Low algal concentration narrows the salinity but not temperature tolerance of *Eurytemora affinis*

BG Hammock, S Lesmeister, I Flores, G Bradburd, F Hammock, & S Teh

Bay-Delta, Oct 28 2014

http://www.100thmeridian.org/

Ricciardi et al. 1998

- **Resource limitation**
- **Niches, particularly related to metabolism**
- **Aquatic ecosystems: T and Sal**
- **Invasive species**

http://www.okbassfednation.com/

Corbicula fluminea

http://www.animalspot.net/corbicula-fluminea-asian-clam.html

Corbula amurensis

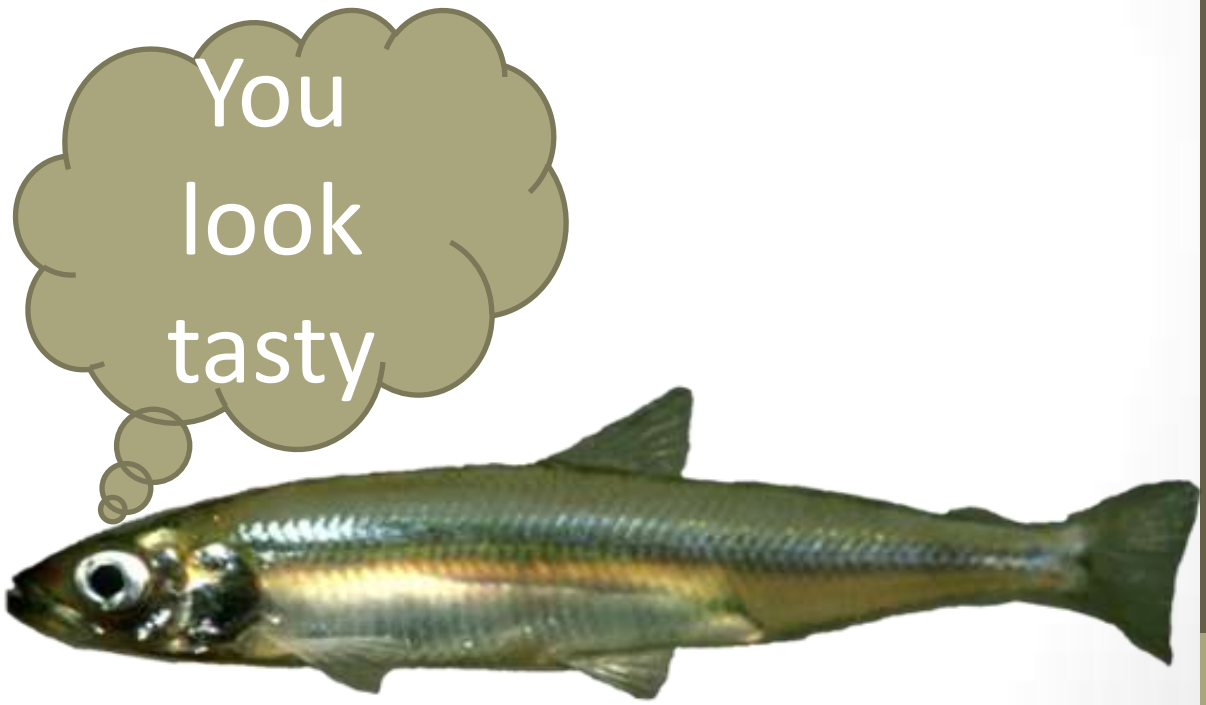
http://www.exoticsguide.org/corbula_amurensis

C. amurensis =>[Chl-a] from 11 to 2 µg/L in Suisun Bay.

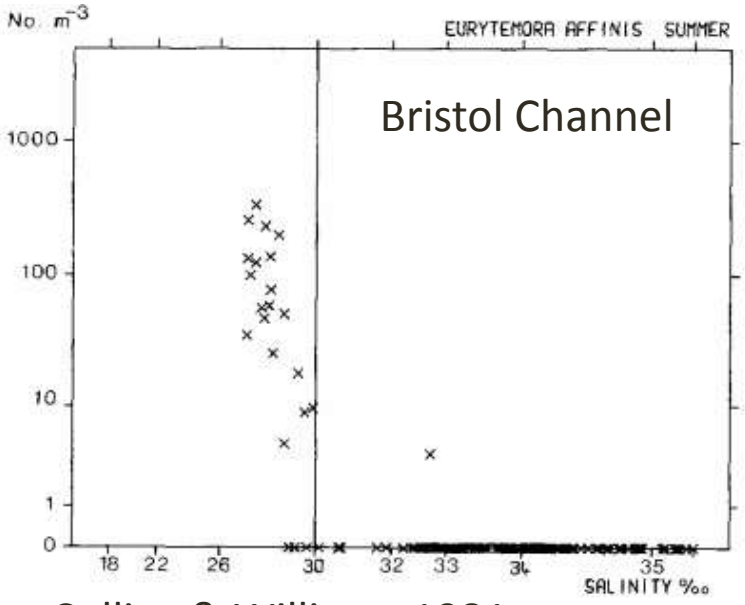
Cloern & Jassby, 2012

Consequences for salinity or thermal niche axes of SFE zooplankton?

