



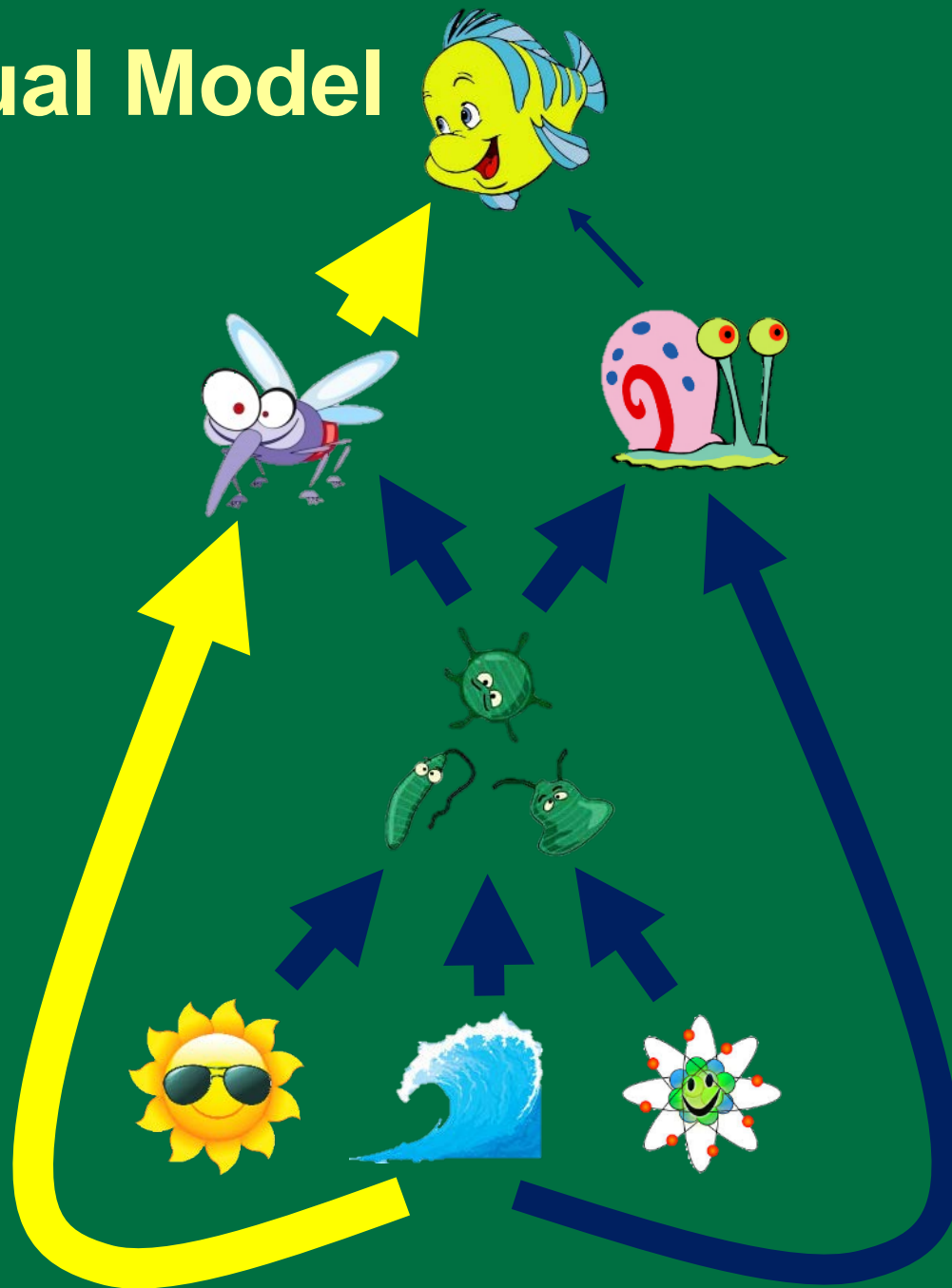
Floods, flows, and the aquatic foodbase

Presenter: Ted Kennedy

Contributors:

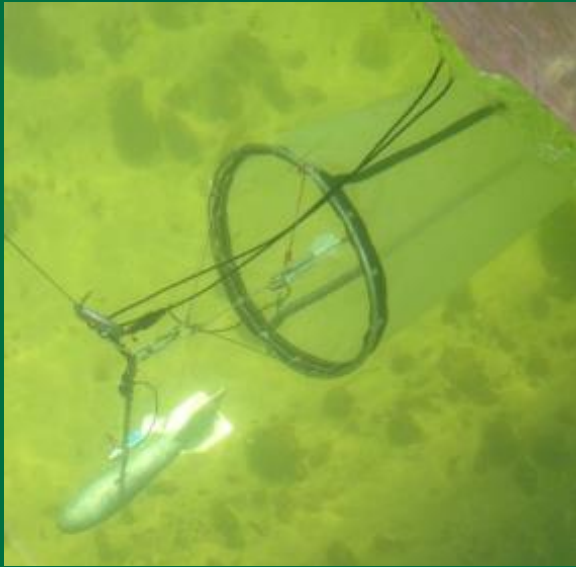
Mike Dodrill, Charles Yackulic, Jeff Muehlbauer

Conceptual Model

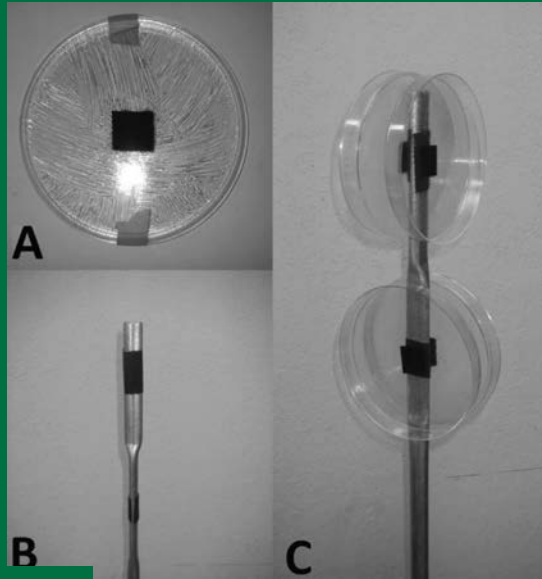


Monitoring the foodbase

Invertebrate Drift



Insect emergence



Plankton nets

Direct measure of prey availability for drift feeding fishes

Captures EDIBLE, high quality prey
(midges, blackflies, and Gammarus)



and

INEDIBLE, low quality prey
(worms, mudsnails)



Sticky traps

Captures adult midges and blackflies,
high quality prey items for fishes



Light traps

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Foodbase Knowledge Assessment

