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# Foodweb Update

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

# Outline

- 1) Previous findings—food limitation of fishes
- 2) Why are fish food limited?
  - Invertebrate assemblage is IMPAIRED
- 3) Evidence that normal dam operations affect extant prey base
  - Drift studies
  - Emergence studies
- 4) Conclusions

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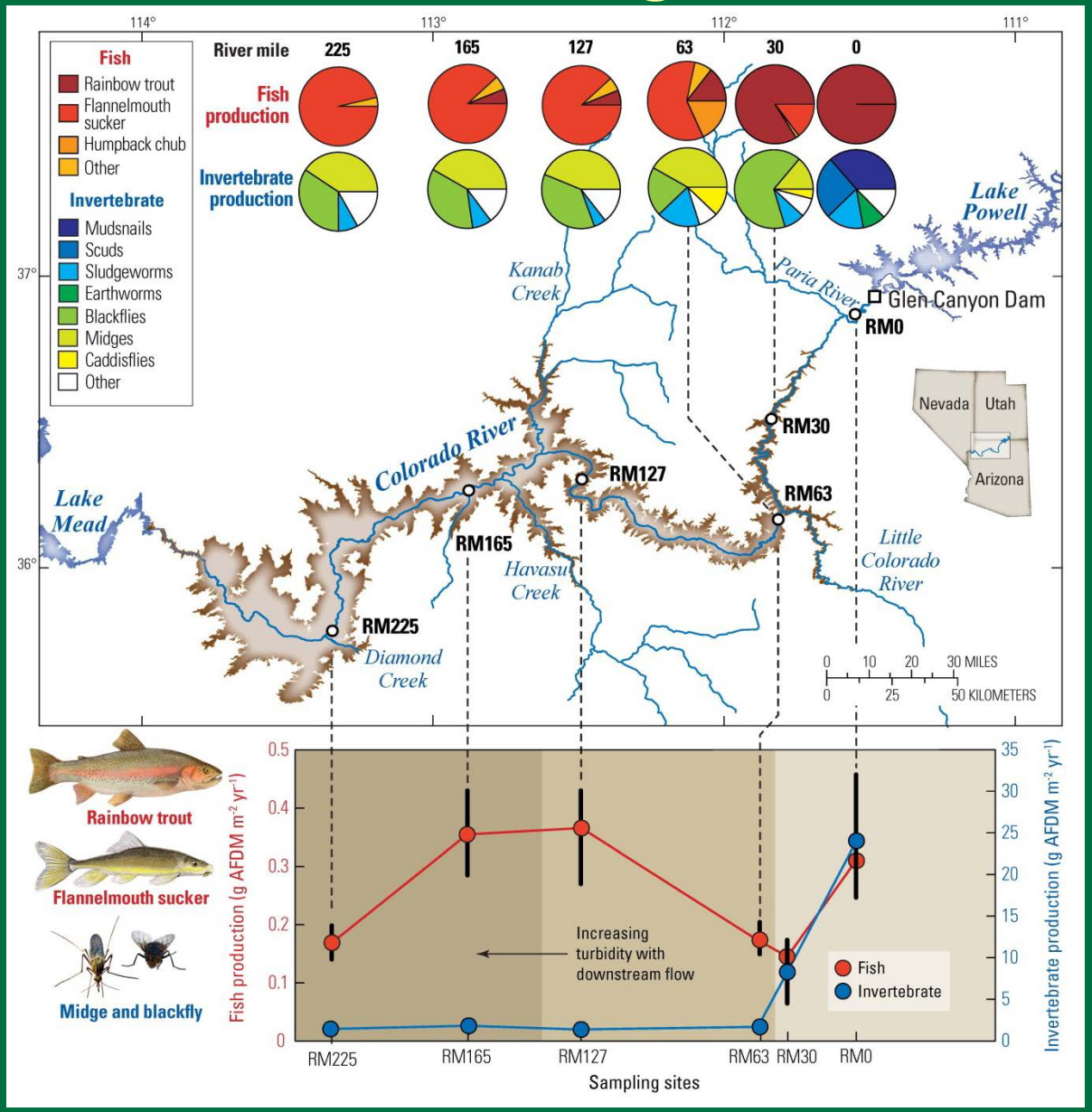
# Previous findings

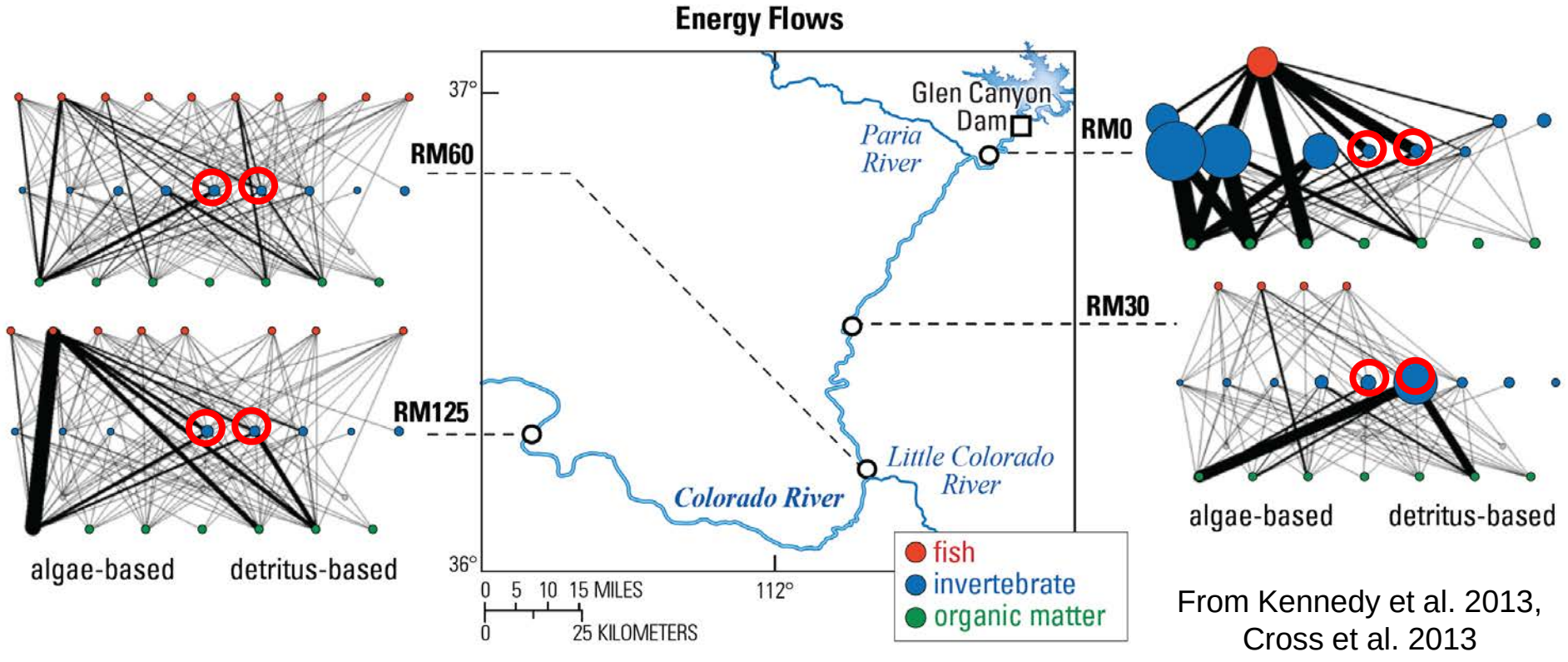



Invertebrate production
-Downstream decline
-Shift towards aquatic insects

Fish production
-No pronounced decline
-Shift from trout to bottom-feeding suckers

From: Kennedy et al. 2013, Cross et al. 2013

# Previous findings




From Kennedy et al. 2013, Cross et al. 2013

--Fish populations are food limited.
--Food web in Glen Canyon is simple and unstable.
--Midges and blackflies key prey items everywhere.
--Midges and blackflies are the only aquatic insects.

# But is having only two types of insects unusual for a tailwater?

- **%EPT: Nationally accepted metric for assessing stream health**
  - ***DIRECT measure of the ability of a stream to support aquatic life***

Ephemeroptera (mayflies)

Plecoptera (stoneflies)

Trichoptera (caddisflies)

# But is having only two types of insects unusual for a tailwater?

- %EPT: Nationally accepted metric for assessing stream health
  - *DIRECT measure of the ability of a stream to support aquatic life*

