Project F update:
Lead decomposition, bat monitoring, aquatic insects

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Ted Kennedy[1], Eric Scholl[1], Anya Metcalfe[1], Jeff Muehlbauer[2], Charles Yackulic[1], Morgan Ford[1], Cheyenne Szydlo[1]

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Outline

- **Leaf decomposition study (9 slides)**
- **Bat monitoring update (3 slides)**
- **Light trap update (3 slides)**

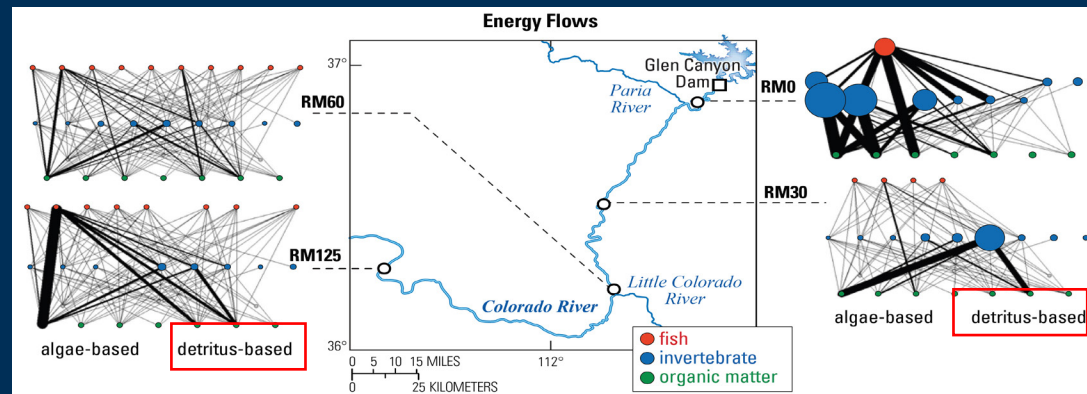Leaves decomposing in a stream

Community science bat monitoring

Community science insect monitoring

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Decomposition Study Background:

- Decomposition of organic matter represents a fundamental ecosystem process in rivers

- Changes in decomposition alter how energy and nutrients move through aquatic and riparian food webs

Food webs of the Colorado River circa 2006 2009. From Kennedy and others, 2014 USGS Fact Sheet

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Decomposition Study Background:

Drivers of decomposition are rapidly changing in the Colorado River

Water temperatures ~10°C warmer by end of experiment

2022
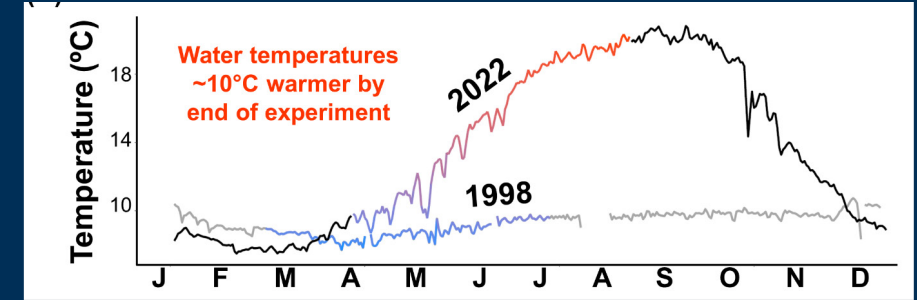
1998
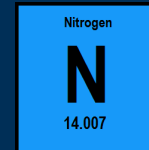
From Scholl and others, in press, *Ecosphere*
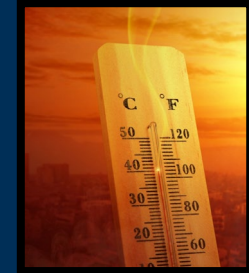
Biological invasion

Biocontrol

Water nutrients
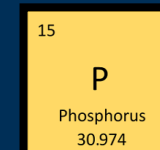
Temperature

Objective: Compare the breakdown of cottonwood, willow, and saltcedar to a 1998 experiment (Pomeroy et al. 2000) that was conducted in context of:

-cooler temperatures

-lower mudsnail density

-saltcedar litter not affect by biocontrol beetles

-higher phosphorus concentrations

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Water temperature
1998: cool
2022: warm

Estimates of marginal impact derived from literature

35% increase

Leaf chemistry (% nitrogen)
1998: low
2022: high

122% increase (saltcedar only)

Mudsnails
1998: low
2022: high

?% increase

Water phosphorus
1998: high
2022: low

67% decrease

Prediction: Saltcedar decomposition will show strongest response owing to warming and higher leaf nutrient content associated with herbivory

Insect biological control accelerates leaf litter decomposition and alters short-term nutrient dynamics in a *Tamarix*-invaded riparian ecosystem

Shauna M. Uselman, Keirith A. Snyder and Robert R. Blank

S. M. Uselman (shauna.uselman@ars.usda.gov), K. A. Snyder and R. R. Blank, USDA-Agricultural Research Service, Exotic and Invasive Weeds Research Unit, 920 Valley Road, Reno, NV 89512, USA.

Herbivory by Tamarix beetles leads to early senescence of leaves before nutrient translocation.

