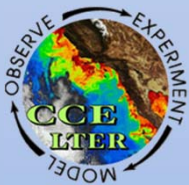


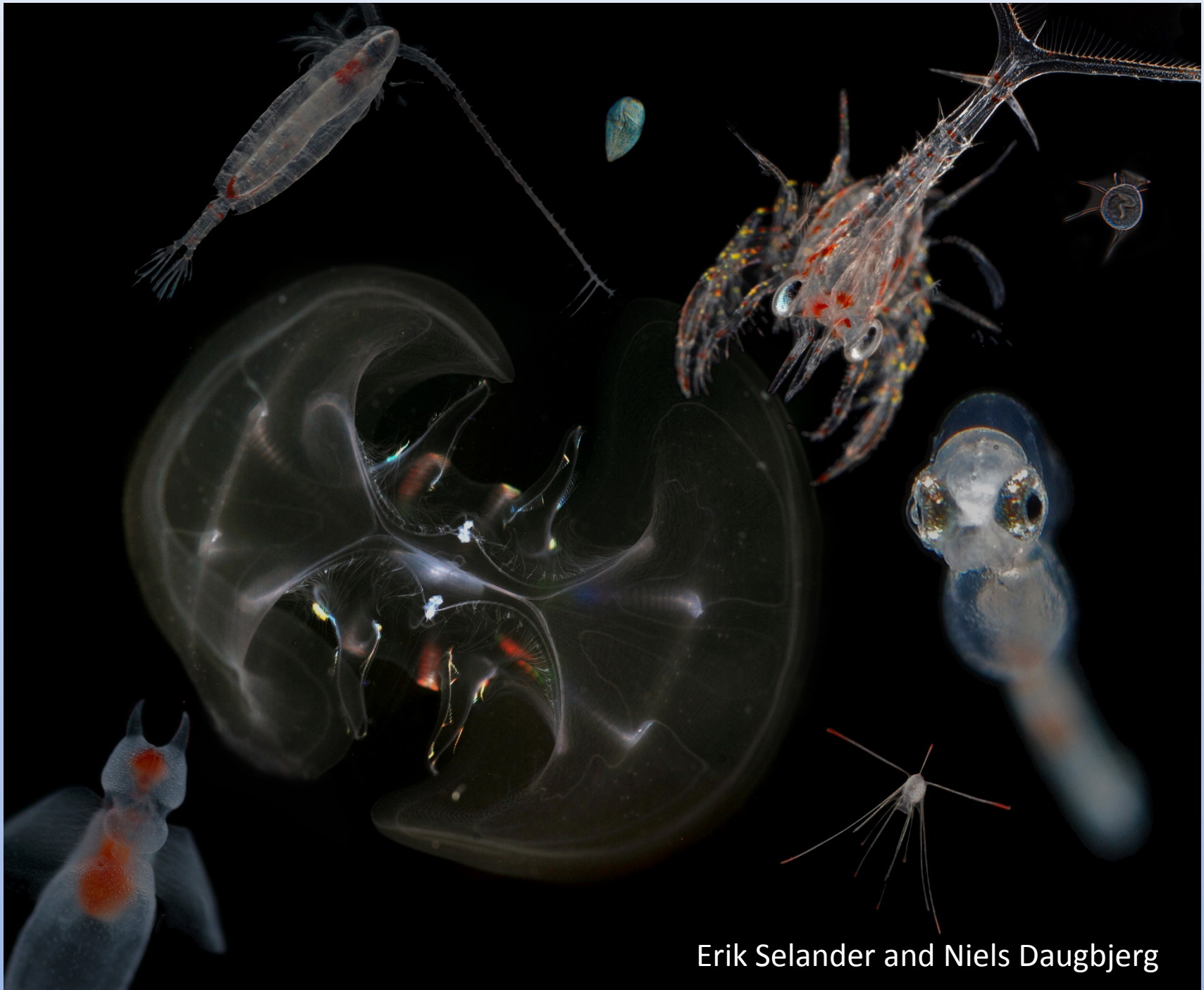
Risks and rewards in the zooplankton: nonlinear dependencies on body size

