Characterizing Metabolism Dynamics in U.S. Intermittent Streams

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Aquatic Intermittency Effects on Microbiomes in Streams

How does flow variability in intermittent streams influence ecosystem metabolism?

Background

- Many streams in Kansas are characterized by periods of intermittent flow, and this proportion is expected to increase as a result of climate change and anthropogenic activities (e.g., groundwater pumping).
- Despite the ubiquity of intermittent streams, the effect of stream drying and rewetting on ecosystem metabolism is not well understood, particularly in comparison to how well ecosystem metabolism is studied in perennially running systems.
- Recent work in perennial systems found flow variability and light to be key drivers of metabolism dynamics (Bernhardt, et al. 2022), however, how these are impacted by flow disturbance is unknown.

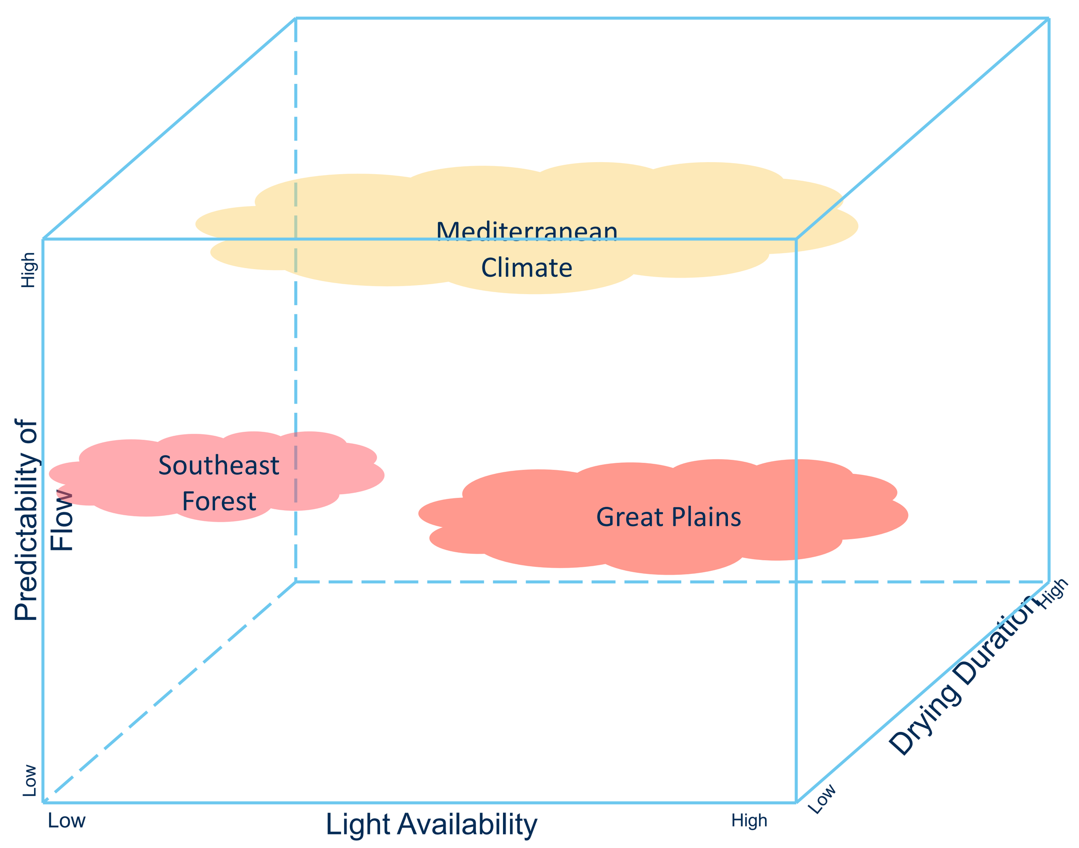

Fig. 1: Conceptual diagram modified from Bernhardt et al. 2022, with a hypothesized 3rd axis representing stream intermittency.

