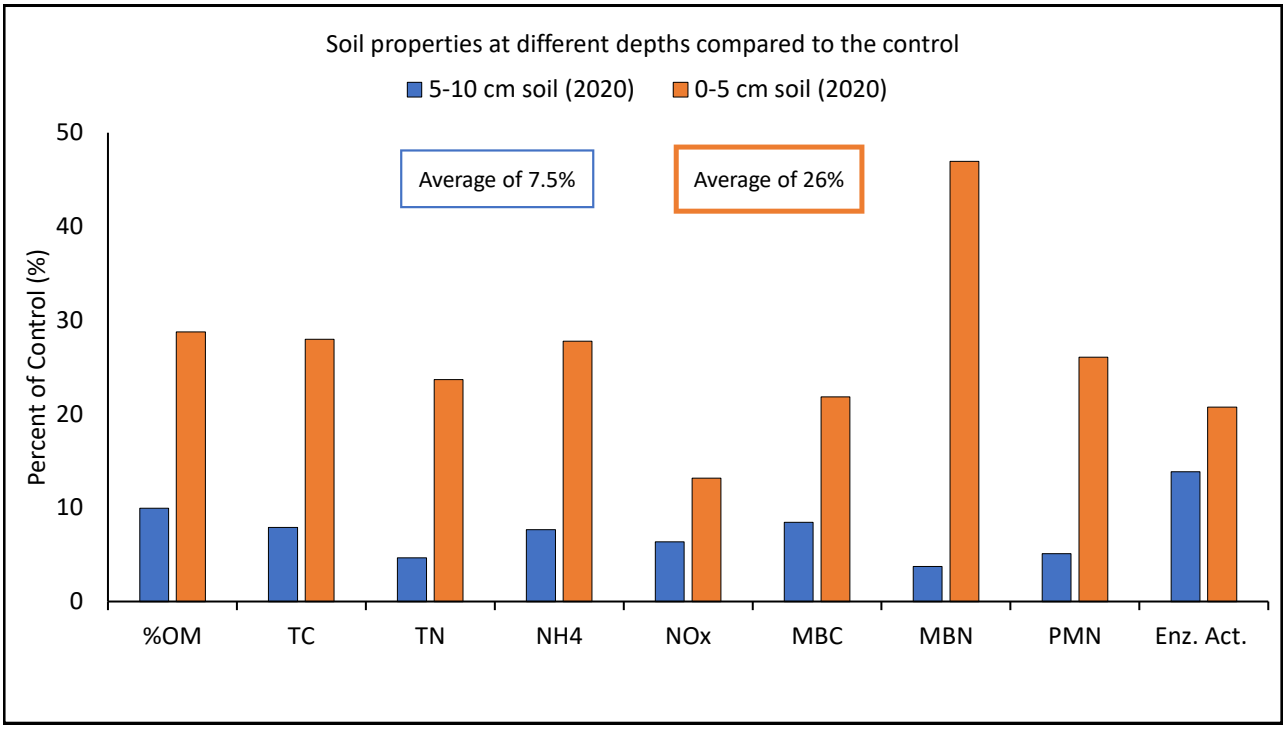

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Comparison to Initial study

Pictured above is one of the sampling sites in 2016, about 1 year after planting occurred

Picture of a sampling site in 2020 from LOSCO

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Physiochemical properties over time

Soil Properties	Percent of Control, 2016	0-5 cm soil Percent of Control, 2020
Percent Weight Organic Matter	11	29
Total Carbon	15	28
Total Nitrogen	7.4	24
Soil Moisture	35	63

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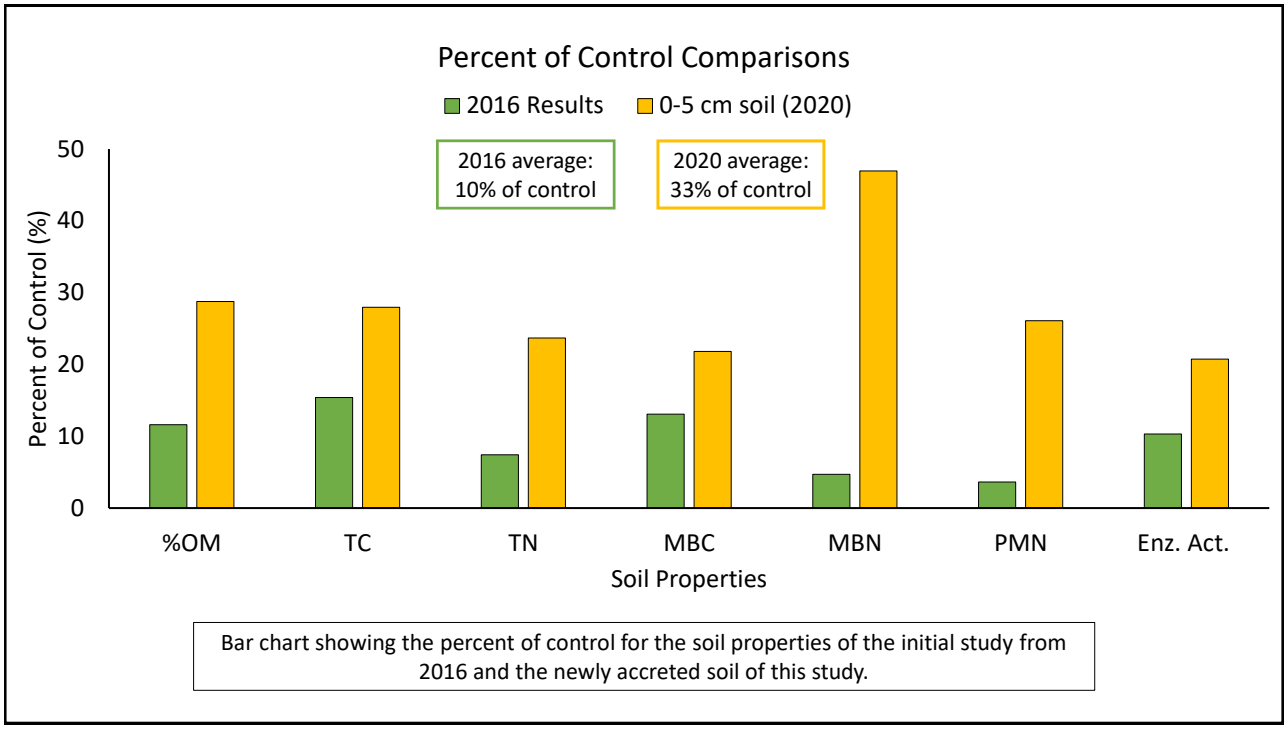
Microbial properties over time

