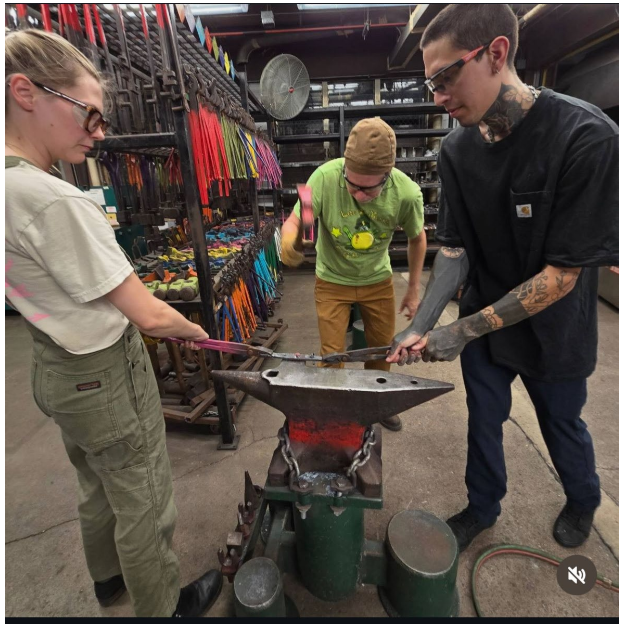
2024 Data Visualization Challenge

Quick summary

- 23 Entries across 4 universities and ERDC
- 8 MS students, 3 PhD, 3 post-doc, 7 ERDC, 1 professor, 1 professional
- 5 videos, 18 images across a wide range of projects
- Entries doubled the weekend before the due date (cough cough)

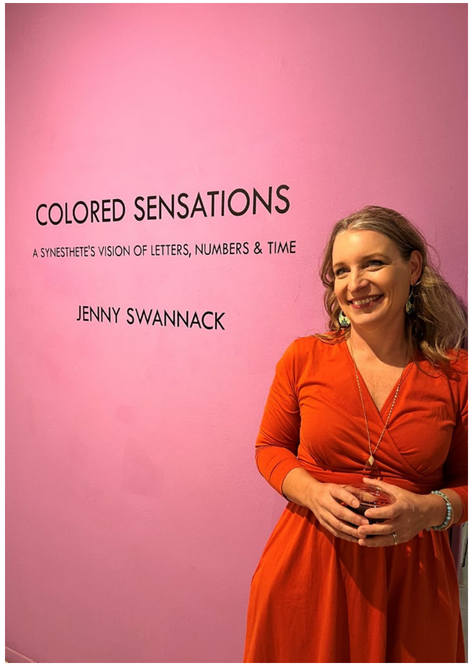
About your judges



Todd Swannack is a senior research biologist at the US Army Engineer Research and Development Center. He loves art of all kinds, but right now is focused on shaping metal with a hammer.

Insta: @goteamecomod.

Kyle McKay is a senior research civil engineer at the US Army Engineer Research and Development Center. He loves art of all kinds, but doesn't have any skills to manifest those ideas into reality. As such, data viz is Kyle's science- and code-adjacent creative outlet



Jenny Swannack is the principal at Langtry Studios, a design and art studio in Austin. Her art is displayed in several galleries around Central Texas. She recently showcased her work in the solo show *Colored Sensations.*

Insta: @jennyswannackart.

How we judged

- **Effective communication (10 pts):** Clear presentation of results through visualization
- **Creativity and innovation (10 pts):** New direction in field to approach to visualizing the data
- **Design and aesthetics (10 pts):** Appropriate use of color and design

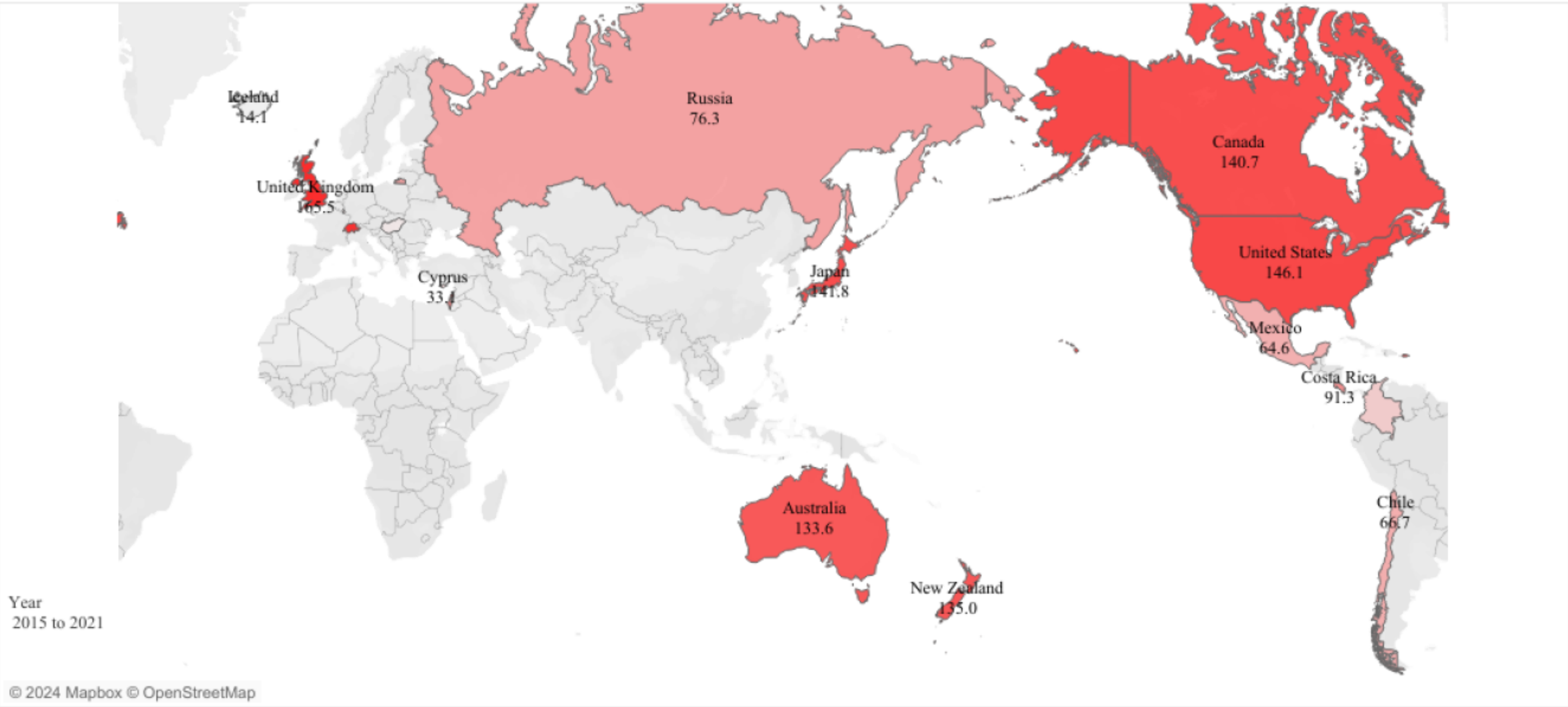
E-Waste Analysis : Towards a Sustainable Tomorrow !

Overview	E-Waste Generation Trend	E - Waste Classification	Recycling Rate	Conclusion

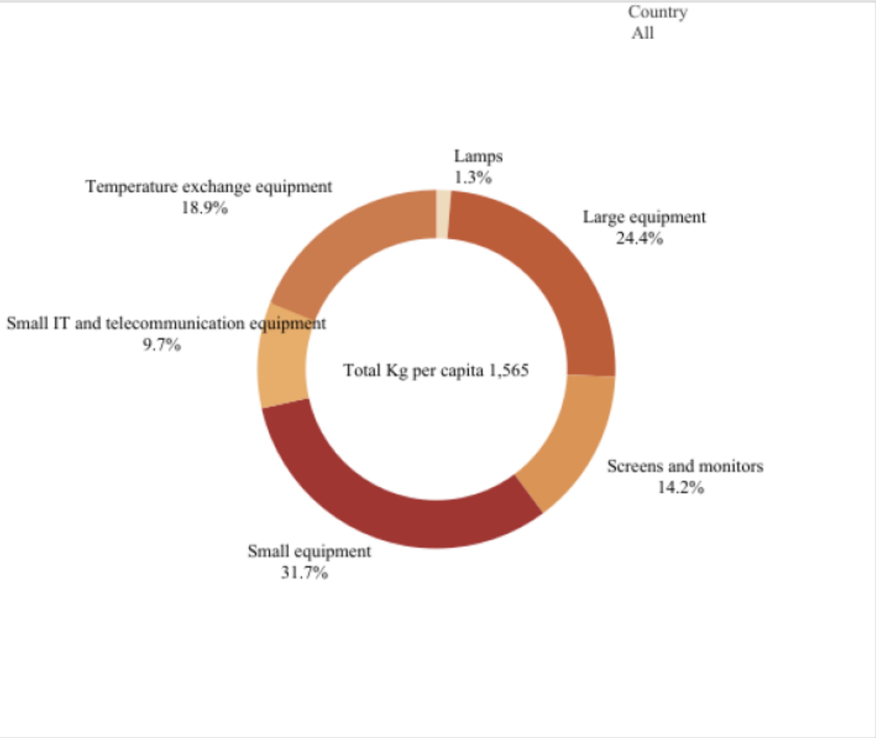
What is an E-Waste ?

E - Waste / Electronic Waste refers to the waste that is generated from discarded electrical and electronic devices. There is an increase in demand for electronics, which results in higher E- Waste volume. According to Statista report, it is seen that E- Waste contributes to **70%** of the total toxic waste. The toxic materials from E- waste includes mercury , lead , cadmium etc. which is harmful for the environment , animals and human health. Hence, E-Waste is a serious issue and should not be neglected. The most common E-Waste consists of Lamps, Screens & Monitor, Small Equipment , Large Equipment, Small IT and telecommunication equipment and Temperature Exchange Equipment. WHO reports shows that in 2019, only **17.4%** of the E-Waste was collected properly and taken to recycling facilities. From 2015-2021, the highest quantity of E- Waste is generated in the UK (**165.5** kg per capita) and mostly from small equipments. Where as Iceland marks the lowest (**14.1** kg per capita) , with large equipment contributing to **50%** of the composition .

E- Waste Generated by Countries (Kg/capita)



E- Waste Composition



https://public.tableau.com/app/profile/mary.thankam/viz/E_Waste_Analysis/HomePage

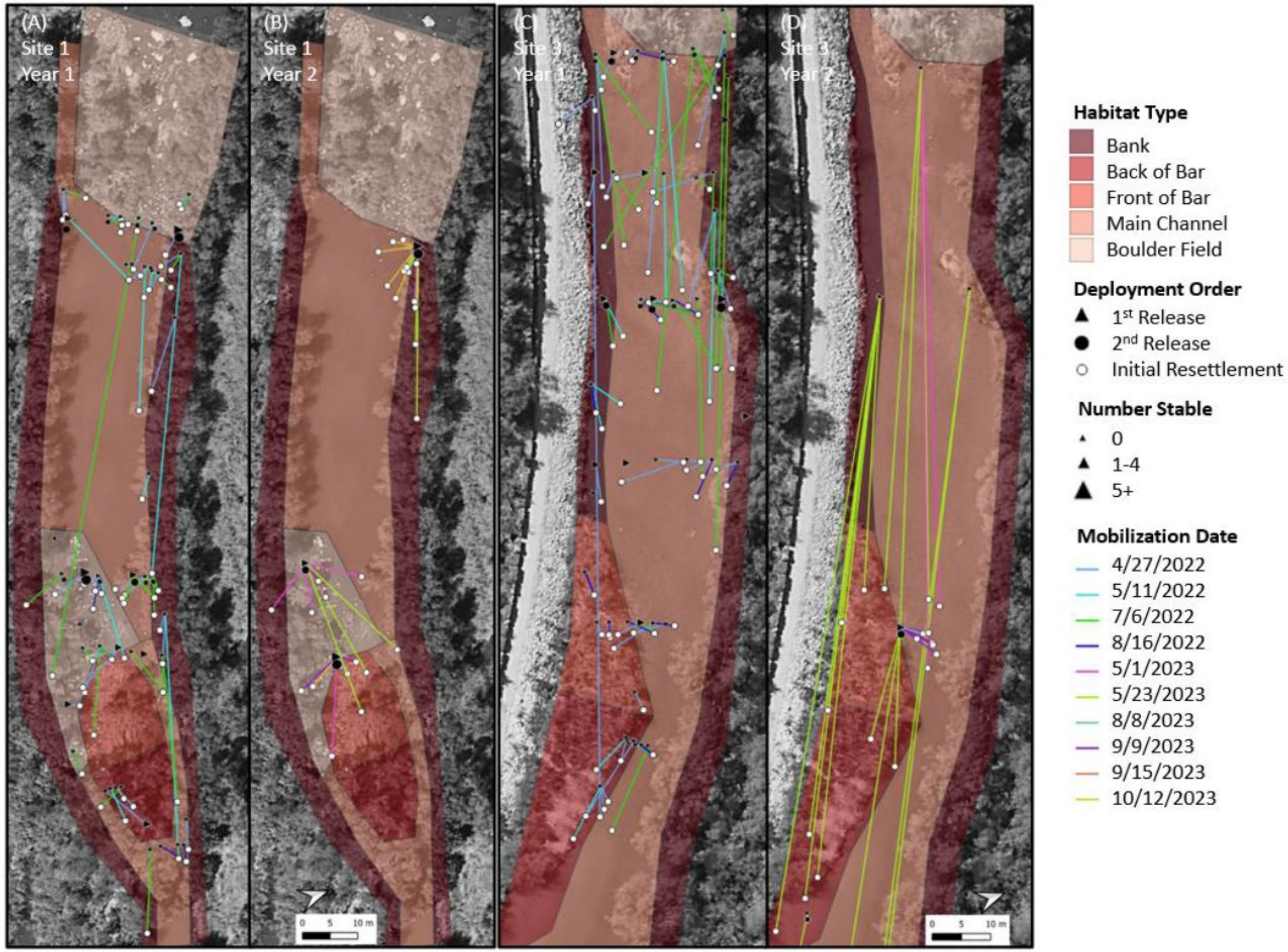
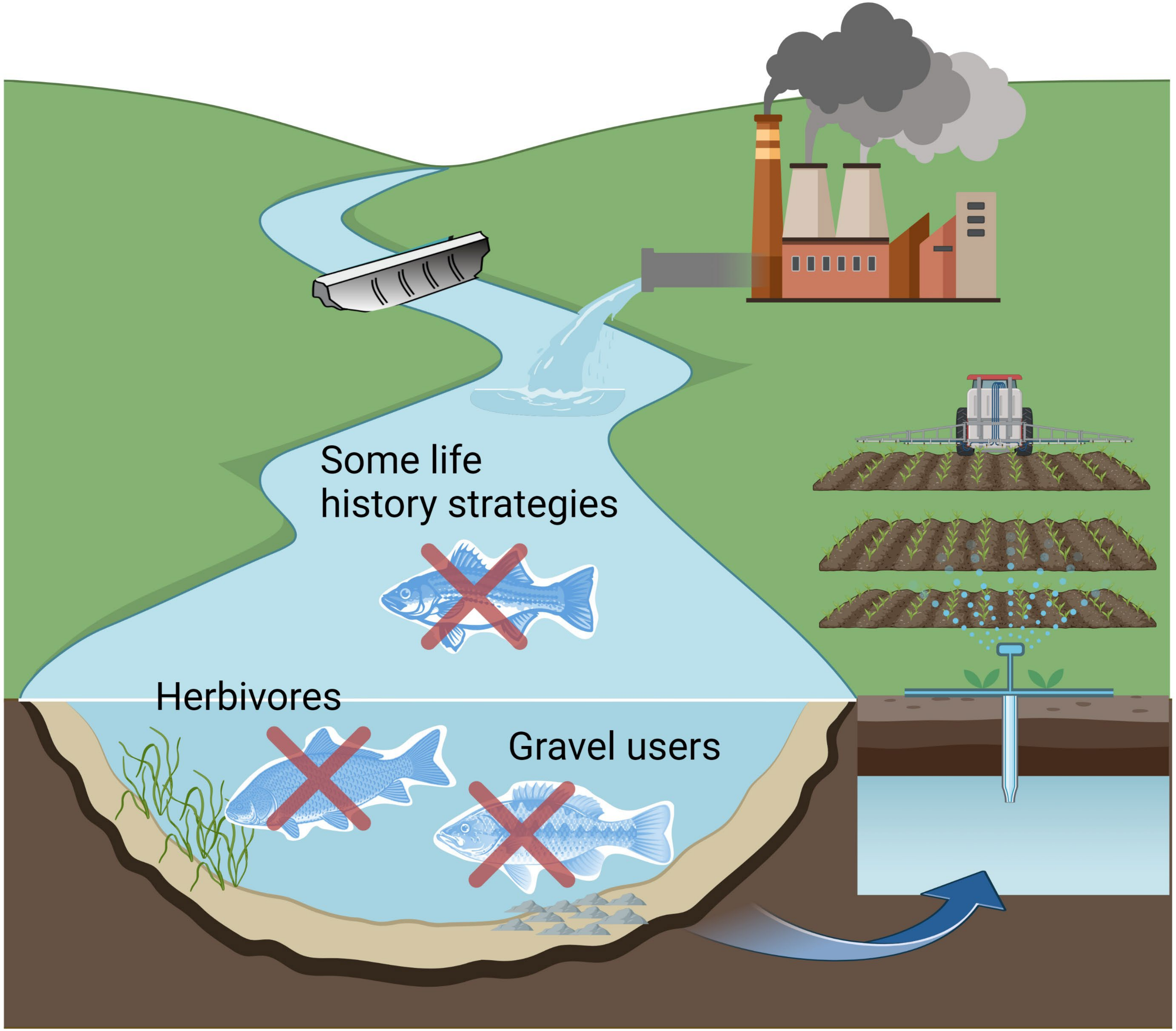


