How saturated are predator feeding rates?

Kyle E. Coblentz

Senior Research Associate

University of Nebraska-Lincoln

Some history

- “Functional Response” introduced in 1949 by M.E. Solomon

THE NATURAL CONTROL OF ANIMAL POPULATIONS

By M. E. SOLOMON
Department of Scientific and Industrial Research, Pest Infestation Laboratory, Slough, Bucks.

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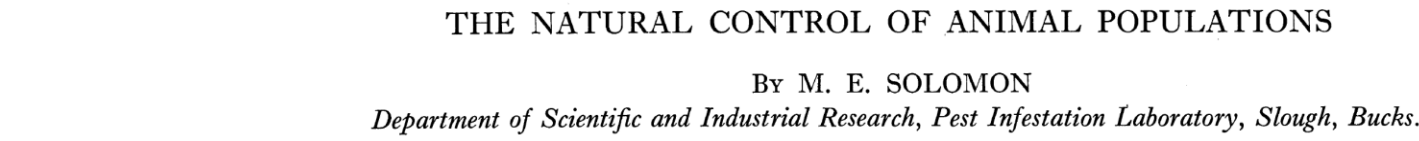

THE NATURAL CONTROL OF ANIMAL POPULATIONS

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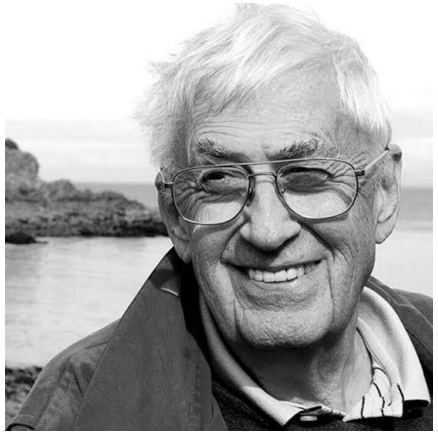
- Solomon distinguished between predator “functional” and “numerical” responses
  - Functional response is the change in predator feeding rates with prey densities
  - Numerical response is the change in the number of predators with prey densities

Some history

- In 1959, a decade later, “Buzz” (C.S.) Holling is working on European sawflies (a pest of pine plantations) and small mammal predation on cocoons in Canada



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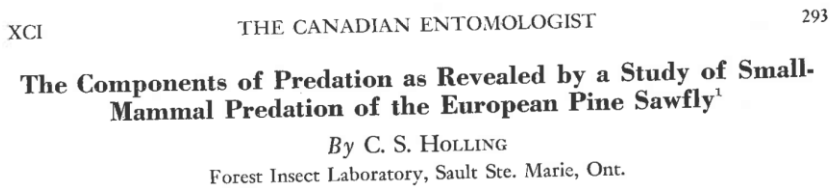
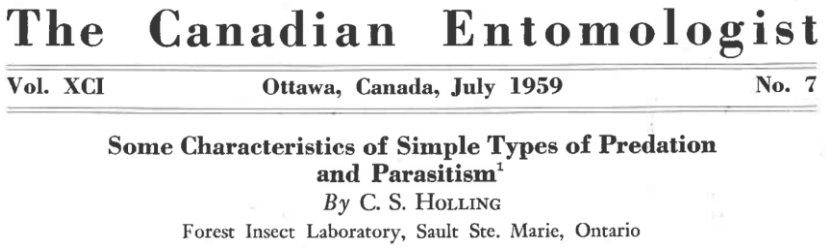


XCI THE CANADIAN ENTOMOLOGIST 293

The Components of Predation as Revealed by a Study of Small-Mammal Predation of the European Pine Sawfly[1]

By C. S. HOLLING

Forest Insect Laboratory, Sault Ste. Marie, Ont.



The Canadian Entomologist

Vol. XCI Ottawa, Canada, July 1959 No. 7

Some Characteristics of Simple Types of Predation and Parasitism[1]

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- These papers do two important things:
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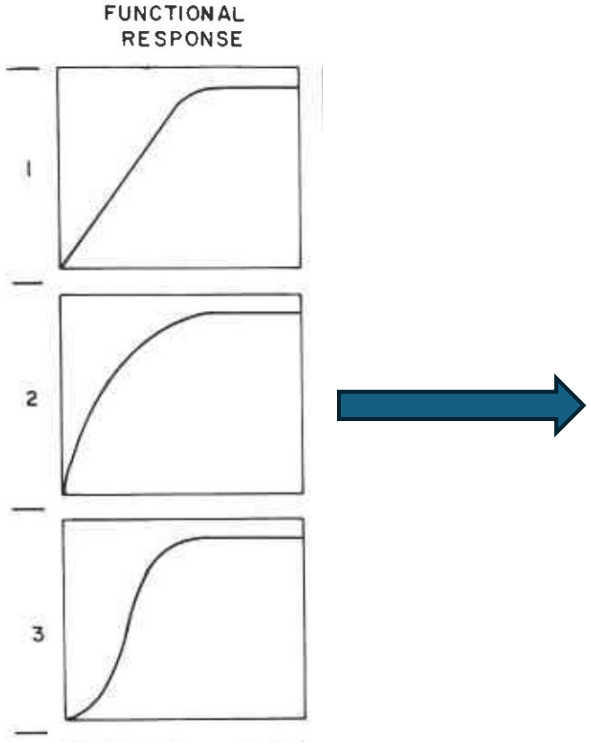

$$y = \frac{T_t ax}{1 + abx}$$

Some history

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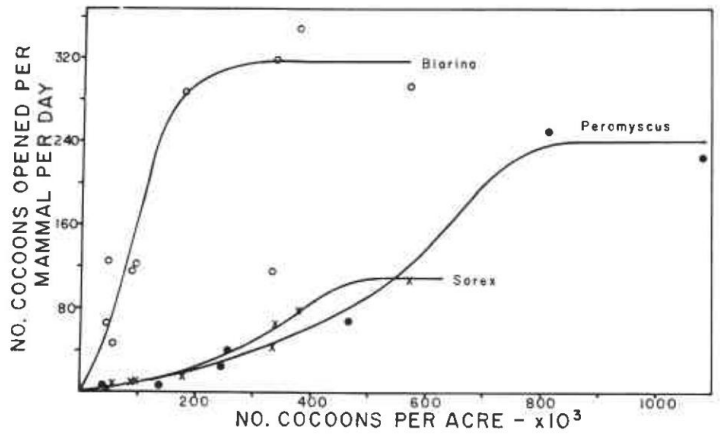

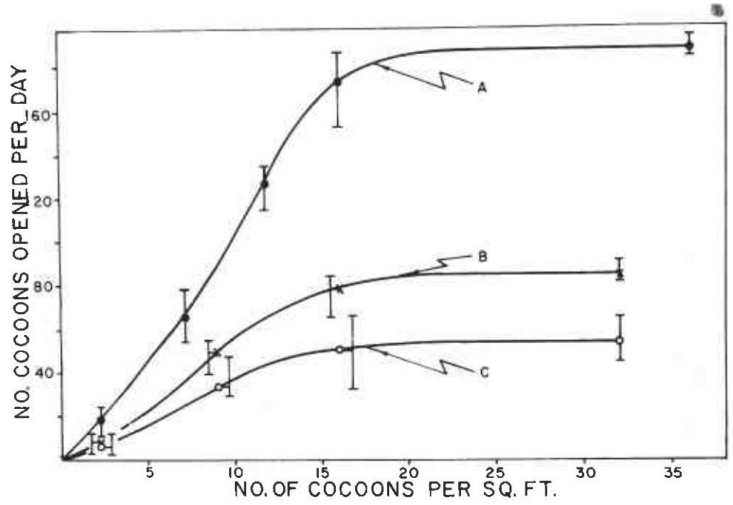

Some history

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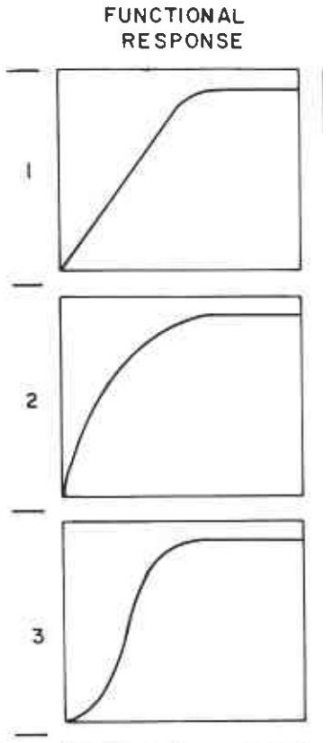
- Lasting effects:
    1) Holling Disc Equation remains the default functional response description
    2) Over 3,000 experiments have been performed to measure functional responses!

Saturation: A conflict with history?



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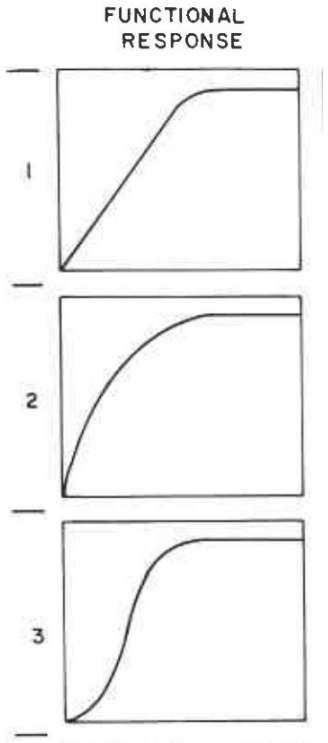

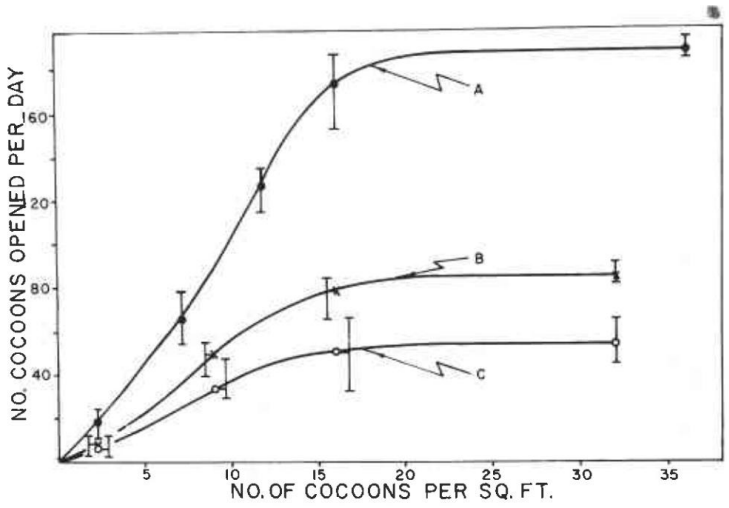

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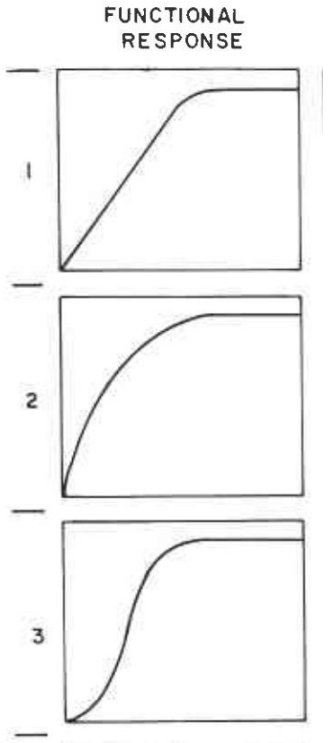

Mark Novak

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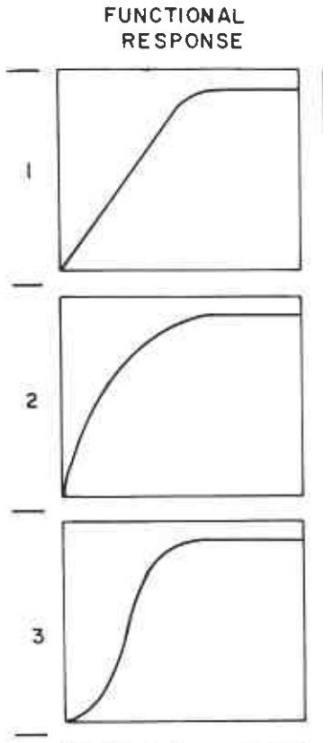

