Winipakw Climate Change, Contaminants and Blue Carbon Ecosystems Community-based Monitoring Project: Progress Report

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1 Background

This project aims to build scientific capacity in Chisasibi by monitoring blue carbon ecosystems using environmental indicators stemming from Cree Traditional Ecological Knowledge (TEK) and environmental sciences. This project is one element of a longer-term initiative to develop an integrated, Indigenous-led, landscape-level conservation strategy across James Bay. In James Bay, blue carbon habitats are essential for their global contribution to climate change mitigation and their close link to sustaining the indigenous Cree way of life as crucial habitats for fish and migratory waterfowl. We focus on monitoring key blue carbon ecosystem indicators and assessing current and emerging threats to these systems and their potential impacts on Cree's traditional livelihoods. Through this project, we wish to build a framework for participatory environmental monitoring in Chisasibi that can be scaled up in other communities and contribute to conserving the blue carbon ecosystems in eastern James Bay.

2 Objective

This project aims to initiate a long-term monitoring program to support community-driven decision-making on environmental conservation locally and across James Bay. Our approach is to monitor a suite of biophysical and climate change indicators in strategic blue carbon ecosystems using Cree TEK and scientific methods. Assessments will understand the cumulative impacts and emerging threats to these ecosystems. Monitoring activities will concentrate on the north of La Grande river. Using monitoring data, we hope to gain the necessary depth and breadth of knowledge to understand blue carbon ecosystems' current and future state, ecosystem services, and impacts on traditional practices through this strategy.

3 Methods

We visited several sites during the summer of 2021, 2022, and 2023. We collected the following baseline data on eelgrass habitats using environmental monitoring methods.

- Sediment cores
- Historical and current distribution
- Collection and measurement of plant samples
- Water quality indicators
- Presence or absence of potentially harmful algal blooms

In addition, we sent the sediment cores for analysis to the GEOTOP lab at the University of Quebec in Montreal. We obtained the results of organic carbon estimates and Lead210 dating for the accumulation rates. These data will be integral to assessing the target ecosystems' role as greenhouse gas sinks or sources. The information also contributes to answering guide questions about the state of the target ecosystem:

1. How much organic carbon (C) is James Bay blue carbon ecosystems accumulating per unit area per year?
2. What are the threats to blue carbon ecosystems, and how do these threats affect the sequestration rate of blue carbon in James Bay and their traditional ecosystem services?
3. What is the state of James Bay eelgrass and other coastal ecosystems as blue carbon sinks/sources?
4. How does climate change impact blue carbon accumulation in James Bay?
5. What management actions best maintain and promote carbon sequestration and traditional use of blue carbon ecosystems in James Bay?

4 Project Accomplishments

- Collection of sediment cores
- Ten days of fieldwork on eelgrass sites of potential coring for organic carbon estimation (Figure 1)
- Collected environmental and other water quality parameters
- Collected and measured eelgrass samples

- Collected traditional knowledge on the historical distribution of eelgrass
- Collection and identification of harmful algal or cyanobacterial blooms and diatoms
- Analyses of core sections for percent organic carbon, Pb210 dating, and sediment accretion rates.