Figure. Deployment, mobilization, and resettlement of freshwater mussels across study site 1 (A and B) and site 3 (C and D) for year 1 (A and C) and year 2 (B and D) of the study. Flow is from top to bottom. Both live and 3D printed mussels of all sizes are included. Black triangles and squares represent the initial and secondary deployment locations of mussels during a given study year, respectively. The size of the deployment symbols indicates the number of mussels that were stationary throughout the study year. White circles indicate the resettlement location of mobilized mussels and the color of the path indicates the survey date the displacement was recorded. Mussel displacements are overlaid on habitat type plots derived from aerial imagery and site visits.

Submitted by Megan DiNicola



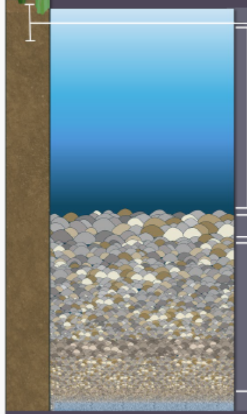
Submitted by Noah Santee

FROM THE BOTTOM UP

The Hyporheic Zone's Role in River Health

TEXAS STATE UNIVERSITY · TRIAGE · ERDC · THE UNIVERSITY OF TENNESSEE

From Eryl Austin-Bingamon & the Groundwater Ecology and Hydrogeology Lab at Texas State University, part of the Texas Research Institute for Aquatic and Groundwater Ecology



Riparian zone – The terrestrial area next to the stream channel [1].

Pelagic zone – The open water column [1].

Benthic zone – The top layer of sediment on the stream bed [2].

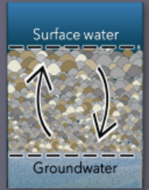
Hyporheic zone – The interface between stream water and underlying groundwater [3].

Much like the ocean, rivers can be subdivided into different zones.

Each zone plays a crucial role in maintaining healthy and functioning river ecosystems [1].

One of these zones is the **hyporheic zone**, an understudied realm of river ecology that supports rich biodiversity and facilitates vital ecological processes [2, 3].

Beneath the stream bed, the hyporheic zone is a transitional area between surface water and groundwater.



Hyporheic organisms inhabit the small open spaces between particles of sediment, such as sand or cobble [1].

Although its often underrepresented in river ecology, the hyporheic zone contributes several vital functions that support whole-river health.

Here, we will look at three critical hyporheic functions in more detail.

GROUNDWATER-SURFACE WATER EXCHANGE

Although they were once treated as separate entities, surface water and groundwater are now known to be highly interactive [1]. In a stream, the majority of these interactions take place in the hyporheic zone [3], helping to maintain stream health through…

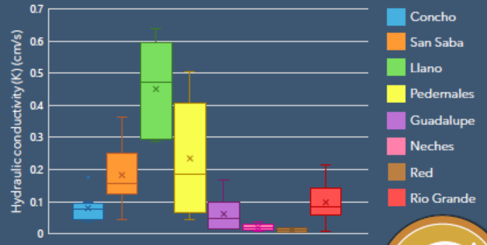
Transport of Nutrients
- Influx of surface water transports nutrients and organic matter, enabling critical biogeochemical reactions [2].

Temperature Regulation
- The temperature of water entering the hyporheic zone is buffered and rereleased, stabilizing stream temperatures [2]

Physical Filtering
- The matrix of sediment in the hyporheic zone acts as a mechanical filter, capturing small particles [2, 3].

Data Highlight

Hydraulic conductivity (K) measures how easily water flows through soil and rock. From 2021-2024, K was measured at 7 Texas rivers, with the highest K in the Llano River and lowest in the Red River. Higher K was also correlated with higher invertebrate abundance and diversity.



BIOGEOCHEMICAL PROCESSES

The hyporheic zone is often called the "liver of the river" due to its ability to drive river metabolism [2]. In fact, some studies have shown that over 90% of whole-river metabolism occurs in the hyporheic zone [3]. These critical processes include…

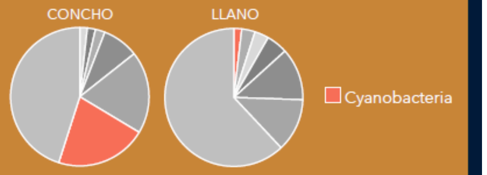
Nutrient transformation
- Nutrients such as carbon or nitrogen are transformed, making them available for uptake by other organisms [2].

Pollutant Attenuation
- Hyporheic microbial activity can reduce the concentration of anthropogenic pollutants [2].

River Respiration
- Microbes degrade organic material, releasing CO^2, which is then used by aquatic plants to generate O^2 [2].

Data Highlight

Hyporheic microbial community composition can help us better understand the water quality and ecological condition of an entire system.



2021 sampling found higher cyanobacteria in the Concho River vs the Llano, which may indicate more fertilizer runoff and a greater risk of water quality degradation [1].

HABITAT AND REFUGE

The hyporheic zone is habitat for a diverse assemblage of benthic and groundwater invertebrates, and its own distinct biological community, the *hyporheos* [2]. The hyporheic habitat supports to the health of the entire river, providing…

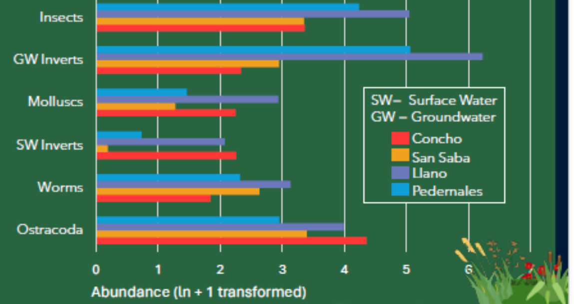
Habitat
- The hyporheic zone is habitat for invertebrate and vertebrate species, and a nesting site for some species of fish [2].

Refuge
- Benthic invertebrates use the hyporheic zone as refuge during severe drought and floods [2, 4].

Stream Food Web
- Hyporheic invertebrates form a large proportion of lower-trophic level prey [4].

Data Highlight

2021 hyporheic sampling revealed differences in taxa abundance between the four rivers of study.



THE HYPORHEIC ZONE

Unlocking Climate Resilience through Whole-River Management

The hyporheic zone exemplifies the profound interconnectedness of river ecosystems, demonstrating how critical processes beneath the surface can have far-reaching impacts.

Ultimately, the benefits of the hyporheic zone permeate the river ecosystem from the bottom up, fostering a resilient, vibrant, and sustainable aquatic environment.

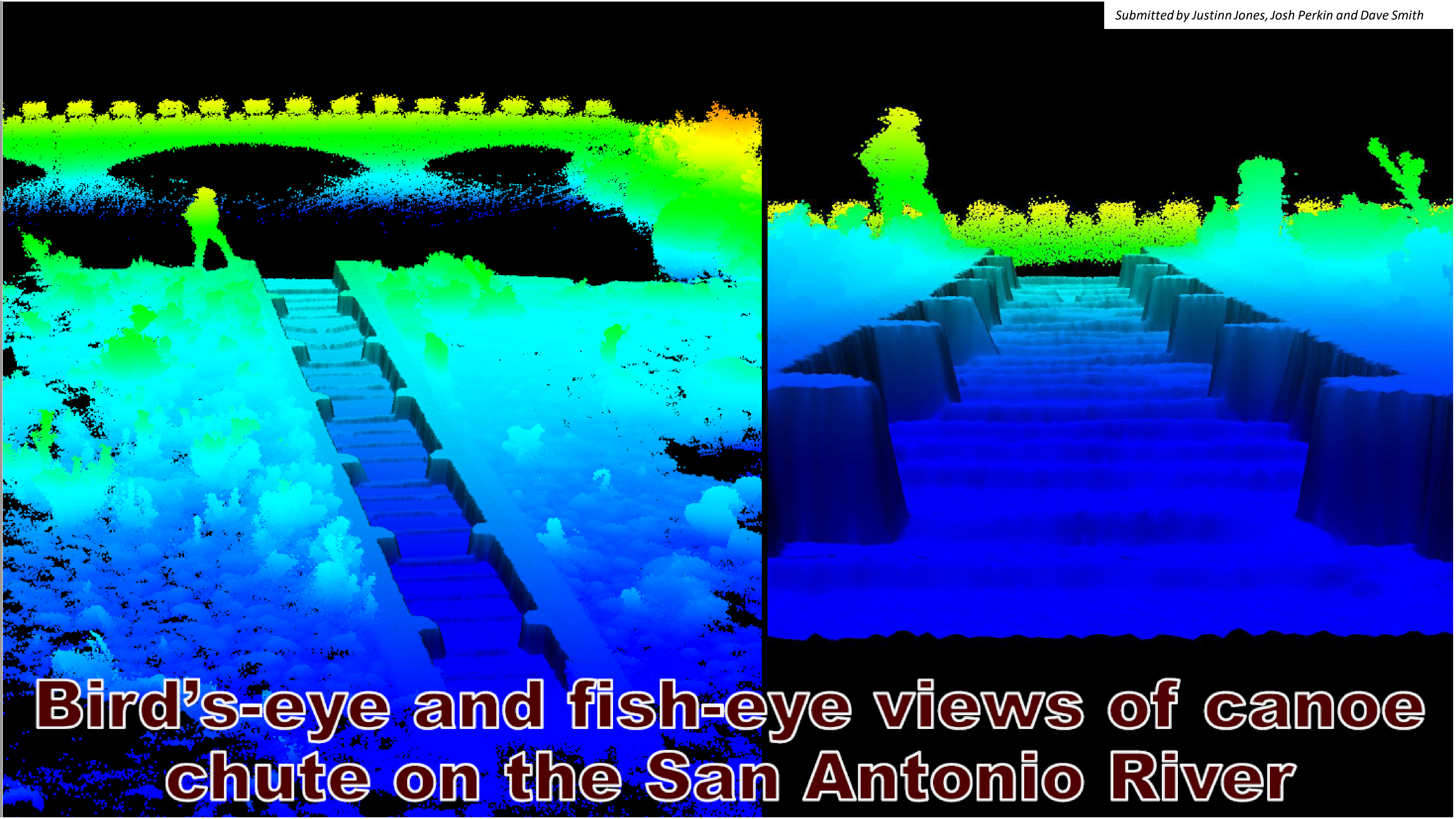
As we continue to explore these hidden depths, we gain insights into the holistic functioning of our rivers, empowering us to protect these precious natural resources for future generations.

1. Wohl, E., Hall, R., & Walters, D. (2019). Lotic Freshwater: Rivers. *Encyclopedia of the World's Biomes* 152-169.
2. Lewandowski, J., Arnon, S., Banks, E., Batelaan, O., et al. (2019). *Water* 11(11): 2230.
3. Brunke, M., & Gonser, T. (1997). *Freshwater Biology* 37: 1-3.
4. Krause, S., Hannah, D., Fleckenstein, J., Heppell, C., et al. (2011). *Ecohydrology* 4: 481-499.