Saltcedar

Cottonwood

Willow

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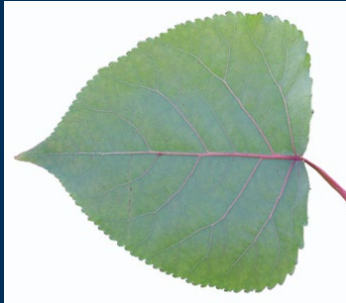
Experimental Approach:

- Constructed 105 total leaf packs (4g of litter/pack)

- Packs at Lees Ferry, collected 5 replicates per litter type on days 1, 2, 7, 24, 46, 84, 142 (April 4th – Aug 24th 2022)

- Dried, weighed, and ashed all litter shortly after retrieval to estimate mass loss throughout experiment

- Removed, counted, measured, and identified all invertebrates

Results: Saltcedar decomposition rate more than doubled between 1998 and 2022

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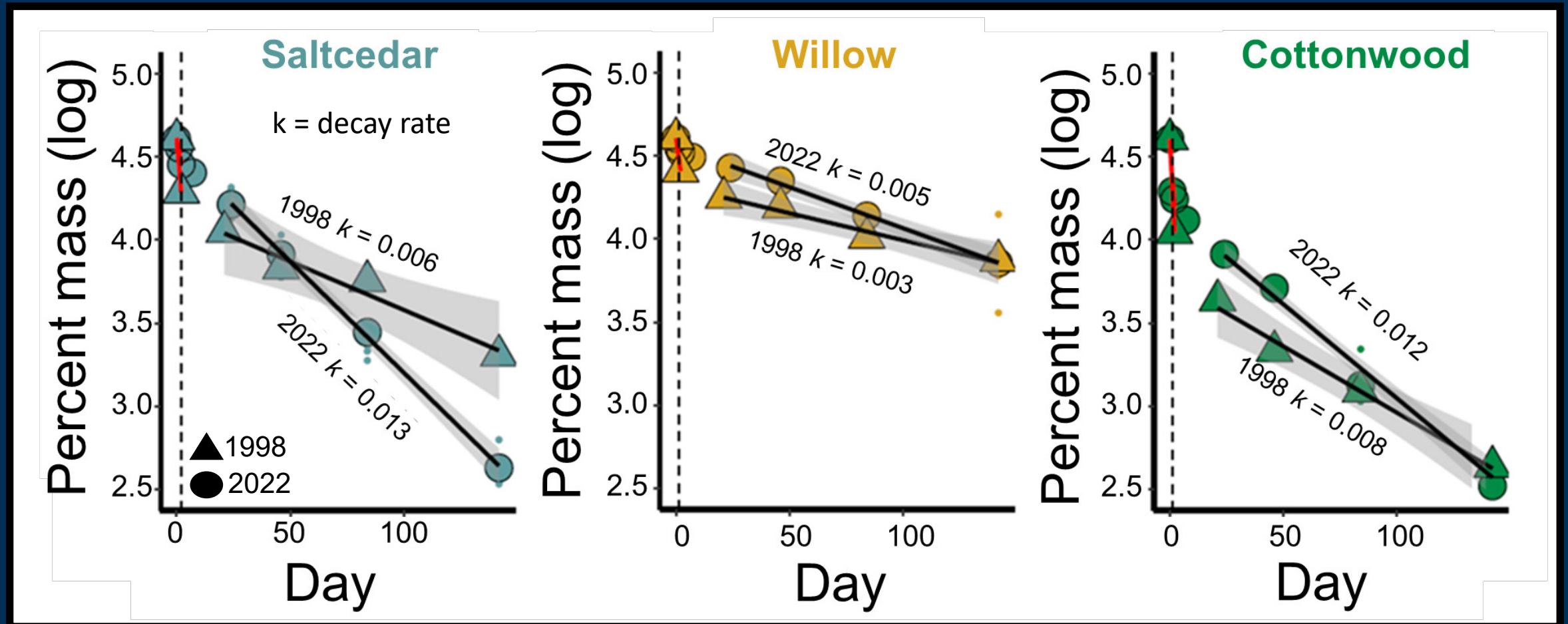
Results: Interaction between warmer temps and higher quality litter (10X higher N content) likely led to largest response in saltcedar

Beetle herbivory causes premature litterfall before nutrients are translocated during senescence

% Nitrogen

2.0

1.5

1.0

0.5

Saltcedar   Cottonwood   Willow
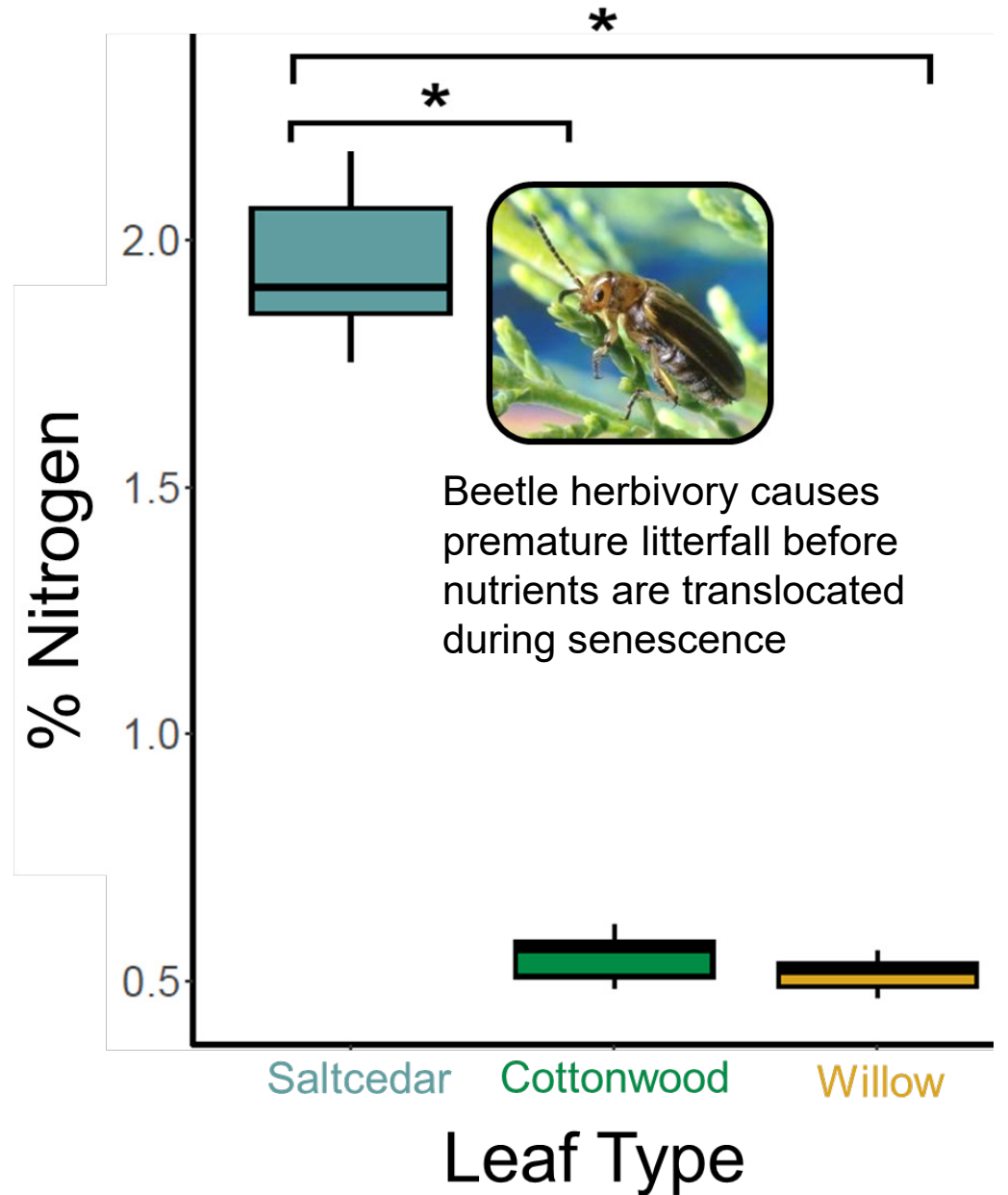
Leaf Type