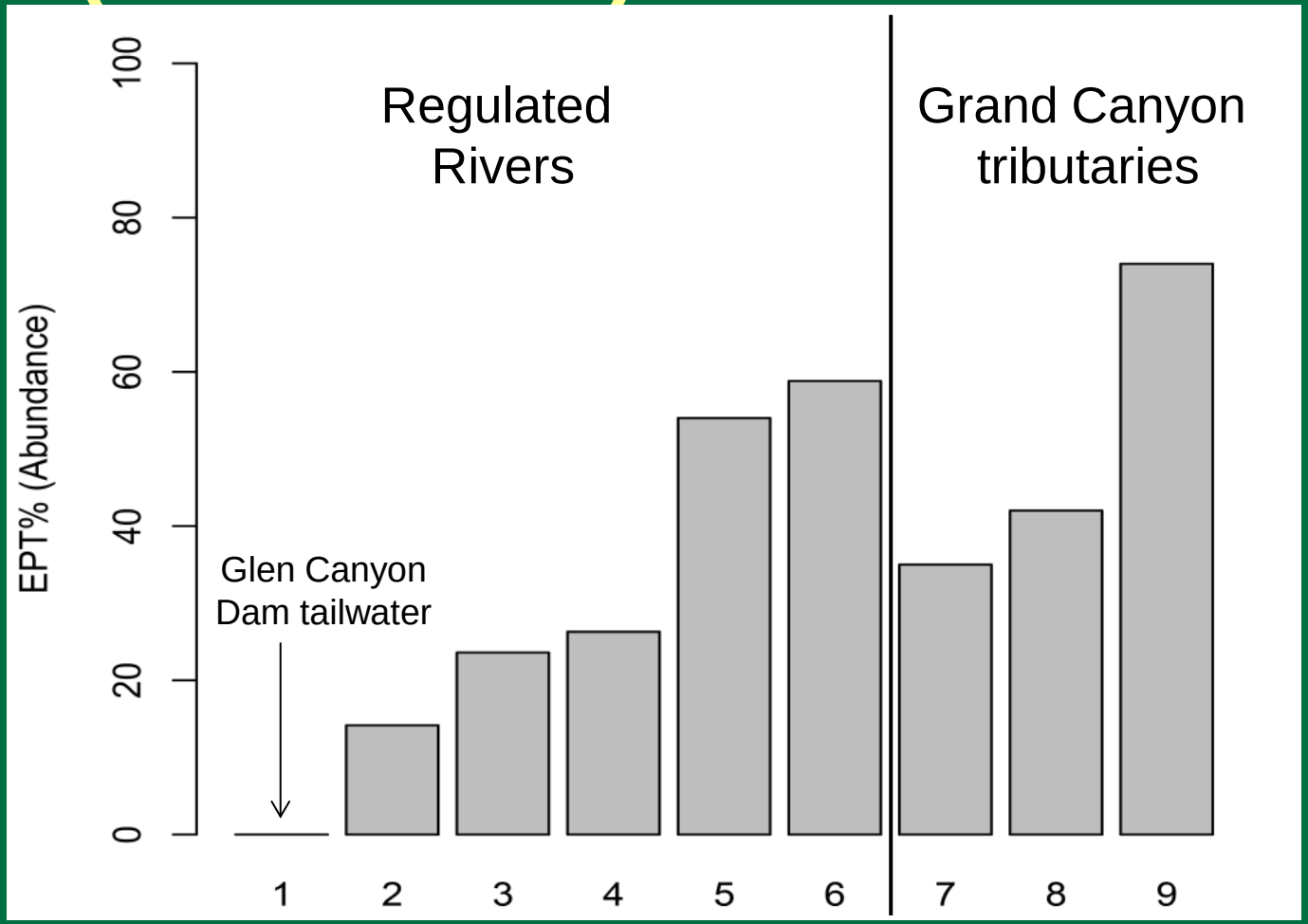
Ephemeroptera (mayflies)

Plecoptera (stoneflies)

Trichoptera (caddisflies)

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

# Yes, having only two types of insects (and no EPT) is unusual

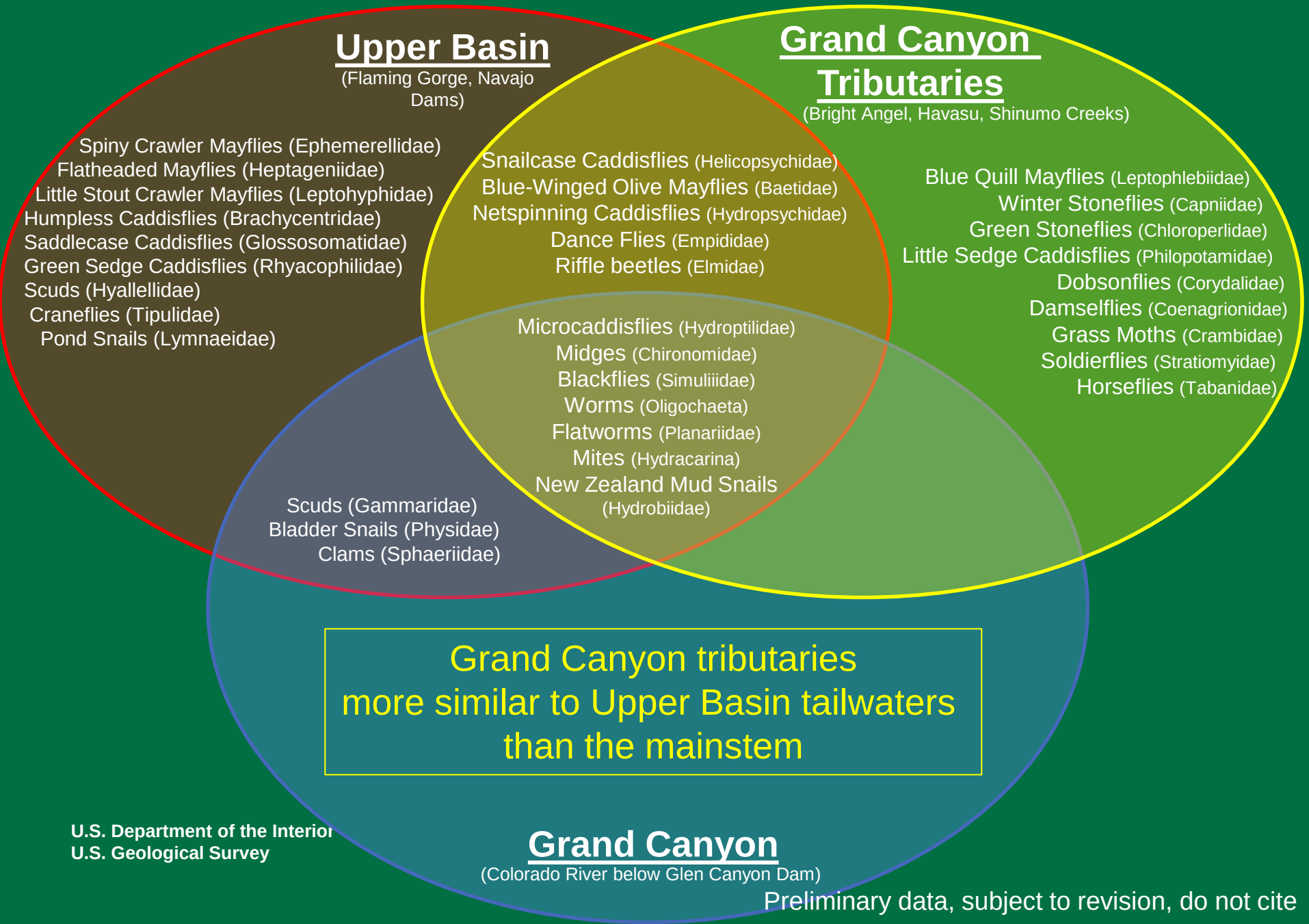



Glen Canyon invertebrate assemblage is IMPAIRED

Key: 1) Colorado River, 2) Kootenai River, 3) Flathead River, 4) Green River, 5) Madison River, 6) San Juan River, 7) Bright Angel Creek, 8) Shinumo Creek, 9) Havasu Creek. Grand Canyon tributary data courtesy of Brian Healy, NPS. Regulated rivers data courtesy of Kim Dibble, USGS.

Preliminary data, subject to revision, do not cite

# Aquatic Invertebrate Families in the Colorado River Basin

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Colorado River in Glen Canyon: Genera Richness= 7, EPT= 0

Green River below Flaming Gorge Dam: Genera Richness =29, EPT=14

Grand Canyon Tributaries (Bright Angel, Shinumo, Havasu): Genera Richness= 28, EPT= 14

San Juan River below Navajo Dam: Genera Richness= 13, EPT=5

Preliminary data, subject to revision, do not cite

# Why are there so few aquatic insects in the Colorado River?

Pre-dam invertebrates

Post-dam invertebrates

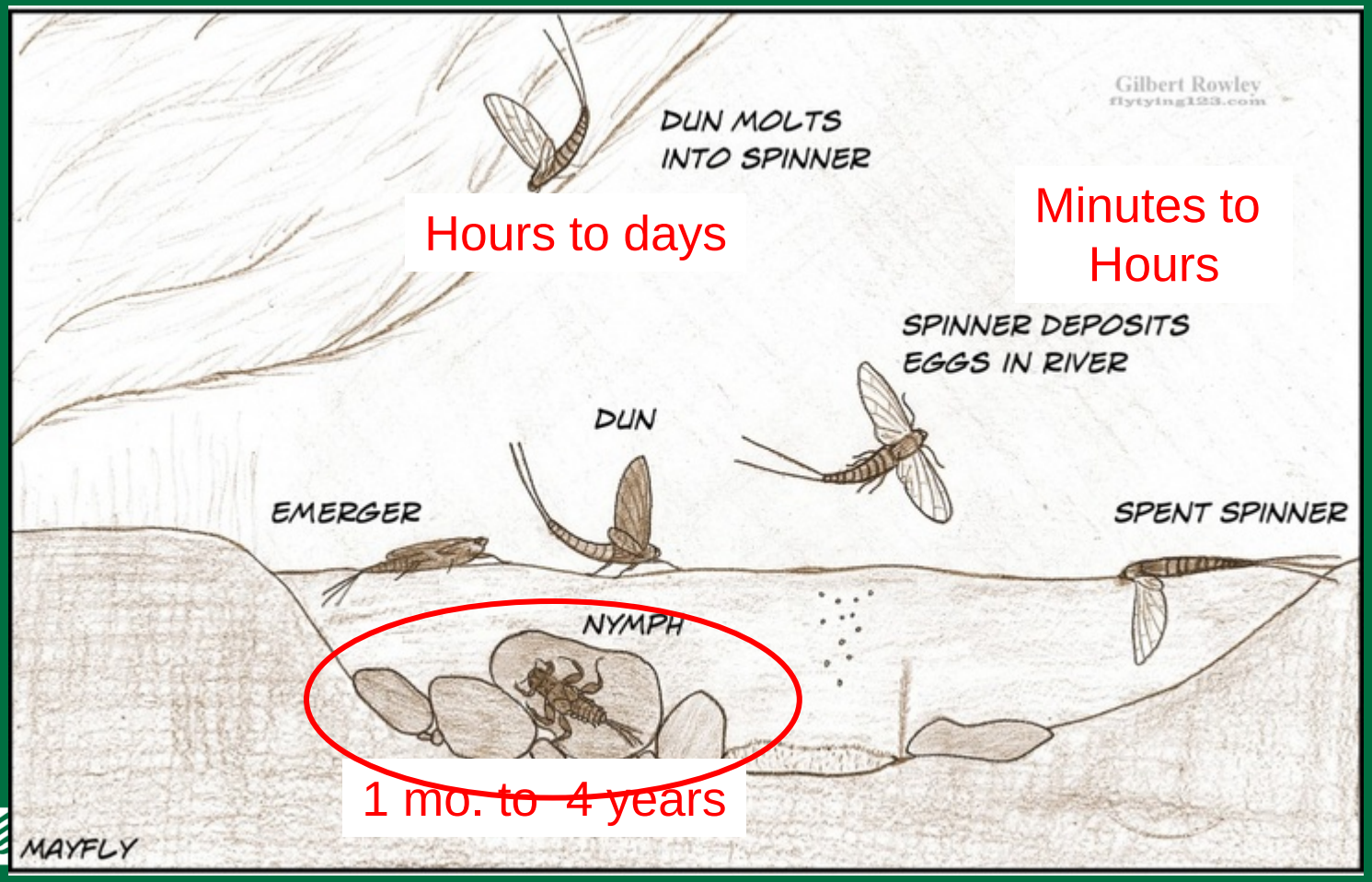
Ephemeroptera (mayflies)

