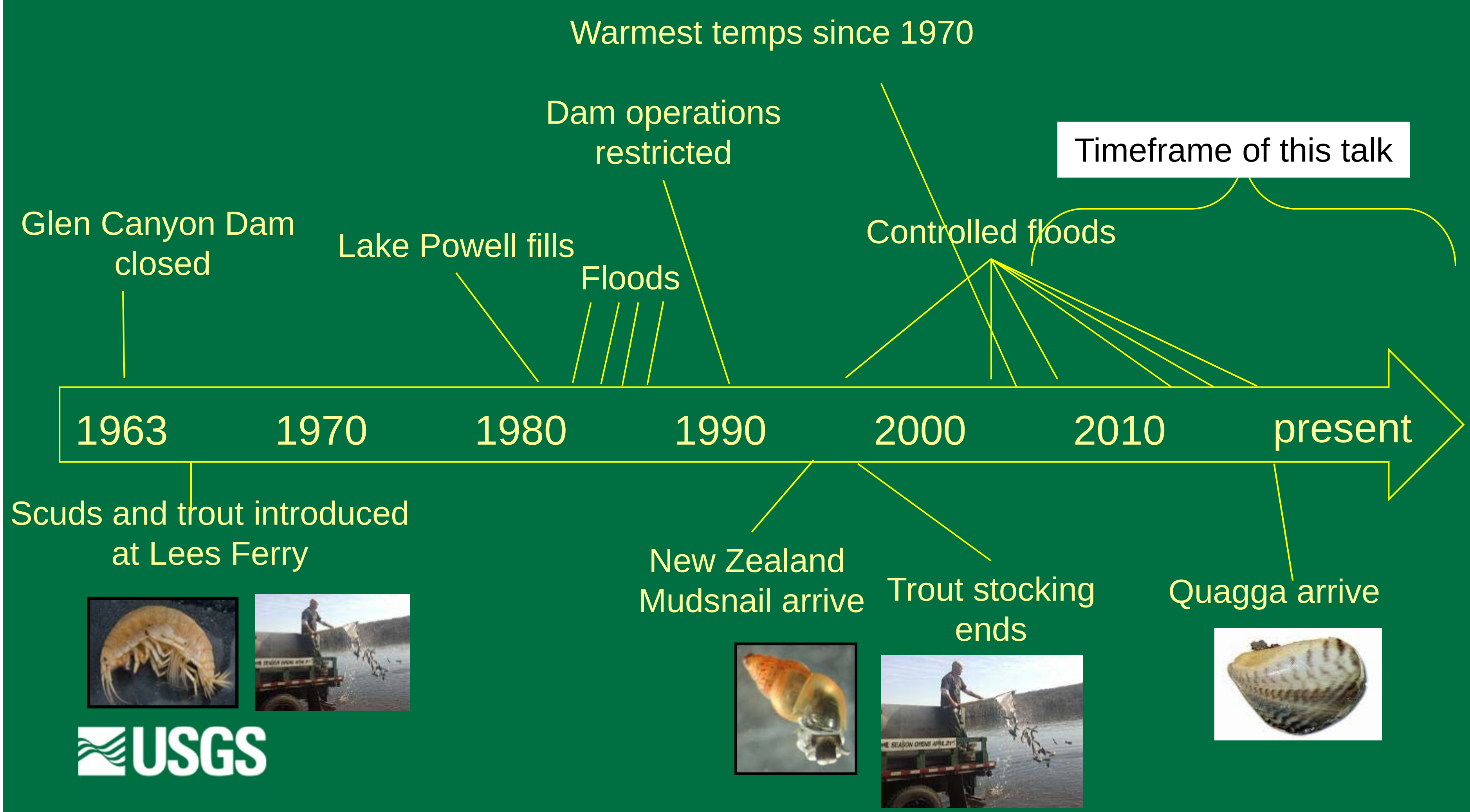
Big Flood,
Small Flood,
Spring Flood,
Fall Flood:

HFE timing affects foodbase response in Lees Ferry

Presenter: Ted Kennedy - GCRMC
Contributors: Mike Dodrill, Jeff Muehlbauer, Charles Yackulic, Robert Payn

Timeline



Warmest temps since 1970
Dam operations restricted
Timeframe of this talk
Glen Canyon Dam closed
Lake Powell fills
Floods
Controlled floods
1963
1970
1980
1990
2000
2010
present
Scuds and trout introduced at Lees Ferry
New Zealand Mudsnail arrive
Trout stocking ends
Quagga arrive
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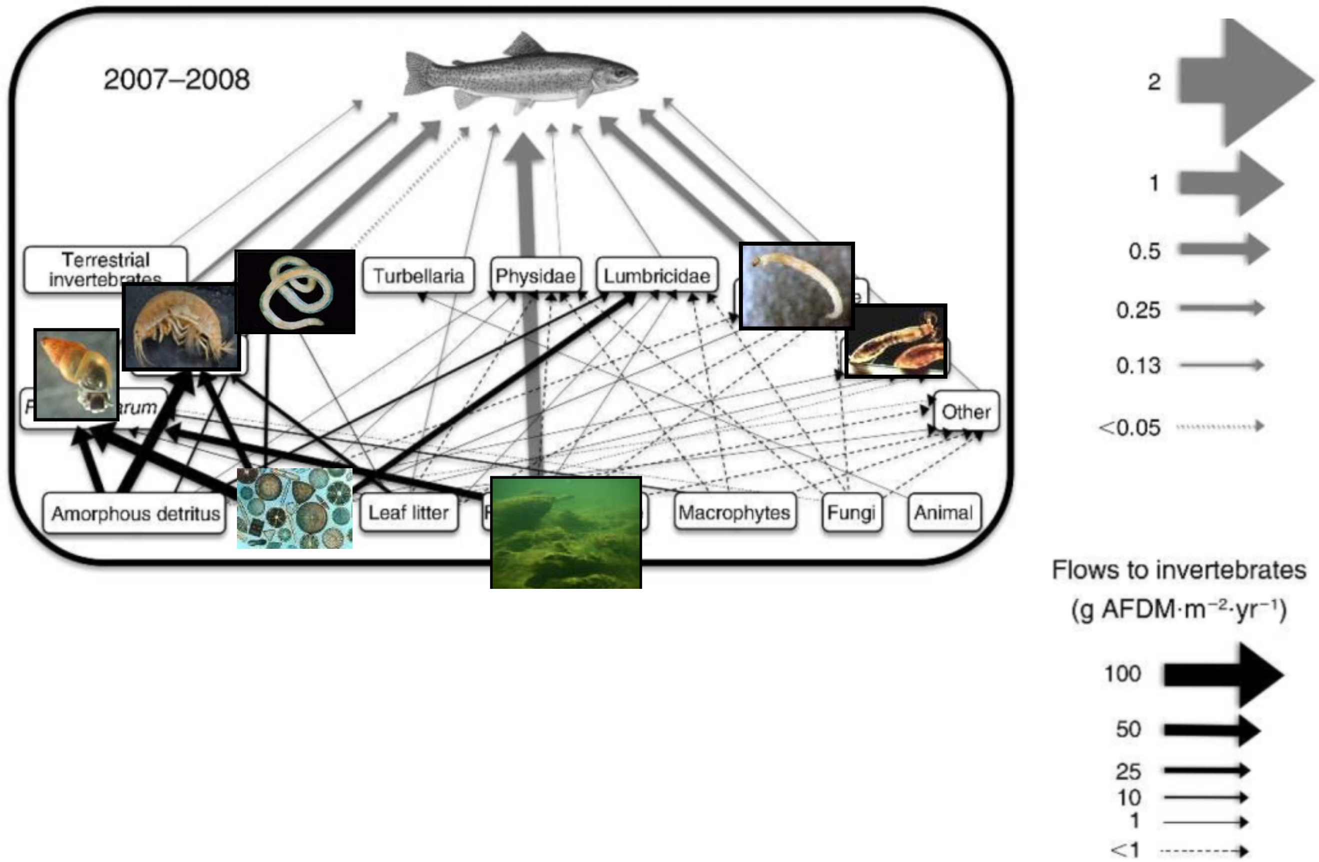
Lees Ferry Food Web