Soil Properties	Percent of Control 2016	0-5 cm soil Percent of Control, 2020
Microbial Biomass Carbon	13	24
Microbial Biomass Nitrogen	4.7	47
Potentially Mineralizable Nitrogen	3.6	26
β-Glucosidase Enzyme Activity	10	21

38



Bar chart showing the percent of control for the soil properties of the initial study from 2016 and the newly accreted soil of this study.

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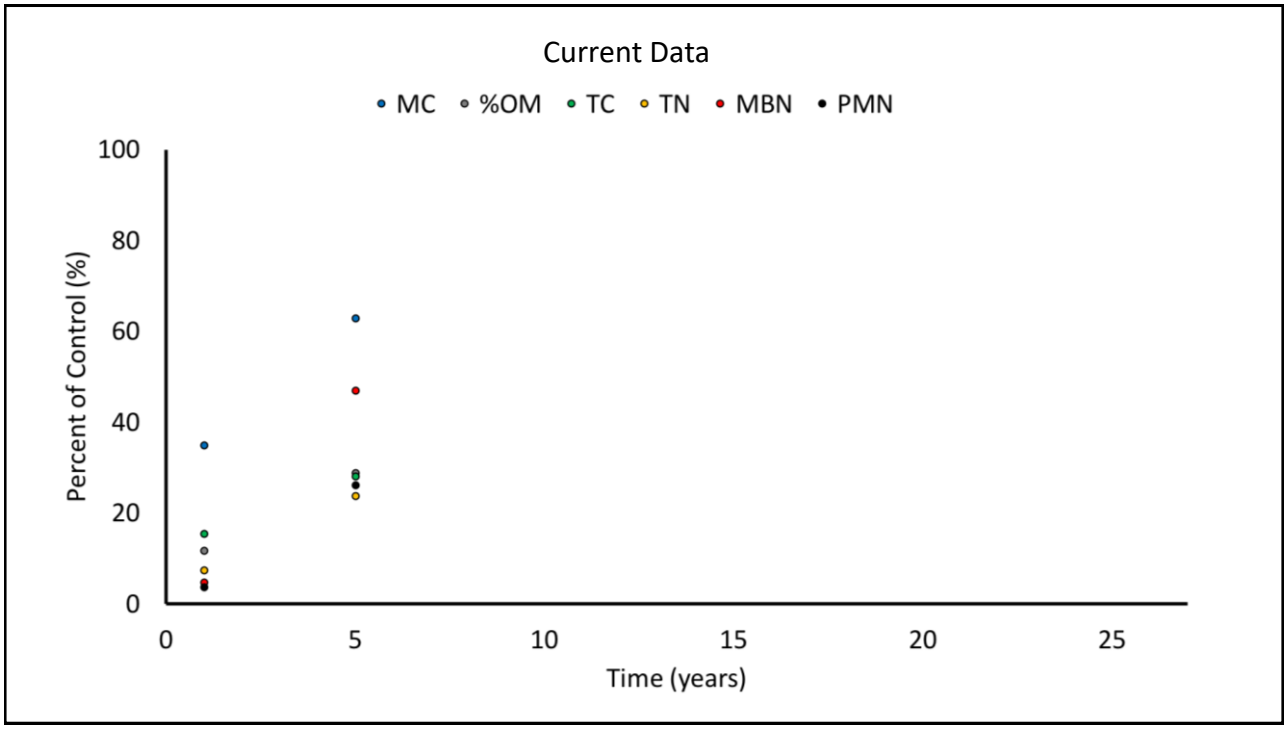