Plecoptera (stoneflies)


Trichoptera (caddisflies)

Preliminary data, subject to revision, do not cite

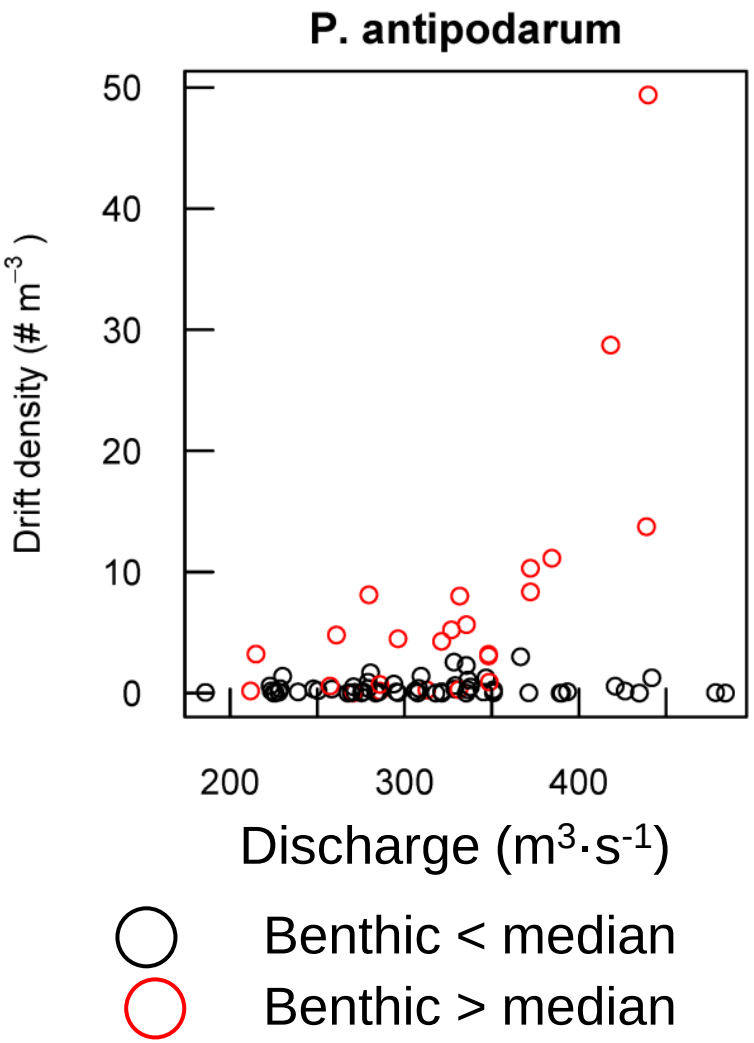
# Aquatic Insects Have Complex Life Cycles

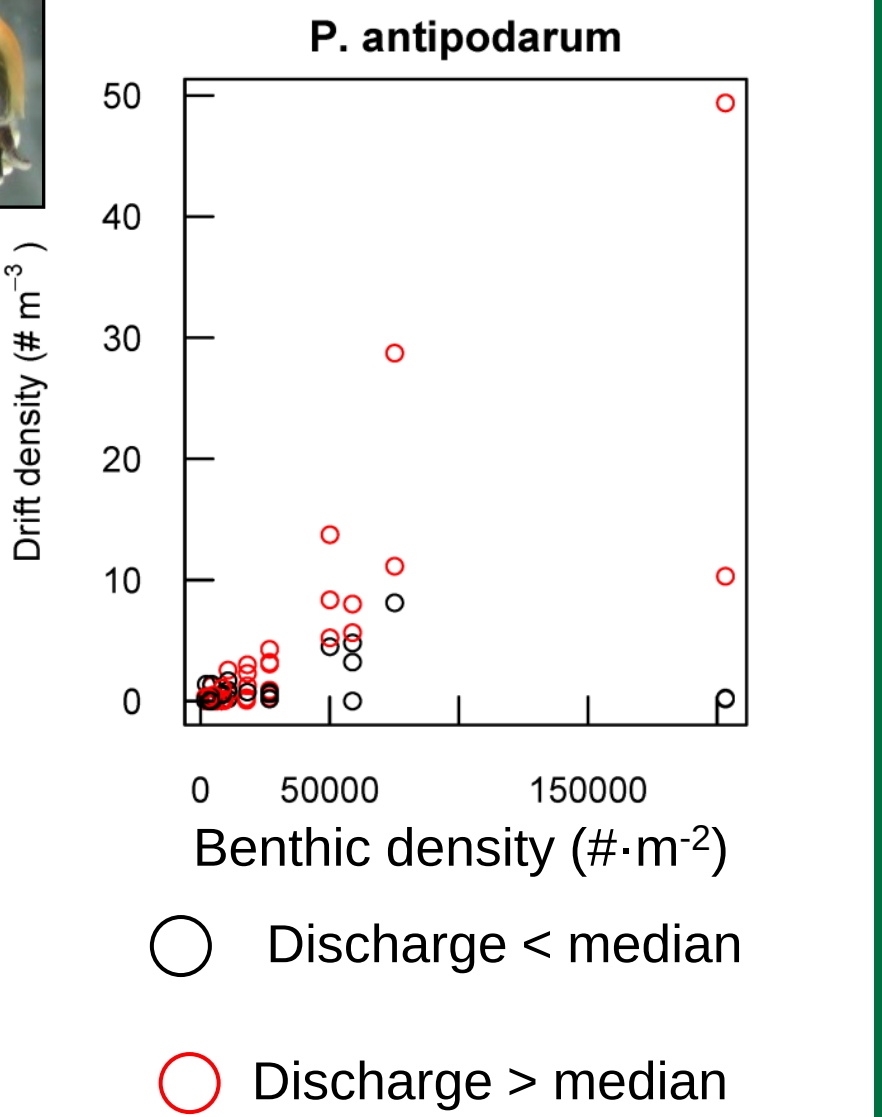


# Invertebrate drift

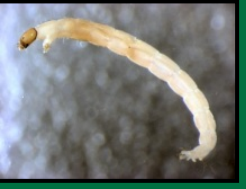
# Drift increases exponentially with discharge

