The Omnivore's Advantage:
Implications of diet on the winter energy budget of Antarctic krill

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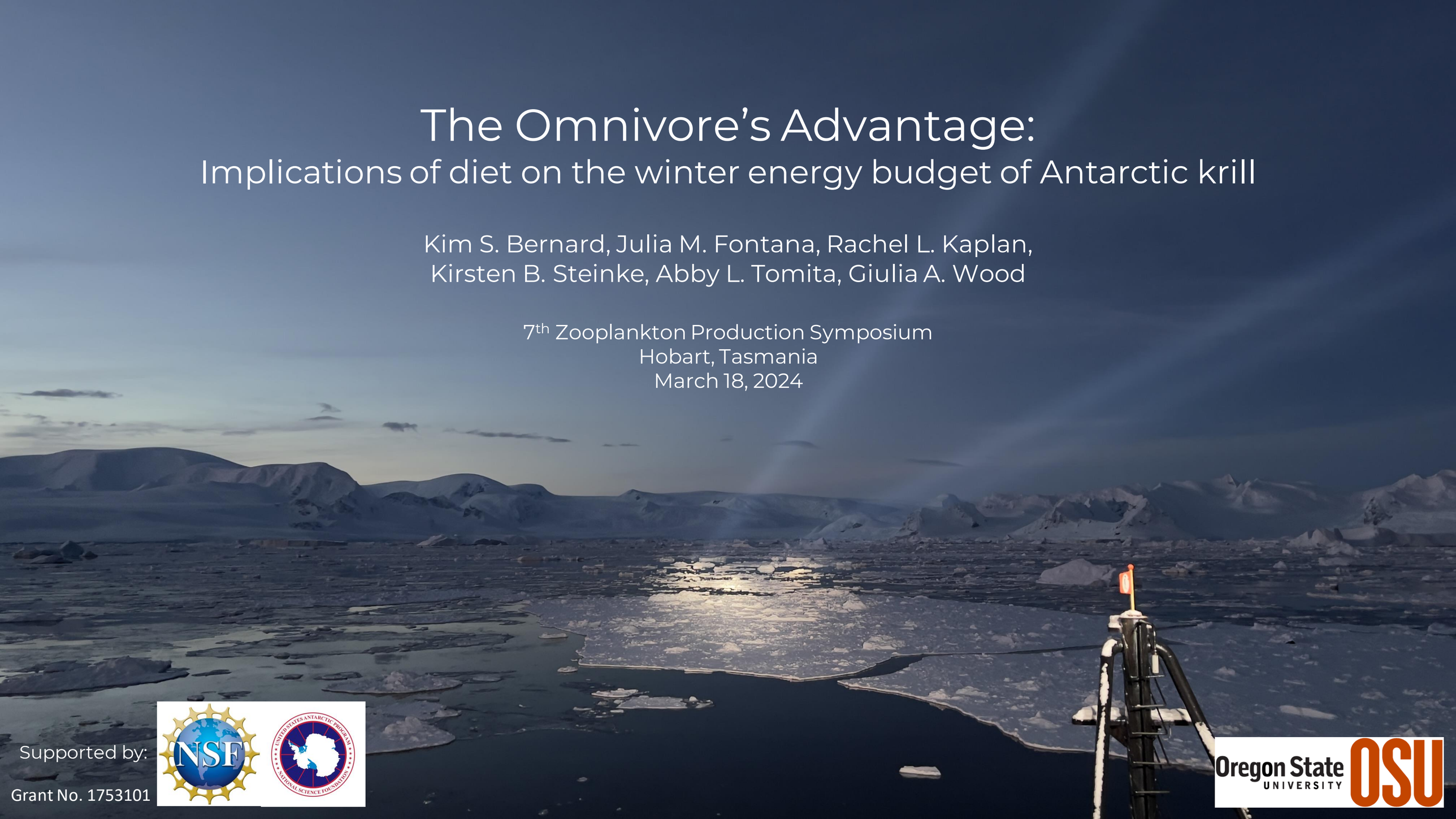

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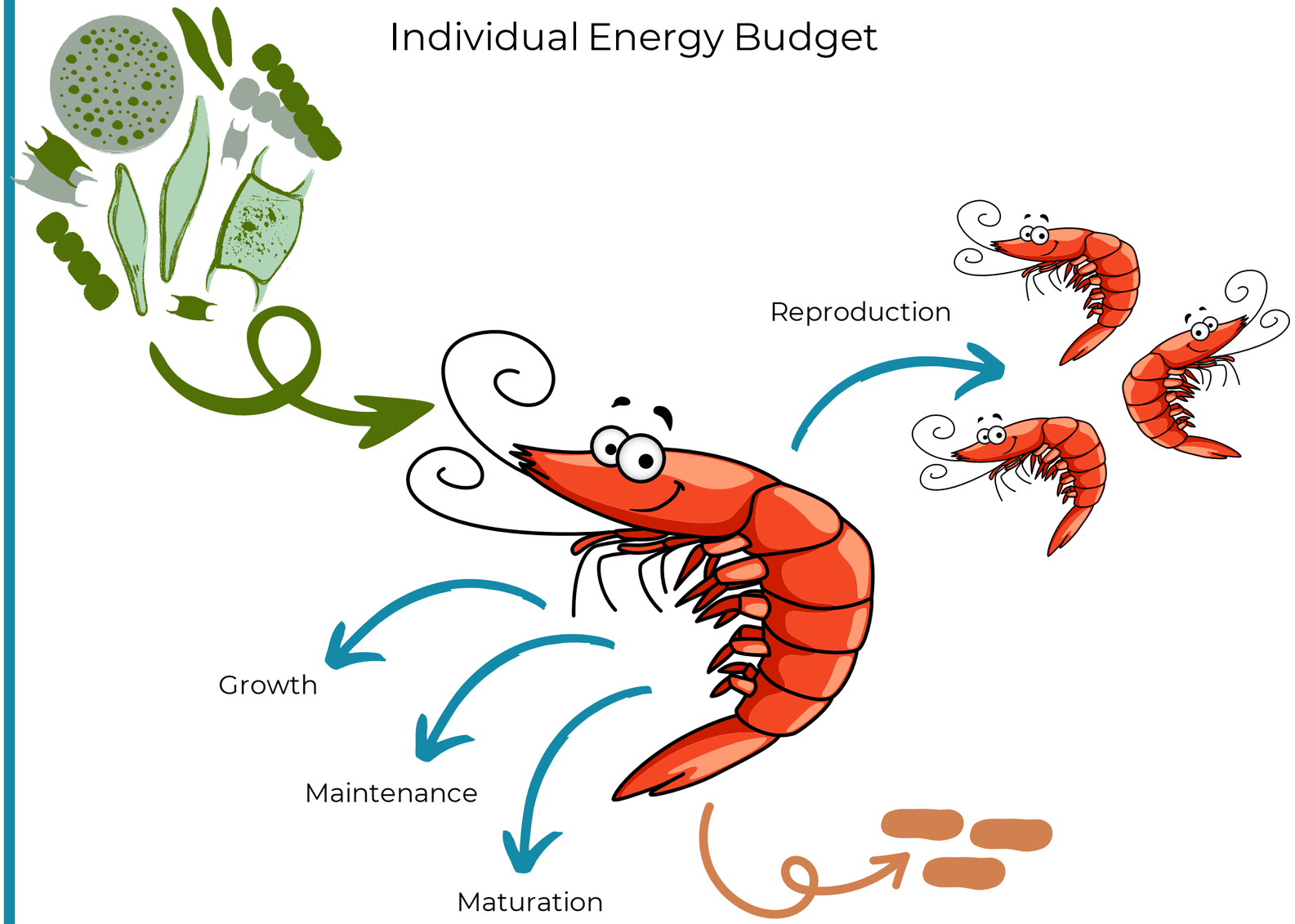
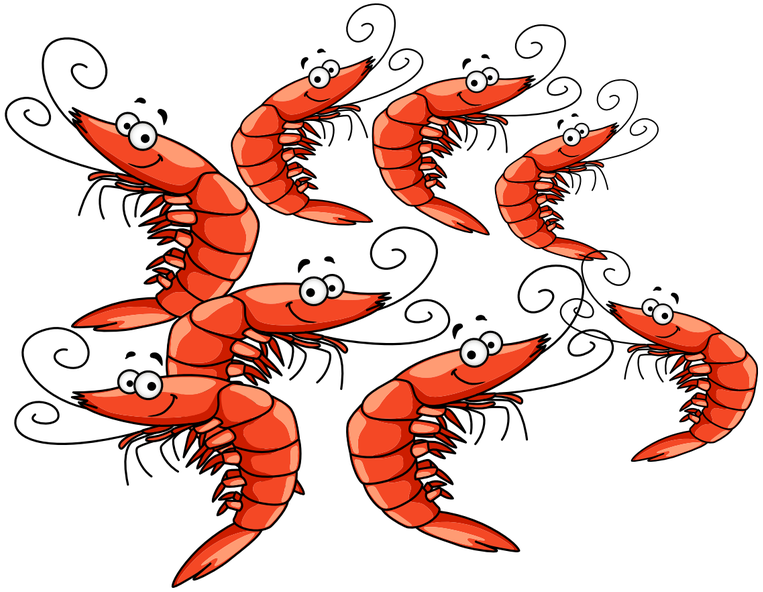
Individual Energy Budget