Mudsnails usurping lots of energy

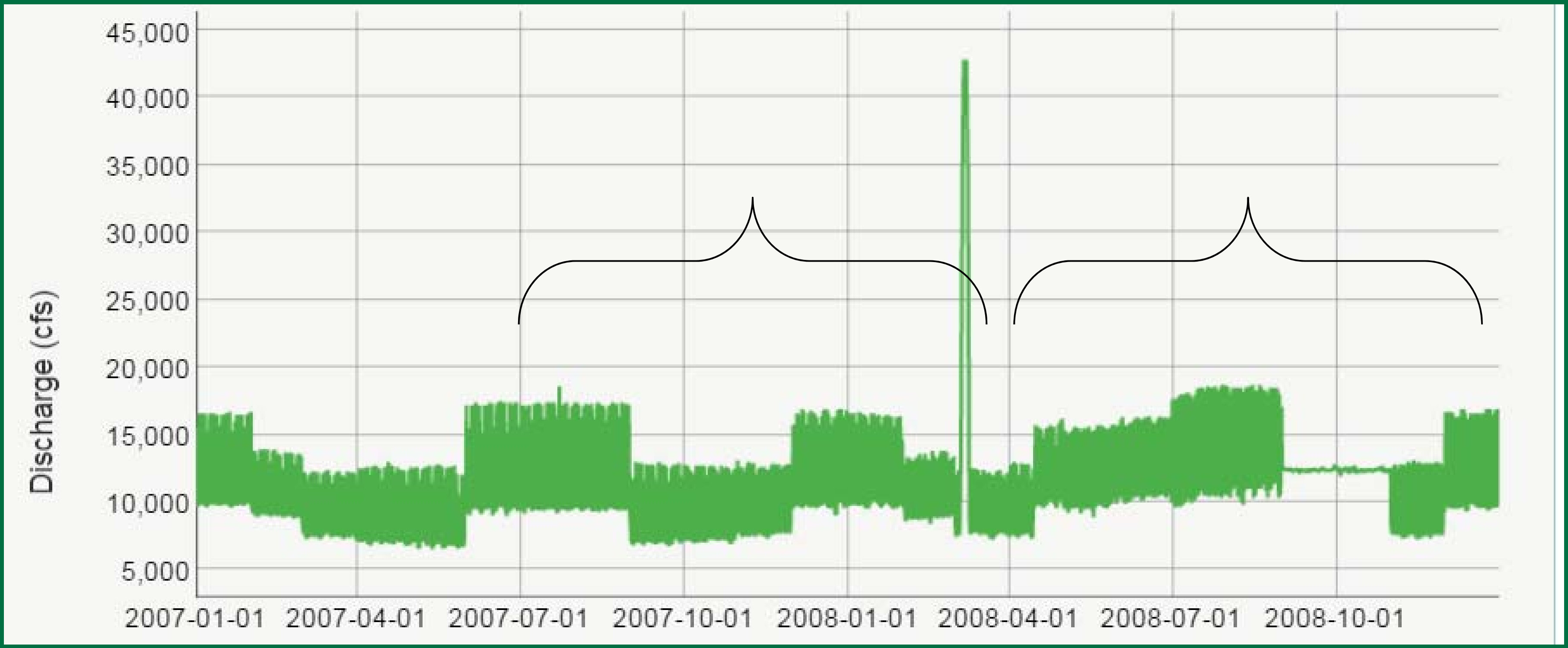
Midges and blackflies key prey items for trout

Midges and blackflies only aquatic insects present



From Cross and others, 2011

Controlled flood (HFE) released in March 2008



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http://www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09380000

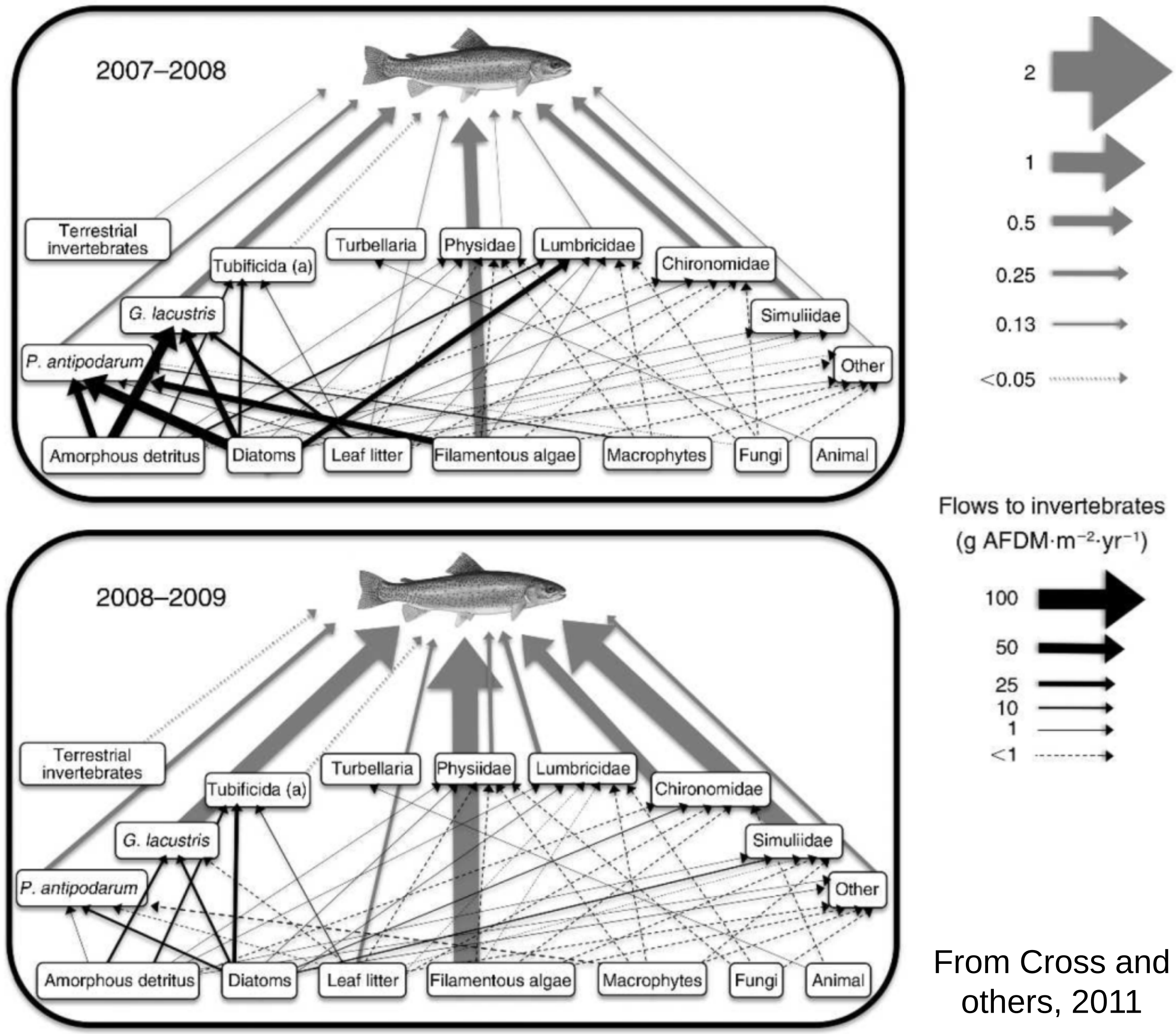
2008 Controlled Flood Enhanced the Invertebrate Prey Base