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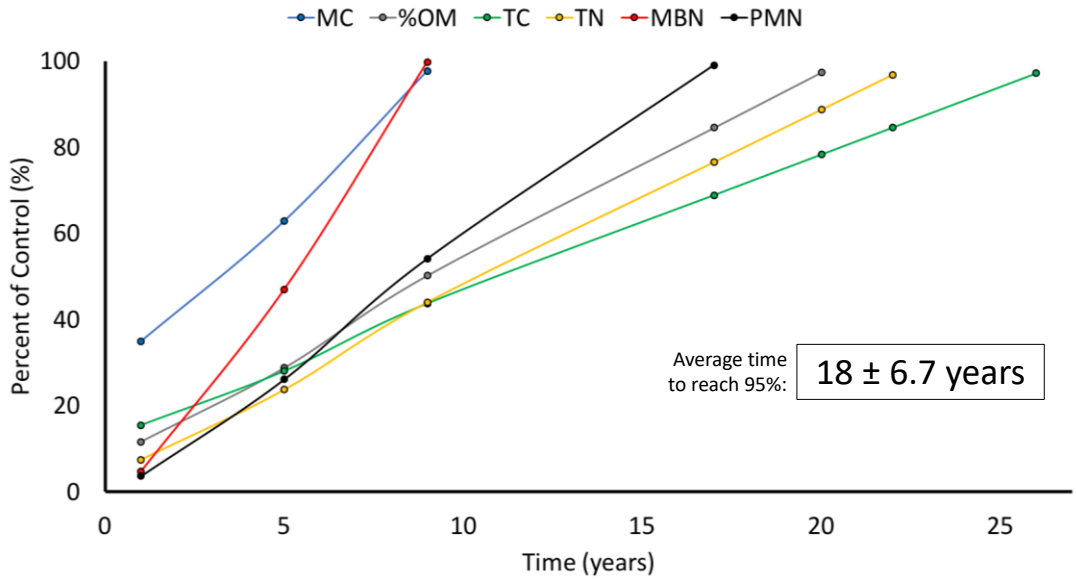
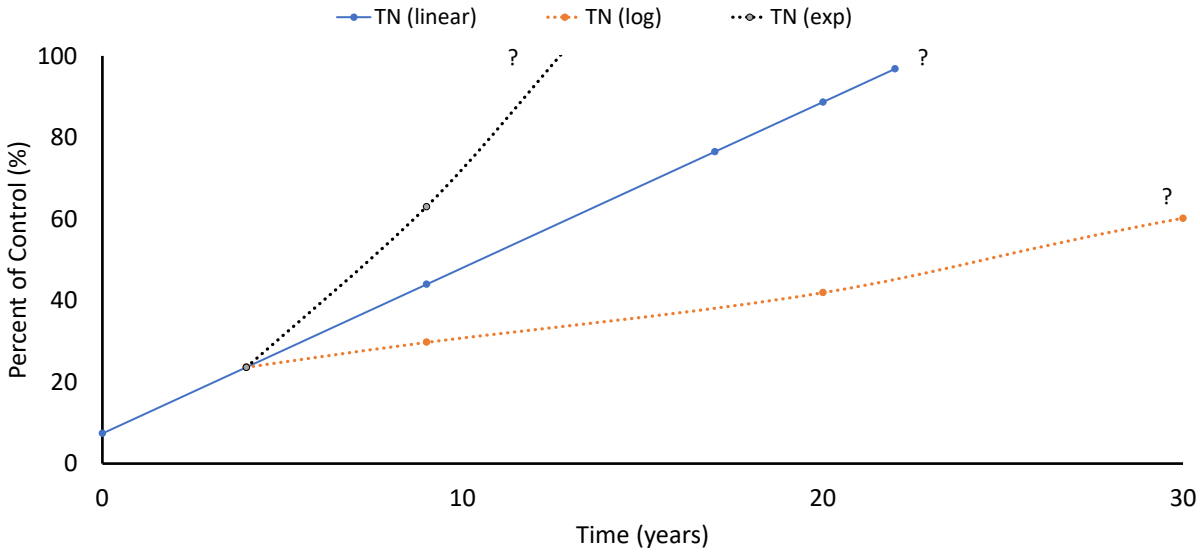
Forecasted marsh development



Estimated trajectories for select soil properties combined.

41

With only 2 data points, the future is unknown



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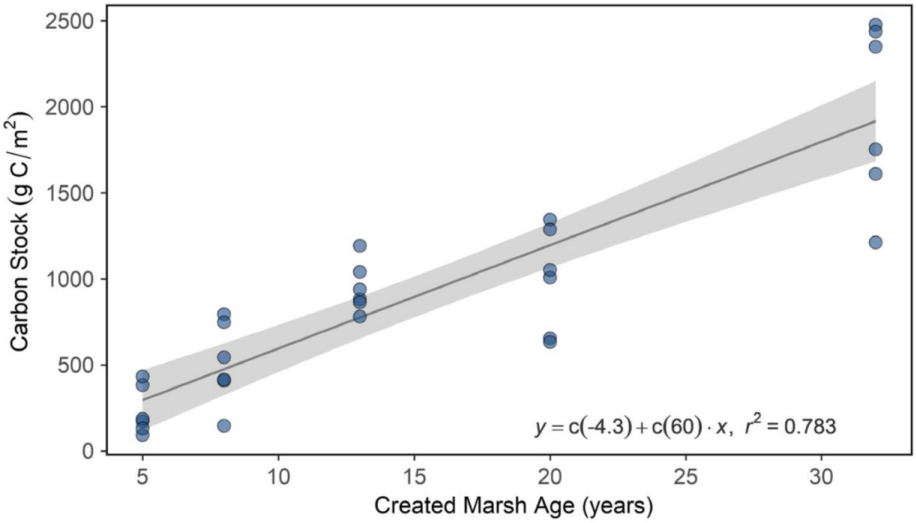
Other studies