Delta smelt eat zooplankton, and their abundance is declining



Declining upper salinity range of *E. affinis*



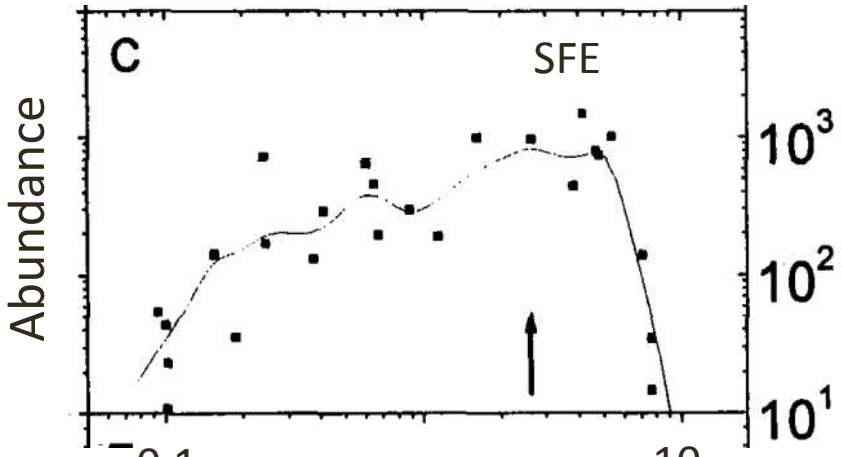
Collins & Williams 1981

Up to 30 ppt in 1980

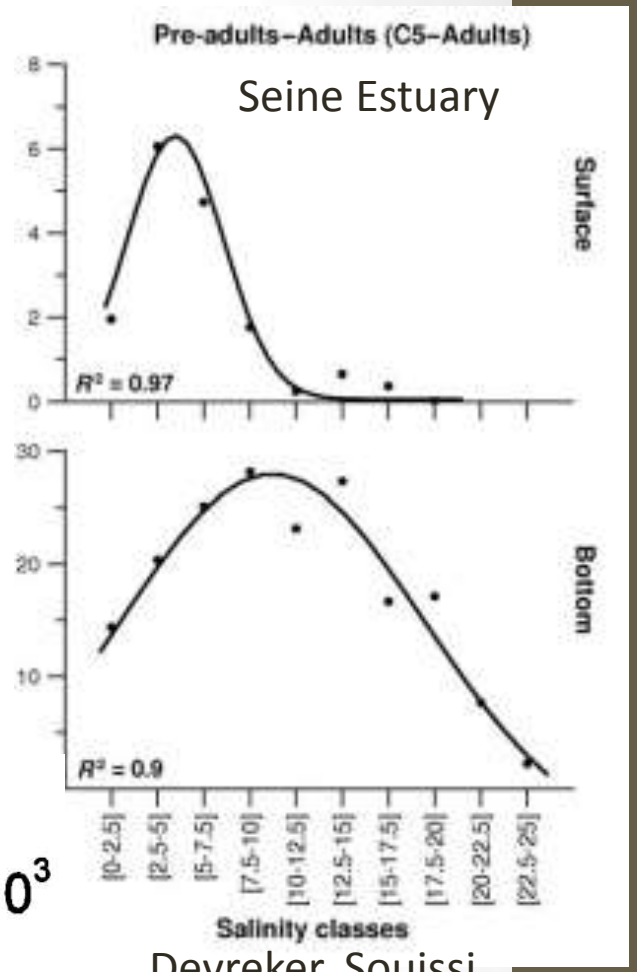
in SFE

Ambler et al. 1985

SFE in 1987

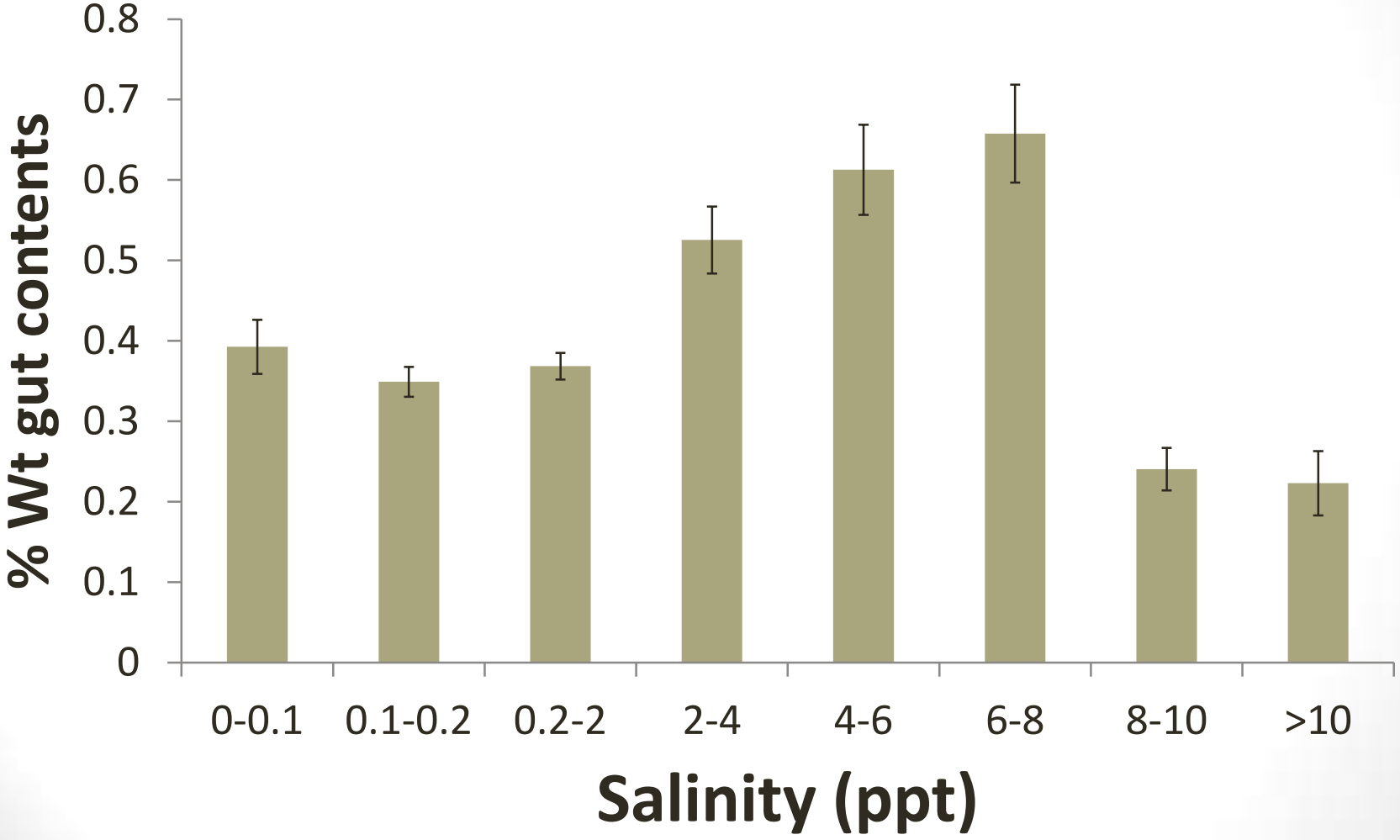


Kimmerer, Burau, & Bennett 1998



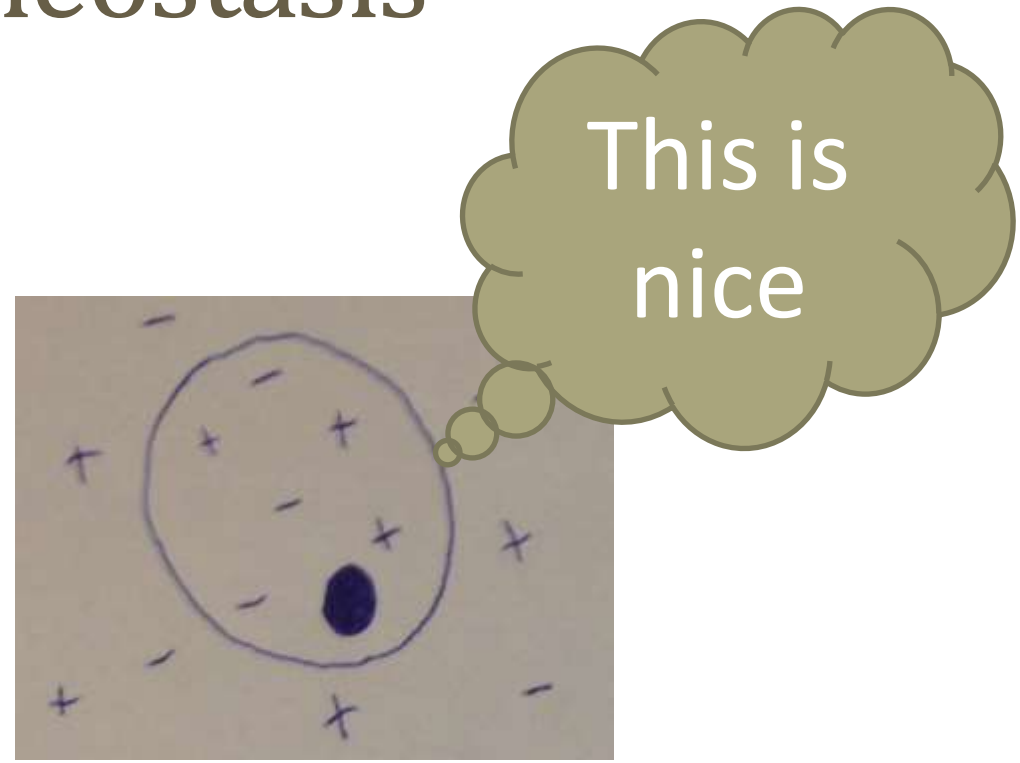
Devreker, Souissi, Molinero & Nkubito 2008

Smelt gut contents by binned salinity (~1250 fish)

