Annotated Bibliography

Kristine Bernabe

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Arias-Ortiz et al. (2021)

Arias-Ortiz et al. (2021) investigated the primary predictors of methane (CH_4) flux in tidal marshes across the continental United States and explored how spatial and temporal variations influence CH_4 emissions. The researchers sought to identify dominant predictors of CH_4 flux across diel, seasonal, and annual timescales, and to evaluate methods for scaling chamber-based measurements to annual flux estimates. Their data included 35 CH_4 flux datasets from 122 tidal marsh sites as well as nine independent eddy covariance (EC) tidal marsh sites. Using both chamber and EC data, they found that porewater sulfate, salinity, mean daily maximum annual temperature, and elevation were key predictors of CH_4 flux. On a diel scale, tidal height significantly influenced flux timing and variability, and the average annual CH_4 flux across sites was 26 ± 53 g CH_4 m^{-2} yr^{-1}. While the study is extensive, synthesizing data across many systems, the scaling of chamber measurements for annual flux estimates to match the EC data is slightly problematic as chamber and EC methods differ in spatial and temporal resolution. The analysis assumes comparability between methods, which may lead to uncertainty or bias. This paper serves as a valuable reference for understanding CH_4 flux patterns in tidal wetlands across the U.S. It provides a baseline for comparing how my study site behaves relative to national trends and helps contextualize my own flux measurements within broader wetland carbon (C) dynamics.

Arias-Ortiz et al. (2024)

Arias-Ortiz et al. (2024) studied how EC flux measurements, soil accretion, and carbon accumulation rates, when combined with variables such as salinity, tidal influence, and landscape configuration, can be used to quantify carbon sequestration rates, greenhouse gas (GHG) emissions, and lateral carbon losses. The study also examined how different restoration practices affect GHG budgets in restored wetlands under climate change. Focusing on wetlands in California's San Francisco Bay, the researchers combined flux measurements with sediment accretion and carbon burial data to estimate long-term C budgets. They found that methane emissions in nontidal freshwater and brackish marshes fully offset the carbon dioxide (CO_2) removed via carbon burial for approximately the first 2–8 decades post-restoration. In contrast, tidal wetlands contributed to GHG removal almost immediately. These results emphasized the role of soil accretion and hydrology in determining restoration success. A major strength of this study is its comprehensive comparison between tidal and nontidal systems, providing practical insights for wetland managers, such as maintaining permanent flooding in nontidal wetlands. However, the studies focus on the San Francisco Bay may limit the scalability of its findings to otherwetland ecosystems. This paper is highly relevant for understanding the role of wetlands in climate change mitigation. It provides critical context and justification for wetland restoration as a carbon management strategy which is useful when communicating the broader importance of my research.

Bansal et al. (2023)

Bansal et al. (2023) conducted a comprehensive review designed to guide wetland researchers in selecting appropriate sampling methods, interpreting past carbon studies, and promoting standardization across wetland carbon research. The paper synthesizes existing methods for quantifying carbon pools and fluxes within soils, vegetation, water, and gases. It organizes carbon measurements into the categories C pools and C fluxes. Bansal et al. (2023) defines each category, explains their relevance to the overall wetland carbon cycle, and outlines best practices for quantification. For each measurement type, the authors describe the rationale, discuss commonly used and new techniques, and evaluate the pros and cons of each method. They also identify important complementary measurements that improve data interpretation. The review concludes that improving the consistency and quality of data collection and reporting will reduce global uncertainties in carbon budgets and inform management strategies for using wetlands as nature-based climate solutions. The review's strengths is in its extensive coverage and clarity. It breaks down complex methodologies into a single accessible resource while encouraging active engagement with cited literature. This paper has been a crucial methodological reference for my research. I have used it to design and interpret my flux measurements, including guidance on chamber construction, placement, and calculation methods. I plan to continue consulting it to ensure my methods remain up to current standards, fostering syntheses across studies.

Cornu & Sadro (2002)

Cornu and Sandro (2002) investigated how constructed marsh surface elevation changes over time relate to the influence of fill depth, vertical accretion, tidal channel size, vegetation colonization, and fish density and diversity after restoration. Their study focused on Kunz Marsh within the South Slough National Estuarine Research Reserve, a site previously diked and drained for agriculture that later experienced subsidence. The marsh was divided into four cells (high, mid, low 1, and low 2) with reference sites at Danger Point High and Tom's Creek High. Including the removal of the marsh's dike, each cell was graded to specific elevations using fill material, with some topsoil from the original marsh. Over three years, they monitored surface elevation changes, vertical accretion, tidal channel development, vegetation colonization, and fish use. Their results indicated that mid-elevation marsh areas favored rapid colonization by emergent vegetation and supported vertical accretion beneath mean higher high water (MHHW), while low-elevation areas benefited fish in the early recovery stages but did not promote vegetation colonization or channel development as effectively. A limitation of the study is its relatively short time frame. Three years may not capture longer-term trends, which could differ substantially over multiple decades. This study is directly relevant because Kunz Marsh is the site of my research. Understanding its restoration history and how elevation influences vegetation and hydrology at my site specifically can help interpret GHG flux patterns in my data.