Carbon stock in a chronosequence of marshes ranging in age between 5-32 years old, showing a general increase over time (Abbott et al. 2019).

Abbott et al. (2019)

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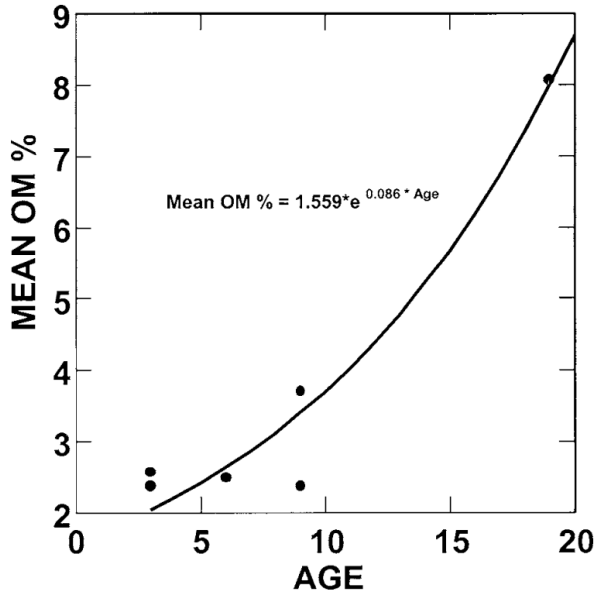

Percent organic matter of a chronosequence of marshes ranging in age between 3-19 years old, showing an exponential increase over time (Edwards and Proffitt, 2003).

Edwards and Proffitt (2003)

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Trajectory Applications

- Carbon credits
- Water quality credits

- Future projects
  - Planning
  - Design
  - Implementation
- Better assessment of created marshes (sampling instead of rapid)

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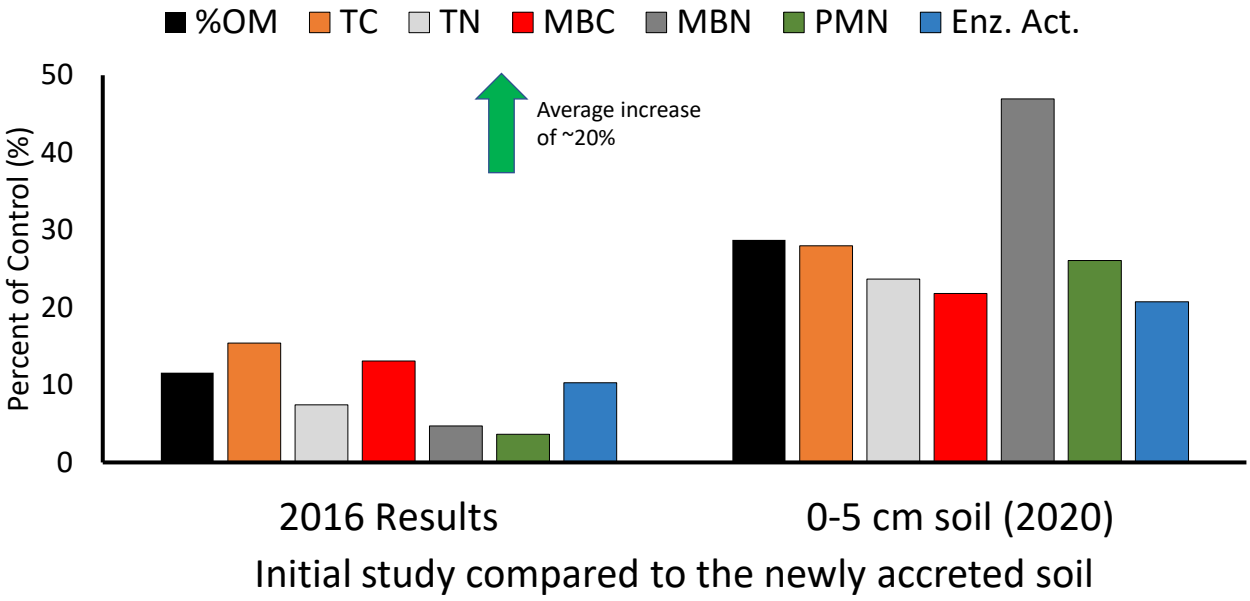
Soil Properties Over Time