Study Sites

Fig. 2: Map of study sites

Methods

- Used gages from the USGS GAGES II dataset identified by Zipper et al. 2021 as intermittent and NEON intermittent streams.
- Estimated ecosystem metabolism using streamMetabolizer.
- Calculated flow variability metric
  - Coefficient of variation of stream discharge normalized by watershed area

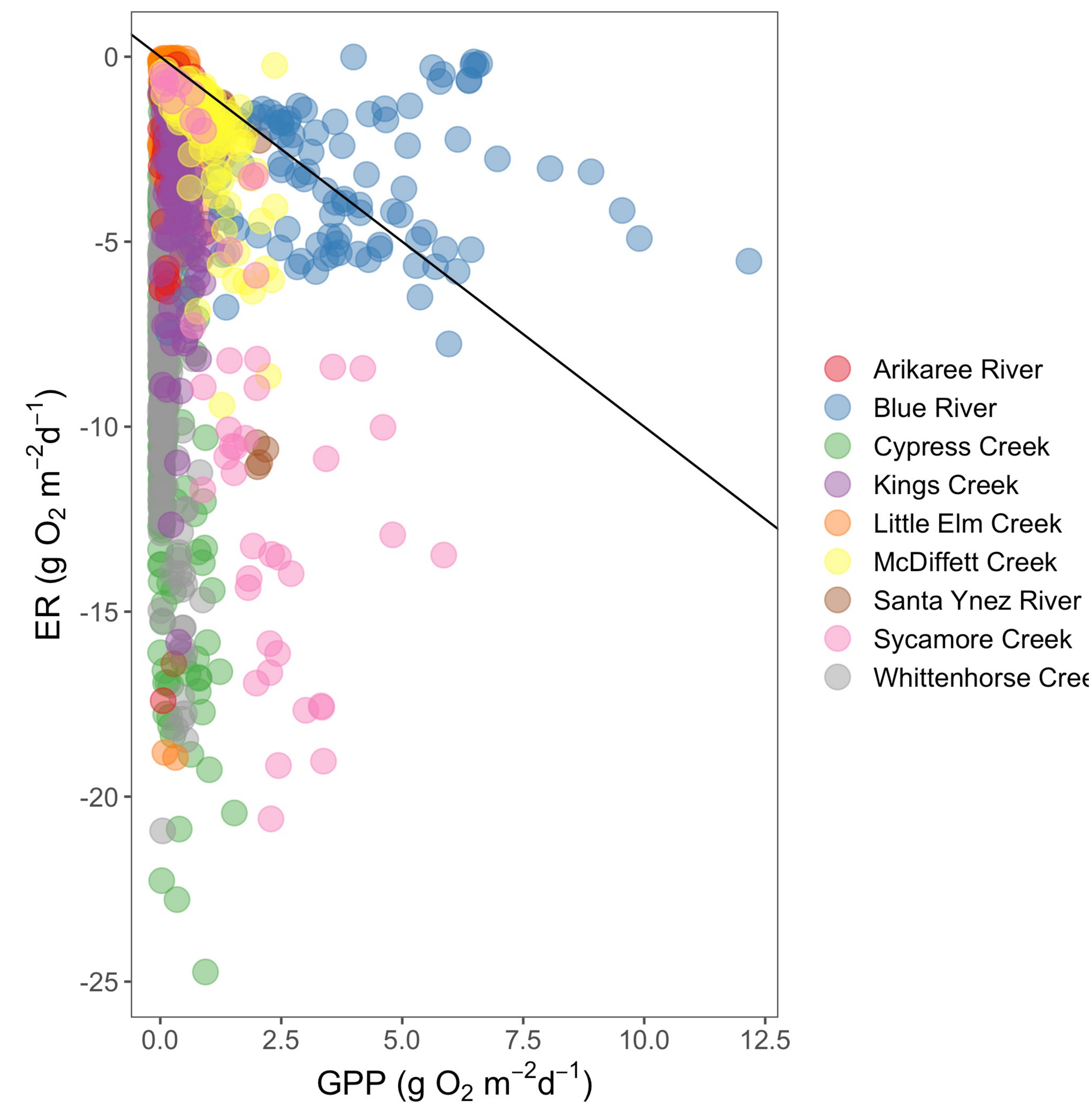

Fig. 3 (left): Average monthly gross primary production (GPP) and ecosystem respiration (ER) for nine sites with intermittent flow. Avg

Result: Most intermittent streams are net heterotrophic for the period of time that stream metabolism can be measured