Mueller et al. (2020)

Mueller et al. (2020) explored the effects of sea level rise (SLR) and its interactions with elevated CO_2 (eCO_2) and coastal eutrophication (i.e. increased nitrogen availability) on CH_4 emissions in an estuarine tidal wetland. Using a multifactorial experimental design, they combined field-deployed marsh mesocosms that simulated sea level changes with floating open-top chambers to manipulate atmospheric CO_2 levels. They found that CH_4 emissions increased under elevated CO_2 and rising sea levels but did not change with eutrophication. Notably, the relationship between SLR and CH_4 flux was nonlinear meaning that emissions initially decreased with rising sea levels before increasing again at higher levels. This pattern was driven by shifts in plant community composition, particularly the relative abundance of C_3 sedges and C_4 grasses, which influenced the direction and magnitude of CH_4 responses. The study's inclusion of multiple interacting drivers and different plant functional types strengthen it. However, its scalability may be limited because plant species like *Spartina* and *Schoenoplectus*, which the study focuses on, does not dominate all wetlands. This work is particularly useful for understanding the vegetation-mediated controls on gas fluxes. Although my research does not include vegetation metrics, the study highlights the importance of plant community dynamics in wetland gas exchange, which can inform the interpretation and discussion of my own results.

Salimi et al. (2021)

Salimi et al. (2021) conducted a literature review to assess how natural and constructed wetlands, particularly peatlands, might respond to climate change in terms of greenhouse gas emissions and nutrient release. The authors synthesized peer-reviewed studies published between 1990 and 2020, drawing from databases such as Web of Science and Google Scholar. Their analysis examined how changes in temperature and water availability influence wetland function, ultimately proposing a management framework for enhancing wetland resilience to climate change. They recommended long-term mesocosm experiments simulating climate change, monitoring of both CO_2 and N_2O emissions, greater research on constructed wetlands, and studies on vegetation succession in peatlands before restoration. Additionally, they emphasized the need for studies combining water-level management with climate scenario simulations to improve wetland adaptation strategies. While comprehensive, the review may be limited by language and geographic biases because non-English and Indigenous management perspectives were not well represented. This paper, though focused on peatlands rather than tidal wetlands, offers valuable insights into how different management approaches can influence climate mitigation potential. It provides a conceptual foundation for discussing how constructed and natural wetlands differ in GHG source and sink dynamics and will help me frame my reseach within a climate change mitigation context.

Schultz et al. (2023)

Schultz et al. (2023) aimed to quantify the importance of environmental drivers—specifically water table depth, temperature, and salinity—on CH_4, carbon dioxide CO_2, and nitrous oxide (N_2O) fluxes across Oregon wetlands. The study also assessed whether GHG fluxes in disturbed, restored, and reference wetlands could be adequately modeled using relationships with these environmental drivers, and whether different management regimes produced distinct flux patterns. Data were collected from 22 wetland sites across Tillamook and Coos Bay, spanning reference, disturbed, and restored wetlands across a salinity gradient. Fluxes were measured using light and dark chambers, and boosted regression trees were applied to identify key drivers and predict annual GHG fluxes. The study demonstrated that spatially extensive chamber measurements, when combined with continuous environmental monitoring and machine learning approaches, can effectively model GHG fluxes across management regimes, providing a cost-effective alternative to high-frequency EC measurements. A strength of this study is its spatial extensiveness and focus on a previously underrepresented region, providing valuable data for Oregon wetlands. A potential limitation is the reliance on chamber-based fluxes, which may underestimate variability captured by continuous EC methods. The study assumes that chamber-based measurements, in combination with regression models, can reliably represent annual fluxes across diverse wetland types. This paper informs the design of my own study by providing experimental and analytical approaches for modeling GHG fluxes. It also offers a regional baseline for comparison, helping me assess the credibility of my flux estimates and contextualize the environmental factors driving variability in my study area.