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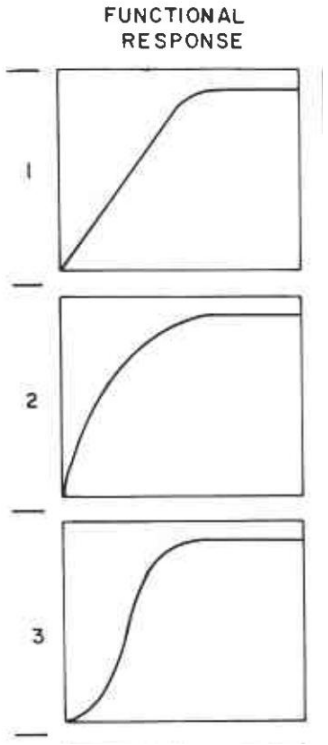

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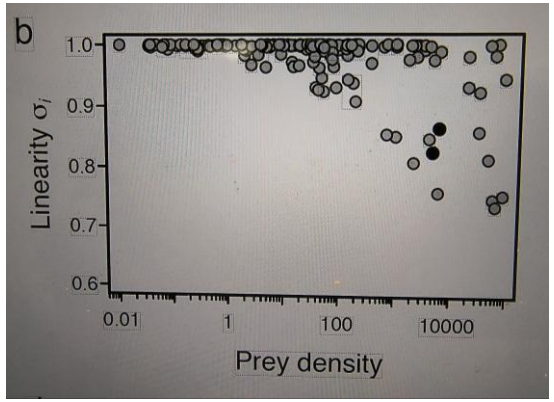

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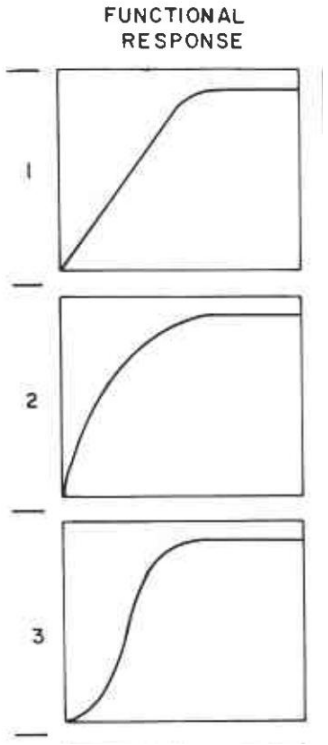

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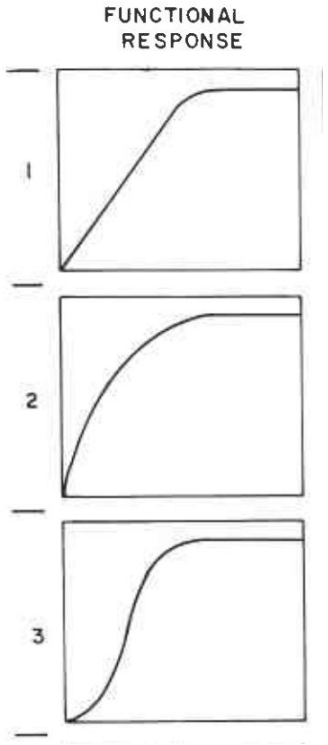

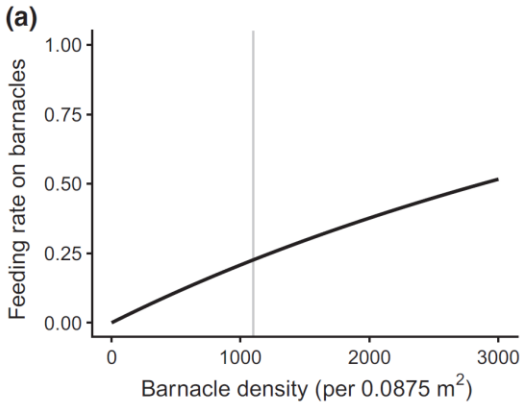

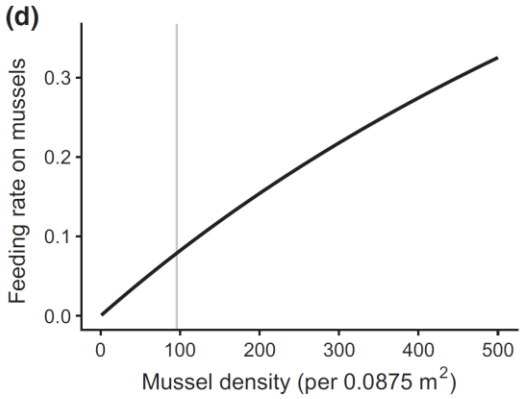

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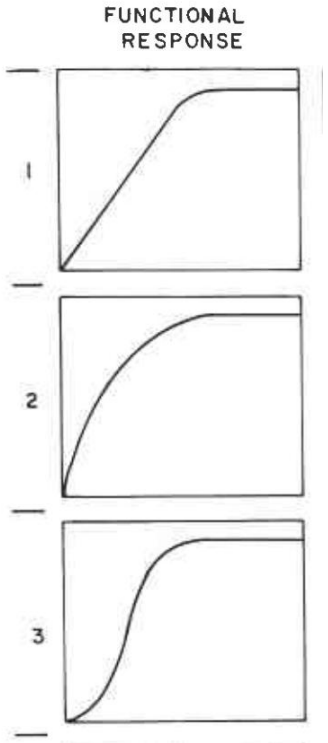

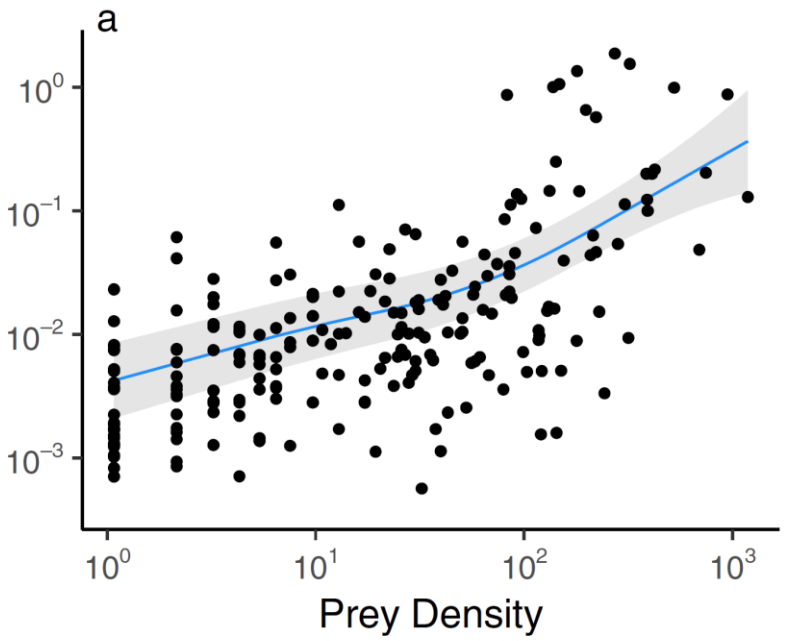

How saturated are feeding rates in nature?

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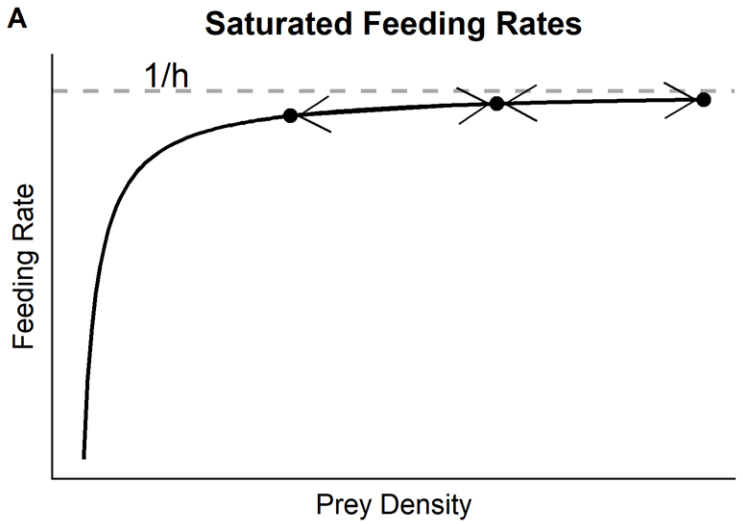
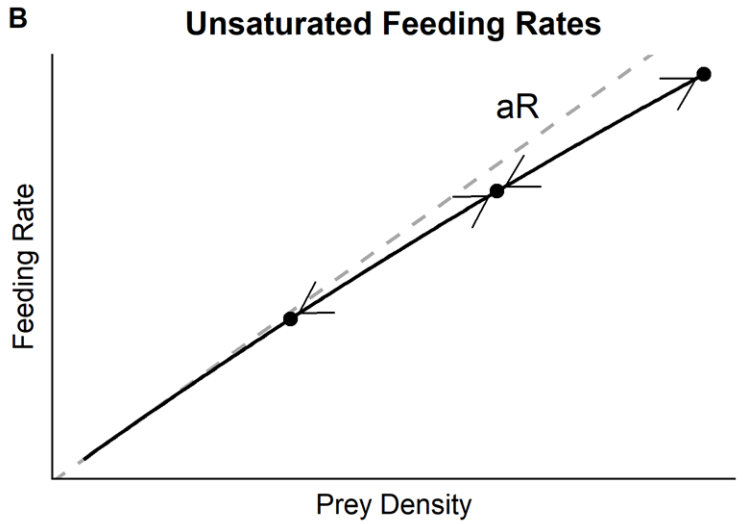
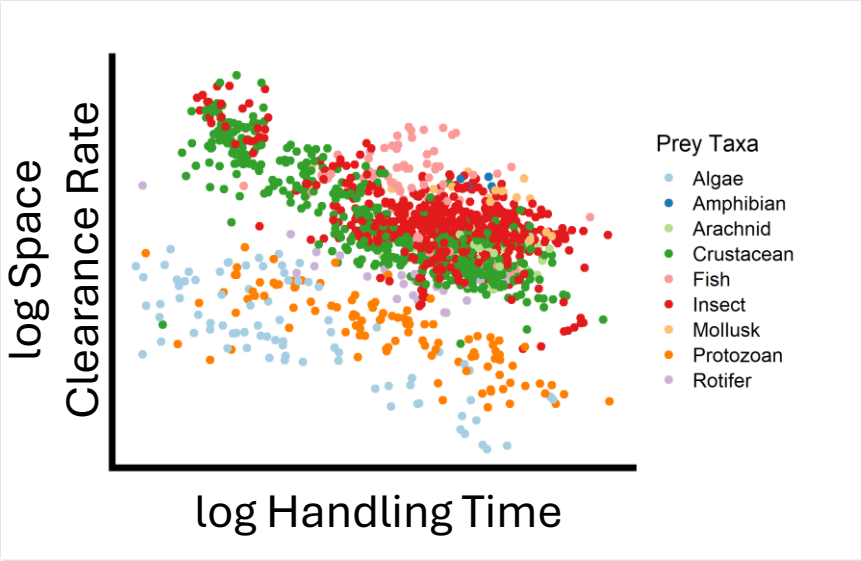




Our approach – Bring together two databases

FoRAGE



Uiterwaal et al. 2022. *Ecology*.

