Intro:

* Marx
* Most stream carbon studies rarely include high-frequency data especially on multi-annual scale, creating uncertainties in stream carbon dynamics across time.
* However, the advent of high-frequency, durable sensors—many of which are cost-effective and efficient—presents an opportunity to observe carbon dynamics across seasonal fluctuations, disturbances, and "hot moments."

Inland waters and their role in the C

* *Inland waters play a crucial role in the global carbon budget, functioning as the primary drainage network for the terrestrial biosphere(Cole et al., 2007; Drake et al., 2018; Raymond et al., 2013).*
* *Carbon cycles linked to water cycle*
* *Although only 1% of the Earth, inland waters collective contribution to global carbon fluxes is substantial- they disproportionately active.*
* *The transfer of terrestrial C to inland waters is larger than C delivery to oceans yet roughly equal to NEP estimates of the terrestrial biosphere*
* *“the couplings between the land and water and between the hydrologic cycle and the carbon cycle”*
* *Not all the terrestrial carbon ends up in the oceans: carbon burial and aquatic carbon turnover (mineralization of OM and outgassing)*
* *Rivers/streams outgass 2.58 PG C/year*
* *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 fated to settle in streams (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 tremendous gap, 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).

Introduce stream-wetland and why they are of growing interest: “Exploring the stream-wetland exchange could remediate these knowledge gaps

* 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).
* Streams, the “active pipes” of the watershed, “plumb” the terrestrial uplands transporting and transforming uphill debris and particulates (Abril & Borge; Cole et al, 2007).
* Wetlands are “capacitors” for their watersheds serving as storage reservoirs for water and nutrients.
* Nutrients held within wetlands can be transported downstream via subsurface or overland flow pathways while the stored water raises the local water table, providing a watershed-scale buffer against drought (Evenson et al., 2018; Li et al., 2023; McLaughlin et al., 2014) (CITE, Cohen & Kaplan).
* Through the streams downstream movement of water 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).
* The exchange of water and its nutrients, and the subsequent transformation of nutrients as it passes through each ecosystem, creates a distinct biogeochemical fingerprint of the watershed (maybe sight Bernhardt? Fingerprint stuff).
* Wetlands, at the global scale, are challenging to delineate; wetlands are not terrestrial nor are they always aquatic, often 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)
  + Wetlands are intermediates between the terrestrial and the aquatic.
* Headwater streams are challenging to delineate
* This oversight likely overestimates…

Why we need better estimates

* *The objective of the carbon budget is to identify and quantify the significant components, and the key exchanges among them.*
  + *Integration of these fluxes into the C cycle is needed for CO2 management and climate change mitigation*
  + *Critical for constraining estimates and predicting feedbacks*
* *Sources and contributions by groundwater, soil, and wetlands are relatively unknown*
* *Estimates are provisional* and low because of difficulties associated with measuring the areal extent of inland waters and the pp of CO2, gas exchange rates
* *Explained by difficulty in defining river/stream surface area, and in stream processing is relatively unknown* 
  + *Small order streams remain insufficiently represented i*
* Sampling and processing all carbon species (organic carbon, carbonate, CO2, and CH4) is laborious; carbon-detecting instruments are costly, DIC samples expire quickly, and researchers are always battling with the inevitable degassing of gaseous carbon (CO2, CH4) and its reactivity (DIC, CH4) of their samples.
* Furthermore, few studies have observed the long-term trends in stream carbon transport and fluxes.
* Most publications target hot-spot moments, namely post-disturbance responses, or have a single, wet-season study period.
* Projects with longer study periods, largely only periodically sample for dissolved organic carbon (DOC), ignoring or inferring trends on dissolved inorganic carbon (DIC).
* However, with the advancements of high-frequency, durable and submersible sensors, and the subsequent research push to develop alternative, low-cost options, understanding the detailed mechanisms of stream carbon transport and transformation is now possible.

My Project:

* Improving our understanding of the global carbon budget and how humans have changed it. Determine how aquatic pathways link them together
* For my dissertation, I aim to investigate the detailed mechanism of stream carbon within Bradford Experimental Forest (BEF), a flatwood landscape located in North Florida. Primarily managed for pine stands, BEF features a low relief terrain dotted with numerous wetland depressions ideal for carbon storage. Due to the Hawthorne Formation and BEF’s dense wetland area
* Deep groundwater seepage from the Upper Floridia Aquifer (UFA) is minimal, and the flux of carbon to streams is driven by lateral transport via the shallow water table where particulates flow laterally downhill before ultimately discharging into tannic, blackwater streams.
* My dissertation is divided into three chapters: stream carbon, river corridor carbon, and surrounding landscape influences.
  + Chapter 1. Exploring the seasonal timing of stream carbon and its relationship to discharge,
  + Chapter 2. The carbon contribution and fluxes of the river corridor,
  + Chapter 3. The surrounding landscapes influence, namely wetland area, to stream carbon fluxes.
* From my findings, I will establish a detailed understanding of how landscape hydrology dictates stream carbon flux and transport, and aid in future research endeavors exploring and how carbon is stored (wetlands, soils) and lost (downstream transport and fluxes), as well as draw broad inferences of stream carbon patterns with discharge and its surrounding landscape outside of my ecosystem of interest.
* Furthermore, this research will provide evidence that hydrologic management can (or cannot) be used as a means to optimize carbon sequestration and storage, optimizing managed land for fiscal gain as well as ecosystem services.