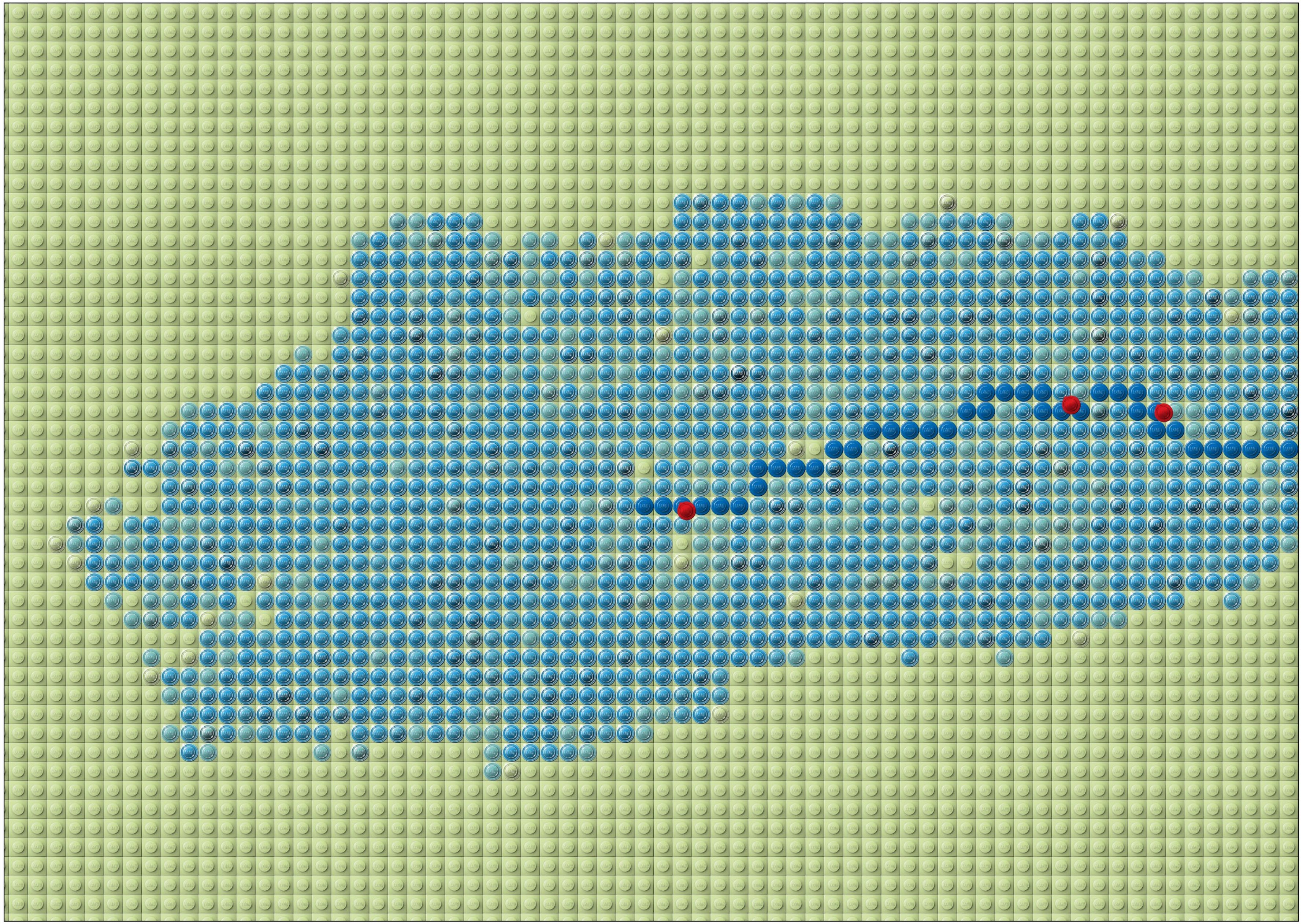
Picture Credits: Andrei Savitsky, 2019; Shakir_R , 2020; Keller & Krieger, 2003; Schmidt, Shoobs, & McMullin, 2018; Robin1605, 2008; Joel Sartore, 2024; Kim et al., 2017; Alvear et al., 2020; Alexsandr Novikov, 2020; Matthew Niemiller, 2018

Submitted by Eryl Austin-Bingamon

Submitted by Justinn Jones, Josh Perkin and Dave Smith



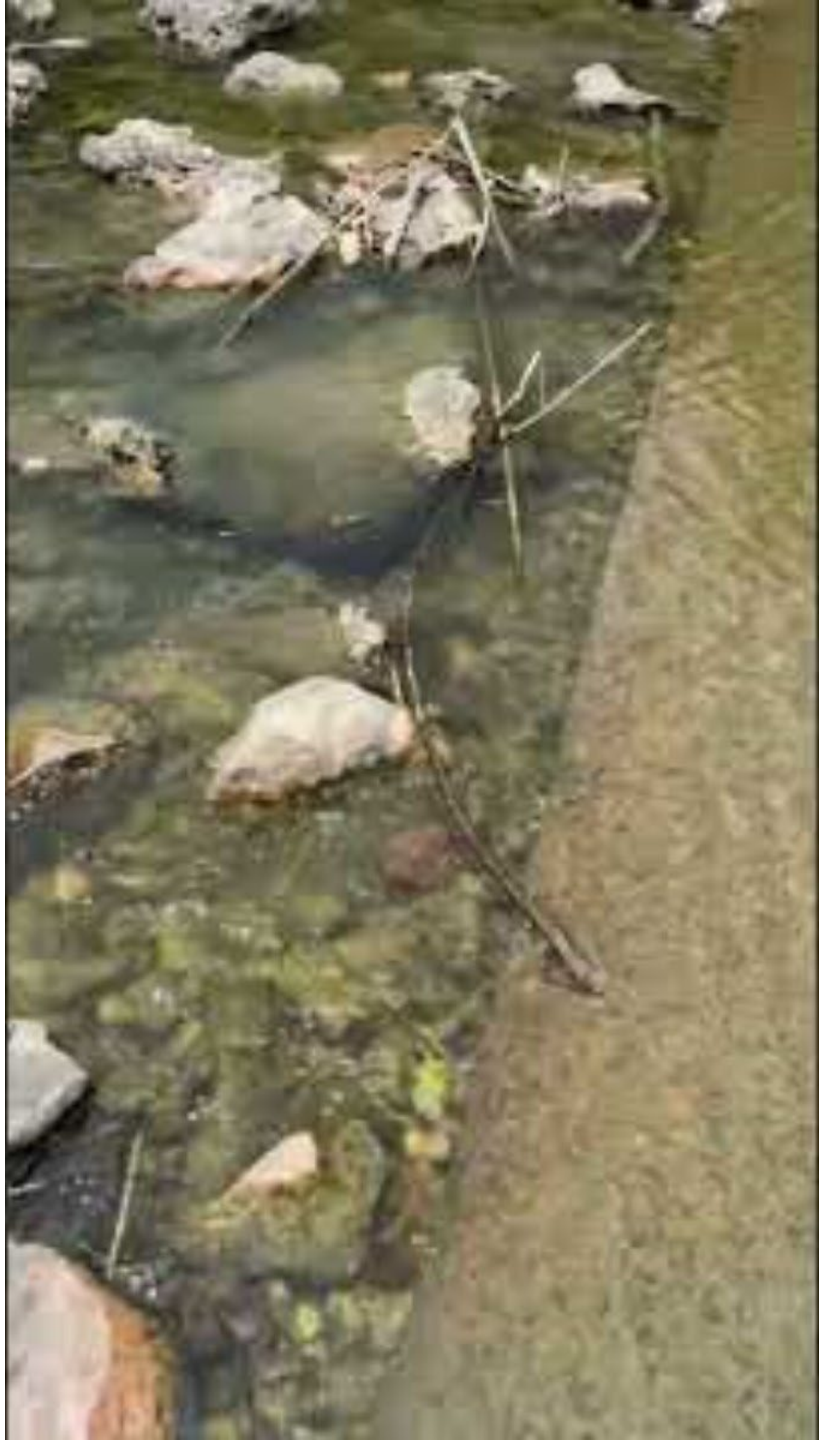
Bird's-eye and fish-eye views of canoe chute on the San Antonio River



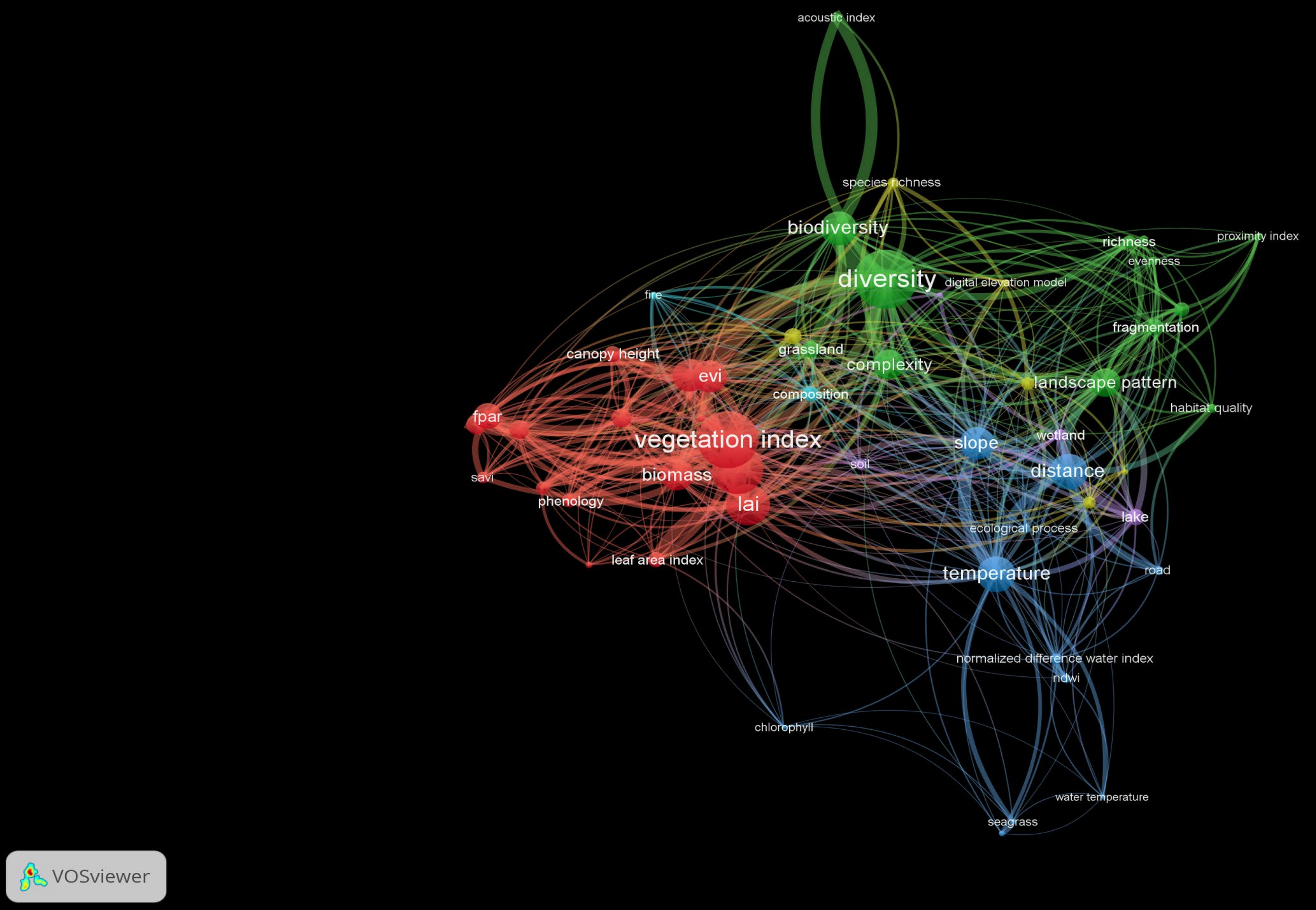
Upper San Saba River

2024

Submitted by Hannah Mattes



Submitted by Jake Barrett



Submitted by Christina Saltus

Submitted by Corey Trahan and Mark Loveland

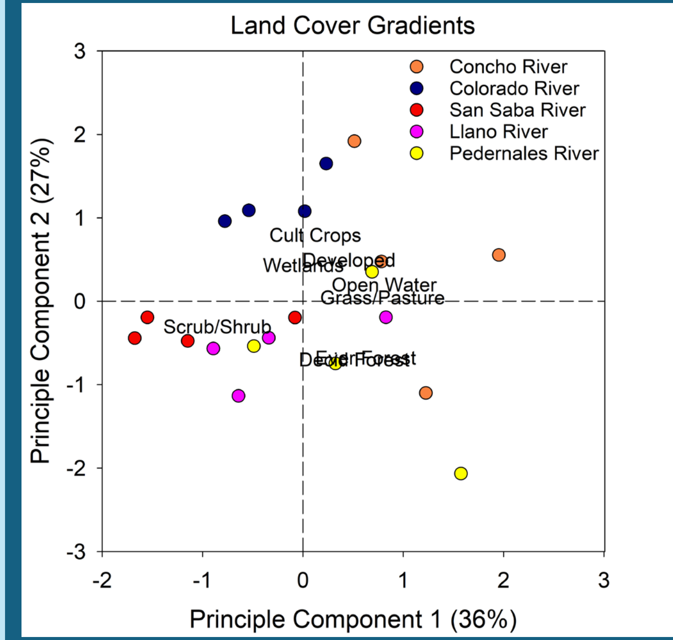
Elevated concentrations of atmospheric mercury deposit onto the landscape via wet and dry deposition

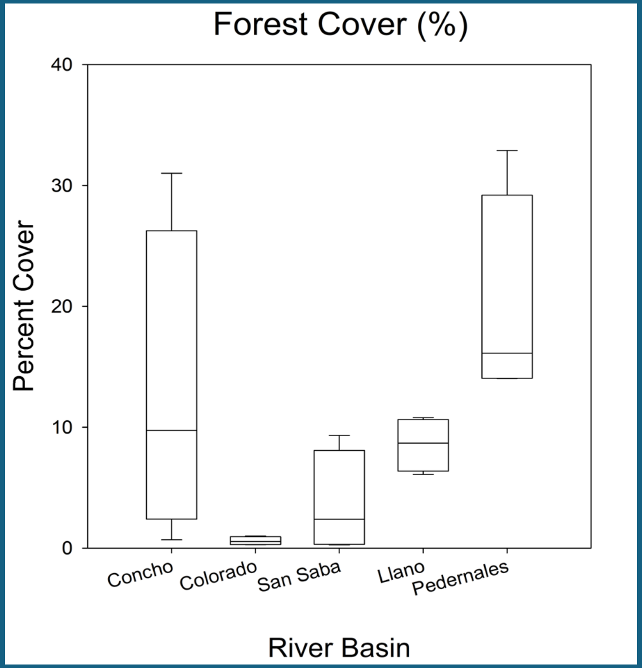
Type of surrounding landcover has shown to be a driver of mercury in rivers

Greater forest cover suggests greater bioavailability and transport

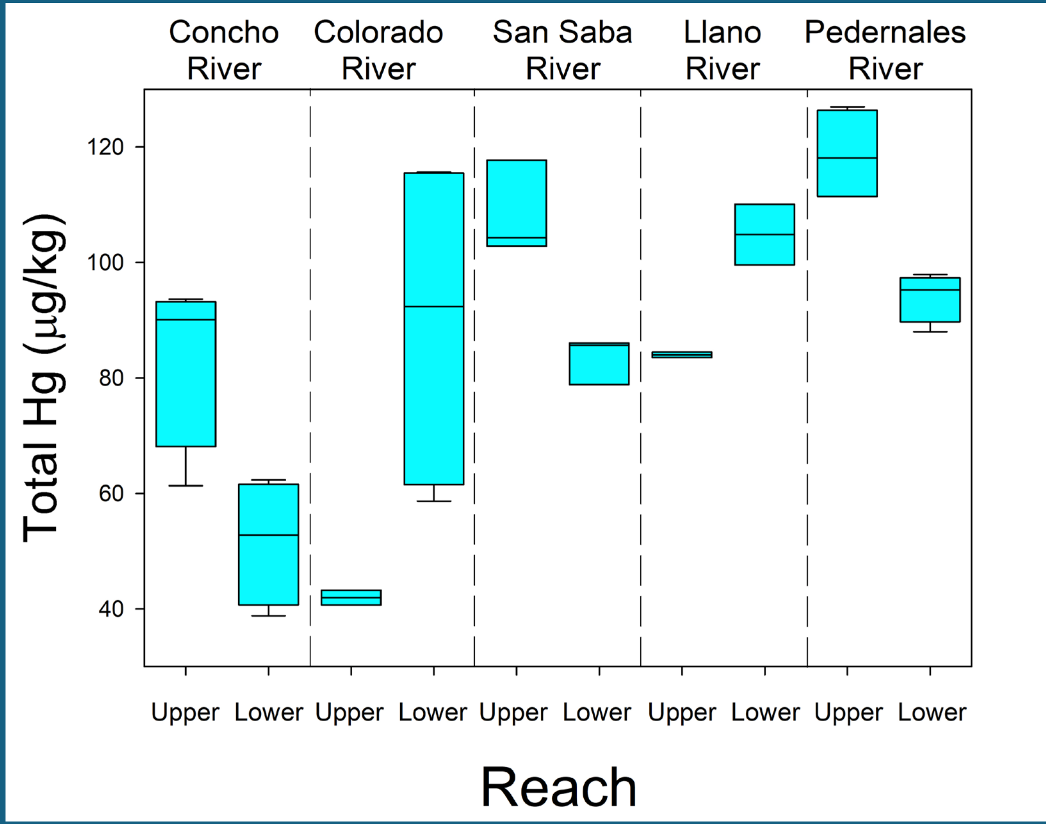
Transforms to it's toxic, organic form, MeHg, by bacterial methylation