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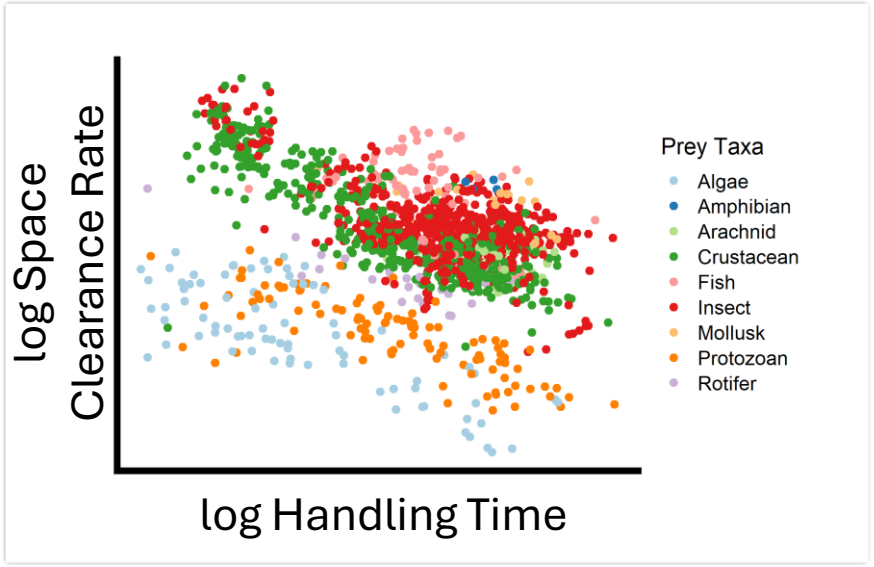

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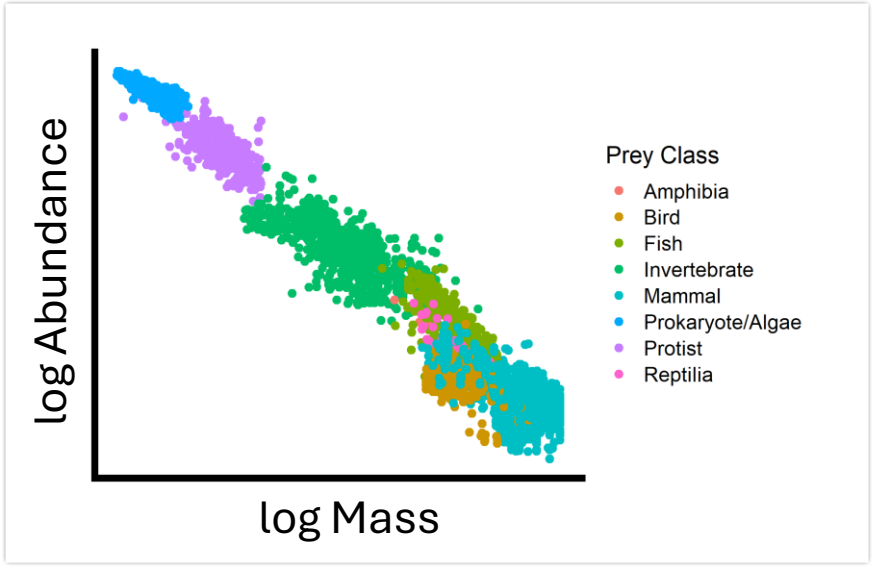
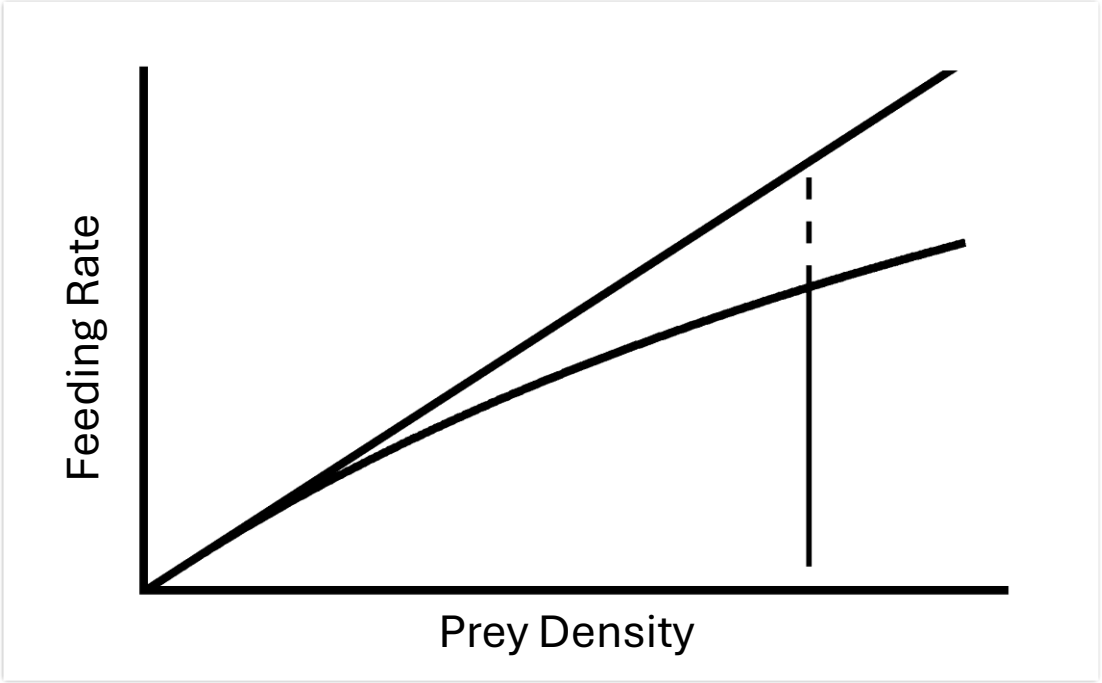
Mass-Abundance Scaling



Hatton et al. 2019. *PNAS*.

Measuring Feeding Rate Saturation – An Index



$$I = \frac{f_I(R) - f_{II}(R)}{f_I(R)}$$

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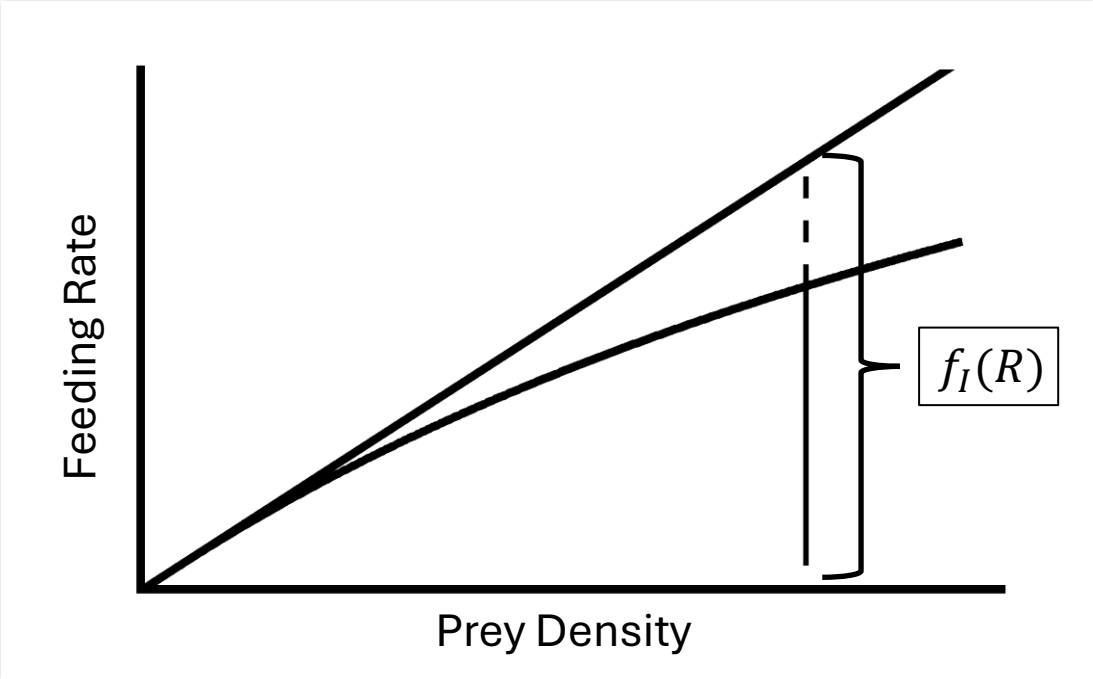

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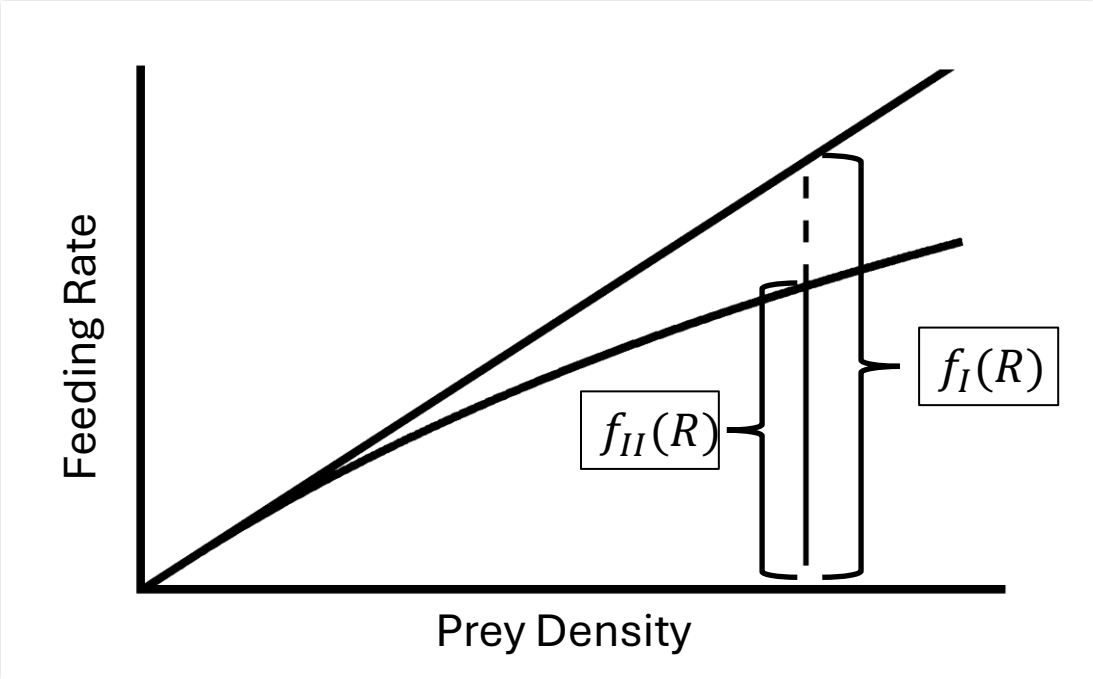

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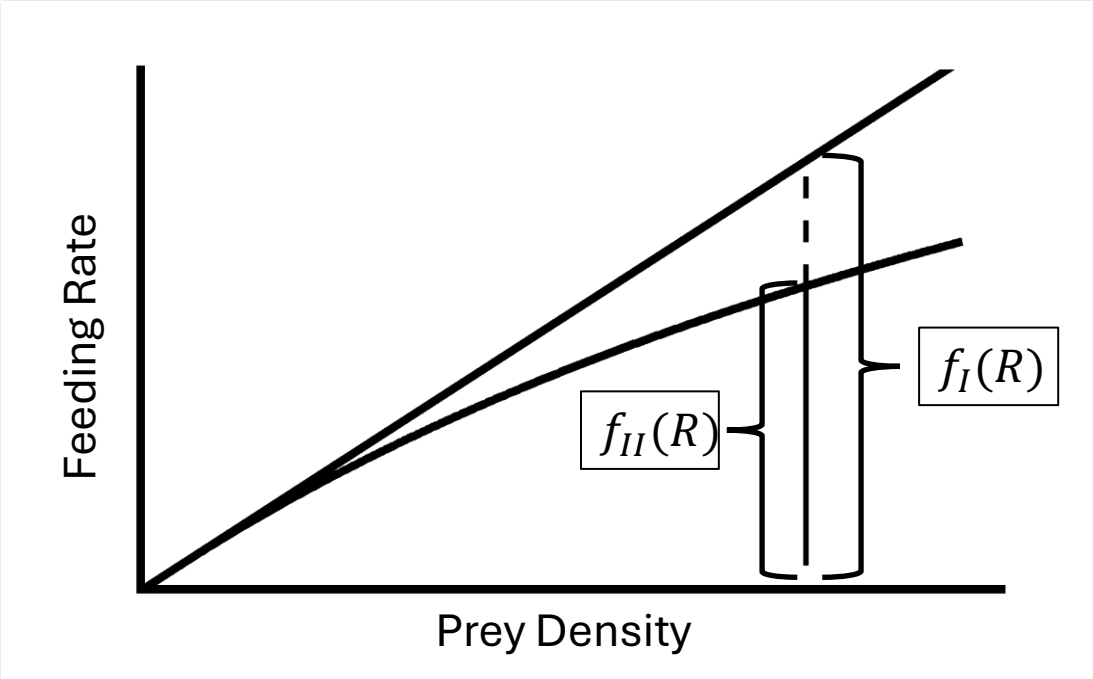

