

From Farms to Fish Pee:

Agricultural Growth Alters the Stoichiometry of Nutrient Recycling by a Desert Fish

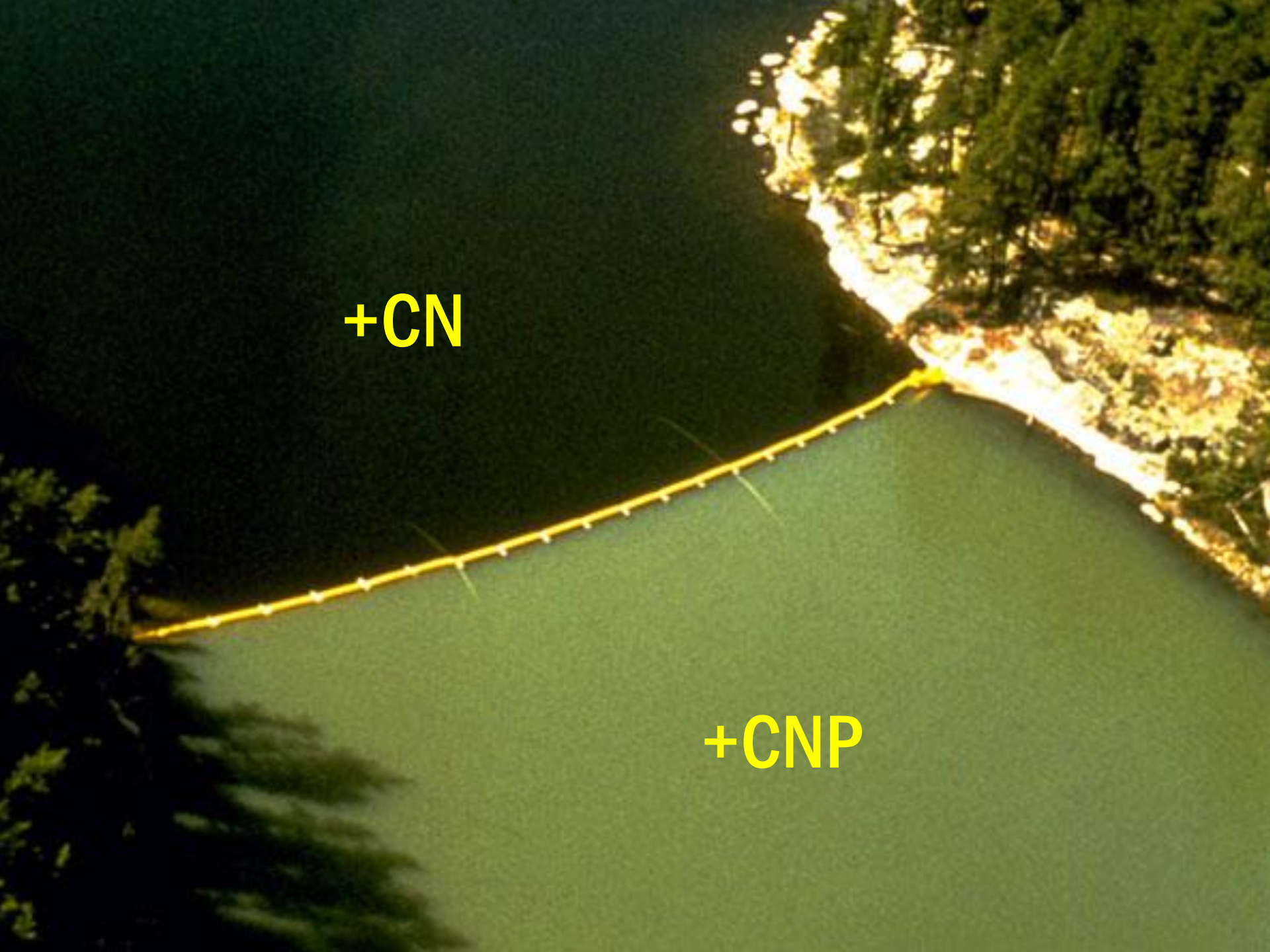


Eric Moody, Jessica Corman, Hector Espinosa-Pérez, Jorge Ramos,
John Sabo, & James Elser