# But benthic density is also an important control



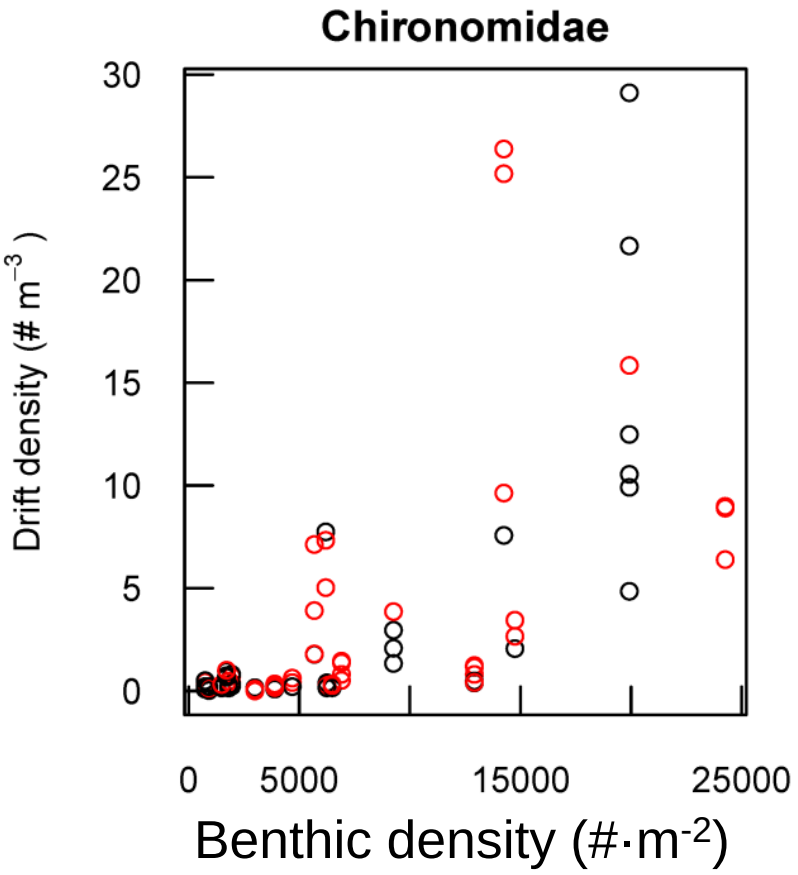




Kennedy et al. 2014, supporting online information



# Discharge and benthic densities jointly control drift concentrations

## Benthic→Drift

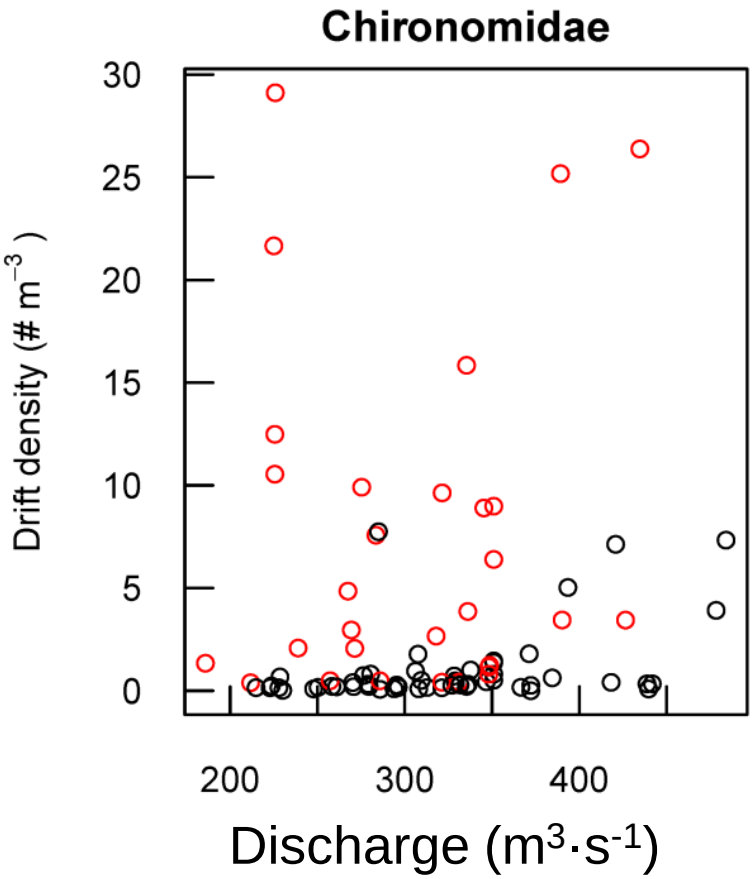



Discharge < median

Discharge > median

Kennedy et al. 2014, supporting online information

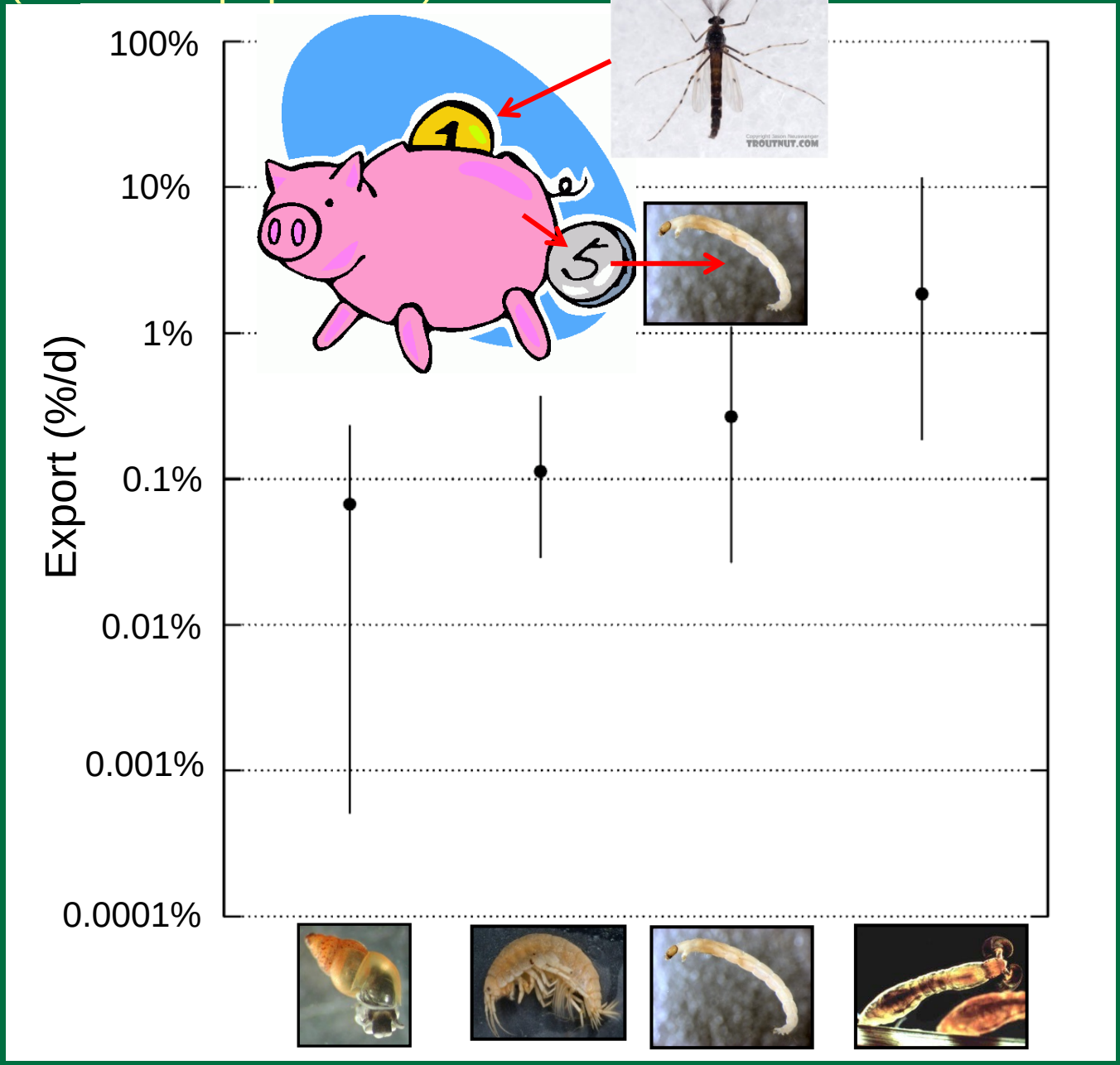
## Discharge→Drift




Benthic < median

Benthic > median

# Daily export of Glen Canyon invertebrates past Lees Ferry (% of total population)




Banking analogy:

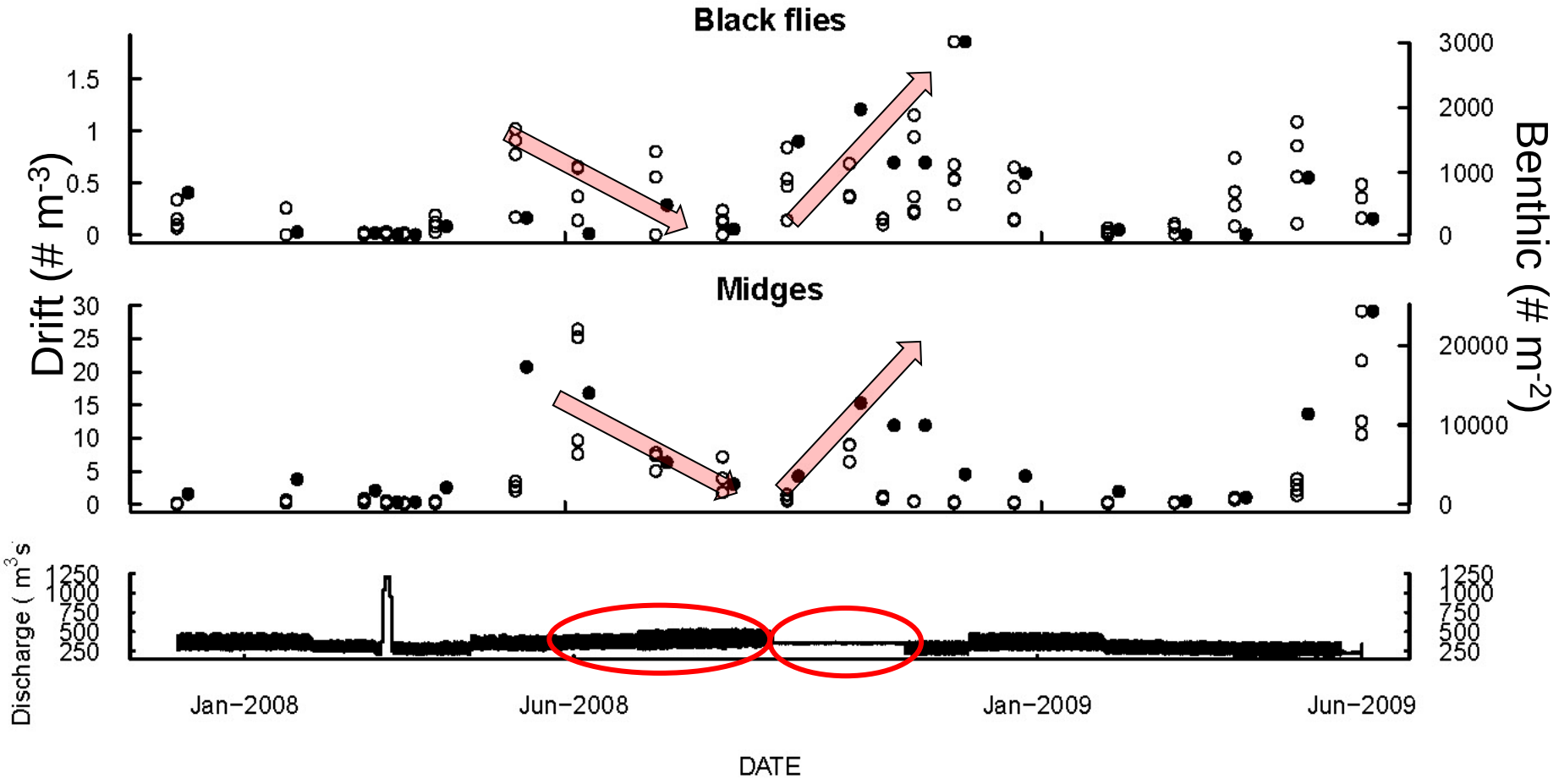
Larval drift export = withdrawals

Adult Egg laying = deposits

To grow account, withdrawals (drift) must be less than interest off principal (via egg laying)