Results: Minor changes in other leaf types despite warmer temperatures likely driven by lower phosphorus concentrations

Willow / Cottonwood decomposition plots — Percent mass (log) vs. Day. Willow: 2022 k = 0.005, 1998 k = 0.003; markers for 1998 (triangle) and 2022 (circle). Cottonwood: 2022 k = 0.012, 1998 k = 0.008.

From Scholl and others, In Press, Ecosphere
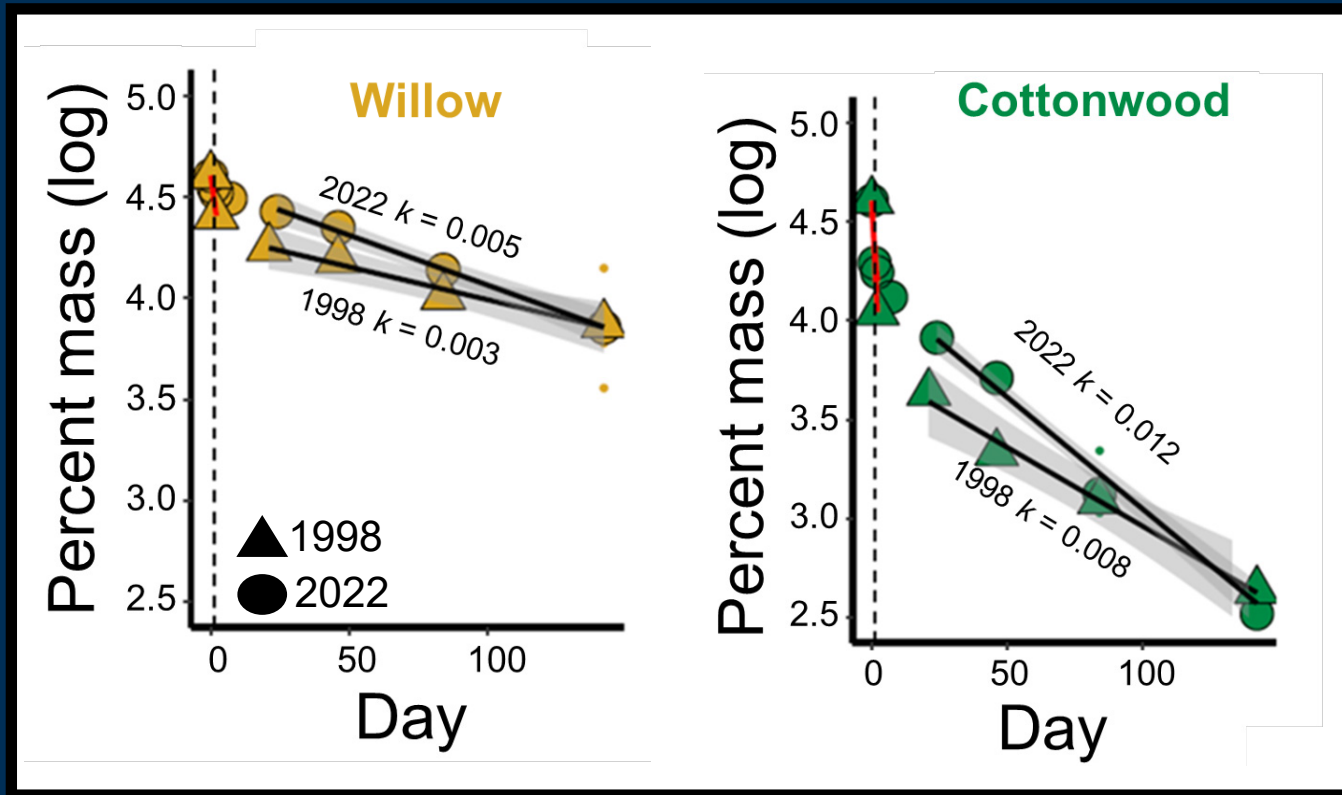
Water phosphorus declines