$$I = \frac{f_I(R) - f_{II}(R)}{f_I(R)}$$

$$I = \frac{aR - \frac{aR}{1+ahR}}{aR}$$

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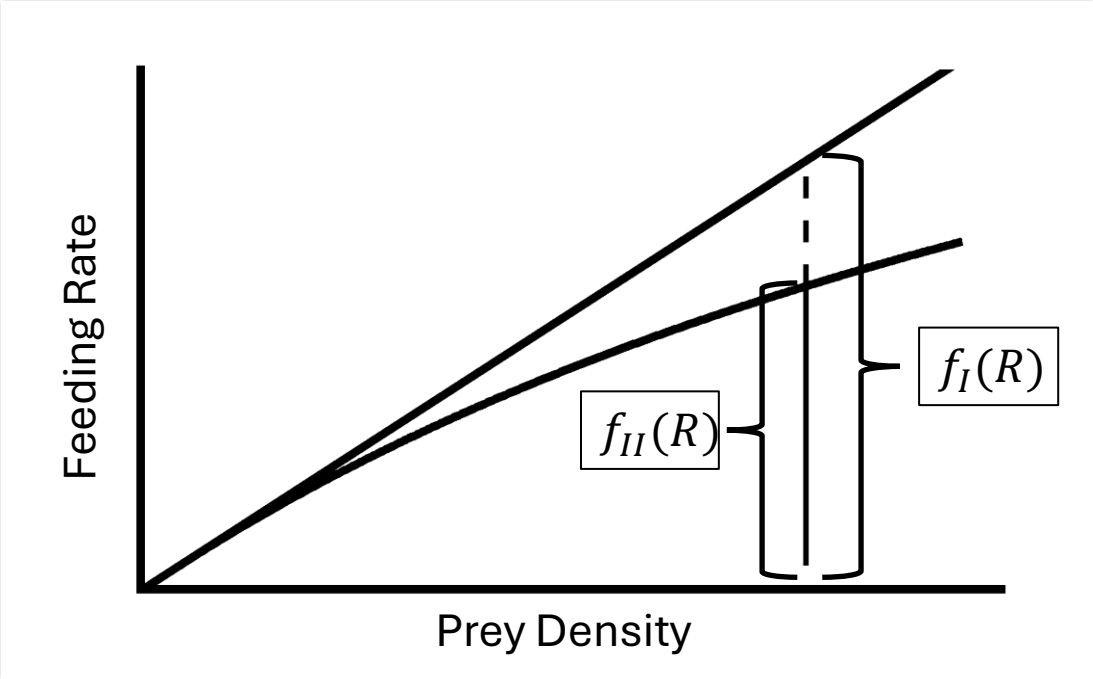

$$I = \frac{f_I(R) - f_{II}(R)}{f_I(R)}$$

$$I = 1 - \frac{1}{1+ahR}$$

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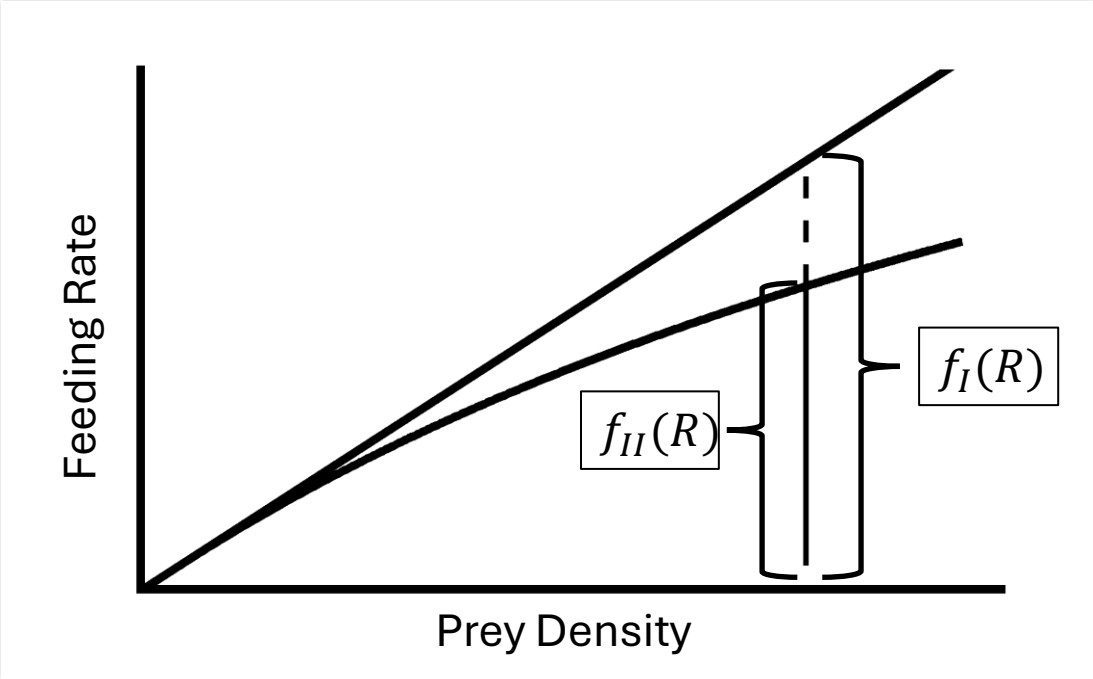

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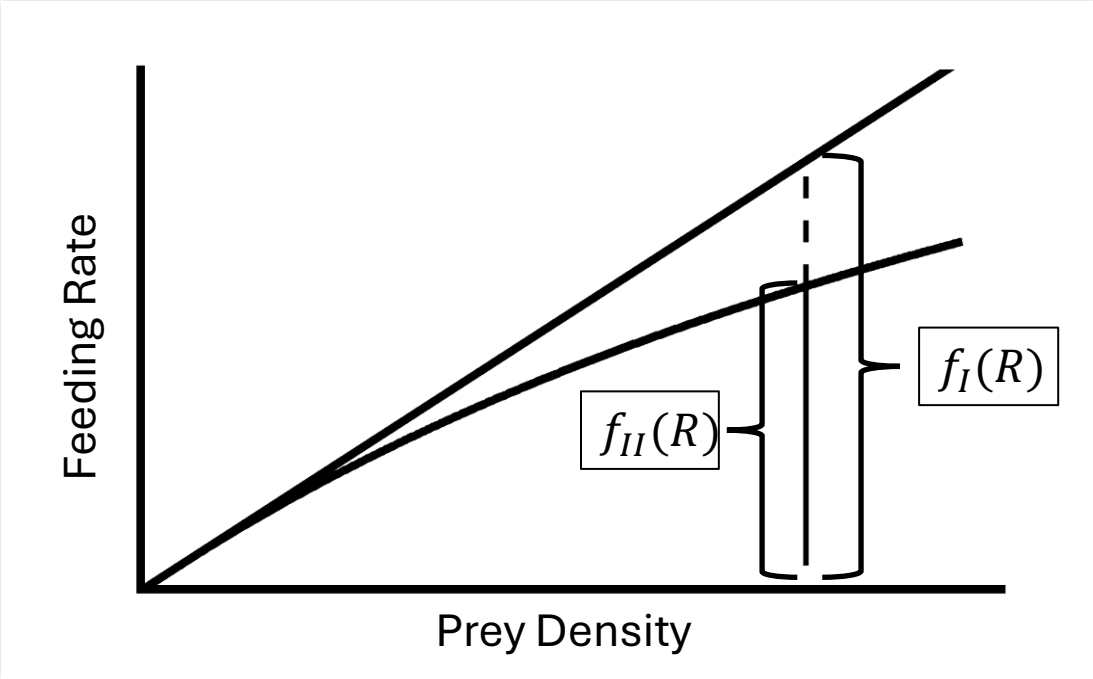

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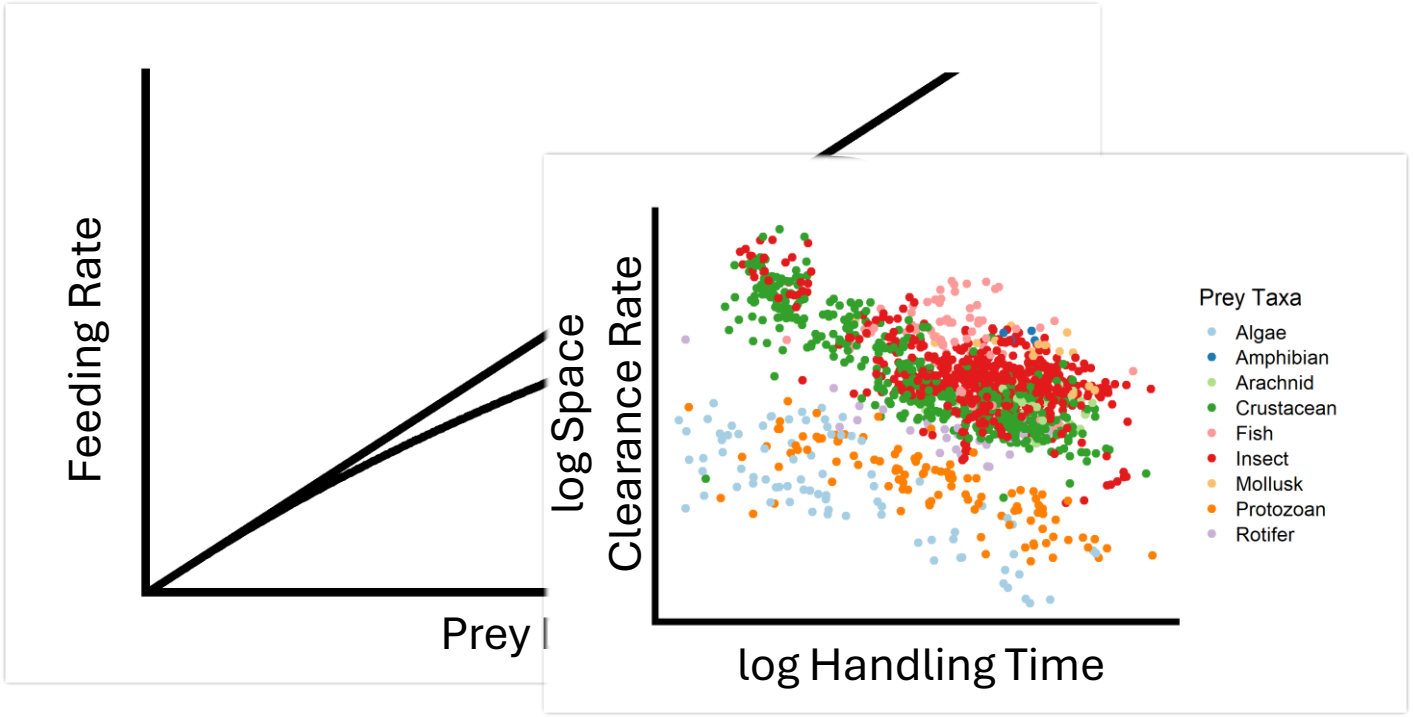