Initial study compared to the newly accreted soil

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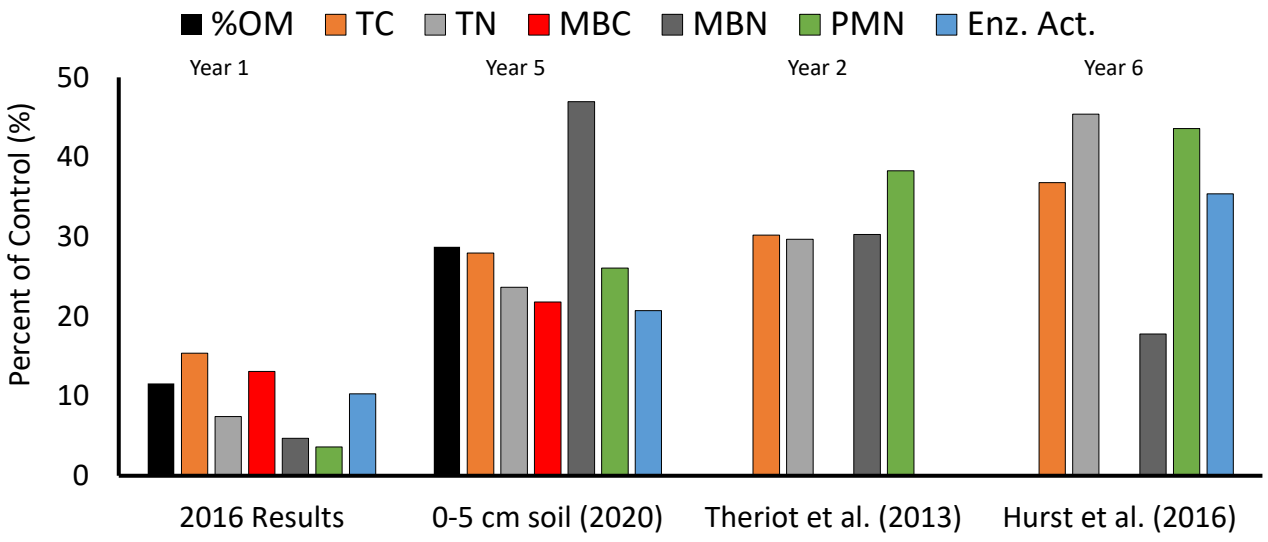
Comparison to Other Studies



Percent of control comparison between the 2016 study, the 0-5 cm soil of this study, the Theriot (2013) study, and the Hurst (2016) study

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Study Site pictured in 2014 (1-2 months post construction)

Image from LOSCO

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Study Site pictured in 2015- before vegetation planting (~6 months post construction)

Image from LOSCO

49

Sampling station pictured in 2016 (1 year after vegetation planting, 2 years post construction)

Average soil properties were 18% of the control

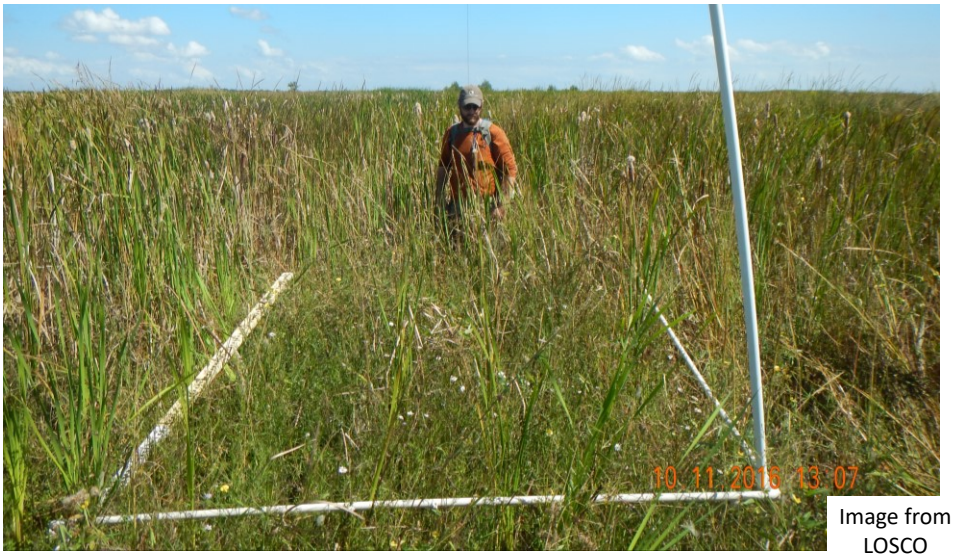


Image from LOSCO

50

Sampling station in 2020 (5 years after vegetation planting, 6 years post construction)