1998 to 2022
Total P ⬇ 63%
SRP ⬇ 69%

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Results: Mudsnails were the dominant invertebrate across all dates and leaf types (compared to worms in 1998)...still unclear if they influenced decomposition in our study
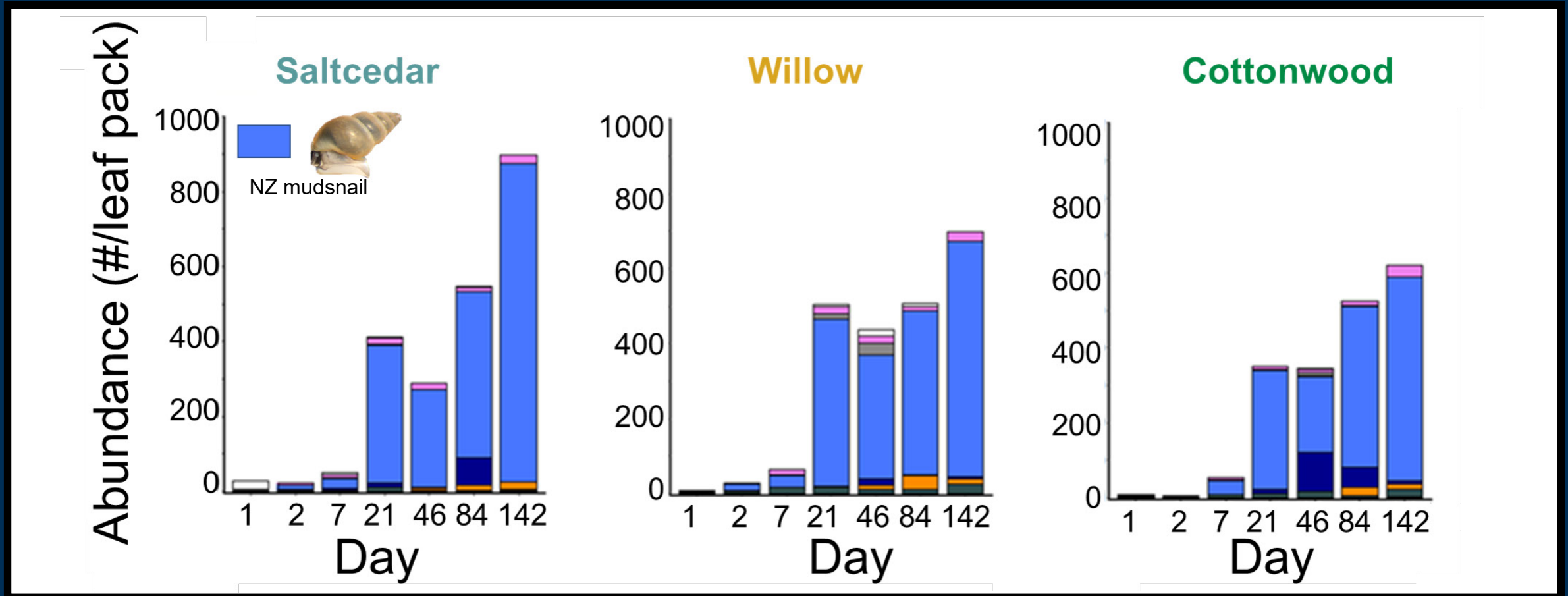
Conclusions:

- Drivers of decomposition are changing in the Colorado River

- Warmer temperatures likely interacted with higher litter quality to accelerate saltcedar decomposition

- Declines in water phosphorus may have offset effects of warming on cottonwood and willow decomposition

- Future work is needed to examine: 1) mudsnail impacts (diff. mesh size) and 2) patterns of decomposition farther downstream

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Numerous bat-human encounters in 2023, but was there more bat activity?   No.

Modeled bat activity 2017-2023
Community science data (Echometers)

(a)

