MEASUREMENT OF GREENHOUSE GAS EMISSIONS IN LOUISIANA COASTAL FRESHWATER FORESTED WETLANDS

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Comite Resources

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The Water Institute
RESTORE ACT
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LOUISIANA

COMITE RESOURCES

Research Question: What happens to CH_4, CO_2 and N_2O flux as freshwater forested wetlands degrade?

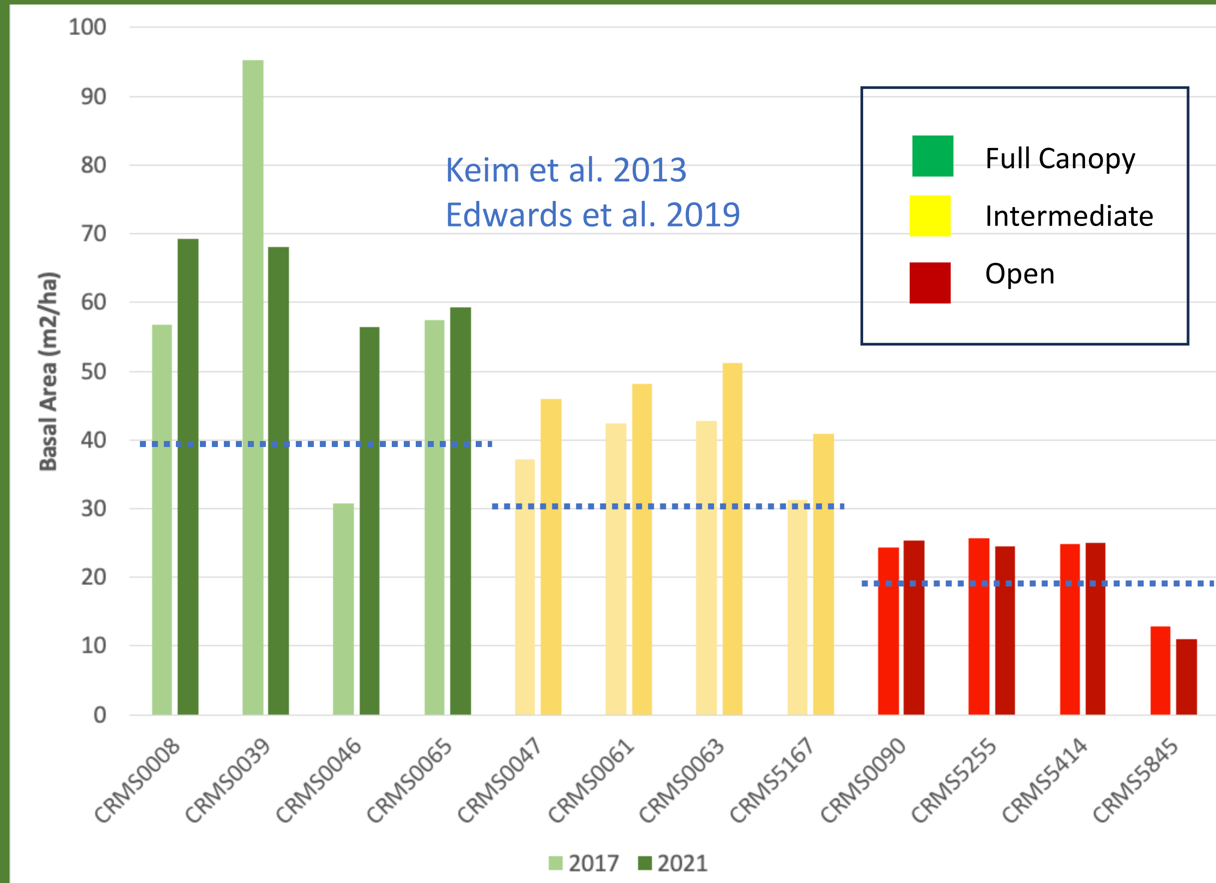
Freshwater forested wetlands degrading to marsh due to:

- Impoundment, subsidence → Reduced productivity, lack of recruitment
- Saltwater intrusion, sea level rise → Reduced productivity, altered species composition, baldcypress and water tupelo mortality

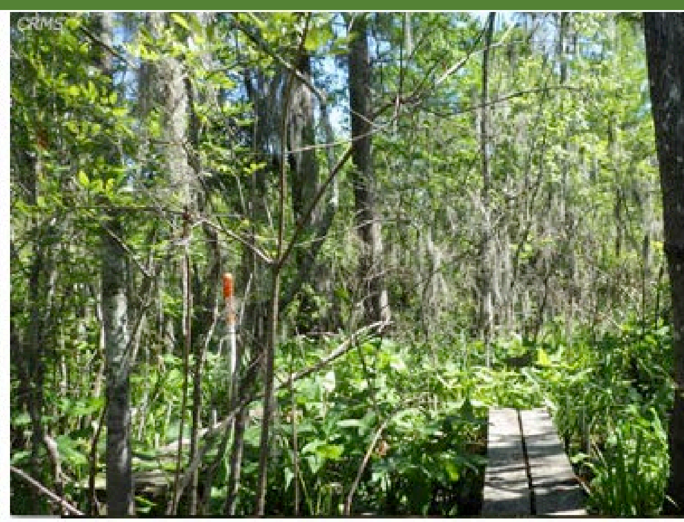
Soil organic matter quantity and type, soil temperature, water depth, redox → Biogeochemical cycles, microbial populations

STUDY SITES – CRMS

- 12 study sites in the Maurepas Swamp Wildlife Management Area, Pontchartrain Basin, LA
- Forested Floristic Quality Indicator (FFQI): Uses vegetation parameters (tree basal area, species composition, and canopy cover)
- Hydrology, accretion rate, basal area, water DO, pH, salinity, vegetation productivity, soil organic characteristics