Mudsnails, worms, and scuds declined

Production of midges and blackflies increased

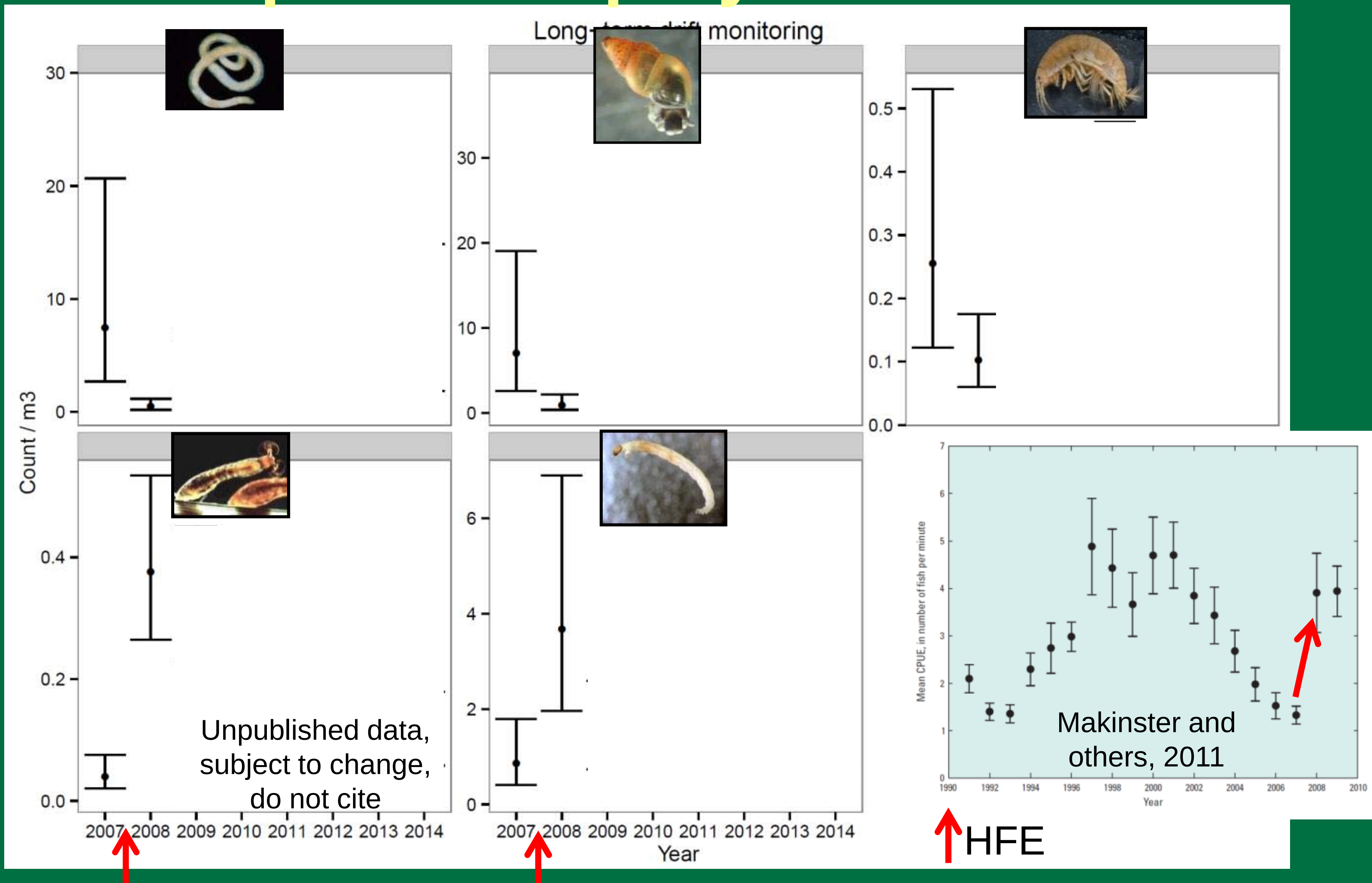
Trout growth and numbers increased

USGS



From Cross and others, 2011

Drift of preferred prey increased



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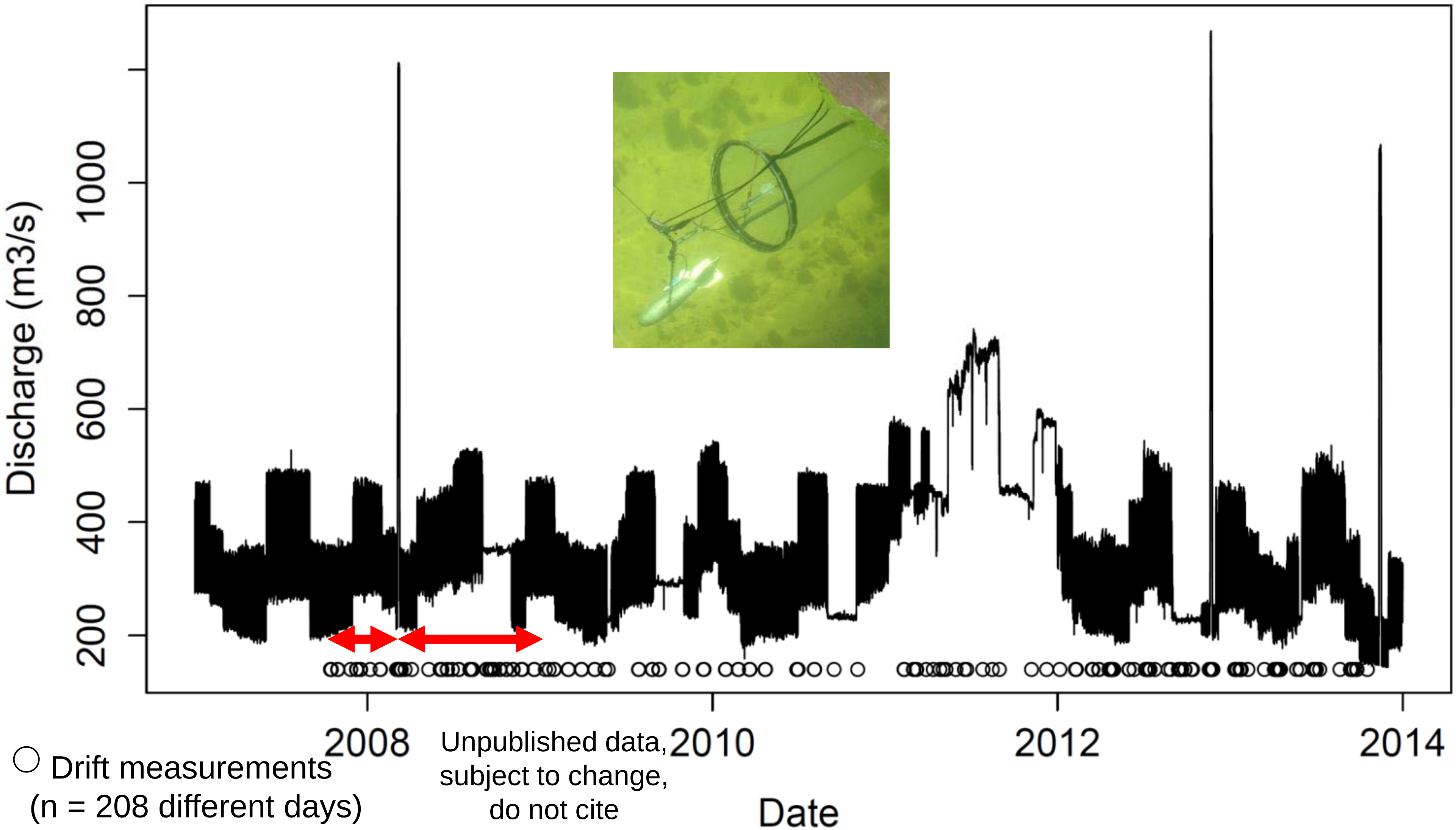
Drift Period of Record