Assess ability to meet energy requirements for survival

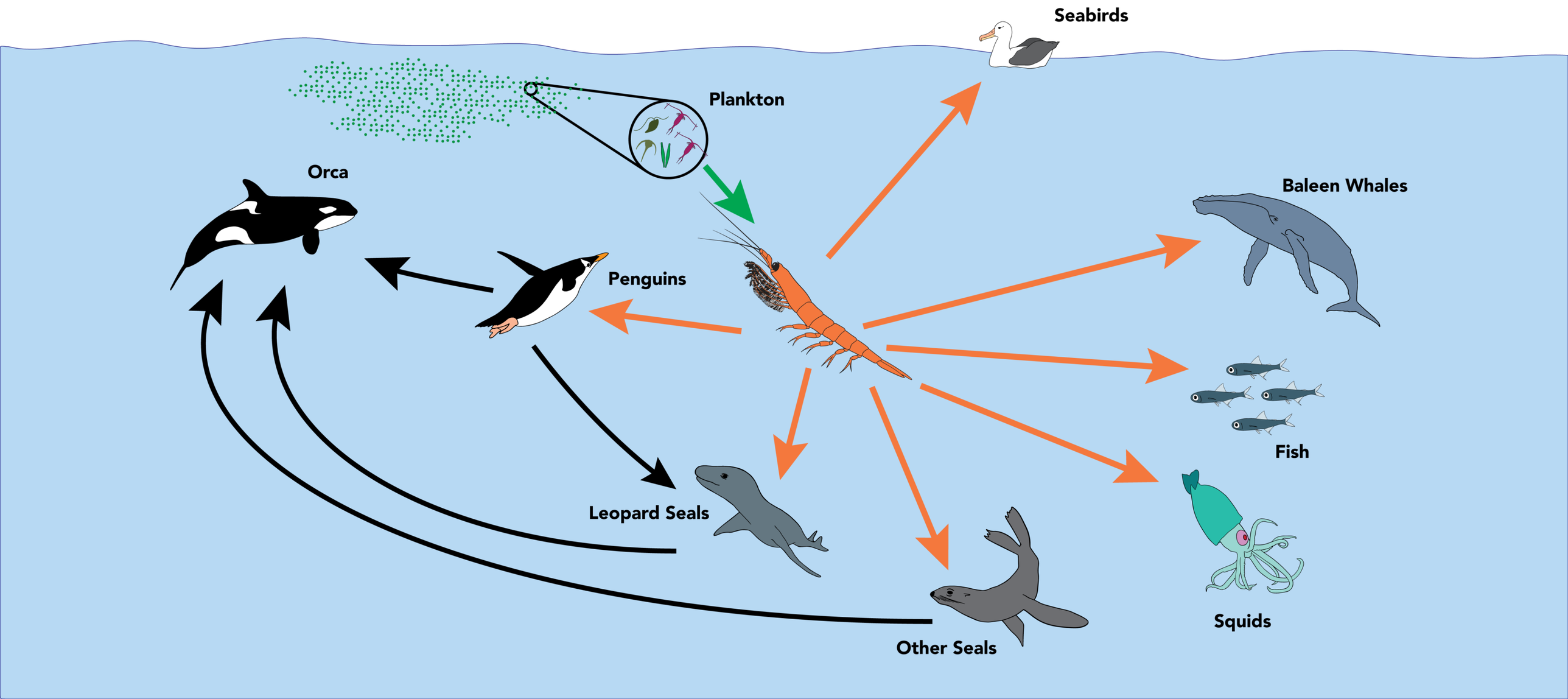
Population Dynamics



Assess population health and resilience

Climate Change → Krill Energy Budget → Krill Population Dynamics → Predator Energy Budget

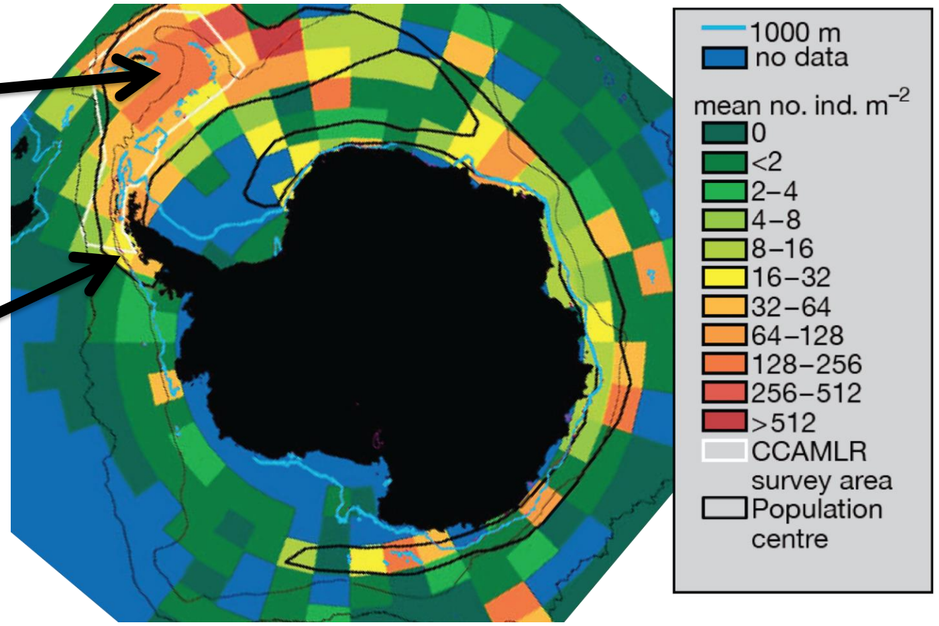
Predator Population Dynamics → Ecosystem Dynamics



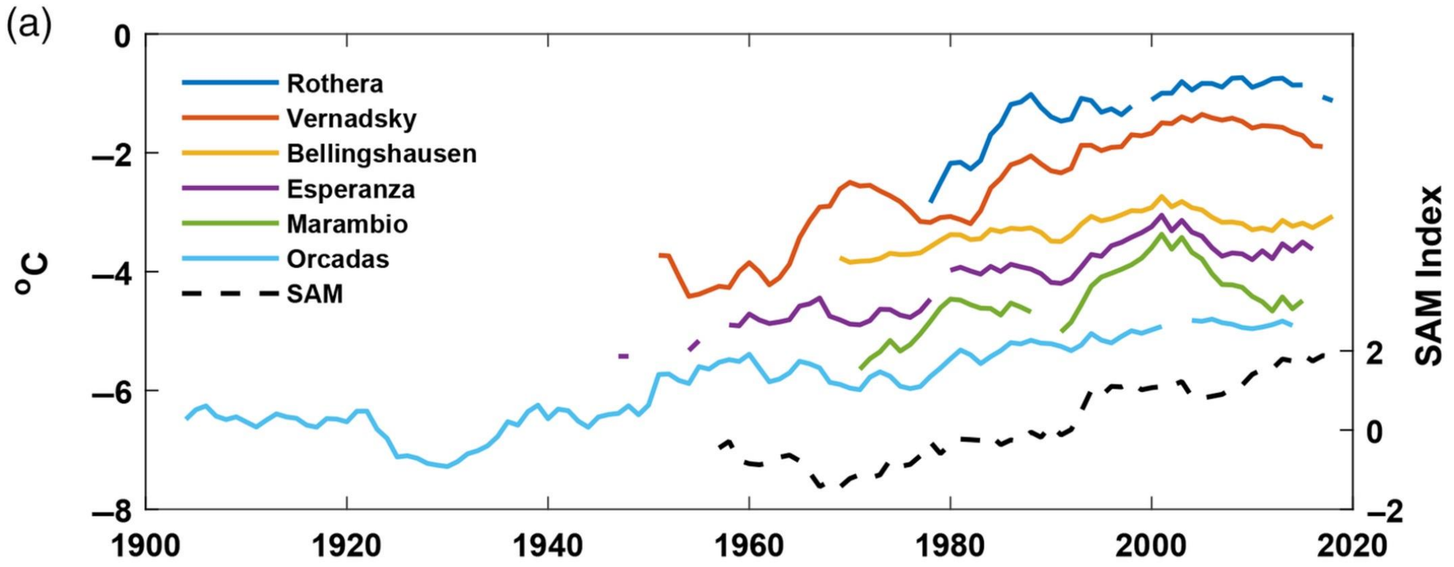
Antarctic krill

Scotia Sea

Western Antarctic Peninsula

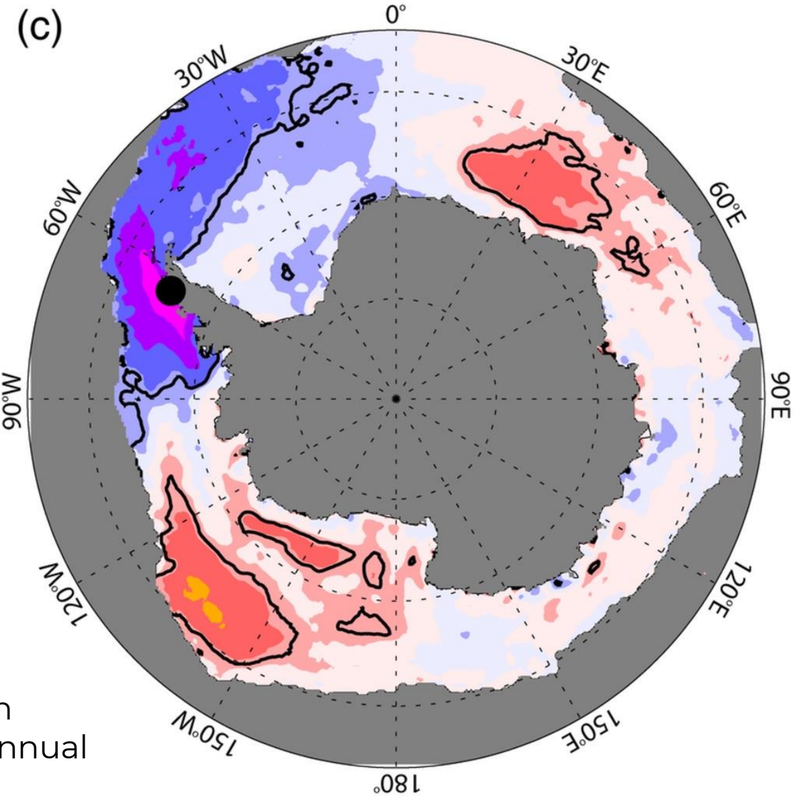


Data: 1962 - 2008
Adapted from Atkinson *et al.* 2008

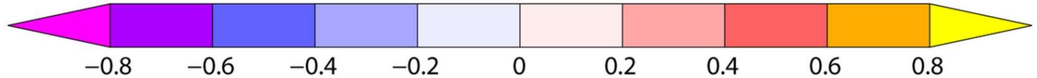


Greatest increase in temperature has been in winter

The 11-year running mean annual mean temperatures for the Antarctic Peninsula/Scotia Sea stations with temperature offsets applied as follows: Rothera (+3°C), Vernadsky (+1°C), Bellingshausen (−1°C), Esperanza (+1°C), Marambio (+4°C) and Orcadas (−2.5°C)



The correlation of the observed annual mean station temperatures for 1979–2018 at Vernadksy with the annual mean sea ice concentration.