CRMS5373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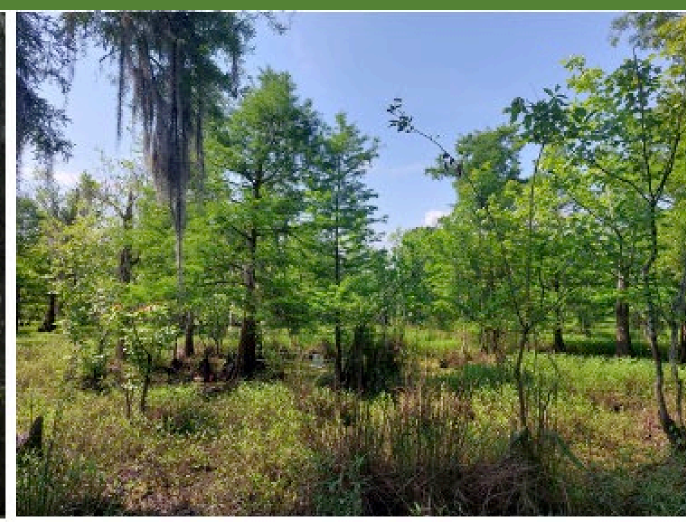
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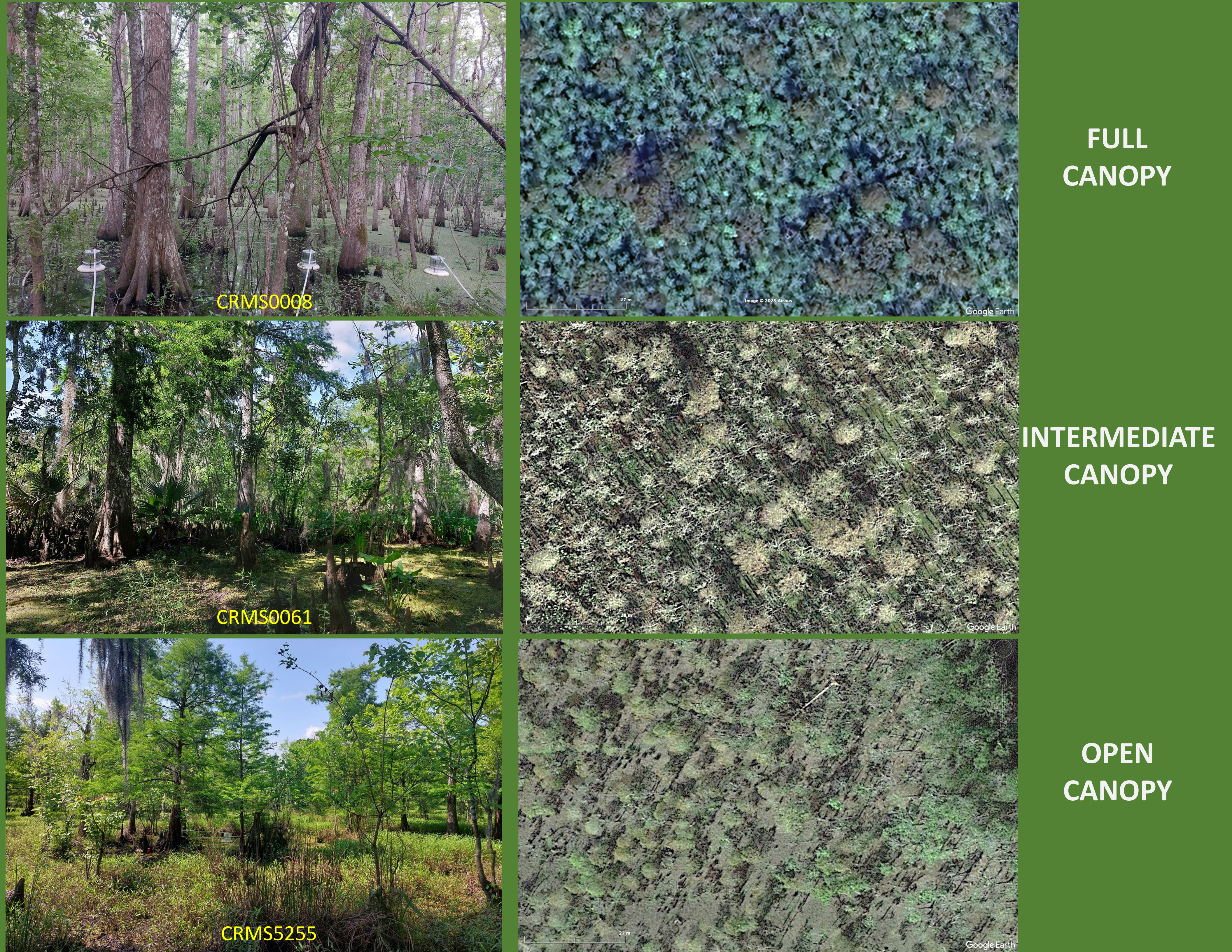
Decreasing FFQI


CRMS0008
FULL CANOPY
CRMS0061
INTERMEDIATE CANOPY
CRMS5255
OPEN CANOPY
Google Earth
Google Earth
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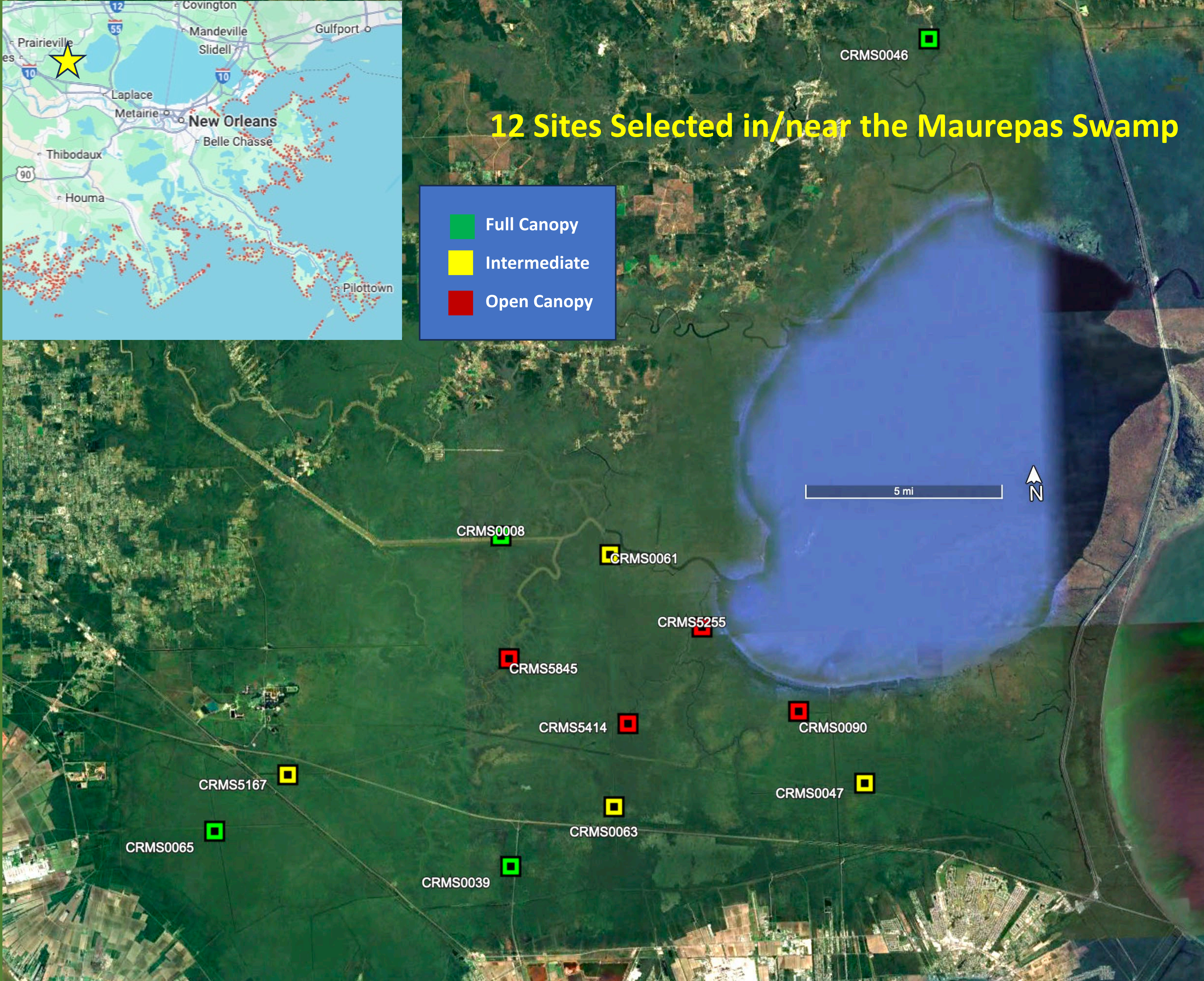
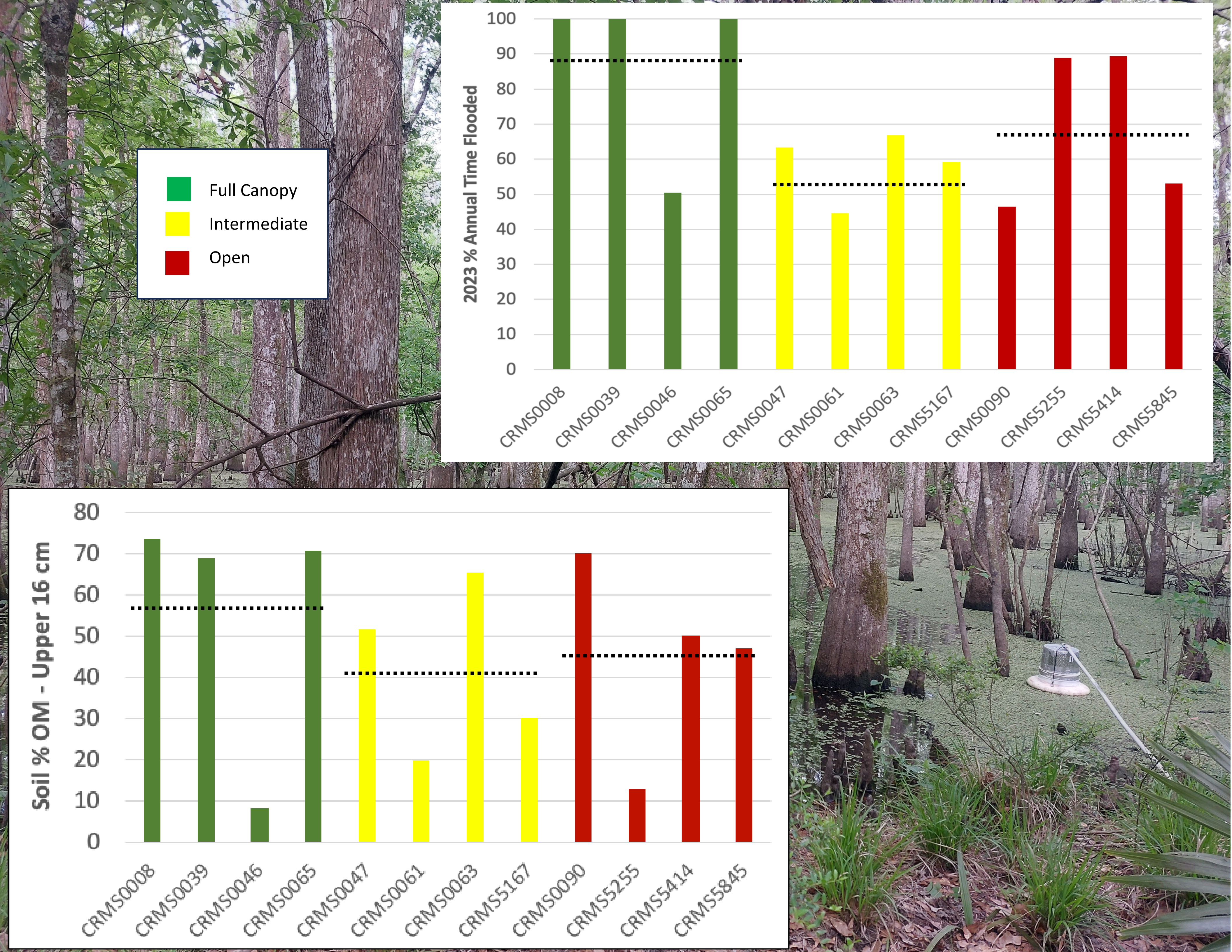