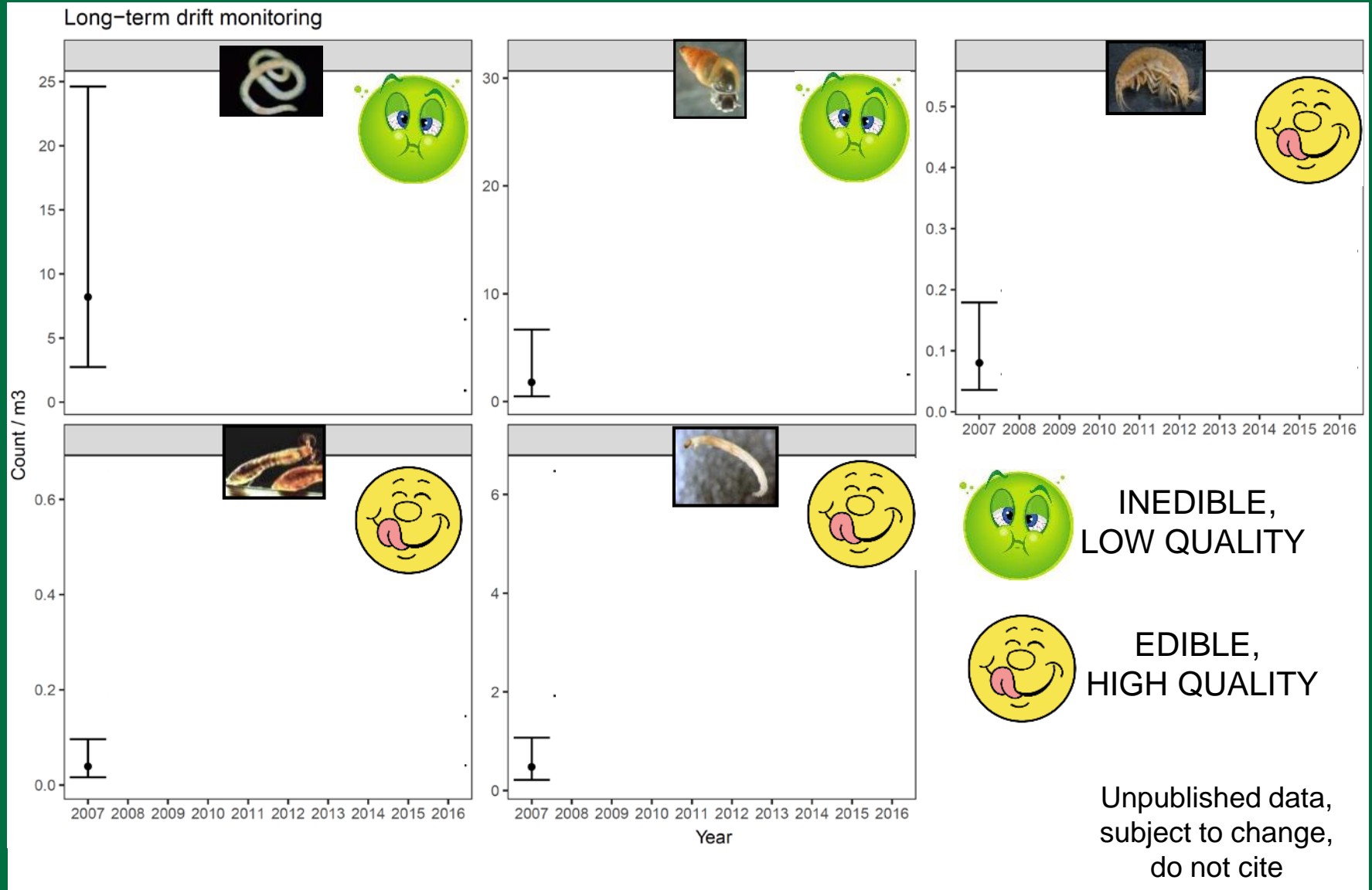
Resource Characteristic	Specific Measure	Status	Trend	Confidence	Rationale: status & trend	Rationale: confidence	Recommendations
Invertebrate Production	Drift and Emergence Monitoring	Significant Concern	Deteriorating	High	Condition of HBC, and annual number of HBC spawners, is down and correlated with declining food base availability. Drift and emergence monitoring both large declines in abundance of key prey species.	Declines in key prey evident in both drift and emergence monitoring, and across all sites (Glen, Marble, and Grand Canyon) indicating a system-wide constraint on aquatic insects.	Test Spring HFEs + Bug Flows
Insect diversity	EPT abundance (%)	Moderate Concern	Unchanging	High	The Colorado River downstream of Glen Canyon Dam is one of the few streams/ivers in the western US that doesn't have populations of EPT.	Food base efforts, including intensive research and monitoring since ~2006, indicate EPT% is zero/low and unchanging under MLFF.	Test Bug Flows



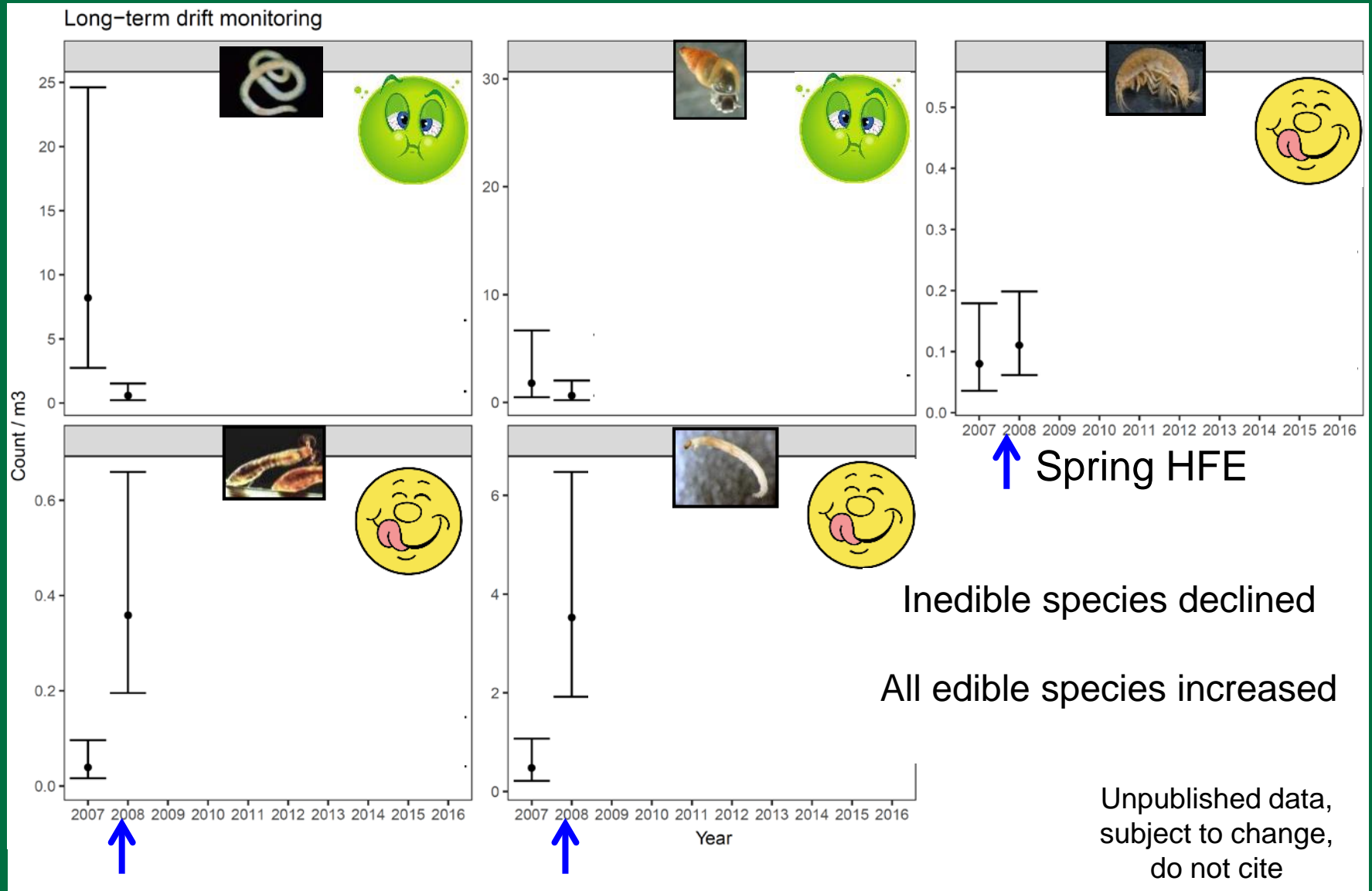
Subsequent slides present ratings and terminology from the Food Base Knowledge Assessment