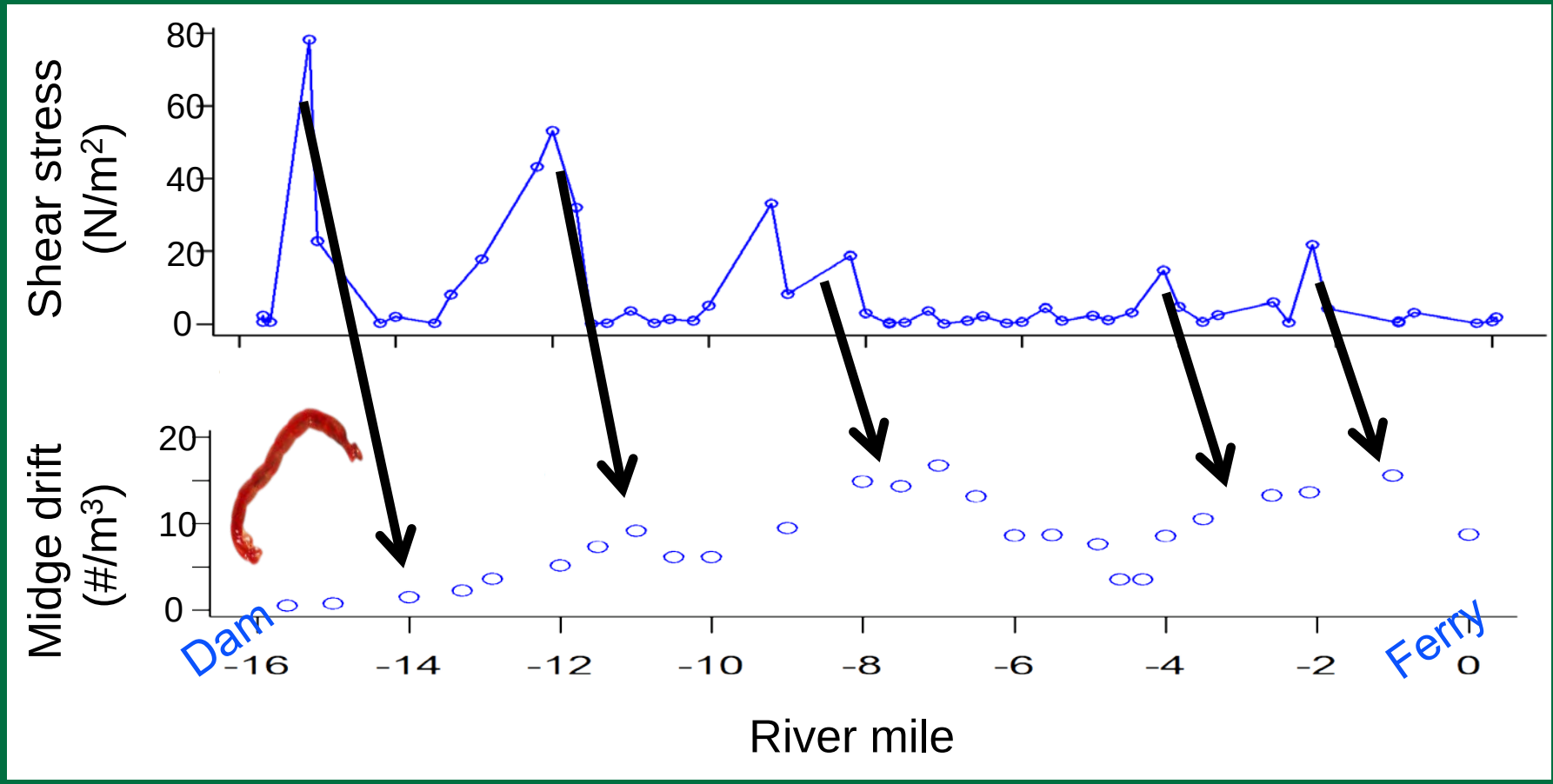
Kennedy et al. 2014

# Evidence for Negative Feedbacks




Preliminary data, subject to revision, do not cite

# Drift varies spatially, highest below riffles

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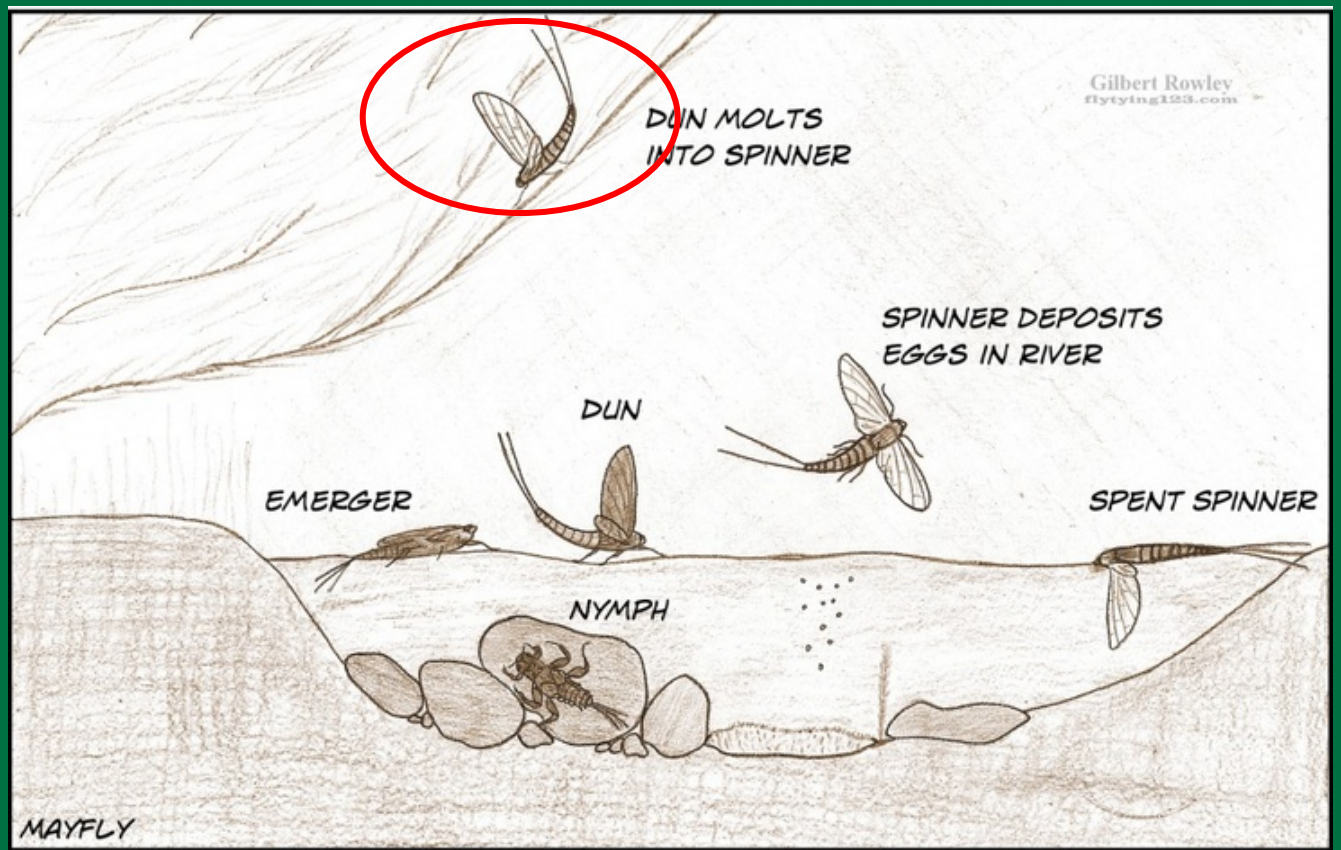
# Emergence

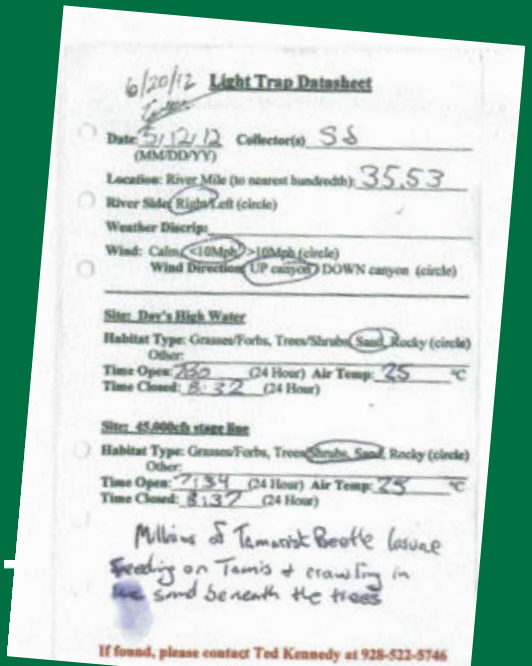
- Advantages of this approach:
  - Critical life stage for aquatic insects
  - Integrated in space and time