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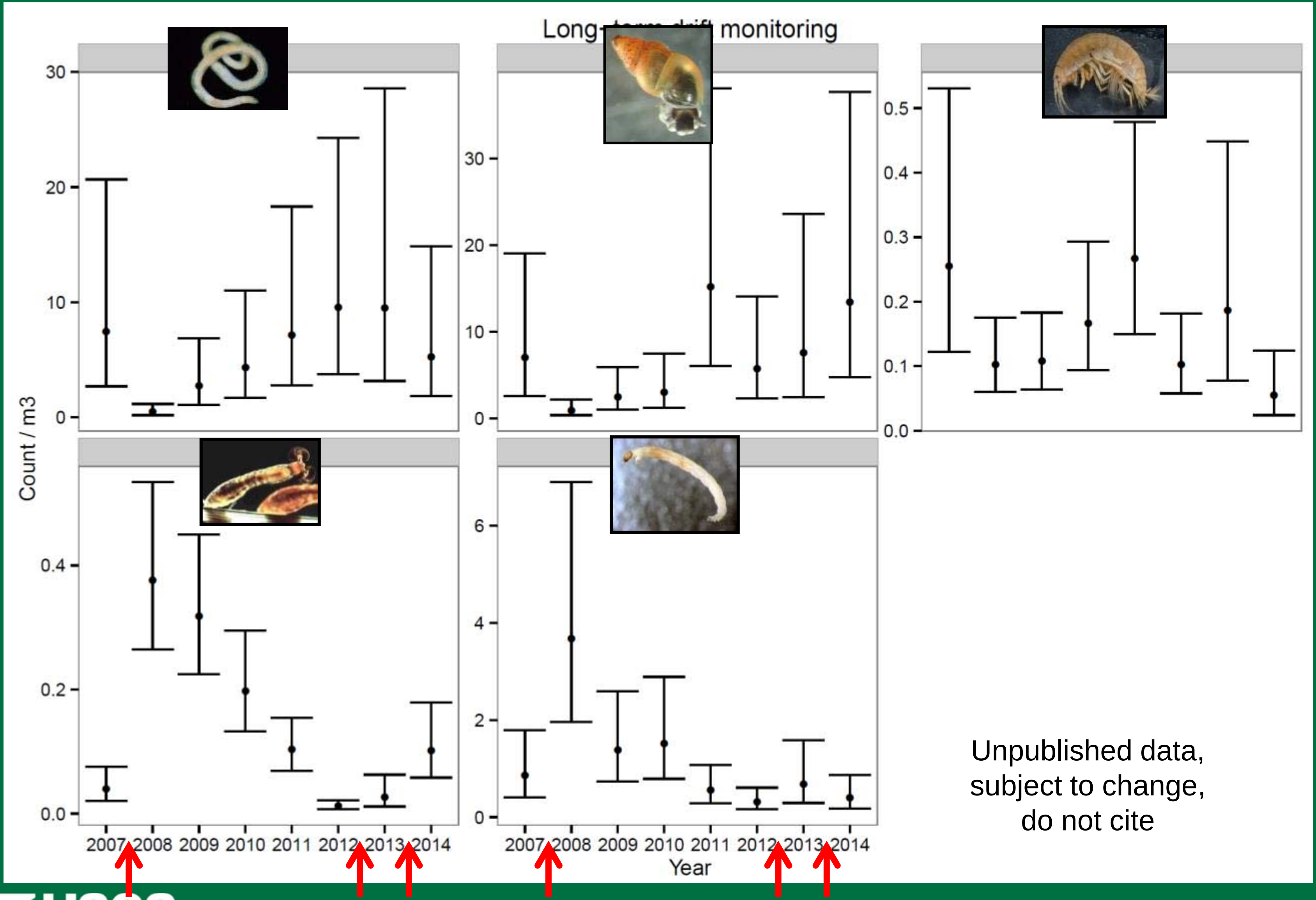
Long term trends in the foodbase



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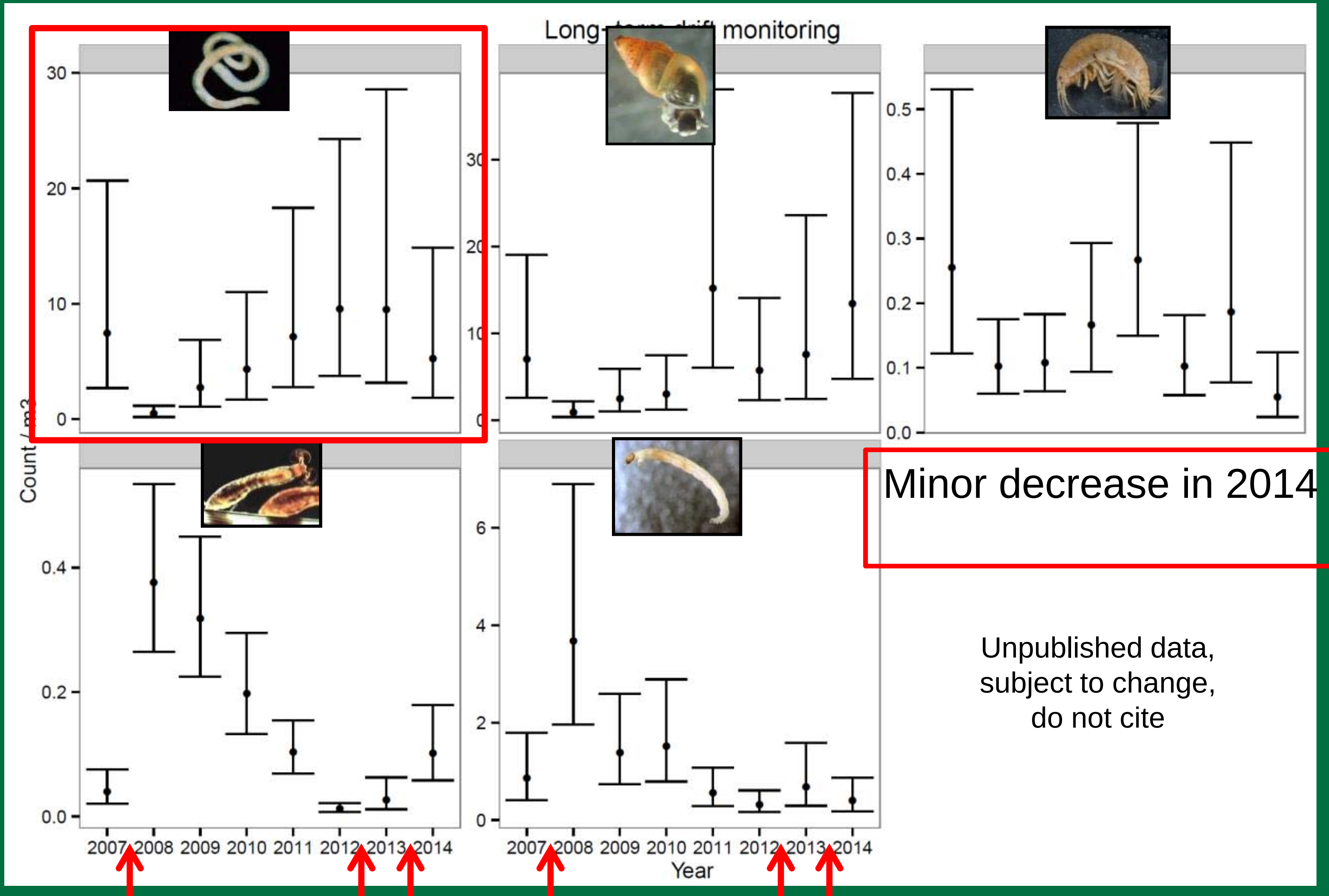
Long term trends in the foodbase



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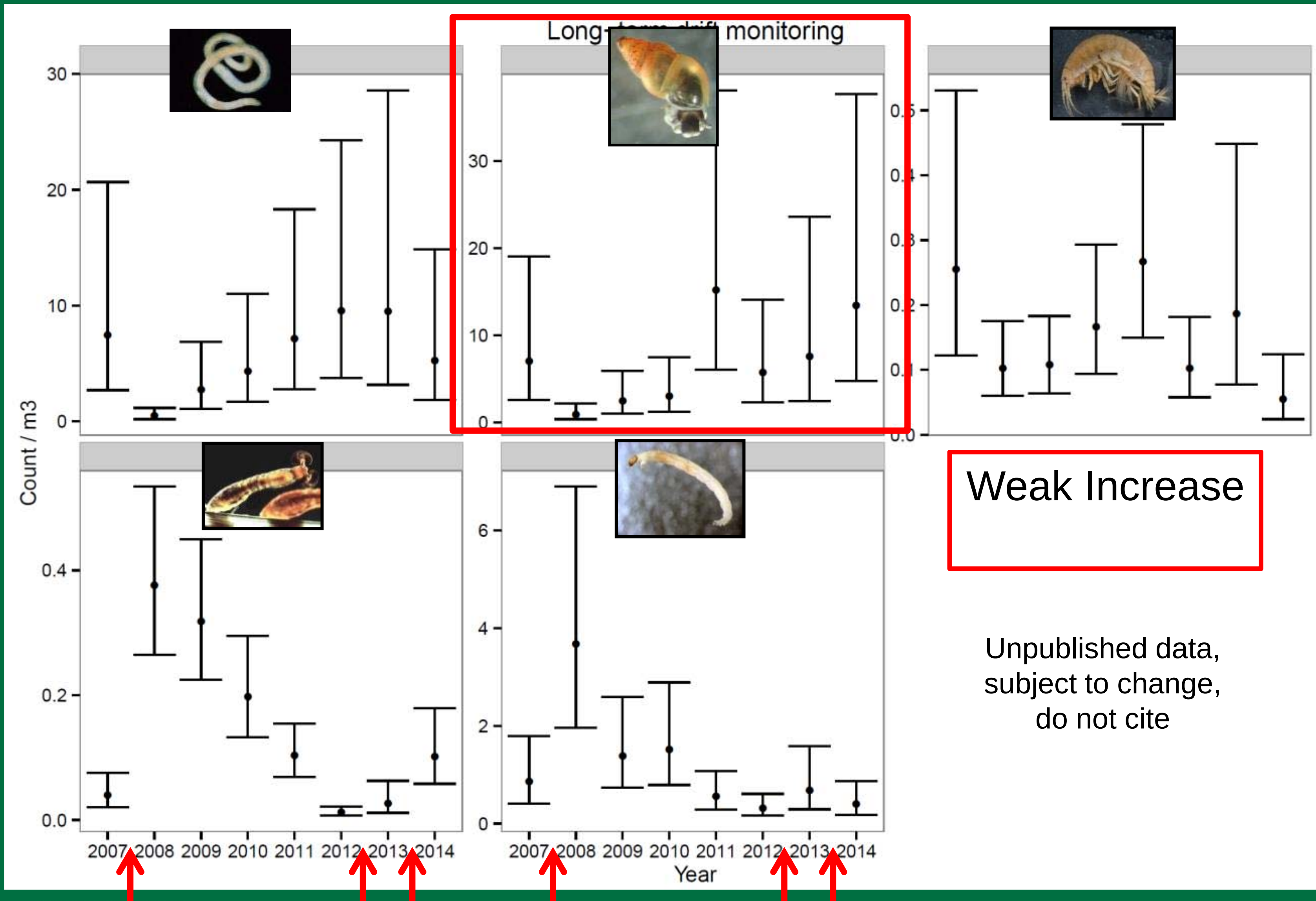
Long term trends in the foodbase