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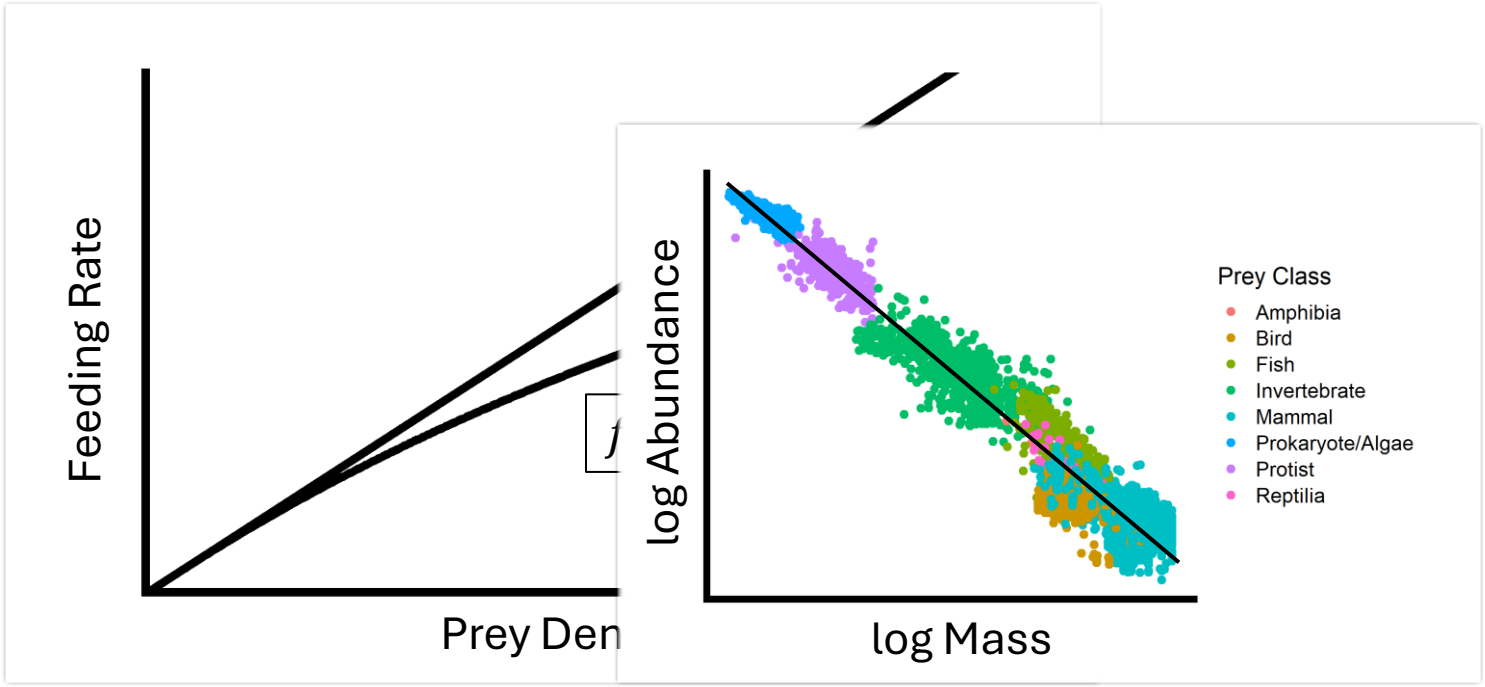

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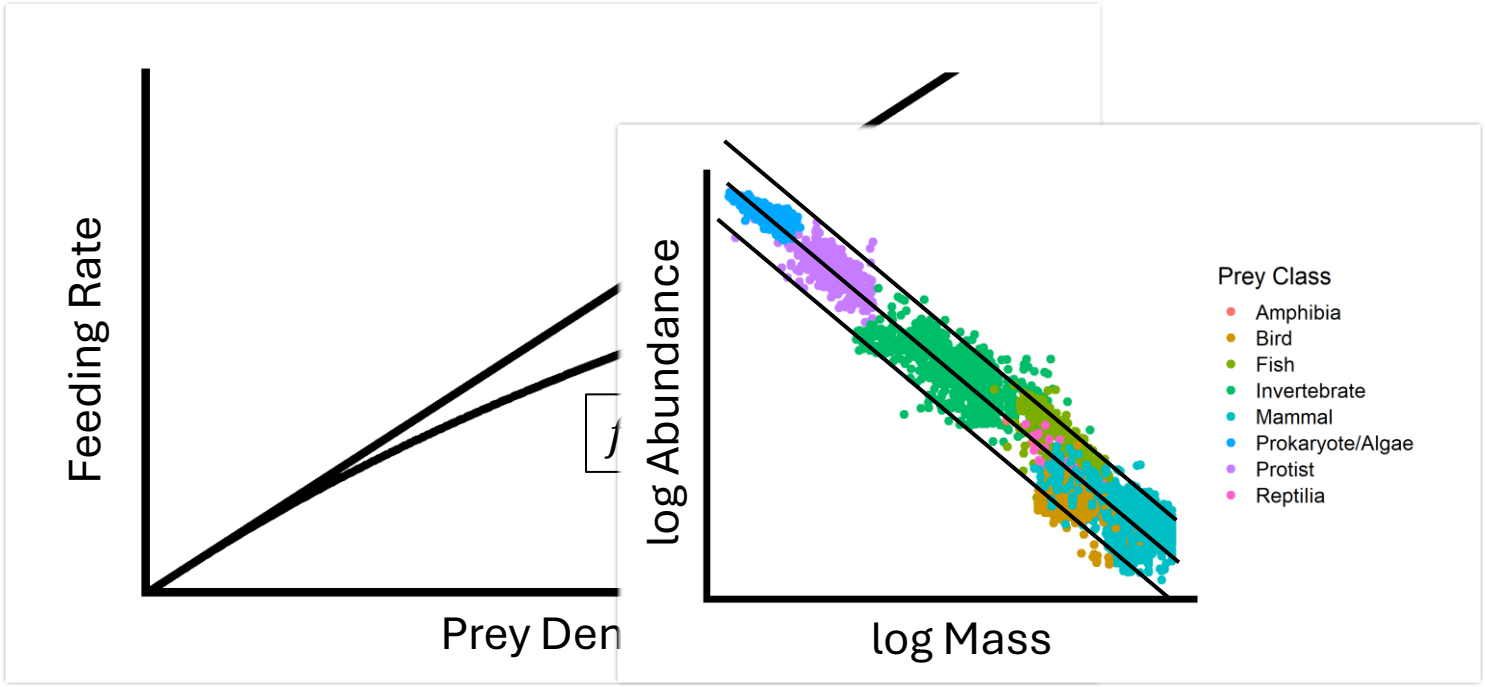

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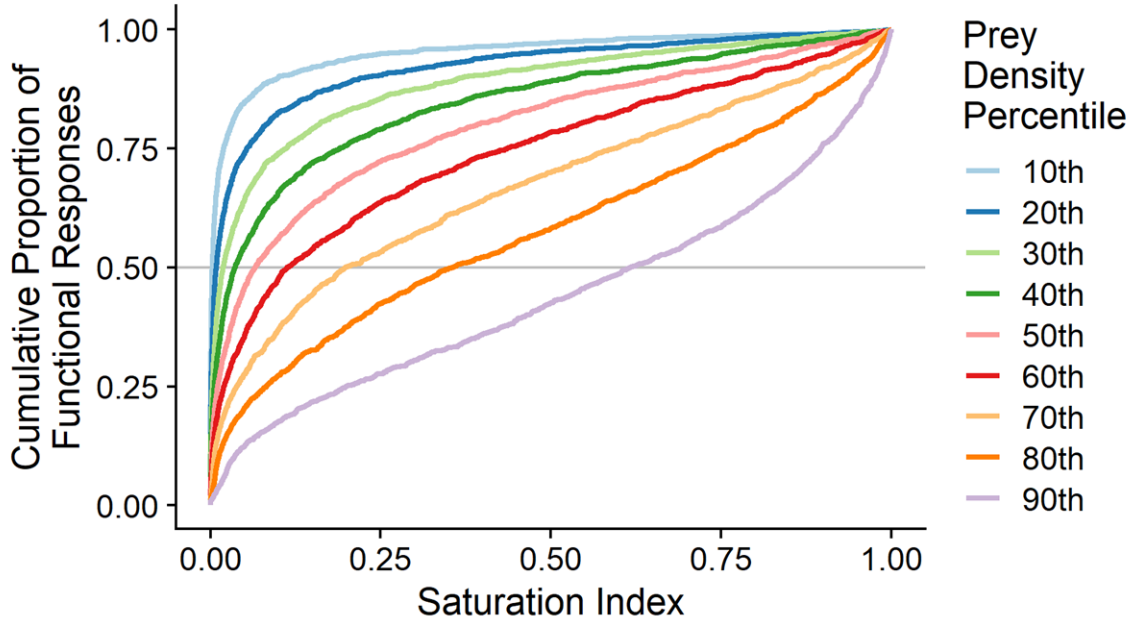
Overall Saturation



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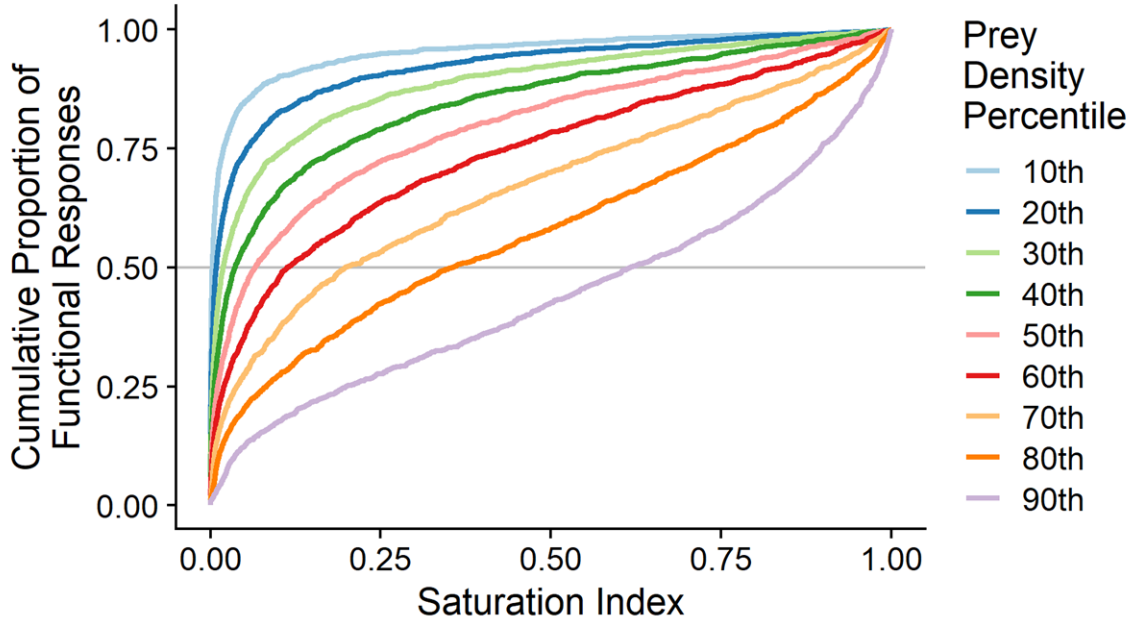

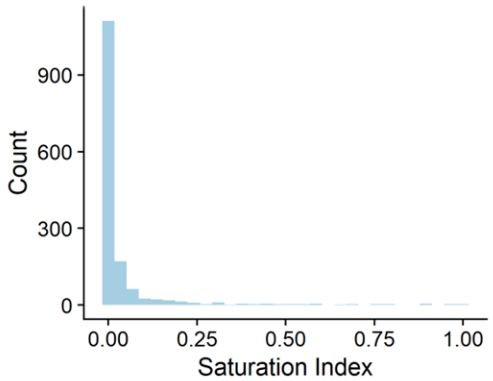

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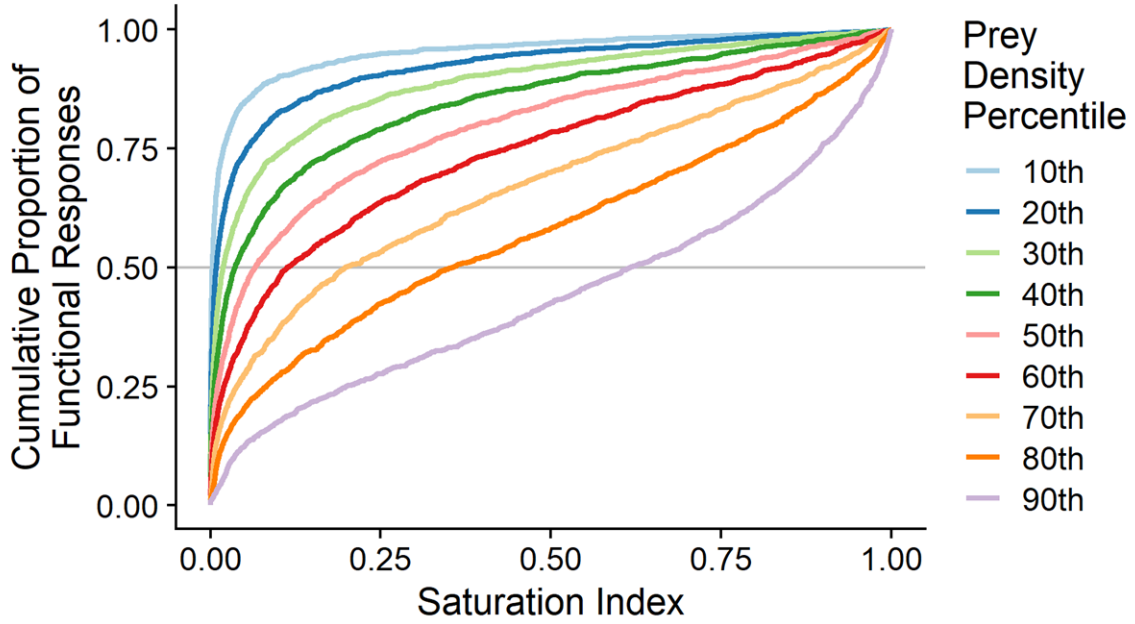