(b)
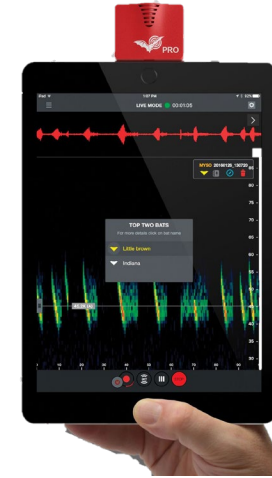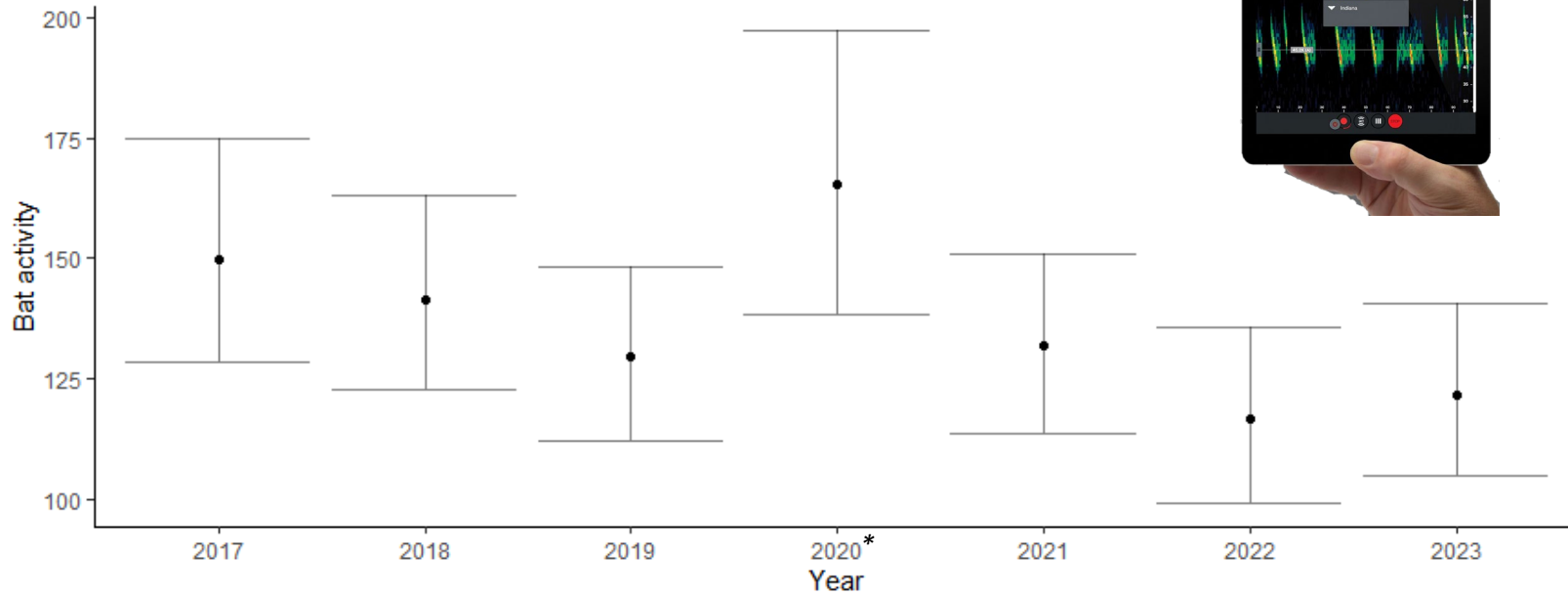
Mixed effects model run using BRMS, includes Year, Month, and Site as random effects and offsets for sampling duration
Post-hoc Tukey test found no significant differences between years (confidence level 0.95, alpha=0.05)
*Sampling effort in 2020 was reduced and did not include spring
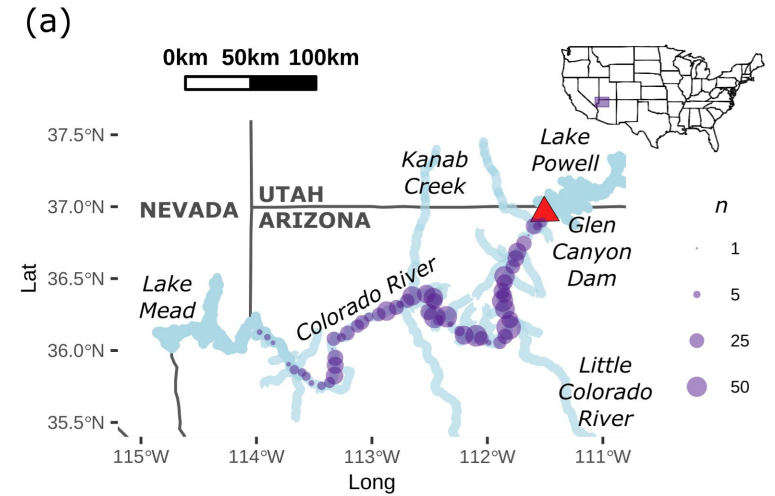
Metcalfe et al. 2023

Provisional data, subject to change.
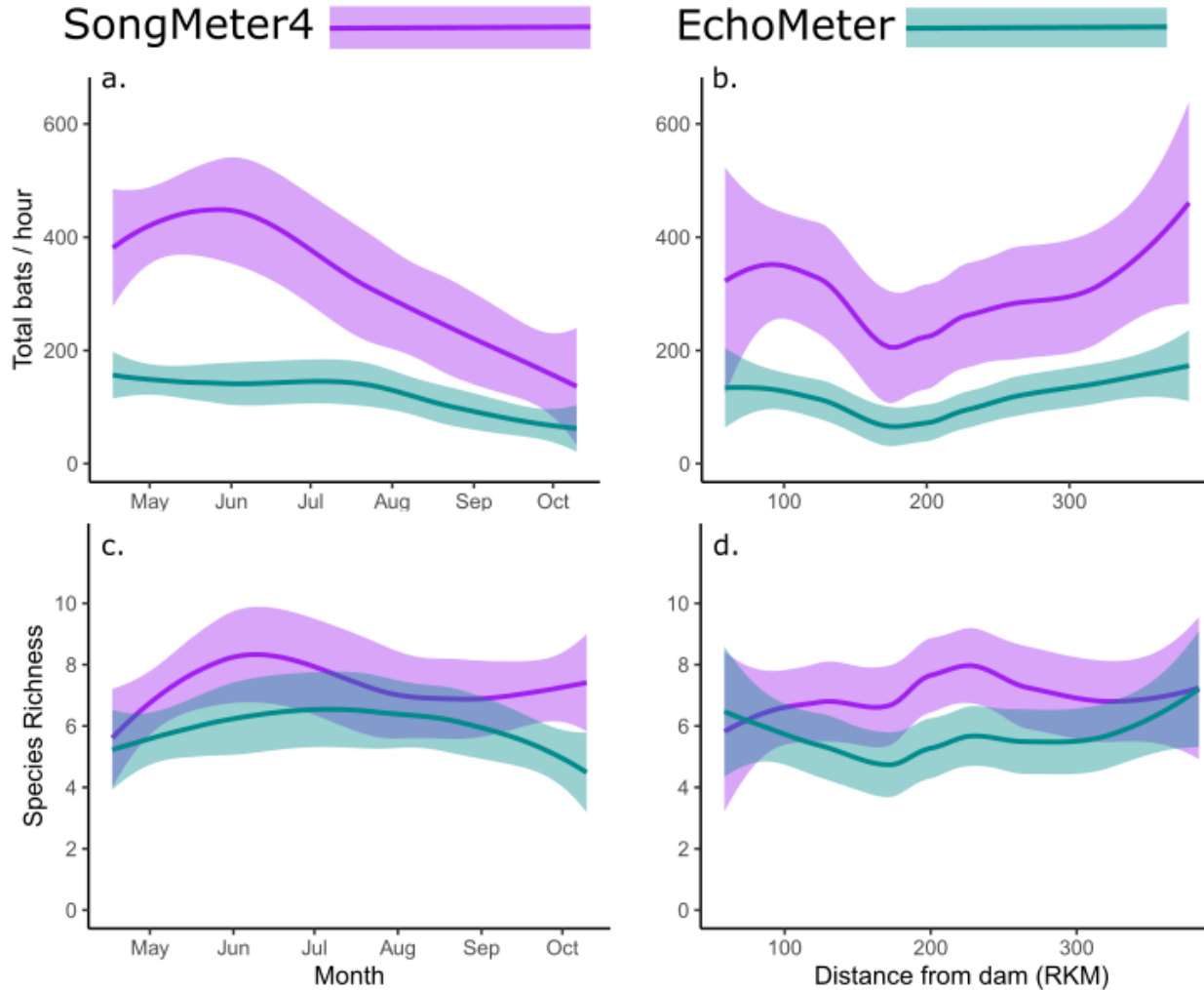
How do SM4 and Echometer Touch data compare?