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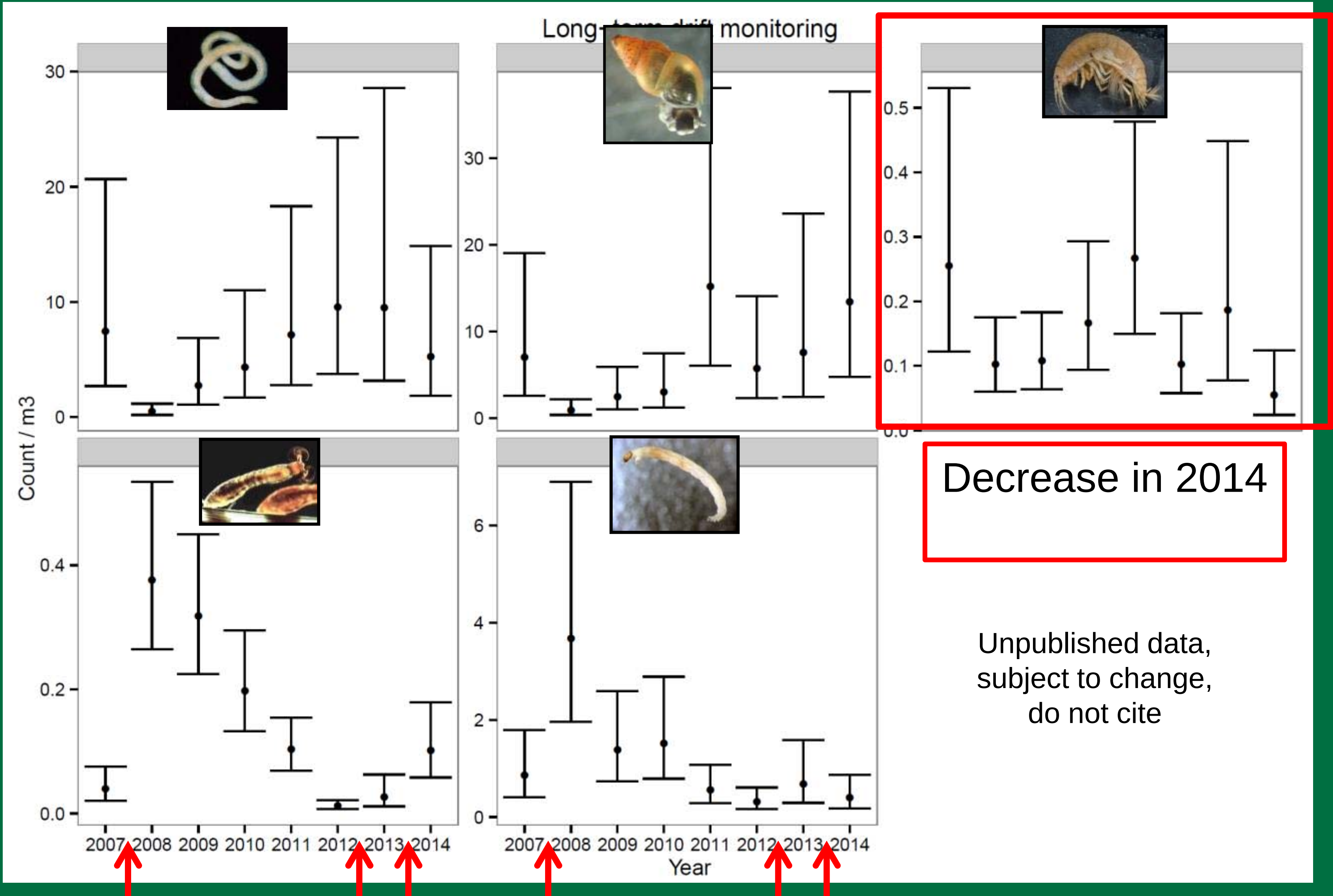

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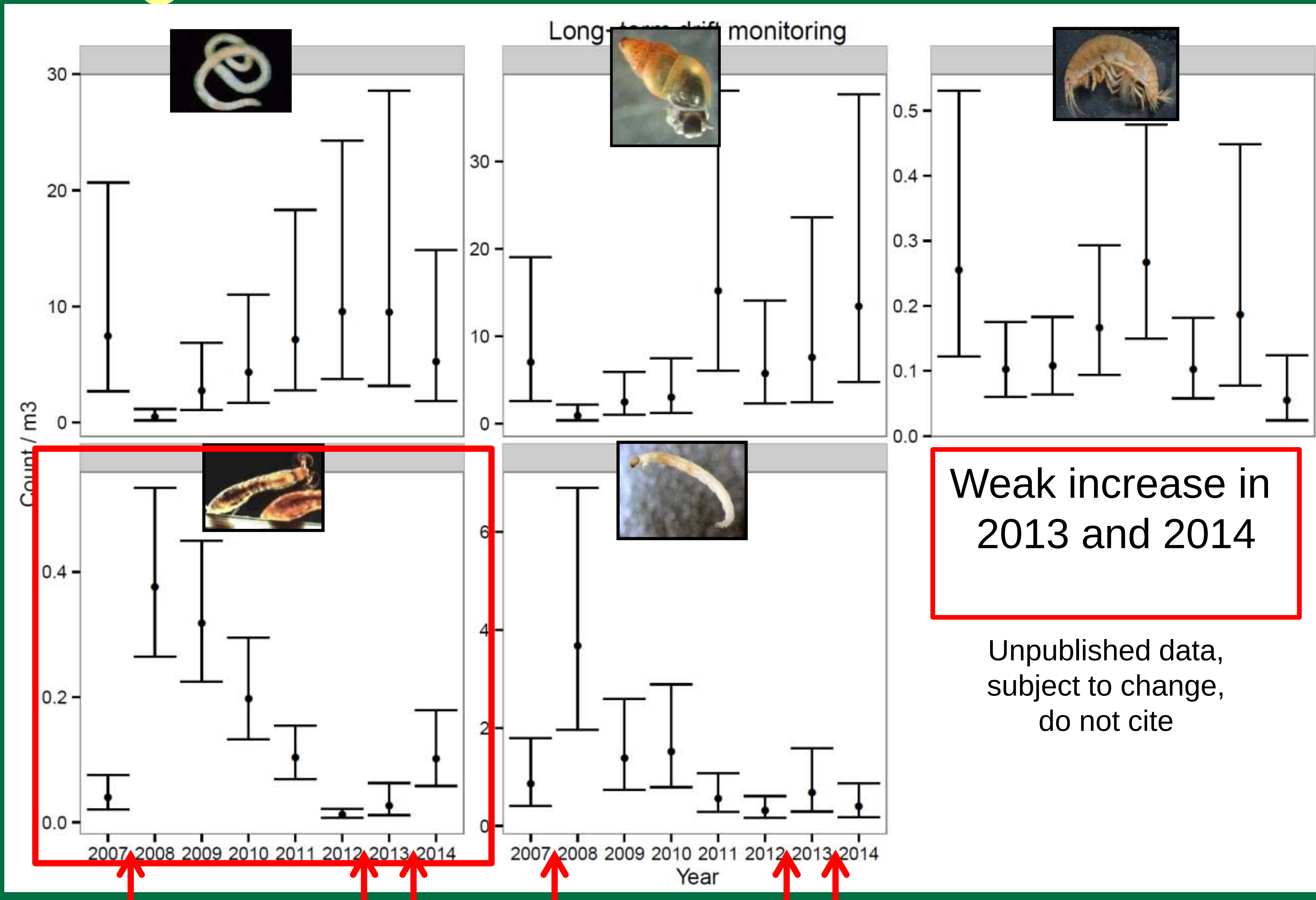
Long term trends in the foodbase