See poster on new sticky trap method

# Methods

- Standardized light trapping conducted every night in camp
  - Guides paid $10/sample to ensure high quality data (2013 samples cost $6,000)



6/20/12 **Light Trap Datasheet**

Date: 5/12/12 (MM/DD/YY) Collector(s): SS

Location: River Mile (to nearest hundredth): 35.53

River Side: Right/Left (circle)

Weather Discrip:

Wind: Calm/<10Mph/>10Mph (circle)

Wind Direction: UP canyon/DOWN canyon (circle)

Site: Dav's High Water

Habitat Type: Grasses/Forbs, Trees/Shrubs, Sand, Rocky (circle)

Other:

Time Open: 1852 (24 Hour) Air Temp: 25 °C

Time Closed: 8:32 (24 Hour)

Site: 45,000cfs stage line

Habitat Type: Grasses/Forbs, Trees/Shrubs, Sand, Rocky (circle)

Other:

Time Open: 7:34 (24 Hour) Air Temp: 25 °C

Time Closed: 8:37 (24 Hour)

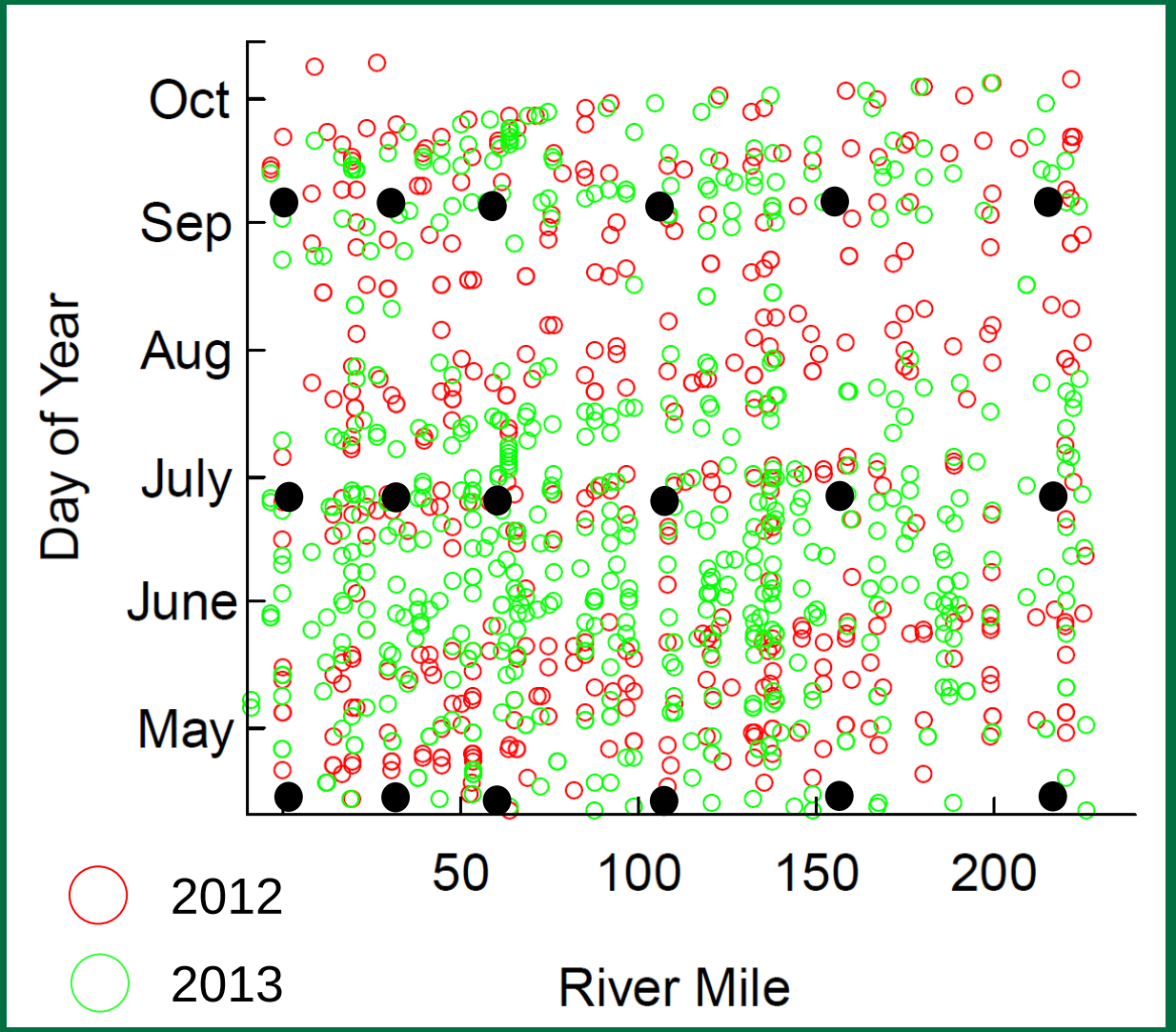
Millions of Tamarisk Beetle leaves feeding on Tamis & crawling in the sand beneath the trees

If found, please contact Ted Kennedy at 928-522-5746

# Now that's a dataset!

Because of 20+ dedicated river guides, we have a continuous record of insect emergence for Grand Canyon!

See poster on sample tracking

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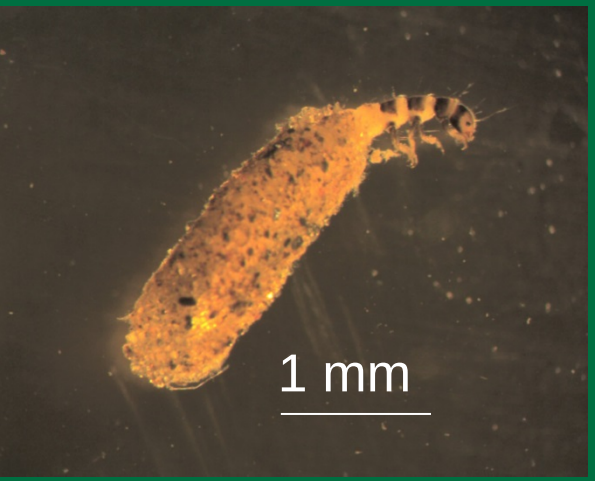
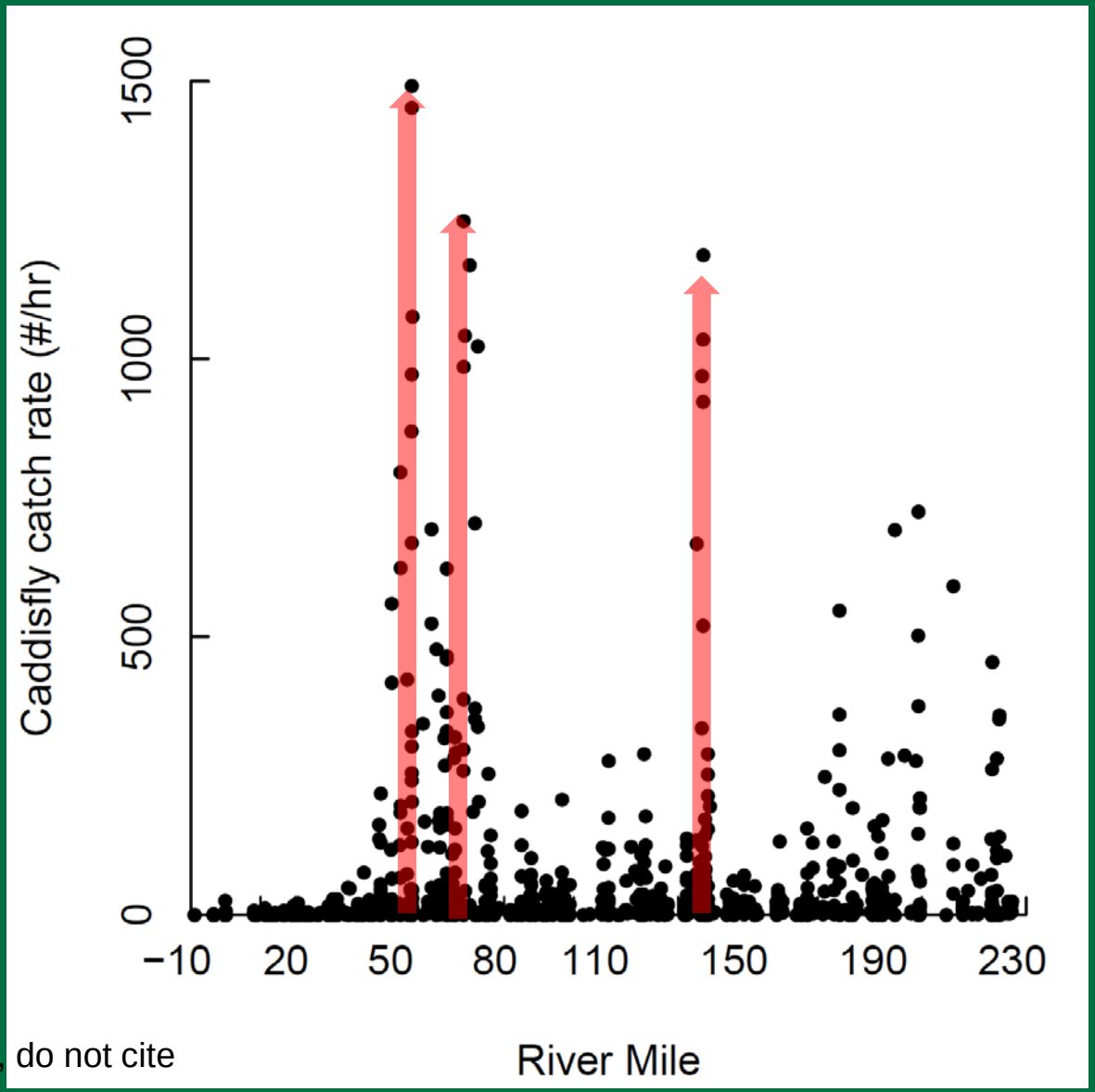
# Caddisflies in Grand Canyon

Trichoptera are present in Grand Canyon!