EchoMeter
Strength: real-time display is great for comm. science
Weakness: modest microphone range, sensor saturation

SongMeter4
Strength: large microphone range, not easily saturated
Weakness: black box, no real time viewing (guides hated it)

SongMeter4 ▬▬▬▬ EchoMeter ▬▬▬▬

Result: More bat activity detected using SM4 than EchoMeters.

Result: 1.6 more bat species per sampling event using SM4s than EchoMeters

...sional data, subject to change.

Metcalfe et al. In prep. Trade-offs in designing a participatory acoustic study of bats:
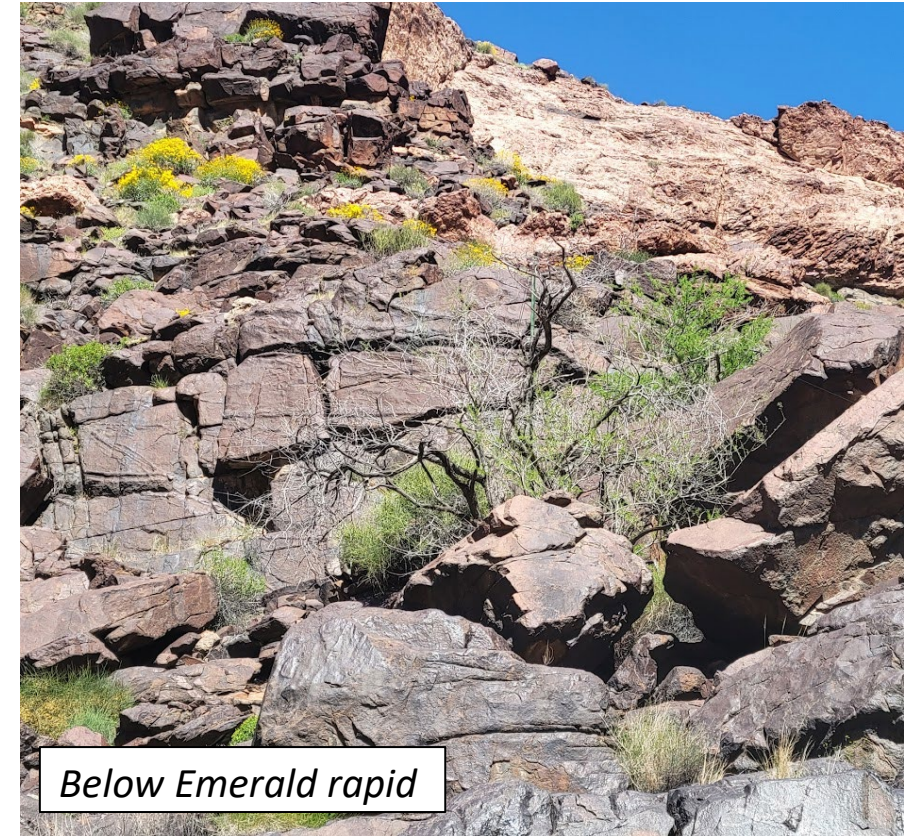*User engagement and data quality comparison of SongMeter4 and Echometer.*

April 2023: Six new stationary bat detectors deployed in GRCA

Above Kwagunt rapid

SM4BAT-FS

Below Emerald rapid

Sites chosen based on high and low nodes of insect availability, NABat priority, and NPS site compatibility

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Site name	RM	Side
Below Tatahatso	38.9	R
Above Kwagunt	56.2	L
Science Camp	63.8	R
Below Emerald	104.8	R
184-mile – below Lava	184	L
Fall Canyon	213	R

NPS sites

Site	RM	Side
North Canyon	20.8	R
Malgosa Canyon	58	R
Bright Angel Creek	88	R
Kanab Creek	144	R
Parashant Canyon	199	R
Surprise Canyon	248.7	R
275 Mile Marsh	275	R

Recording took place dusk:dawn twice a week (Sundays and Thursdays)