Turner *et al*. 2019

National Geographic, used with permission

Predicting population dynamics under future climate change for:

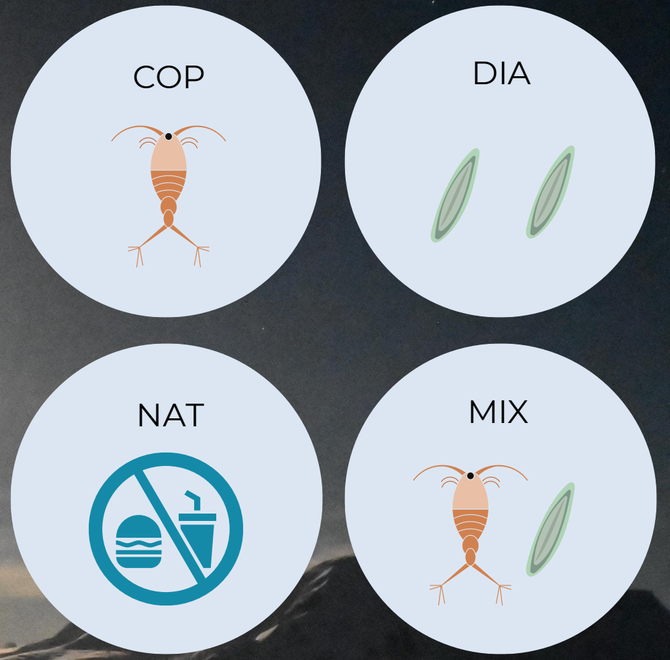
- Improved management of the krill fishery
- Improved conservation of the Antarctic ecosystem
- Improved input into global biogeochemical models

Mechanisms underlying changes in population dynamics are defined by factors that control individual energy budget.

Winter???

- Absence of empirical data
- Krill are most vulnerable
- Greatest warming

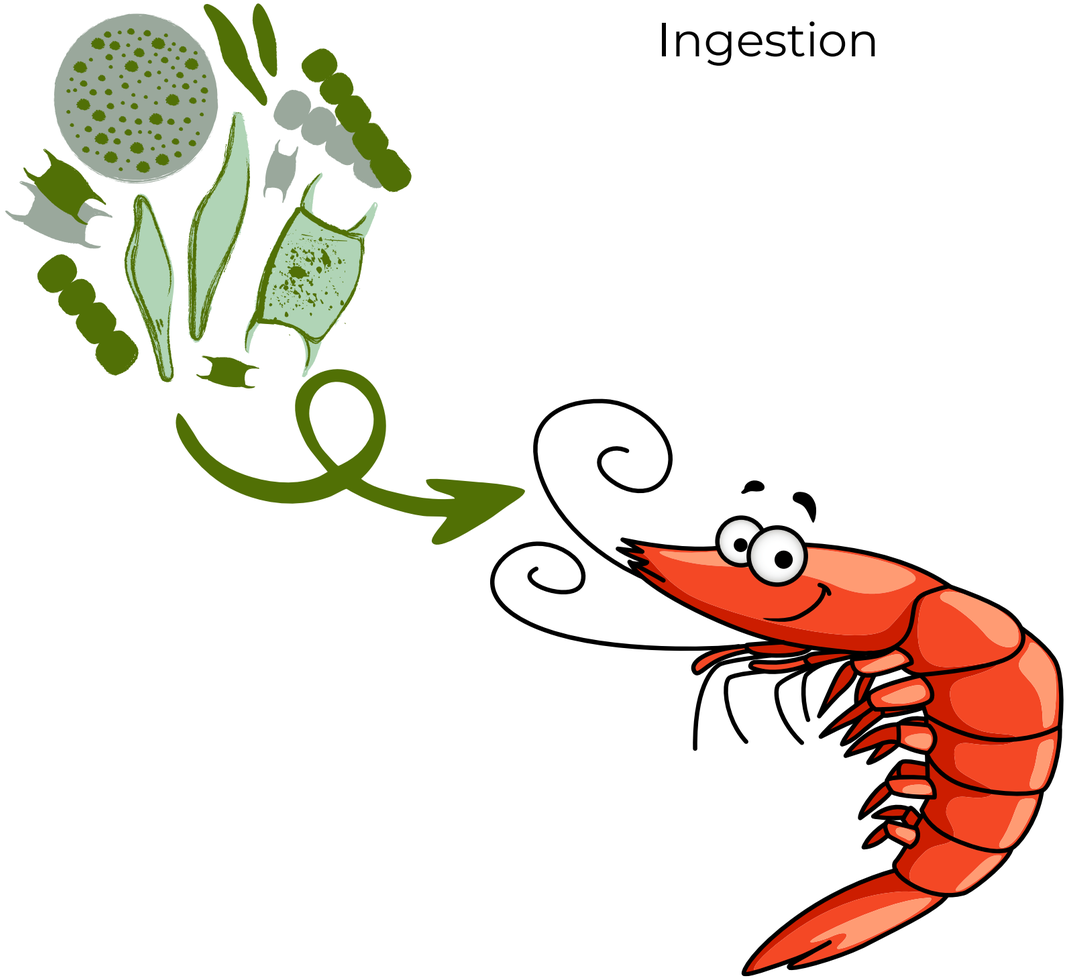
The Omnivore’s Dilemma – 5-year NSF Early Career Award (2019-2024)

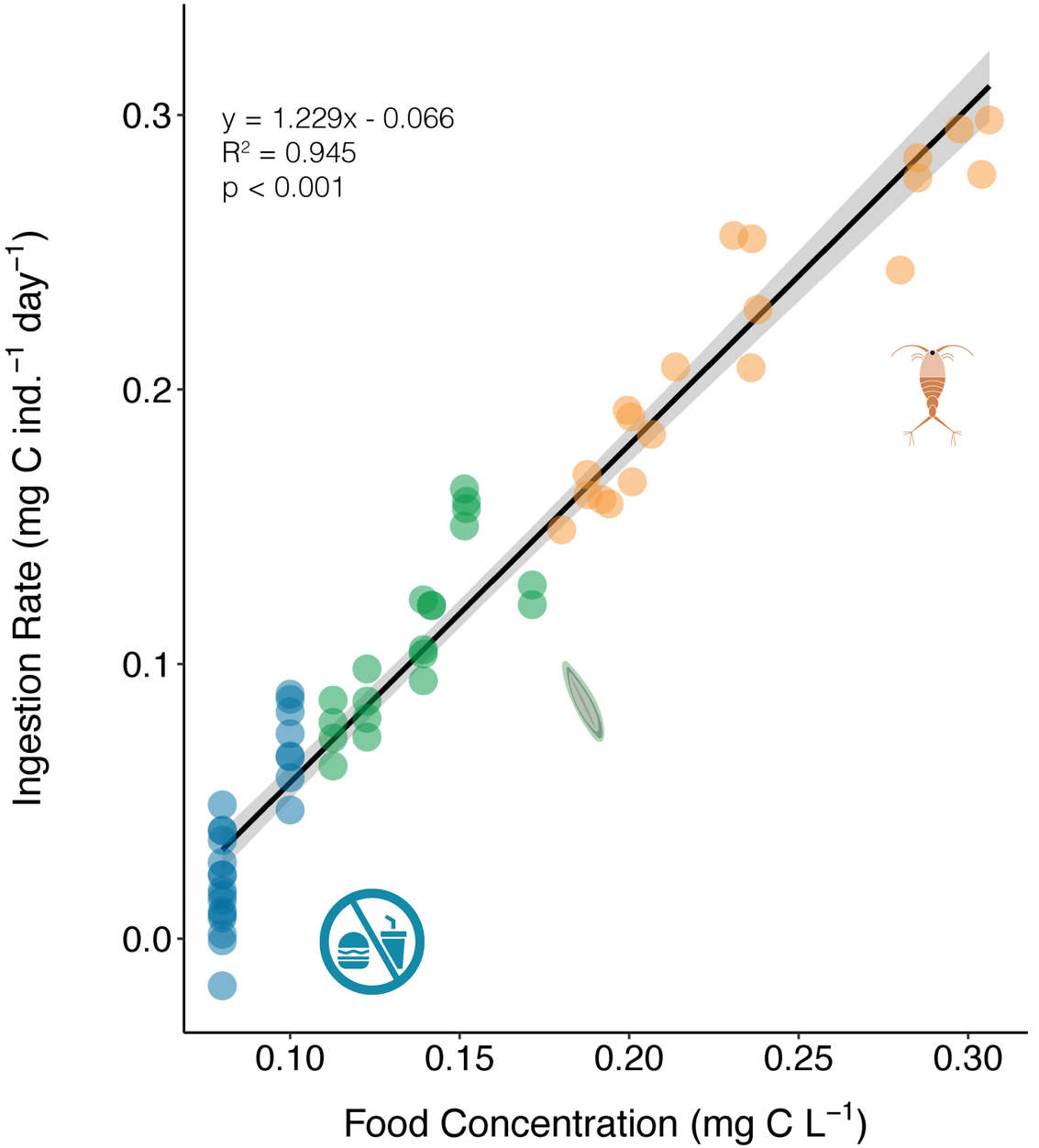


Brief Project Overview…

- Conducted three 6-month winter field seasons at Palmer Station: 2019, 2022, and 2023
- Kept 1,000’s of juvenile and sub-adult Antarctic krill in ~1,300L large circular tanks
- Ran long-term experiments at Palmer Station through each winter testing the effect of diet
- Took monthly time-points to measure various rates and assess condition of krill