Weak increase in 2013 and 2014

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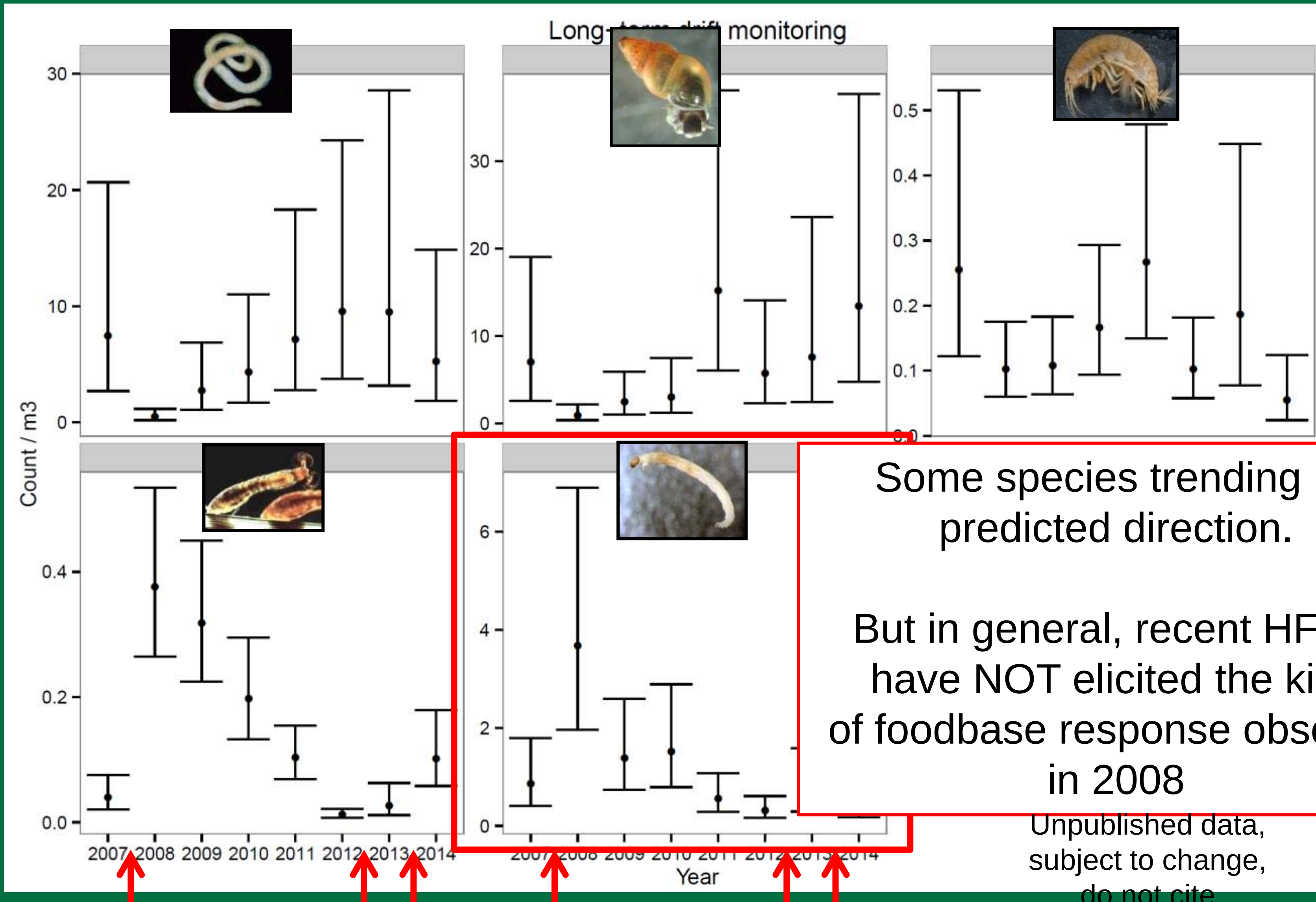
Long term trends in the foodbase



Some species trending in predicted direction.

But in general, recent HFEs have NOT elicited the kind of foodbase response observed in 2008

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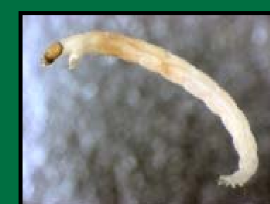
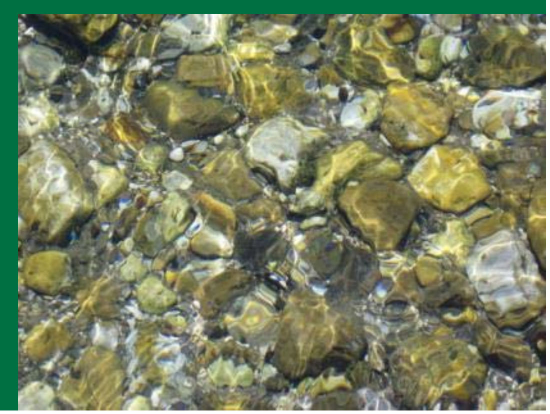
Maybe Fall Floods Don't Change Habitat?

Habitat for Non-Insect

Habitat for Insects





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New Method For Quantifying Primary Production (aka Habitat)

LIMNOLOGY and OCEANOGRAPHY

ASLO

Limnol. Oceanogr. 00, 2015, 00–00

doi: 10.1002/lno.10031

Turbidity, light, temperature, and hydropeaking control primary productivity in the Colorado River, Grand Canyon

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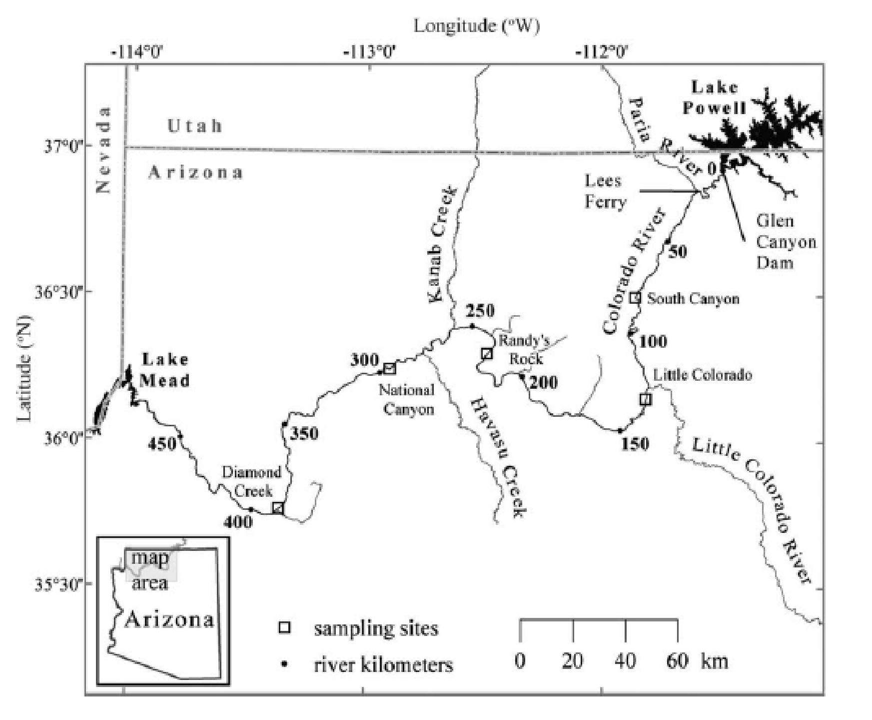
Abstract

Dams and river regulation greatly alter the downstream environment for gross primary production (GPP) because of changes in water clarity, flow, and temperature regimes. We estimated reach-scale GPP in five locations of the regulated Colorado River in Grand Canyon using an open channel model of dissolved oxygen. Benthic GPP dominates in Grand Canyon due to fast transport times and low pelagic algal biomass. In one location, we used a 738 days time series of GPP to identify the relative contribution of different physical controls of GPP. We developed both linear and semimechanistic time series models that account for unmeasured temporal covariance due to factors such as algal biomass dynamics. GPP varied from 0 g O_2 m^{-2} d^{-1} to 3.0 g O_2 m^{-2} d^{-1} with a relatively low annual average of 0.8 g O_2 m^{-2} d^{-1}. Semimechanistic models fit the data better than linear models and demonstrated that variation in turbidity primarily controlled GPP. Lower solar insolation during winter and from cloud cover lowered GPP much further. Hydropeaking lowered GPP but only during turbid conditions. Using the best model and parameter values, the model accurately predicted seasonal estimates of GPP at 3 of 4 upriver sites and outperformed the linear model at all sites; discrepancies were likely from higher algal biomass at upstream sites. This modeling approach can predict how changes in physical controls will affect relative rates of GPP throughout the 385 km segment of the Colorado River in Grand Canyon and can be easily applied to other streams and rivers.