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2023 Light Traps

Freshwaters Illustrated
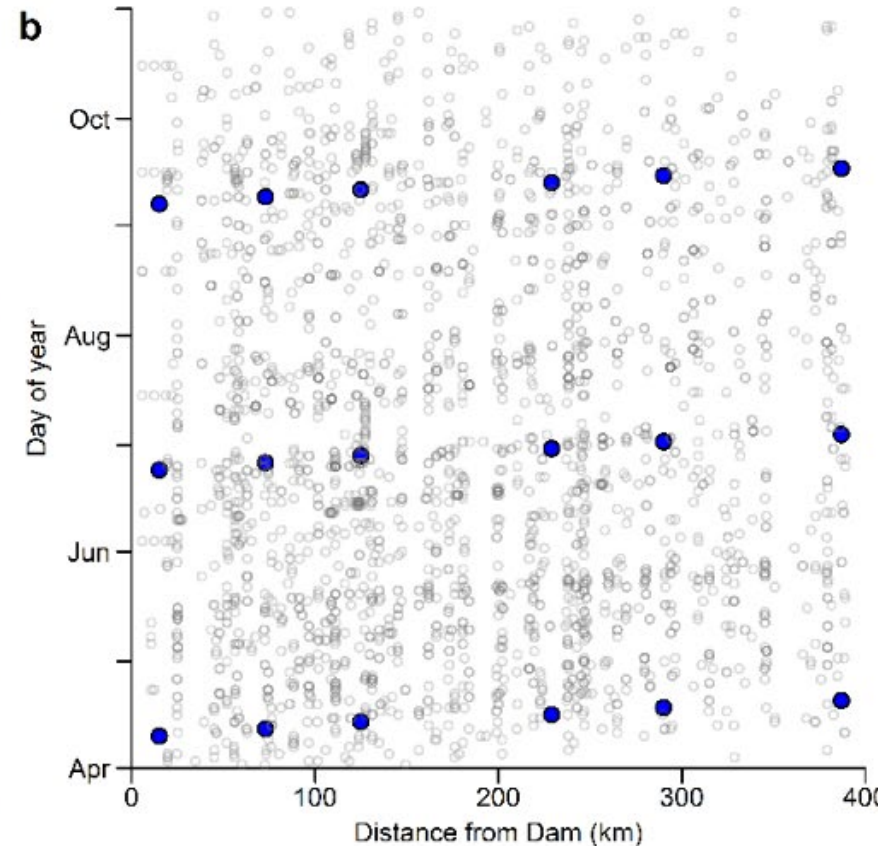
Collector	#samples	Collector	#samples
GCY	60	WilliamsK	23
RatayR	51	KennedyT	17
FadeleyB	47	MansfieldL	16
LouvierM	43	AllenK	14
RoussisO	43	MetcalfeA	14
LokeyE	42	SellerP	14
BurchR	38	SiemionG	14
KristjonsdottirS	37	SzydloC	9
LowryM	35	TownsendJ	8
SeabaughC	35	CatlettJ	6
TankersleyG	35	PettyJ	6
MagnificoS	32	PalmquistE	4
GantertJ	27	StalveyA	3

Thank you guides, GCY, and others!!

Kennedy and others 2016, Bioscience

In a nutshell

Community science monitoring started in 2012

~700 samples of adult aquatic insects per year

Robust dataset for quantifying insect population response to Bug Flows

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2023 Caveats

- **~29% of samples processed (200 out of 680)**
  - **However, samples randomly selected for processing and models account for variation in sampling effort across years**

Result

- **2023**
  - **55% decrease in midges**
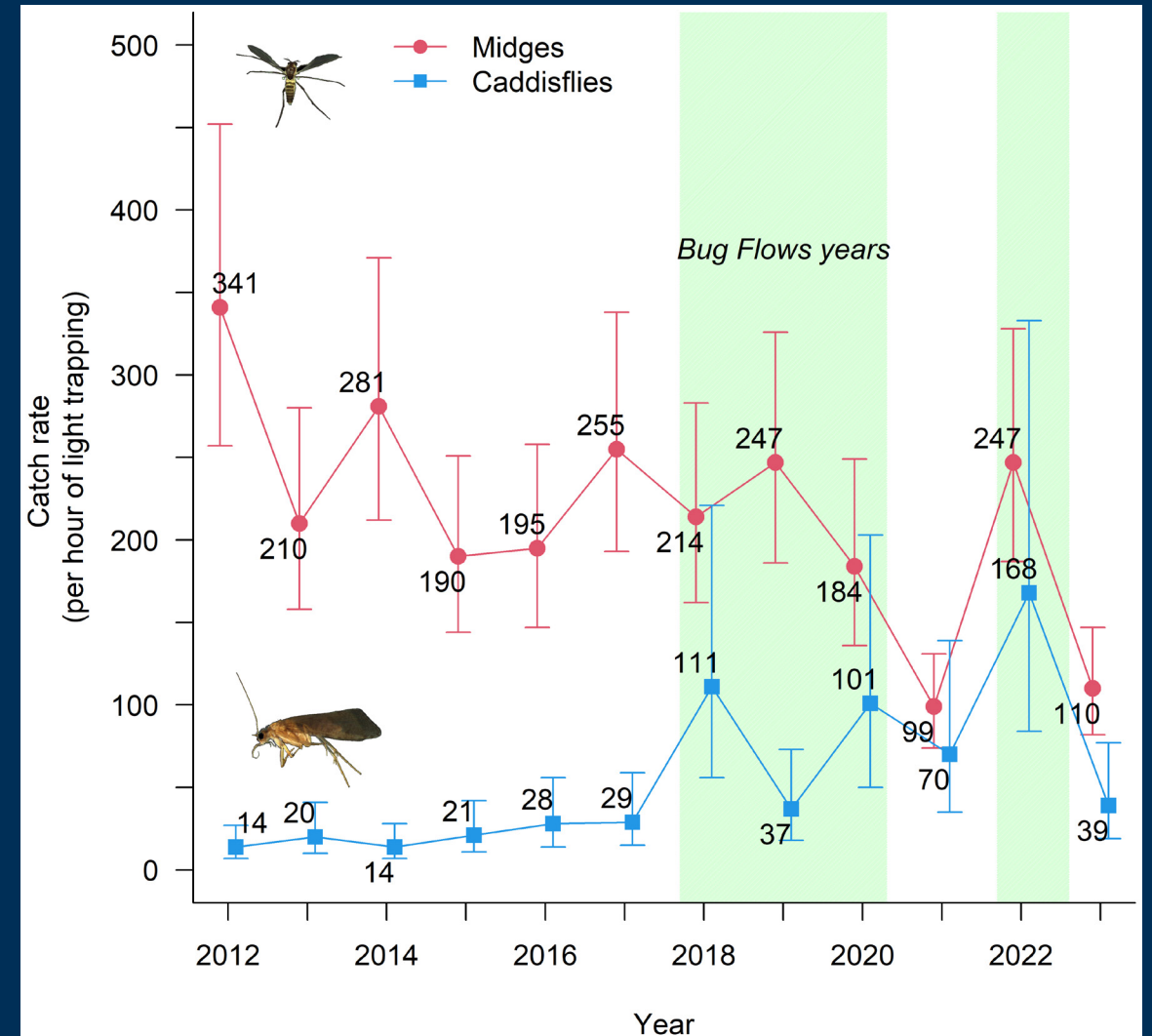 - **77% decrease in caddisflies**
- **Statistics**