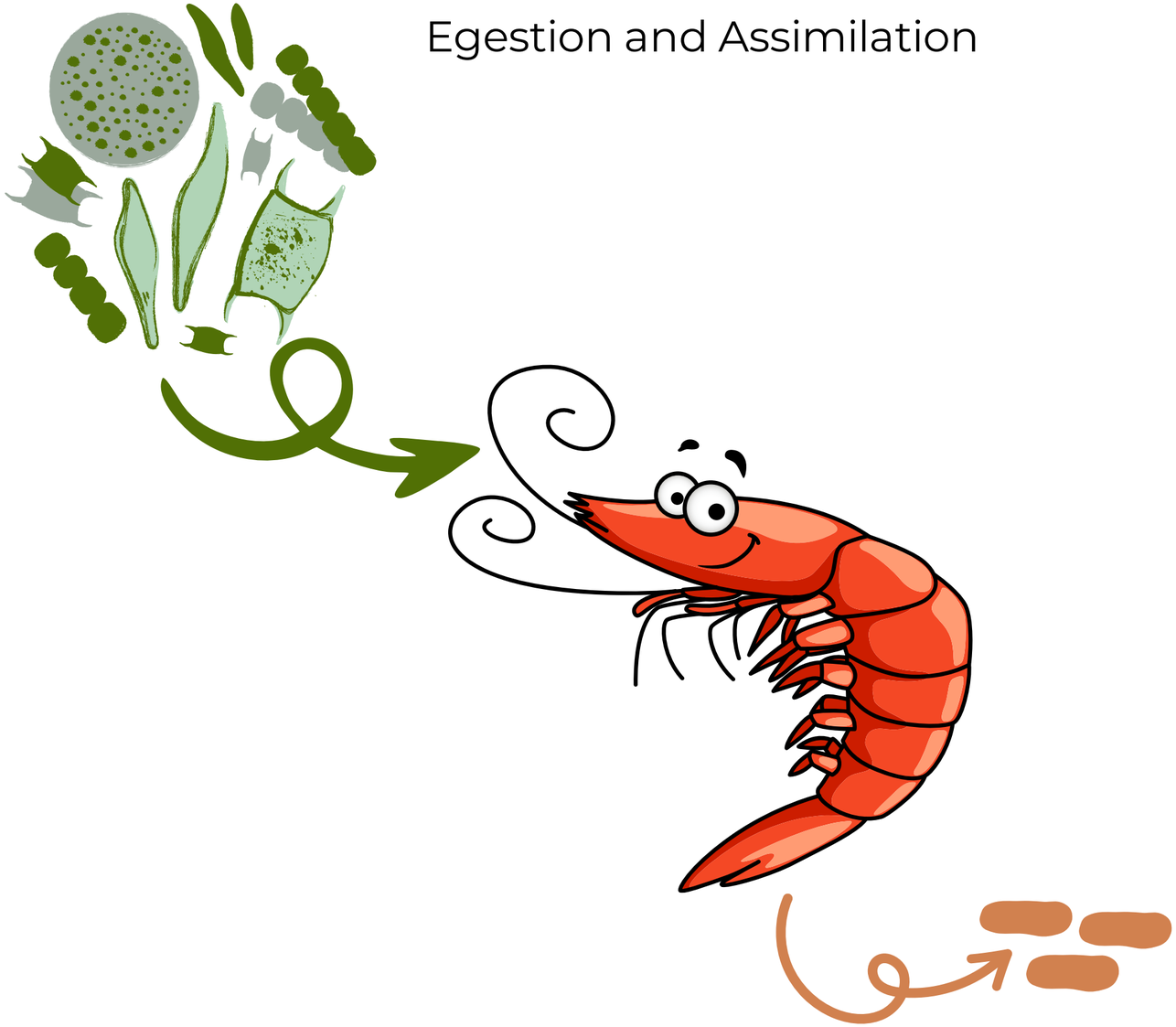
Ingestion

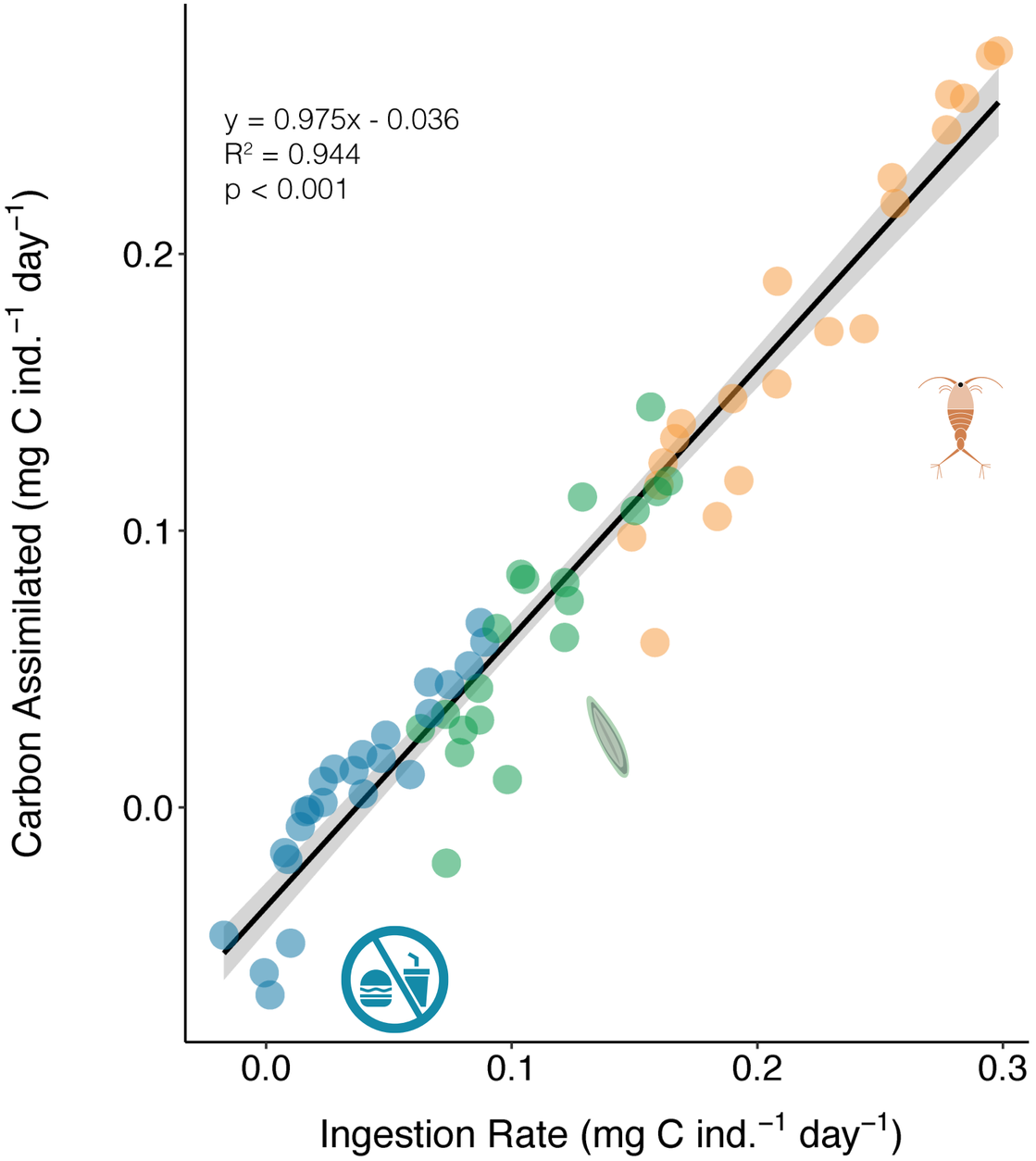




2019

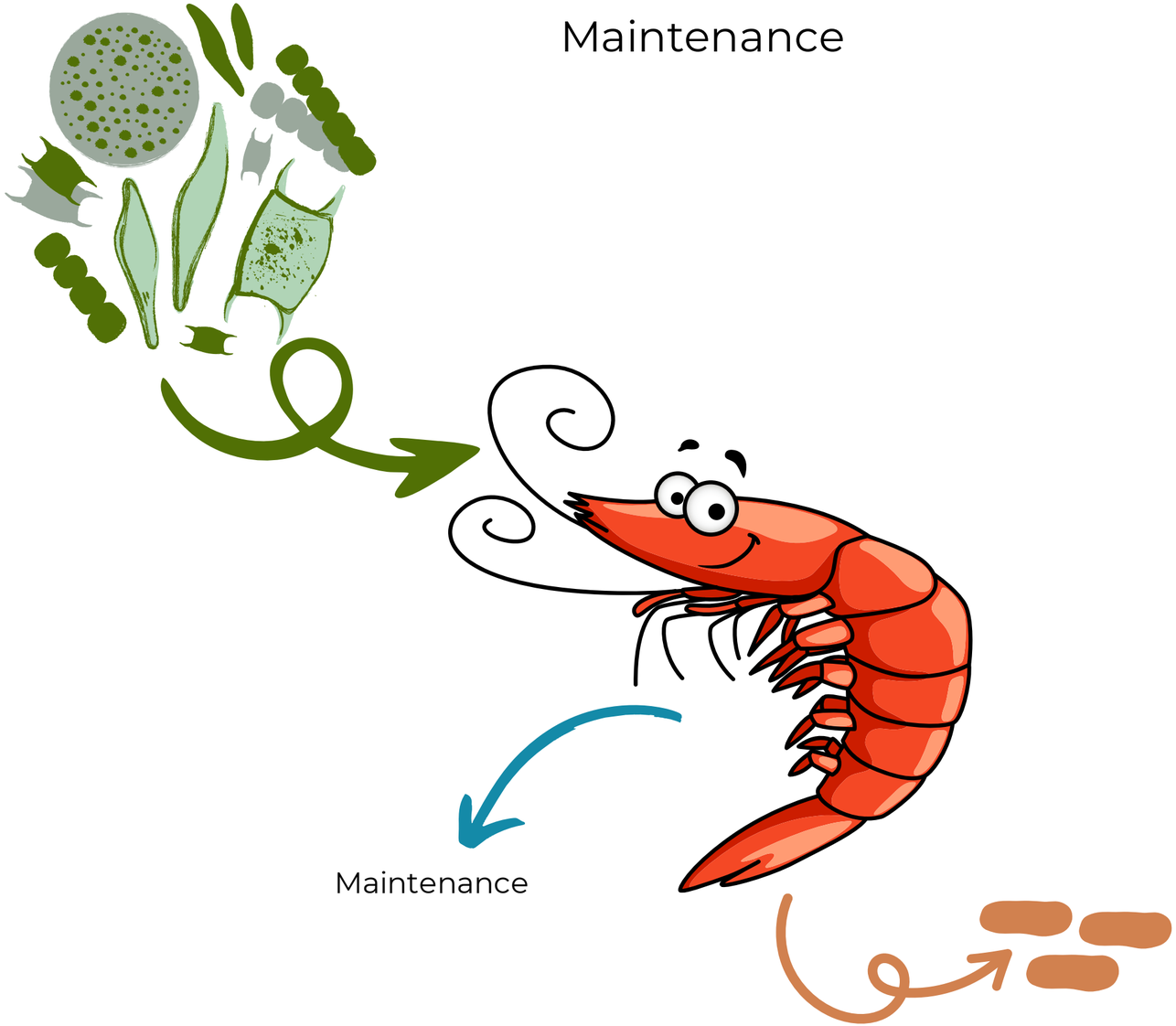
