Outline:

* **Big picture: introduce stream and wetland contribution to the global carbon budget**
* Inland waters- streams and wetlands- play a crucial role in the global carbon budget, functioning the primary drainage network and water storage for their watersheds (respectively) (Cole et al., 2007; Drake et al., 2018; Raymond et al., 2013).
* Streams, the “active pipes” of the watershed, “plumb” the terrestrial uplands transporting and transforming upstream debris and particulates downstream (Abril & Borge; Cole et al, 2007).
* Wetlands are “capacitors” for their watersheds serving as reservoirs for water and nutrients, which can be circulated throughout the watershed via subsurface or overland flow pathways and providing a watershed-scale buffer against drought (Evenson et al., 2018; Li et al., 2023; McLaughlin et al., 2014) (CITE, Cohen & Kaplan).
* Through the downstream movement of water via streams, and the lateral flow from wetlands, inland waters form a dual-pathway transport network (Leibowitz et al., 2018), with wetlands acting as stream headwaters and catchments, and streams facilitating connectivity between the upstream and downstream boundaries (Abril & Borges, 2019; Casson et al., 2019; Li et al., 2023; Moustapha et al., 2022).
* **Discuss the current issues with current global carbon budget in relation to inland waters (Dive deeper into streams as pipes)**
* Current global C-budget models estimate that of the 4.5 Pg-C/year produced by the terrestrial landscape, 3.4 Pg-C/year is delivered to inland waters (Regnier et al., 2022).
* Stream carbon is predominantly allochthonous (sourced from the terrestrial uplands), and is therefore regarded as a global carbon source, emitting more carbon dioxide (CO2) than what is accounted for by stream metabolism alone (Cole et al., 2007; Raymond et al., 2013, Battin et al., 2009; Regnier et al., 2022).
* Utilizing mass counting and employing estimated global stream-CO2 emissions, of the 3.4 Pg-C/year produced by terrestrial landscapes, 0.6 Pg-C/year is buried in sediment, 0.3 Pg-C/year is photosynthesized, and 0.95 Pg-C/year is transported to oceans, leaving a significant 1.5 Pg-C/year gap.
* This major missing carbon, by default, is assumed to be degassing from groundwater seepage (Hotchkiss et al., 2015), however, current global carbon budgets exempt wetlands, leaving their contributions to stream carbon unclear and potentially overestimating groundwater’s significance. (Battin et al., 2009; Drake et al., 2018; Kirk & Cohen, 2023; Regnier et al., 2022).
* Yet, at the global scale, wetlands are challenging to delineate; wetlands are not terrestrial nor are they always aquatic, potentially drying outside of the wet season and thus, are frequently excluded from global C budget assessments (Raymond et al., 2013; Vlek, 2014). (Harvey & Gooseff, 2015; Kirk & Cohen, 2023; Leibowitz et al., 2018; Vázquez et al., 2007)
* This oversight likely overestimates global groundwater influence while overlooking wetlands carbon contribution.
* Furthermore, few studies have observed long-term trends in stream carbon transport and fluxes.
* Most publications target hot-spot moments, namely post-disturbance responses, or have a single, season-long study period,
* as water quality sampling and processing for carbon can be laborious.
* As a result, the long-term timing and influences of stream carbon fluxes and trends are largely unexplored, however, with the improvement of technology, and durable, long-term, high frequency sensors…
* **Introduce flatwoods of Florida- why they are important, how they are related to the global carbon budget**
* **Introduce project- three chapters and over arching goals**