@EvoEcoEric

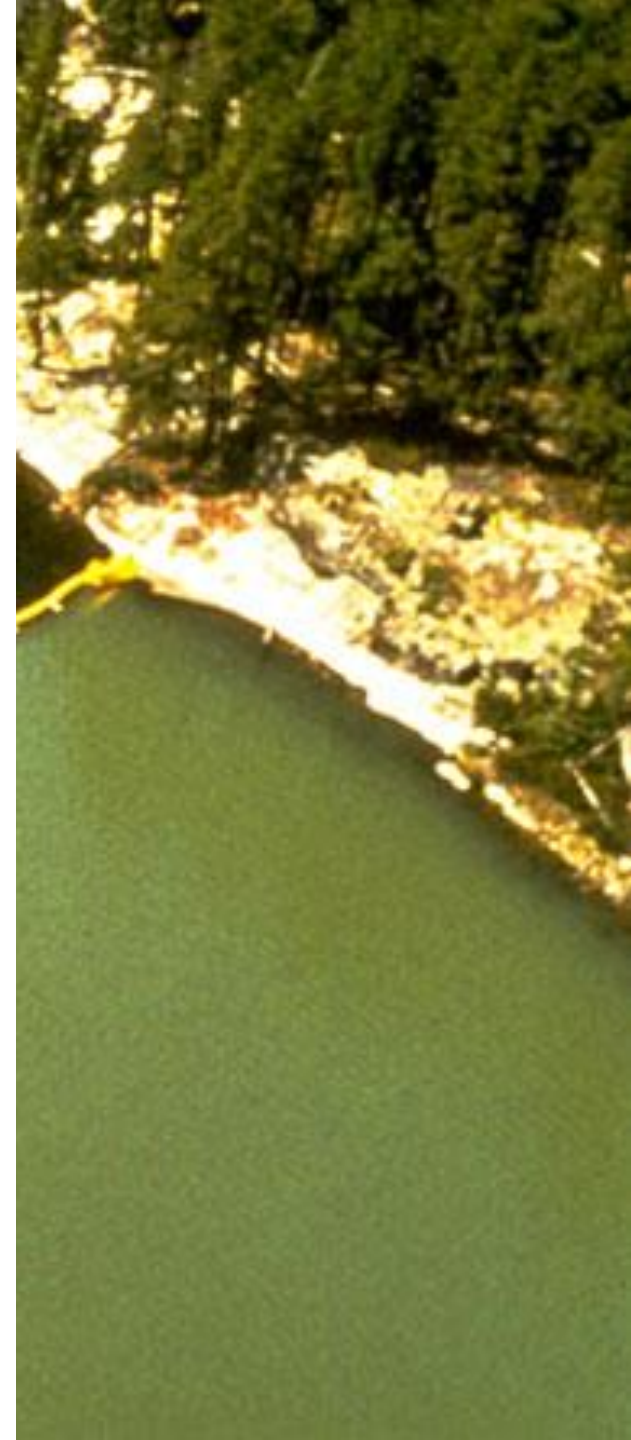
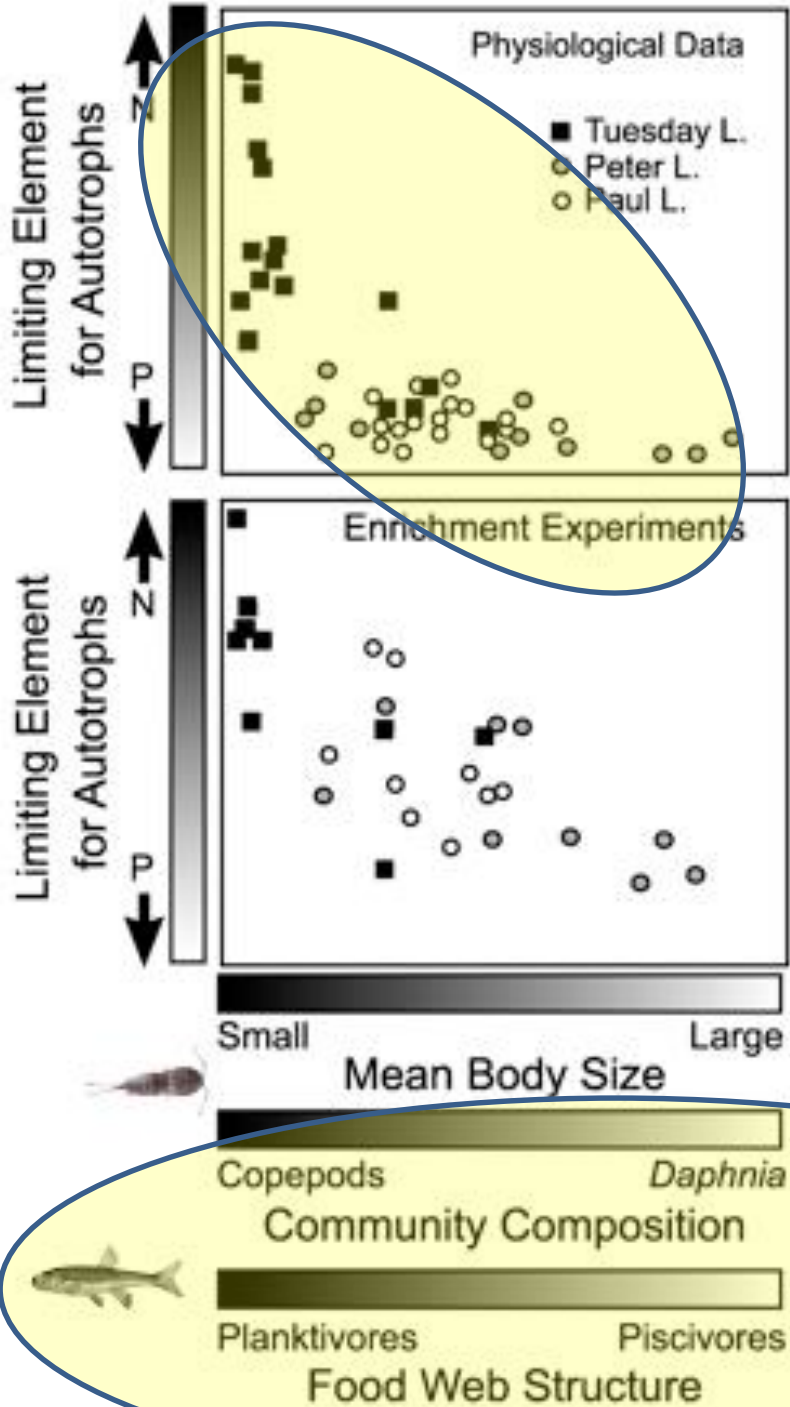


An aerial photograph of a lake with a yellow line running diagonally across it. The line is composed of small white floats. The lake is surrounded by a forested shoreline. The text '+CN' is in the upper left and '+CNP' is in the lower right.