Egestion and Assimilation

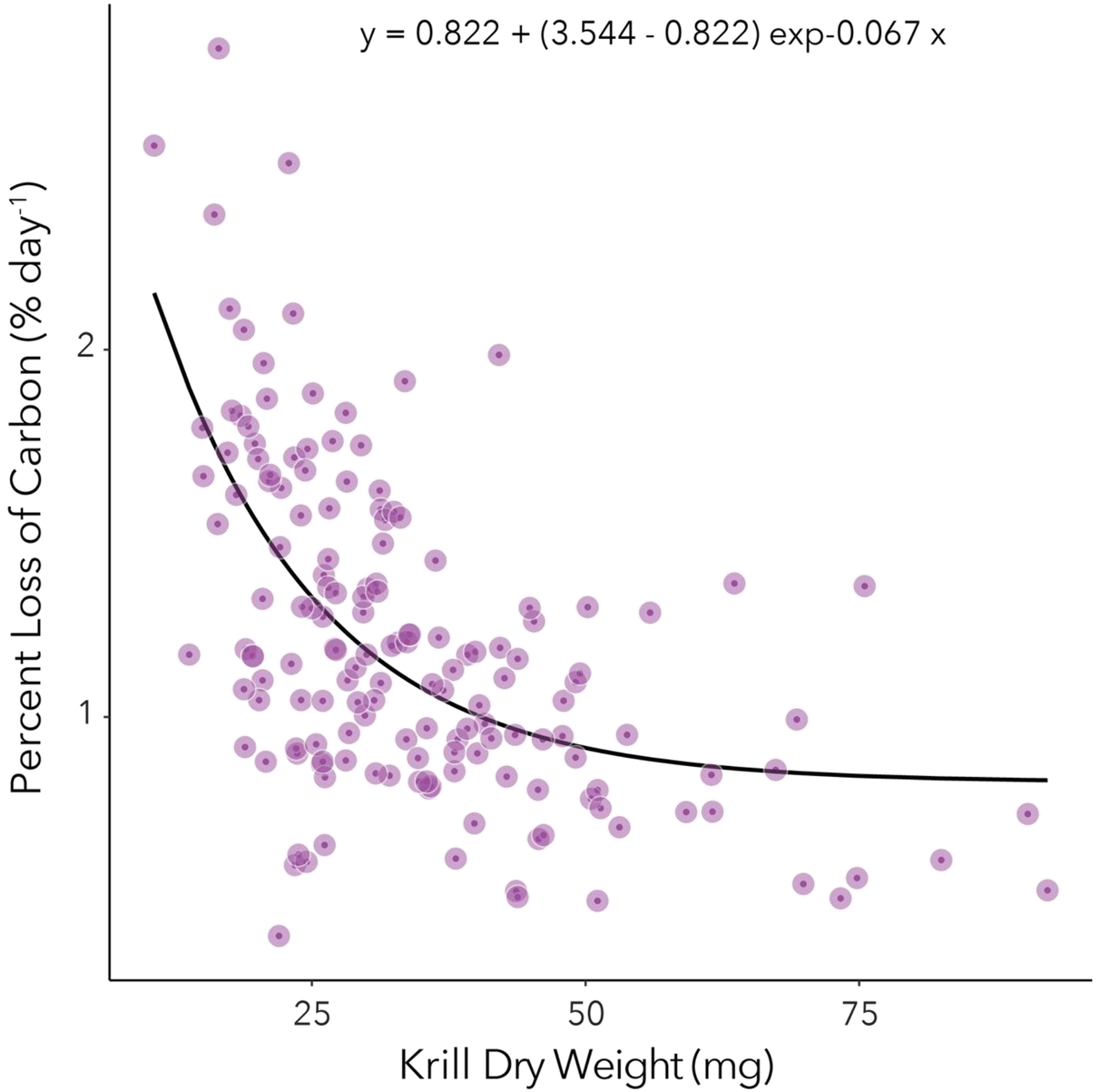




2019

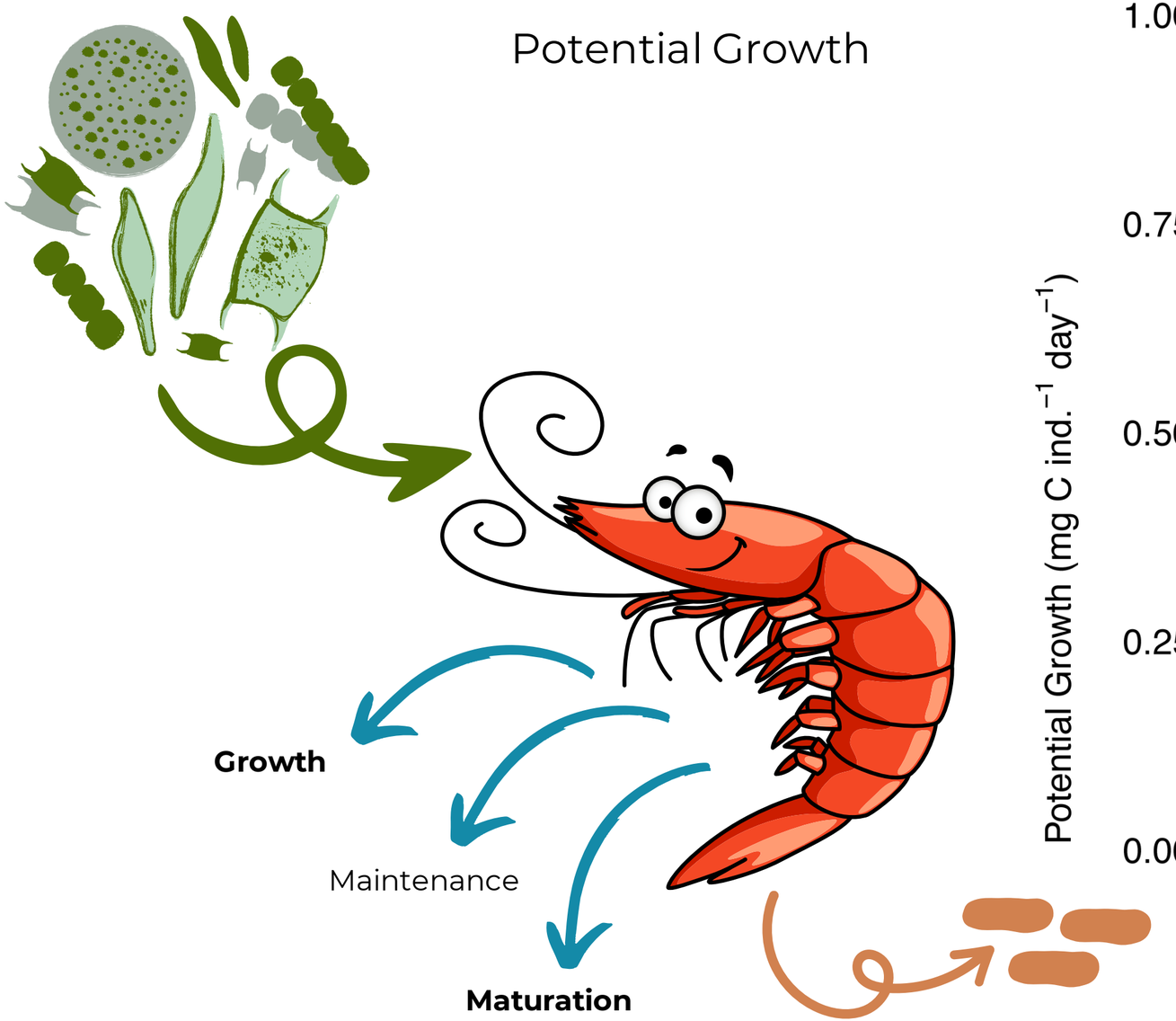
Maintenance

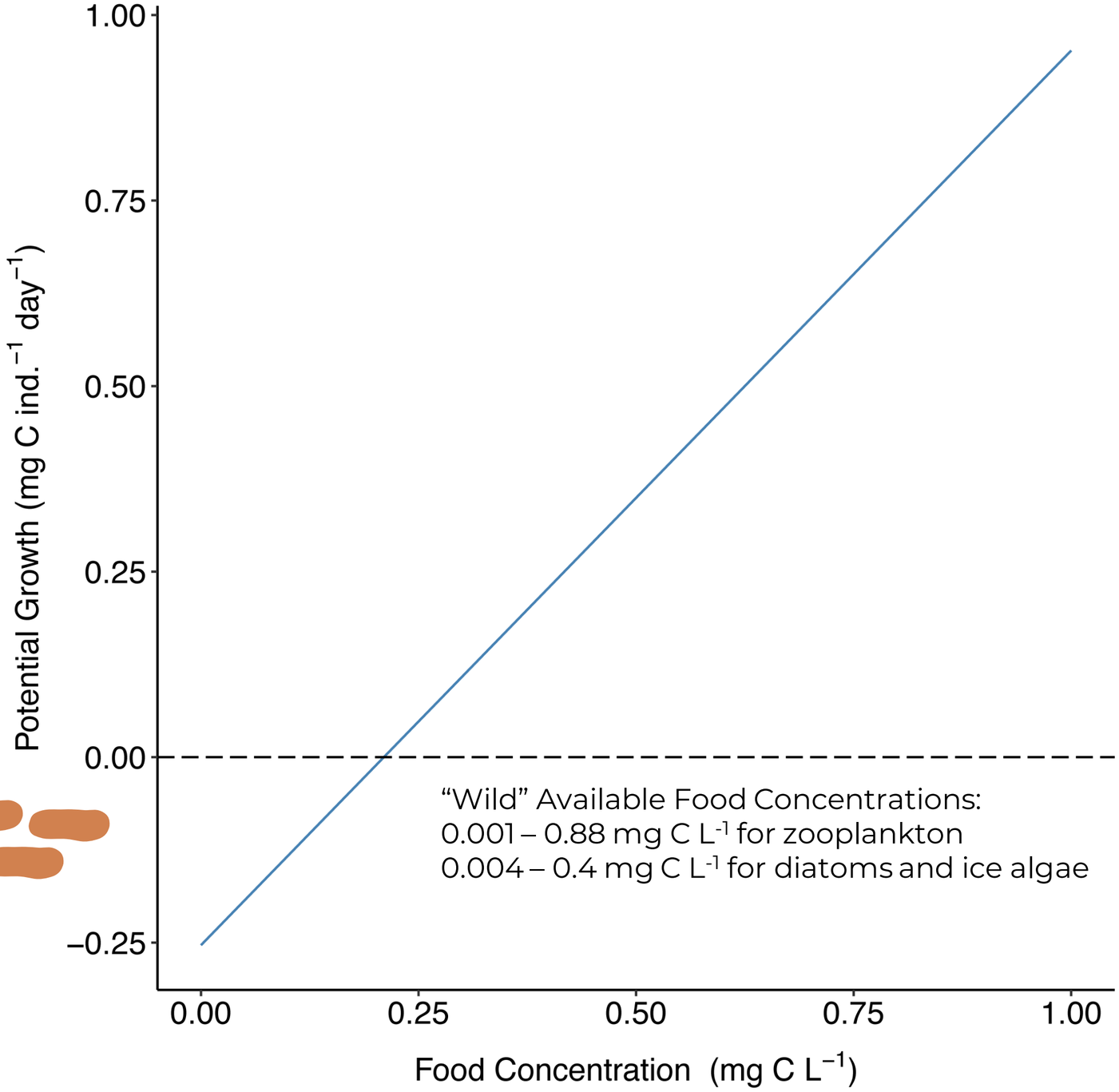