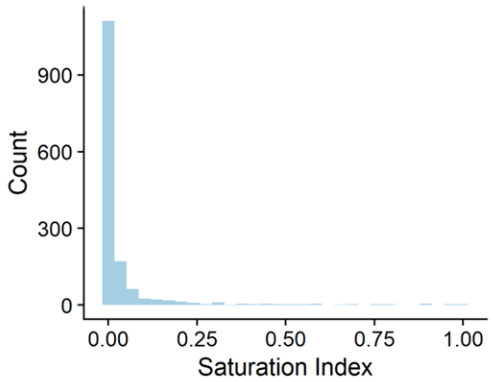

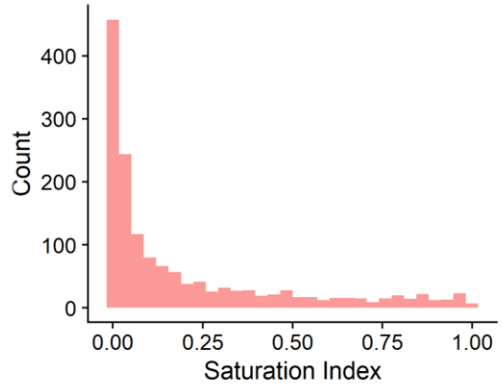

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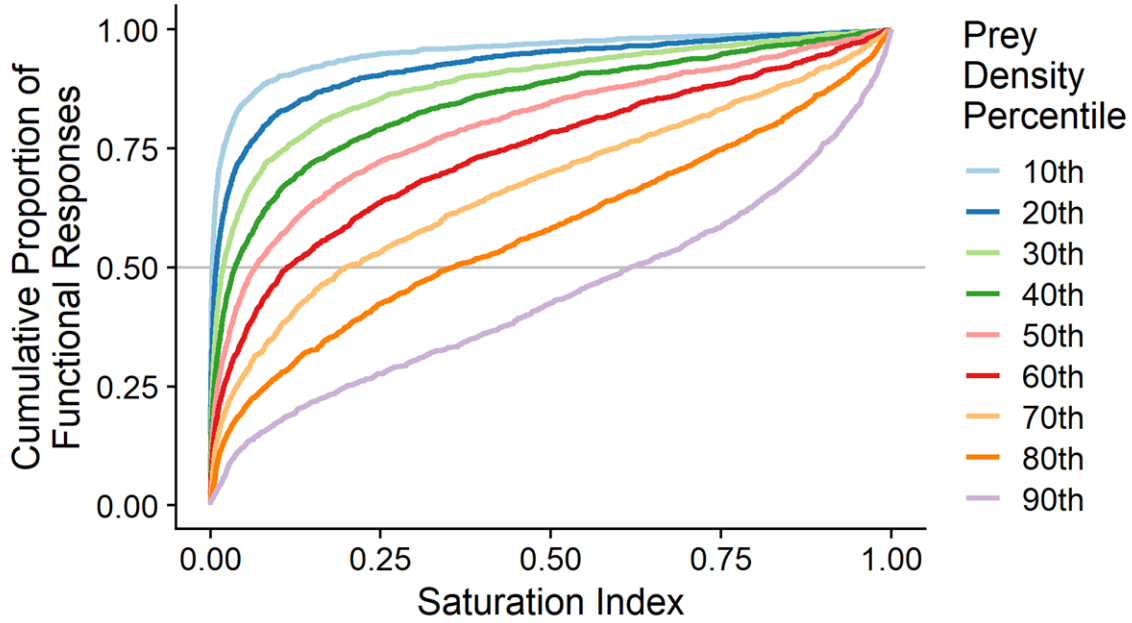

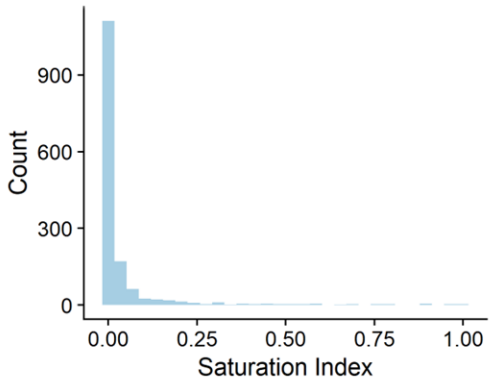

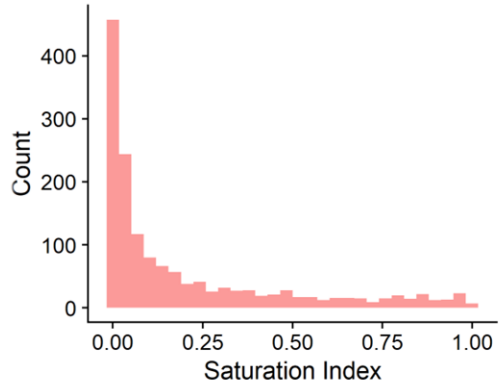

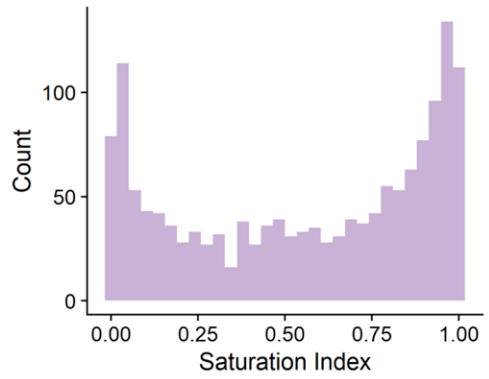

Conclusions

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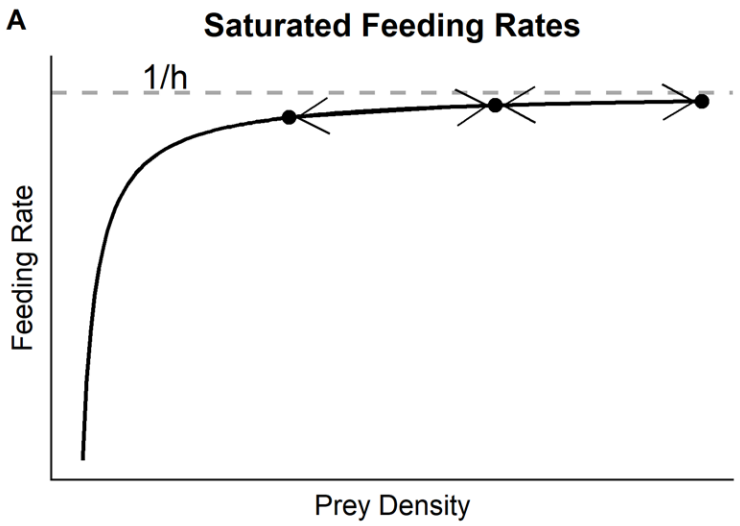
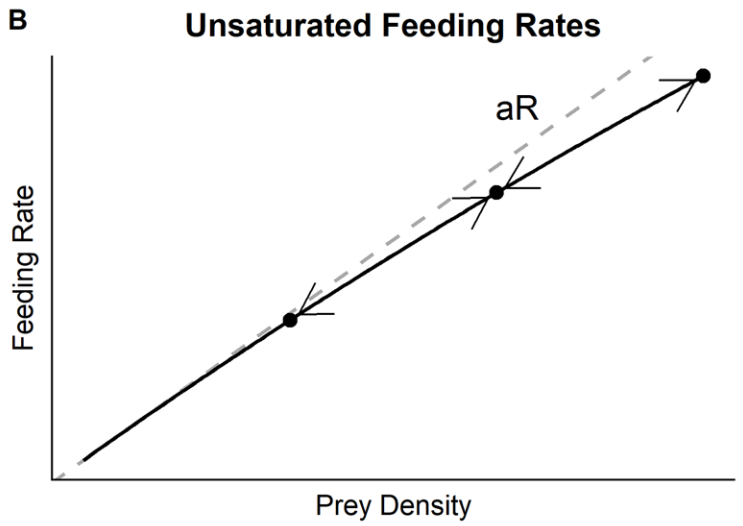
- We live closer to the unsaturated world than the saturated world (in general)





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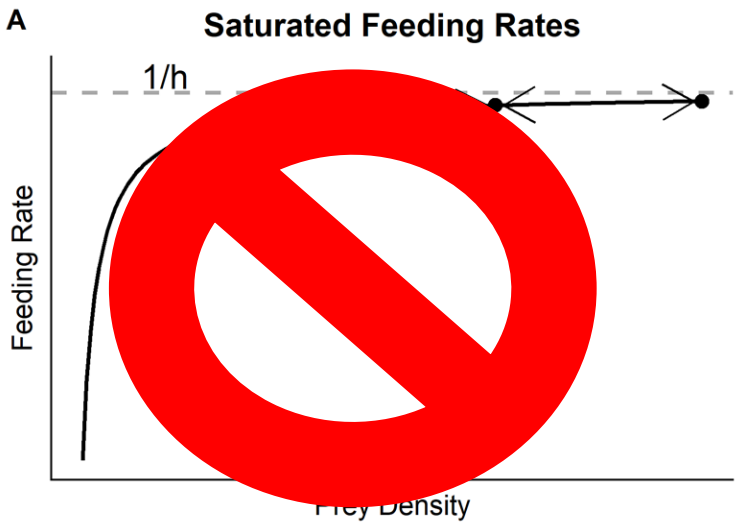

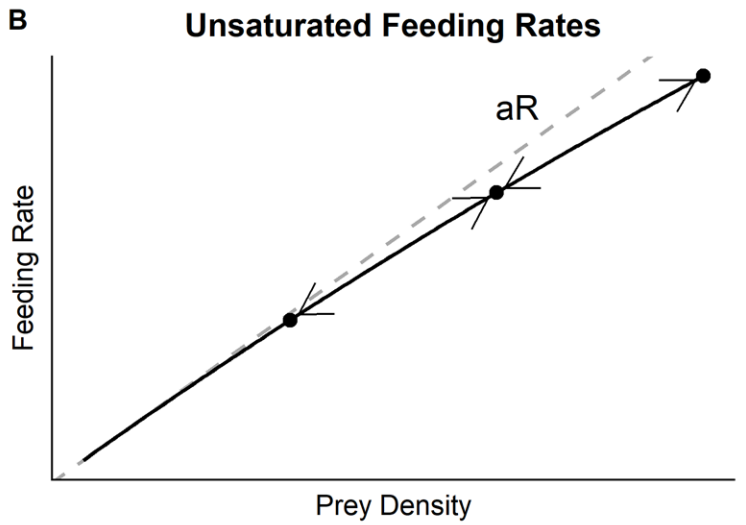

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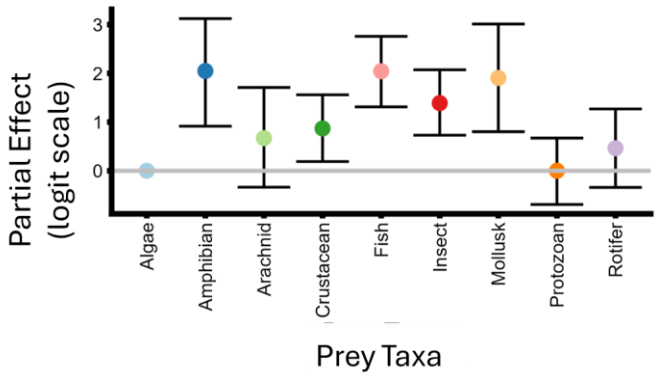

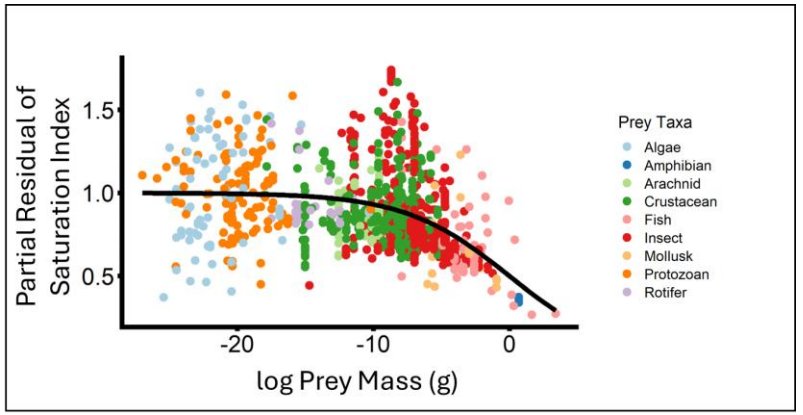

Conclusions

- We live closer to the unsaturated world than the saturated world (in general)
- Where particular predators and prey fall on this spectrum depends on their qualities and how they interact
- Approximating feeding rates using a linear relationship between feeding rates and prey densities might be fine in a lot of cases

Where is this work going in the future?