Accumulates in benthic macroinvertebrate communities, moving through the food web





Understanding the sources and types of vegetation and the ratio between Thg:MeHg will provide better assessment of the relative strength of local- and watershed- factors

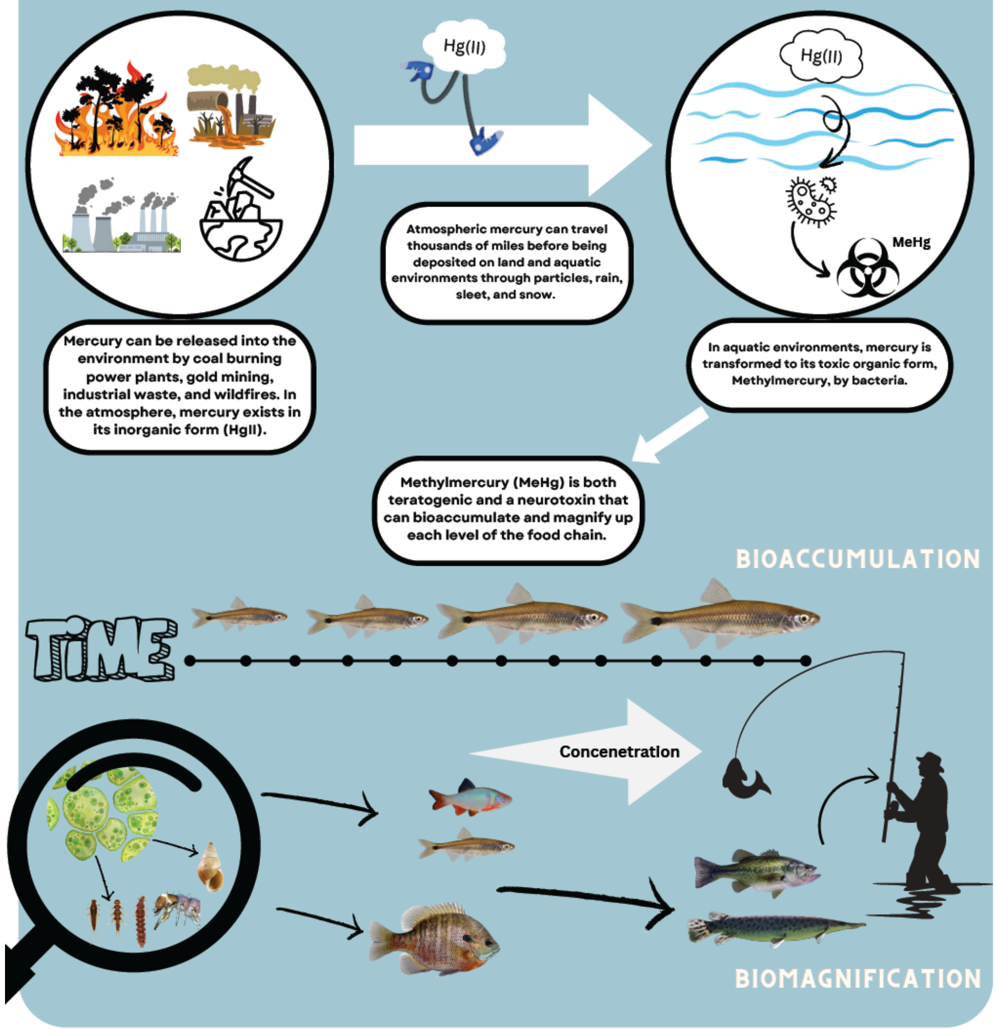


Submitted by Waverly Wadsworth

REGIONAL AND LOCAL SCALE EFFECTS ON MERCURY CONCENTRATIONS IN TEXAS RIVERS

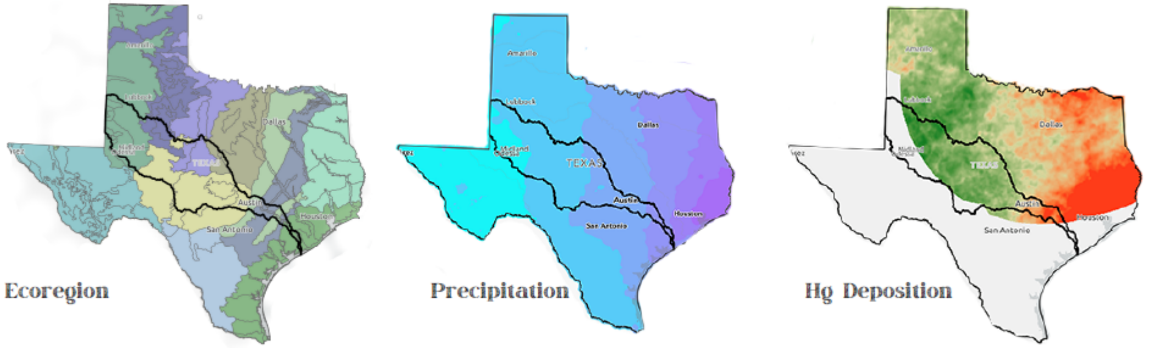
Mercury is a persistent global pollutant that can effect human and ecosystem health. Limited information exists regarding the spatial patterns of mercury concentrations in biota of Texas Rivers.

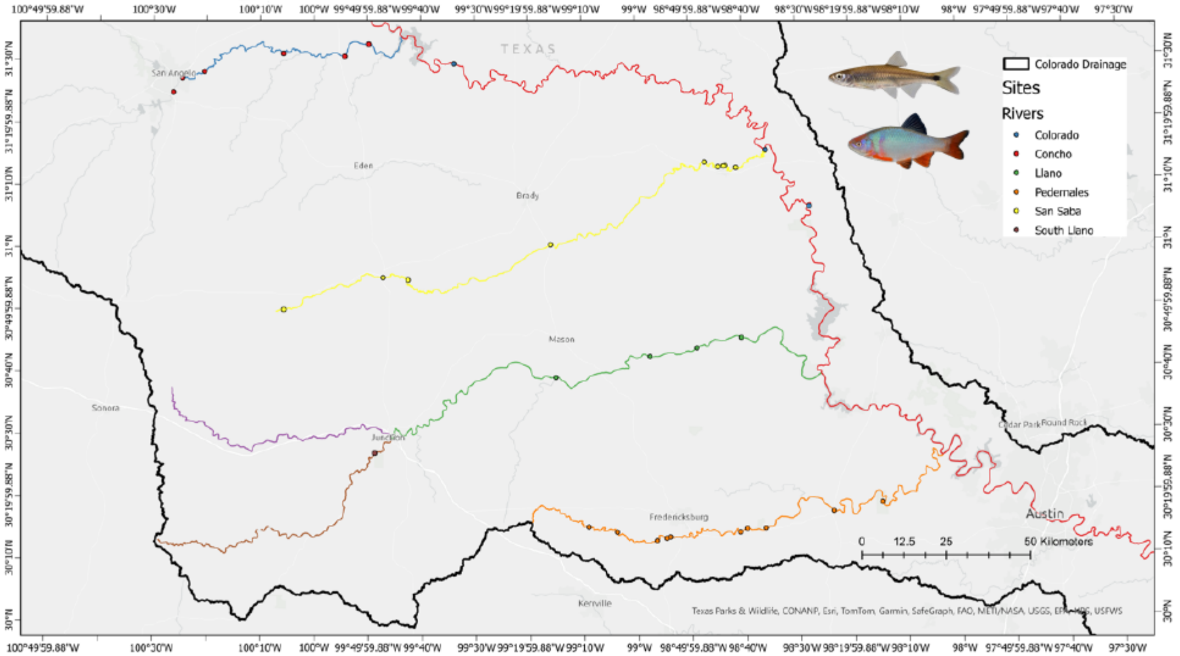
THE MERCURY CYCLE



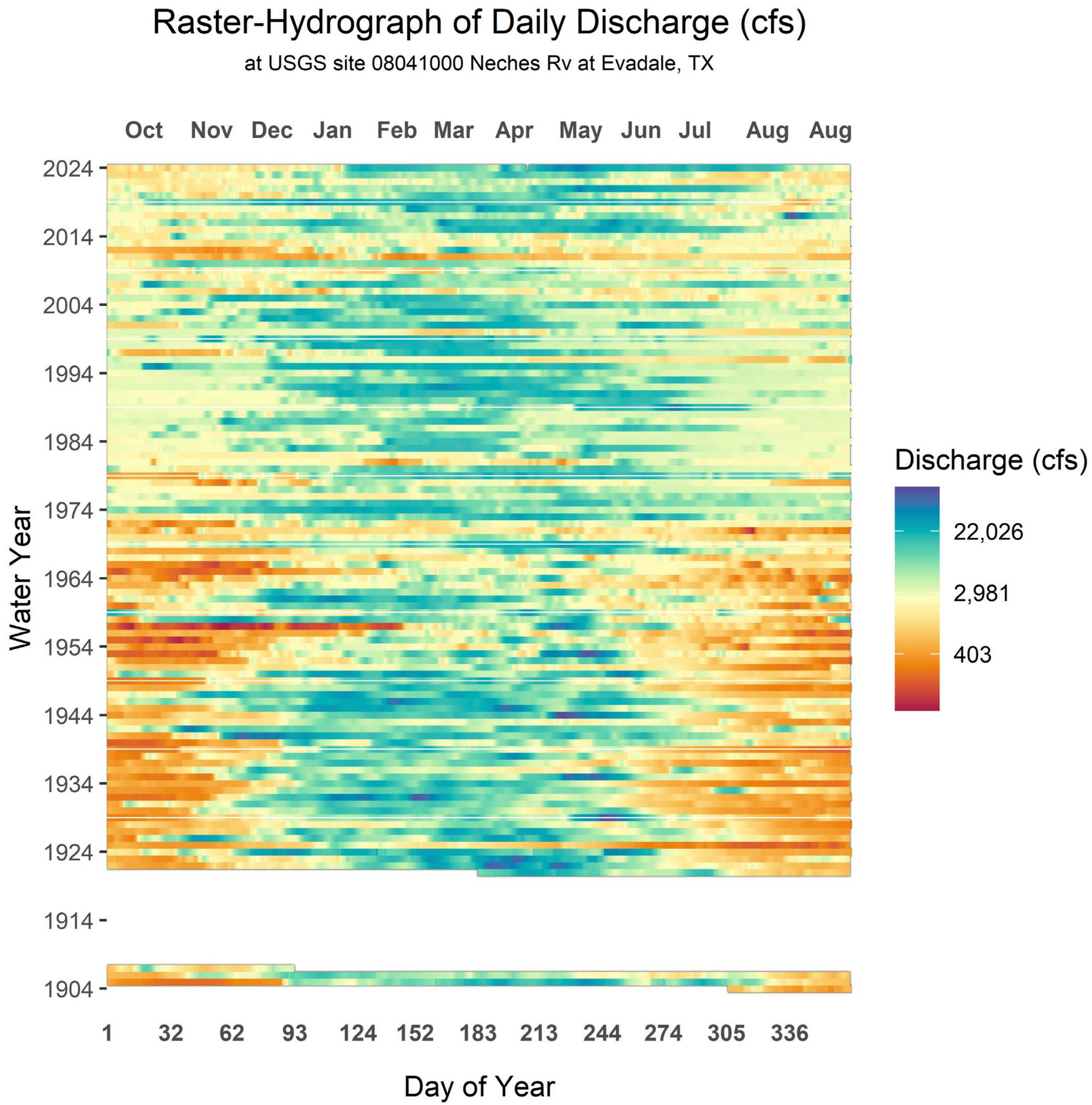
GOAL

Measure Hg concentrations in two frequently encountered fish species in rivers throughout the Colorado drainage basin and determine which factors (regional or local) contribute most of the Hg variation. Regional factors include vegetation type (ecoregion), land use/land cover, precipitation, and deposition rates. Local factors include water physicochemical properties, Hg in sediment, and dietary sources.