12 Sites Selected in/near the Maurepas Swamp
Full Canopy
Intermediate
Open Canopy
Covington
Mandeville
Slidell
Gulfport
Prairieville
Laplace
Metairie
New Orleans
Belle Chasse
Thibodaux
Houma
Pilottown
5 mi
N
CRMS0046
CRMS0008
CRMS0061
CRMS5255
CRMS5845
CRMS5414
CRMS0090
CRMS5167
CRMS0047
CRMS0063
CRMS0065
CRMS0039


Full Canopy
Intermediate
Open
2023 % Annual Time Flooded
100
90
80
70
60
50
40
30
20
10
0
CRMS0008
CRMS0039
CRMS0046
CRMS0065
CRMS0047
CRMS0061
CRMS0063
CRMS5167
CRMS0090
CRMS5255
CRMS5414
CRMS5845
Soil % OM - Upper 16 cm
80
70
60
50
40
30
20
10
0
CRMS0008
CRMS0039
CRMS0046
CRMS0065
CRMS0047
CRMS0061
CRMS0063
CRMS5167
CRMS0090
CRMS5255
CRMS5414
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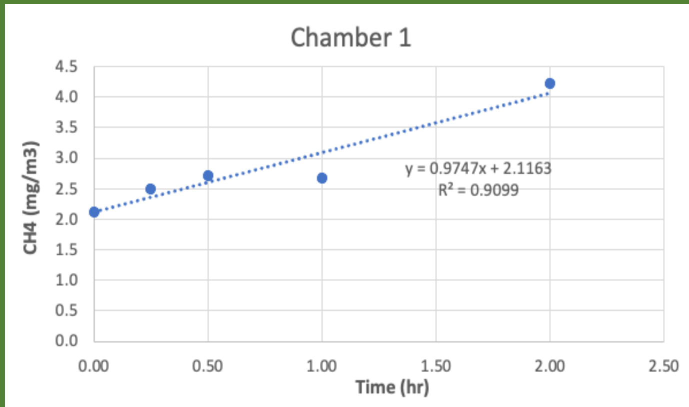
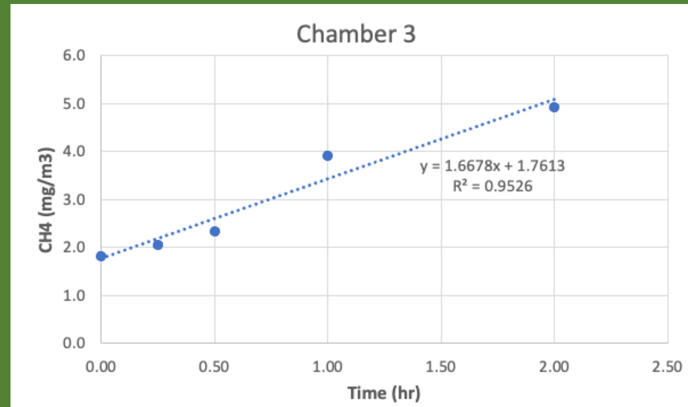
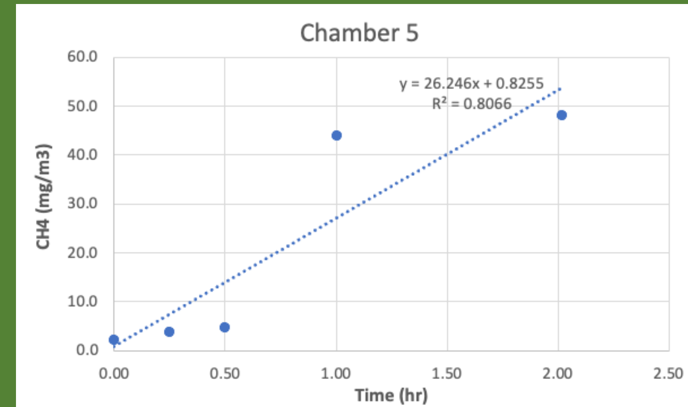
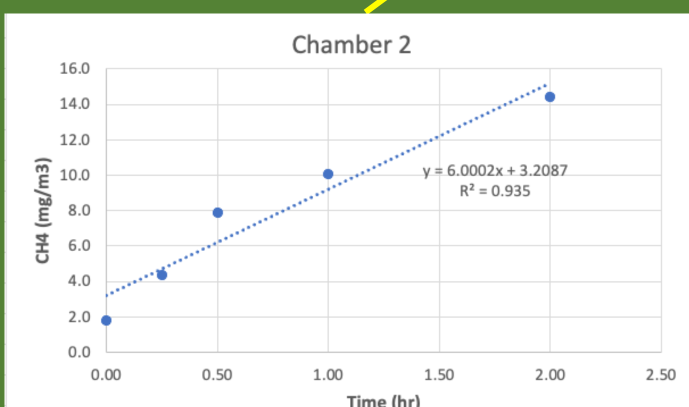