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Lees Ferry Drift Monitoring: Edible vs. Inedible Prey

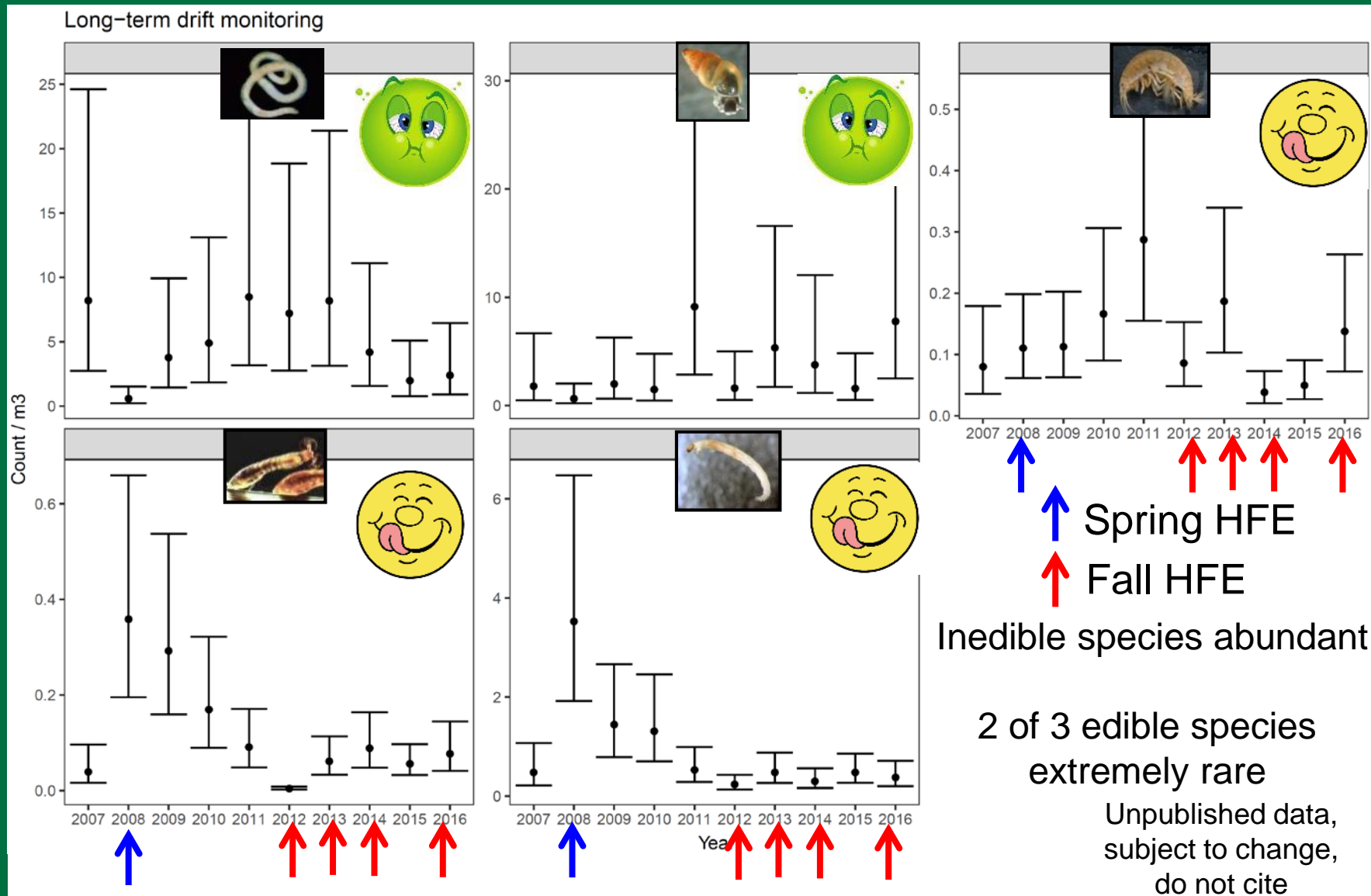


Spring HFE: Improving Food Base, Good Condition



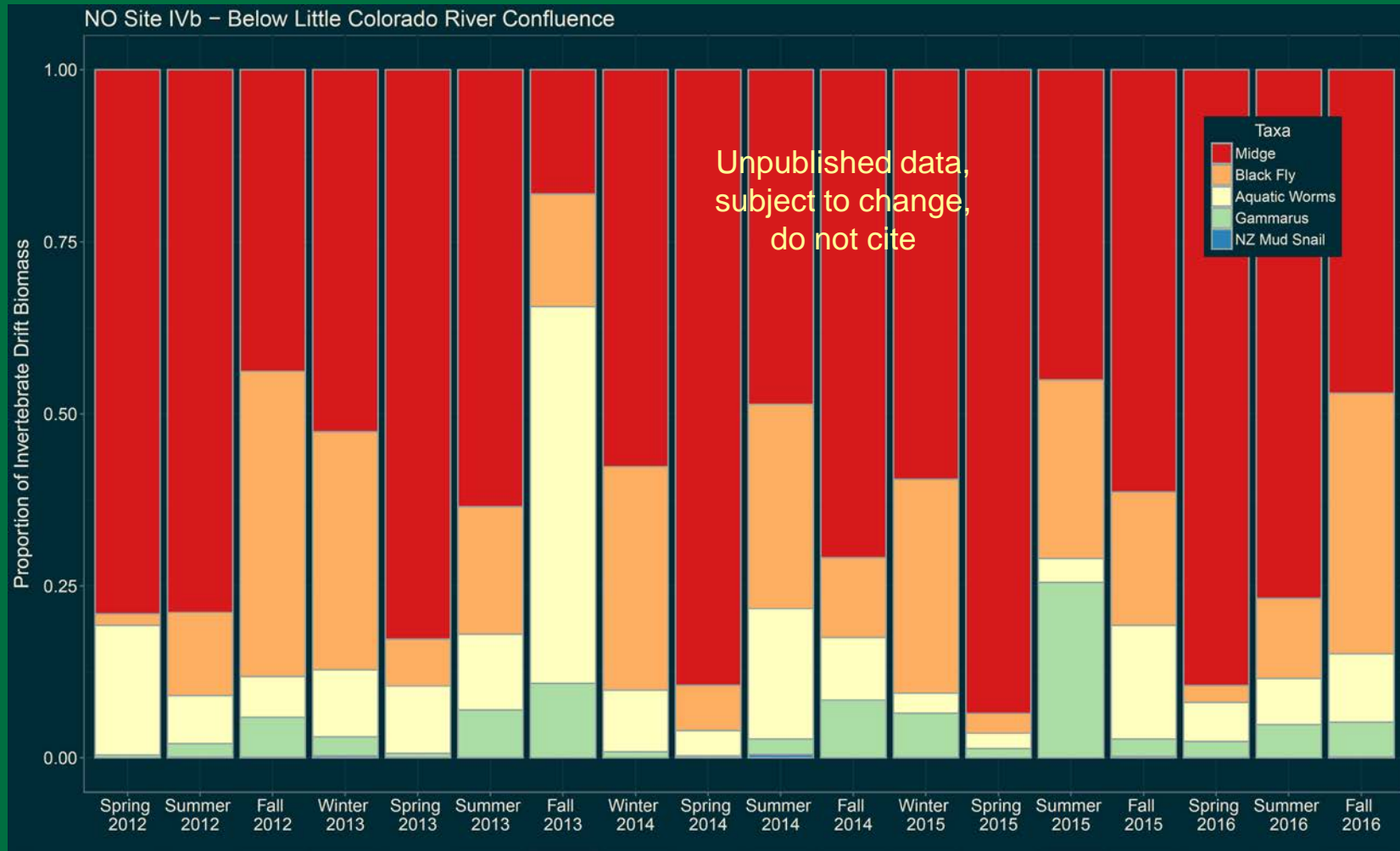
Fall HFEs:

