Improving the Lake Powell CE-QUAL-W2 Water Quality Model

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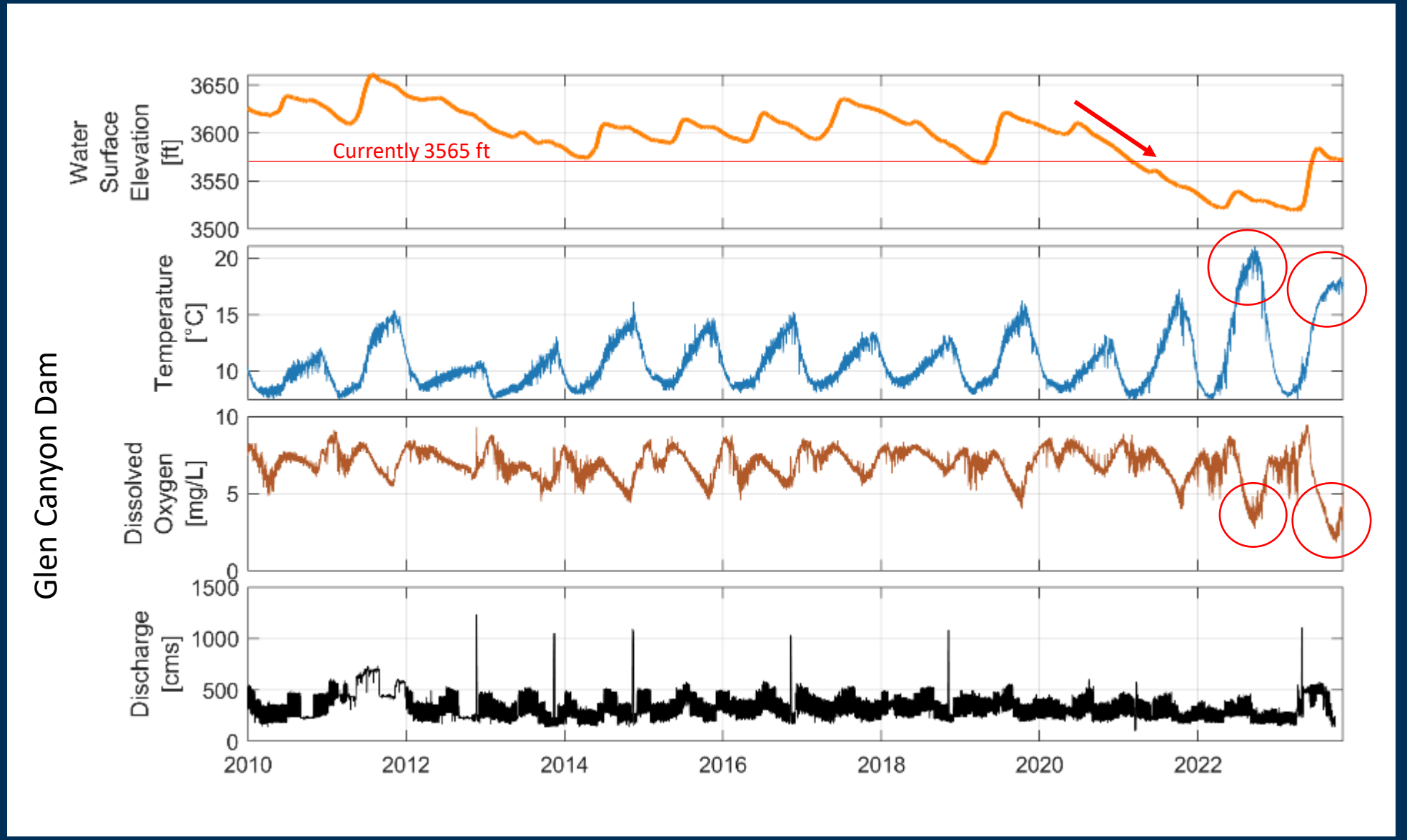
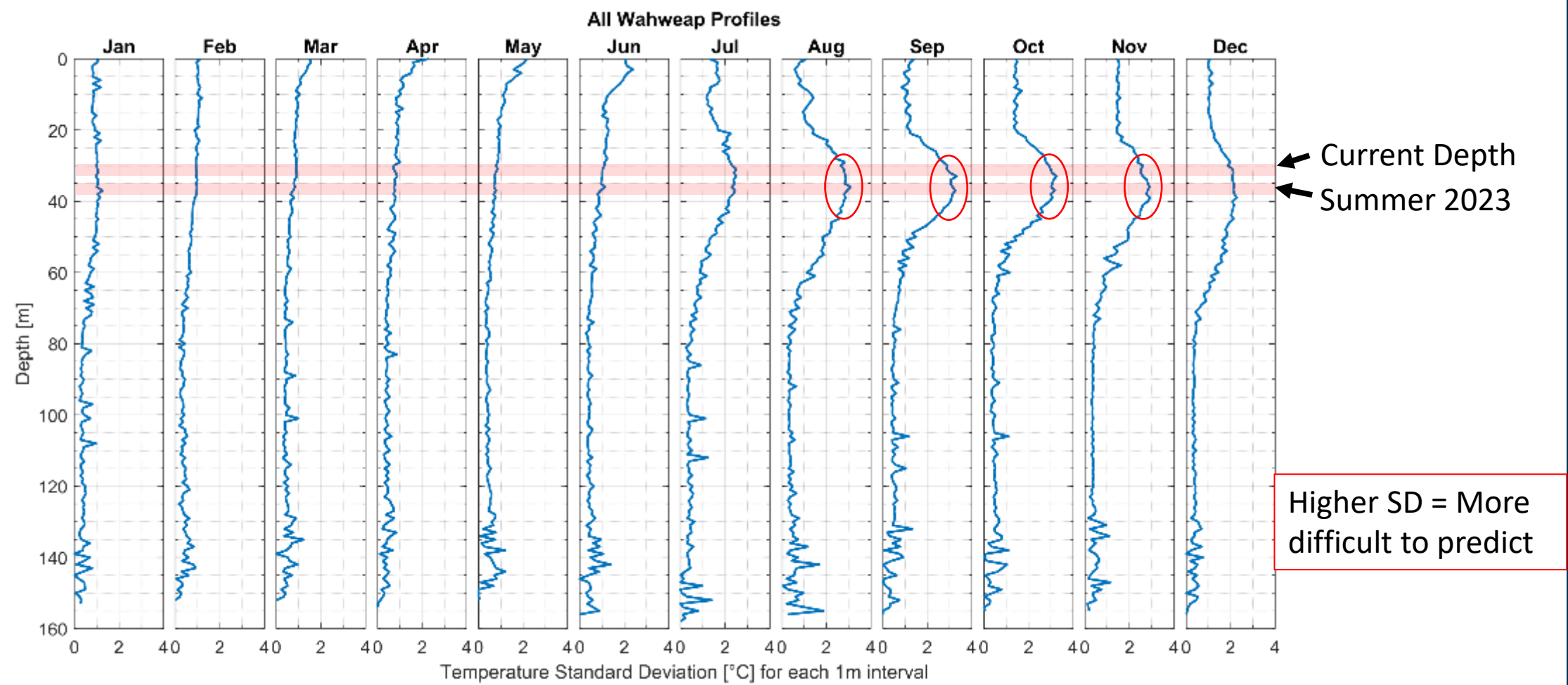
Recent Water Quality Trends