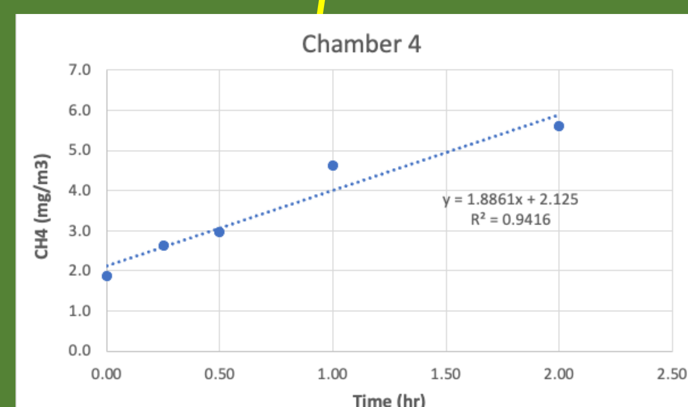




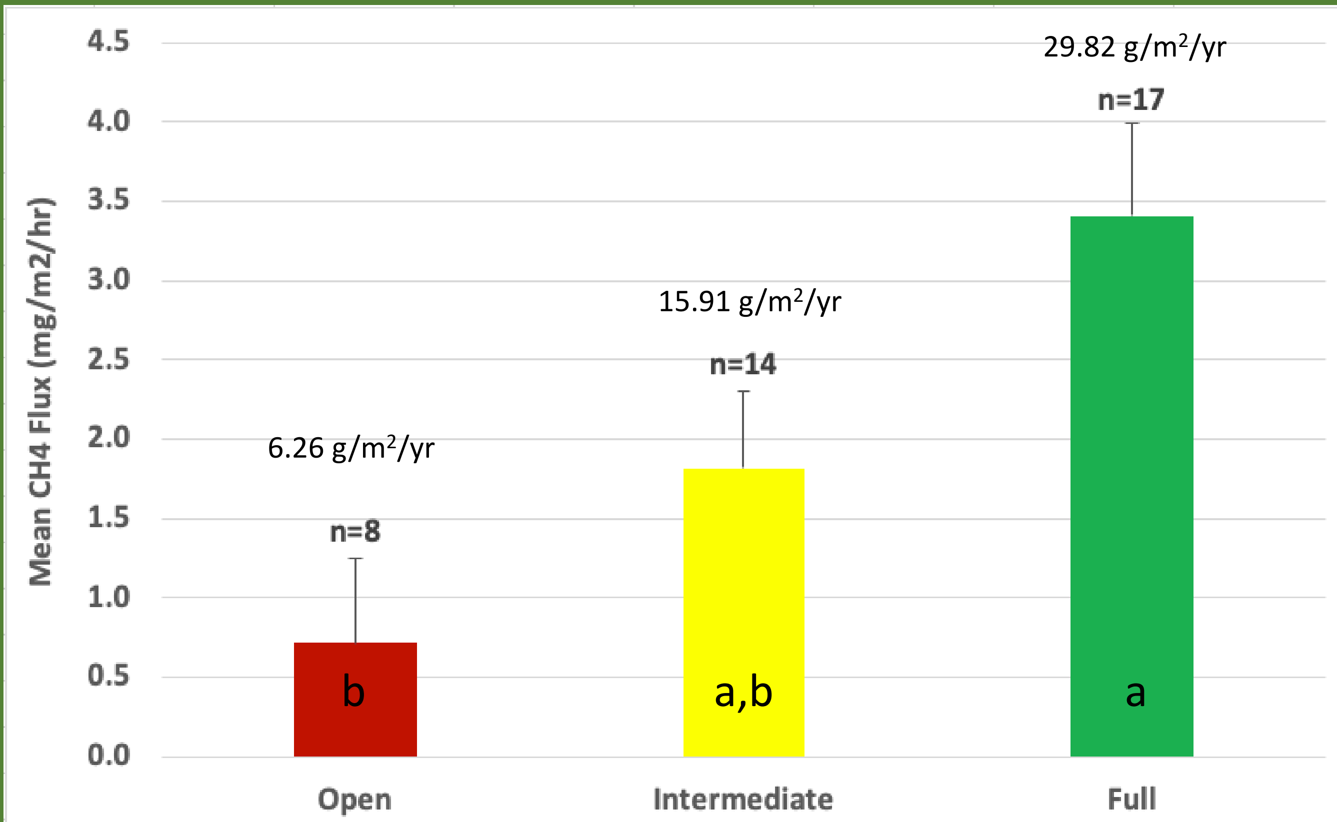


CRMS0046
Full Canopy Site

Methane flux over time

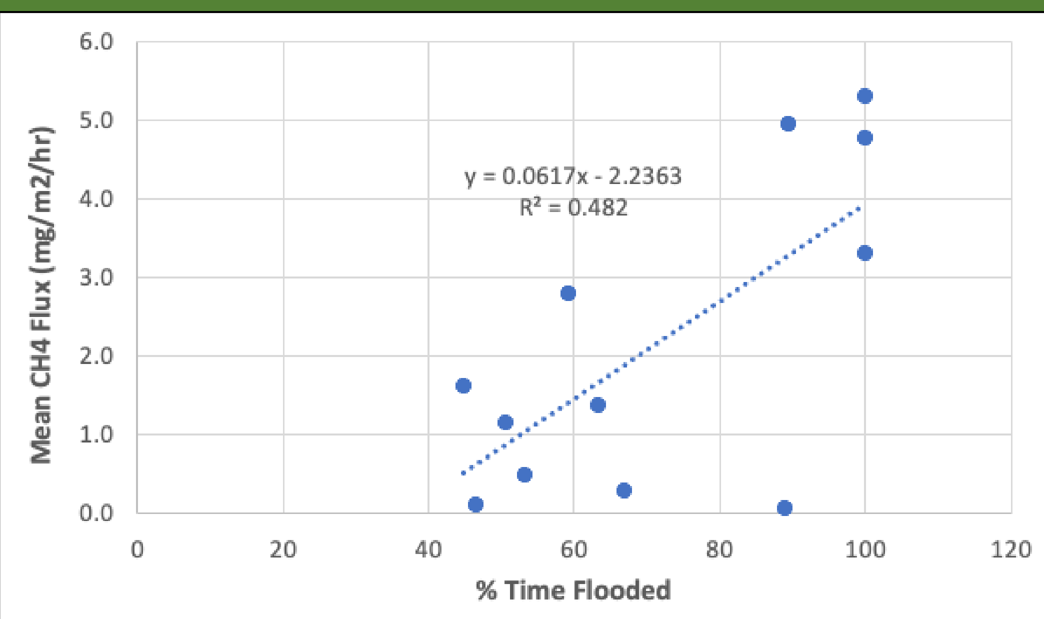


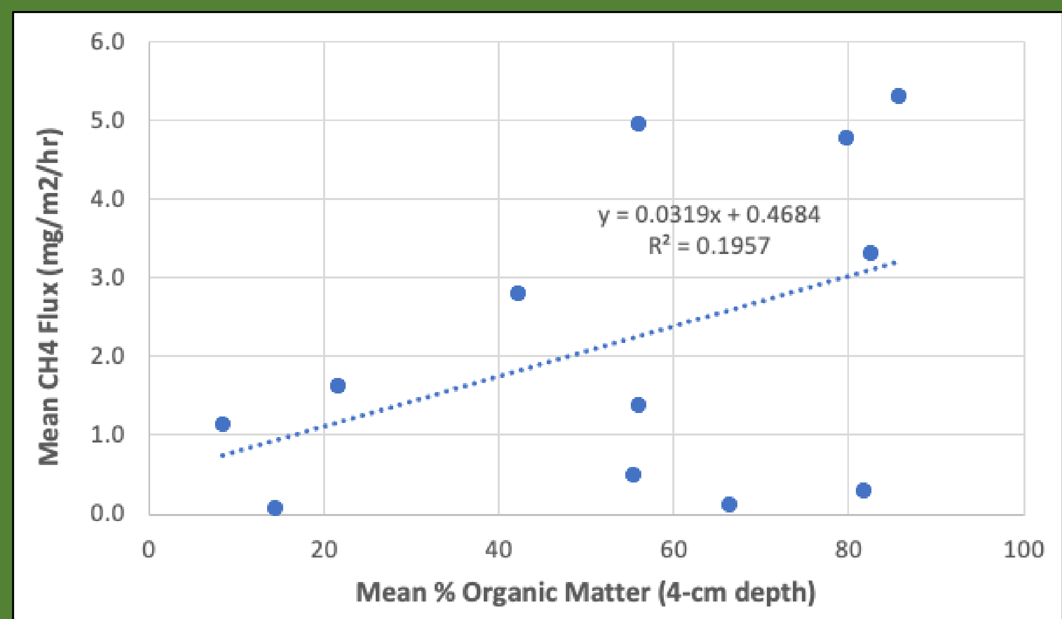
October 2024 – Methane Flux Results