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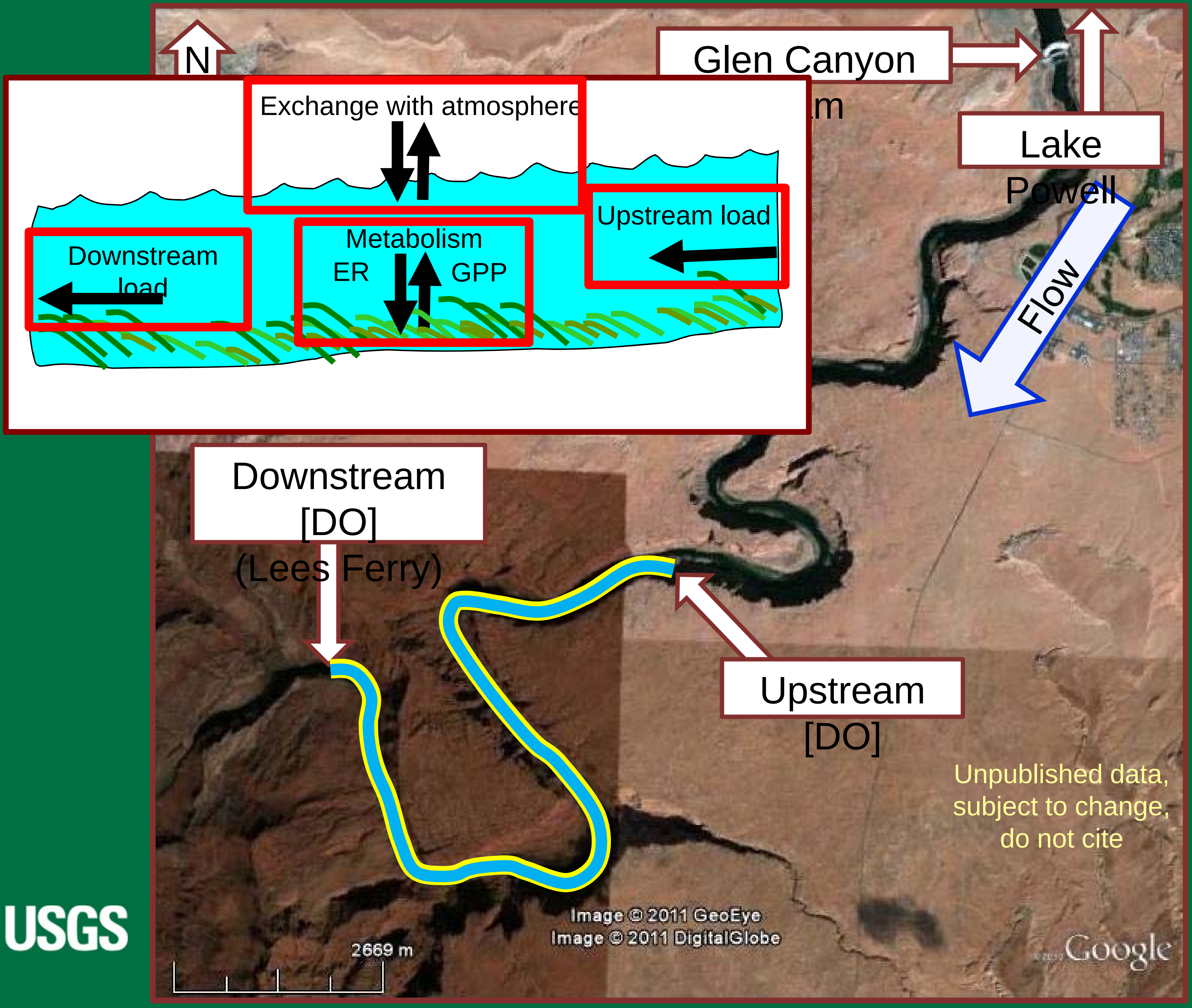
N
Glen Canyon
Dam
Lake
Powell
Flow
Exchange with atmosphere
Upstream load
Metabolism
ER
GPP
Downstream
load
Downstream
[DO]
(Lees Ferry)
Upstream
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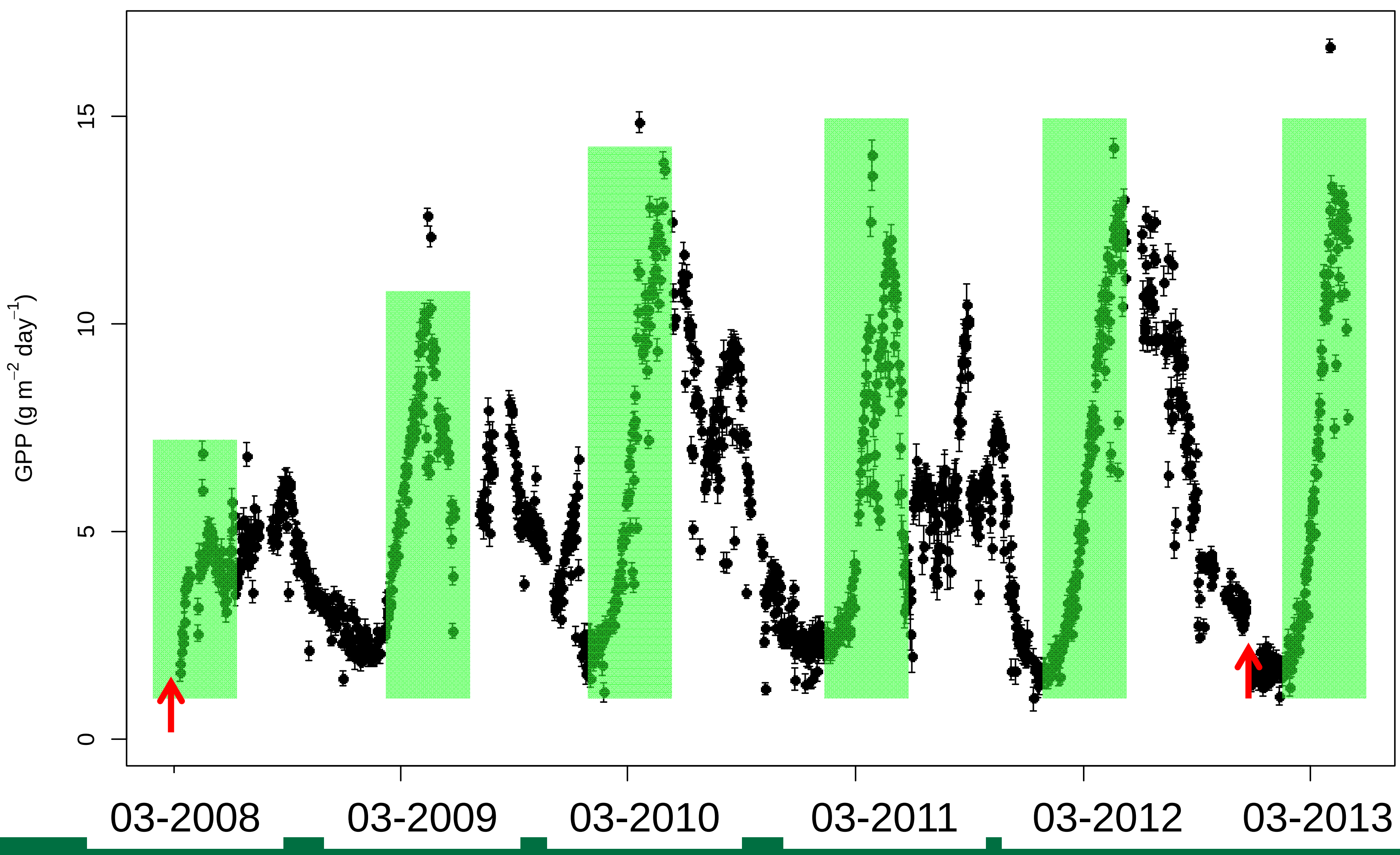
Macrophytes are resistant/resilient to Fall Disturbance