- We need more measurements of functional responses for predators that eat multiple prey species in the field

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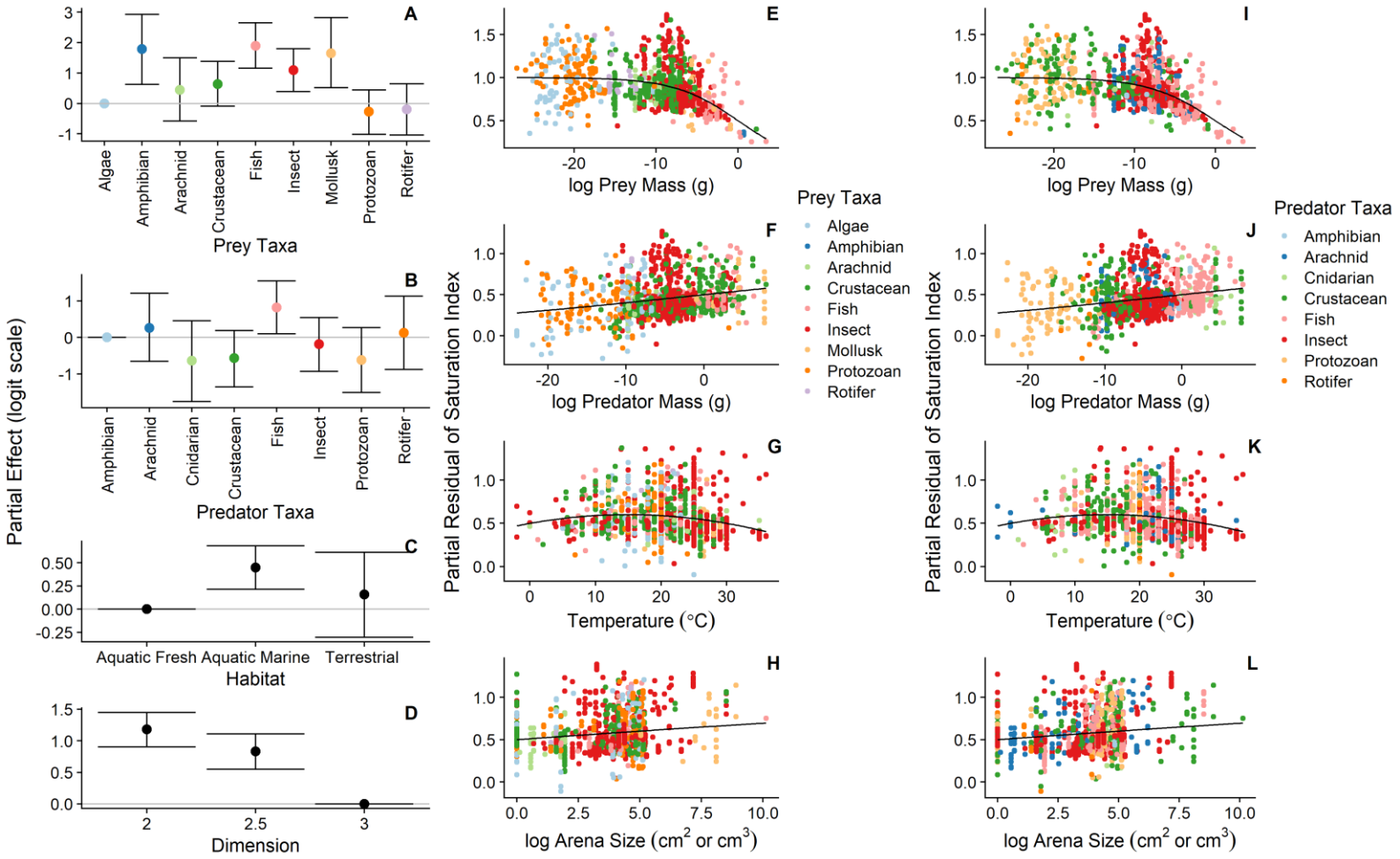
- Why are feeding rates unsaturated? Why have space clearance rates and handling times evolved to lead to unsaturated feeding rates?

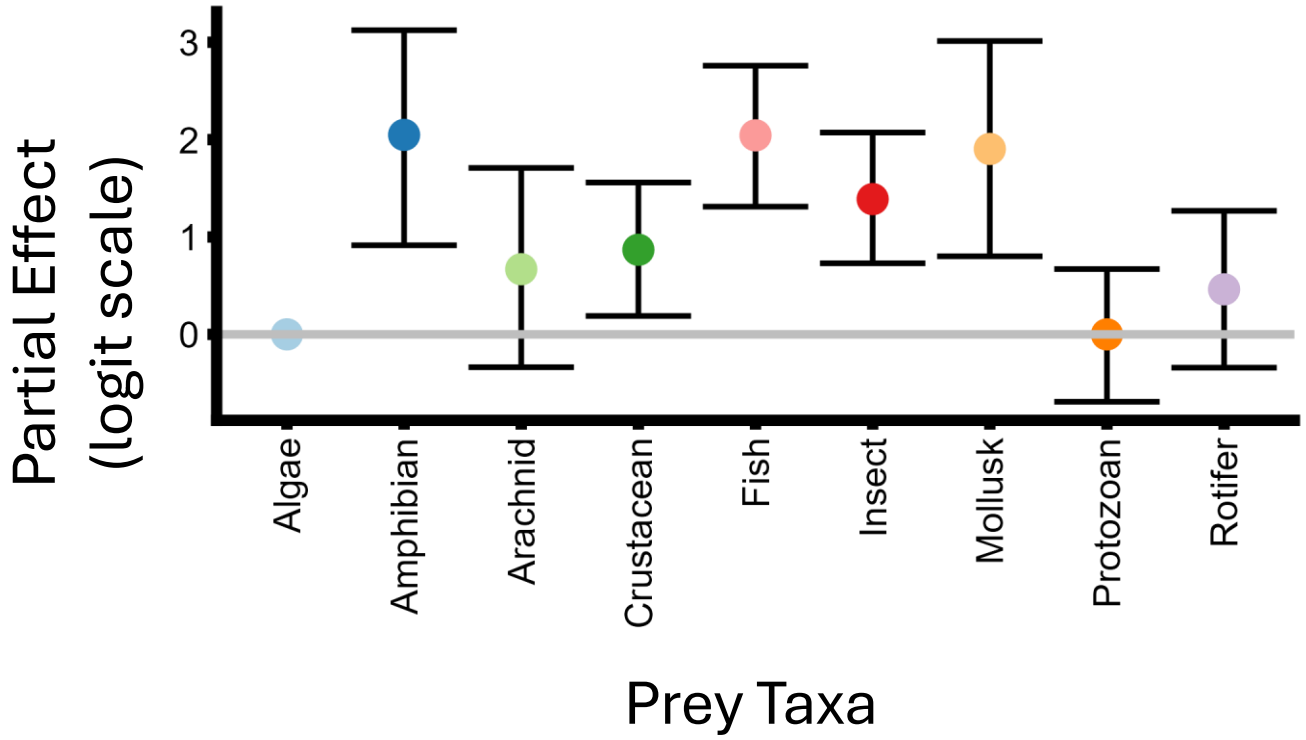
Questions and Discussion

$$y = \frac{T_{t}ax}{1 + abx}$$

Correlates with the Saturation Index?