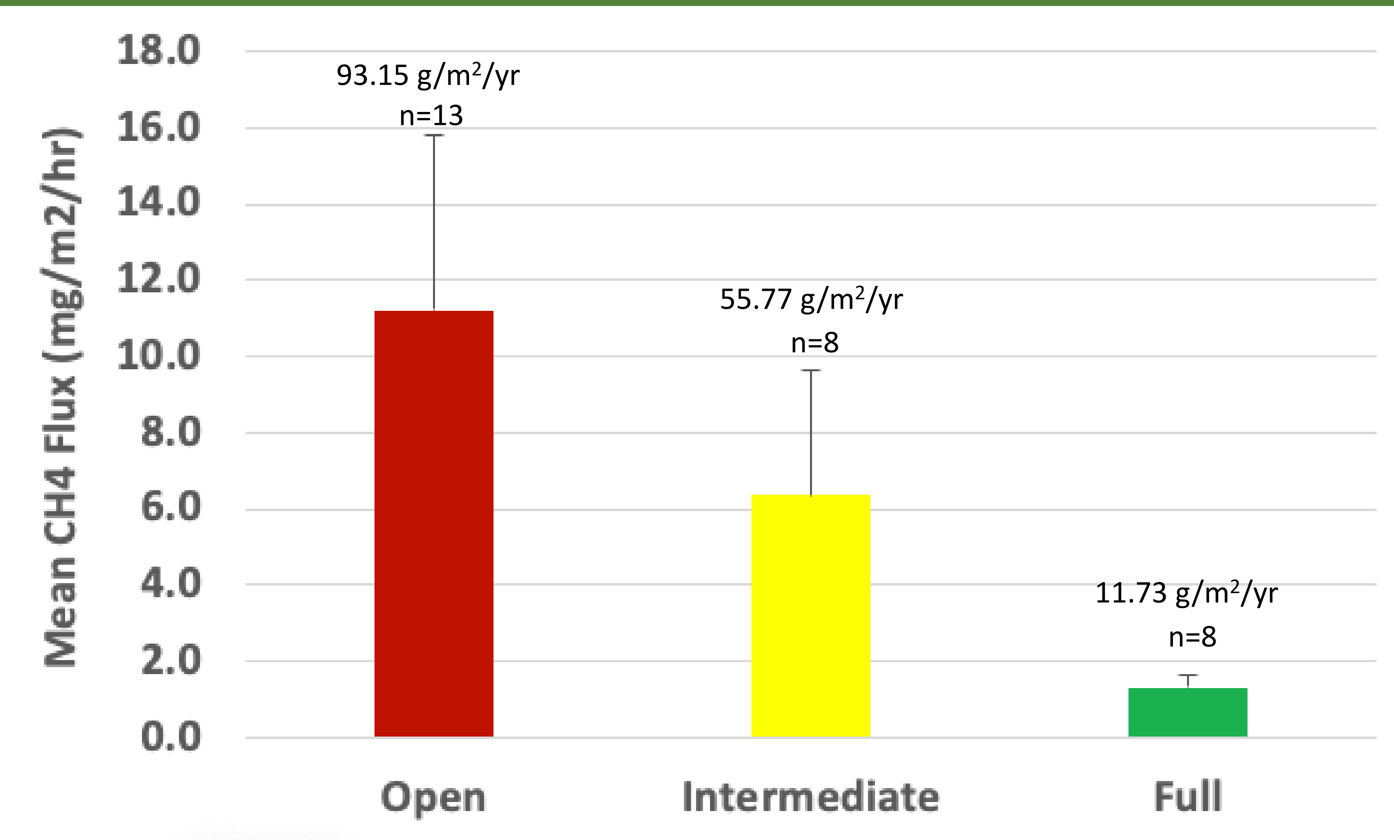
CH_4 efflux – diffusion from soil, water and vegetation or via ebullition

<u>CH_4 Flux (g/m²/yr) FFW:</u>
53.5 - Alford et at. 1997
78.8 - Lane et al. 2017
1 – 11 Calabrese et al. 2021
-0.04 to 182.4 – Yu et al. 2008