"Preliminary Information- Subject to Revision. Not for Citation or Distribution."

USGS

Wahweap Temperature Variability



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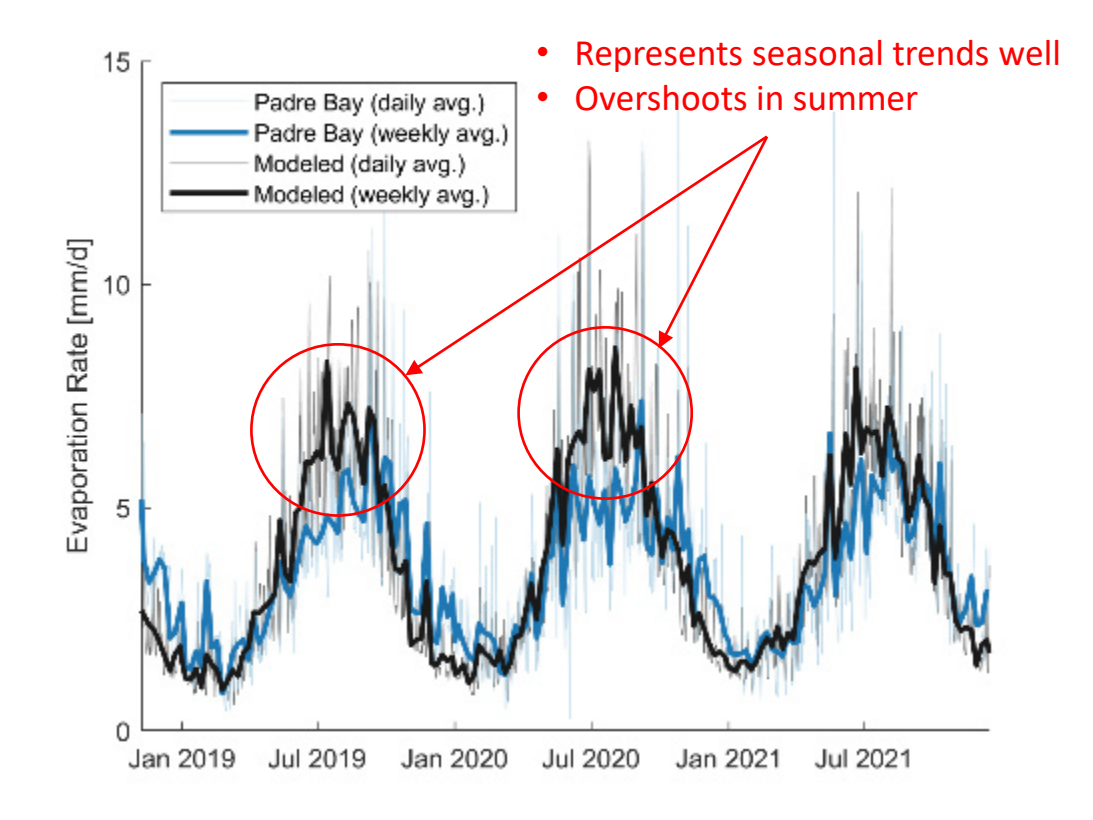
Updated Model Evaporation Rates

- Estimated evap. coefficients based on USBR study
- Impacts surface heating and mixing