Mark D. Ohman

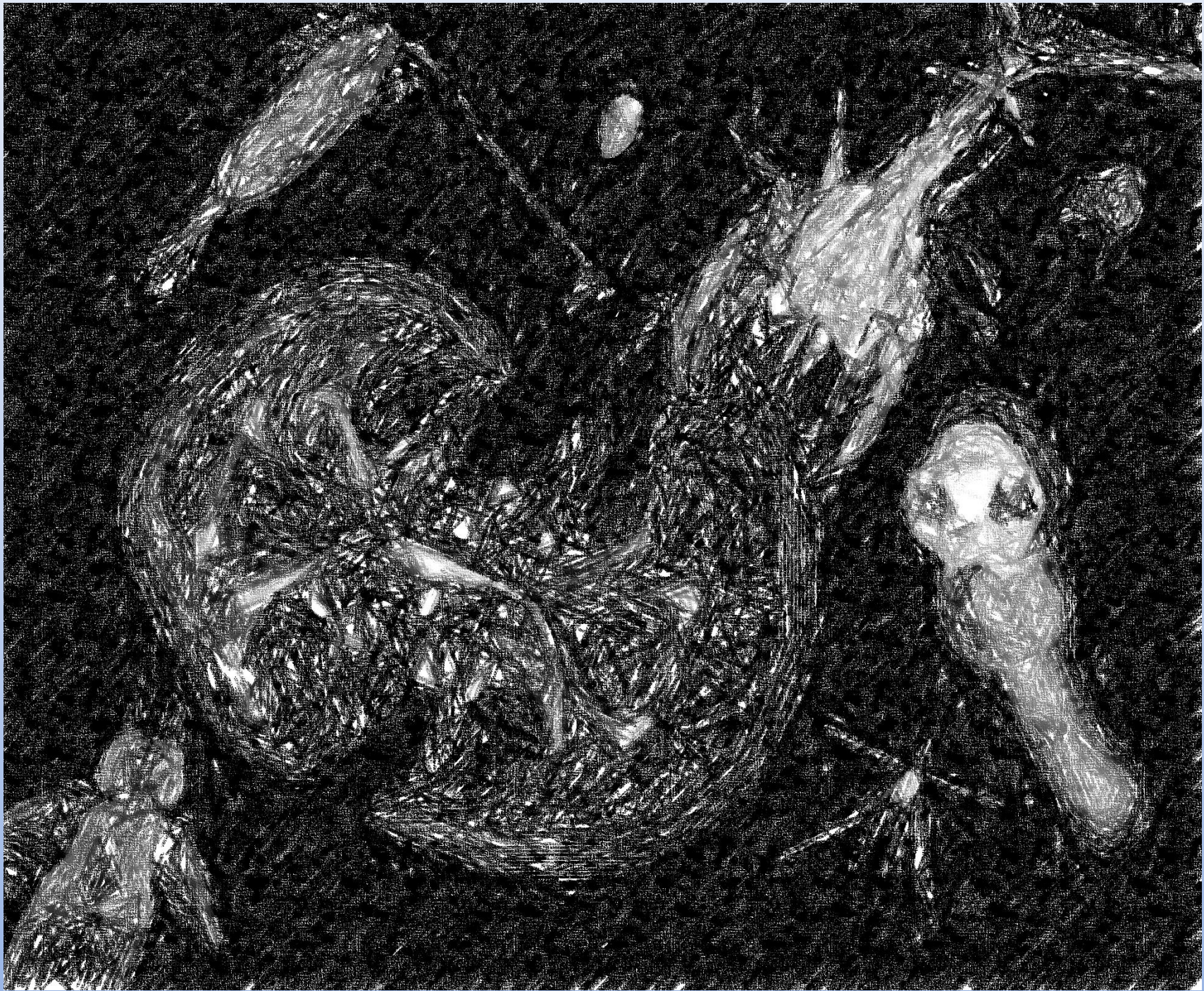


California Current Ecosystem LTER site
Scripps Institution of Oceanography





Erik Selander and Niels Daugbjerg



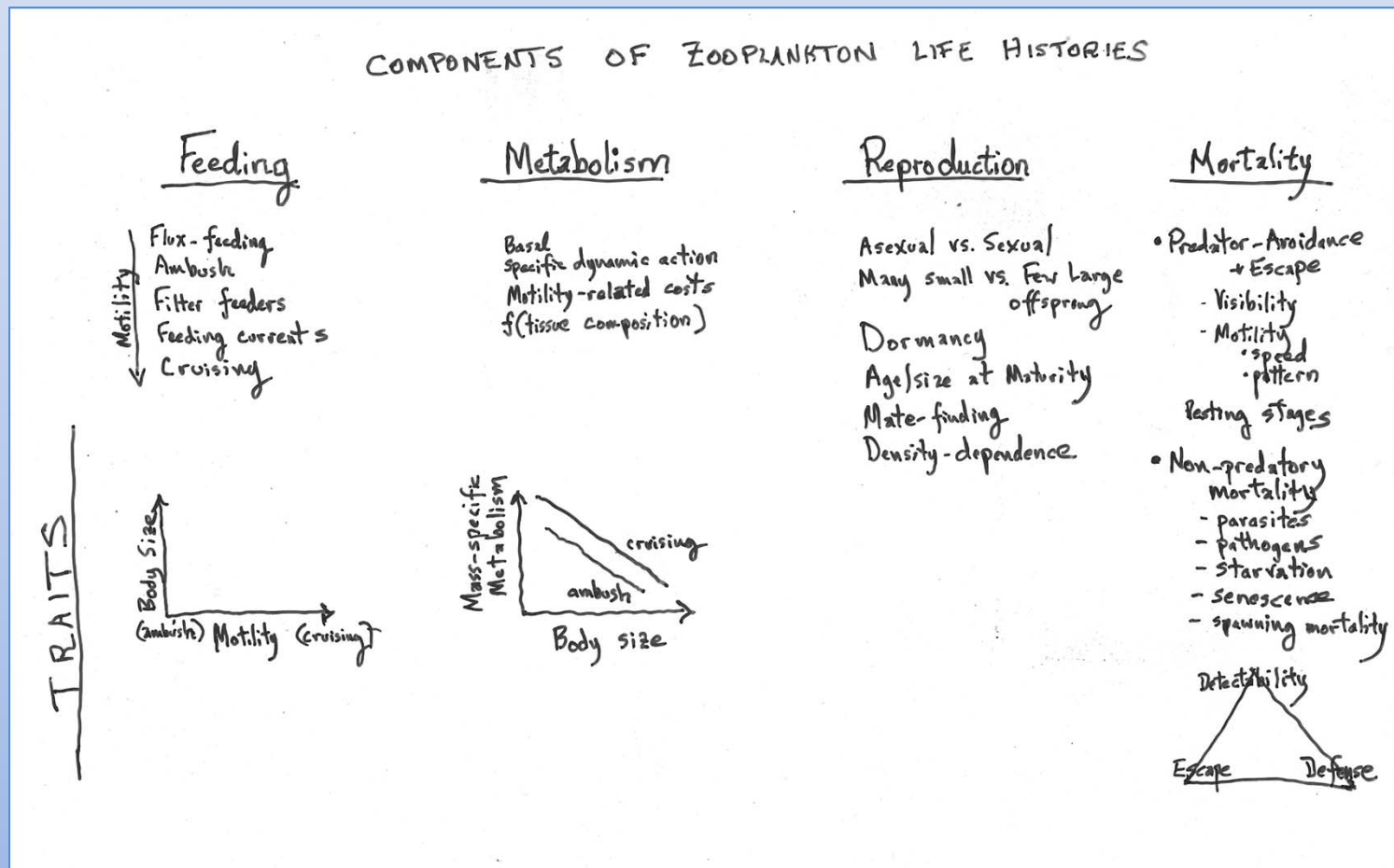
Maurizio Ribera d'Alcalà

"The Naples Workshop"