+CN

+CNP

Elser et al. 1988





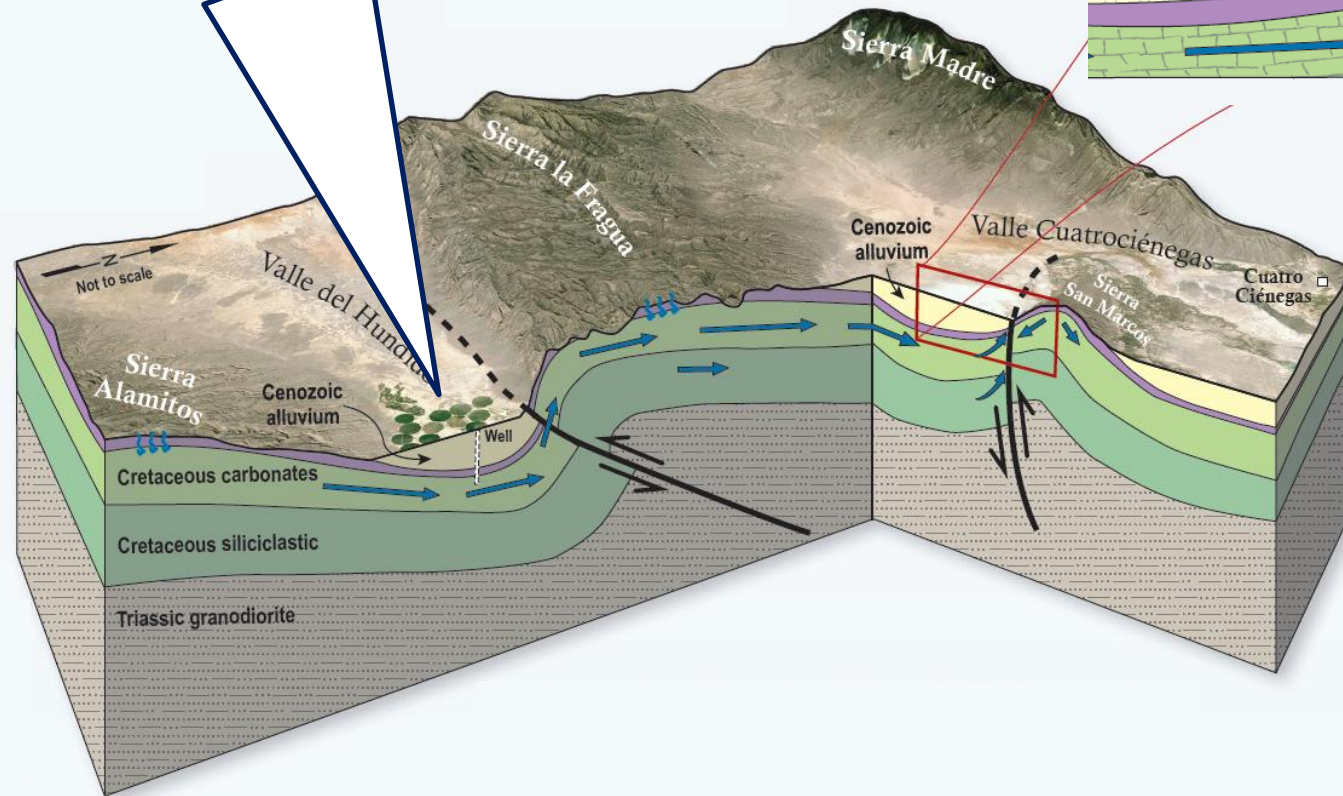
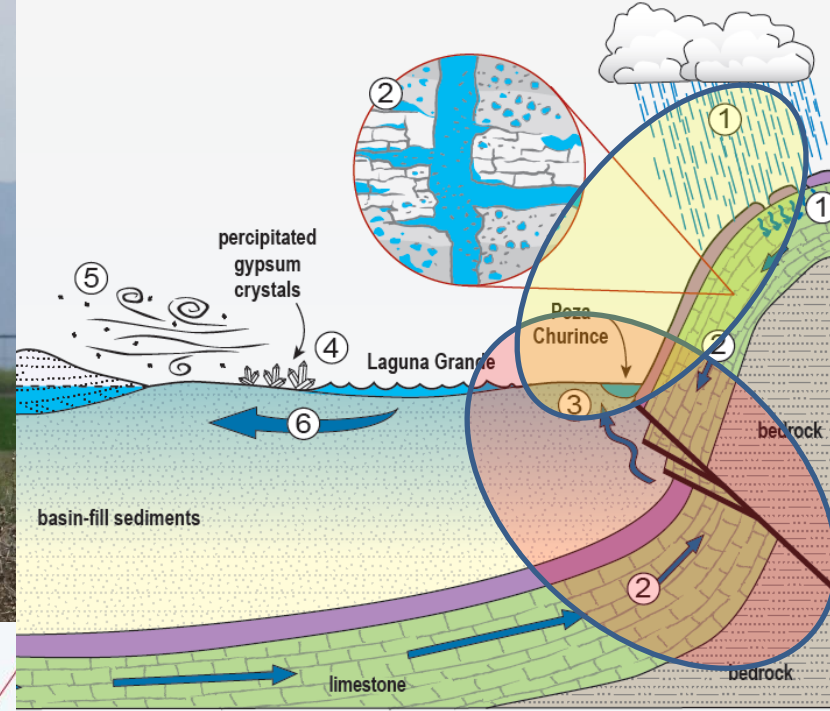
Gambusia marshi