BUREAU OF RECLAMATION

Evaporation from Lake Powell: In-situ Monitoring between 2018 and 2021

Technical Memorandum No. ENV-2023-007
Upper Colorado Basin Region

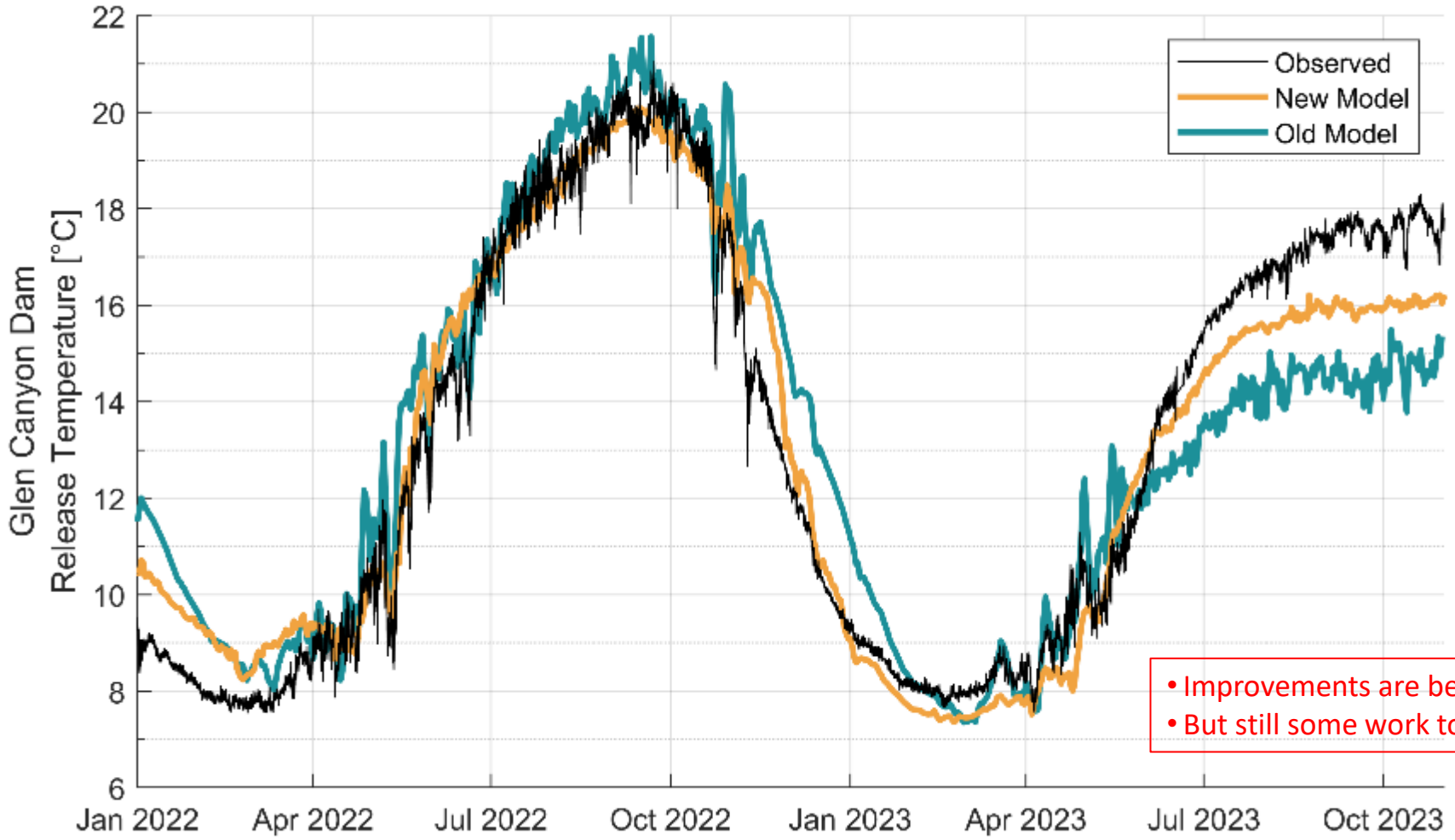
(Padre Bay)

U.S. Department of the Interior

September 2022

USGS

How are model predictions looking?



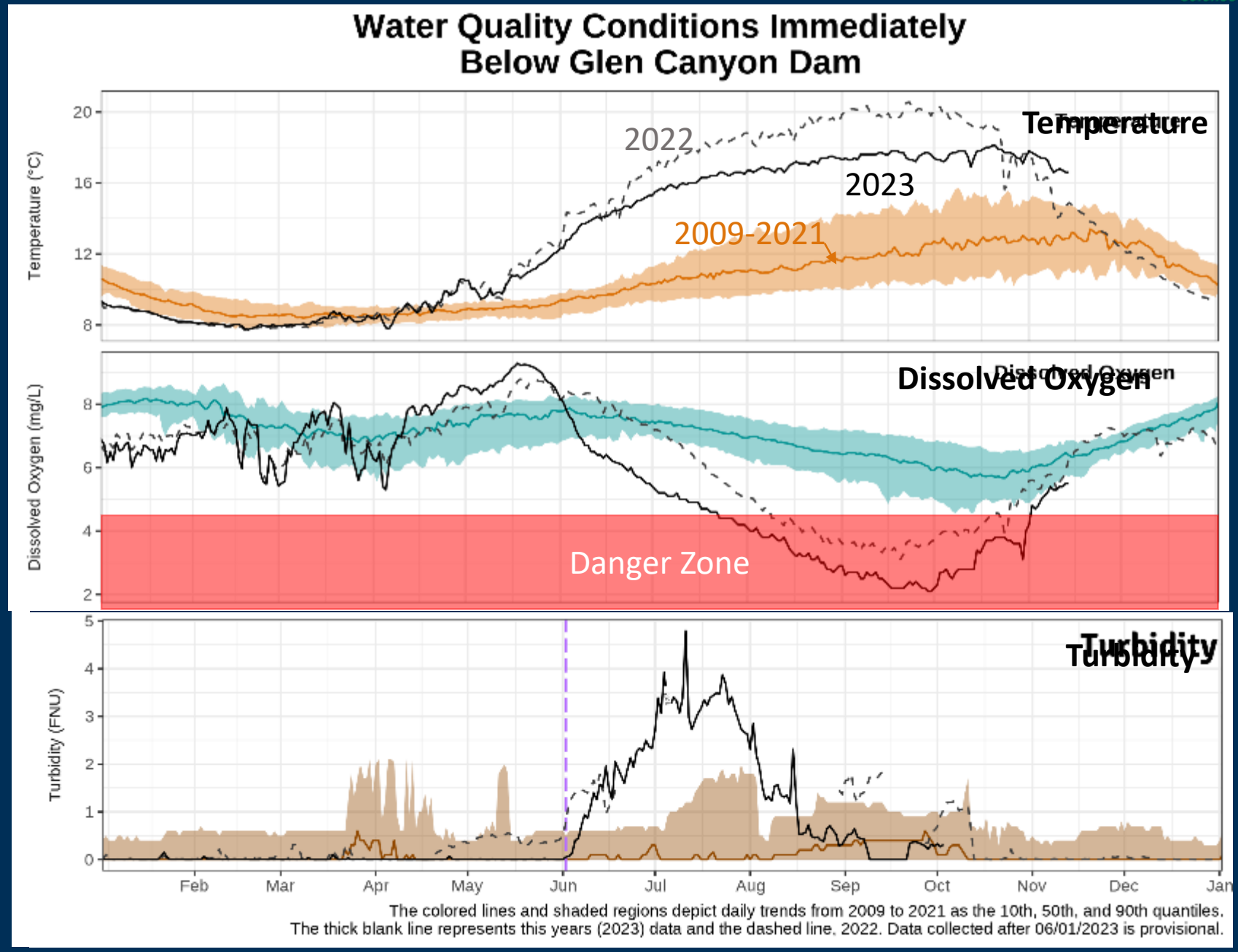
Dissolved Oxygen Dynamics in Lake Powell and Glen Canyon