Constrain, Understand and Model Biocomplexity in Plankton Communities

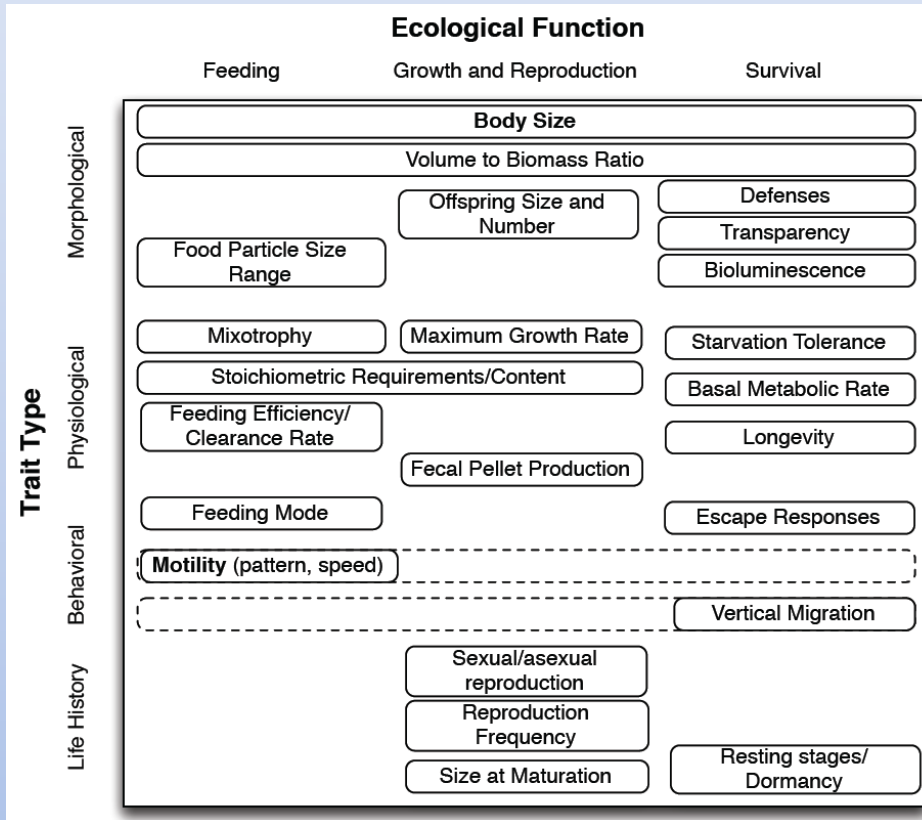
Stazione Zoologica Anton Dohrn

Nov. 2008



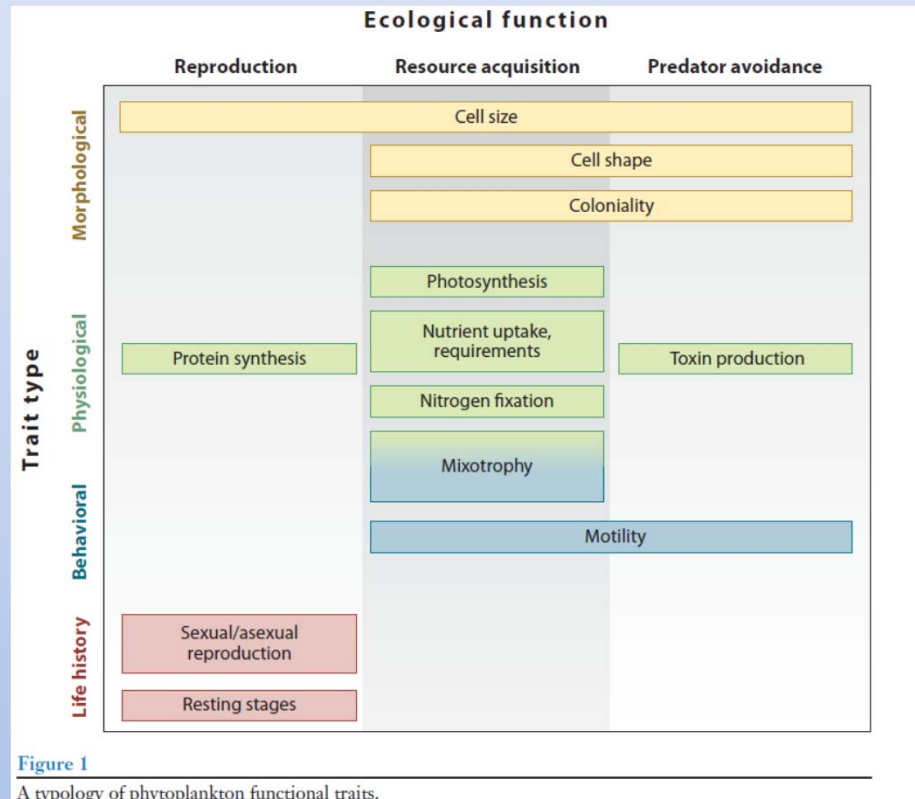
(synthesis of discussion group on applicability of TBA to the zooplankton, led by Ohman, Kiørboe, and Litchman)