CUATRO CIÉNEGAS, COAHUILA

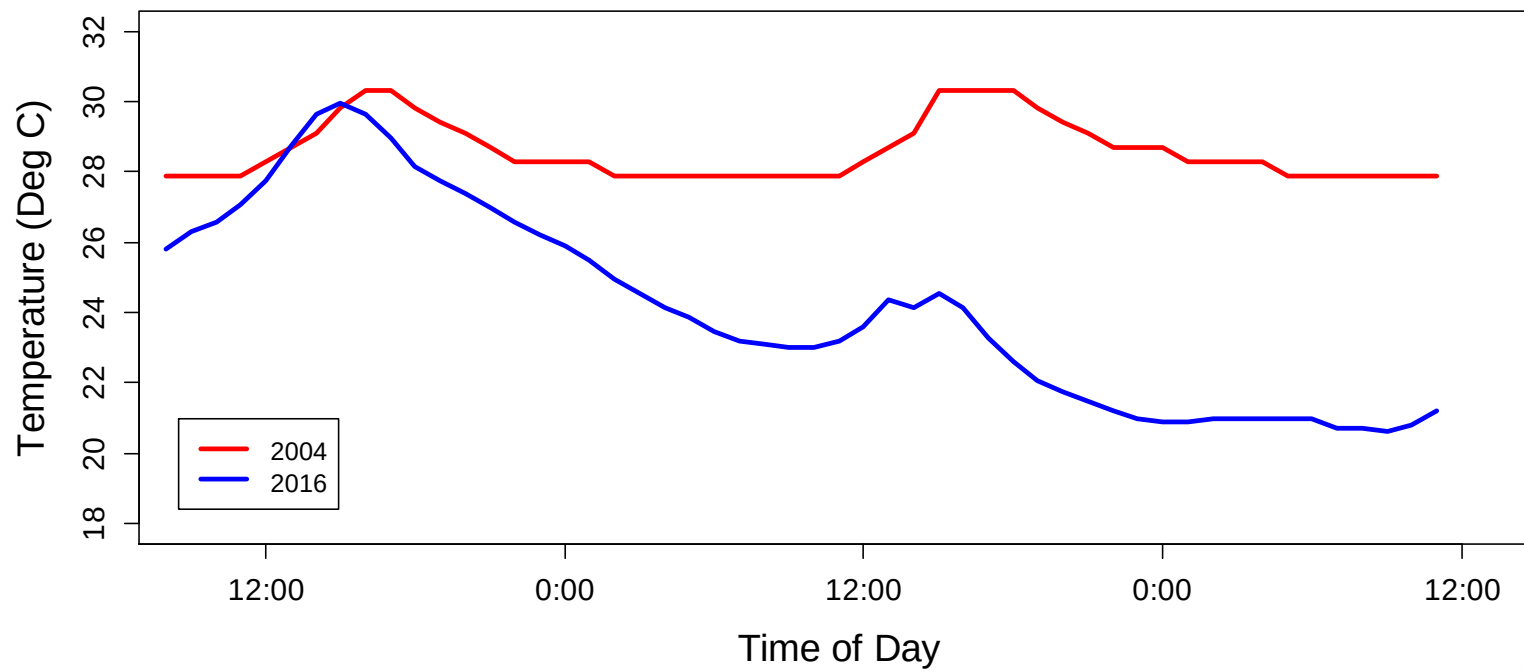


PHOTO: DAVID JARAMILLO





**How is
agricultural
growth
affecting
spring flows?**



Feb 2011

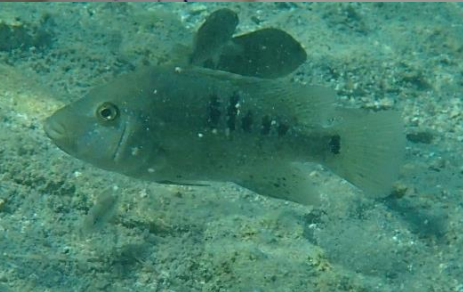


Oct 2011



Photo: Ana Gutiérrez-Preciado

Effects of Spring Failure



Modeling variation in nutrient recycling

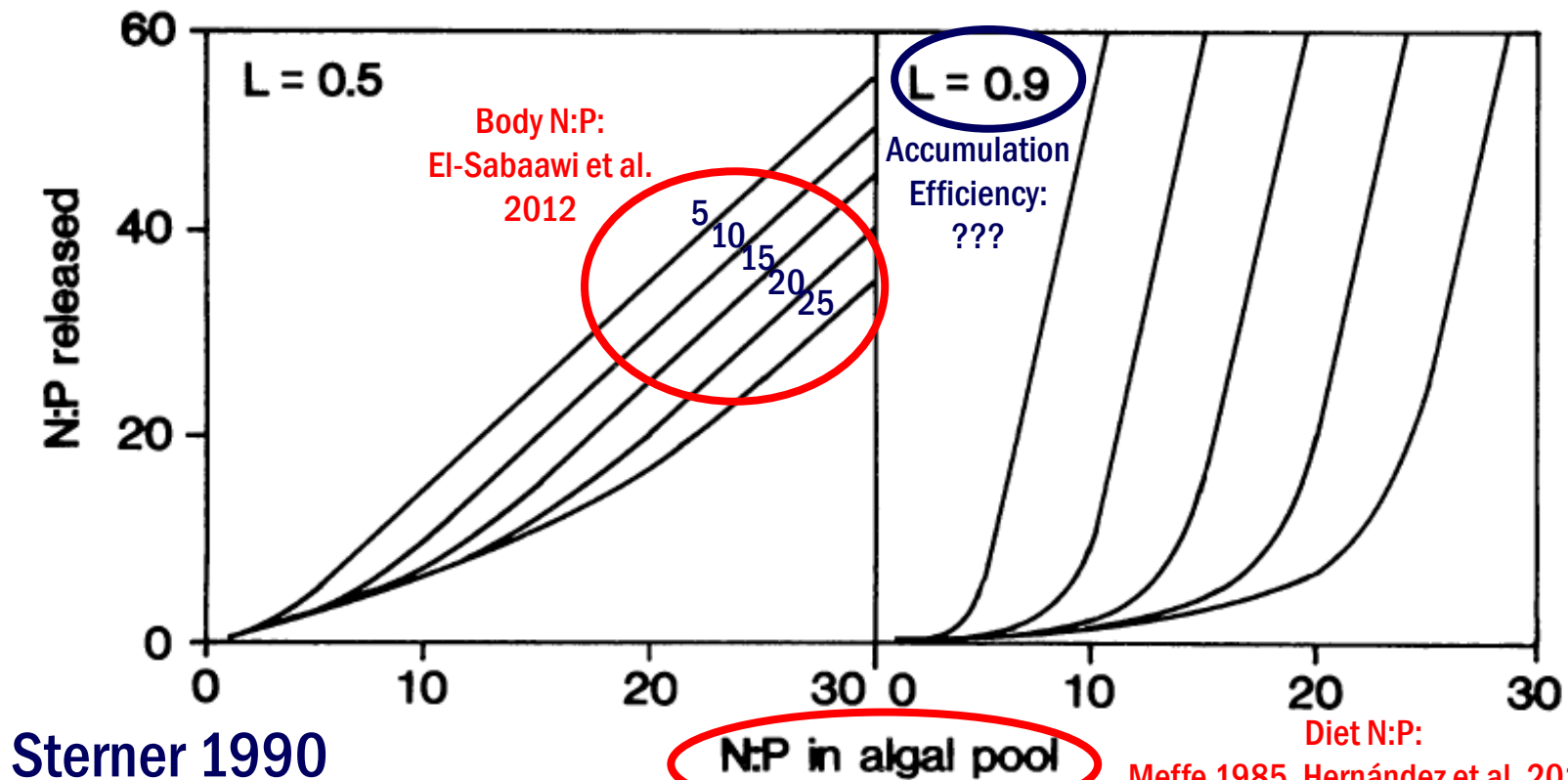
Moody et al. 2015

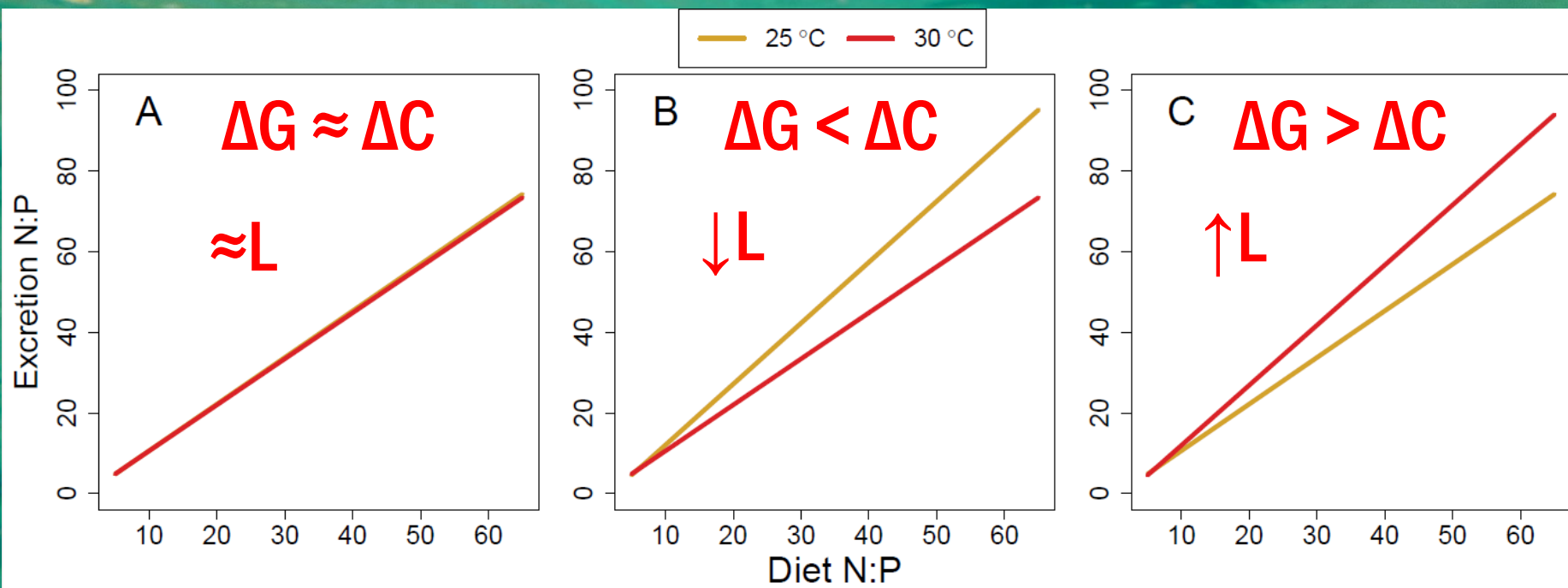
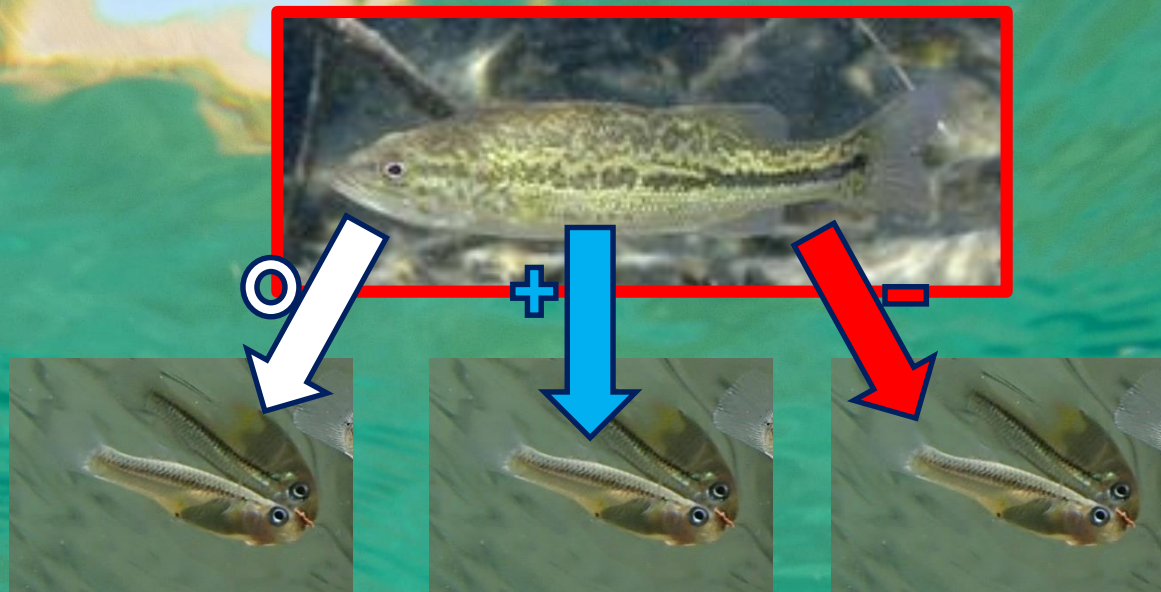
$$L = \text{Growth} / \text{Consumption}$$