Bridget Deemer, Tom Sabol, Caitlin Andrews, Robin Reibold, Charles Yackulic
U.S. Geological Survey, Southwest Biological Science Center

Glen Canyon Dam Adaptive Management Program
February 28, 2024

Photo Credit. David Herasimtschuk, ©Freshwaters Illustrated

Escalante arm of Lake Powell
Campsite for Lake Powell quarterly trip- March 9, 2022



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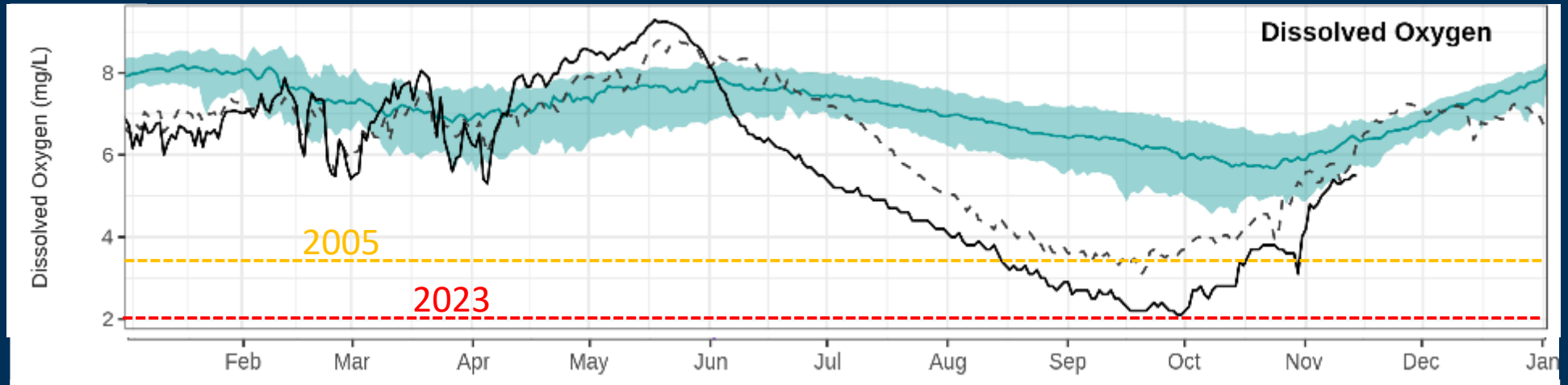
How Low is Low?

The low oxygen in dam releases last year were unprecedented in both magnitude and duration



The colored lines and shaded regions depict daily trends from 2009 to 2021 as the 10th, 50th, and 90th quantiles.
The thick black line represents 2023 and the dashed line represents 2022. Data collected after 6/01/2023 is provisional.

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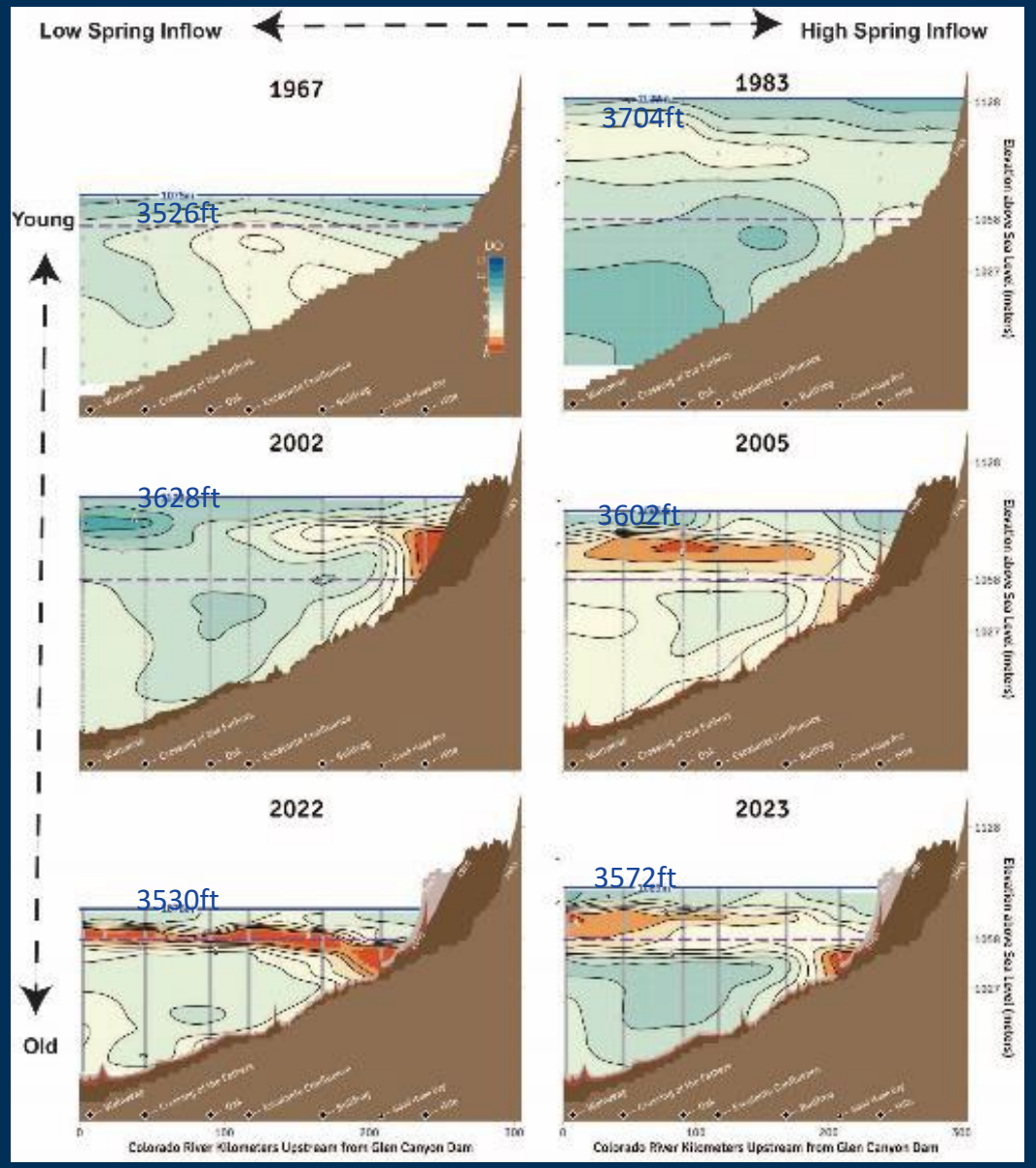
What Can The Historical Dataset Tell Us?