Zooplankton Traits Framework

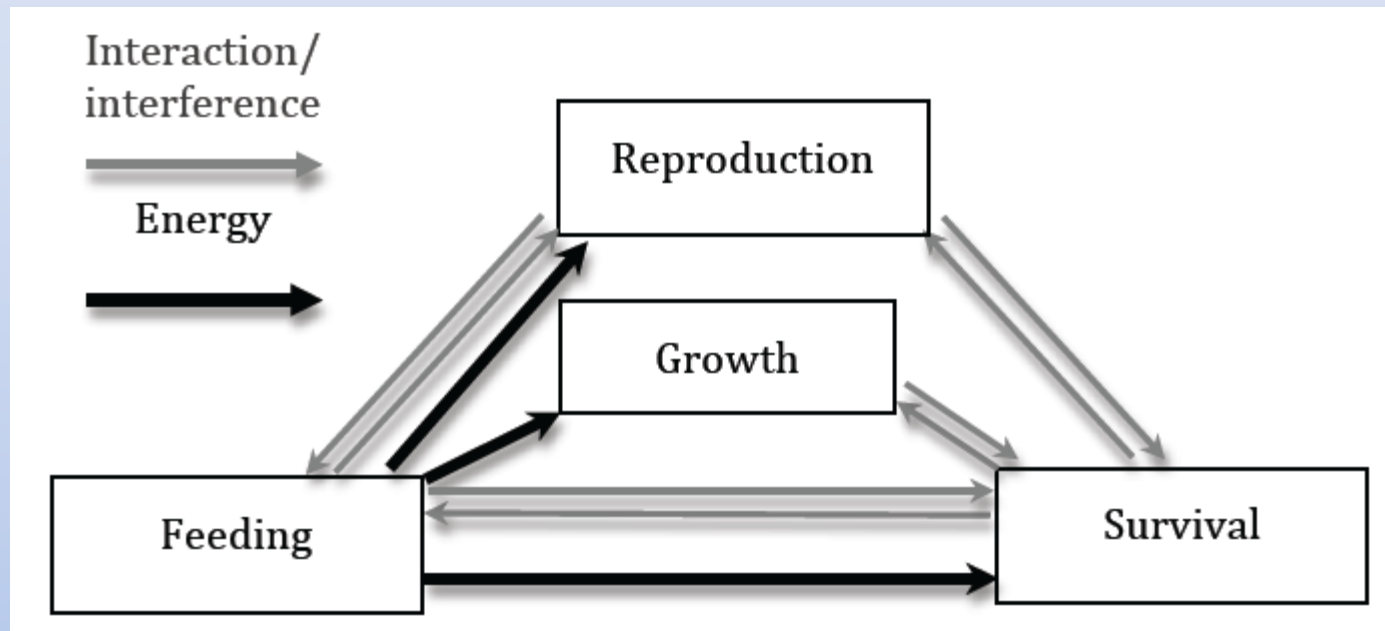


Litchman, Ohman, & Kiørboe (2013) JPR

Phytoplankton Traits Framework



Litchman and Klausmeier (2008) ARES



Litchman, Ohman, & Kiørboe (2013) JPR

Trade Offs

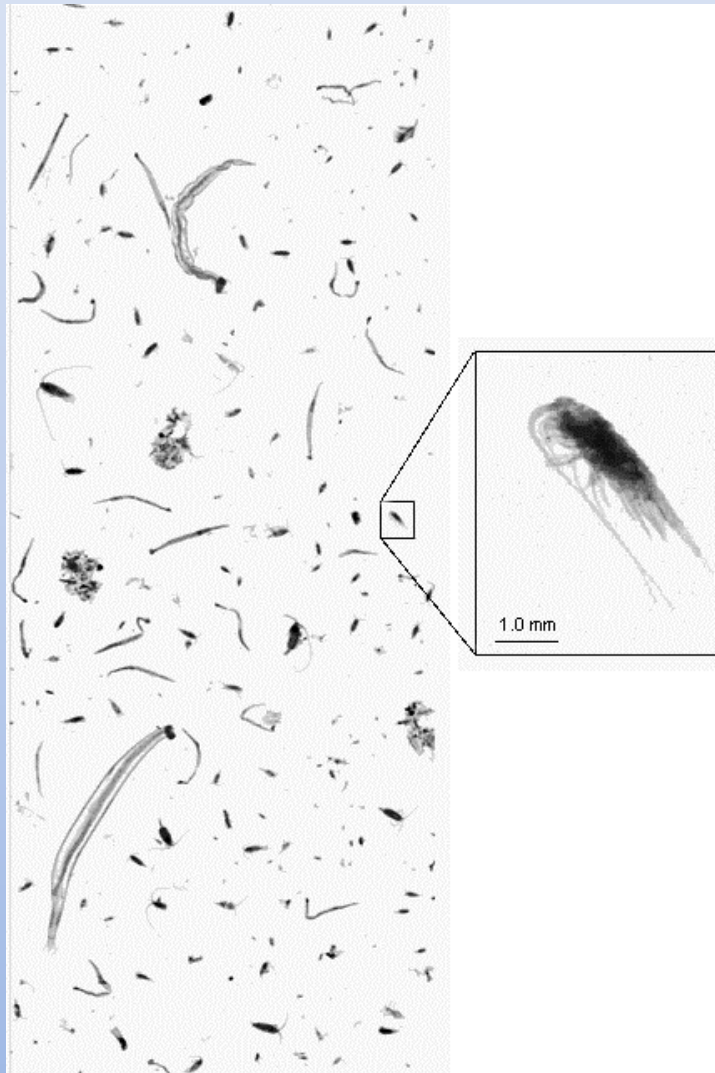
Gilliam's rule

Minimization of: $\frac{\mu}{g} = \frac{\text{mortality rate}}{\text{energy gain}}$

Gilliam and Fraser (1987) *Ecology*

De Robertis (2002) *L&O*

ZooScan + digital image analysis



Semi-automatic approach:

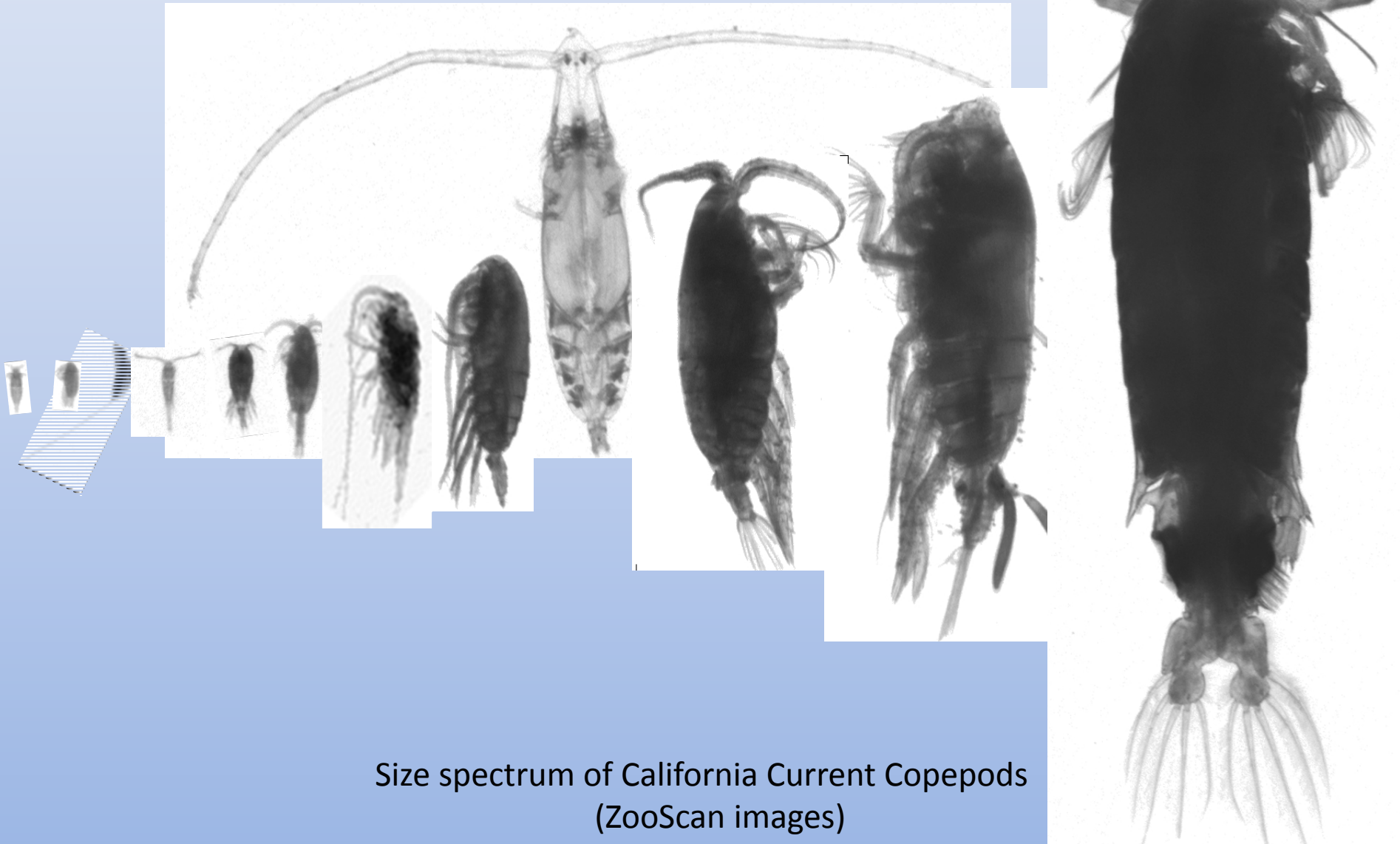
Machine Classification
by Random Forest Algorithm