Average soil properties are 33% of the control

Image from LOSCO

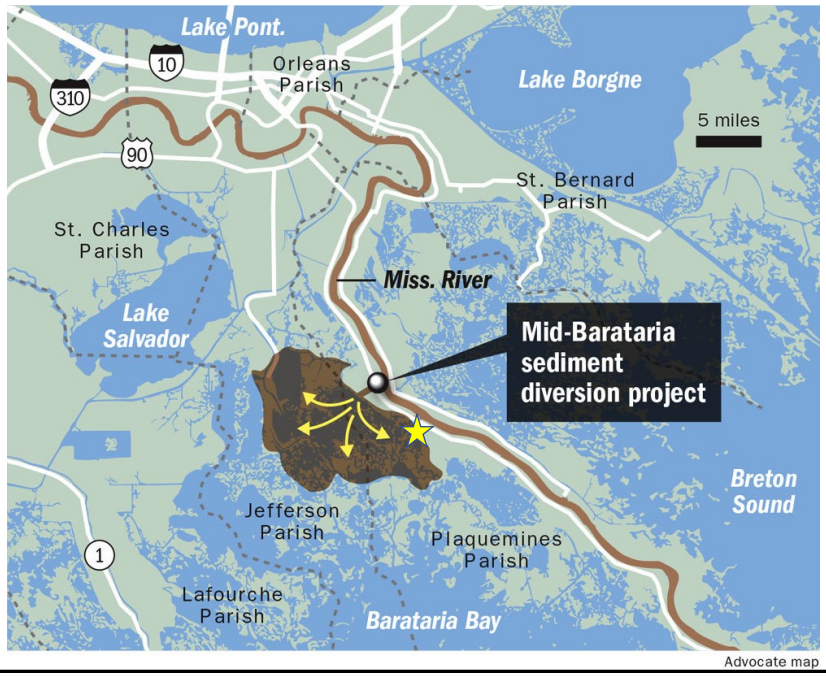
51

Marsh creation projects wont work alone, they need help

Sediment

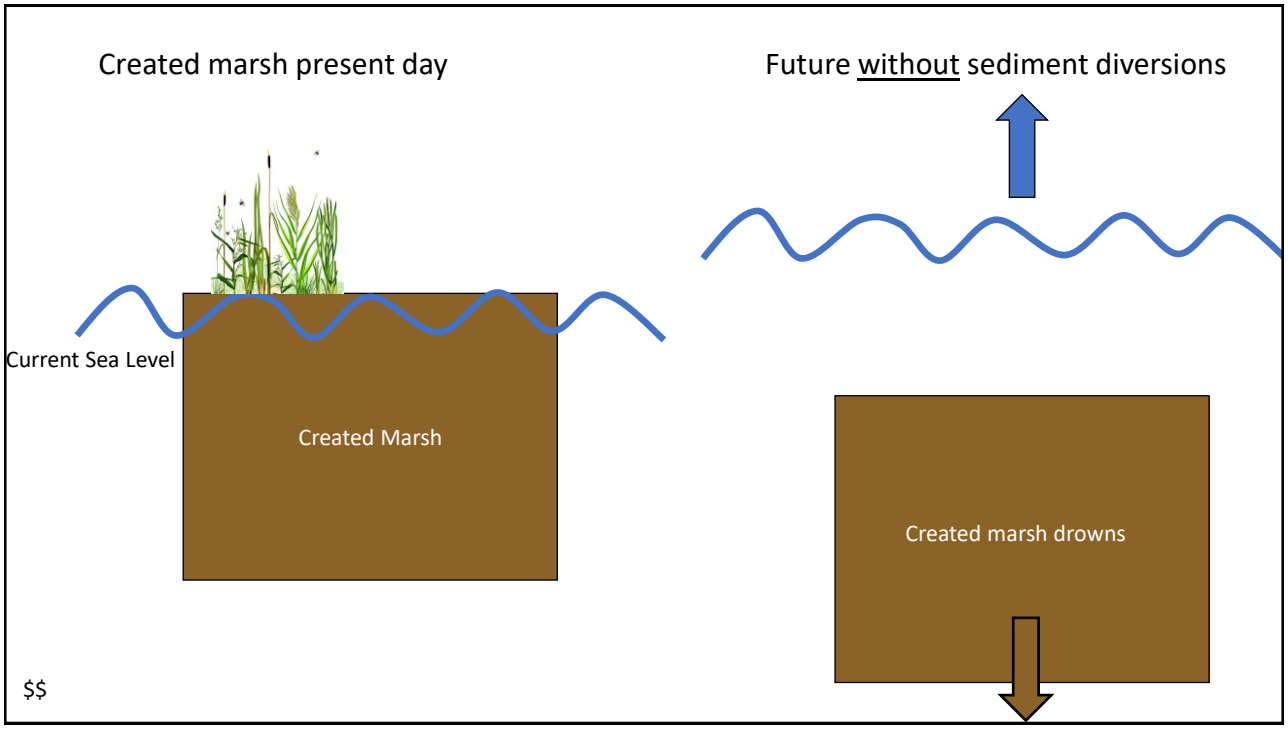
Nutrients