Deteriorating Food Base, Moderate Concern

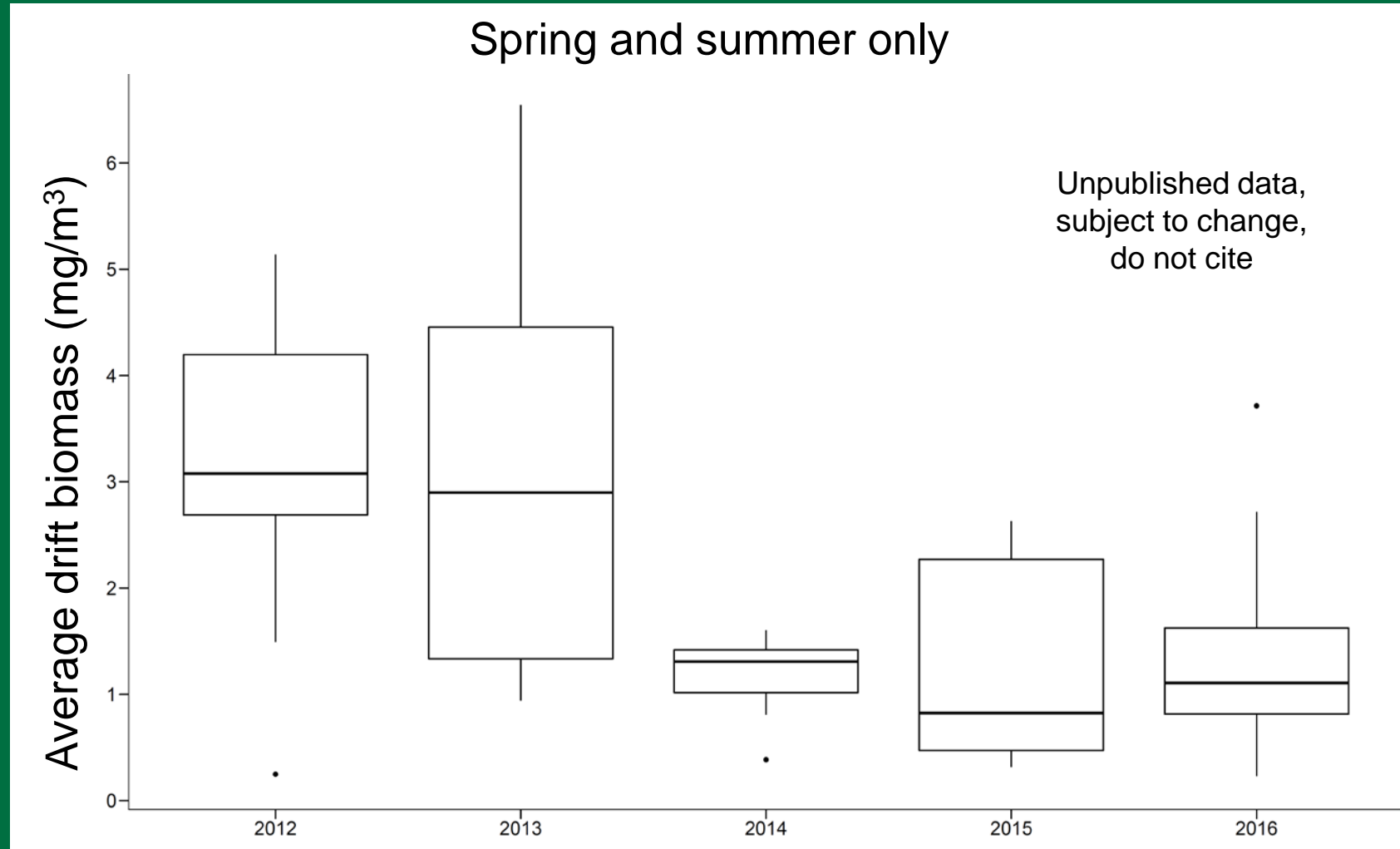


LCR Confluence

Midges and blackflies dominate



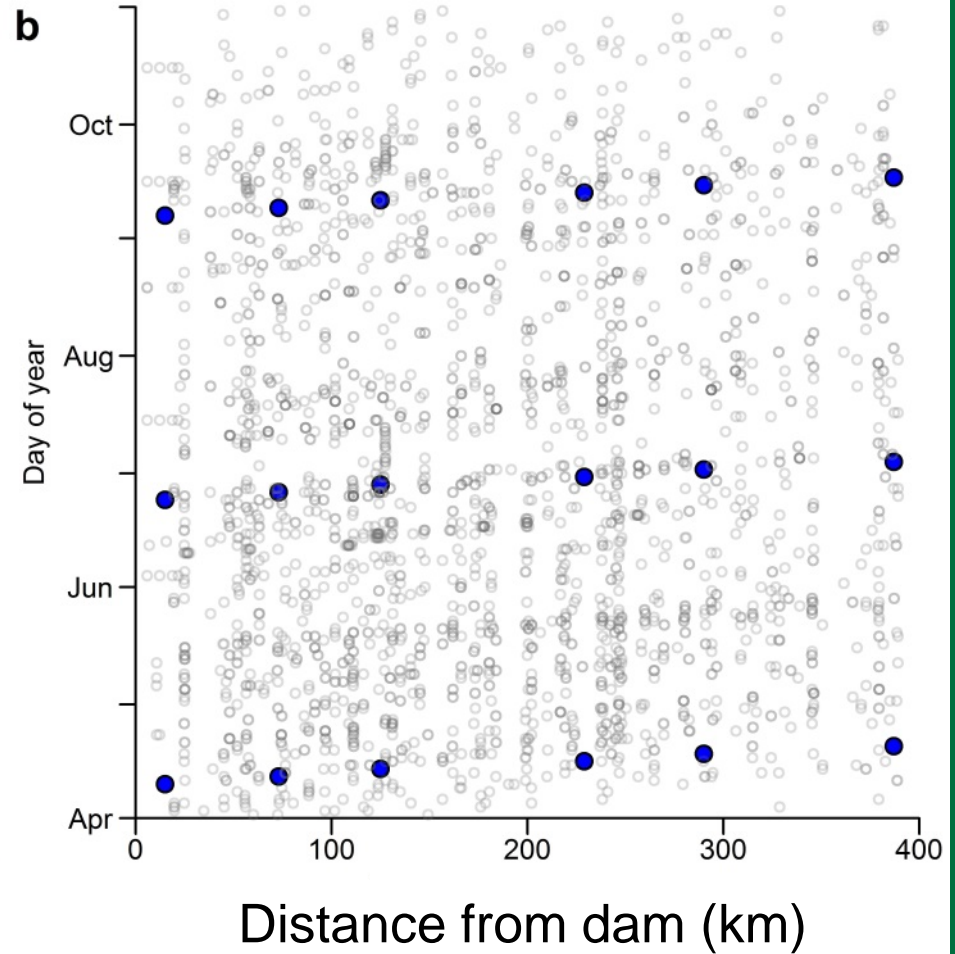
LCR confluence: Deteriorating Food Base, Significant Concern



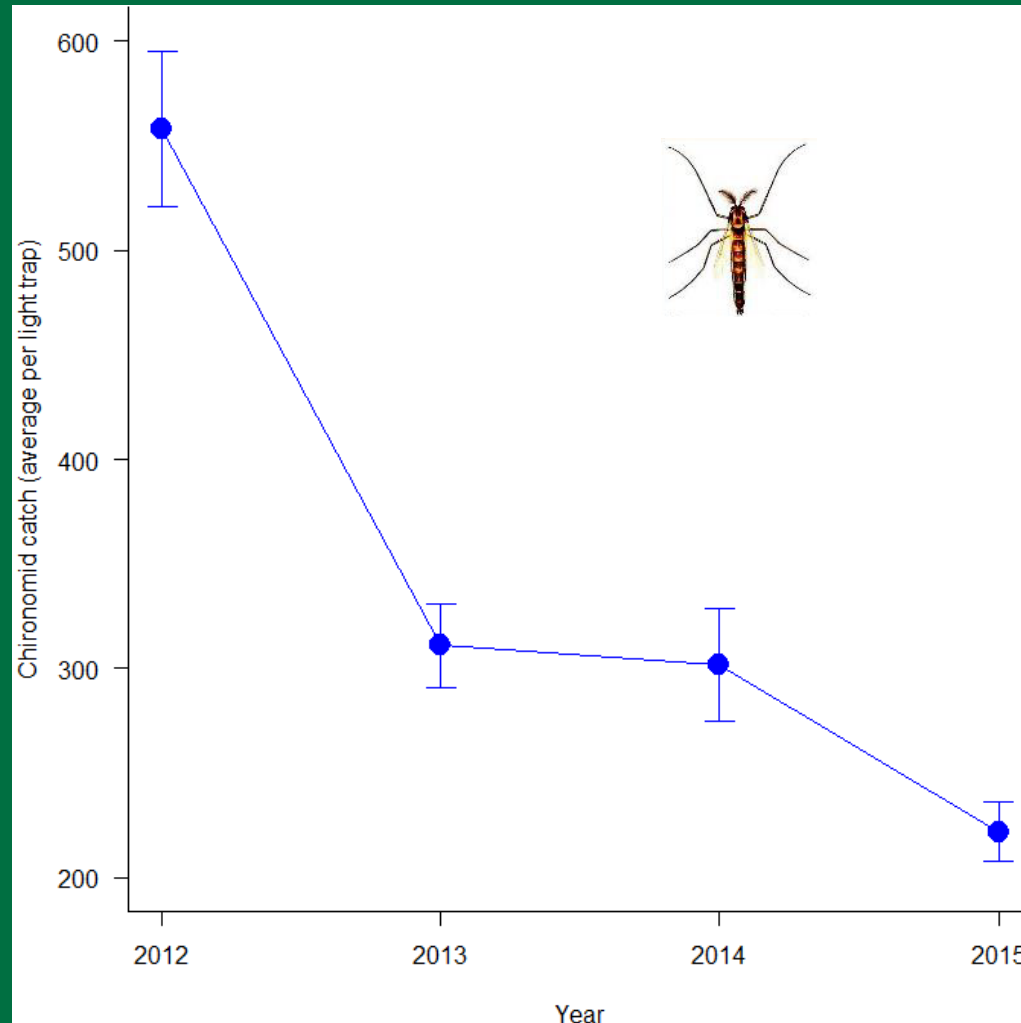
Drift biomass decreased by >50% over period of record
Correlates strongly with drop in native fish condition (Yackulic presentation)

Citizen science in Grand Canyon 2012-2015

N > 3000



Marble and Grand Canyon: Deteriorating Food Base, Significant Concern



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Midge catch rates decreased by >50% over period of record
Correlates strongly with drop in native fish condition (Yackulic presentation)

Foodbase Knowledge Assessment

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Effects of Three High-Flow Experiments
on the Colorado River Ecosystem
Downstream from Glen Canyon Dam, Arizona