Gambusia affinis

Data from Wurtsbaugh & Cech 1983







33.4 °C



32.5 °C



31.8 °C



30.2 °C



30.0 °C



29.8 °C



26.2 °C

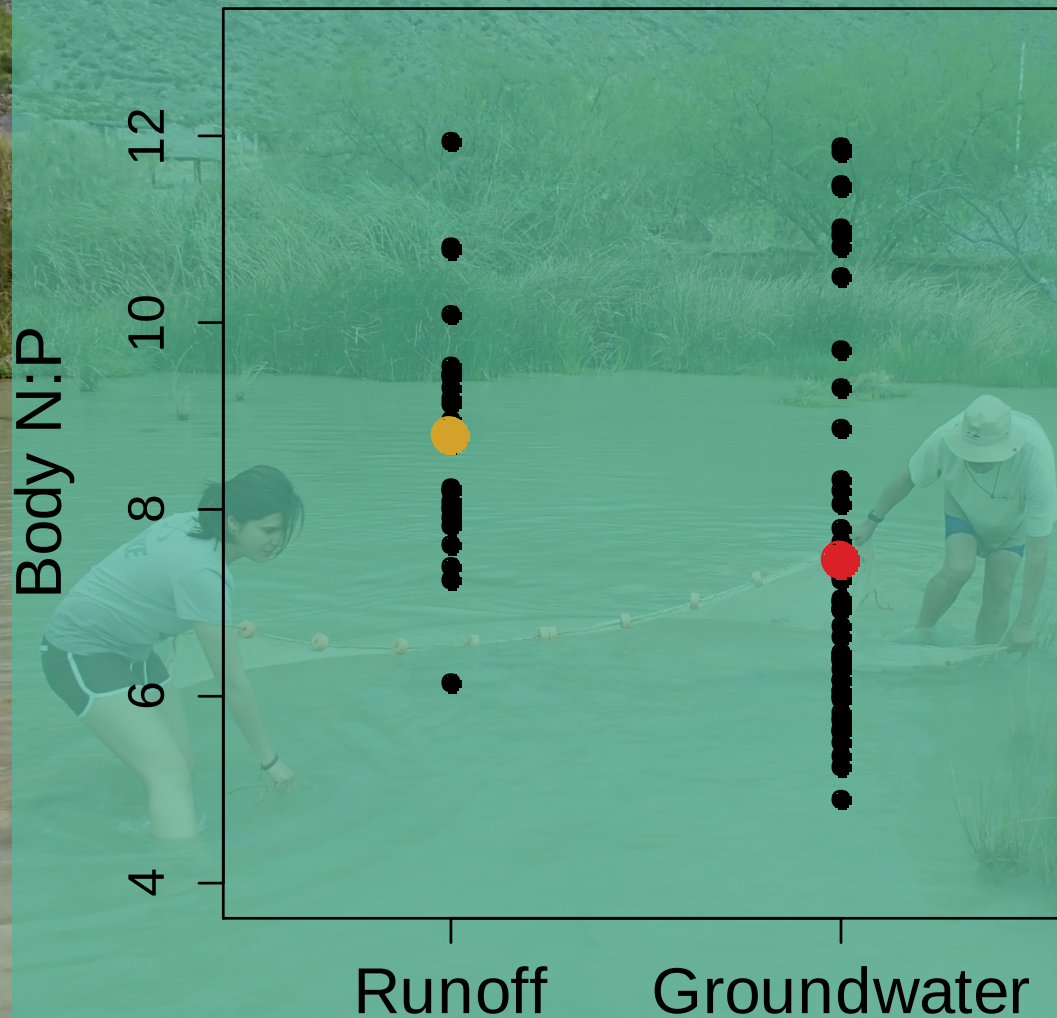


25.7 °C



25.2 °C

Collected 15 females per site



Fish in groundwater-fed springs have lower body N:P
($F_{1,78}=99.99$, $p<0.001$)



Measured Fish Excretion Rates

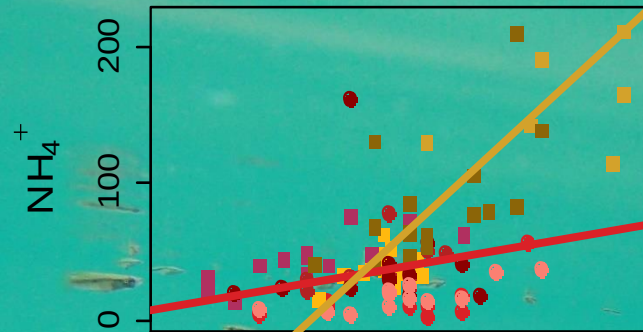
SRP excretion rates
measured w/ acid
molybdate method
(APHA 2005)