100% Manual validation

Gorsky et al. (2010) JPR

A Master Trait: Body Size

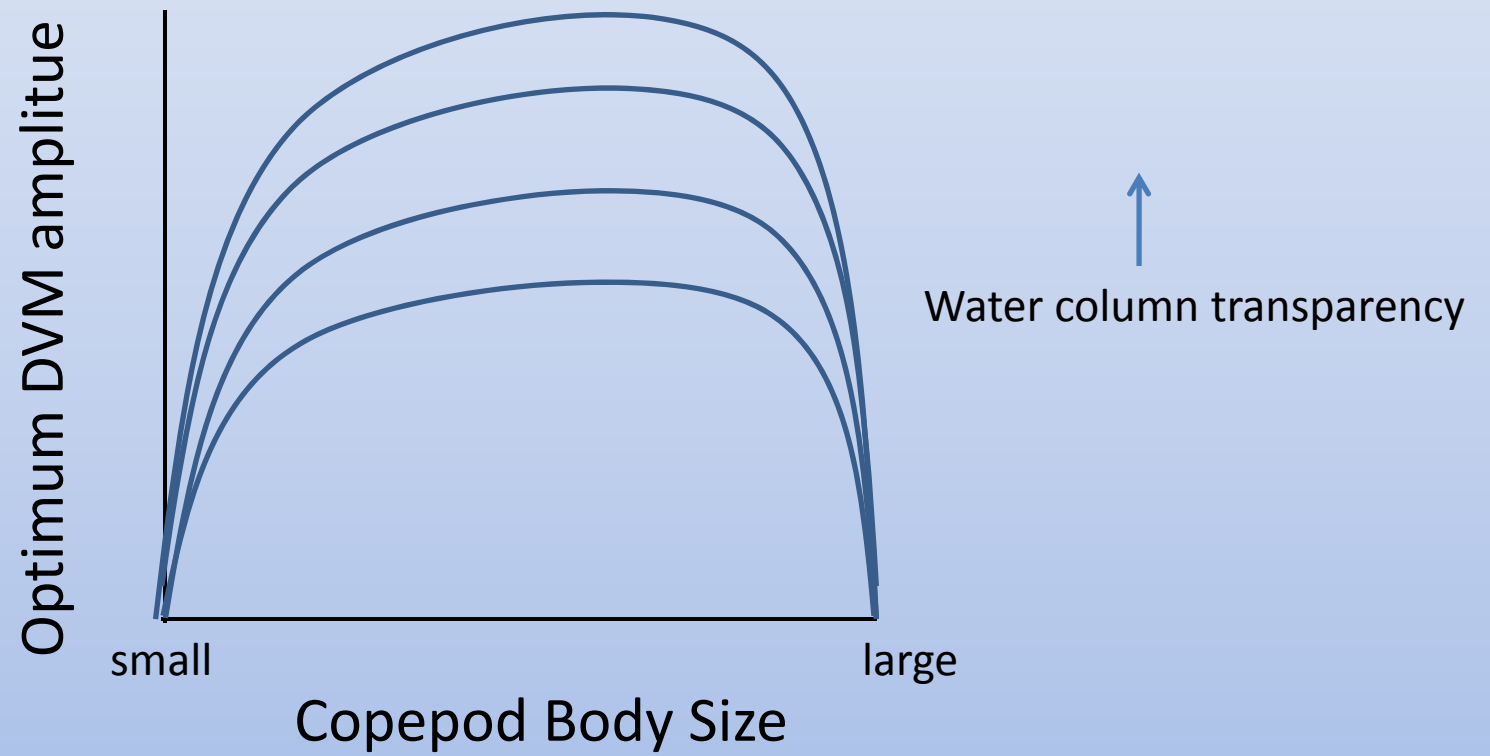


Size spectrum of California Current Copepods
(ZooScan images)

Is **Diel Vertical Migration** behavior

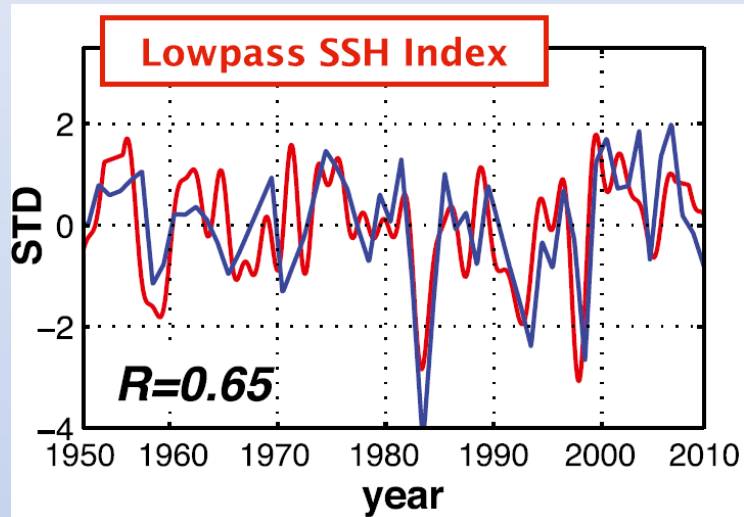
a f(copepod body size)?