Circular 1366

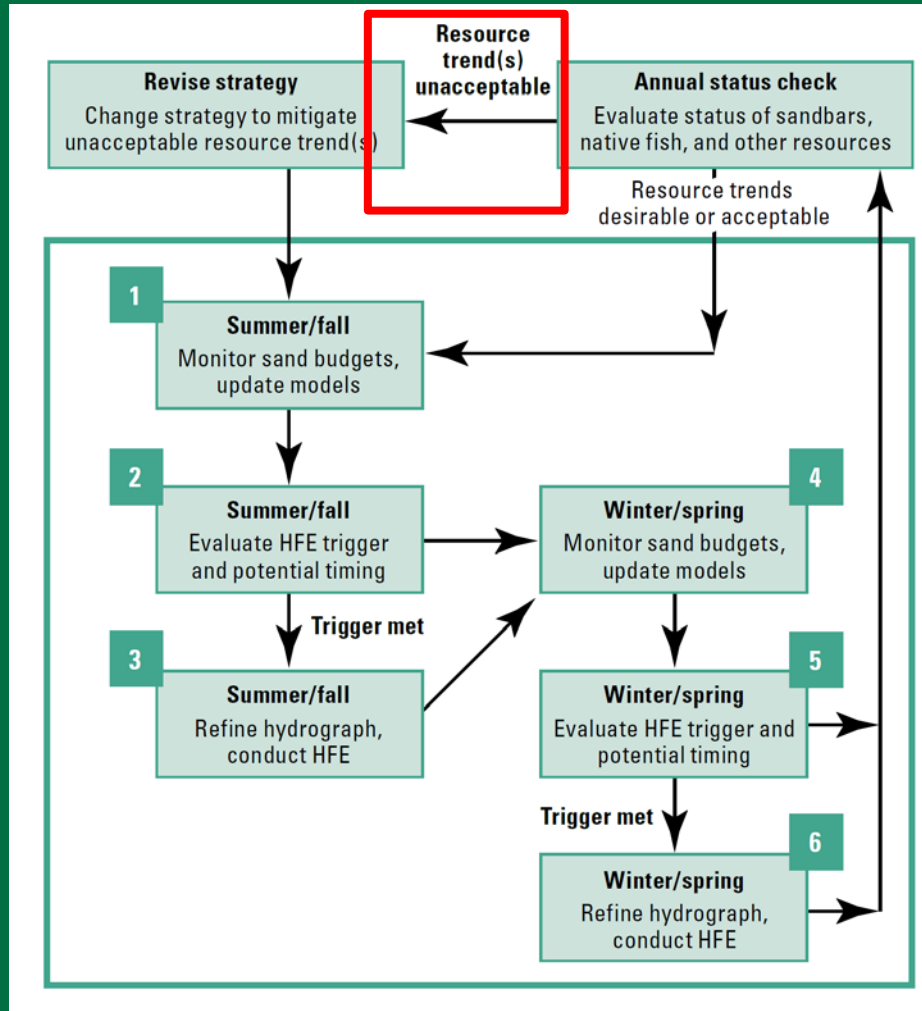
U.S. Department of the Interior
U.S. Geological Survey

***“The fundamental fish-related science question is:
Does the seasonal timing of controlled floods influence rainbow trout response?”***

-From Wright and Kennedy, 2011, Science-based strategies for future high flow experiment

ANSWER: Yes, flood timing influences rainbow trout response. Fall-timed floods are bad-to-neutral for foodbase.

Resource Trends Unacceptable?



“The annual status check would consist of reviewing available monitoring data and scientific interpretations. If any resource trends are deemed to be unacceptable by natural-resource managers (for example, rainbow trout response), other HFE implementation options could be considered (some examples are presented in table 1).”

-From Wright and Kennedy, 2011, HFE Circular

HFE Menu

Table 1. Various options for high-flow experiments (HFEs). The options in this table generally trend from top to bottom, from options based solely on “tributary sand-input triggers” (HFEs are tied to the amount of sand stored in the river) to those that are less dependent on sand storage but more dependent on seasonal timing.

Option number	HFE timing and frequency	HFE magnitude and duration
1	Immediately following sand inputs, if sand storage in the river reaches the trigger level	Based on sand storage conditions in the river before the HFE
2	Fall and spring, if sand storage in the river reaches the trigger level	Based on sand storage conditions in the river before the HFE
3	Fall, if sand storage in the river reaches the trigger level	Based on sand storage conditions in the river before the HFE
4	Every spring; fall, if sand storage in the river reaches the trigger level	Spring HFEs unknown because not based on sand storage conditions in the river before the HFE; fall HFEs based on sand storage conditions
5	Spring, if sand storage in the river reaches the trigger level	Based on sand storage conditions in the river before the HFE
6	Every spring	Unknown because not based on sand storage conditions in the river before the HFE
7	Every fall	Unknown because not based on sand storage conditions in the river before the HFE

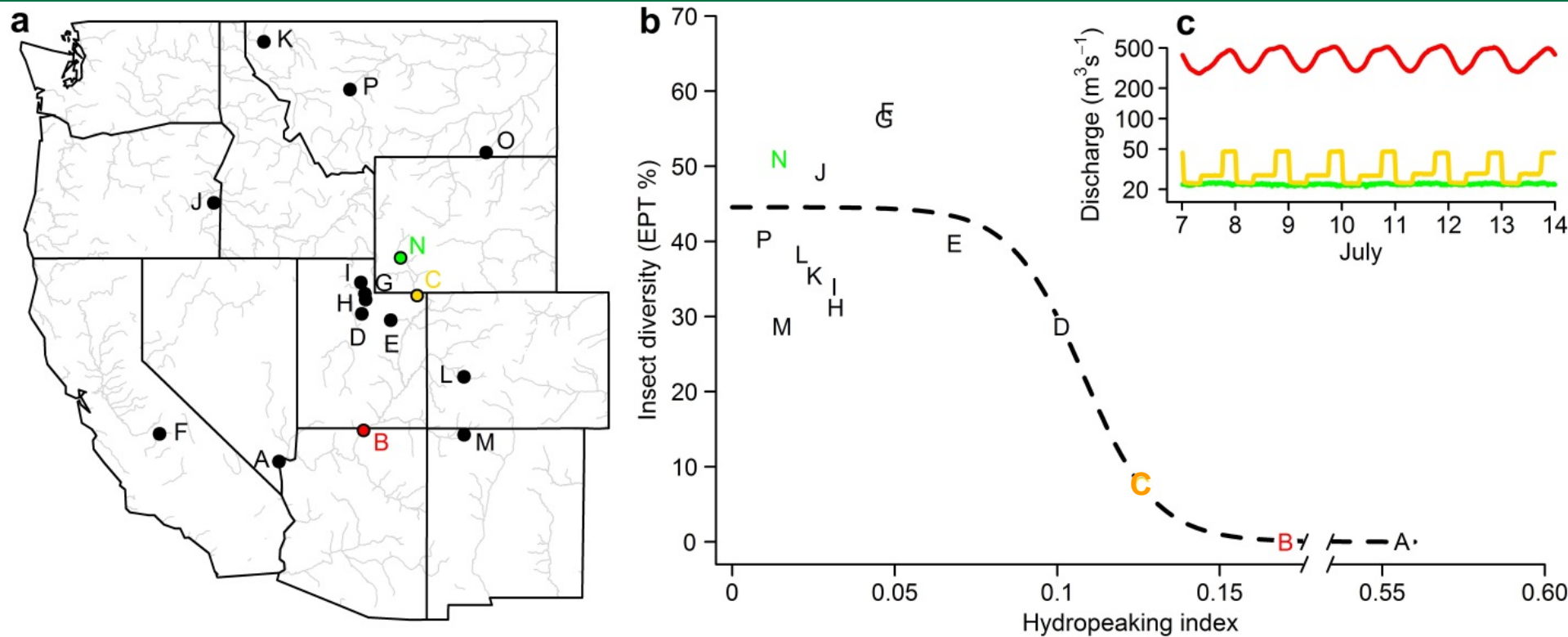
Current HFE implementation strategy based on option #2.