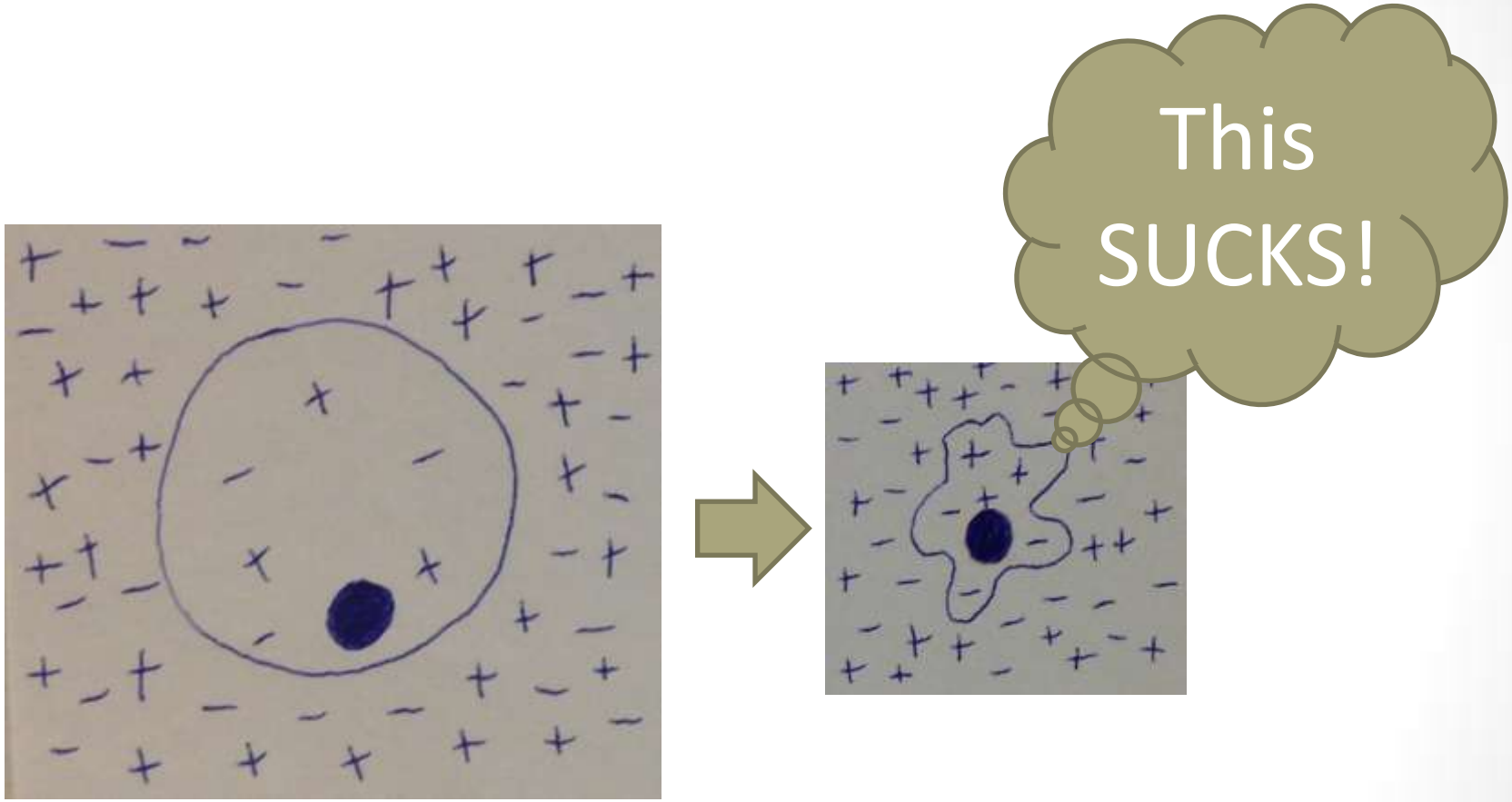


Gut content data courtesy of Steve Slater

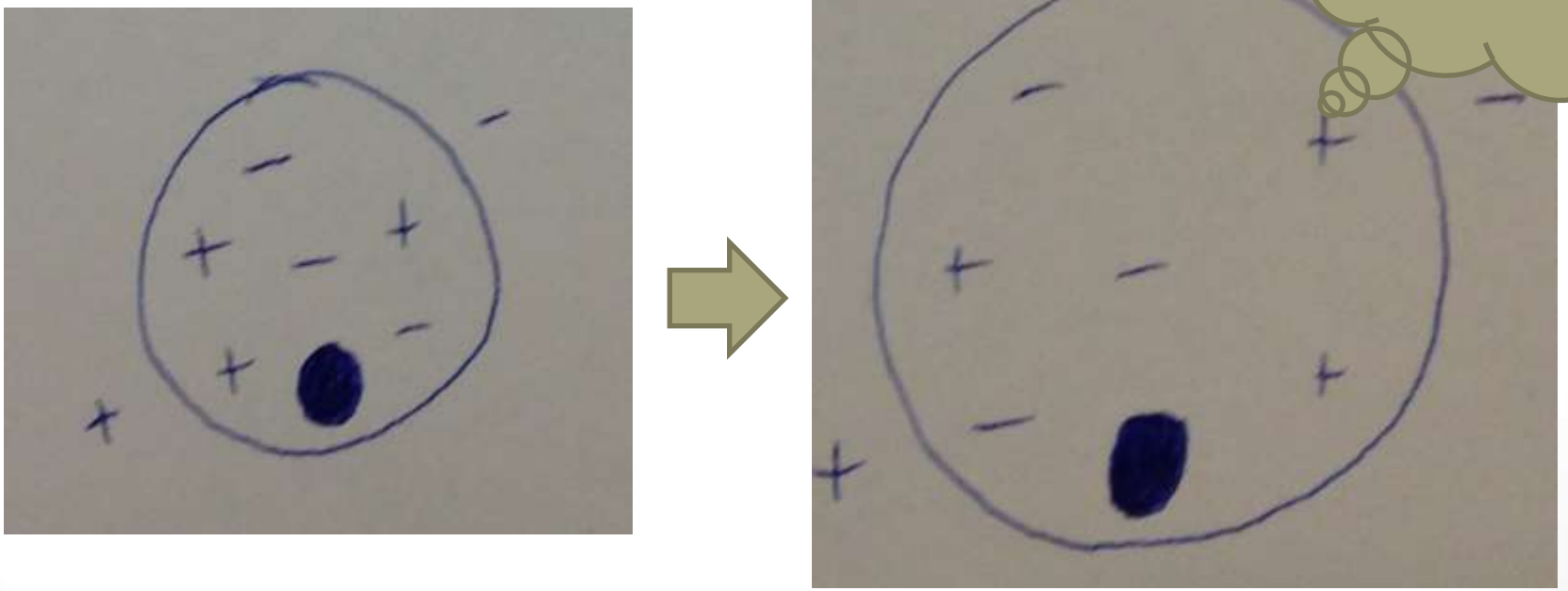
Cell is isosmotic to solution & at homeostasis



Solution is hyperosmotic to cell



Solution is hyposmotic to cell



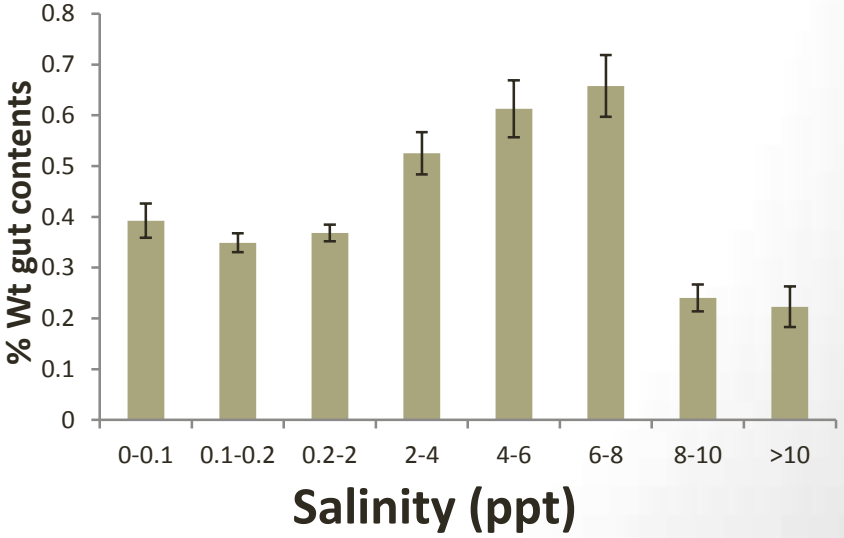
Osmoregulators maintain homeostasis with enzymatic pumps, which require ATP

Hypothesis #1

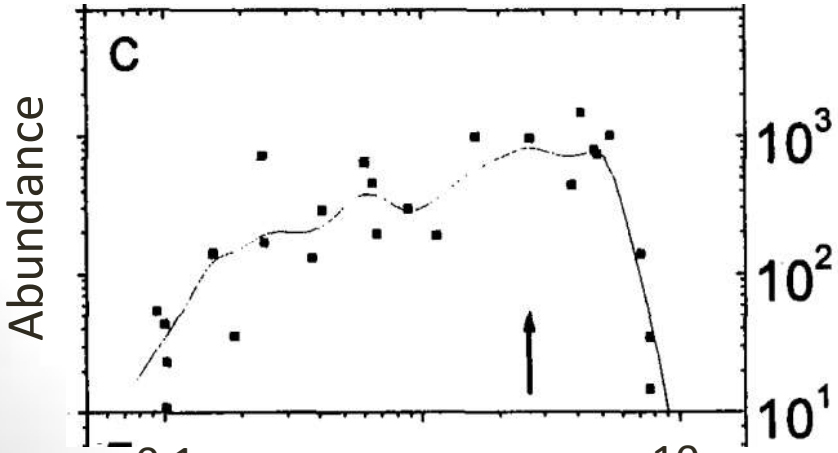
- Low algal concentration narrows the salinity tolerance of *E. affinis*.
- Rationale: Deviations from isosmotic salinities increase metabolic demand (enzymatic ion pumps), but copepods cannot increase feeding if food is limited.

Could the clam invasions…

…thereby contributing to food limitation of delta smelt >8 ppt



…be narrowing the salinity range of *E. affinis*…



Kimmerer, Burau & Bennet 1998

Comparing T to salinity

- Increases in temperature also increase metabolic demand
- Both will increase in the SFE with climate change (Cloern et al. 2011)
- However, unlike deviations from isosmotic salinity, increases in temperature allow ectotherms to move more rapidly.

Hypothesis #2

- Low algal concentration does not influence high temperature tolerance of *E. affinis*.
- Rationale: increased temperature allows copepods to increase feeding rate, allowing them to compensate for heightened metabolic demand by increasing consumption.