Lower average late summer/fall dissolved oxygen in the metalimnion when:

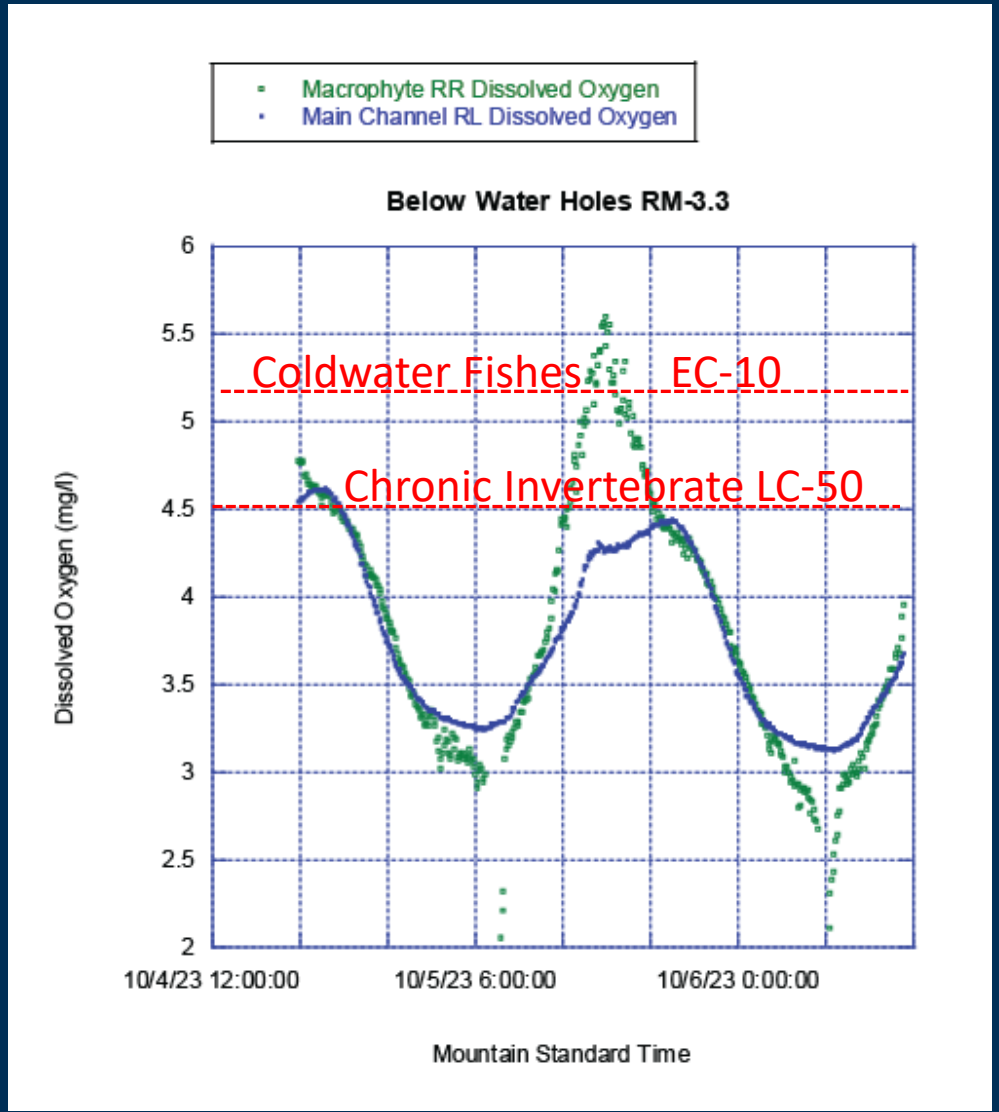
1. Reservoir spring elevation is low
2. Spring inflow is large
3. Age/elevation interaction

Lake-wide low dissolved oxygen events will be increasingly common when lake elevation is below ~3620 ft.



Side Channel Habitats vs. Main Channel

>1 mg/L departures in DO between main channel and macrophyte beds



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

*This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.