Water

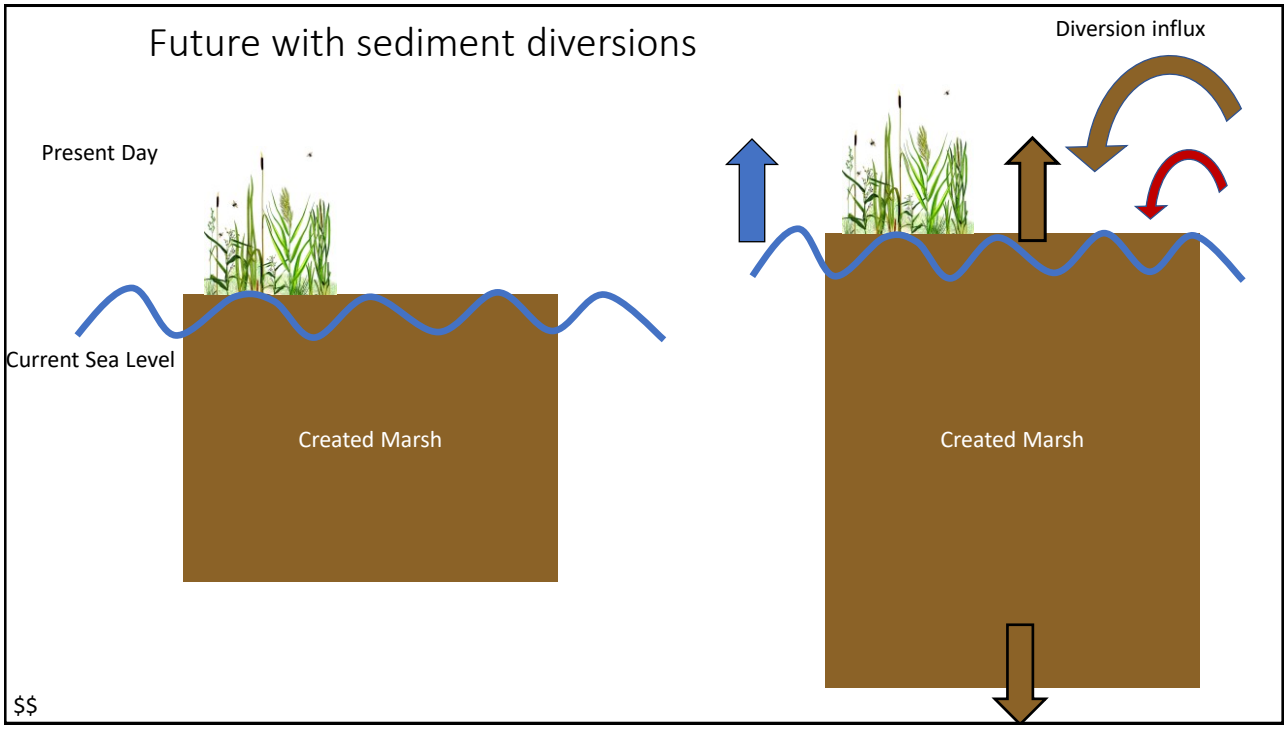


Advocate map

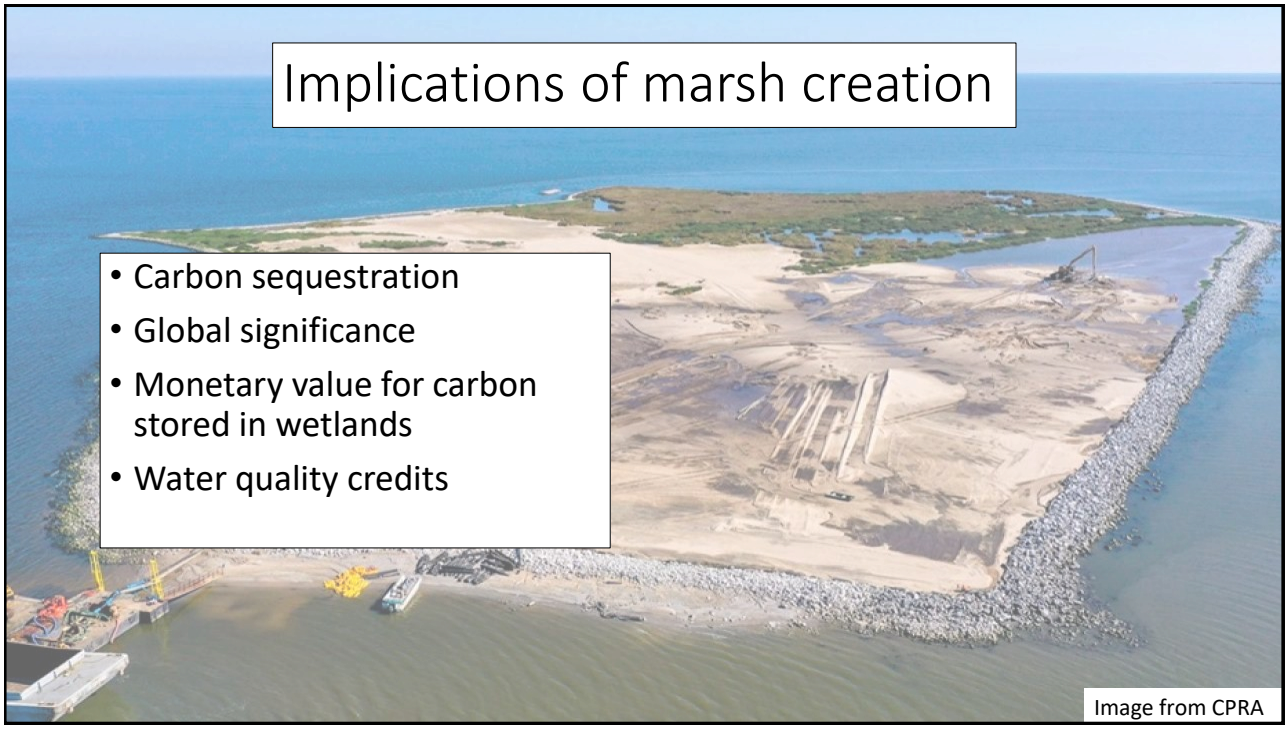
52


Created marsh present day
Future without sediment diversions
Current Sea Level
Created Marsh
Created marsh drowns
$$

