FIRE: THE FIRST-YEAR INNOVATION & RESEARCH EXPERIENCE

PROJECT GREENHOUSE

The Effect of Light Duration on Methane Emissions

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Introduction

Why should someone care about your question?

- Numerous studies emphasize the significant role of sediment decomposition and vascular plants in driving higher methane emissions, which is crucial due to their harmful effects on the environment, including global warming. This is because “temperature directly affects development, survival, range, and abundance” (Bale et al). A different study has also found that there is a correlation between photosynthesis and CH4 production. An increased level of methane is found in more aqueous environments (Günthel et al., 2020).
- However, one area that most studies do not look into is light intensity. Studying the methane and carbon dioxide concentrations due to light intensity could give us insight into the relationship between light intensity and methane production from micro-bacteria (Yang & Chang, 1998).

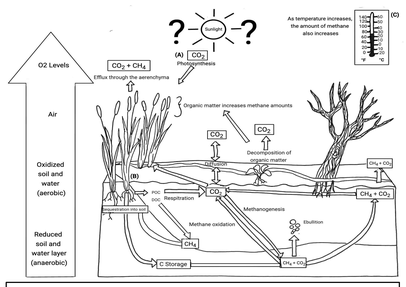

Figure 1: Schematic of methane and carbon dioxide cycling at a wetland. (A) Carbon dioxide is consumed by plants through the process of photosynthesis. (B) Then, the plants die and their organic matter is either oxidized to carbon dioxide or used in a methanogenic pathway to produce methane. (C) Temperature is another factor that influences the methane emissions and an increase of temperature increases the methane emissions.(Figure adapted from USGS 2019)

What does your research answer?

- Higher light intensity reduces methane emissions, while lower light intensity increases methane formation by cleaving methyl groups from amino acids. Methane production by methanogenic organisms is affected by lower temperatures (Günthel et al., 2020).

Question: How does duration of light exposure affect methane and carbon dioxide emissions?

SAMPLE LOCATION AND METHODS

- Gathered samples of soil from the groundwater inlet and groundwater outlet
- Put the soil under different light intensities (24, 12, 4, and 0 hours)
- Ran samples through the GC to see the methane emissions

Figure 2: (A) Samples were taken from the sites labeled with yellow pins. Site B has soil with grainier, sand-like texture. The water level is very shallow, and fluctuates often. Site C has soil with thicker, clay-like texture. The water level is high, but fluctuates often.

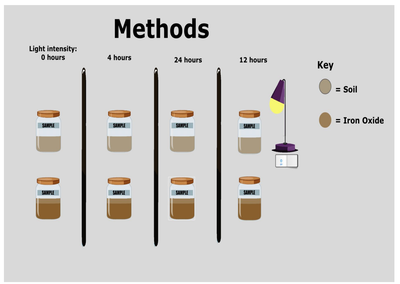

Figure 3: Impact of Light Intensity on Sediment Composition. Four columns represent varying light exposure durations (0, 4, 24, and 12 hours). In the absence of light (0 hours), Sample 1 exhibits predominant sediment, while Sample 2 displays a notable increase in iron oxide. As light intensity increases, iron oxide remains prominent (0 and 4 hours), with a decline observed at 12 and 24 hours. Notably, our findings indicate that lower light intensity correlates with heightened methane emissions, emphasizing the environmental implications of light exposure on sediment dynamics

RESULTS AND DISCUSSION

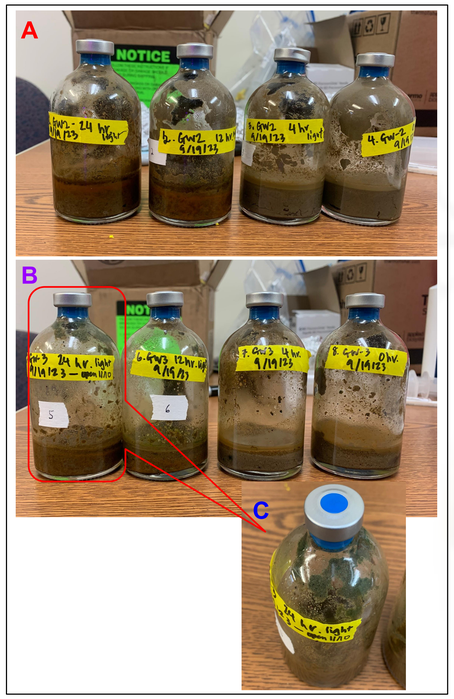

Figure 3: Incubation Vial Set up with Soil Samples. Image A displays soil samples from the Groundwater Inlet. The samples exposed to 12 hours and 24 hours of light having high amounts of iron (orange substance), which decreases methane production. Image B displays soil samples from the Groundwater Outlet. All of the samples have some iron present. The sample exposed to 24 hours of light has a high amount of green substance, which can be seen more closely in Image C. This may be cyanobacteria.

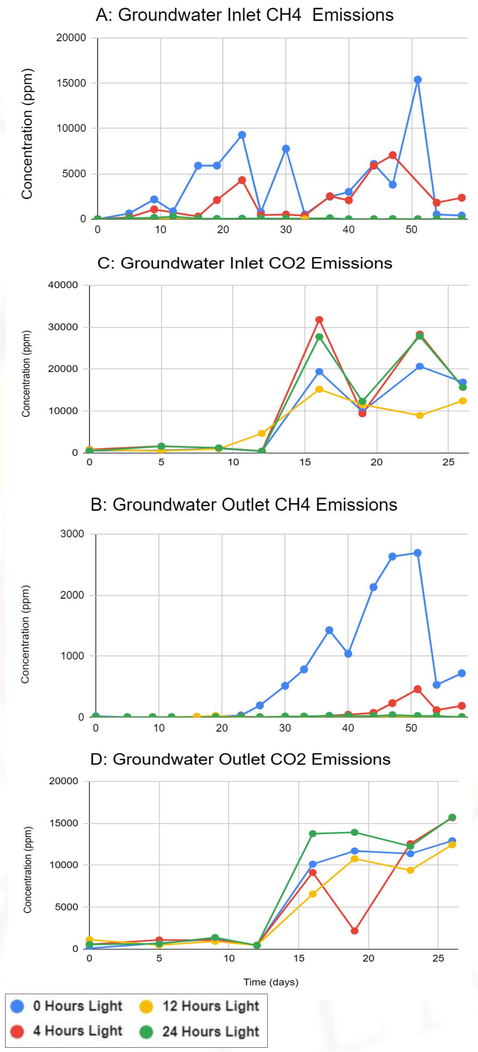

Figure 4 (A,B,C,D): These charts illustrate how varying light exposure over a 24-hour period impacts methane and carbon dioxide emissions from the Groundwater Outlet and Groundwater Inlet. Our findings indicate that reduced light levels correlate with higher methane concentration.

Discussion: Our results show how a decrease in light intensity leads to increased levels of methane. Carbon dioxide however fluctuates with light intensity. Thus, there is a correlation between light intensity and methane and not as likely with regards to carbon dioxide. Wetlands have increased levels of methane in shadier areas. Carbon dioxide does not appear to correlate with methane in your incubation experiments. Additionally, there is also a possibility of temperature affecting methane.

FUTURE WORK

- Examine control (12 hours of light) data to understand discrepancy in data for methane production
- Add additional types of sediment, such as gravel and thicker clay, to further explore the role of soil in methane production
- Look at isotopes to see abiotic and and biotic biological processes
- Repeat the experiment at different times of year to see if there are seasonal changes within the microbial community and the amount of methane they produce

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