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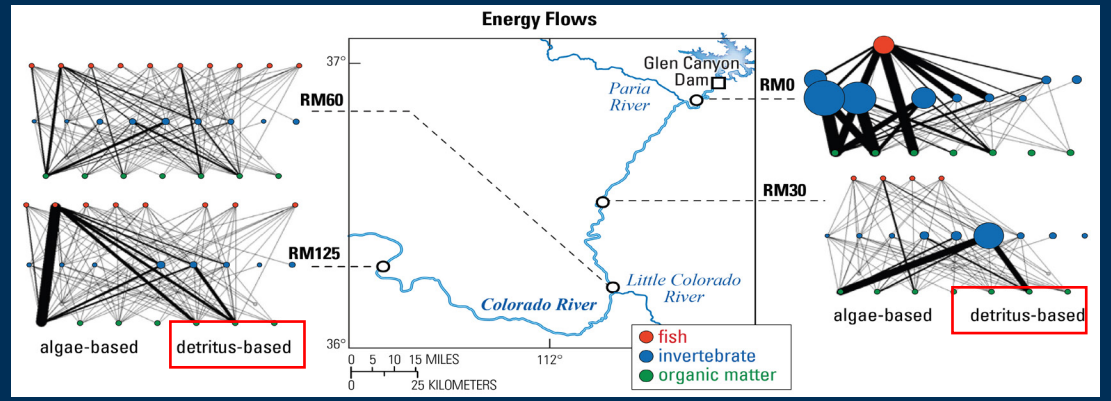
Decomposition Study Background:

- 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

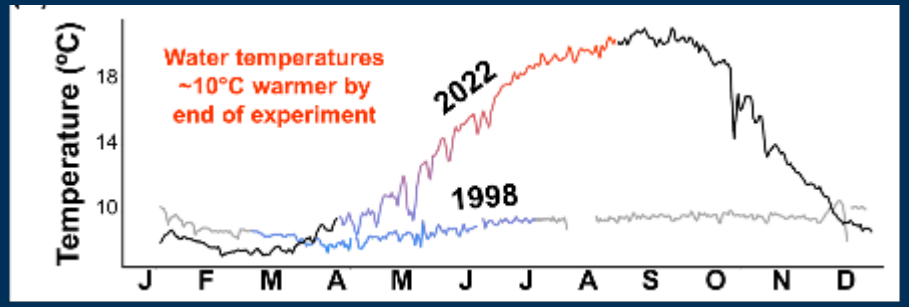


Food webs of the Colorado River circa 2006 2009. From Kennedy and others, 2014 USGS Fact Sheet

USGS

Decomposition Study Background:

Drivers of decomposition are rapidly changing in the Colorado River

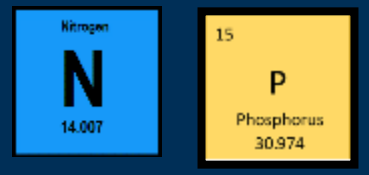


From Scholl and others, in press, *Ecosphere*

Biological invasion

Biocontrol

Water nutrients



Temperature

Objective: Compare decomposition 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

Hydrobiologia 434: 193–199, 2000.
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Leaf breakdown in a regulated desert river: Colorado River, Arizona, U.S.A.

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USGS

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

Water temperature
1998: cool
2022: warm

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

Mudsnails
1998: low
2022: high

Water phosphorus
1998: high
2022: low

Estimates of marginal impact derived from literature

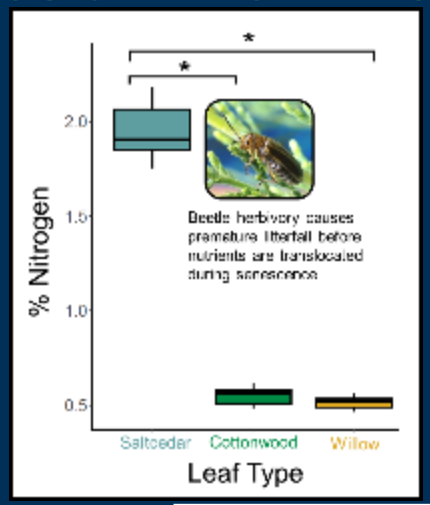
35% increase

122% increase (saltcedar only)

?% increase

67% decrease

Saltcedar



Cottonwood

Willow

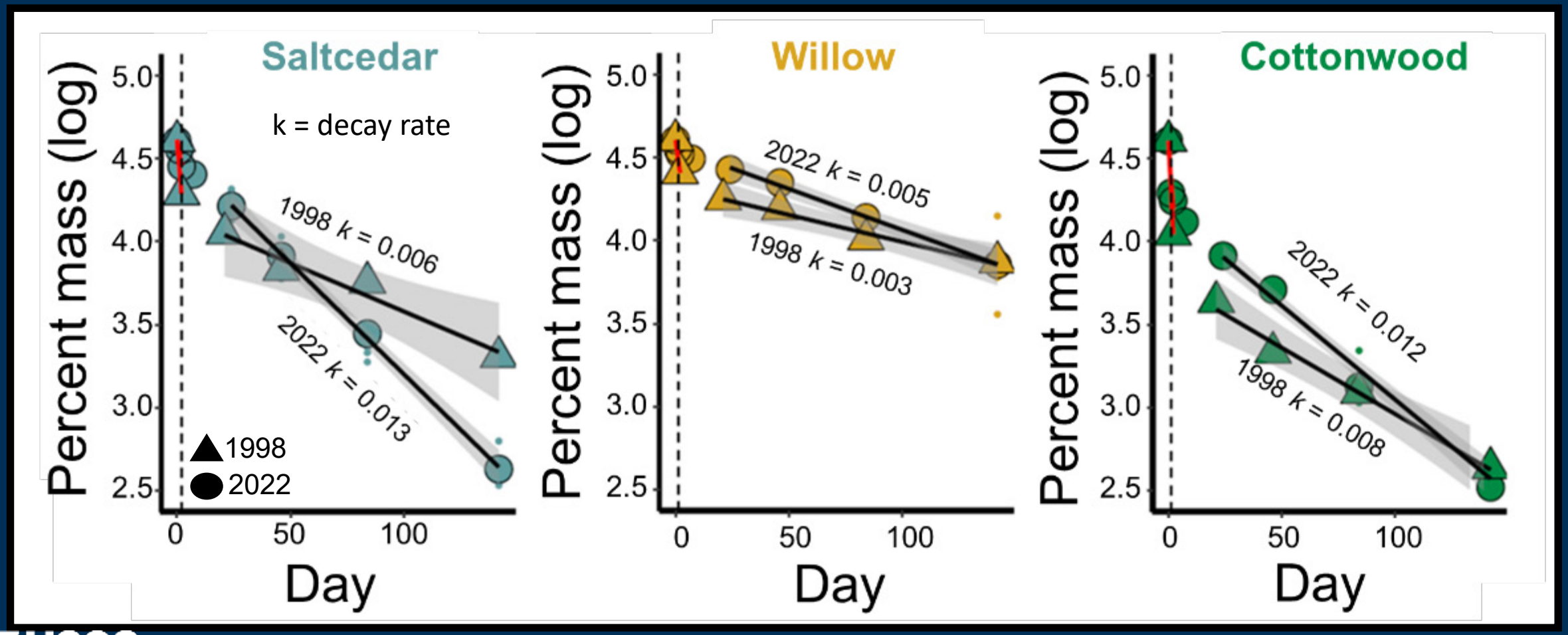
- Leaf packs put in river at Lees Ferry and collected on days: 1, 2, 7, 24, 46, 84, 142 (April 4th – Aug 24th 2022)