February 2025 – Methane Flux Results



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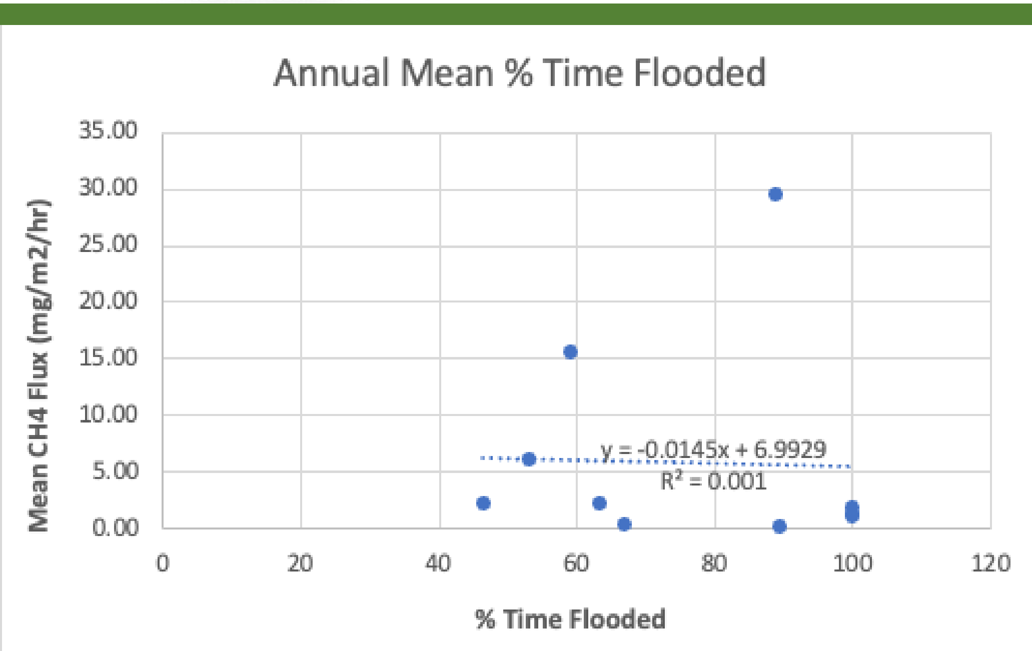
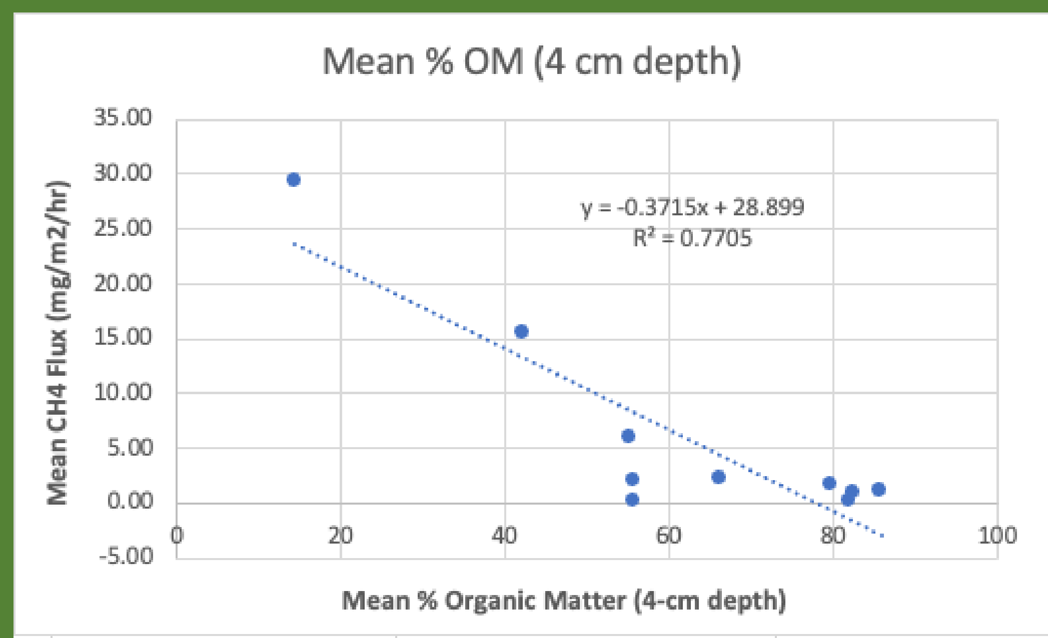
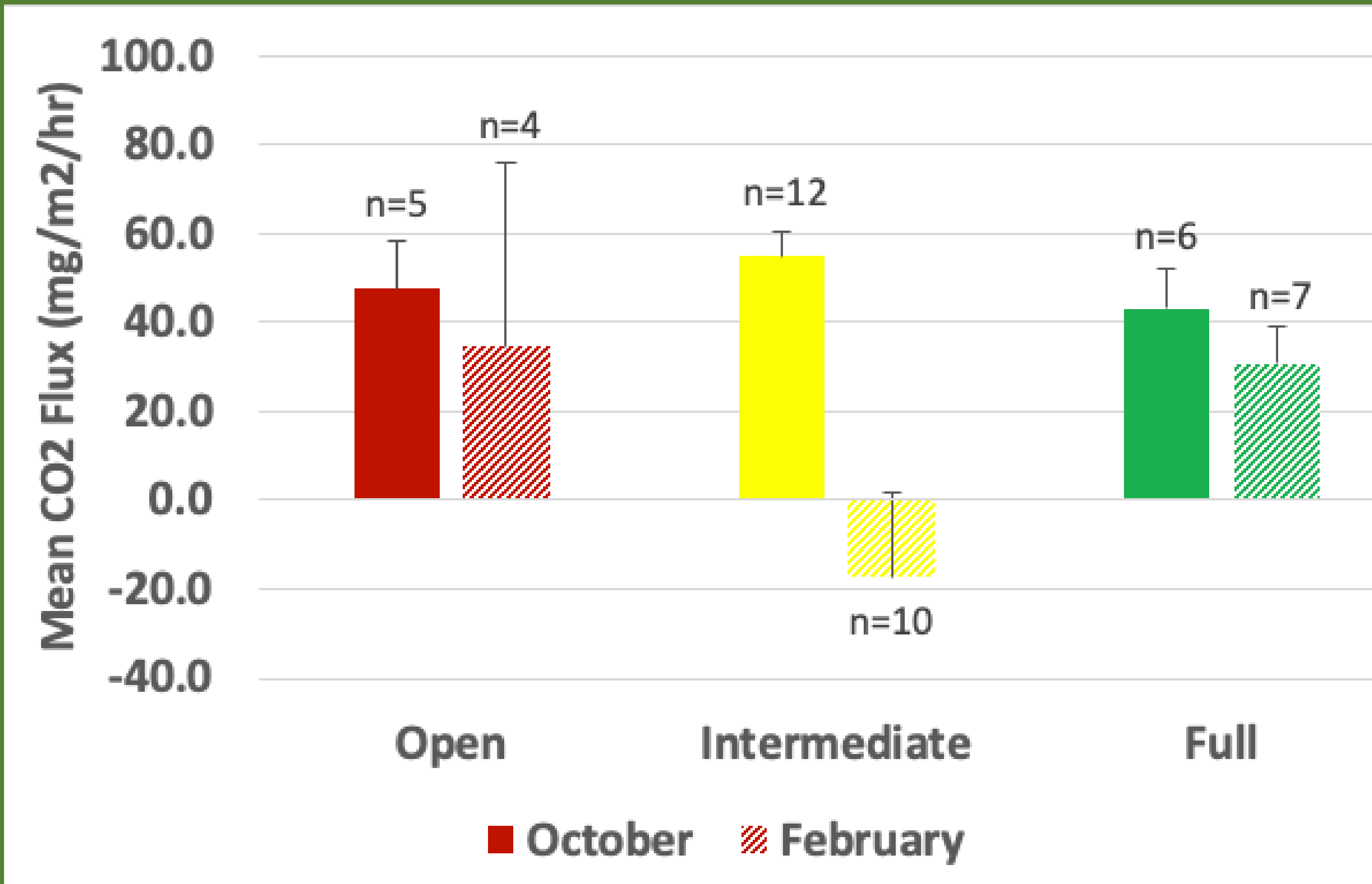




Carbon Dioxide Flux Results
October 2024 and February 2025



Gutenberg et al. 2019
CO_2 Flux ($mg/m^2/hr$)

