Introduction:

Landscape hydrology posits that hydrologic and biogeochemical changes in one region of a watershed have the potential to cascade across the entire basin. Through the lens of landscape hydrology, the watershed is viewed as a singular, relatively closed system, encompassing micro-ecosystems that collectively contribute to the basin’s distinct biogeochemical and hydrologic fingerprint. The relevance of “landscape hydrology” to specific watersheds is dependent on the basin's connectedness, or how water flows and is stored between inland waters. In low-relief, wet biomes where water is transported and mixed through both subsurface and surface flow paths, viewing the watershed as a unified hydrologic unit is particularly pronounced. The biogeochemical signature of each specific inland water body tends to be more homogenous and influenced by nearby waters. In contrast, dry, unconfined watersheds with less exchange between inland waters feature aquatic environments that are more independent from one another, each with distinct characteristics.

The largest determinant of hydrologic connectedness is wetland density. Wetlands, particularly isolated, depression wetlands, act as "capacitors" for the landscape, storing water and transforming nutrients within their basins. Wetland density is strongly correlated with surficial water-table depth, directly influencing subsurface lateral transport and indirectly controlling downstream flow. The greater the wetland area, the higher the degree of wetland-groundwater exchange, impacting downstream water quality through infiltration or exfiltration, even without direct surface connection. Additionally, wetlands are considered global biogeochemical hotspots and carbon sinks. Within wetland basins, the anaerobic conditions, long residence times, and extended hydroperiods can re-mineralize carbon and emit greenhouse gases (GHG), while also exporting processed nutrients downstream via subsurface flow or overland flow ("spill-and-fill"). Due to their productivity and carbon storage potential, wetlands are global carbon pools, and despite covering only 2-6% of Earth's surface, they are assumed to be an infinite carbon source for streams, especially in low-relief landscapes.

Isolated wetlands are recognized for their potential to significantly contribute to global carbon cycling, and consequently, stream carbon. While wetland-stream carbon contributions in higher-order, tropical streams have been investigated, few studies have explored the influence of isolated wetlands on lower-order streams. Existing research on wetland carbon contributions to lower-order streams has primarily focused on seasonal wetlands, which experience prominent dry periods, and did not include river corridor (RC) contributions. Furthermore, results from these studies are contrasting. Wetlands for higher-order rivers contribute the majority of stream carbon (approximately 80%), whereas isolated wetlands associated with smaller, lower-order streams contribute only about 20% of stream carbon. This indicates that larger river-floodplain systems are not directly comparable to smaller headwater streams. Assuming one scenario over the other can lead to significant inaccuracies in carbon inventories.

The global carbon budget currently has major discrepancies, likely overestimating terrestrial and groundwater stream-carbon contributions. To resolve these discrepancies, more detailed observational studies across various landscapes are necessary. For the third chapter of my dissertation, I will estimate the carbon contributions from isolated, depressional wetlands to BEF streams by longitudinally sampling for DIC, DOC, and POC from three streams within basins of various wetland densities. Thus far in my PhD, I will have explored stream-carbon temporal dynamics and RC fluxes with fluctuating water table depths. By coupling my longitudinal sampling results with the findings from Chapters 1 and 2, I can isolate the influence of depressional wetlands. Assuming RC -fluxes and stream-productivity responses to fluctuating discharge are homogeneous throughout the reach, I can investigate how nearby wetlands influence stream carbon and, therefore, landscape hydrology, as water accumulates downstream. Few studies have directly explored isolated wetland carbon contributions, and none have yet to include observed RC fluxes or stream metabolism inferences.

The results from these estimations will provide the foundation for specific hypotheses regarding the sources and dynamics of stream carbon. **(1)** I hypothesize that each stream will gain carbon, increasing in DIC, DOC, and POC as water flows downstream. Although I expect depressional wetlands to contribute to the stream carbon, (**2)** I hypothesize the RC will remain the dominant carbon source. However, during flooded conditions, (**3)** I anticipate the wetland contribution will be greatest due to a shallower surficial aquifer and overland flow. Additionally, **(4)** I expect streams in watersheds with greater wetland density (wetland area/wetland quantity) to have higher total carbon (TC) concentrations and more homogeneous carbon quality across wetland, RC, and stream boundaries. Using the results from my entire dissertation, I aim to holistically map stream carbon sources and fluxes, allowing me to draw detailed inferences on the BEF’s regional carbon budget.

By testing these hypotheses and developing a regional carbon budget, I aspire for this chapter to offer both enhanced understanding of low-relief carbon sources and practical applications. Specifically, my objective for Chapter 3 is to guide management decisions on optimizing landscape hydrology in low-relief ecosystems to maximize regional carbon storage. I plan to develop a detailed regional carbon budget for Florida flatwoods that could be used in future carbon budgeting efforts.