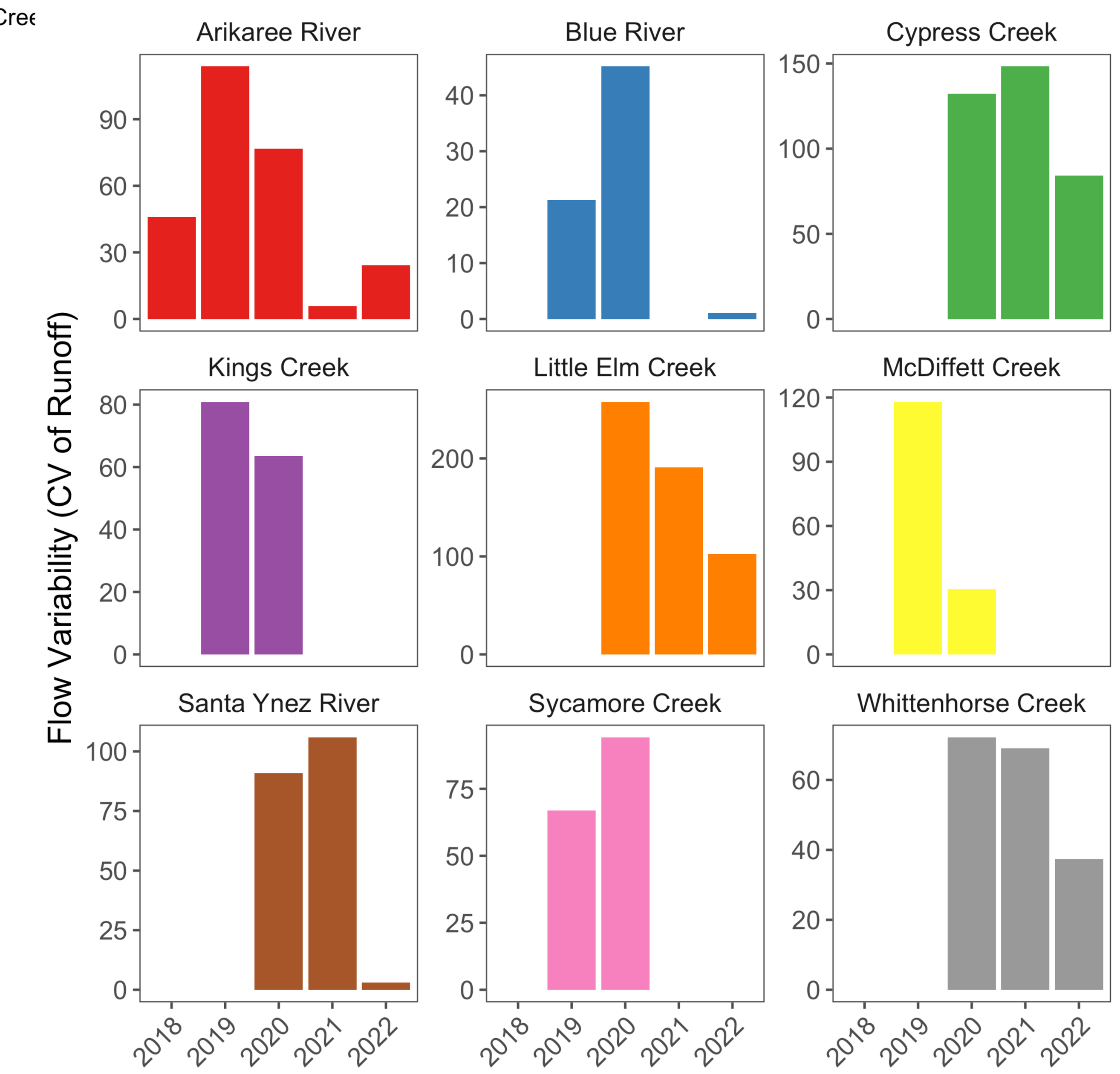

Fig. 4 (right): Annual flow variability (CV of runoff). There is high flow variability within and among sites.

Result: There can be as much year-to-year flow variation within a site as there is among sites.