Range of salinities (0.1-28 ppt) at two algal concentrations (1× & **3.3×**) and range of temps (4.1-35°C) at three algal concentrations (1×, **3.3×** & **4.9×**)

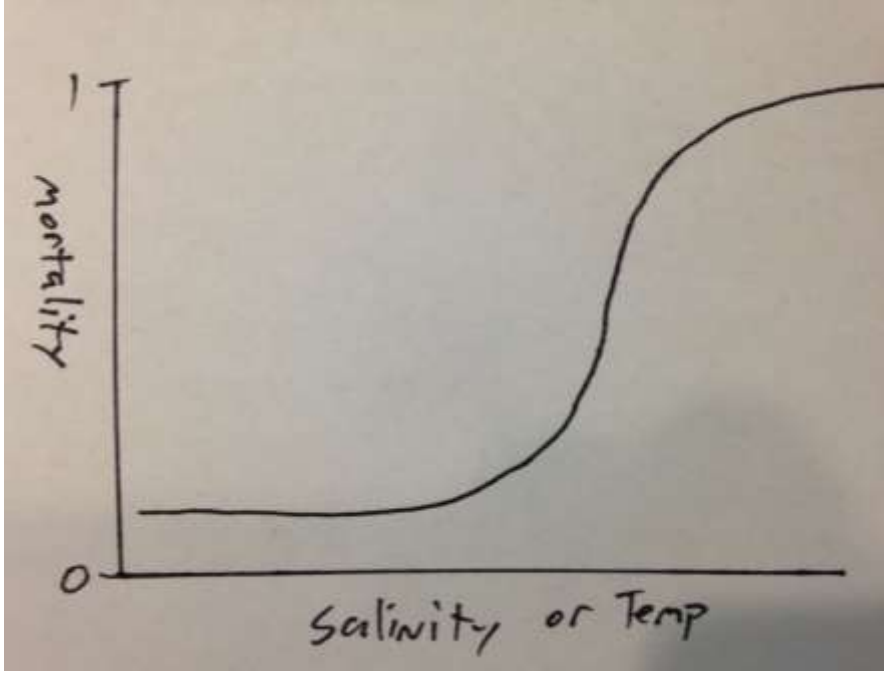
- 600 mL beakers
- 20 juveniles/beaker
- Moved to water bath