Shahan et al. (2022)

Shahan et al. (2022) focused on quantifying CO_2 and CH_4 fluxes in a heterogeneous restored saltmarsh by combining co-located soil chamber and EC measurements. The study site was a marsh along South San Francisco Bay, where soil chamber fluxes were measured during low tide across different vegetation types. Concurrently, an EC tower, established in 2018, recorded ecosystem-scale fluxes of CO_2 and CH_4 (up until 2021 for this study). Ancillary environmental measurements were also collected to contextualize flux patterns. Results indicated that the marsh functioned as a strong net CO_2 sink and a small net CH_4 source. High net CO_2 removal appeared driven by low CO_2 emissions rather than elevated photosynthetic uptake, and vegetated areas removed more CO_2 compared to mudflats. A potential weakness is the combination of EC and chamber data, which have different spatial and temporal resolutions and may introduce uncertainty or biases. Nonetheless, this approach allows for a more comprehensive understanding of carbon dynamics across heterogeneous marsh landscapes, allowing for both spot measurements and ecosystem wide level measurements. This work is particularly relevant because it provides future methodological recommendations, such as using automated chambers and high-resolution imagery, which are applicable for improving monitoring approaches in my own research. Furthermore, it highlights the importance of site-specific assessments for understanding tidal wetland carbon exchange, directly contextualizing the purpose of my study.

Were et al. (2019)

Were et al. (2019) reviewed the potential for enhancing carbon sequestration in wetlands through non-manipulative and manipulative approaches while highlighting challenges that may hinder adoption of such methods. The review focused on synthesizing recent literature according to PRISMA guidelines, with databases including Google Scholar. Non-manipulative methods included expanding the spatial area of wetlands, while manipulative strategies involved altering wetland characteristics to increase carbon storage. The authors emphasized that conserving existing wetlands should be the primary focus for carbon sequestration enhancement projects and recommended integrating economic incentives, particularly for non-manipulative projects, to improve their competitiveness against alternative land uses. The review also highlighted current gaps in understanding caused by overlapping datasets and insufficient integration of stakeholder perspectives. A major limitation of this review is the lack of Indigenous perspectives, which could restrict the applicability and success of recommended strategies. This paper is relevant for situating my research within the broader climate change mitigation context. It provides justification for studying wetland carbon fluxes, highlights potential enhancement strategies, and offers management-oriented recommendations that show the importance of my work.

Williams et al. (2025)

Williams et al. (2025) investigated how environmental variables and plant community composition influence CH_4 and N_2O fluxes in estuarine wetlands. The study used chamber-based measurements across multiple sites in Washington and one site in Oregon, collecting data on water table depth, temperature, salinity, pH, elevation. Plant biomass and composition data were also collected through cover and height measurements. The authors found that the most important predictors of GHG fluxes were elevation, water table, and salinity, while groundwater pH, wetland type, and temperature were less influential. CH_4 fluxes were higher in restored tidal marshes and wet pastures compared to reference tidal marshes, tidal swamps, and dry pastures, highlighting the role of estuarine hydrologic gradients. Land use effects on CH_4 flux were mediated by environmental conditions, emphasizing the complex interactions between restoration, hydrology, and gas emissions. The study's strengths include comprehensive environmental and flux measurements across multiple sites in Washington, providing great spatial coverage. Limitations include only one estuarine site in Oregon, which may bias regional generalizations toward Washington conditions. I consulted this paper when I was fist designing my chamber-based flux measurements and determining which environmental variables to monitor. It also acts as a reference for interpreting CH_4 flux patterns relative to wetland type and restoration history.

Wilson et al. (2024)

Wilson et al. (2024) presented the R package *fluxfinder*, which addresses gaps in reproducible processing and calculation of greenhouse gas fluxes from static chamber measurements. The package can parse raw data from commonly used portable gas analyzers, match metadata, convert units, estimate fluxes, and conduct initial quality assurance and quality control. It also provides diagnostic plots to identify measurement issues or nonlinear behavior. By integrating these functions into R, *fluxfinder* facilitates transparent and reproducible data processing workflows for GHG flux analysis. The authors demonstrated the package's usefulness with clear examples, highlighting how it streamlines flux calculation and improves clarity and accessibility of results. The paper itself is well-organized and includes visual examples and reproducible code, making it accessible to researchers without extensive programming experience. This work is directly relevant because I currently use *fluxfinder* to process and calculate my own GHG fluxes. It has served as both a manual and a practical tool, saving me significant amounts of time during data processing. The paper also provides best-practice guidance that enhances the reproducibility and transparency of my analyses.

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