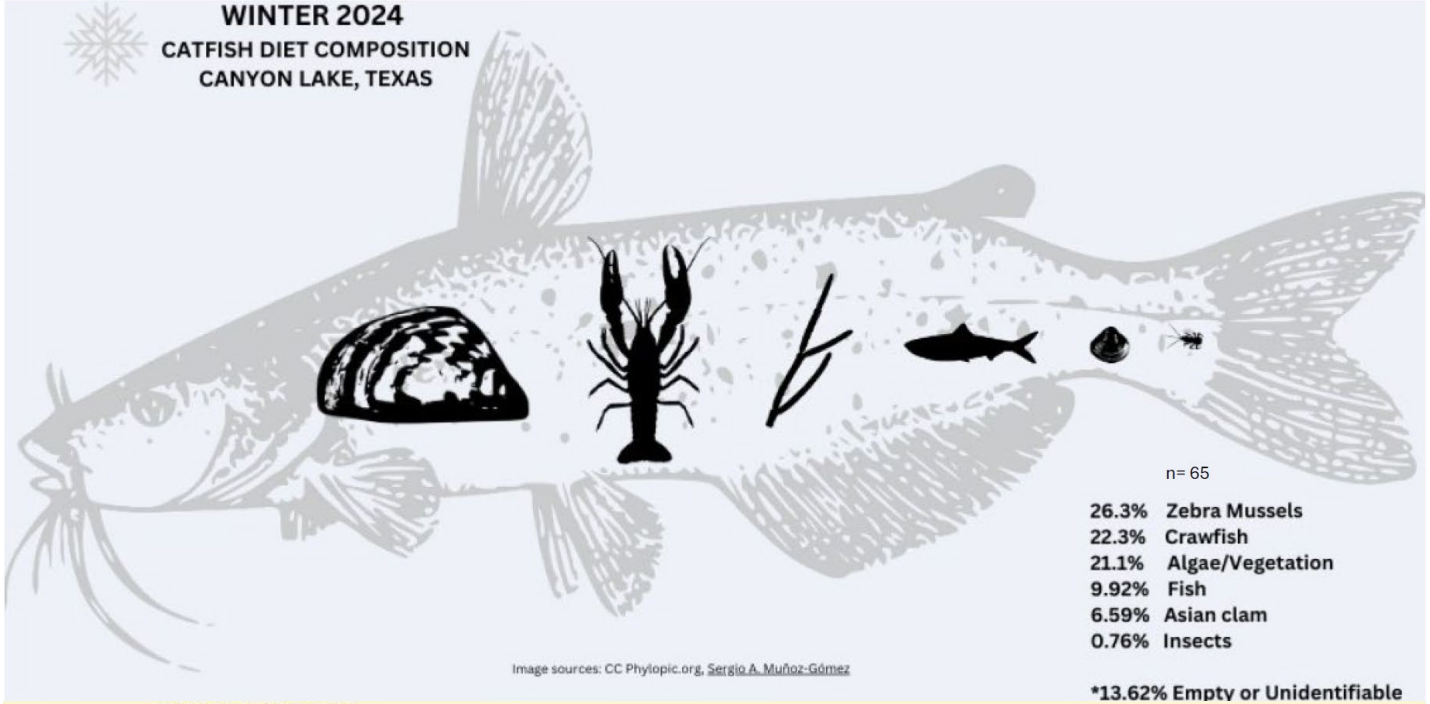


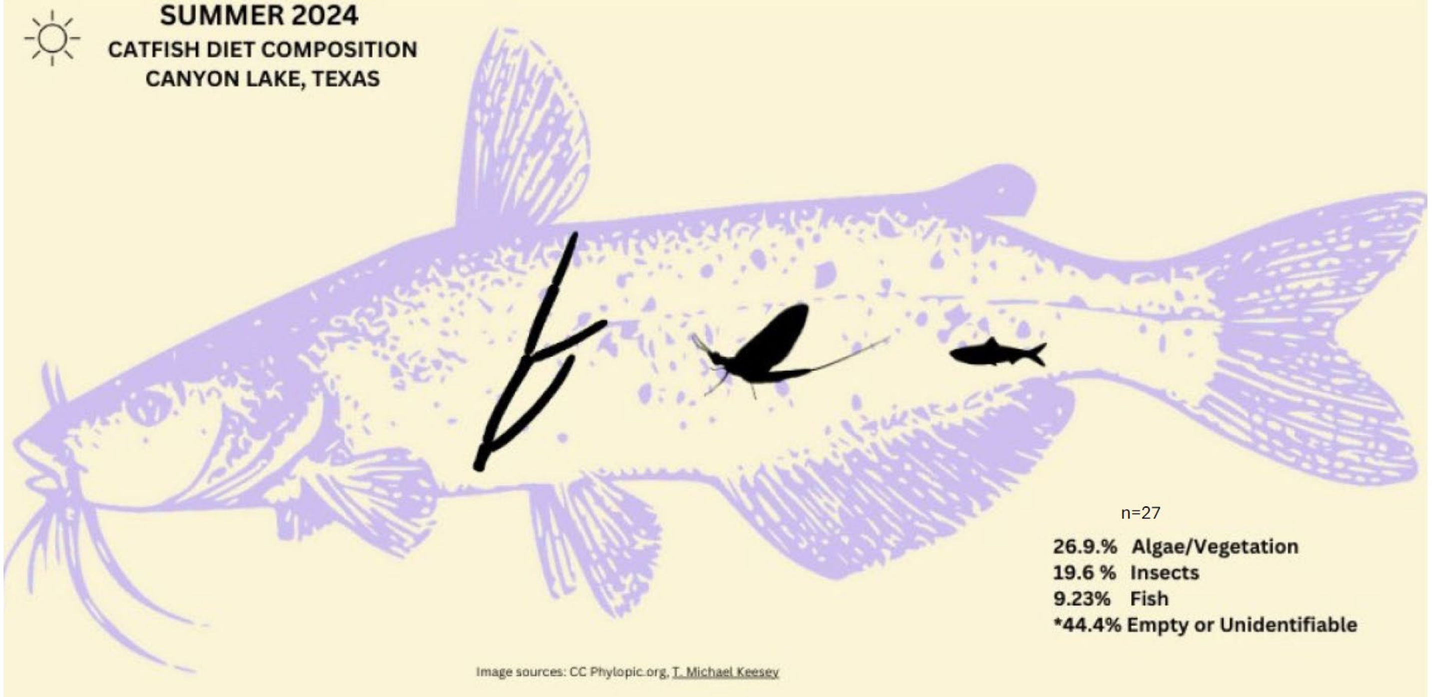


Submitted by Jasmine Rodriguez

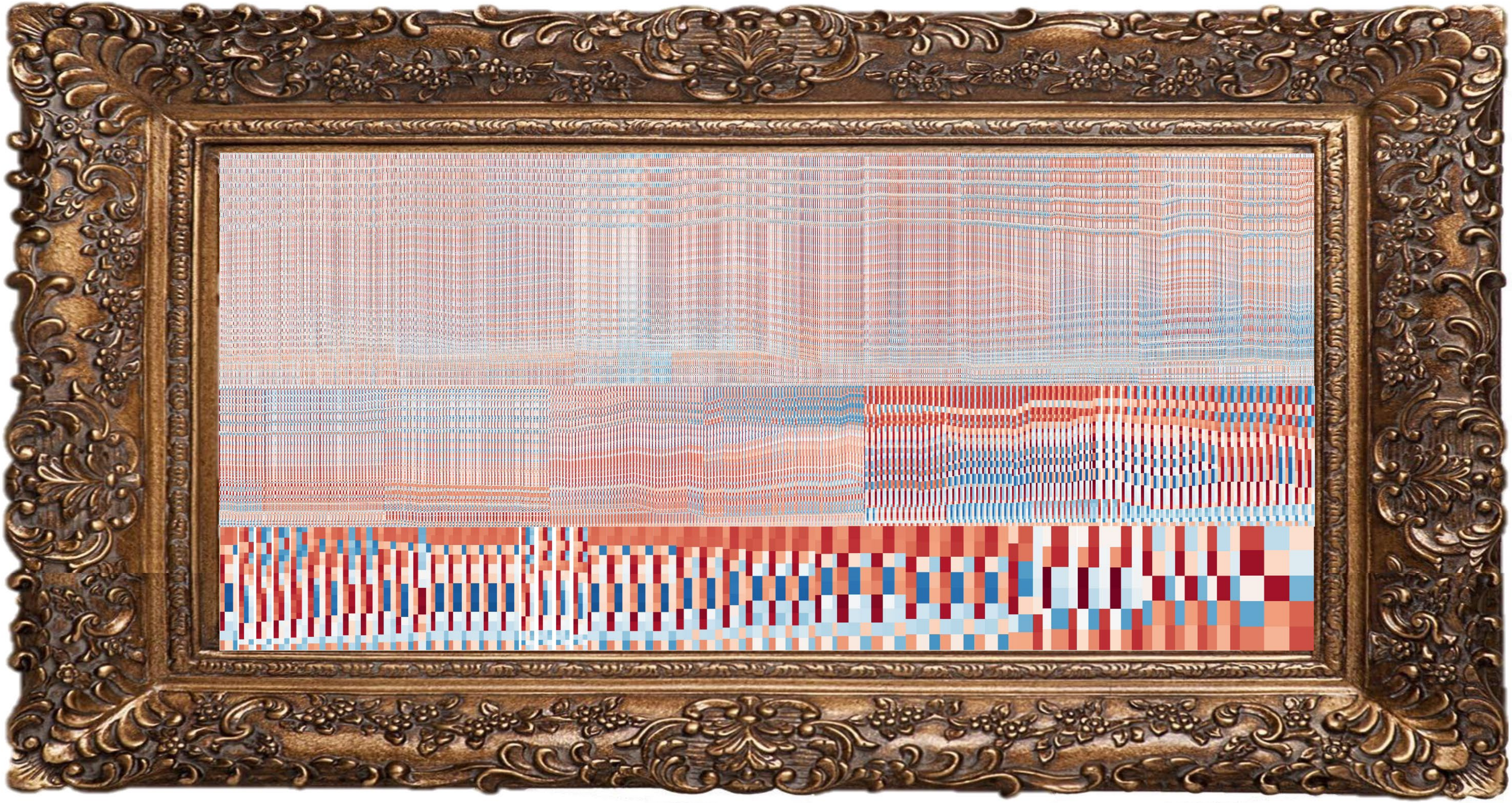


Submitted by Josh Perkin

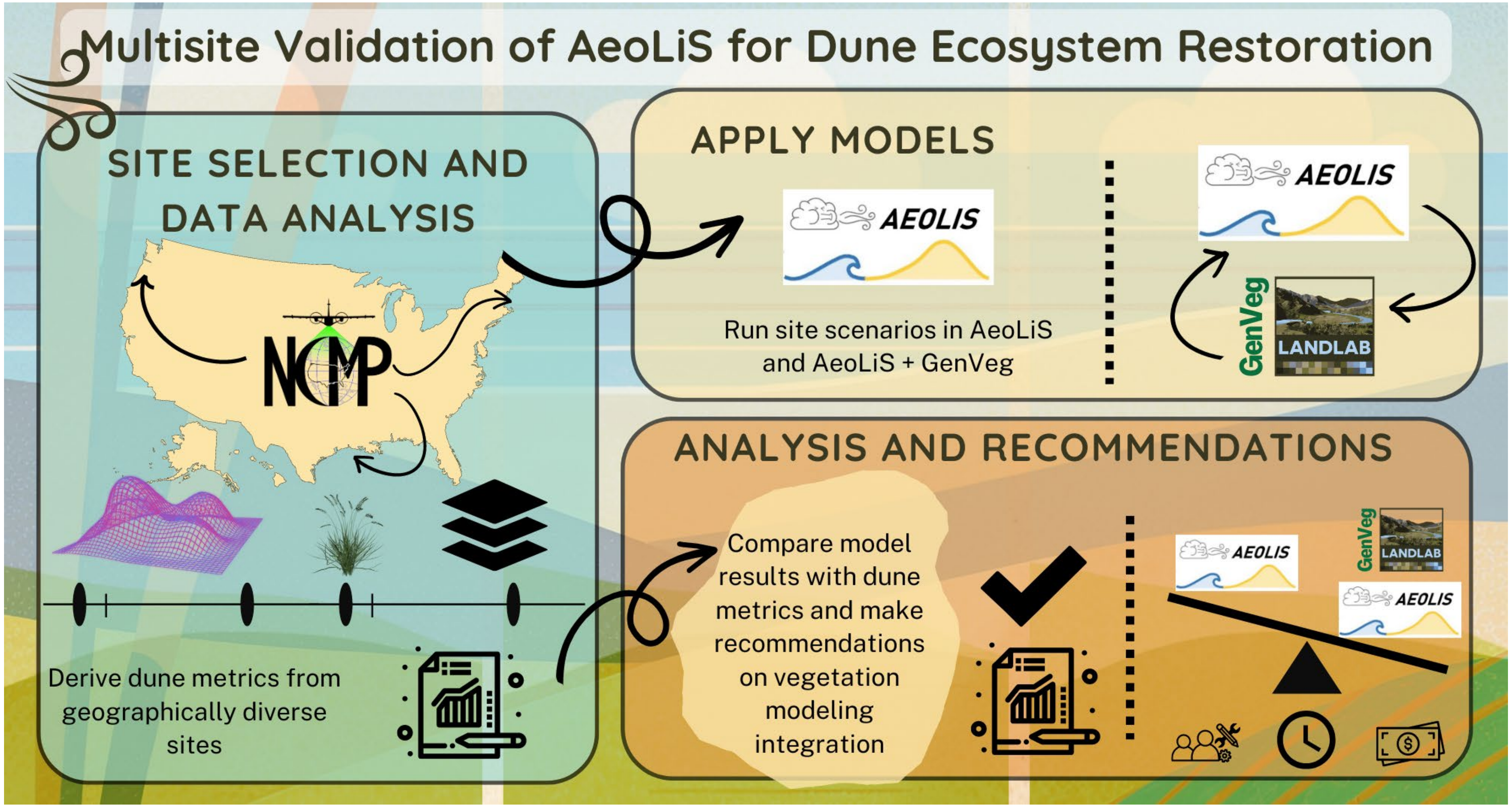




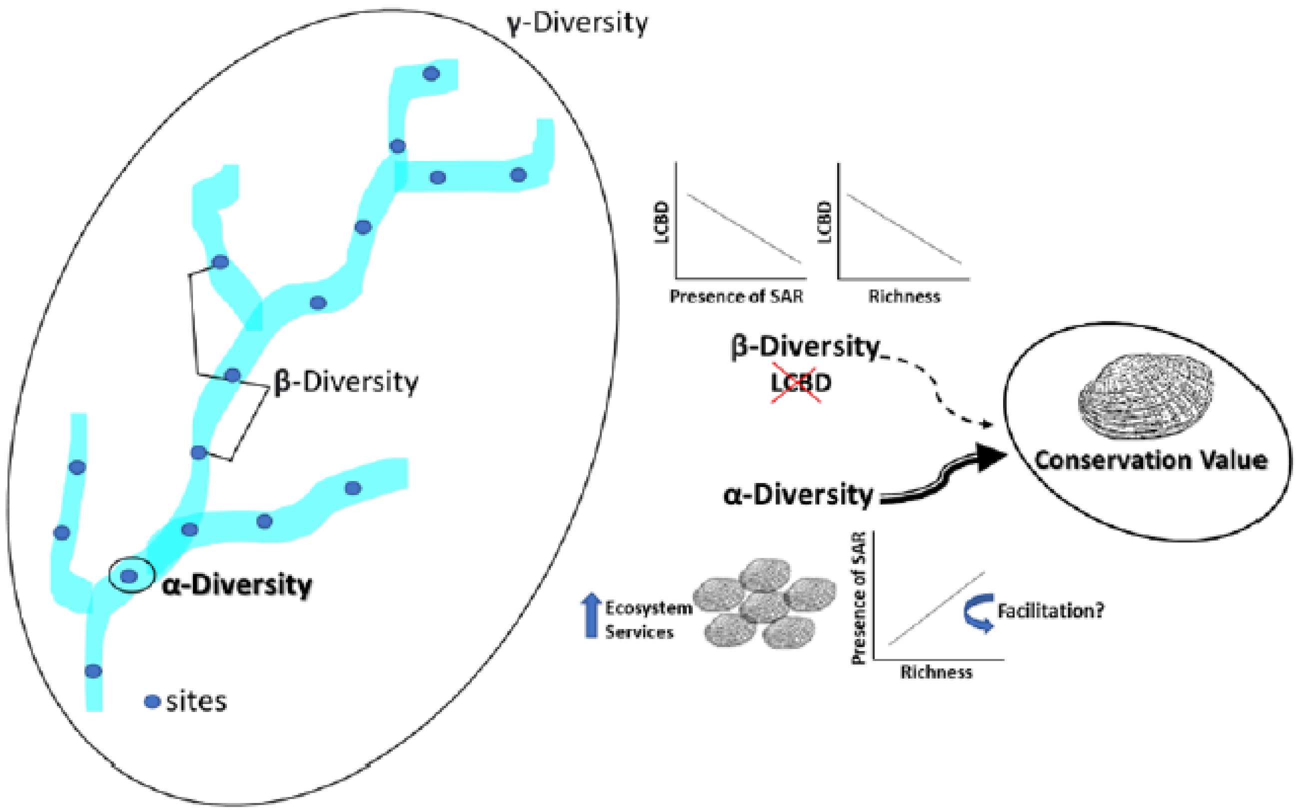
Submitted by Sarah Stannard