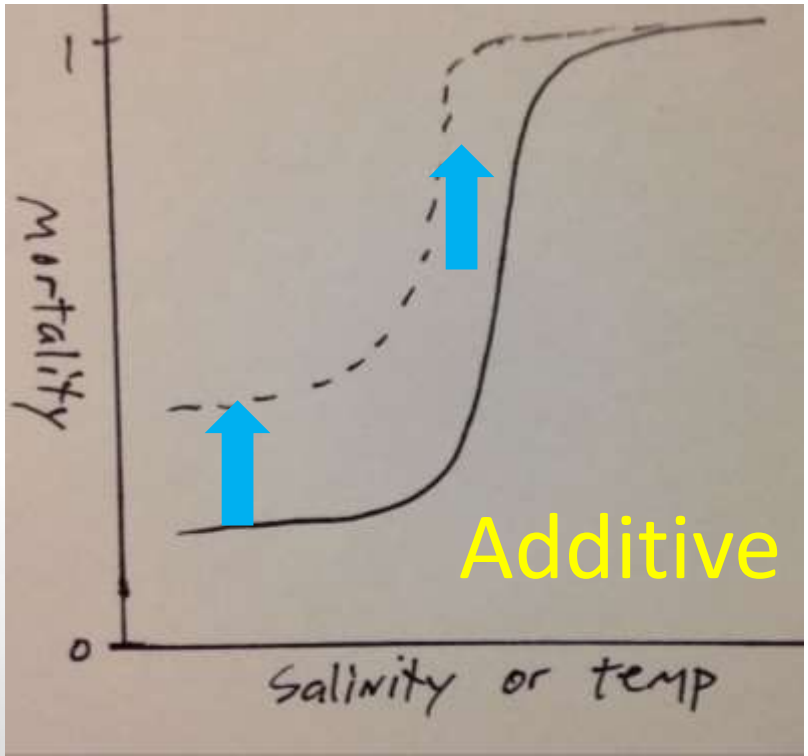
Aerated

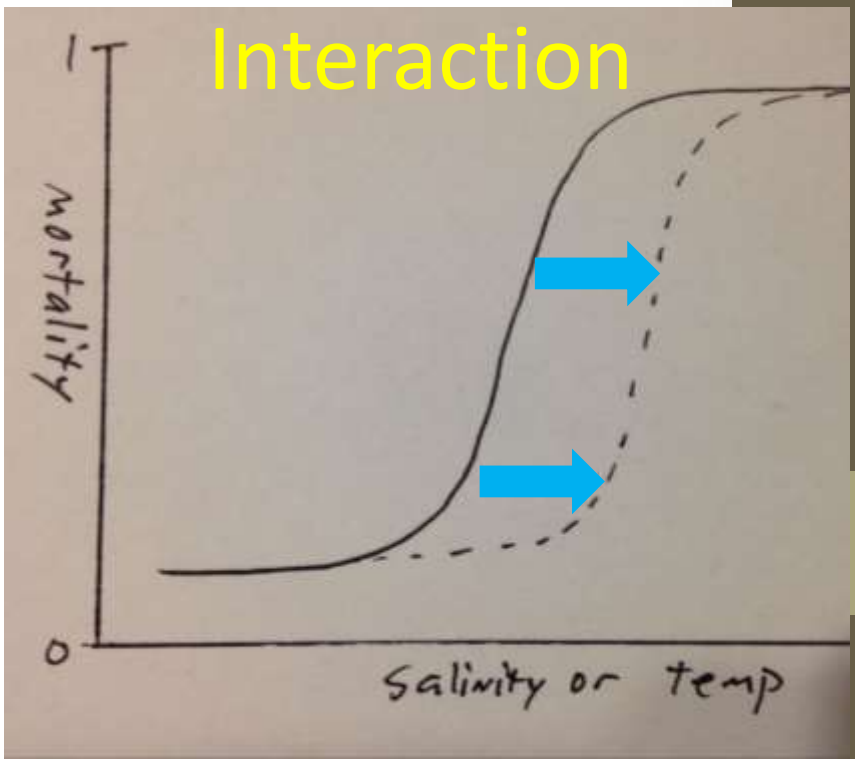
Fed daily

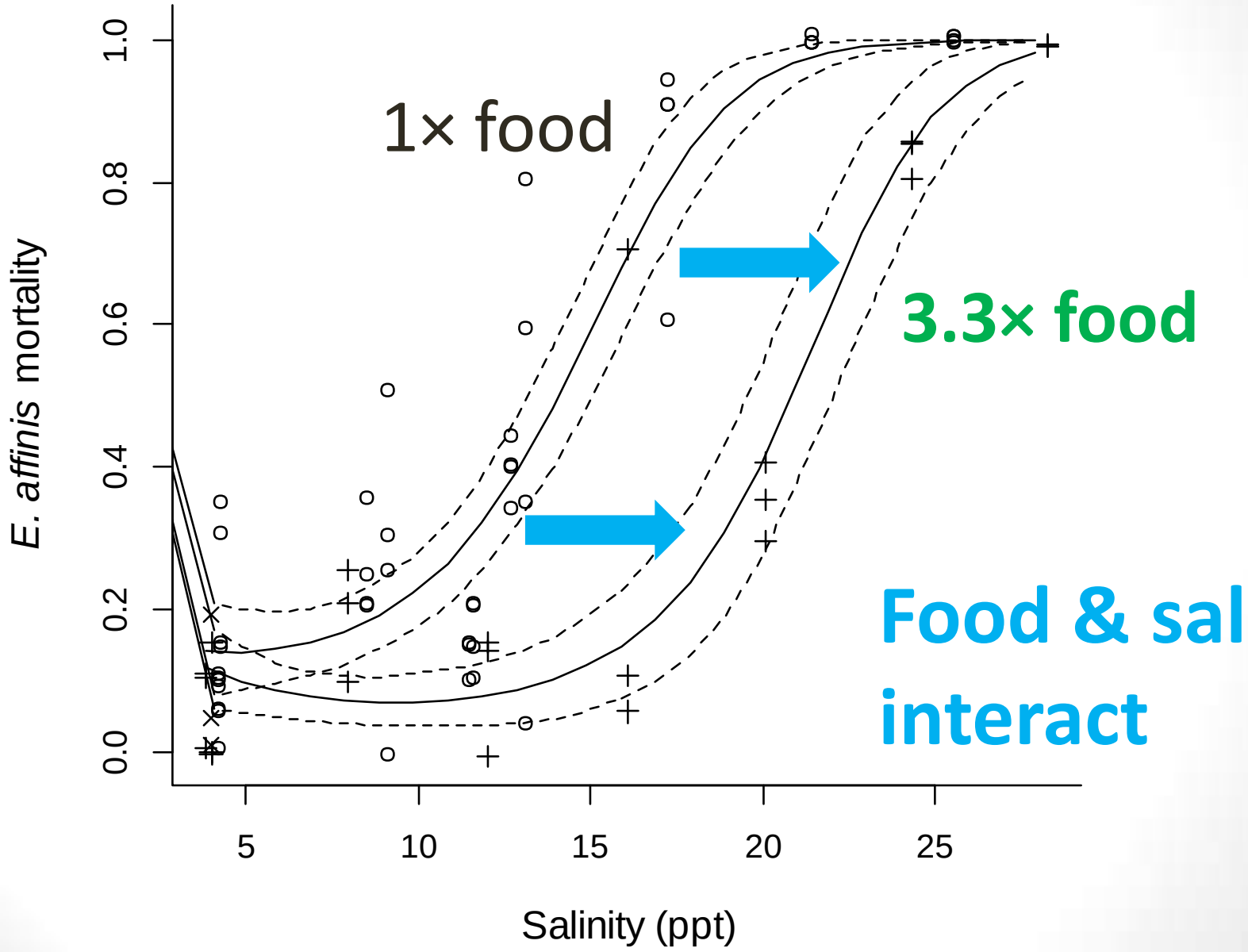
48 h water Δ

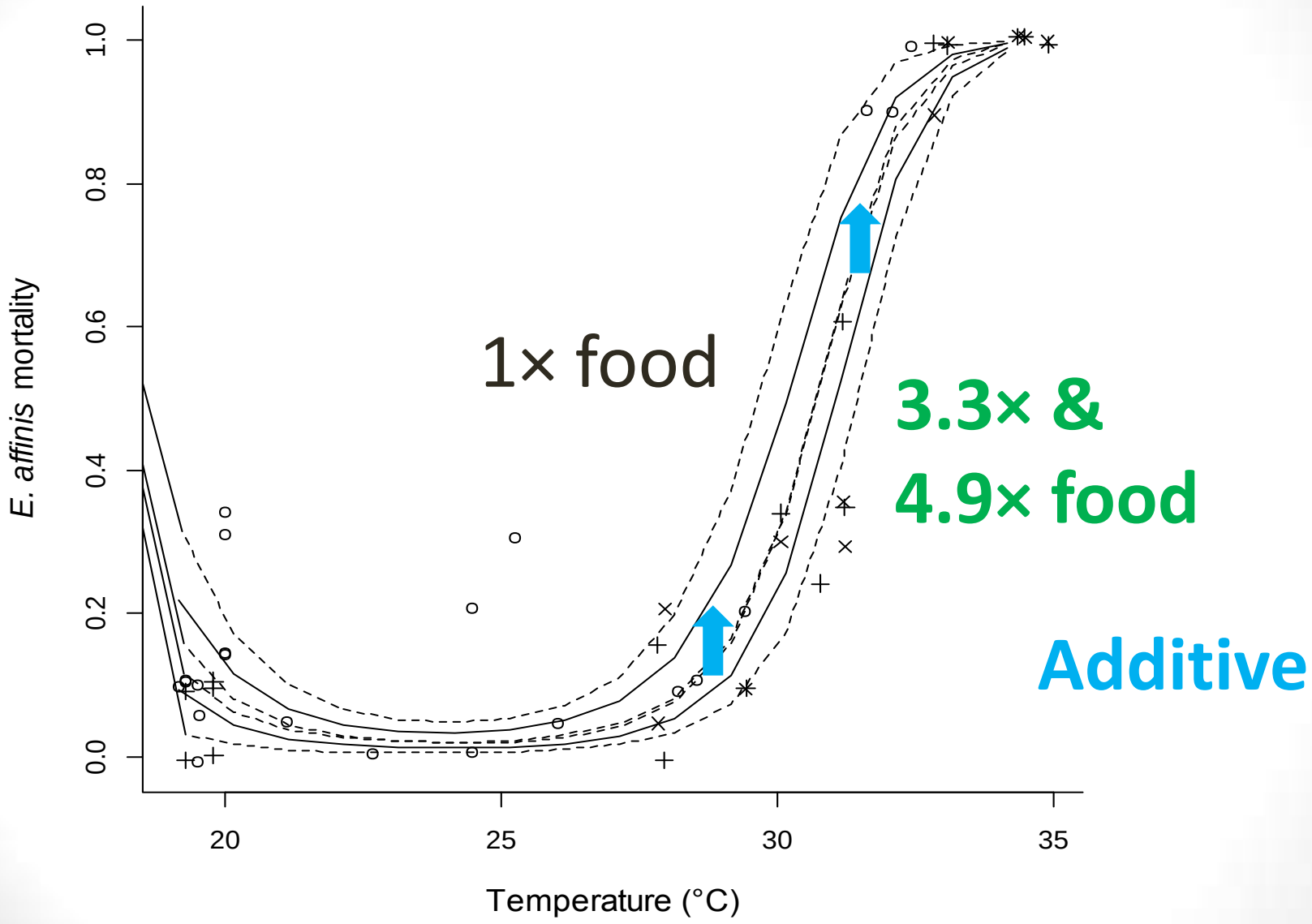
96 h counted live & dead


1
mortality
0
Salinity or Temp