But other HFE implementation options exist, including ones that would lead to primarily spring-timed HFEs

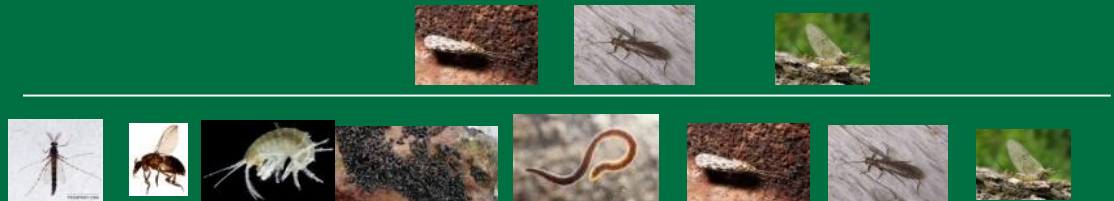


-From Wright and Kennedy, 2011, HFE Circular

But we're not playing with a full deck



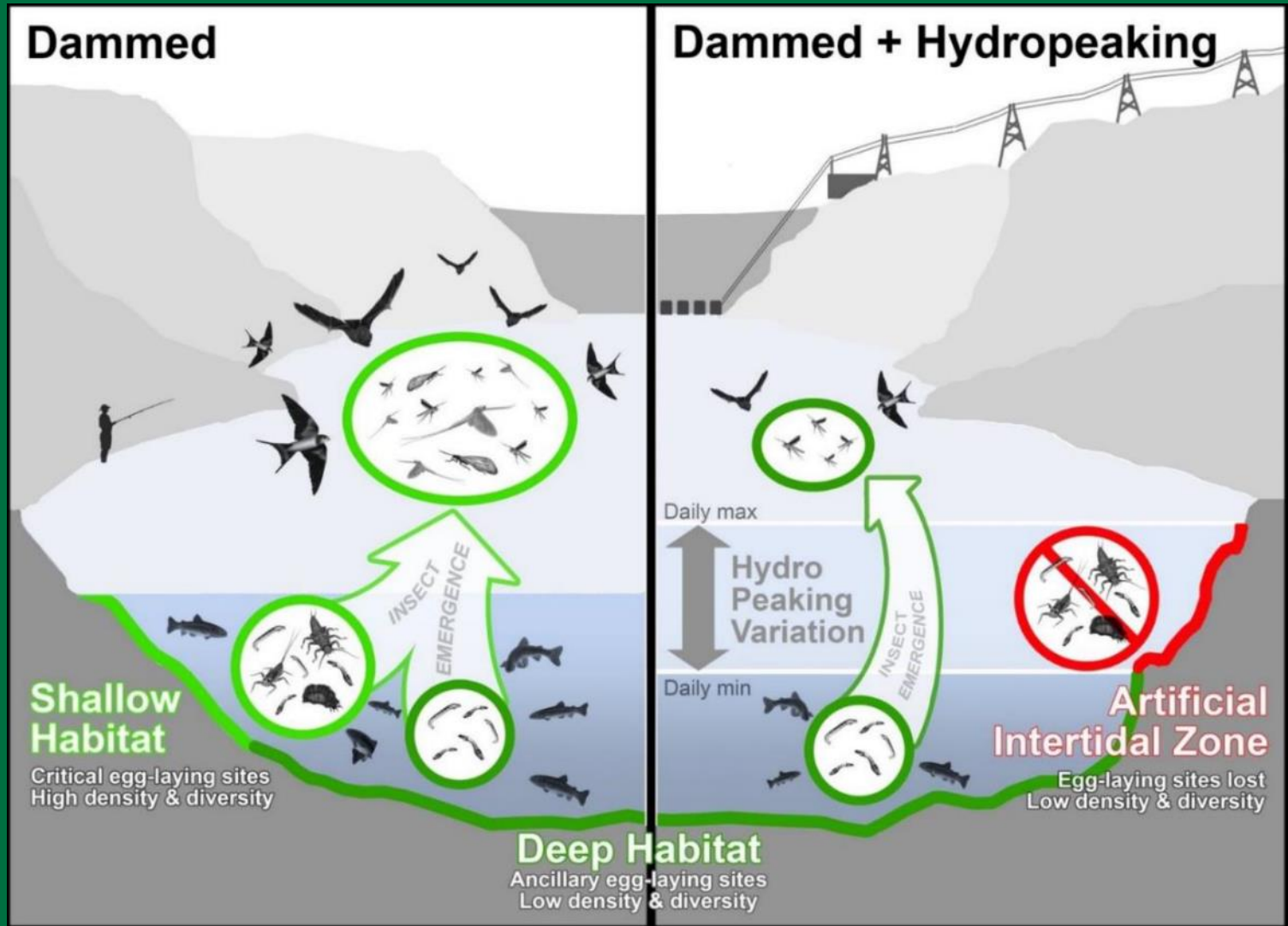
$$\text{EPT} = \frac{\text{\# of } E, P, T}{\text{total \# of invertebrates}} =$$



From Kennedy and others
(2016) BioScience

Hydropeaking index = Daily CV of discharge over 5+ yrs

Recruitment limitation



Hydropeaking strands a lot of midge eggs



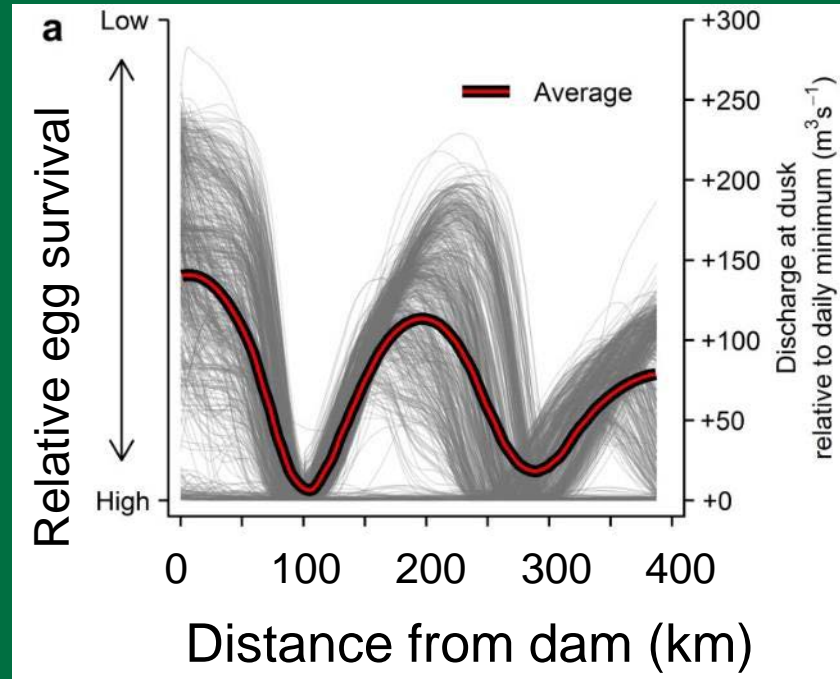
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Dusk
>1,000,000
eggs