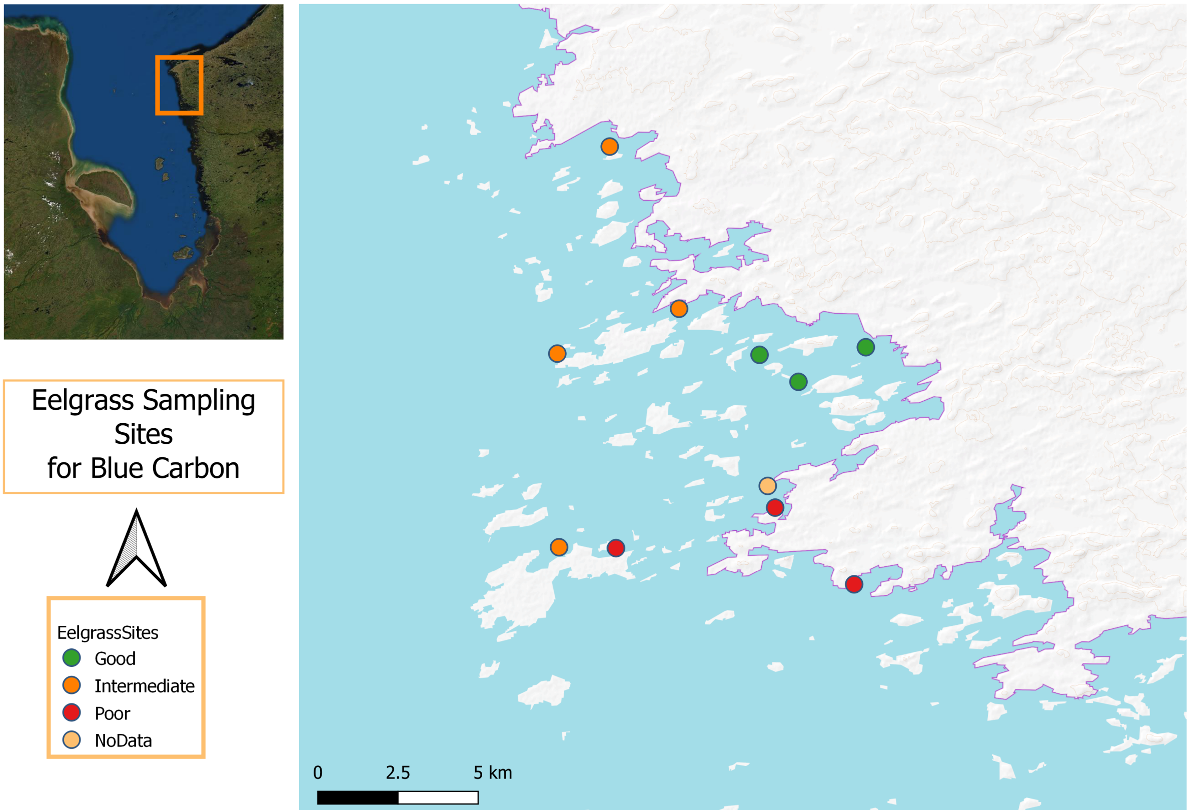

Figure 1: Eelgrass ecosystem sampling locations

4.1 Procurement of laboratory equipment

Percent accomplishment: 100

Despite delays in procurement and delivery, the project acquired needed scientific and field equipment and successfully carried out fieldwork. All the equipment and consumables needed for water quality monitoring have been delivered. Purchase of additional equipment is ongoing.

4.2 Sampling program

Percent accomplishment: 100

The trapline tallymen provided the knowledge that guided site selection. These sites are precise and have a long history of resource use and they also represent areas where land users have observed environmental changes throughout the years. Last fall, we finally collected sediment cores from 2 target sites, one with thriving eelgrass and one from marginal eelgrass beds.

4.3 Analyses of core samples

Percent accomplishment: 95

Two cores were sent out to the GEOTOP lab at the University of Quebec in Montreal for percent organic carbon, isotope analyses, and Pb210 dating. The results has been received and interpretation of the data are on-going.

4.4 Hiring and training of local youth

The funding contributes to the partial salaries of 2 co-researcher. This co-researcher was involved in all the fieldwork and were trained to conduct core sampling and preparation of core sections. They received training in using universal coring devices and core extrusion in the field.

4.5 Community presentation

We made two presentations to the CERRI board about the project and one presentation to the general community assembly. Community members were learning blue carbon and climate change concepts. The community were interested in exploring the synergy between enhancing the blue carbon ecosystem to make them more productive as a carbon sink and waterfowl habitats. They also wanted to know more about algae and cyanobacteria and how it affects traditional resources like fisheries.

5 Key Findings

5.1 General eelgrass state and ecology of core sampling sites

Eelgrass beds at the two coring sites are marginally different. Eelgrass plants on the first site were healthier and cleaner, and had longer leaves. On the contrary, the second sampling location has marginal to no eelgrass growth. Also, the second eelgrass site had enourmous mats of microalgae and cyanobacteria. We are currently identifying the species of cyanobacteria found in that location to understand its toxicity and impacts on eelgrass and waterfowl.