1
Mortality
0
Salinity or temp
Additive


Interaction
1
mortality
0
Salinity or temp

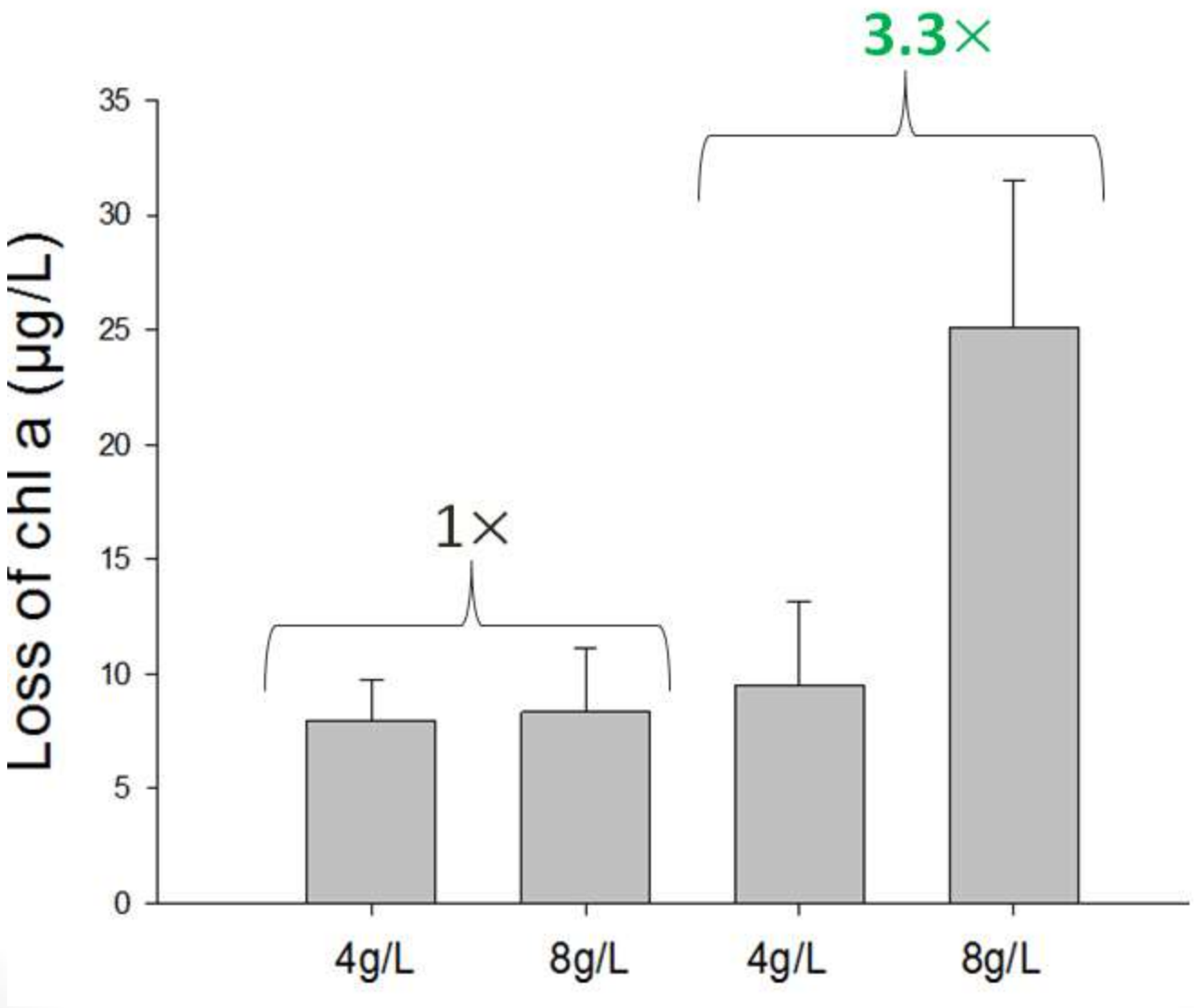

1× food
3.3× food
Food & sal interact
E. affinis mortality
0.0
0.2
0.4
0.6
0.8
1.0
5
10
15
20
25
Salinity (ppt)