Submitted by Aubrey Harris

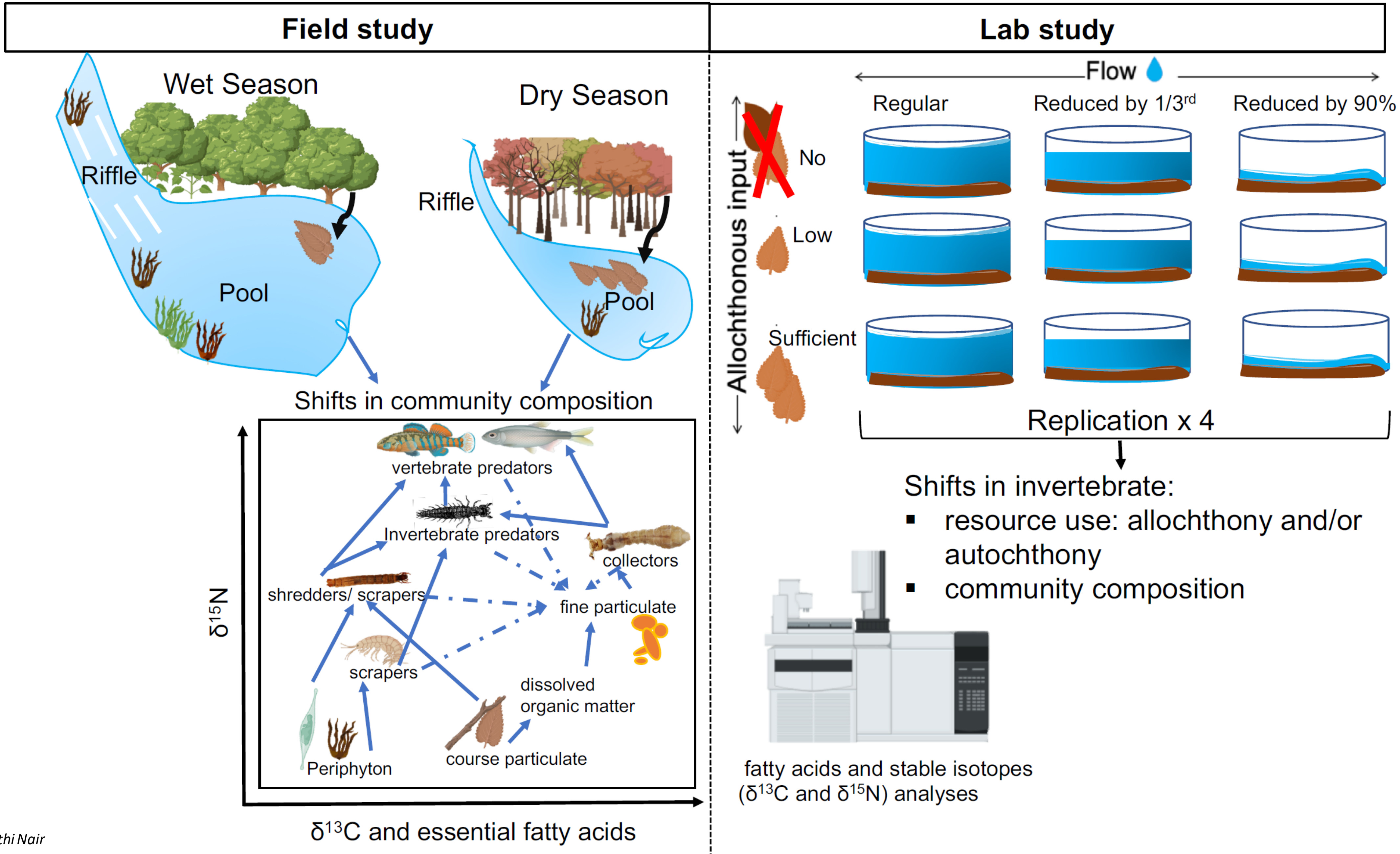


Submitted by Candice Piercy

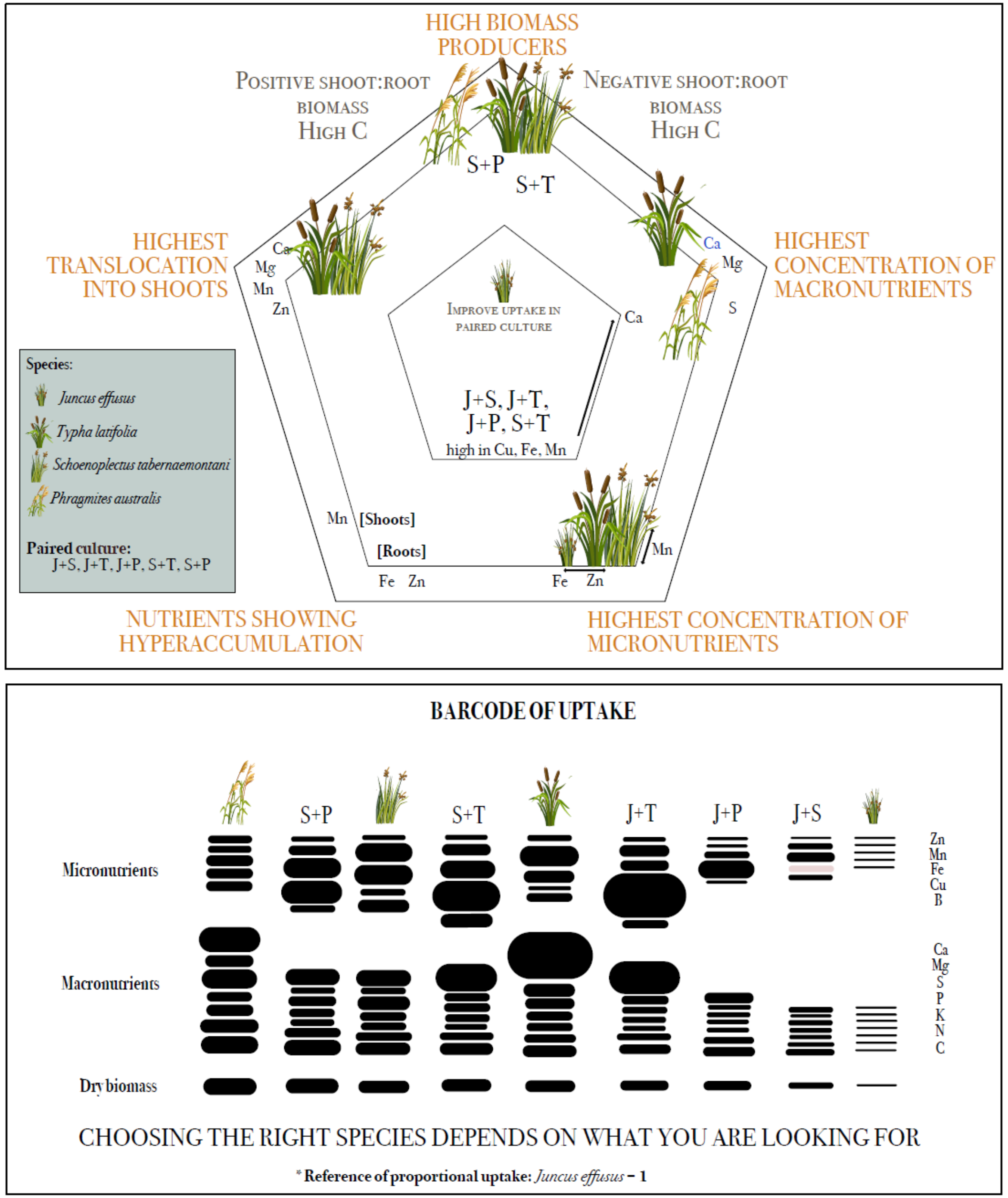


Submitted by Mariana Perez-Rocha

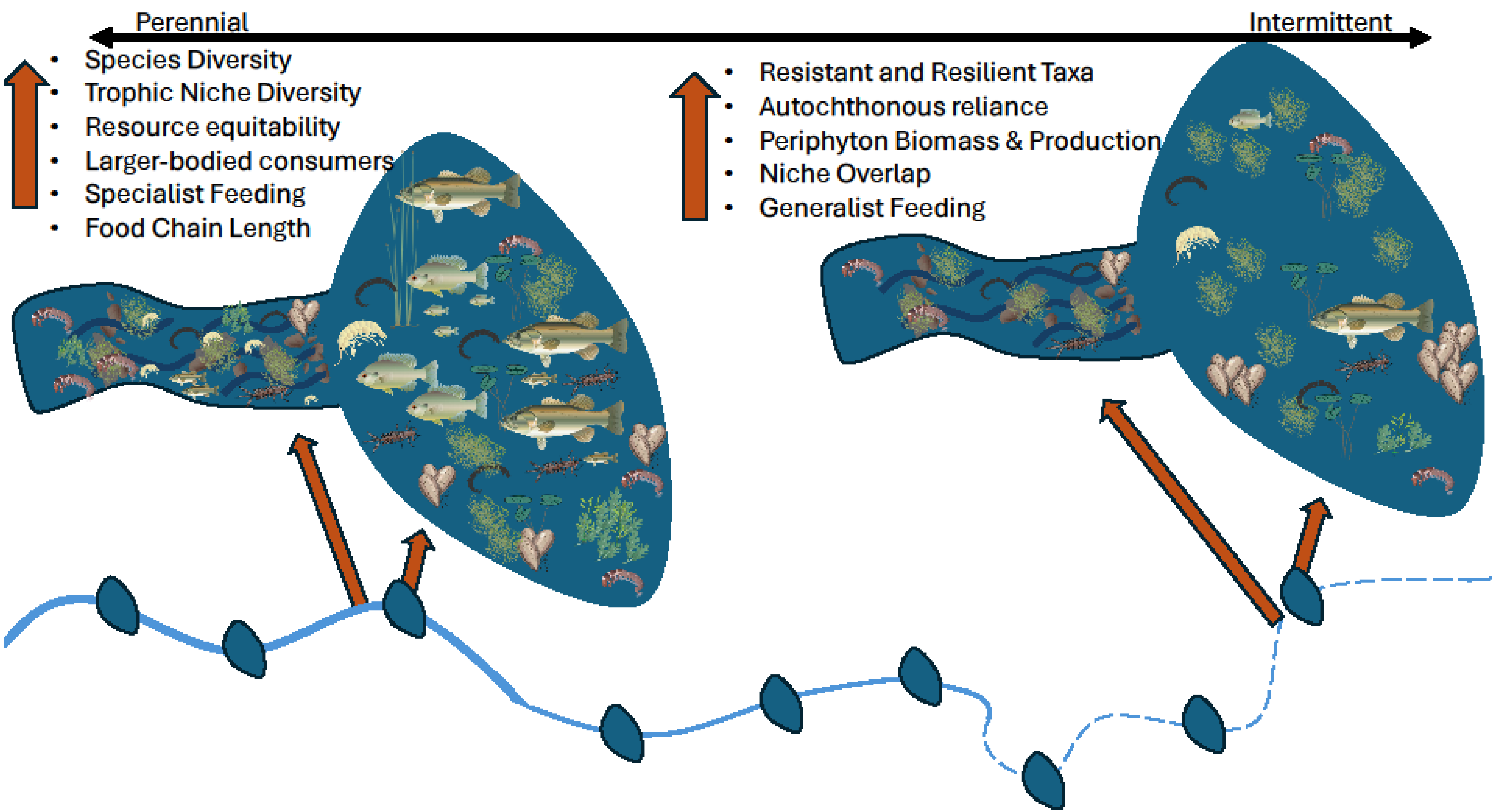
Seasonal shifts in allochthonous contribution to consumer diets in aquatic–terrestrial meta-ecosystems