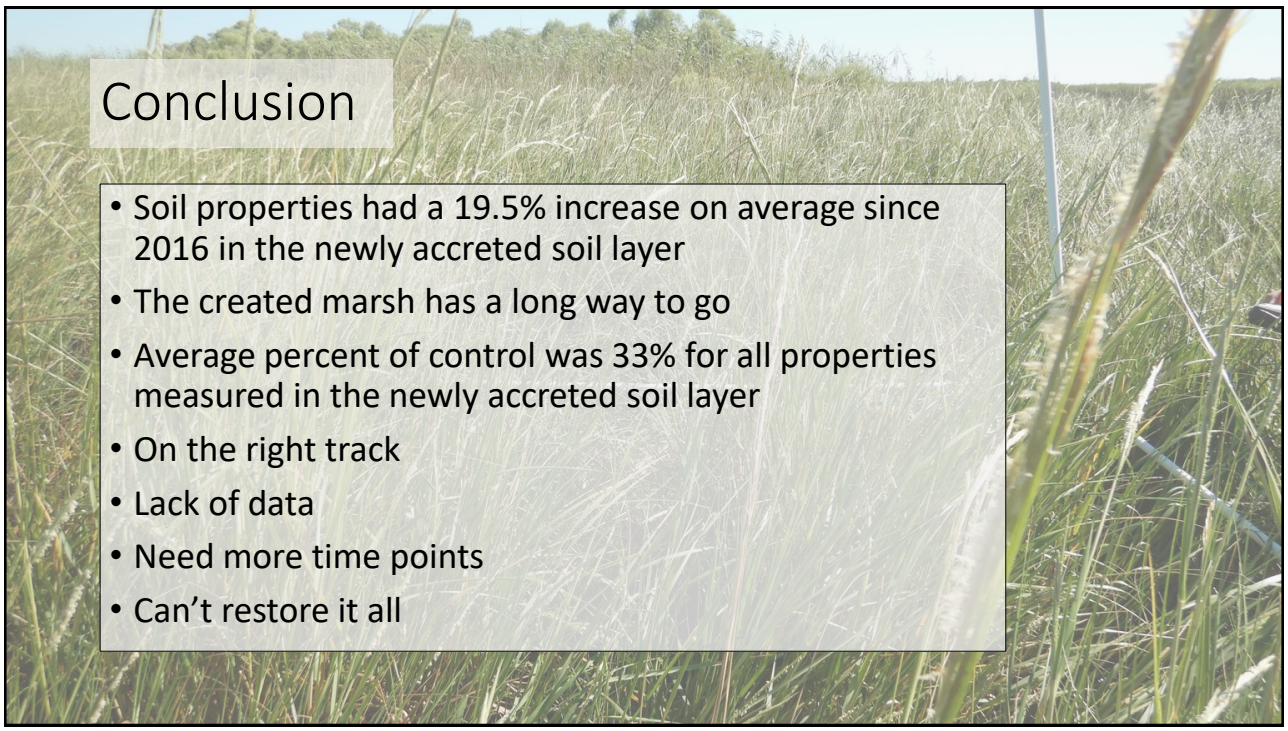
53


Future with sediment diversions
Diversion influx
Present Day
Current Sea Level
Created Marsh
Created Marsh
$$

54


Implications of marsh creation
• Carbon sequestration
• Global significance
• Monetary value for carbon stored in wetlands
• Water quality credits
Image from CPRA

55


Conclusion
• Soil properties had a 19.5% increase on average since 2016 in the newly accreted soil layer
• The created marsh has a long way to go
• Average percent of control was 33% for all properties measured in the newly accreted soil layer
• On the right track
• Lack of data
• Need more time points
• Can't restore it all

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Acknowledgements

- Thank you to CPRA and LA Sea Grant for their partnered funding for me to conduct this research as part of the CSAP program.
- Thanks to LOSCO for the site access and transportation, help in the field, and the data and pictures from the previous studies in Barataria Bay.
- Thanks to Dr. White for reaching out to me about this opportunity and for allowing me to conduct the research in the Wetland and Aquatic Biogeochemistry lab (WABL) on campus, and all the help along the way.
- Thank you to my other committee members Dr. John Pardue, Dr. Clint Willson, and Charles Armbruster for taking the time to read and help edit my paper.
- Thank you to my officemate, Yadav, for his countless times helping me throughout my research and writing process.

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