USGS

Results:

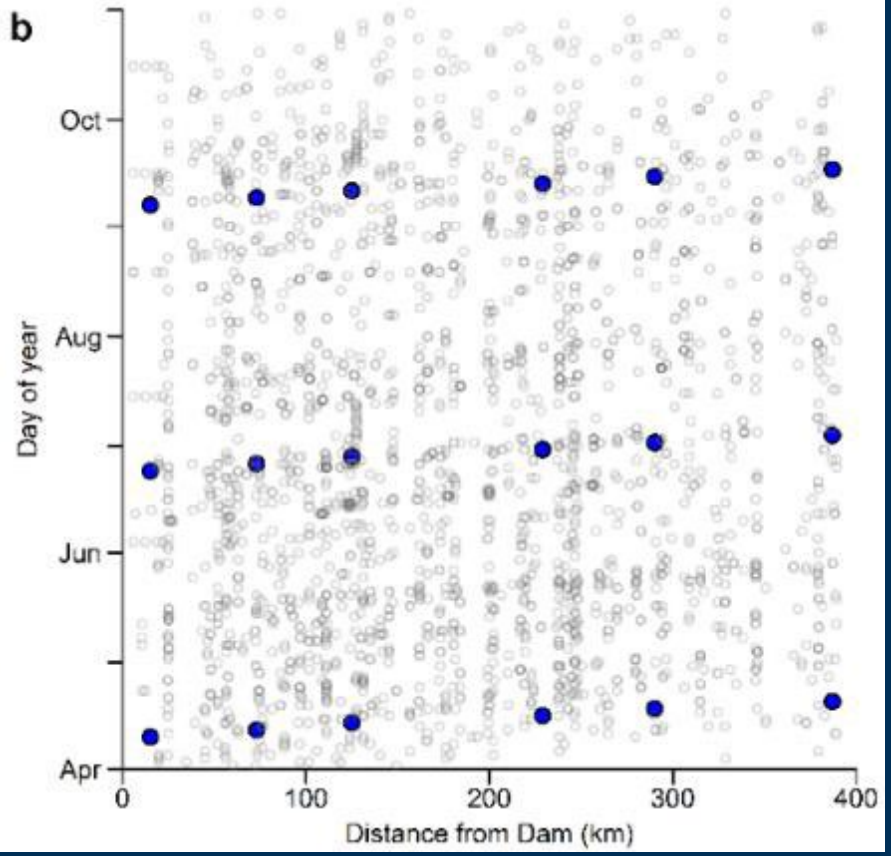
Saltcedar decomposition rate more than doubled.

No change in other leaf types (decrease in P offset ↑temp).



From Scholl and others, in press, *Ecosphere*

2023 Light Traps



Kennedy and others 2016, Bioscience

2023 Community Scientists

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!!

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

USGS

2023 Light Traps - New species of caddisfly detected

Smicridea fasciatella

Photo Credit: Kim Beubauer 2022

- 12 individuals detected in 3 light trap samples in August between river miles 216 and 222
- Considered to be excellent prey for fish, birds, and bats
  - 3x larger than most common Grand Canyon caddisflies
- Common and not known to be a nuisance species to boaters in Cataract Canyon
- Species of management concern in lower Colorado River Basin
  - considered a nuisance by residents (large hatches)
  - do not bite or sting