But they are tiny and functionally equivalent to midges




And strongly tied to tributaries

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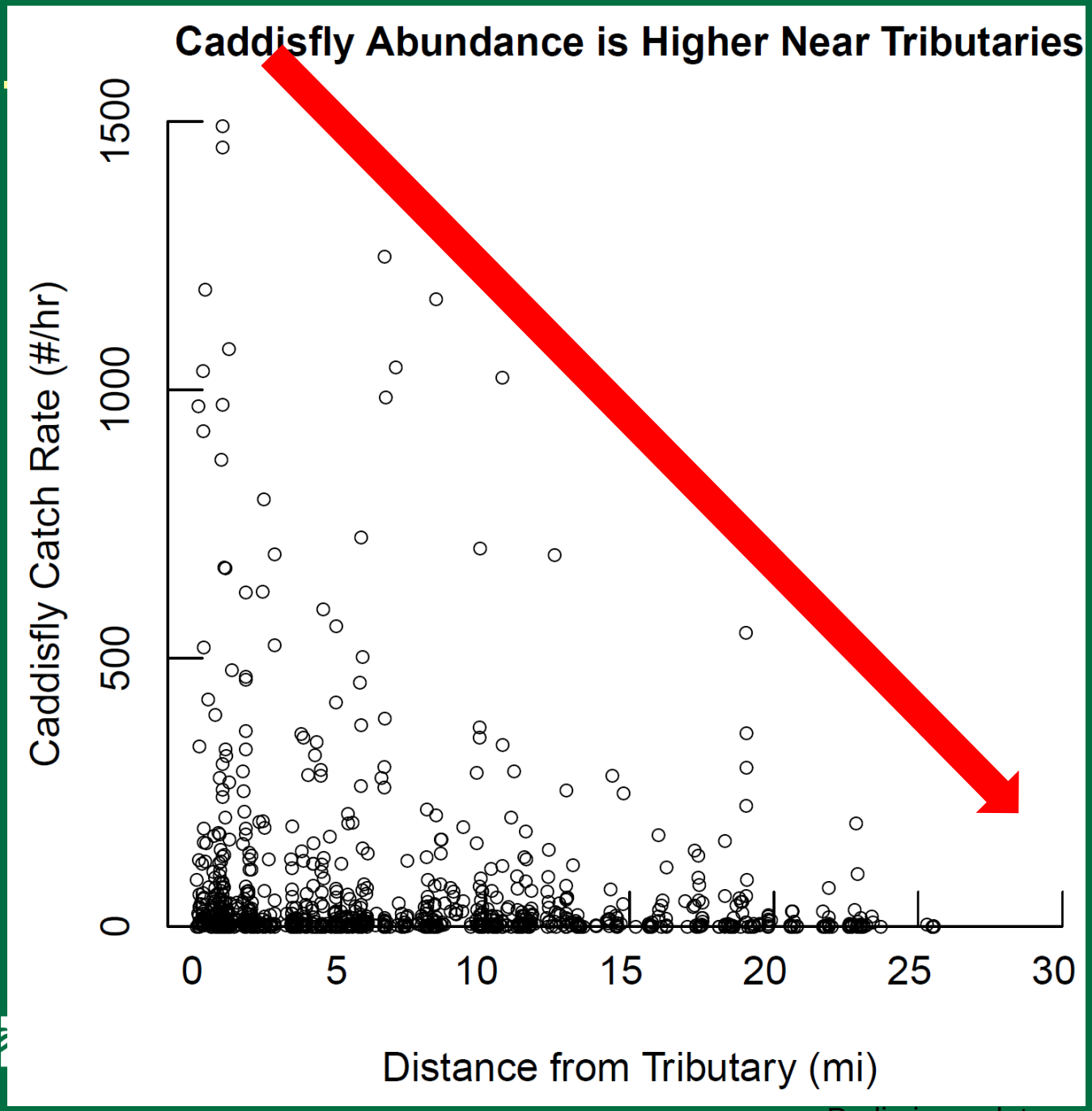
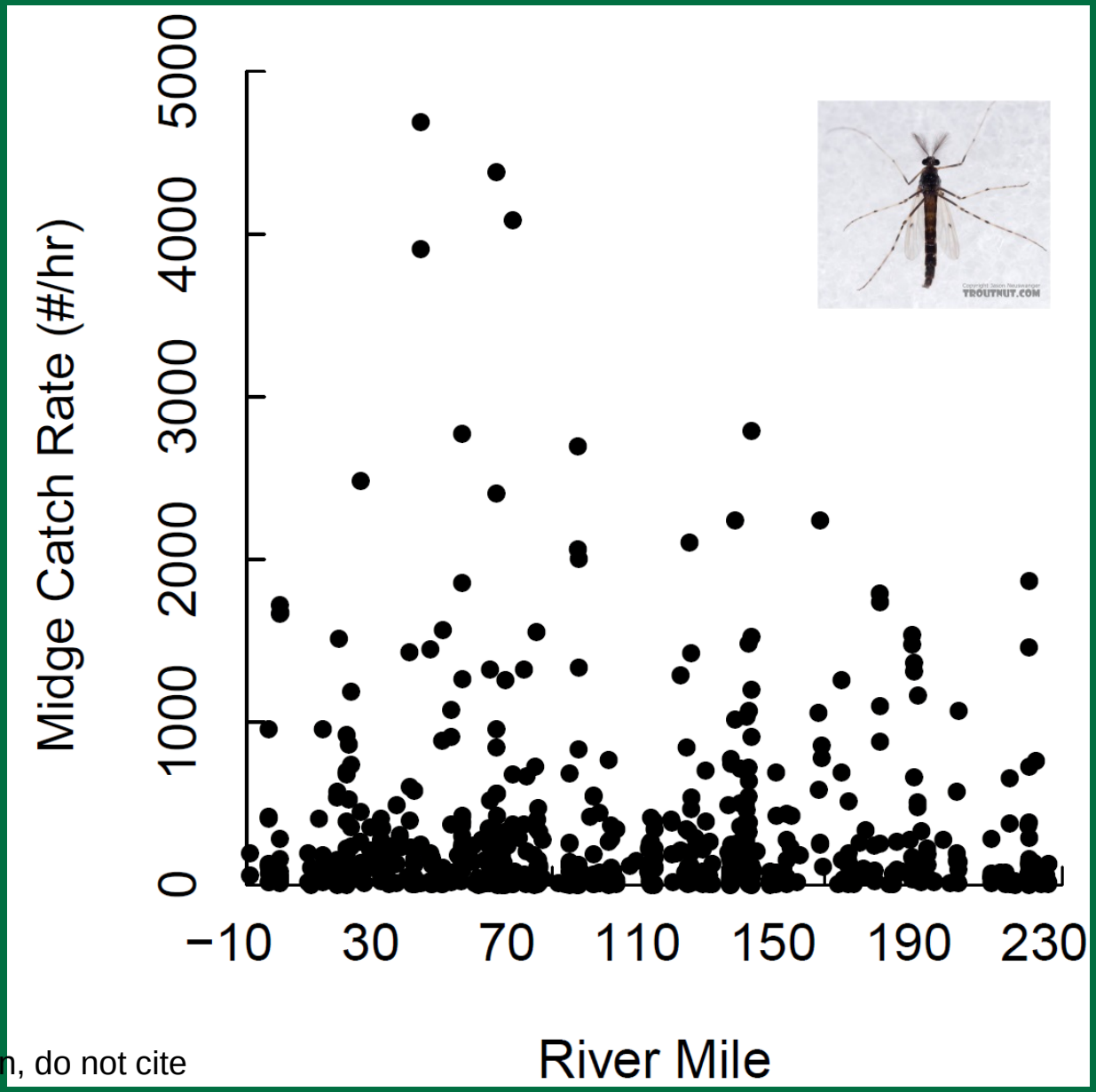