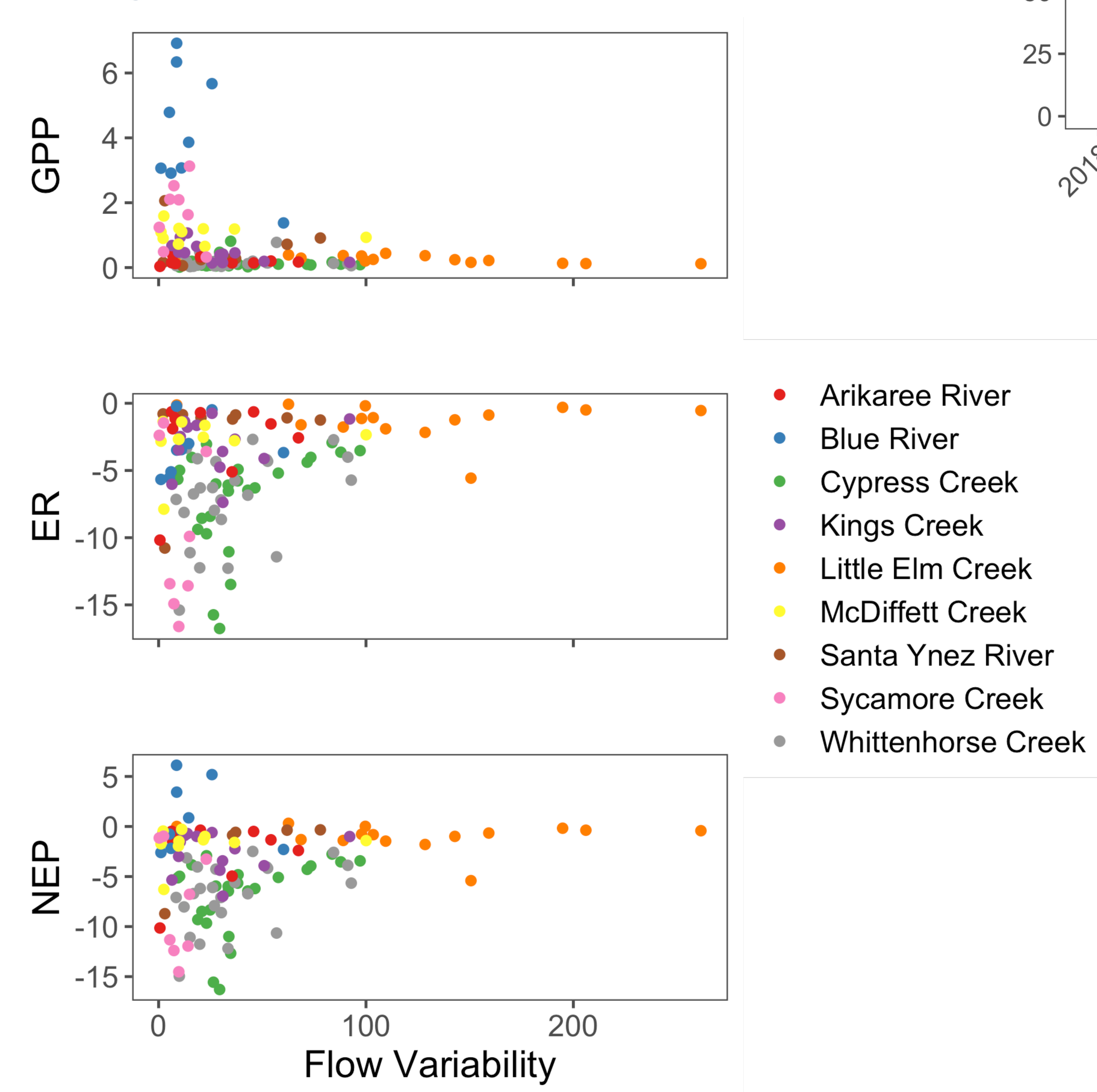

Fig. 5 (left): Monthly averages of gross primary production (GPP), ecosystem respiration (ER), and net ecosystem production (NEP) and monthly flow variability (CV of runoff). GPP, ER, and NEP are in $gO_2m^{-2}d^{-1}$.

Result: Sites with lower flow variability have a greater range of metabolism rates, suggesting other factors control metabolism in more stable flow conditions.

Context & Conclusions

- **Only 0.04% of sites** in the USGS GAGES II network and 0.06% of NEON sites are ***both*** intermittent and collecting dissolved oxygen data. Intermittent streams are severely underrepresented in our national monitoring networks, despite the abundance on the landscape.
- This highlights the pressing need for additional water quality monitoring in intermittent systems, particularly as more streams will dry with changing climate.
- Despite limited data, we demonstrate that low flow variability had the greatest range of GPP, ER, and NEP, while high flow variability suppressed GPP, ER, and NEP.

Future Directions

- Explore these relationships at seasonal time scales
- Develop conceptual model for intermittent stream metabolism.
- Expand intermittent stream monitoring.
- Develop methods for estimating ecosystem metabolism for intermittent streams during various flow states.
- If you know of other data sources let us know!

Acknowledgments

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