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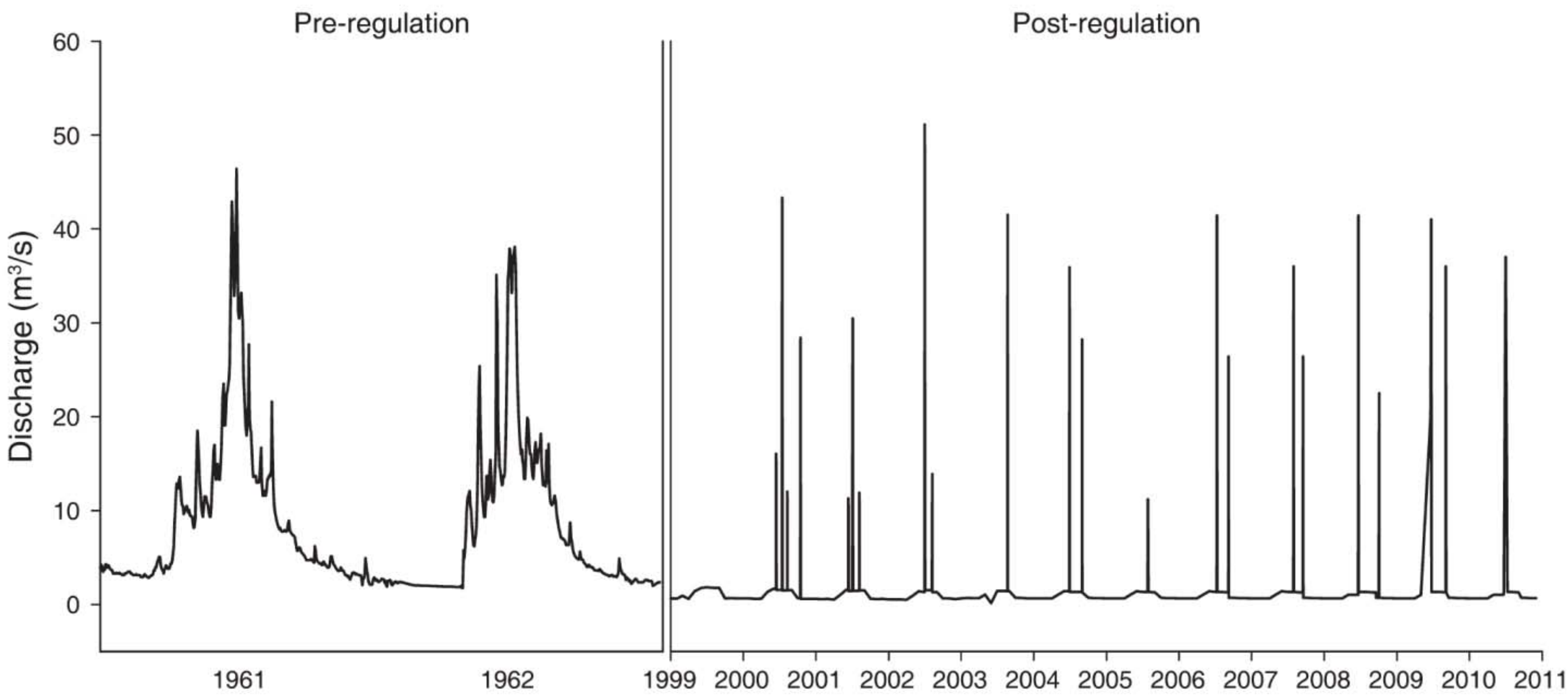
What about foodbase response to controlled floods on other rivers?

River Spöl in Switzerland/Italy

-22 floods in 10 years



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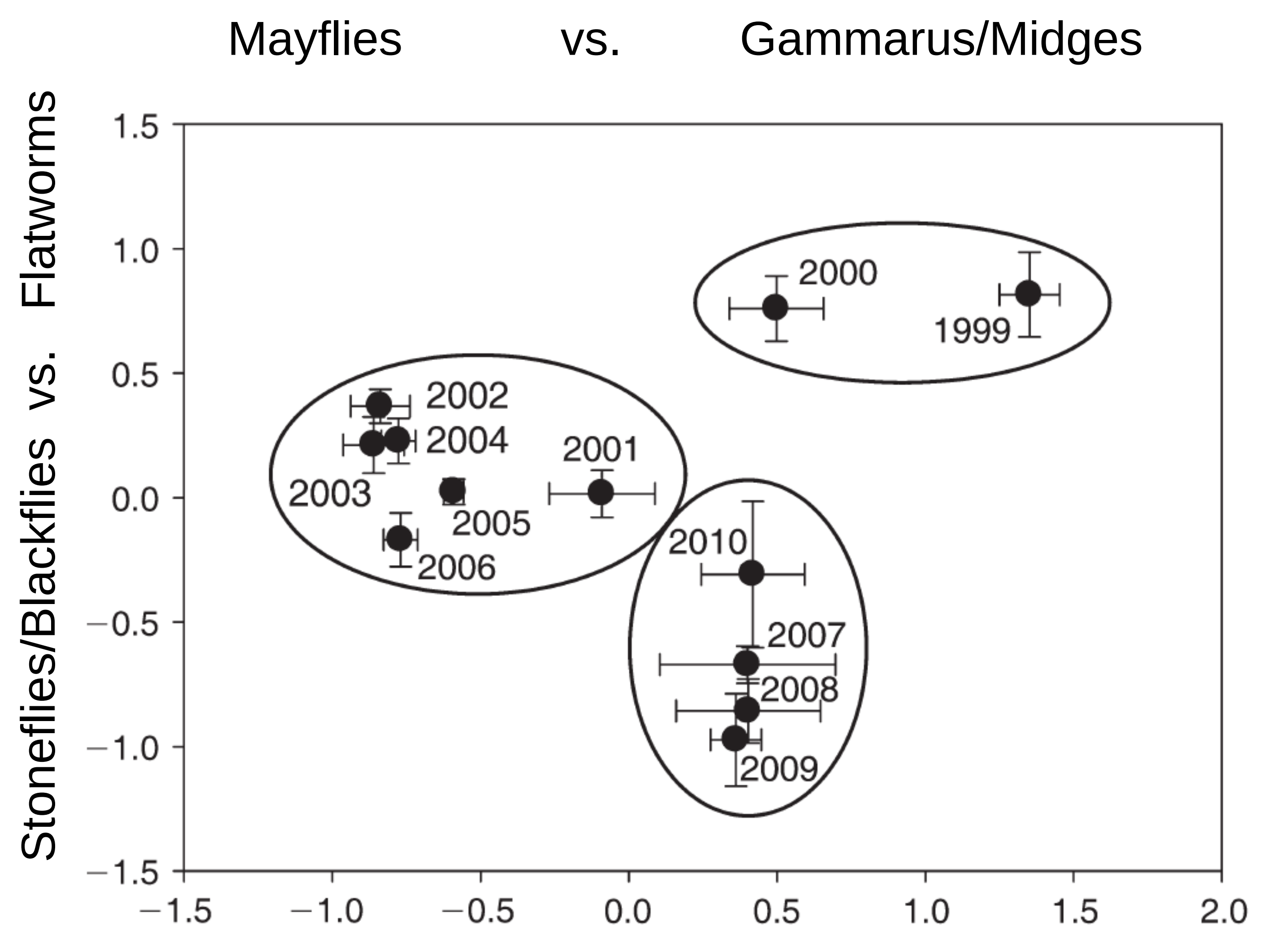
Robinson 2012, Ecological Applications

Foodbase response to flood regime on River Spöl

Foodbase took 8 years to equilibrate



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Robinson 2012, Ecological Applications

Conclusions

1) Spring floods are different than Fall floods

-macrophytes and non-insects more resistant/resilient to disturbance in fall

2) Repeated Fall floods may nevertheless shift foodbase to new equilibrium

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Acknowledgements

Funding:

Bureau of Reclamation

Western Area Power Administration

Technicians:

Moriah Evans, Tom Quigley, Adam Copp, Eric Kortenhoeven, Anya Metcalfe, Ali Ingram, David Goodenough


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