NH_4^+ excretion rates
measured w/

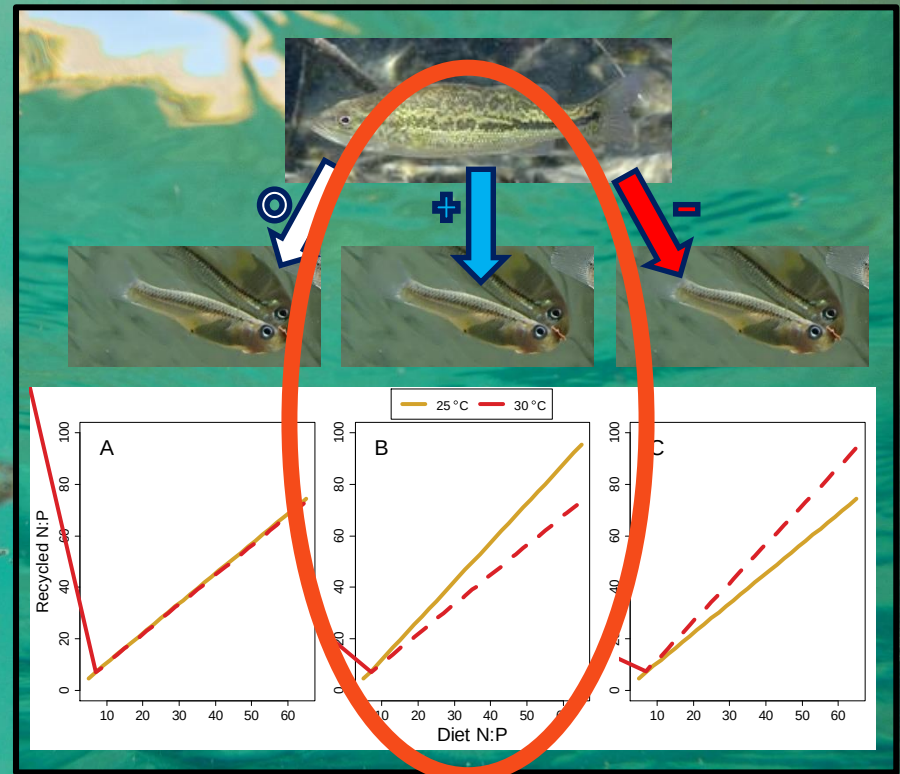
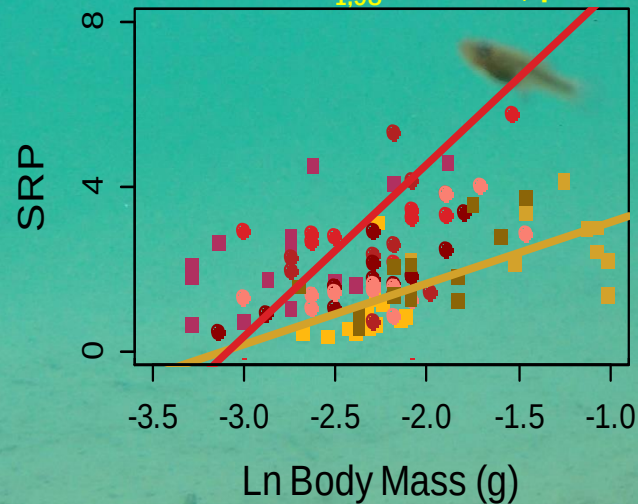
Turner Designs AquaFluor
Handheld Fluorometer
(Taylor et al. 2007)



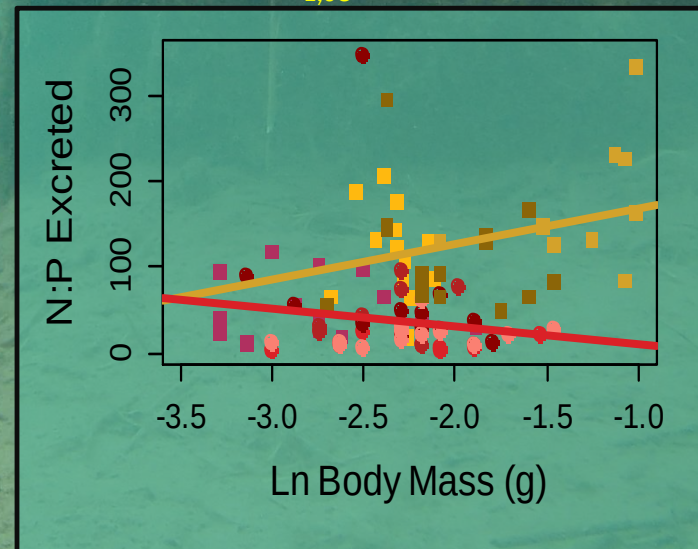
Water Source : $F_{1,98}=47.43, p<0.001$



Water Source : $F_{1,98}=112.30, p<0.001$



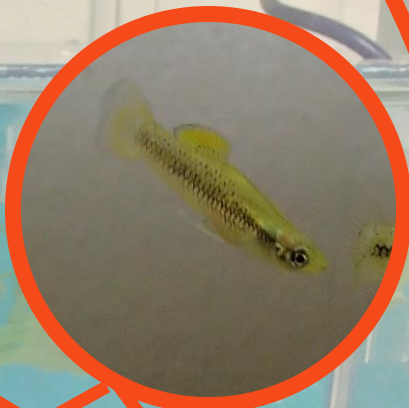
Water Source : $F_{1,98}=124.92, p<0.001$