Correlates with the Saturation Index?
Prey Taxa



Correlates with the Saturation Index?
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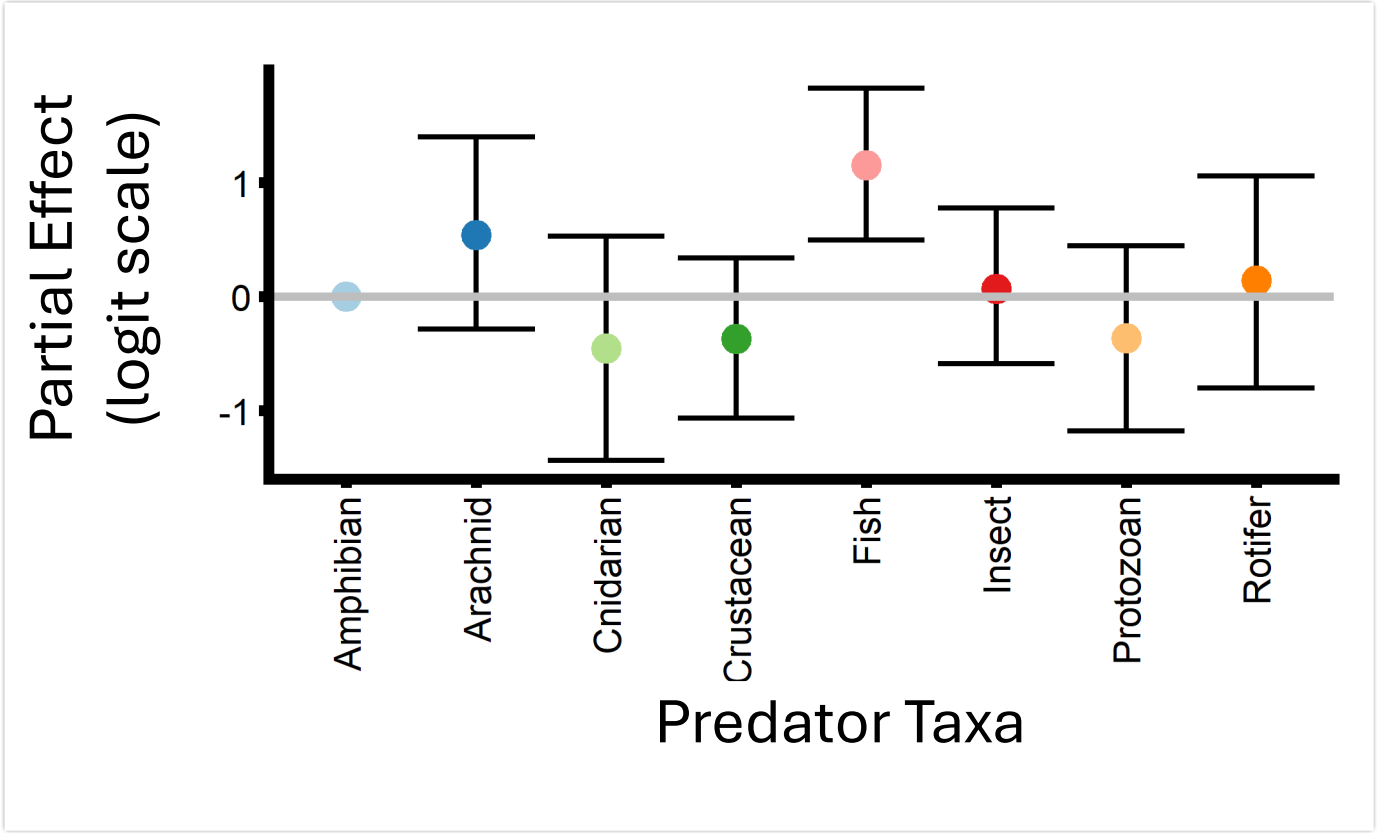
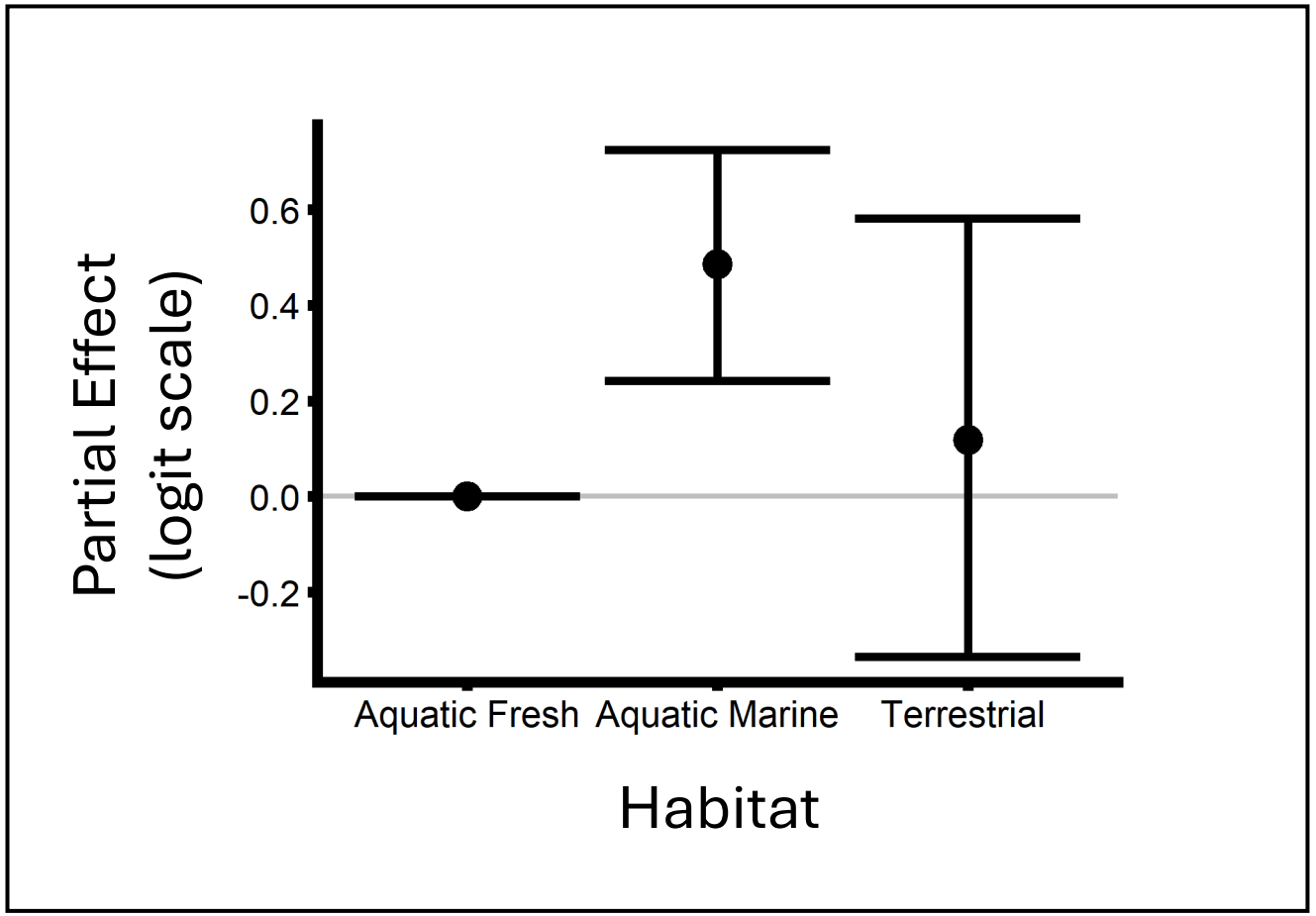
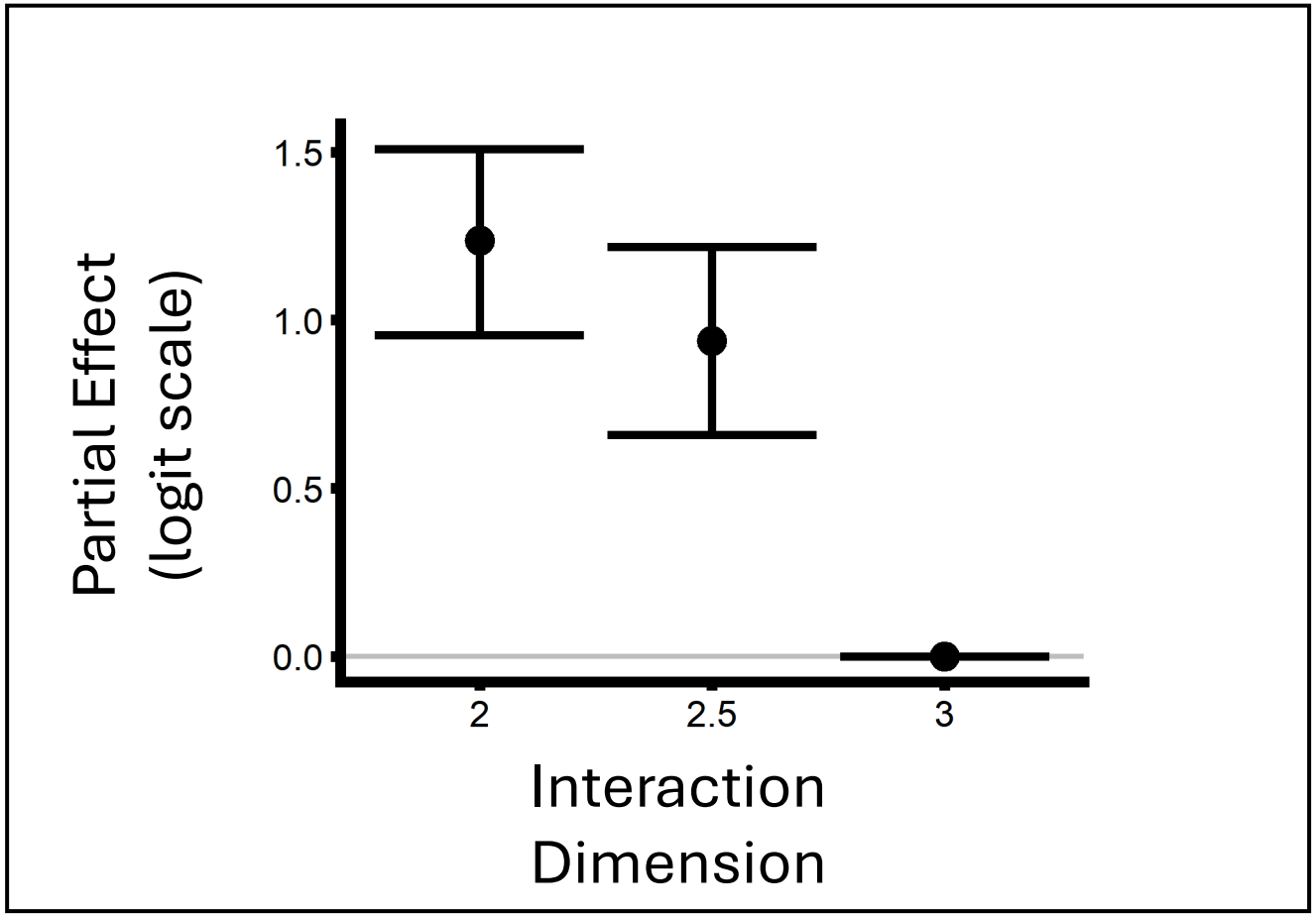


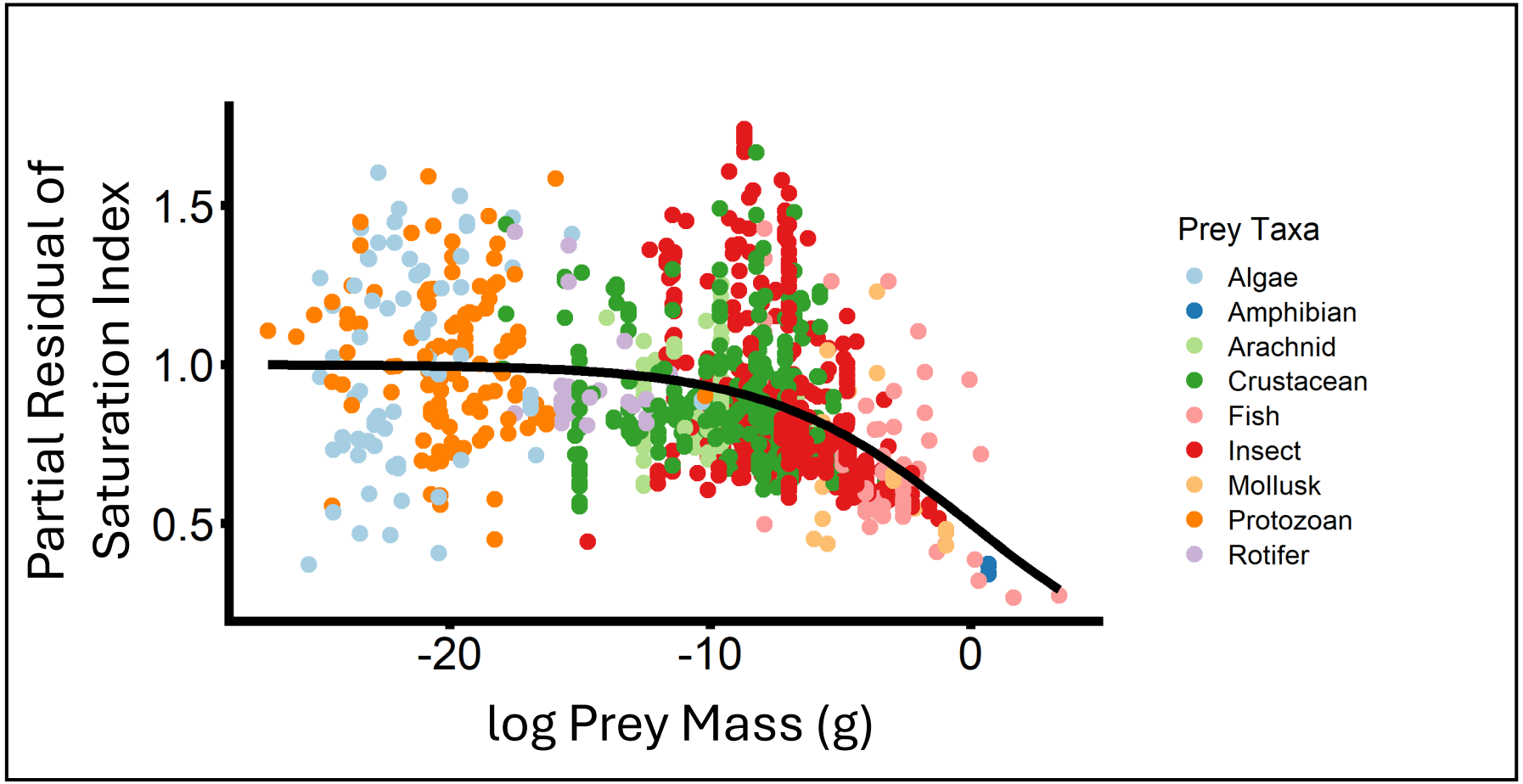
Correlates with the Saturation Index?
Habitat



Correlates with the Saturation Index?
Interaction Dimension



Correlates with the Saturation Index?
Prey Body Size



Correlates with the Saturation Index? Predator Body Size