2019

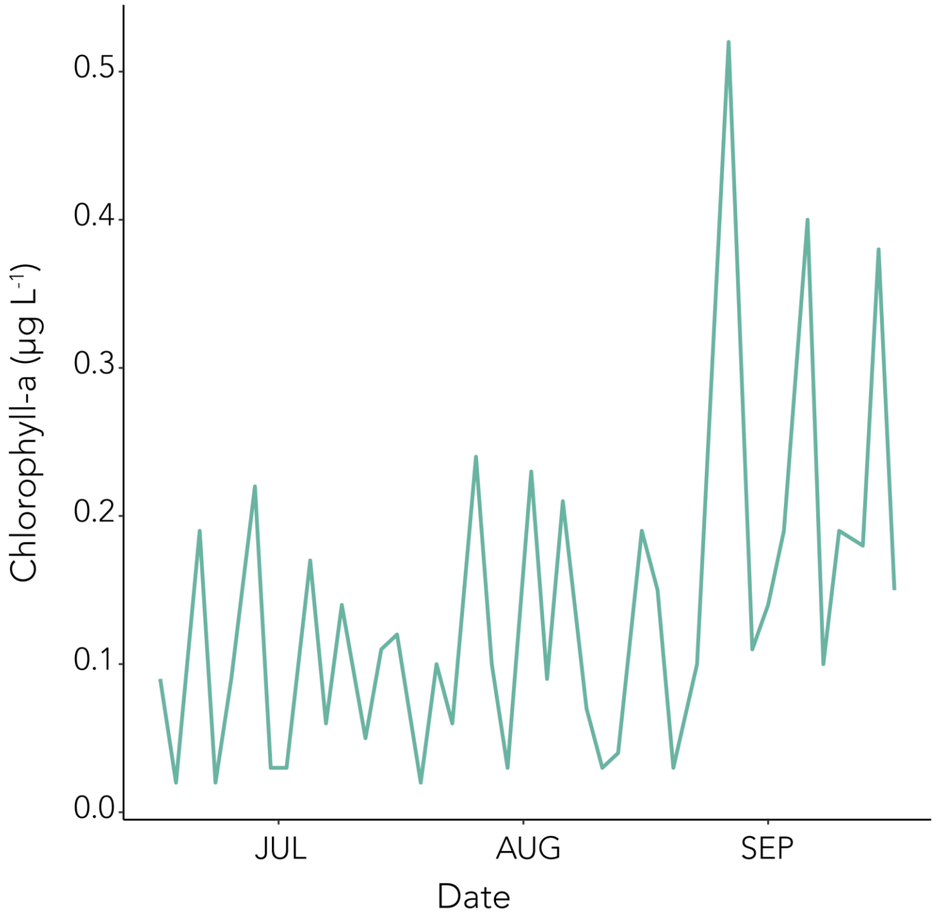
Potential Growth

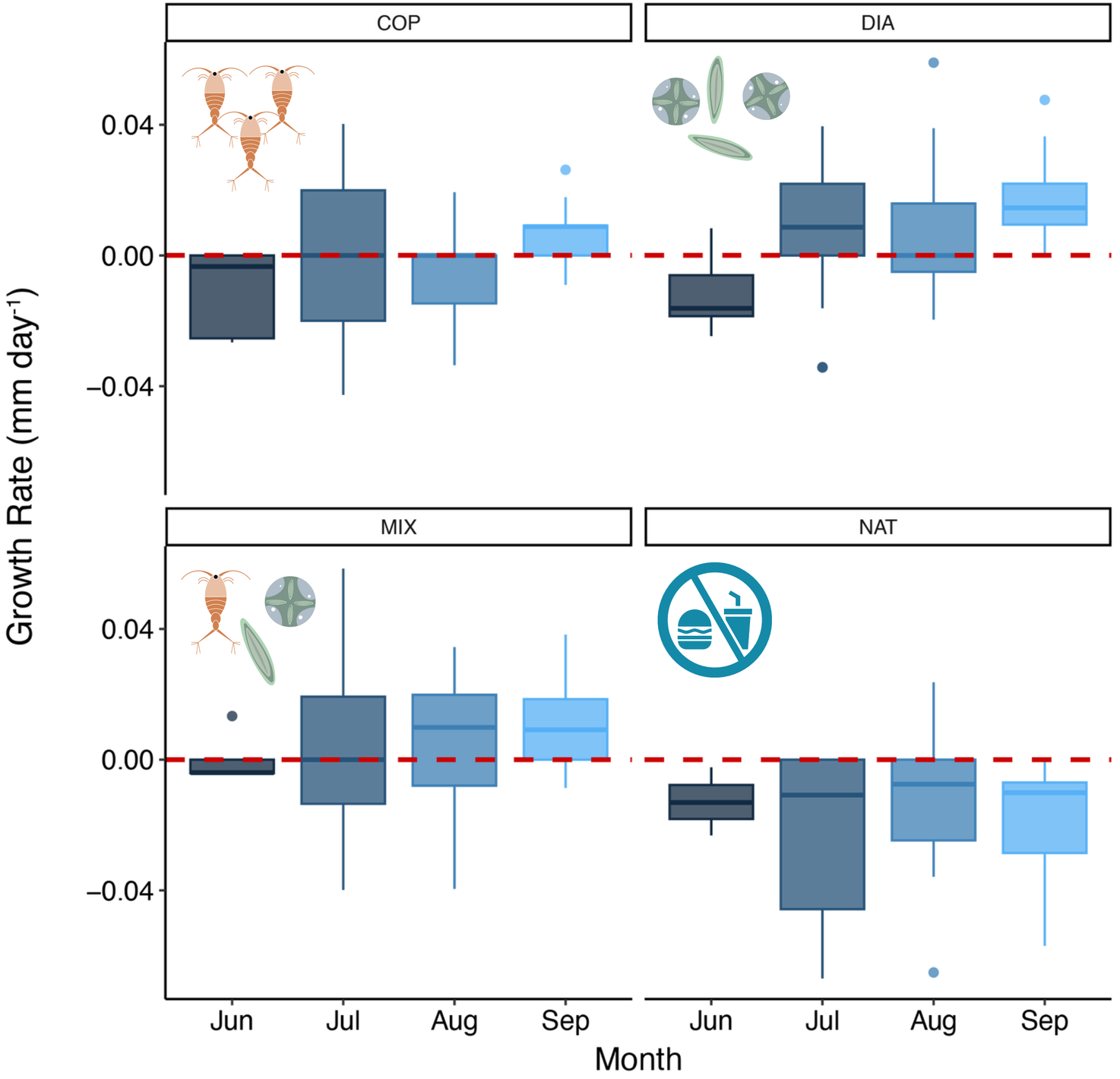




2019