Figure 2: Mats and microscopic images of filamentous cyanobacteria

5.2 Sediment core characteristics

The sediment cores varied in length and substrate characteristics. The site with eelgrass had the deepest sediment at 96 cm while the marginal eelgrass site had about half of the depth(65 cm). In addition, the site with eelgrass is more silty and clayey while the other site had more sand.

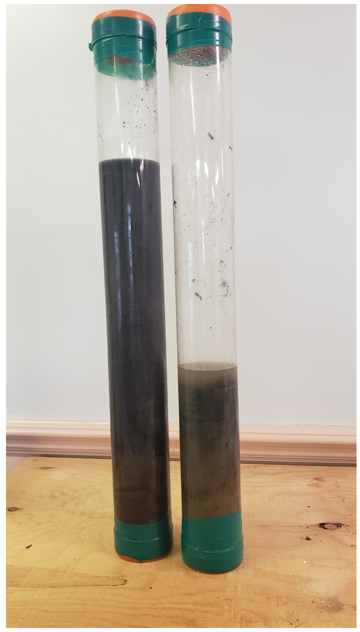

Figure 3: Eelgrass sediment cores

5.2.1 Isotope Analyses

Stable isotope analyses provide valuable insights into the nature of James Bay eelgrass sediments. The results are expressed in delta notation (δ) measures the ratios of stable isotopes of carbon(13C/12C) and nitrogen(15N/14N) in samples. Results expressed as part per thousand (ppt) deviation from a standard material. δ 13C values provides information of the carbon sources in the sediment while δ 15N values values provide information about the nitrogen sources and cycling in the ecosystem. In marine environments, δ 15N values can vary widely, influenced by sources of nitrogen (like upwelling, nitrogen fixation, or anthropogenic inputs) and processes like denitrification.

The δ 13C ranges are typicall between -300‰ to +50‰. More negative values indicate a dominance of terrestrial influence (tress and shrubs-C3 plants), while less negative values suggest marine sources (C4 plants). Typical δ 13C values of seagrass is around -11‰ closely resembling C4 species. C3 and c4 plants in terrestrial environments have δ 13C values around -28‰ to -14‰, respectively (Touchette and Burkholder 2000).

The δ 13C results from the core sample with eelgrass (C04) ranges from -14.7‰ to -24.91‰ while the core without eelgrass (C01) ranges from -15.97‰ to -20.58‰. The more negative values in lower end of core C04 values indicate significant incorporation or mixing of terrestrial organic matter, which is typically more 13C-depleted compared to marine organic matter while the range of values from C01 suggests a predominance of marine organic carbon with a possible minor influence from terrestrial sources(Canuel et al., 1997).

On the other hand, the δ 15N values in core C01 (marginal eelgrass) sample ranging from +2.00‰ to +5.71‰ and core (C04-eelgrass beds) with δ 15N values between 1.79‰ and 4.44‰both suggest that primary production and early consumer interactions dominate(eelgrass and phytoplankton), with marine sources of nitrogen being significant and little influence from denitrification or terrestrial inputs.

5.2.2 Percent Organic Carbon

Table 1: Summary Statistics of Percent Organic Carbon

SITEID	Count	Mean	SD	Min	1st Qu.	Median	3rd Qu.	Max
APAW-CH5-C01	25	1.6192	0.6427151	0.43	1.03	1.770	2.09	2.49
WSJ-CH5-C04	25	0.7624	0.7148676	0.28	0.34	0.395	0.75	2.53

The t-test comparing the percent organic carbon (%C-org) between the two sites yields a t-statistic of approximately 4.456 and a p-value of approximately 0.0000507. Given that the p-value is less than the common significance level of 0.05, we can reject the null hypothesis and conclude that site C01(marginal eelgrass) has a significantly higher organic than the site with eelgrass (C04).