This should probably all go to chapter 2…

* At the watershed scale, studies that have investigated wetland C-fluxes to streams often overlook riparian wetlands, instead focusing solely on isolated or intermittently connected wetlands (those linked to streams by overland flow during periods of high discharge) (e.g. Casson et al., 2019; Hosen et al., 2018; Moustapha et al., 2022; Solano et al., 2024).
* Riparian wetlands-the transitional zone between terrestrial uplands and streams can exert a disproportionate influence on stream chemistry as all particulates and nutrients must pass through them, typically via subsurface flow, before reaching streams (Kirk & Cohen, 2023; Wohl et al., 2017).
* Consequently, riparian wetlands have been hypothesized to harbor significant potential for carbon storage and could serve as significant carbon source for streams (Ledesma et al., 2015), especially if the landscape favors subsurface lateral flow as opposed to longitudinal overland flow from upland sources (Harvey & Gooseff, 2015; Kirk & Cohen, 2023).
* Despite their importance, riparian wetlands, similar to distinguishing global wetland contributions, are challenging to delineate from terrestrial uplands, especially during baseflow, and are frequently neglected in research endeavors.
* The zone of lateral exchange between streams and adjacent riparian wetlands is commonly referred to as the river corridor (RC), encompassing the stream, the hyporheic zone, and the riparian wetland, from water table to canopy (Harvey & Gooseff, 2015; Kirk & Cohen, 2023).
* The RC is hypothesized to contain disproportionately high concentrations of both inorganic carbon (IC) and organic carbon (OC), in gaseous and particulate phases, and serves as the primary pathway for lateral carbon exchange between terrestrial uplands and streams (Kirk, 2023; Ledesma et al., 2015, 2018).
* In boreal forests, studies have shown that up to 90% of stream dissolved organic carbon (DOC) is derived from the RC, which maintains a long-lasting supply of DOC with a theoretical turnover time of hundreds of years (Ledesma et al., 2015, 2018).
* For instance, Kirk and Cohen (2023) found that 86% of the lower Santa Fe River's CO2 originated from its RC, with only 14% sourced from groundwater seepage while isolated and intermittently connected wetlands contribute a relatively minor 15% of carbon to stream C.
* An ecosystem garnering increasing interest for its capacity to store C is the flatwoods of North Florida.
* Predominantly managed for pine stands, North Florida's flatwoods feature low relief terrain dotted with numerous wetland depressions.
* The dense coverage of wetlands in the flatwoods, coupled with the presence of the Hawthorne Formation, supports a shallow, near-surface water table.
* In the flatwoods, deep groundwater seepage from the Upper Floridian Aquifer (UFA) is minimal, and the flux of C to streams is primarily driven by lateral transport via the shallow water table, emphasizing the importance of the river corridor (RC).
* This hydrology fosters C storage and creates a transport network through which nutrients and particulates flow laterally downhill before ultimately discharging into tannic, blackwater streams.
* While groundwater seepage may account for the majority of stream C in some landscapes, particularly those with unconfined aquifers, flatwoods landscapes associated with confined aquifer units exhibit unique modes of C transport that are largely disconnected from deep groundwater upwelling.
* For the second chapter of my dissertation, I will investigate the influence of the river corridor (RC) on stream C by estimating RC C-flux (DIC, DOC, CO2, and particulate organic carbon (POC)) into streams at three locations spanning a gradient of wetland coverage within the flatwoods of Branford County, FL. I hypothesize **(1)** that the RC, the ecotone between the upland terrestrial landscape and the stream channel, delivers the majority of the C to streams and serves as a significant C stock in the flatwood landscape (FIGURE 2). Additionally, I anticipate **(2)** that RCs within basins with greater wetland area will exhibit a greater C-storage potential due to their raised water tables, which encourage lateral subsurface transport, leading to higher concentrations of C. By synthesizing information from the literature, the US Water Quality Portal (WQP), and my research findings, I aim to explore RC C transport across both confined and unconfined watersheds, thereby elucidating the RC's role in stream C fluxes. My overarching goal is to develop a conceptual understanding of the carbon budget within flatwood landscapes and to draw insights into C transport mechanisms within confined and unconfined watersheds.
* A diagram of a stream

  Description automatically generated
* FIGURE 2. Visual aid for hypothesis 1. Red rectangles are proposed well locations, and the above line graph hypothesizes DOC and CO2 concentrations within each well’s zone. Due to the river corridor’s (RC) tremendous carbon storage potential, as water moves laterally towards the stream, the concentration of C increases before discharging to the stream.