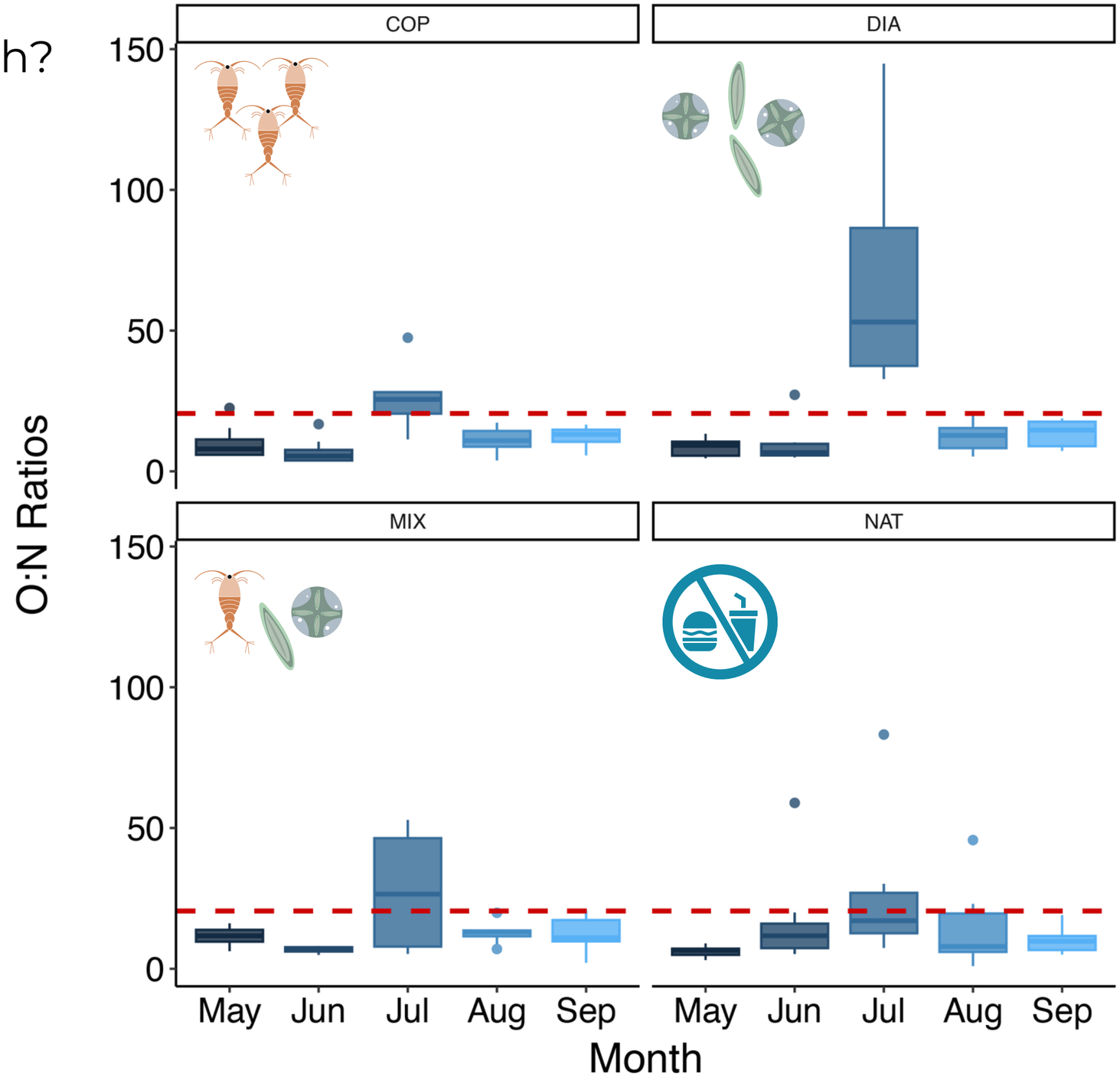
Somatic Growth





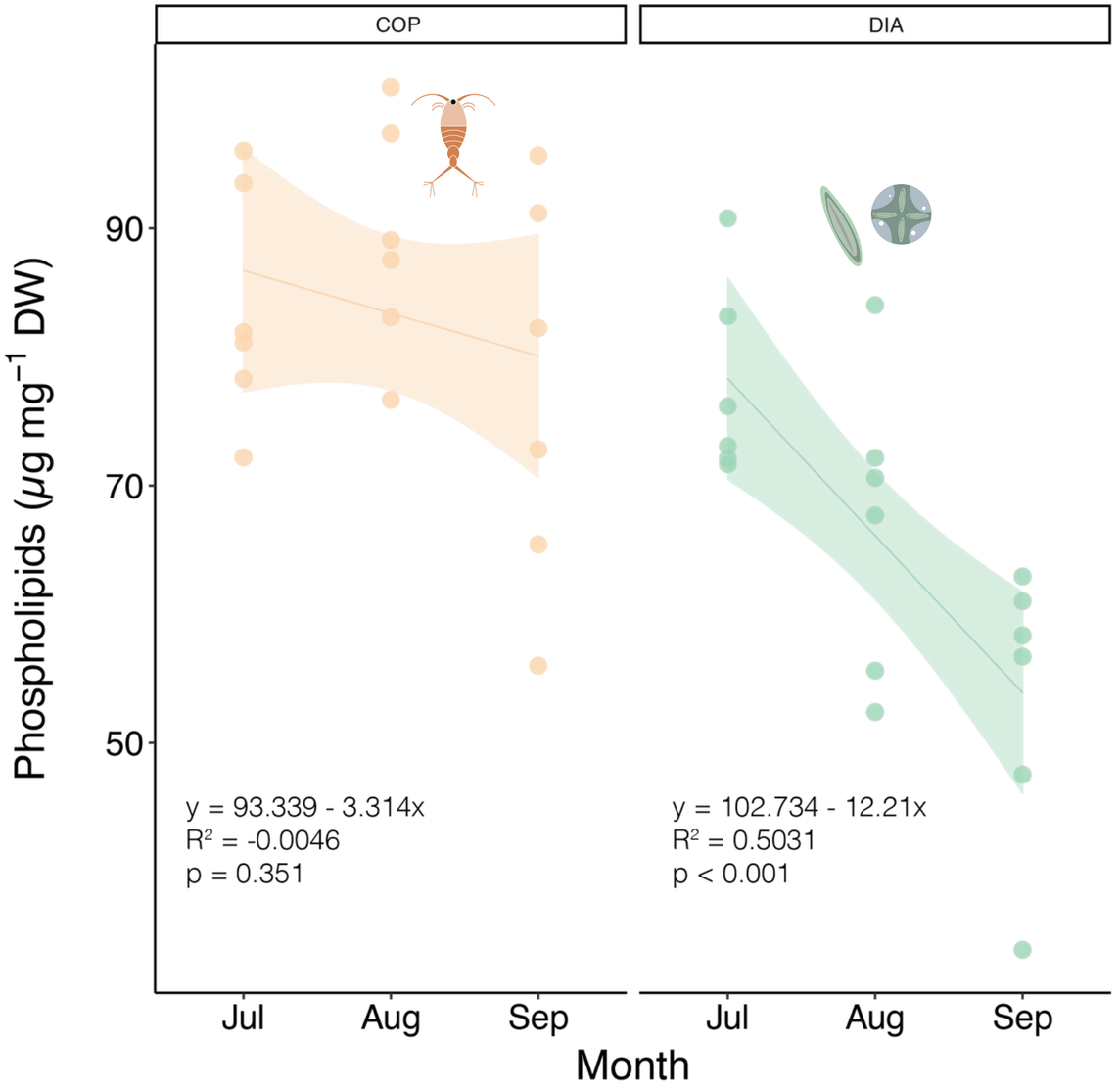
2022

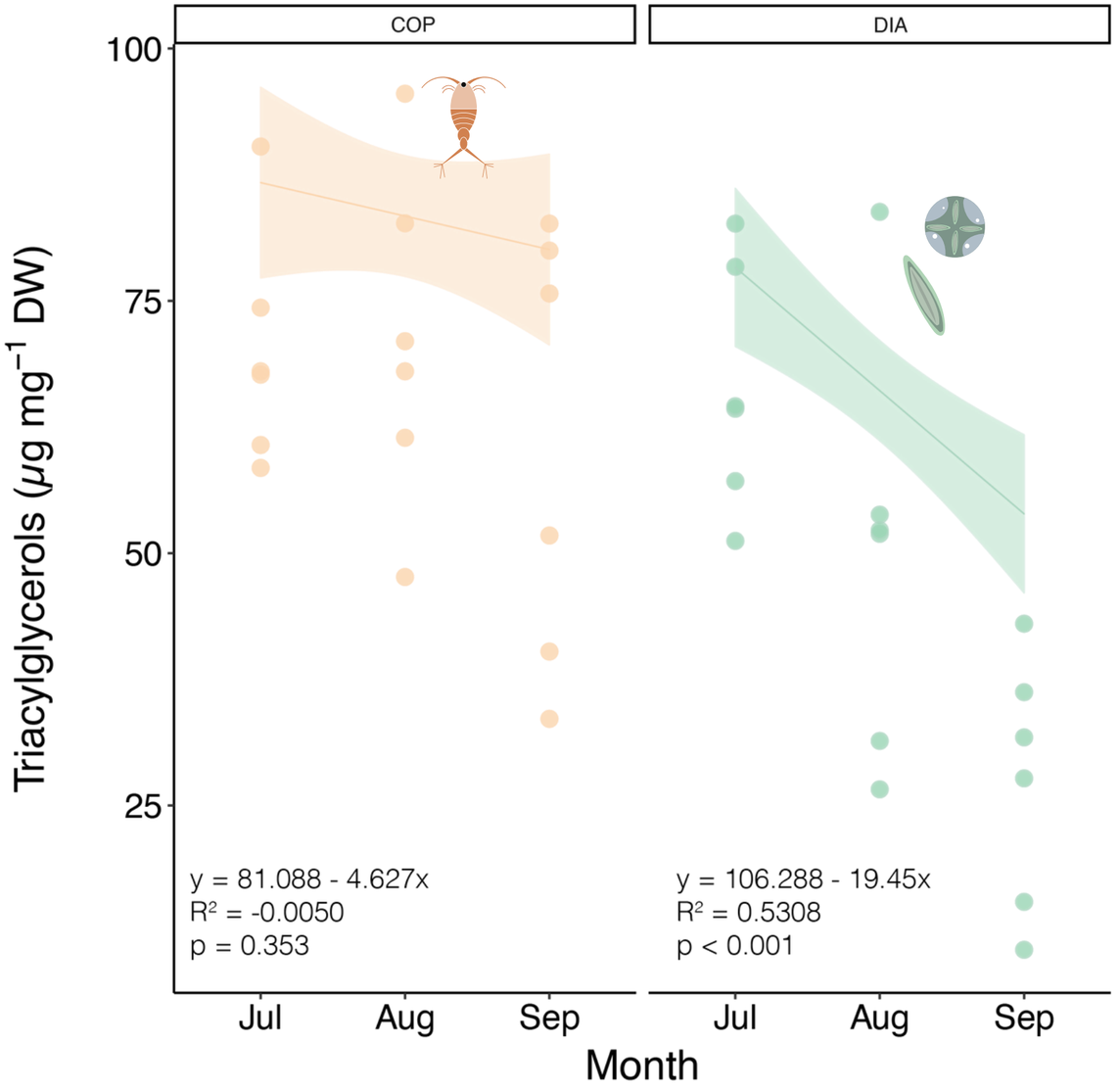
What fuels growth?