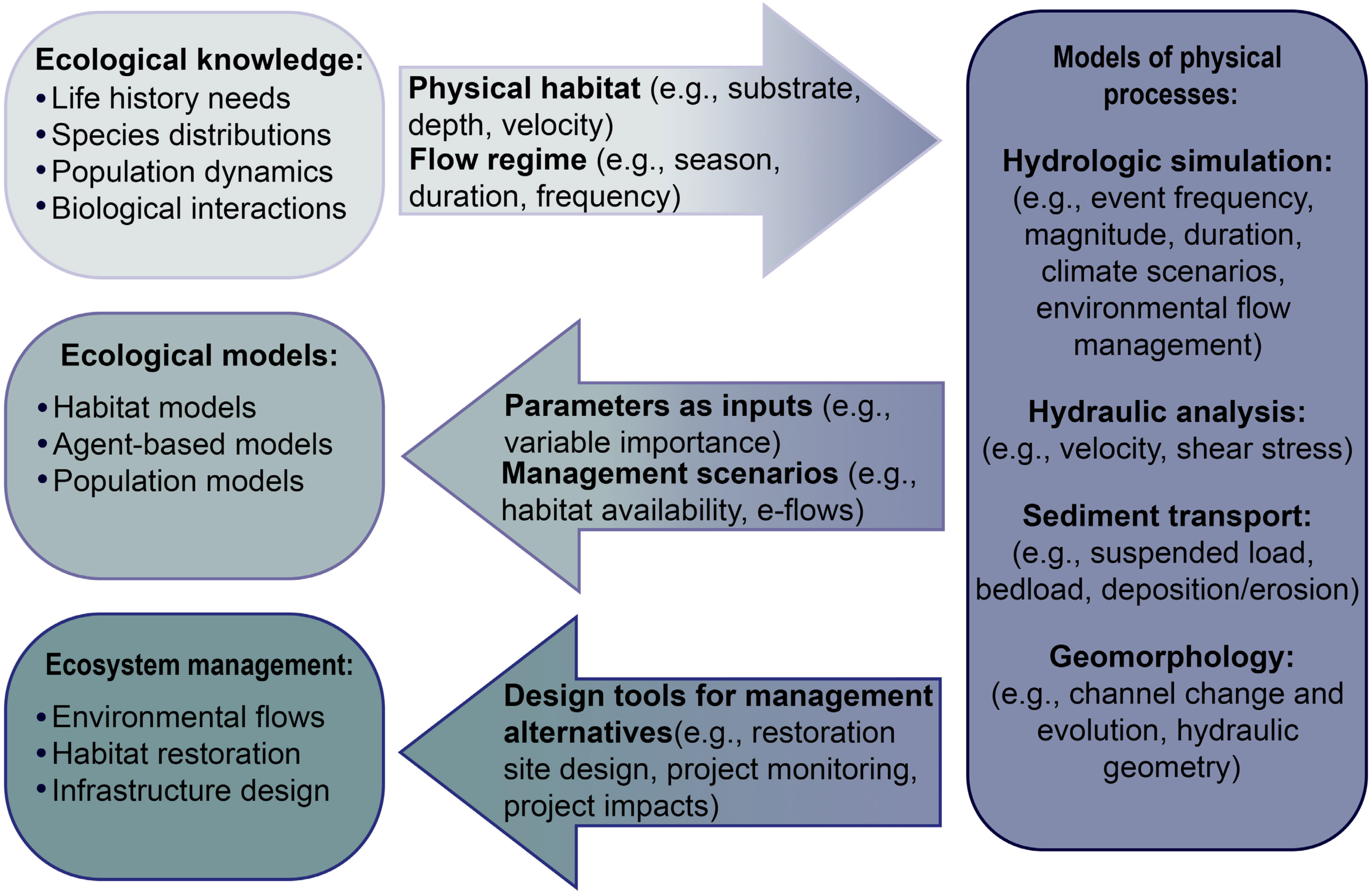
Submitted by Parvathi Nair



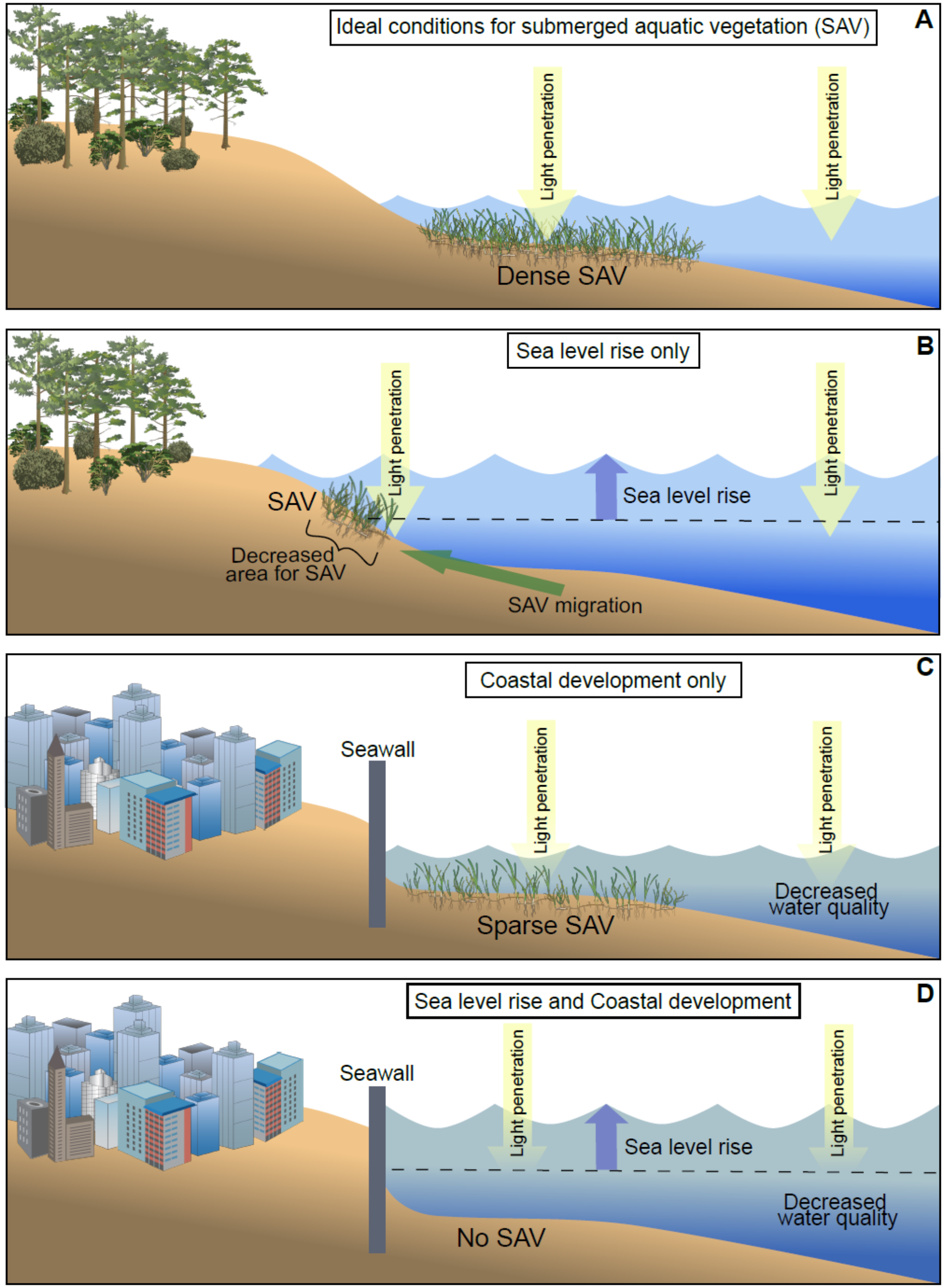
Submitted by Tatiana Lobato de Magalhaes



Submitted by Jered Davenport



Submitted by Aubrey Harris and Kiara Cushway



Submitted by Amy Yarnall, Emily Russ and Safra Altman

SAMPL: An agent-based model to evaluate spatial sampling strategies

Photo Credit Kiara Cushway

PROBLEM

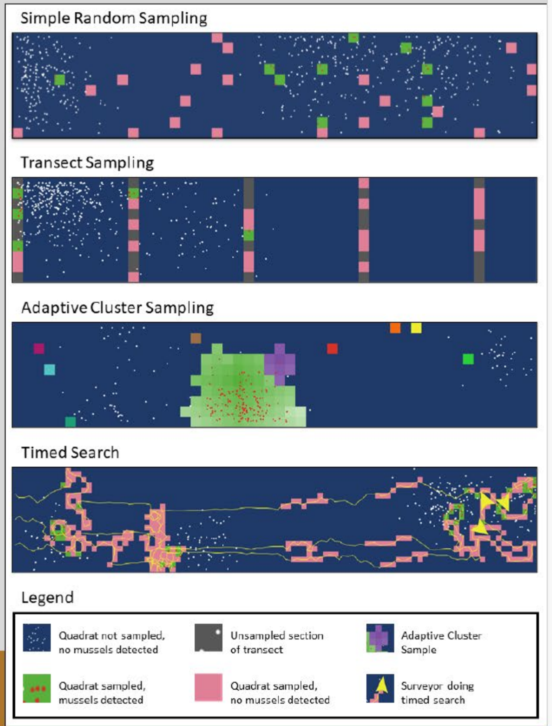
It is difficult to evaluate the accuracy of spatial sampling methods because the true characteristics (e.g., density) of populations of interest are rarely known.

WHAT WE'RE DOING

We developed a model called SAMPL to simulate four sampling techniques when the true population characteristics are known to evaluate tradeoffs between sampling accuracy and sampling effort. We used freshwater mussel sampling as a case study to develop our model.

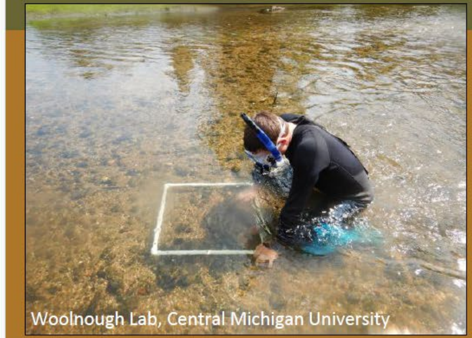
WHY IT MATTERS

Optimizing sampling efficiency and accuracy can help better inform management decisions and reduce costs.



Above: Four spatial sampling methods as seen in the graphical user interface of SAMPL.

Left: A researcher sampling for freshwater mussels in the field.



Woolnough Lab, Central Michigan University

TEAM: Iris Foxfoot (ERDC), Kiara Cushway (ERDC), Dr. Todd Swannack (ERDC/Texas State University), Dr. Astrid Schwalb (Texas State University)

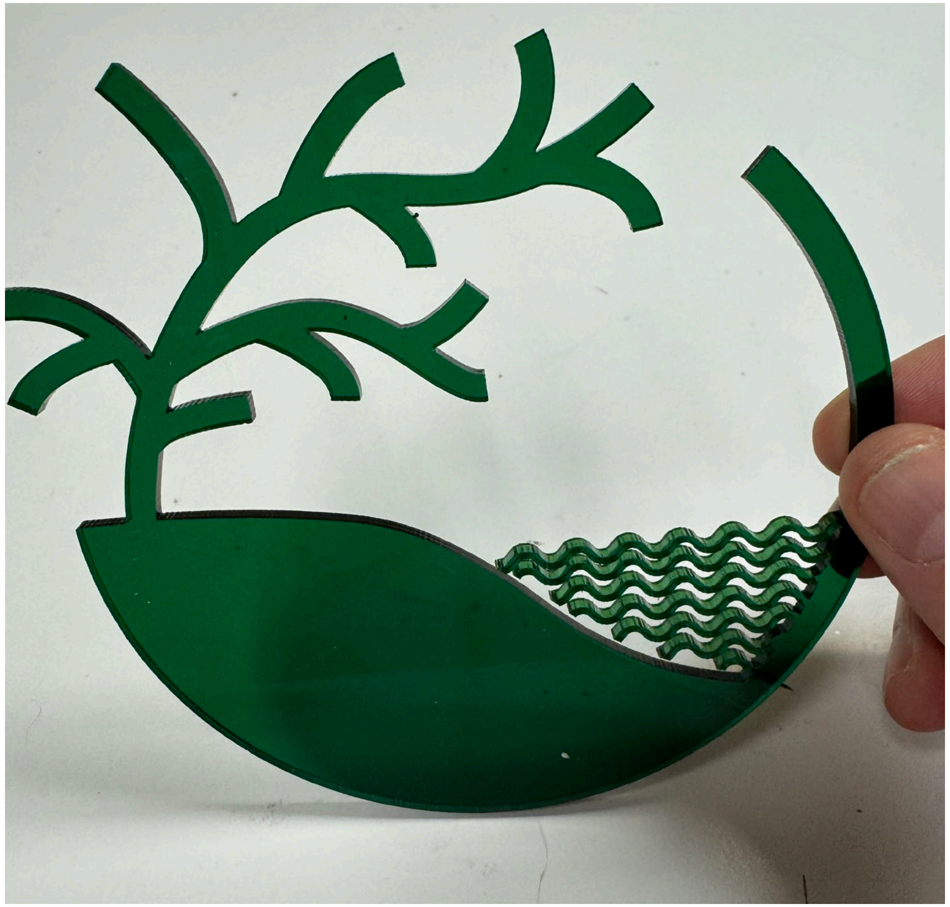
CONTACT: IRIS.R.FOXFOOT@USACE.ARMY.MIL

TEXAS STATE UNIVERSITY · ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER · ecomod

Submitted by Iris Foxfoot and Kiara Cushway

And the winners are…..

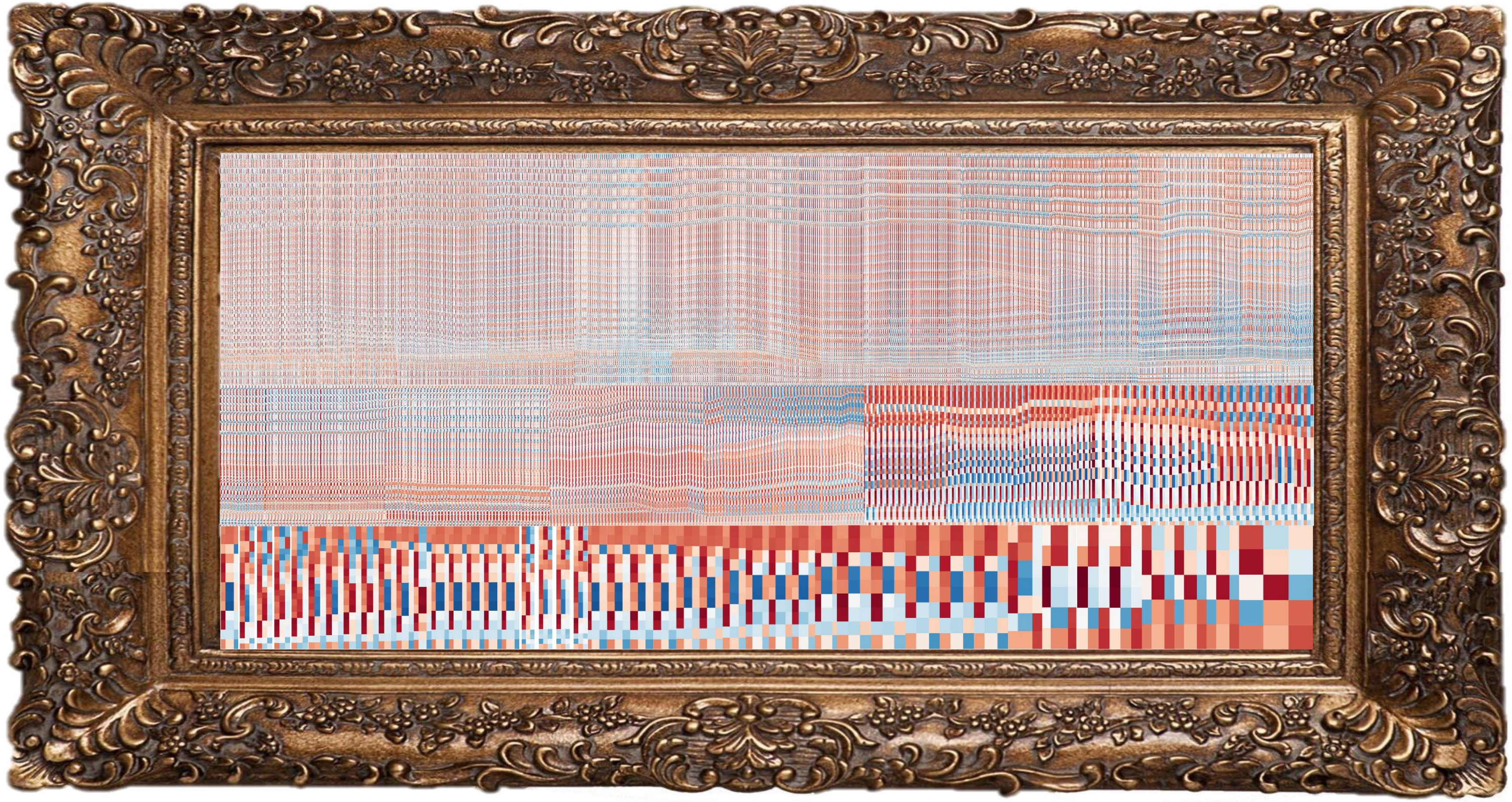
Everyone's a winner!



EcoMod ornament.