(unpublished figures; to be submitted)

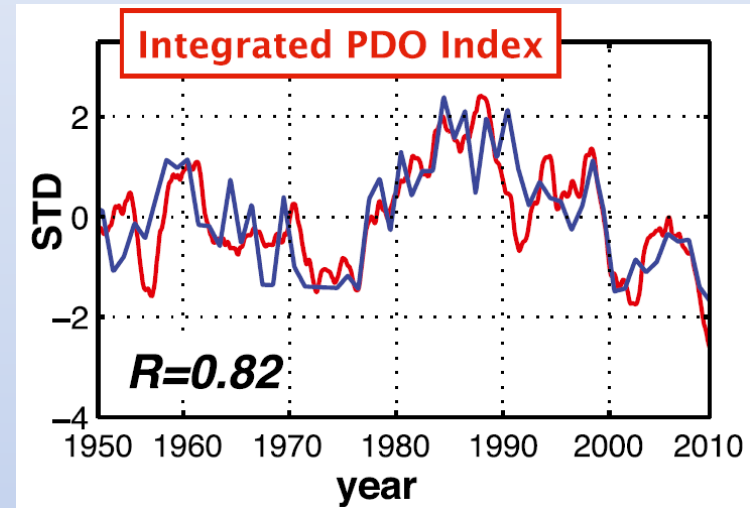


What are the *key traits* that reveal sensitivity to
altered ocean forcing ?