2022

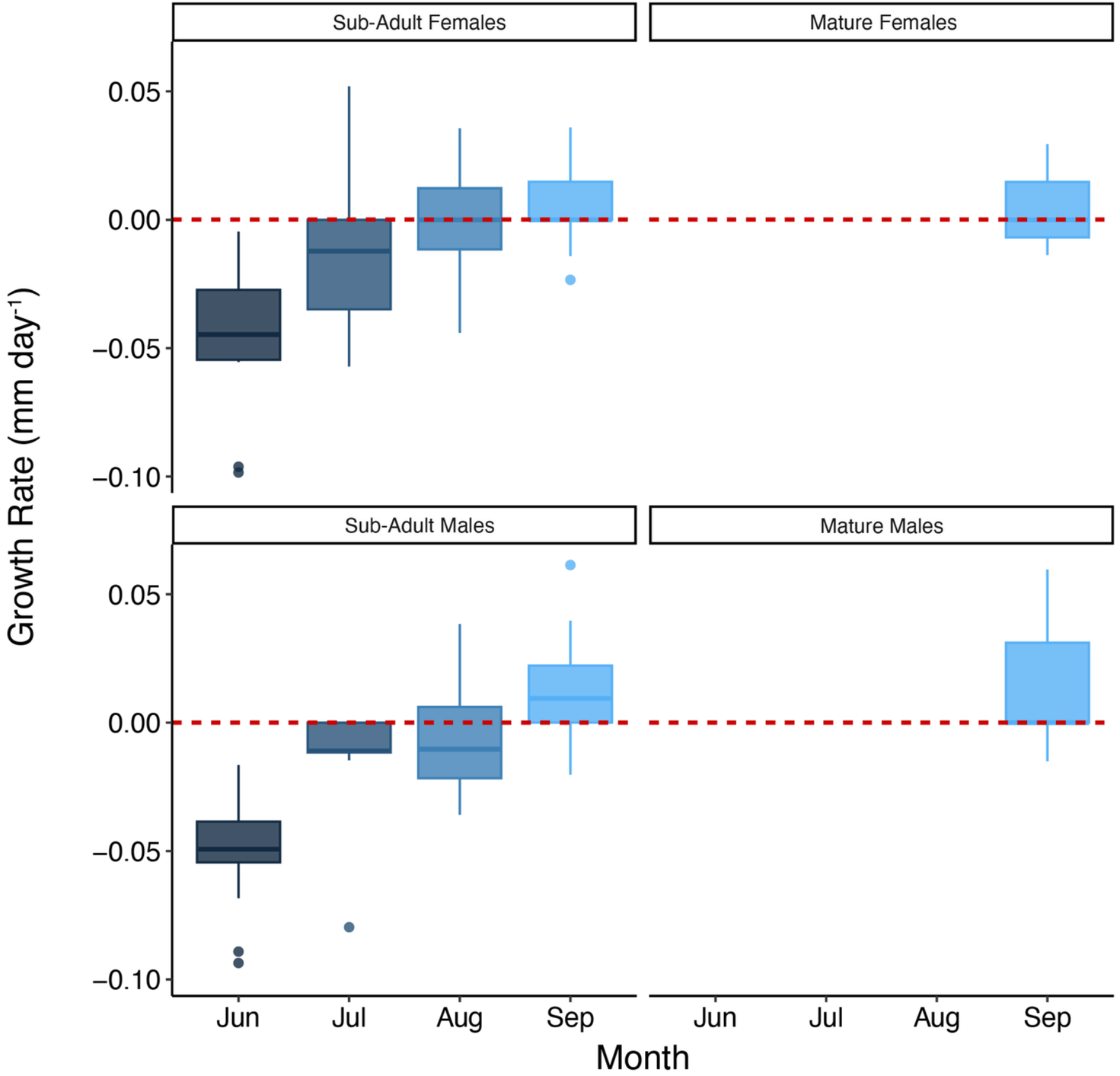
What fuels growth?





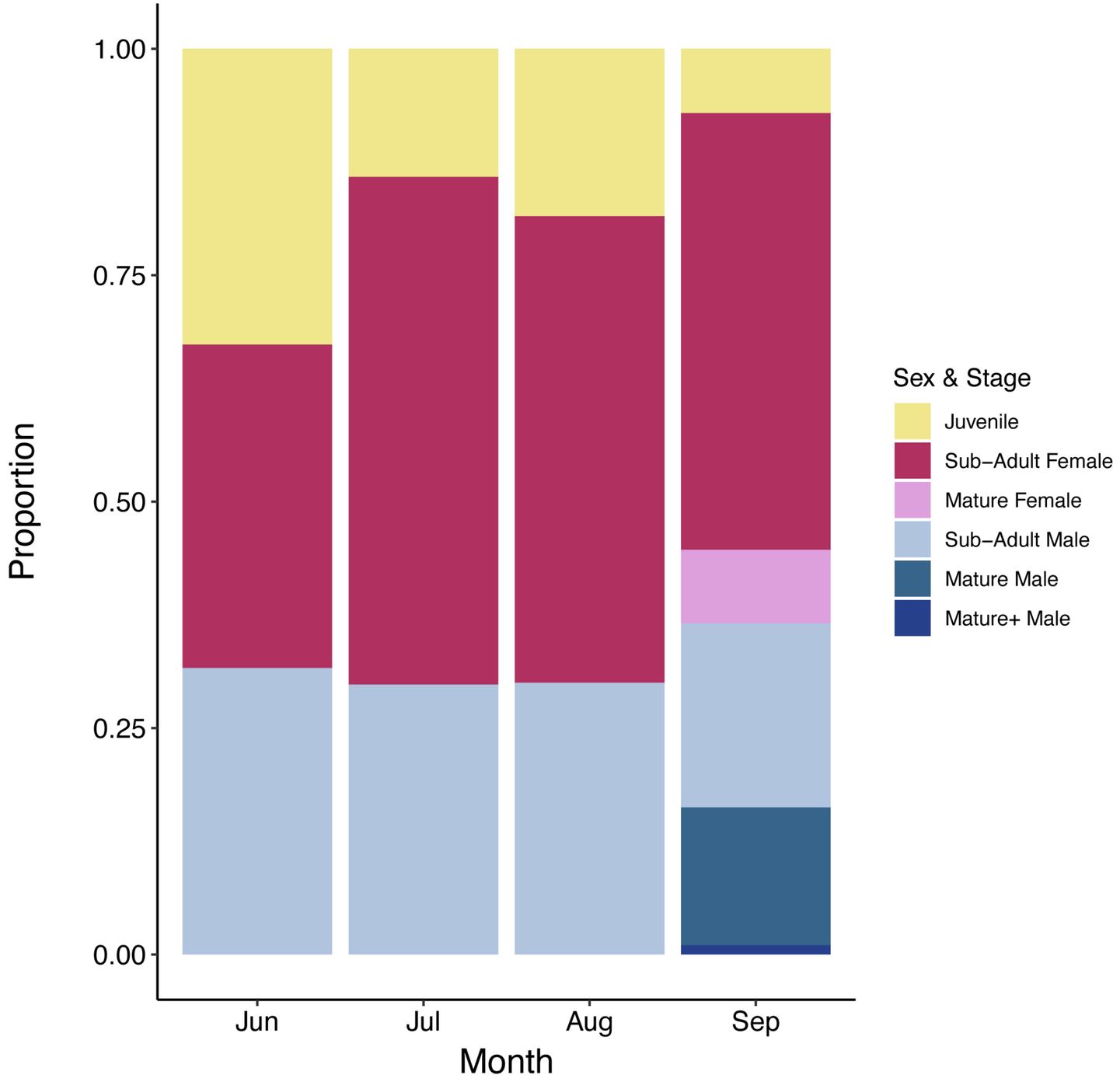
2019

Somatic Growth



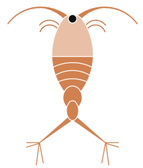
2023

Maturation



2023

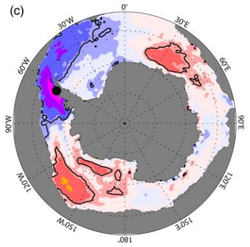
Advantage or Dilemma?



Omnivory is advantageous

- Diatoms → growth
- Copepods → energy stores, ready for growth

But…



Reduced sea ice → diminished food resources

Less food → smaller krill leaving winter and likely delayed spawning

POV: Watching the last ship leave for the winter...

Thank you