Will be delivered/mailed next week

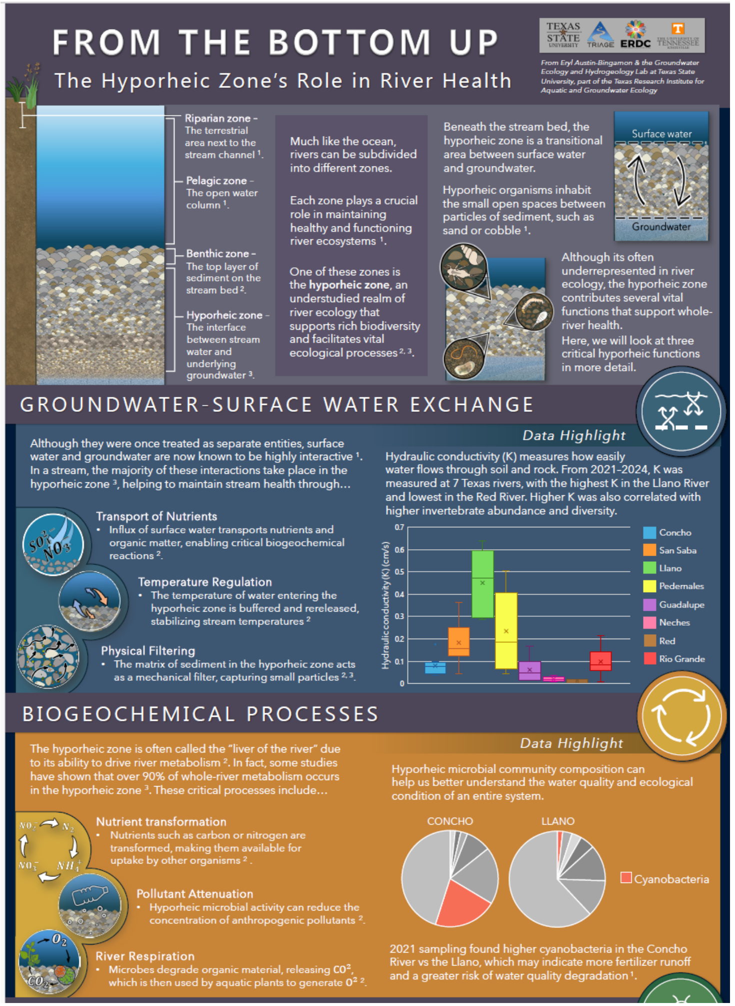
For making Todd laugh out loud



1034 iterations to parsimony

Aubrey Harris

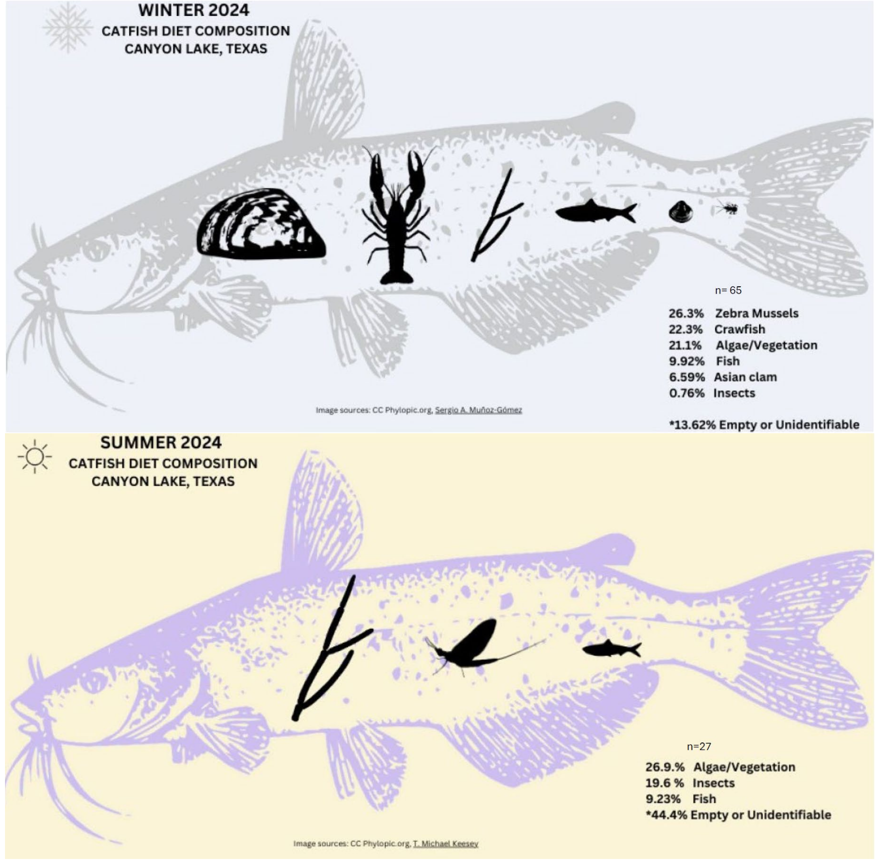
In 2nd place, for communicating the complexities of the hyporheic zone and its role in river health



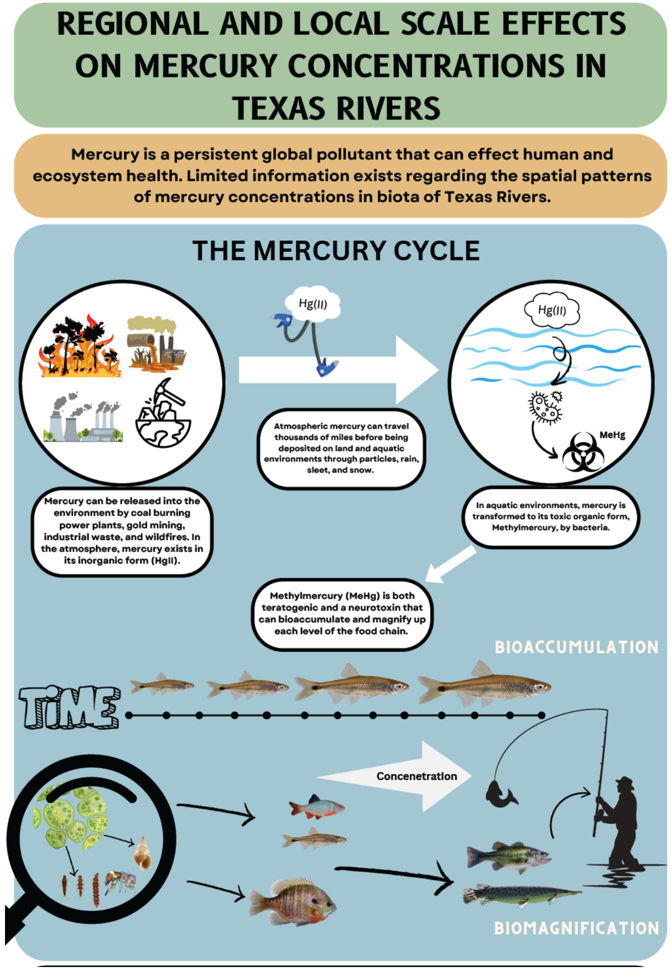
Eryl!

2 tickets to Bat City Scaregrounds!

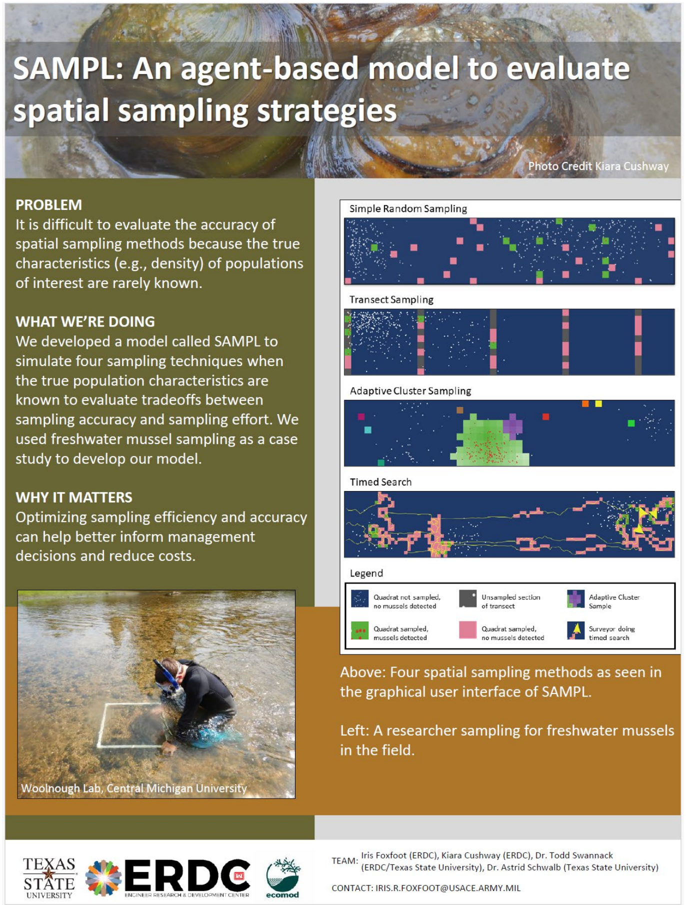
First place (3-way tie),



Sarah!



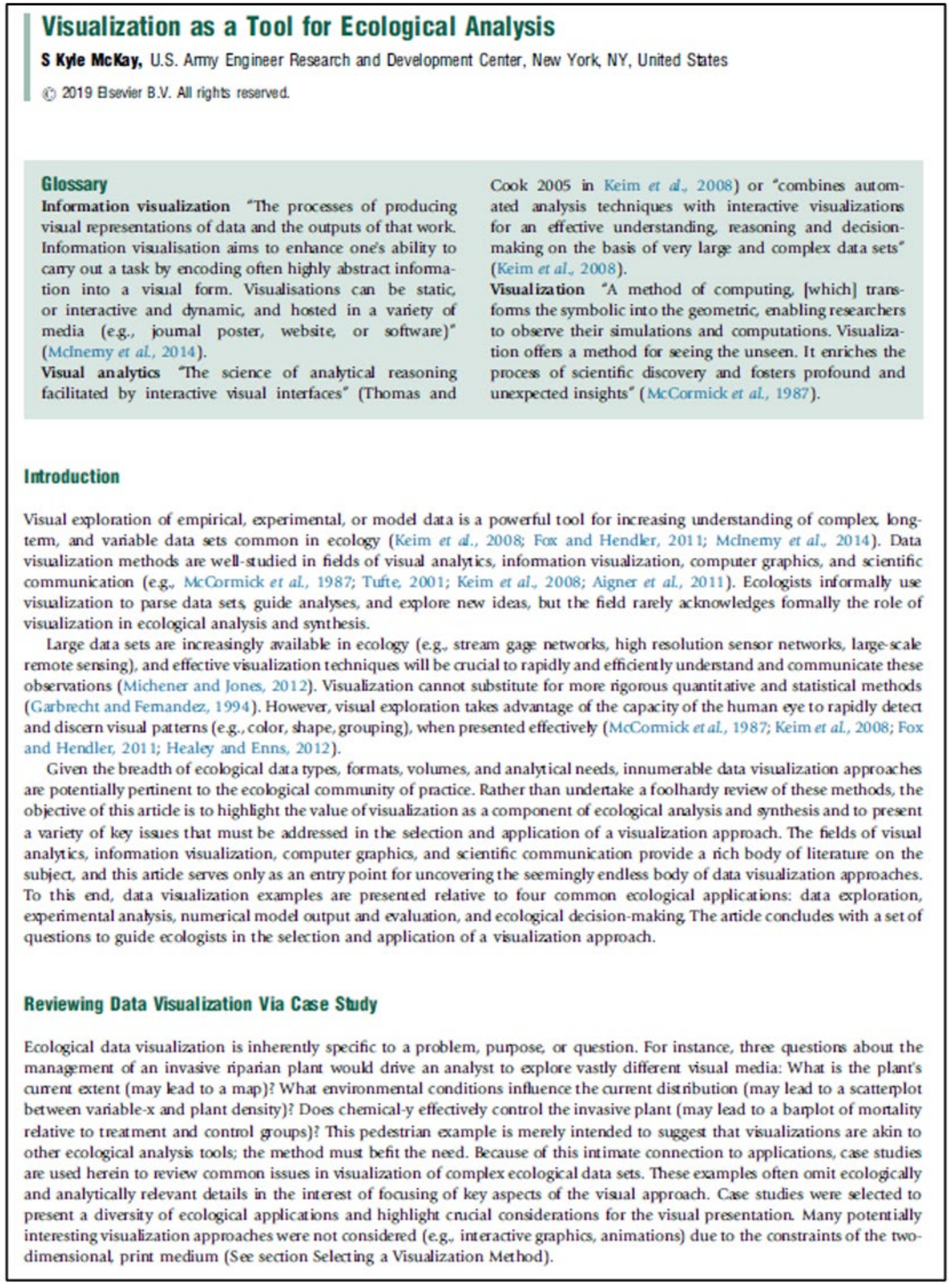
Jasmine!



Iris! Kiara!

Grand Prize

EcoMod trophy and co-authorship on the Data Visualization Entry in the *Encyclopedia of Ecology*, 3rd ed.



Visualization as a Tool for Ecological Analysis

S Kyle McKay, U.S. Army Engineer Research and Development Center, New York, NY, United States

Glossary

Information visualization "The processes of producing visual representations of data and the outputs of that work. Information visualisation aims to enhance one's ability to carry out a task by encoding often highly abstract information into a visual form. Visualisations can be static, or interactive and dynamic, and hosted in a variety of media (e.g., journal poster, website, or software)" (McInerny *et al.*, 2014).

Visual analytics "The science of analytical reasoning facilitated by interactive visual interfaces" (Thomas and Cook 2005 in Keim *et al.*, 2008) or "combines automated analysis techniques with interactive visualizations for an effective understanding, reasoning and decision-making on the basis of very large and complex data sets" (Keim *et al.*, 2008).

Visualization "A method of computing, [which] transforms the symbolic into the geometric, enabling researchers to observe their simulations and computations. Visualization offers a method for seeing the unseen. It enriches the process of scientific discovery and fosters profound and unexpected insights" (McCormick *et al.*, 1987).

Introduction

Visual exploration of empirical, experimental, or model data is a powerful tool for increasing understanding of complex, long-term, and variable data sets common in ecology (Keim *et al.*, 2008; Fox and Hendler, 2011; McInerny *et al.*, 2014). Data visualization methods are well-studied in fields of visual analytics, information visualization, computer graphics, and scientific communication (e.g., McCormick *et al.*, 1987; Tufte, 2001; Keim *et al.*, 2008; Aigner *et al.*, 2011). Ecologists informally use visualization to parse data sets, guide analyses, and explore new ideas, but the field rarely acknowledges formally the role of visualization in ecological analysis and synthesis.

Large data sets are increasingly available in ecology (e.g., stream gage networks, high resolution sensor networks, large-scale remote sensing), and effective visualization techniques will be crucial to rapidly and efficiently understand and communicate these observations (Michener and Jones, 2012). Visualization cannot substitute for more rigorous quantitative and statistical methods (Garbrecht and Fernandez, 1994). However, visual exploration takes advantage of the capacity of the human eye to rapidly detect and discern visual patterns (e.g., color, shape, grouping), when presented effectively (McCormick *et al.*, 1987; Keim *et al.*, 2008; Fox and Hendler, 2011; Healey and Enns, 2012).

Given the breadth of ecological data types, formats, volumes, and analytical needs, innumerable data visualization approaches are potentially pertinent to the ecological community of practice. Rather than undertake a foolhardy review of these methods, the objective of this article is to highlight the value of visualization as a component of ecological analysis and synthesis and to present a variety of key issues that must be addressed in the selection and application of a visualization approach. The fields of visual analytics, information visualization, computer graphics, and scientific communication provide a rich body of literature on the subject, and this article serves only as an entry point for uncovering the seemingly endless body of data visualization approaches. To this end, data visualization examples are presented relative to four common ecological applications: data exploration, experimental analysis, numerical model output and evaluation, and ecological decision-making. The article concludes with a set of questions to guide ecologists in the selection and application of a visualization approach.

Reviewing Data Visualization Via Case Study

Ecological data visualization is inherently specific to a problem, purpose, or question. For instance, three questions about the management of an invasive riparian plant would drive an analyst to explore vastly different visual media: What is the plant's current extent (may lead to a map)? What environmental conditions influence the current distribution (may lead to a scatterplot between variable-x and plant density)? Does chemical-y effectively control the invasive plant (may lead to a barplot of mortality relative to treatment and control groups)? This pedestrian example is merely intended to suggest that visualizations are akin to other ecological analysis tools; the method must befit the need. Because of this intimate connection to applications, case studies are used herein to review common issues in visualization of complex ecological data sets. These examples often omit ecologically and analytically relevant details in the interest of focusing of key aspects of the visual approach. Case studies were selected to present a diversity of ecological applications and highlight crucial considerations for the visual presentation. Many potentially interesting visualization approaches were not considered (e.g., interactive graphics, animations) due to the constraints of the two-dimensional, print medium (See section Selecting a Visualization Method).