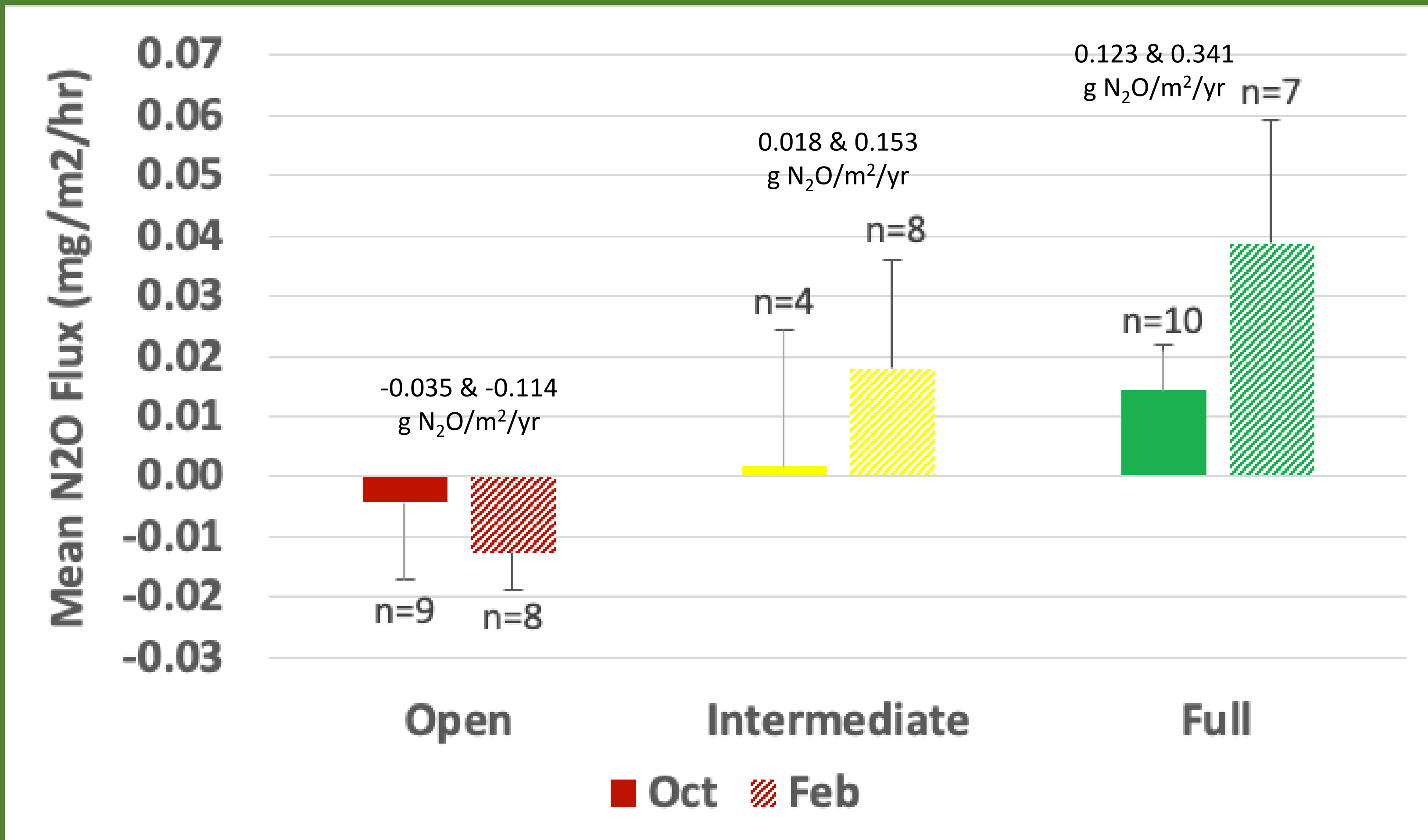
- April – Sep = 121
- Oct – Dec = 43
- Jan – March = 35

Gutenberg et al. 2019 – Great Dismal Swamp:
CO_2 flux - statistically significant relationship with air temperature ($P < 0.001$) and soil temperature ($P < 0.001$)

-relationship with soil moisture content (SMC) in the top 5cm of soil ($P = 0.074$) and in the litter layer ($P = 0.081$) significant at a 90% confidence level.

	P values	Air temperature	Soil temperature	Soil moisture, litter layer	Soil moisture, 0–5 cm	Soil moisture, 5–10 cm
CO_2	*All sites*	***<0.001***	***<0.001***	*0.081*	*0.074*	*0.211*
	Maple-gum	0.056	**<0.001**	0.104	0.758	0.357
	Pocosin	0.258	**<0.001**	**0.024**	**0.018**	0.567
	Cedar	**<0.001**	**0.001**	0.065	0.211	0.322
	Growing season (Apr.–Sept.)	**0.011**	**<0.001**	0.143	0.466	0.192
	Non growing season (Oct.–Mar.)	0.099	**0.001**	0.758	0.570	0.545

Nitrous Oxide Flux Results
October 2024 and February 2025



N_2O Flux ($g/m^2/yr$) FFW:
0.07 – Scaroni et al. 2011
0.89 - Lane et al. 2017
0.04 to 1.1 – Yu et al. 2008

% time flooded
Soils always saturated
NO_3 < 0.15 mg N/L
NH_4 < 0.05 mg N/L

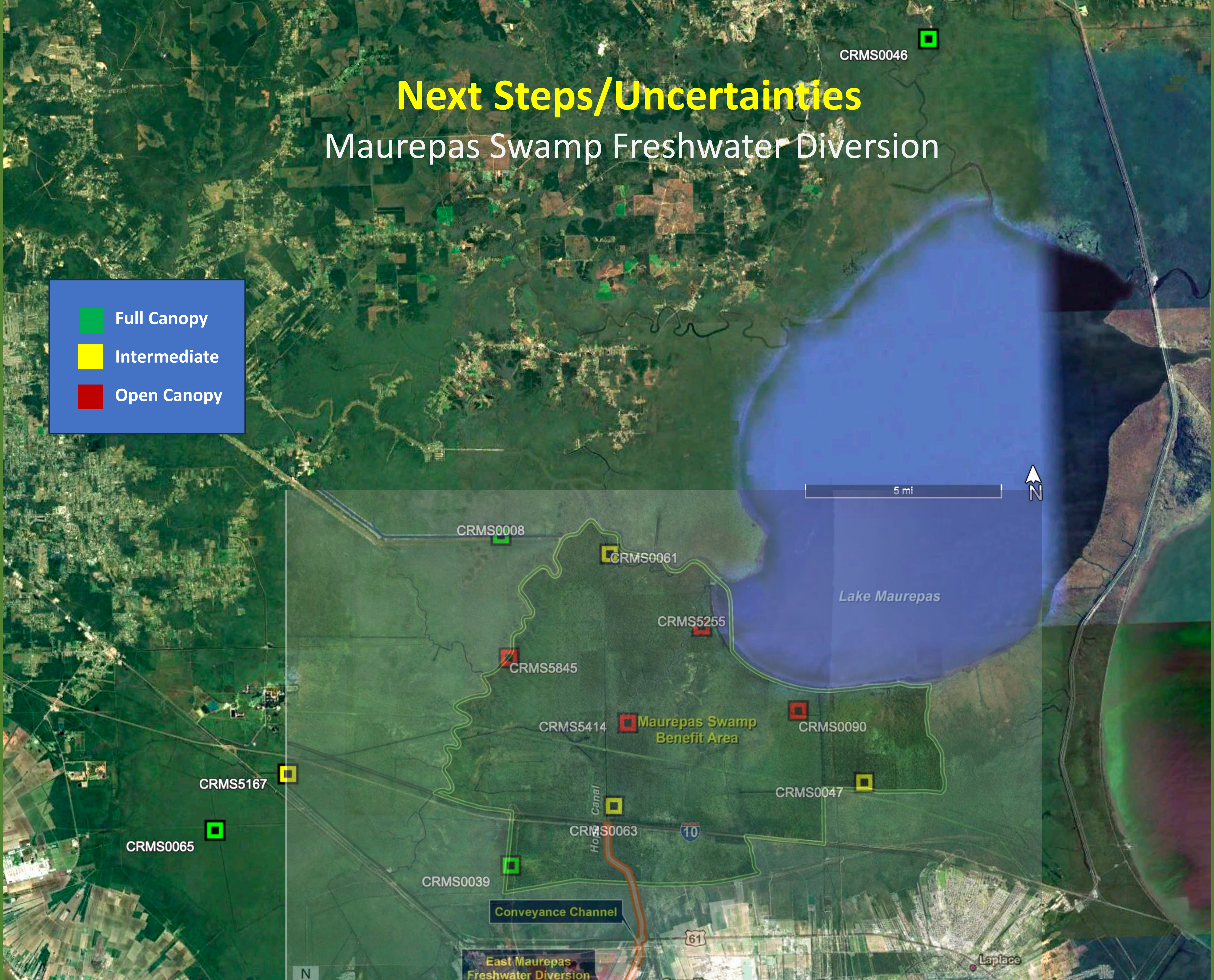
Next Steps/Uncertainties

- Finish GHG sampling over next 16 months
- Water levels (measured and CRMS data) and soil moisture/temps
- Use data to calculate net ecosystem carbon balance
    - Net Ecosystem Carbon Balance = $(C_{TREE} + \Delta C_{SOC}) - \Delta GHG_E$
- Statistical analyses with more data

- Labile carbon concentration of soils at CRMS sites – not measured
- Gas flux from baldcypress knees and from dead trees?
    - Tree stem CH_4 emissions are typically not quantified
    - Diffusion from cypress knees are typically not quantified but can be significant

Next Steps/Uncertainties

Maurepas Swamp Freshwater Diversion



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Questions?