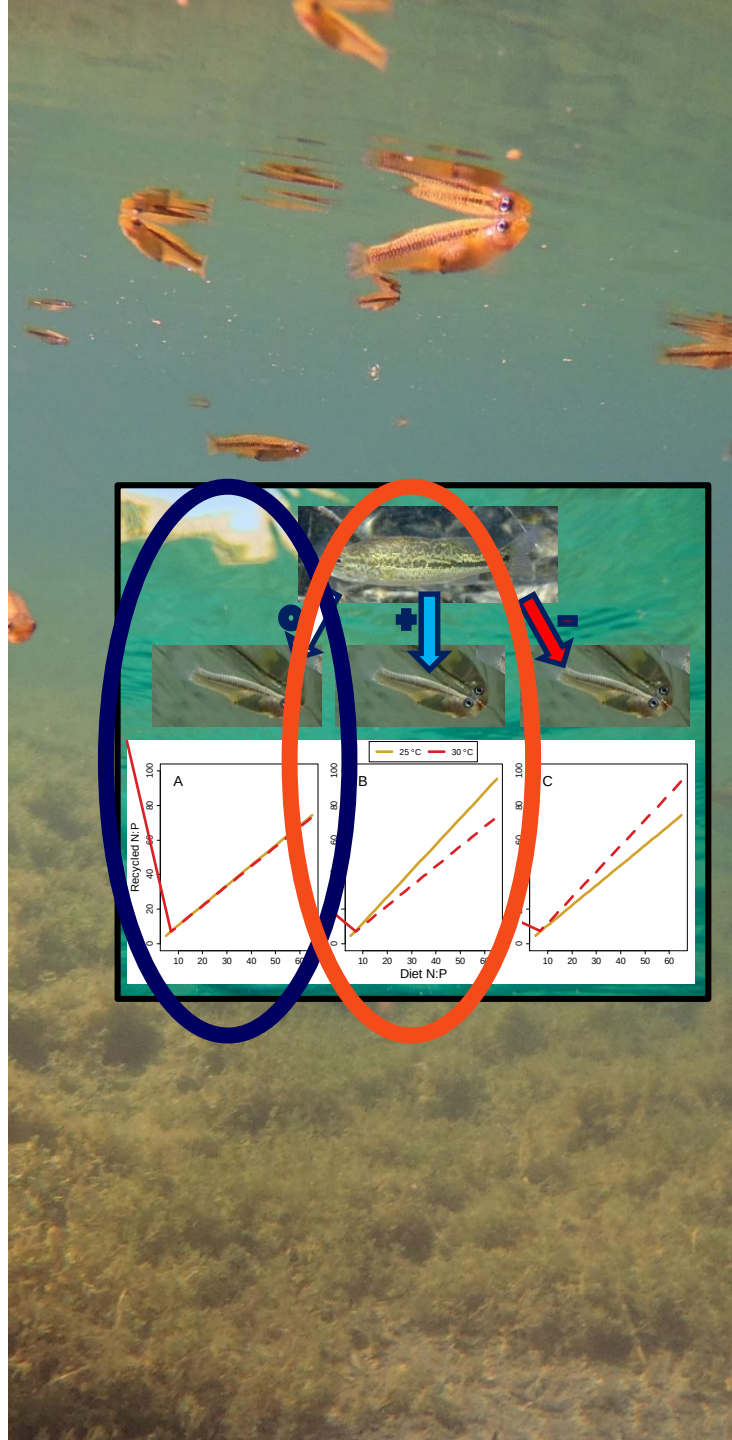
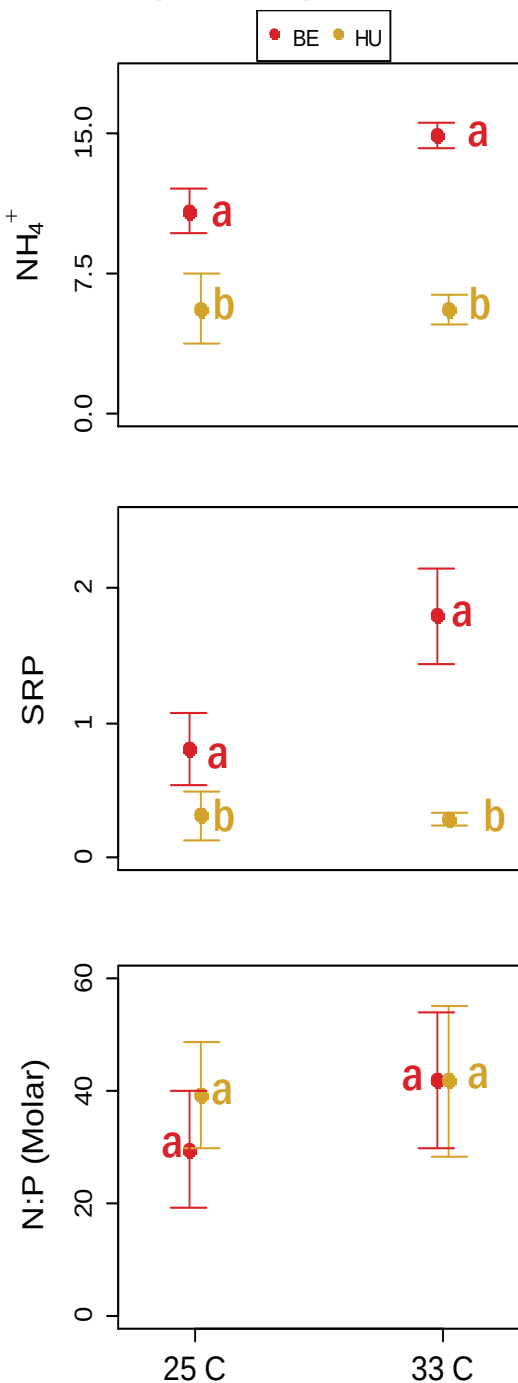
**25 °C Source
Population
(Los Hundidos)**



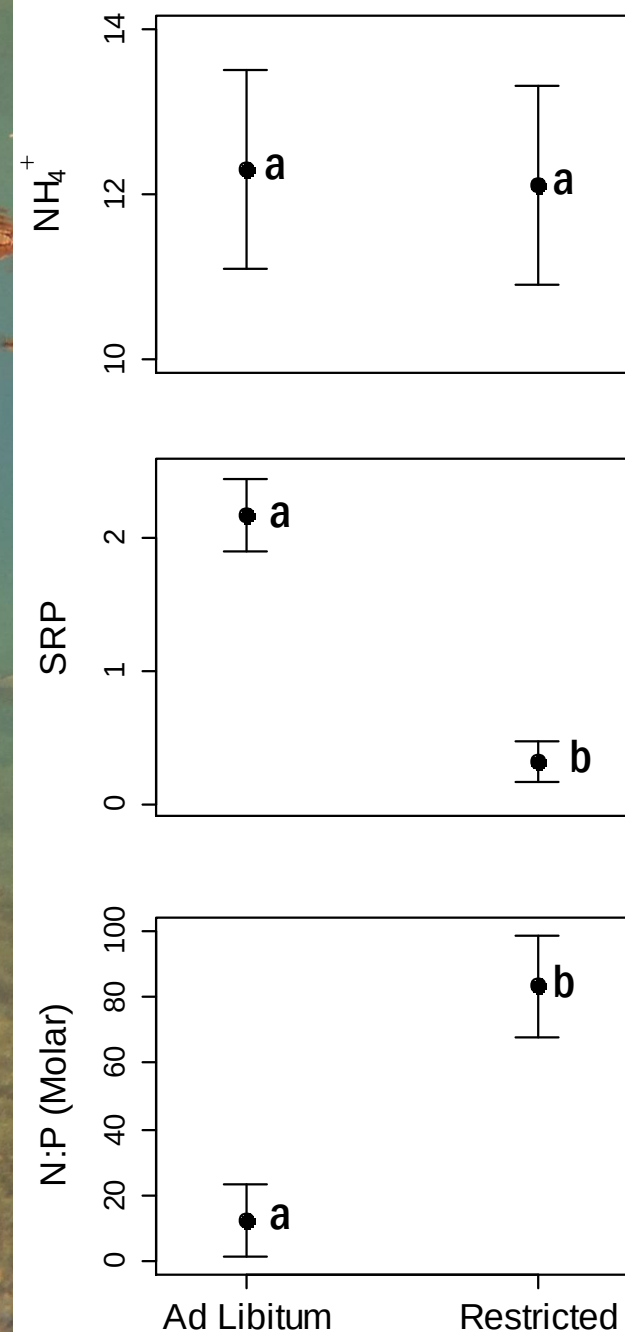
**32 °C Source
Population
(La Becerra)**