Preliminary data, subject to revision, do not cite

# Midge Emergence—Spatial Patterns

Peak in lower Marble Canyon, but abundant throughout

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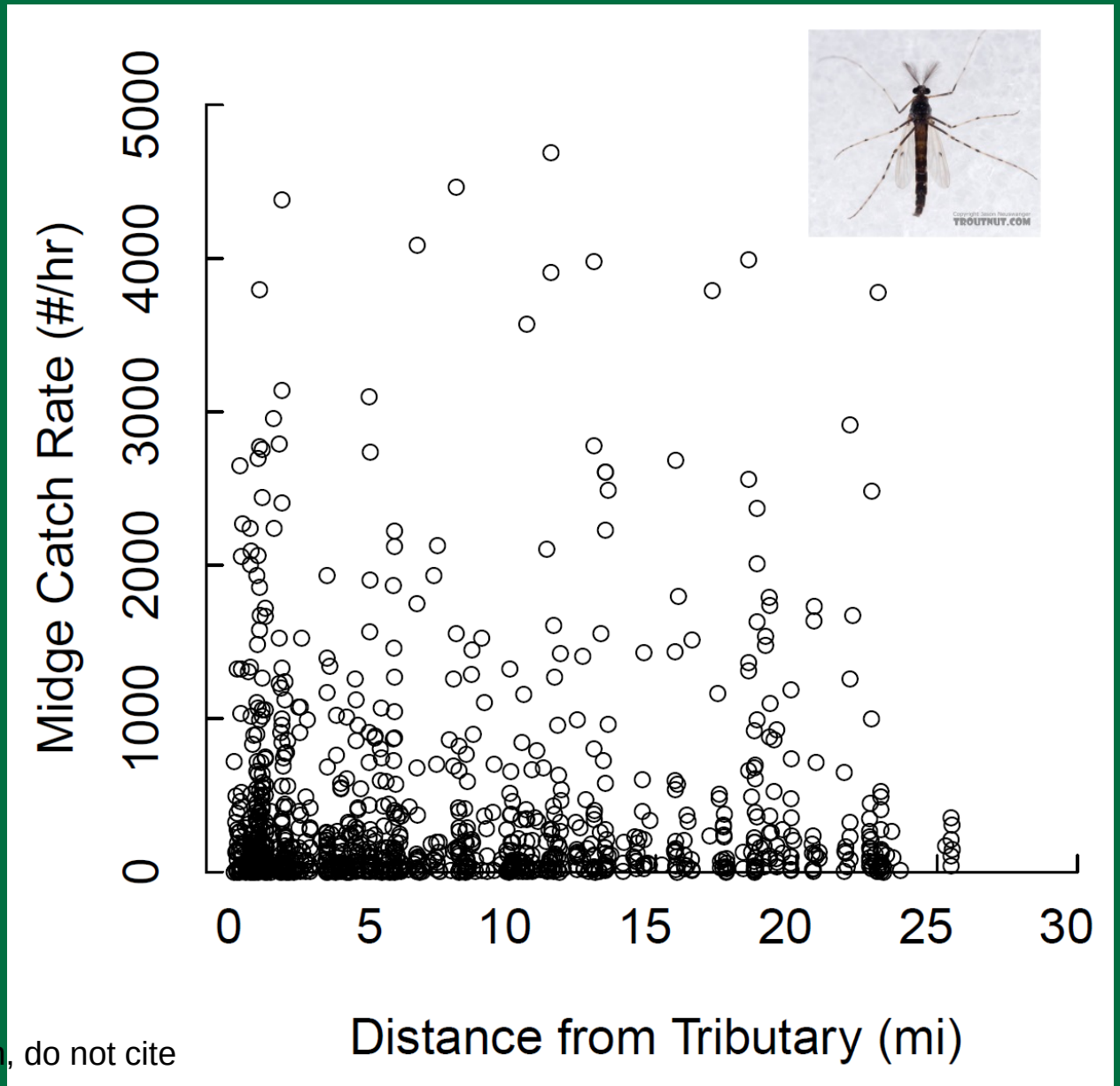
# Midge Emergence—Spatial Patterns

Abundant near and far from tributaries

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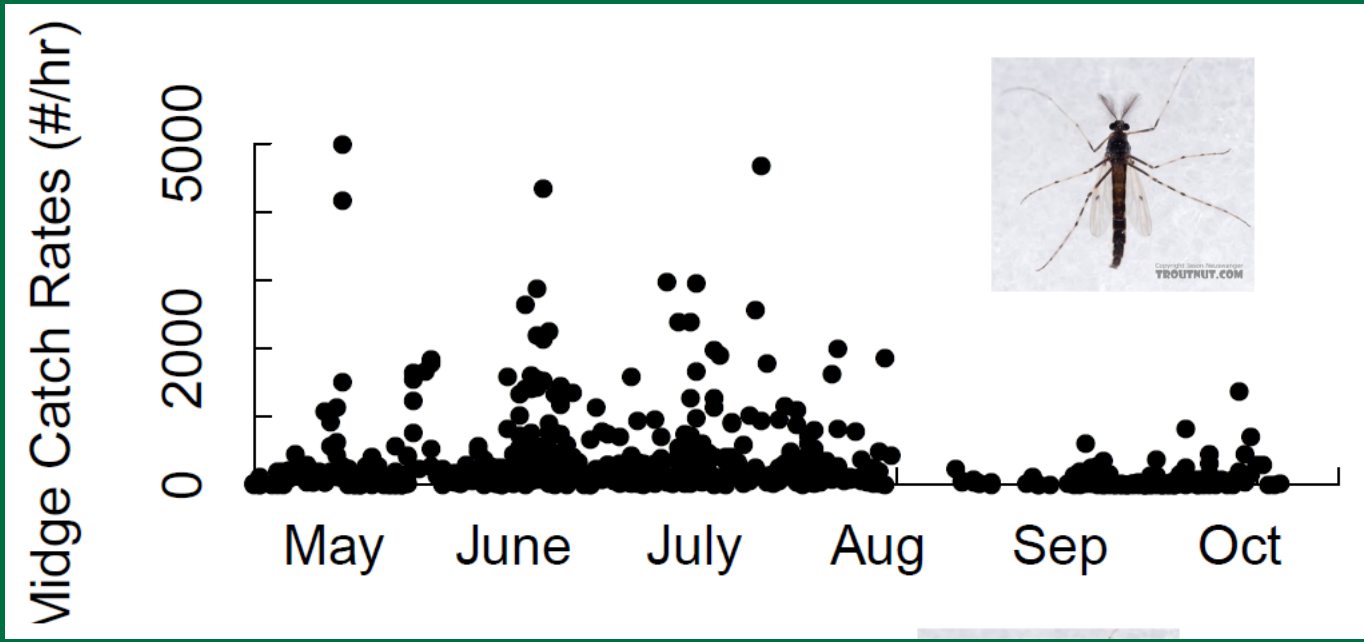
# Midge Emergence—Temporal patterns

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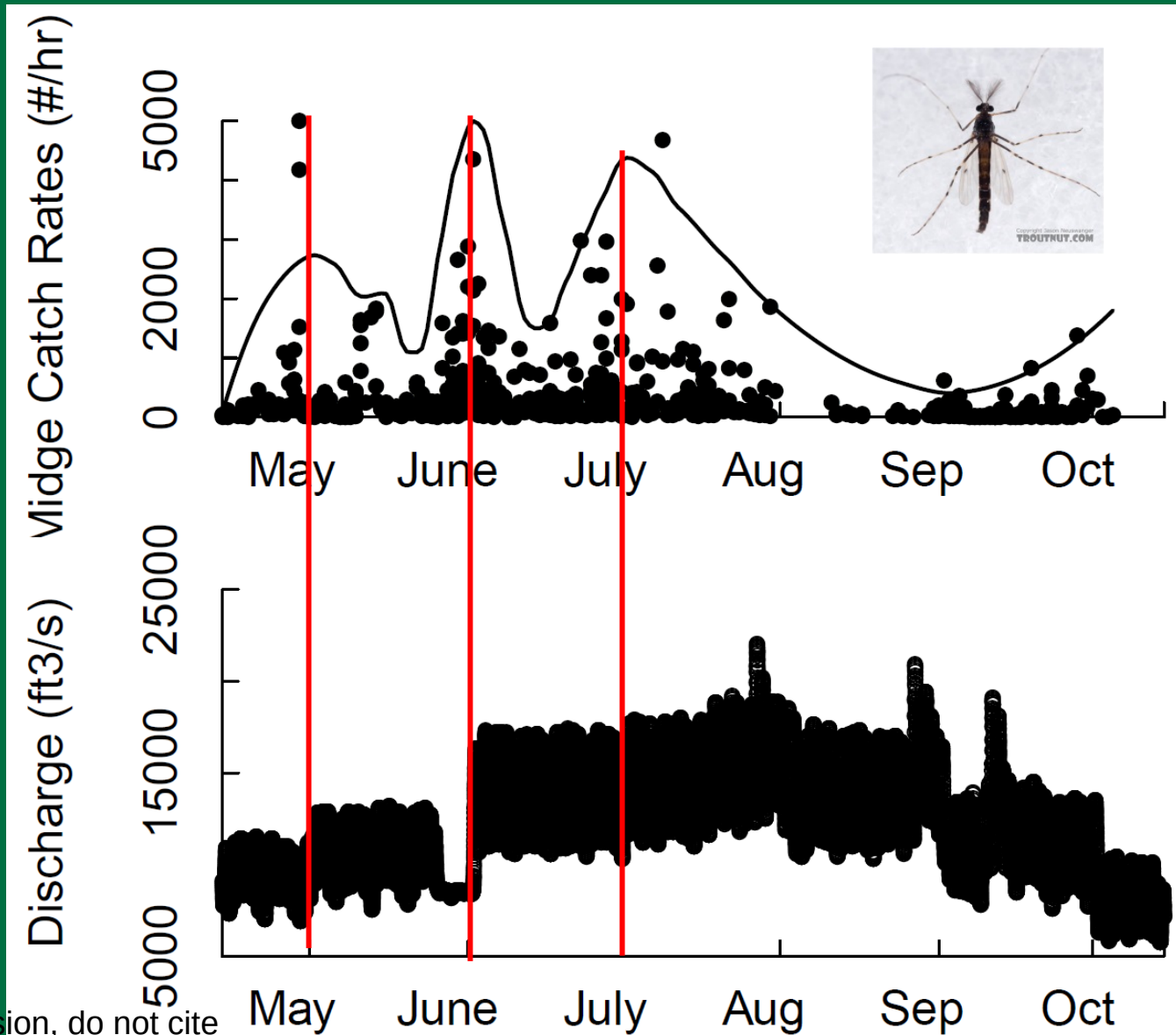
# Midge Emergence--Temporal patterns

Peak emergence occurs near end of month, and then declines precipitously with stepped changes in flow

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# Conclusions

- **Invertebrate assemblage is impaired**
- **Trichoptera are present, but they are strongly tied to tributaries**
- **Evidence that flow management affects larval abundance and emergence rates**

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# Why is this important to fisheries management?

- There are no ‘big-ticket’ items available for fish ANYWHERE
  - The average size of EPT is >> than the average size of midges and blackflies
- Food web stability
  - More invertebrate species = more stable food web and fish populations

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# Acknowledgements


**Thank you Grand Canyon River Guides!!**

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NPS—permitting

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