CONSIDERATIONS

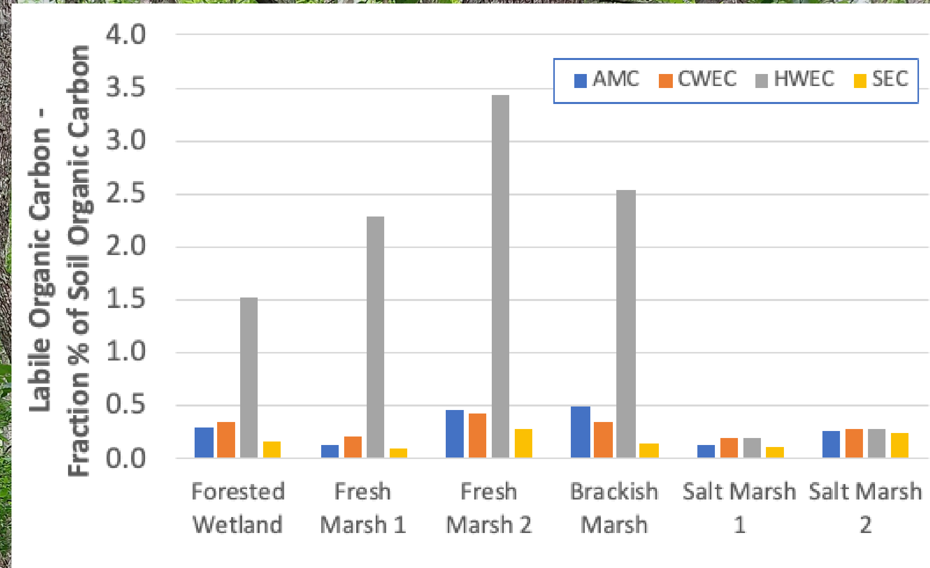
Primary factors affecting greenhouse gas flux in wetlands:

- Soil organic matter
- % OM that is labile

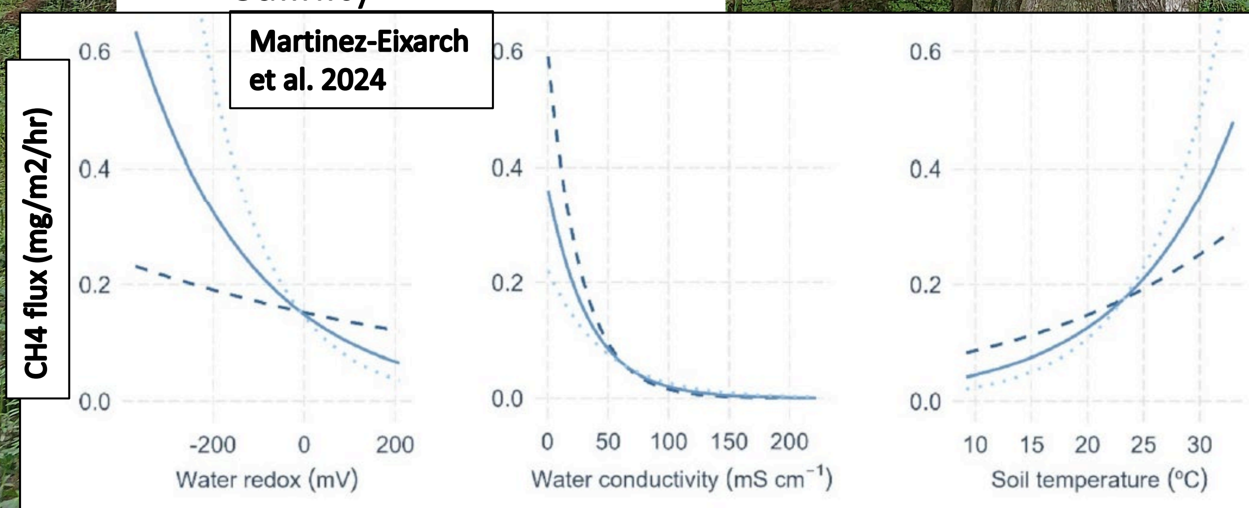
Table 3. *Mean and range of soil bulk density and soil organic matter content (0–24 cm) of different vegetation types based on CRMS soil data analyses (the values in the parentheses represent the minimum and maximum of the observed data).*

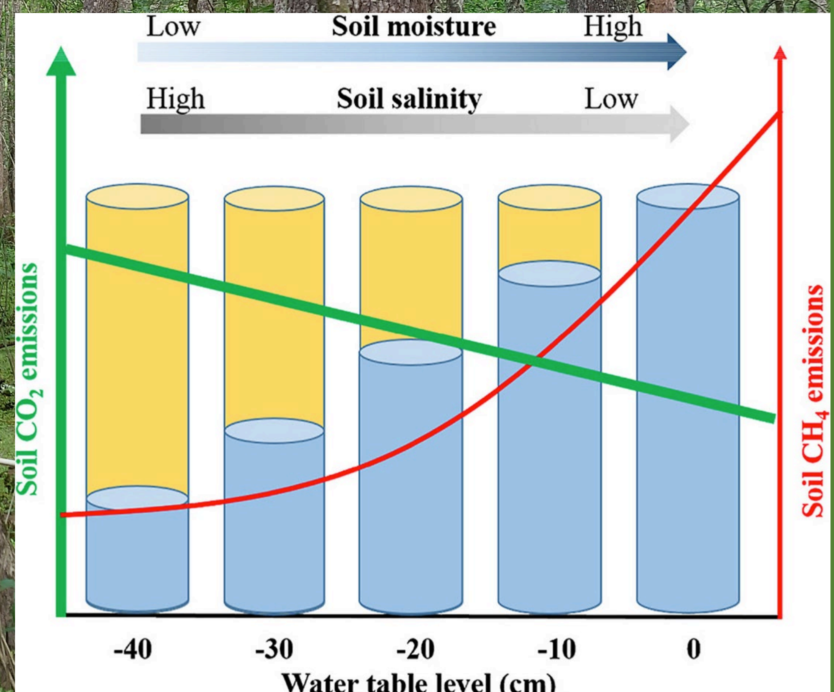
Wang et al. 2017

Vegetation Type	Bulk Density (g cm^{-3})	Organic Matter (%)
Active deltaic	0.86 (0.65–1.04)	6 (3.7–7.1)
Freshwater	0.11 (0.06–0.28)	55 (19.3–81.7)
Intermediate	0.19 (0.11–0.43)	48 (17.2–66.6)
Brackish	0.22 (0.16–0.31)	39 (29.4–48.6)
Saline	0.38 (0.29–0.53)	21 (23.9–25.8)
Swamp	0.33 (0.20–0.41)	39 (21.7–47.9)



- Hydrology/soil moisture
- Temperature
- Salinity





Zhao et al. 2020