Very strong model support for positive

Bug Flow effect

Bug Flow model v. model w/o Bug Flow effect
- **Midges, deltaAIC: 27.5**
- **Caddisflies: deltAIC: 35.1**

**Note: deltaAIC >2 considered strong support**

Estimates of annual average from mixed effects model
Provisional data, subject to change.
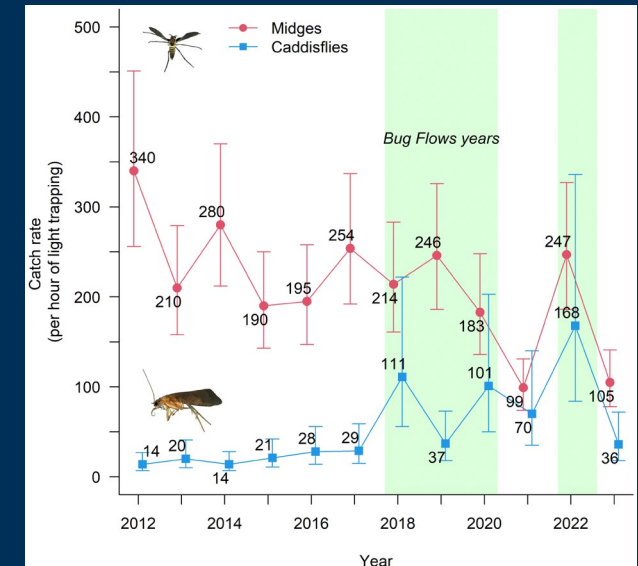
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Conclusions

- **Drivers of decomposition are changing, but in 2022 low phosphorus likely offset warm temperatures except in case of saltcedar**

- **Community science bat monitoring being supplemented by fixed site monitoring in coordination with GRCA**

- **Preliminary result: strong model support for Bug Flow effect on aquatic insects**
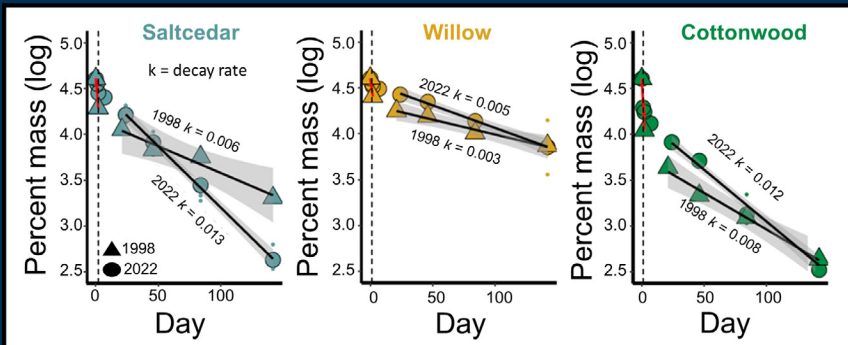
From Scholl and others, In Press, *Ecosphere*
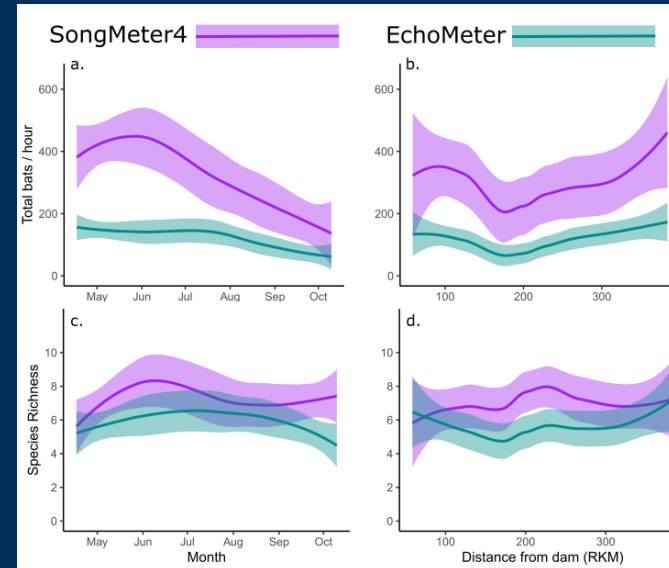
Provisional data, subject to change.

Provisional data, subject to change.

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