E. affinis mortality
0.0
0.2
0.4
0.6
0.8
1.0
20
25
30
35
Temperature (°C)
1× food
3.3× &
4.9× food
Additive

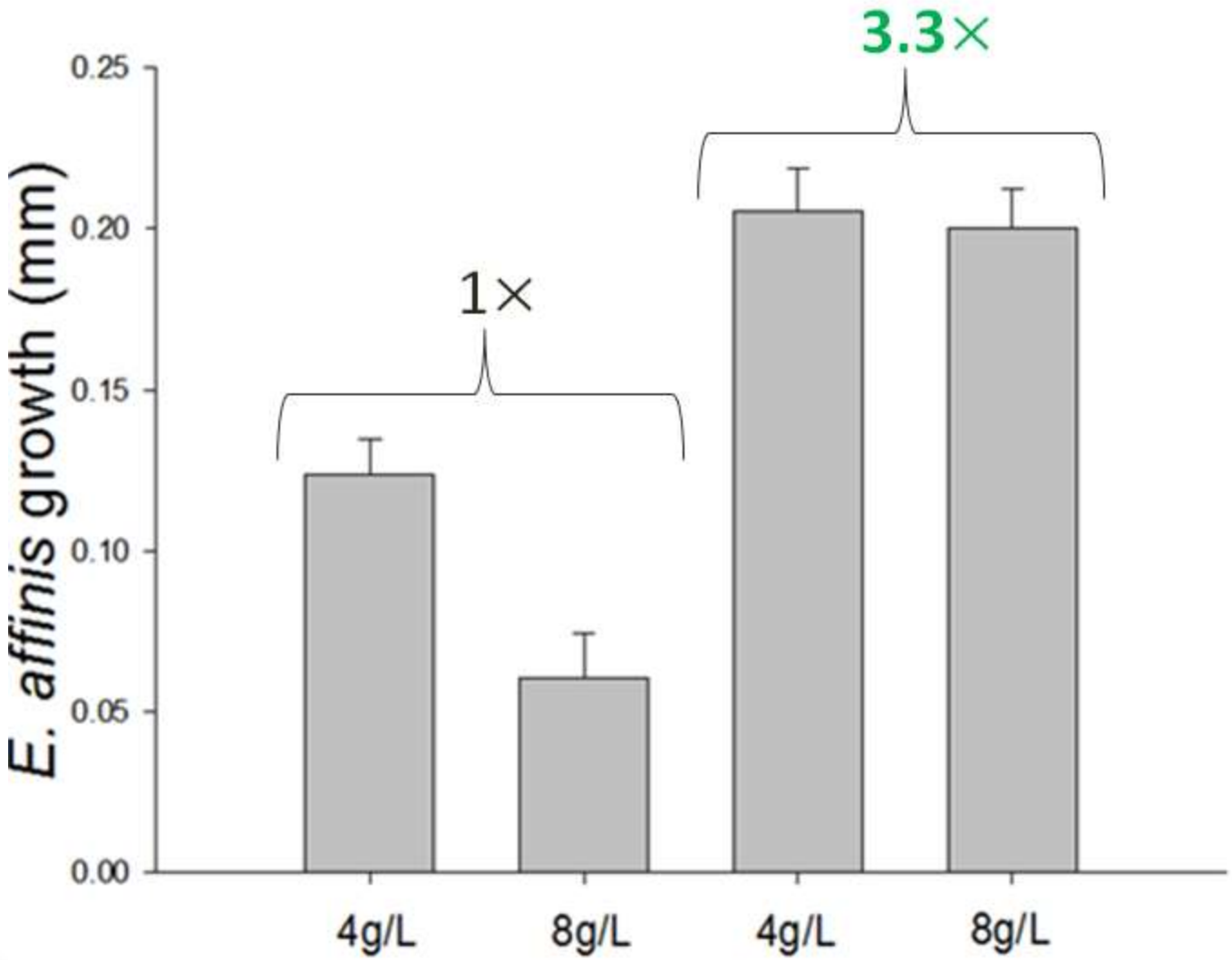
Hypothesis #3

- Low food concentrations prevent *E. affinis* from increasing feeding as salinity deviates from optimal, despite increased metabolic demand, reducing growth and/or survival.

Consumption



Growth



Conclusions

- Low food narrows salinity, but not temperature tolerance of *E. affinis*
- When food is limited and salinity is hyperosmotic, growth is sacrificed, likely in favor of osmoregulation
- When food is abundant, compensatory feeding makes copepod growth less sensitive to salinity stress
- No reason to believe this does not apply to other euryhaline ectotherms

We know that low food narrows the salinity tolerance of *E. affinis* in lab. Does it also narrow the salinity range of *E. affinis* in the SFE?

Thank you!

Ching Teh

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Will Wetzel

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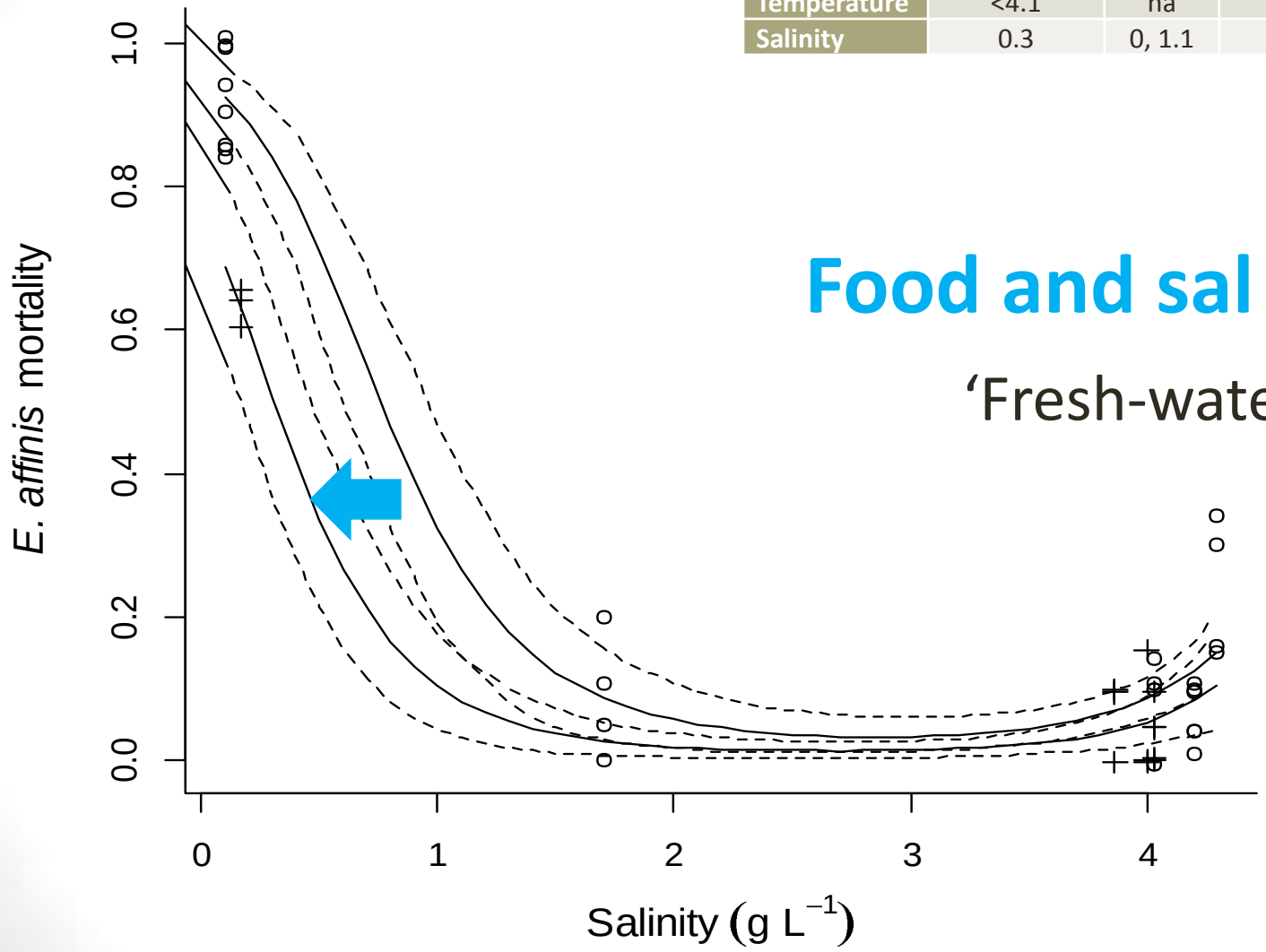
>1 yr of experiments

hundreds of beakers

Stressor	Lower LL_{50}	95% CI	Upper LL_{50}	95% CI
Temperature	<4.1	na	29.6	28.6, 30.6
Salinity	0.3	0, 1.1	21.1	19.7, 22.5



Food and sal interact

‘Fresh-water’ <0.5ppt

http://en.wikipedia.org/wiki/Killarney_National_Park

Hladyz et al. 2011

http://www.arabpestcontrol.com

Human and Gordon 1996

The distribution of *E. affinis* in salinity is much narrower than indicated by its broad salinity tolerance, suggesting a behavioral mechanism for its distribution.

(Journal of Plankton Research Kimmerer et al. 2014)