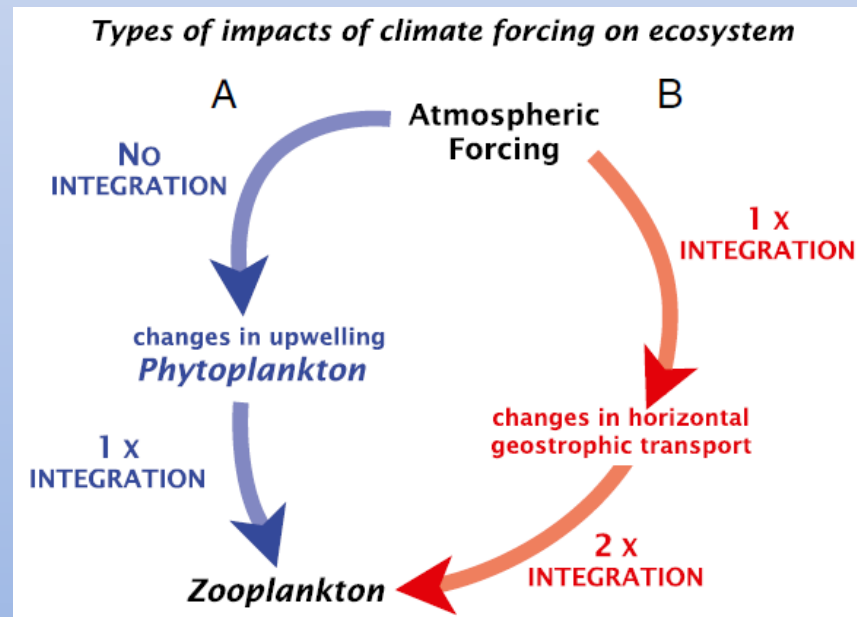
Euphausia pacifica



Nyctiphanes simplex



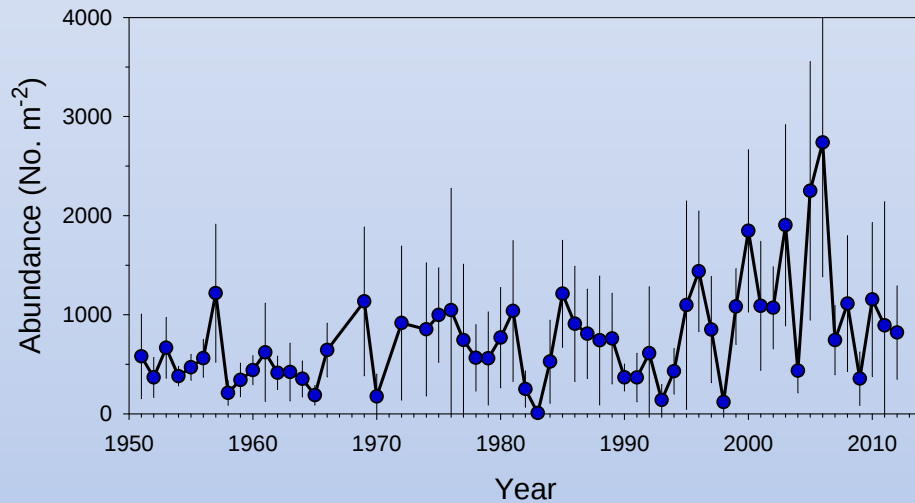
Single
Integration



Double
Integration

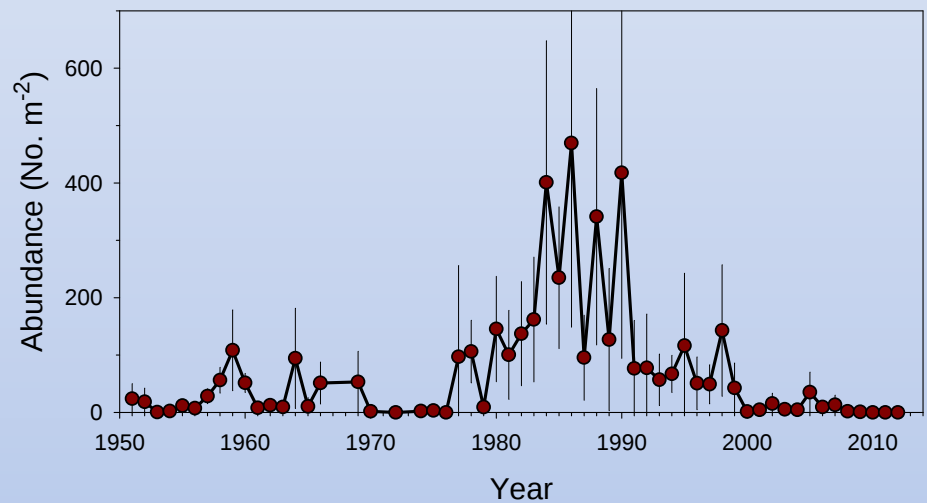
Species Resolution

Euphausia pacifica



Strong interannual variation

Nyctiphanes simplex



Strong multi-decadal variation

source: Brinton–Townsend Euphausiid DB

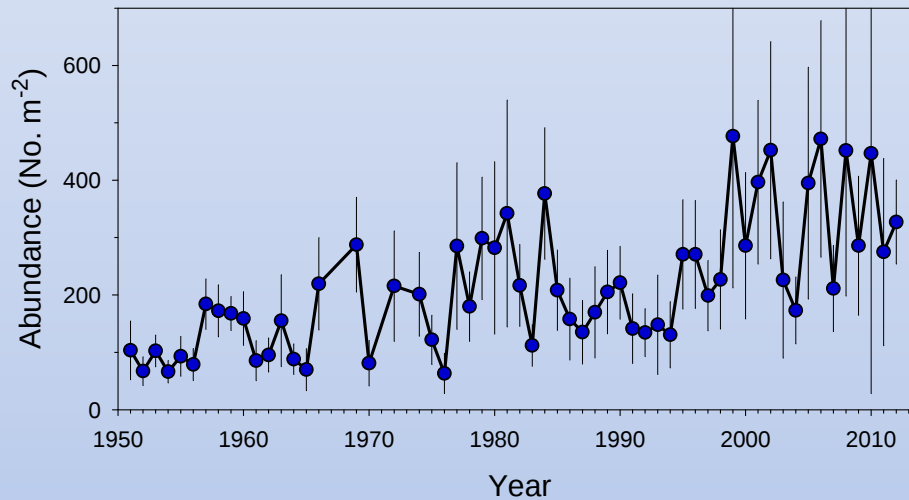


39 spp. of euphausiids in the CCS

Body Size

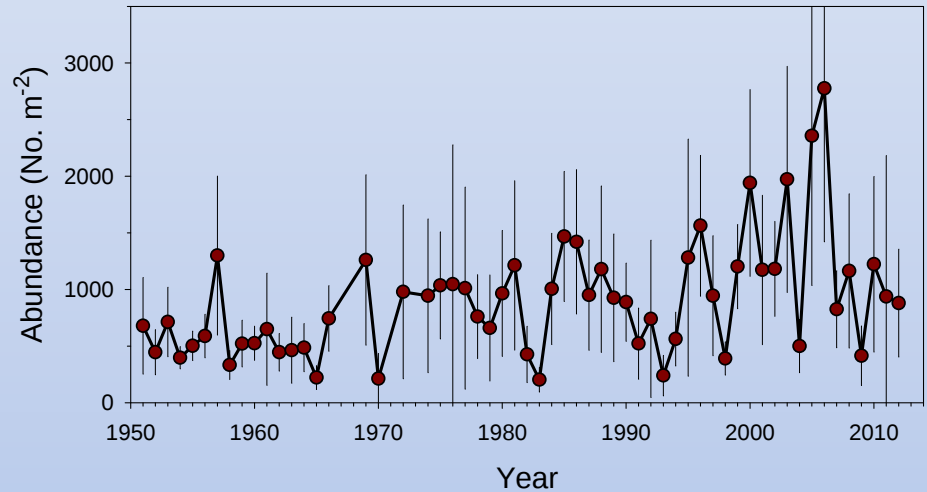
Large-bodied

(≥ 12 mm adults)



Small-bodied

(< 12 mm adults)

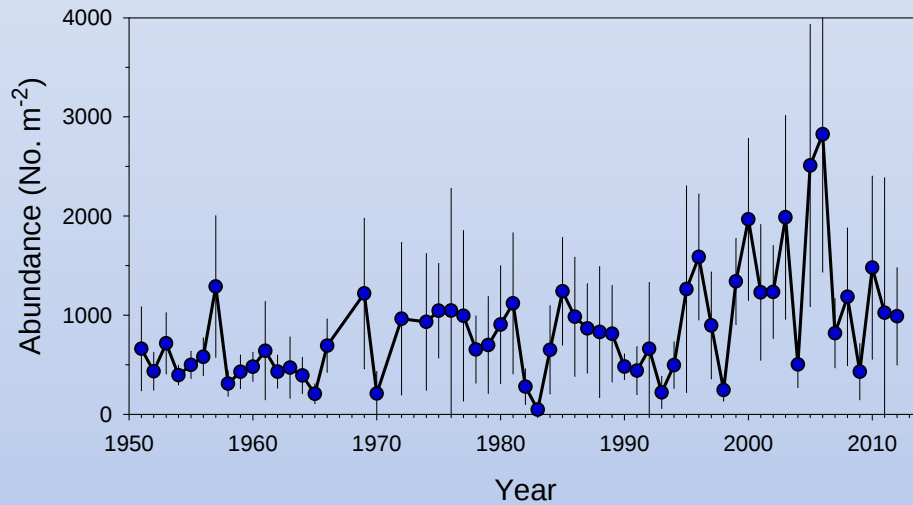


(does not recover the multi-decadal variation)

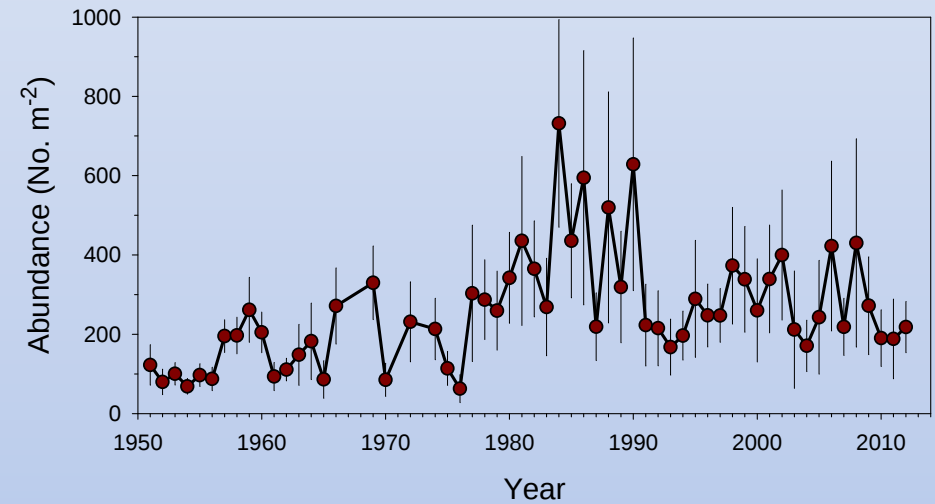
39 spp. of euphausiids in the CCS

Reproductive Mode

Broadcast Spawners



Egg Brooders

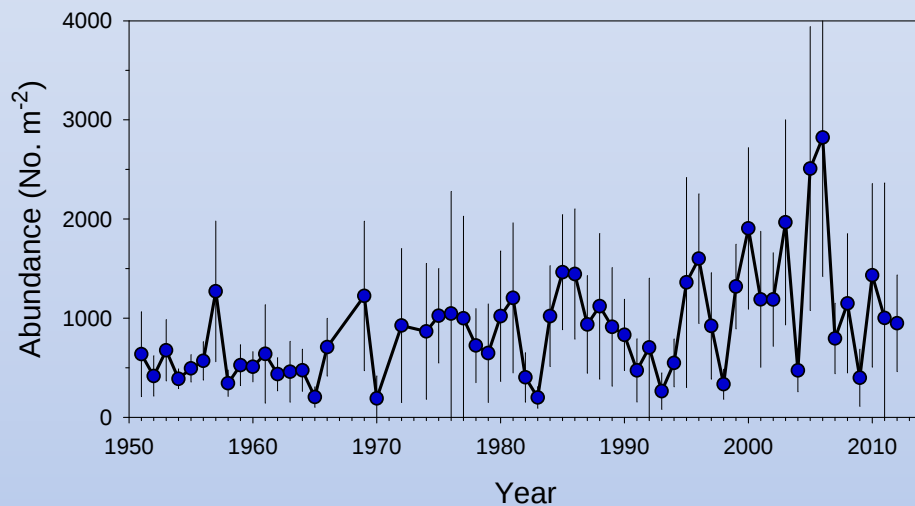


(only partially recovers the multi-decadal variation)