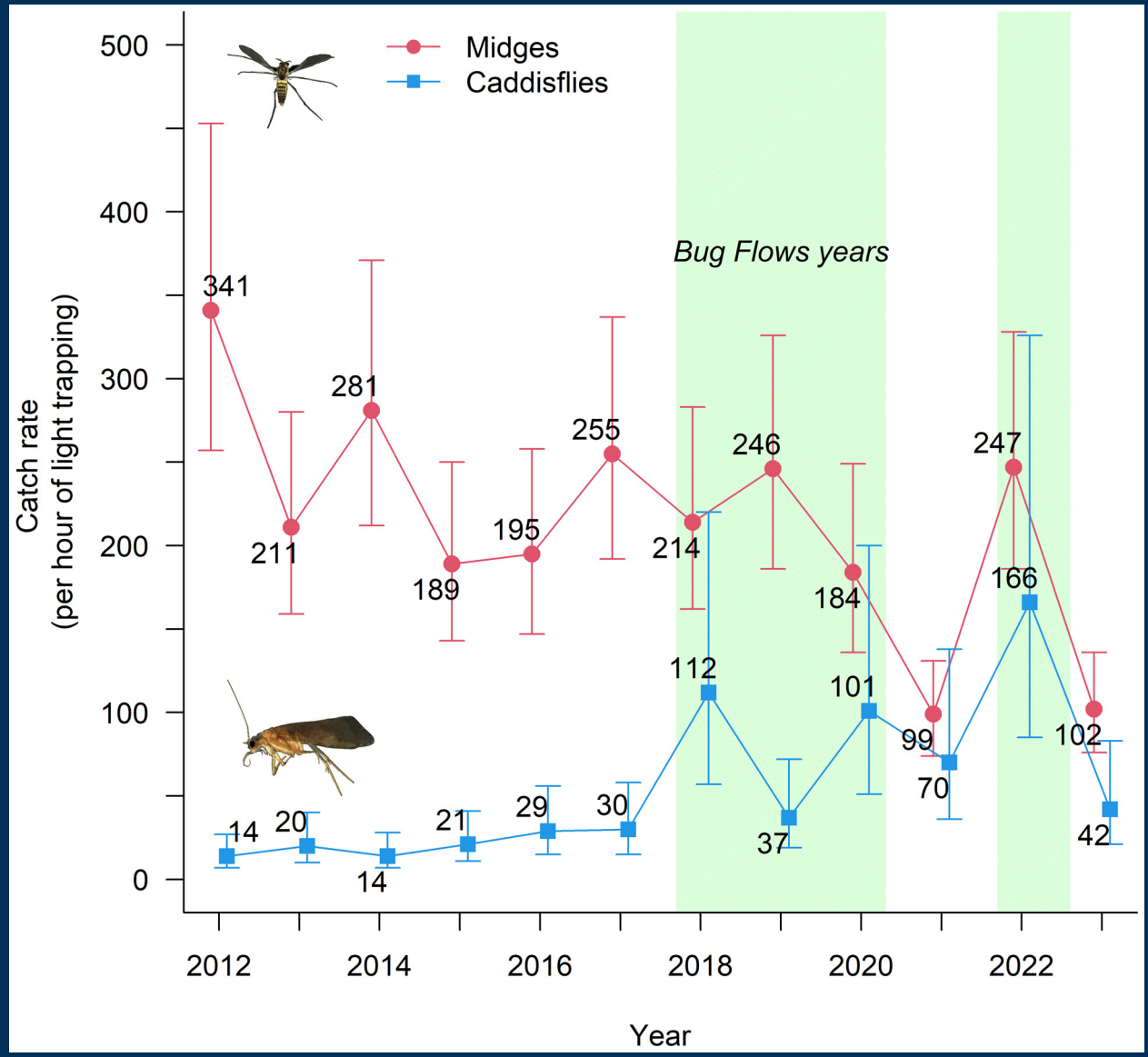
USGS

Result

- Caveat~46% of samples processed (312 out of 680)
- 2023
  - 58% decrease in midges
  - 75% decrease in caddisflies
- Statistics

<u>Very strong model support for positive Bug Flow effect</u>

  - Midges, deltaAIC: 27.6
  - Caddisflies: deltAIC: 36.2
  - Note: deltaAIC >8 considered strong support

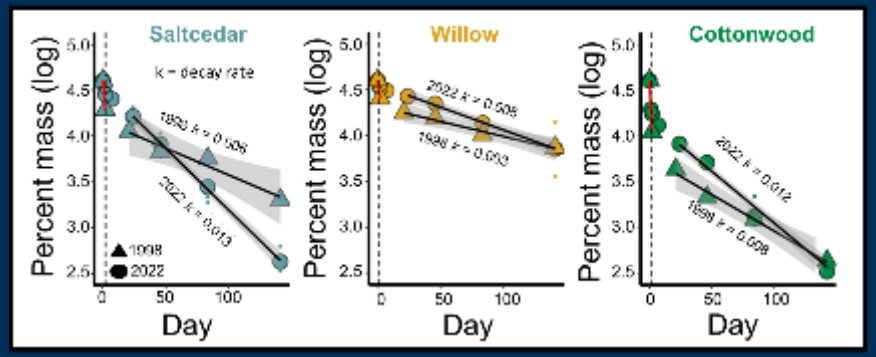


Estimates of annual average from mixed effects model

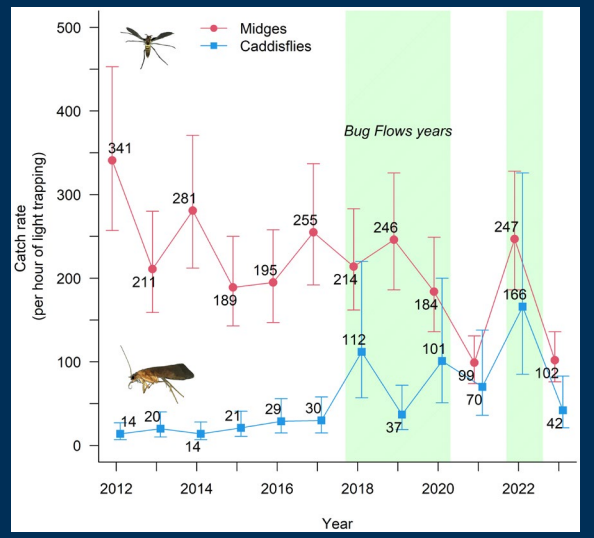
Provisional data, subject to change.

Conclusions

- Drivers of decomposition are changing
  - Decomposition of saltcedar was 2x faster than in 1998 (↑litter quality)
  - But low phosphorus likely offset warm temperatures for other leaf species
- Preliminary result: strong model support for Bug Flow effect on aquatic insects



From Scholl and others, In Press, *Ecosphere*



Provisional data, subject to change.

USGS