

Seasonal Variation of Methane Fluxes in Seagrass Meadow in Lake Komuke, Hokkaido

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Summary

This study evaluated the extent to which methane (CH₄) emissions offset carbon dioxide (CO₂) uptake in seagrass meadows, focusing on Komuke Lagoon in northern Japan, which is dominated by *Zostera marina*. Seasonal observations were conducted from June to October 2024 at 15 sites using both the bulk method and floating chambers to quantify CH₄ and CO₂ fluxes. CH₄ was supersaturated at all sites throughout the study period, with peak emissions occurring in August. In contrast, surface water in Komuke Lagoon first basin remained largely undersaturated with respect to CO₂, indicating net atmospheric CO₂ uptake. Ebullition accounted for approximately 24% of total CH₄ fluxes, indicating its significant contribution. Based on global warming potential (GWP) metrics, CH₄ emissions offset 24.6% (GWP-20) and 8.2% (GWP-100) of CO₂ uptake in the first basin. However, the second and third basins acted as CO₂ sources and exhibited even higher CH₄ emissions, resulting in CH₄-induced warming effects that exceeded CO₂ emissions by factors of 2 - 4. The study also identified seasonal variations in CH₄ sources, with sediment-derived CH₄ dominating in June and freshwater-derived CH₄ contributing more substantially in August and October. These findings underscore the importance of accounting for CH₄ emissions - particularly from ebullition - when evaluating the net greenhouse gas (GHG) budget of blue carbon ecosystems. The results also suggest that CO₂-based assessments alone may substantially overestimate the GHG mitigation capacity of seagrass meadows. Future studies should incorporate nitrous oxide (N₂O) measurements to enable a more comprehensive evaluation of GHG dynamics in coastal vegetated systems.