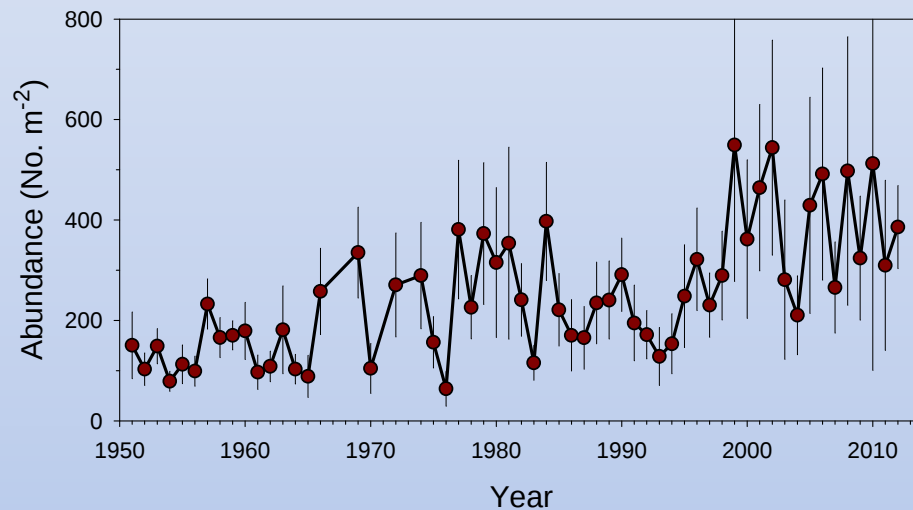
39 spp. of euphausiids in the CCS

Eye Shape

Round Eye



Bilobed Eye

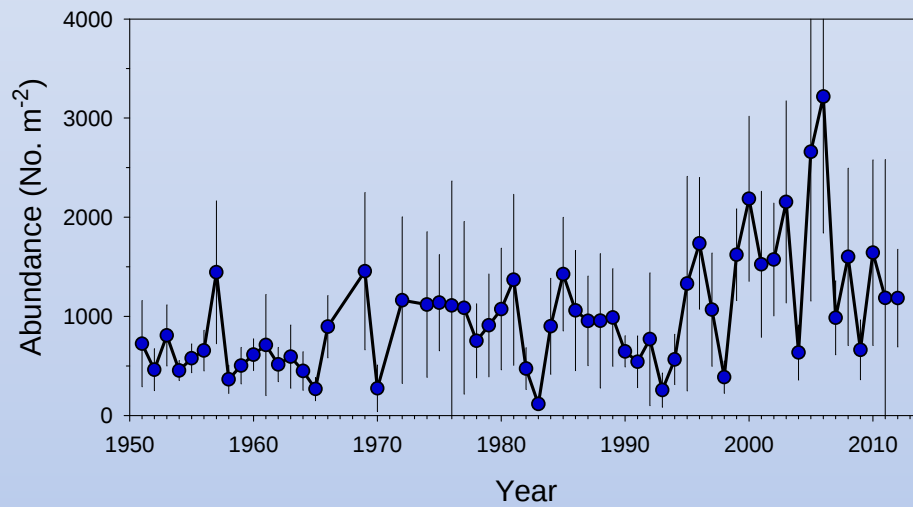


(does not recover the multi-decadal variation)

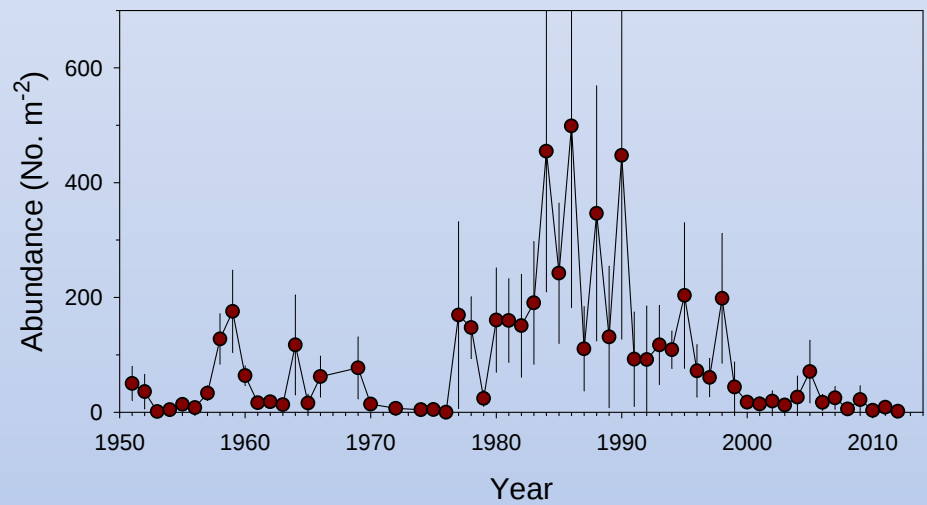
39 spp. of euphausiids in the CCS

Biogeography

Cool Water Affinity



Warm Water Affinity



(fully recovers the multi-decadal variation)

What are the **key traits** that define biogeographic affinities?
(leading to a 'warm water' or 'cool water' species?)

Temp, Food-dependence of:

metabolism

somatic growth

fecundity

Susceptibility to non-visual vs. visual predators

Solve for the key components of Gilliam's rule

Summary

- Nonlinear dependence of copepod DVM on body size

Size-dependent trade-offs

Non-migratory: small & large

DVM: intermediate-sized

modulated by the ambient light field

- Quest for **key traits** to explain differential responses of euphausiids to climate forcing
- Need for **explicit frameworks** for analyzing trade-offs

Mange tak !

fin