Regarding soil organic carbon density site C01 has a higher mean soil organic carbon density as well as a higher median, indicating generally greater organic carbon density in the soil at this site compared to site C04. The variability, as indicated by the standard deviation, is also lower at C01 than at C04. The average soil organic carbon density of the two sites was approximately 0.02055 g/cm^3, which translates to 20.55 kg/m^3.

Table 2: Summary Statistics of Soil Organic Carbon Density (g/m^3

SITEID	Count	Mean	SD	Min	1st Qu.	Median	3rd Qu.	Max
APAW-CH5-C01	25	0.0256418	0.0068006	0.0109540	0.0224566	0.0247331	0.0292674	0.0380788
WSJ-CH5-C04	25	0.0154575	0.0086058	0.0082224	0.0098466	0.0115194	0.0179805	0.0377704

5.2.3 Lead (Pb)210 Dating

1. Results from cores with marginal eelgrass site is summarized in Table 3.

Table 3: C01: Core data from marginal eelgrass site

Depth (cm)	Density g/cm^3	210Pb (Bq/Kg)	sd(210Pb)	Thickness (cm)
1	2.02	34.80	2.51	1
3	2.47	35.27	2.61	1
5	2.55	20.82	1.62	1
7	2.12	16.48	1.25	1
9	1.14	20.54	1.59	1
11	1.61	21.43	1.77	1
13	1.36	22.04	1.74	1
15	1.40	15.04	1.15	1
17	1.38	17.01	1.39	1
19	1.57	15.94	1.33	1
23	1.26	15.67	1.21	1
27	1.19	15.11	1.10	1
31	1.38	17.90	1.40	1

6 Conclusion

1. How much organic carbon (C) is James Bay blue carbon ecosystems accumulating per unit area?

Based on the previous calculation, the average soil organic carbon density of the two sites was approximately 0.02055 g/cm^3, which translates to 20.55 kg/m^3.

Carbon Sequestered in 1 square kilometer of eelgrass Soil
Based on the previous calculation, the average soil organic carbon density of the two sites was approximately 0.02055 g/cm^3, which translates to 20.55 kg/m^3 when converted to kilograms per cubic meter (kg/m^3).

Carbon Sequestered in 1 Square Kilometer of Eelgrass Soil: - Volume of soil in 1 square kilometer area with 1 meter thickness = $1,000,000\,\mathrm{m}^2 \times 1\,\mathrm{m} = 1,000,000\,\mathrm{m}^3$. - Carbon sequestered = Volume of soil × Average soil carbon density = $1,000,000\,\mathrm{m}^3 \times 20.55\,\mathrm{kg/m}^3 = 20,550,000\,\mathrm{kg}$ of carbon.

Equivalent Motor Vehicle Emissions: - Assuming 1 kg of soil organic carbon sequesters about 3.67 kg of CO2 (based on the molecular weight ratio of CO2 to C), the total CO2 sequestered would be $20,550,000\,\mathrm{kg} \times 3.67 = 75,417,350\,\mathrm{kg}$ of CO2. - Converting kilograms to metric tons (since 1 metric ton = 1,000 kg), we get $75,417,350\,\mathrm{kg}/1,000 = 75,417.35\,\text{metric tons of CO2}$. - Given that an average passenger vehicle emits about 4.6 metric tons of CO2 per year, the number of vehicle emissions this amount of CO2 sequestration represents is $75,417.35\,\text{metric tons CO2}/4.6\,\text{metric tons CO2/vehicle/year} \approx 16,393.77\,\text{vehicles/year}$.

Therefore, a square kilometer of eelgrass soil with 1 meter thickness, having the average soil carbon density observed in the two sites, can sequester approximately 75,417.35 metric tons of CO2. This is equivalent to the annual emissions from approximately 16,394 motor vehicles.

2. What are the threats to blue carbon ecosystems, and how do these threats affect the sequestration rate of blue carbon in James Bay and their traditional ecosystem services?

Eelgrass in James Bay are threatened by development in inland watershed. The most significant of these development is the contruction and operation of hydro-electric complex in the region. When the dams were built,some of the major rivers

3. What is the state of James Bay eelgrass and other coastal ecosystems as blue carbon sinks/sources?
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