Dawn
>10,000
eggs

Consistent timing of daily tides

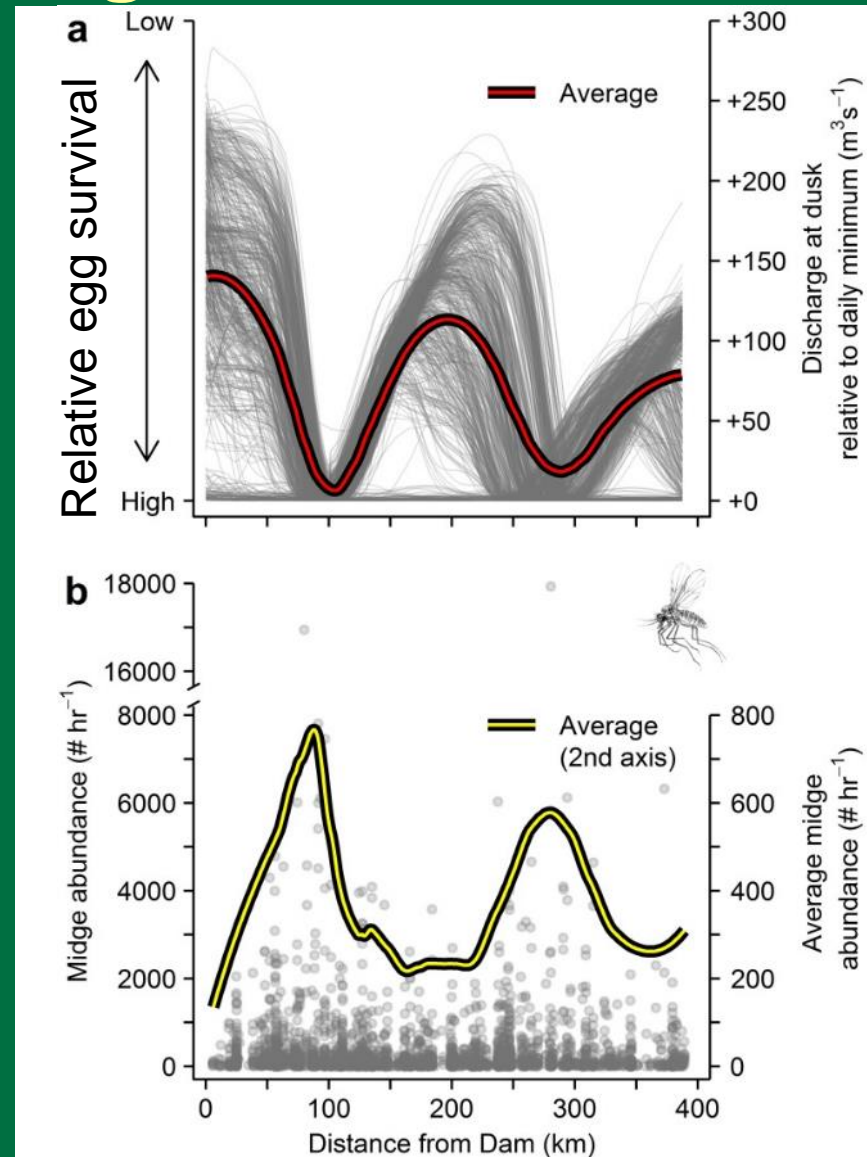


Spatial periodicity in midge abundance

Midges: 3X greater at nodes



From Kennedy and others
(2016) BioScience

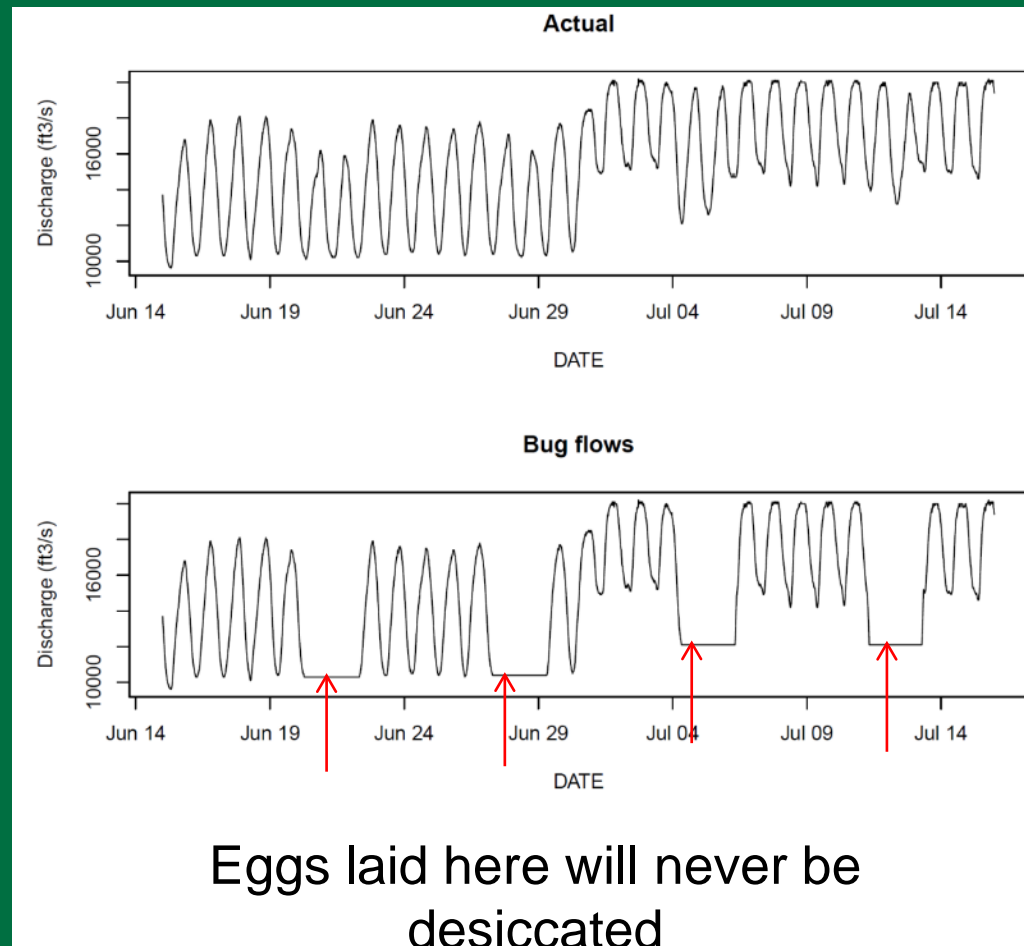


Give bugs the weekend off!!

- Steady/low flows weekends May-Aug (36-38d/yr)
- Periodically create ideal egg-laying conditions



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Conclusions

1) Foodbase was already bad

- No EPT species for >30years

2) And it's getting worse



- Midges and blackflies, declining or scarce



- NZMS, increasing or abundant

3) To improve Food Base:

- consider Bug Flows

- consider Spring HFEs



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