Temp Manipulation



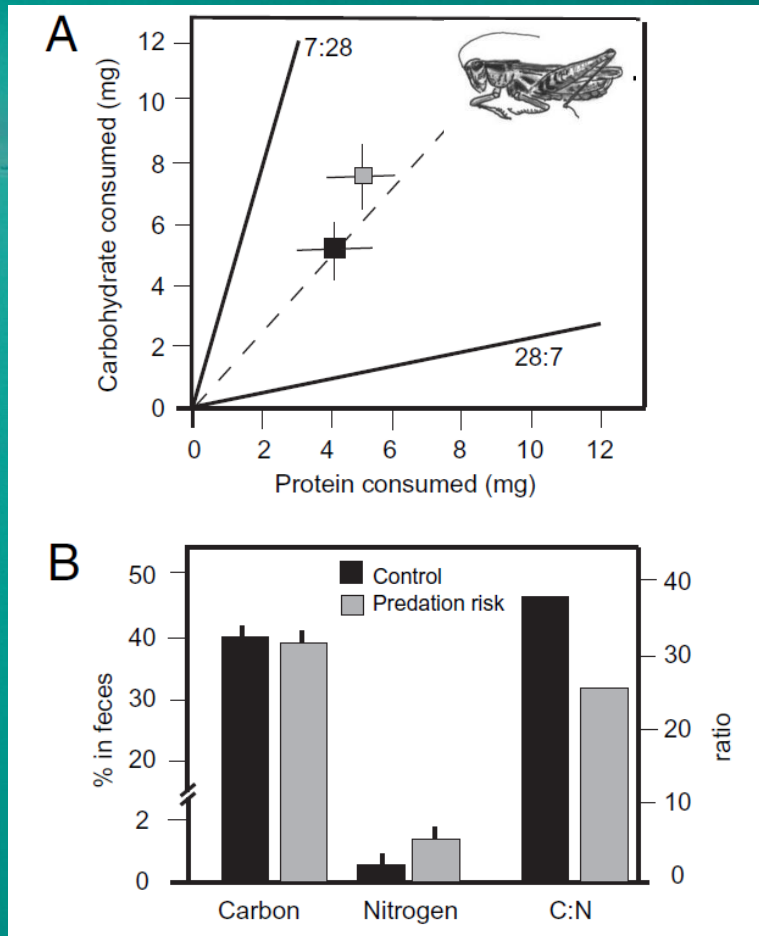
Ration Manipulation



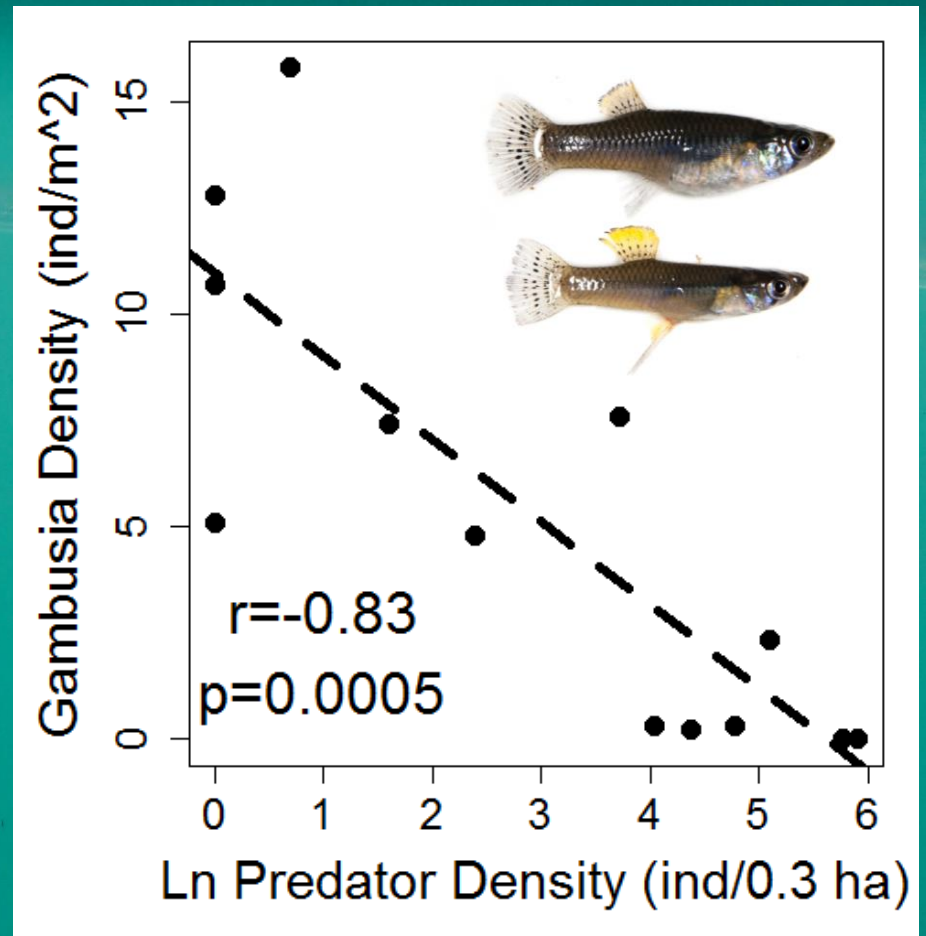
Why would consumption increase with predation pressure?

Metabolism?

Intraspecific Competition?



Hawlena & Schmitz 2010



Modified from Araújo et al. 2014

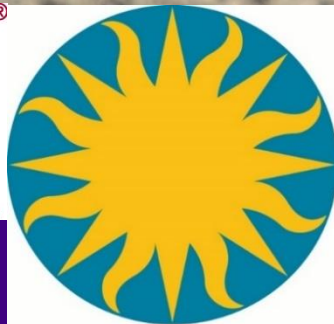
Summary

- Female fish excretion N:P is lower in high-predation, groundwater-fed spring populations even though those fish have lower body N:P
- Consumption rate (manifested through Δ) drives intraspecific variation in excretion N:P
- Decreased groundwater inputs could reduce P supplied by fish to these P-limited systems

Acknowledgements

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Smithsonian

