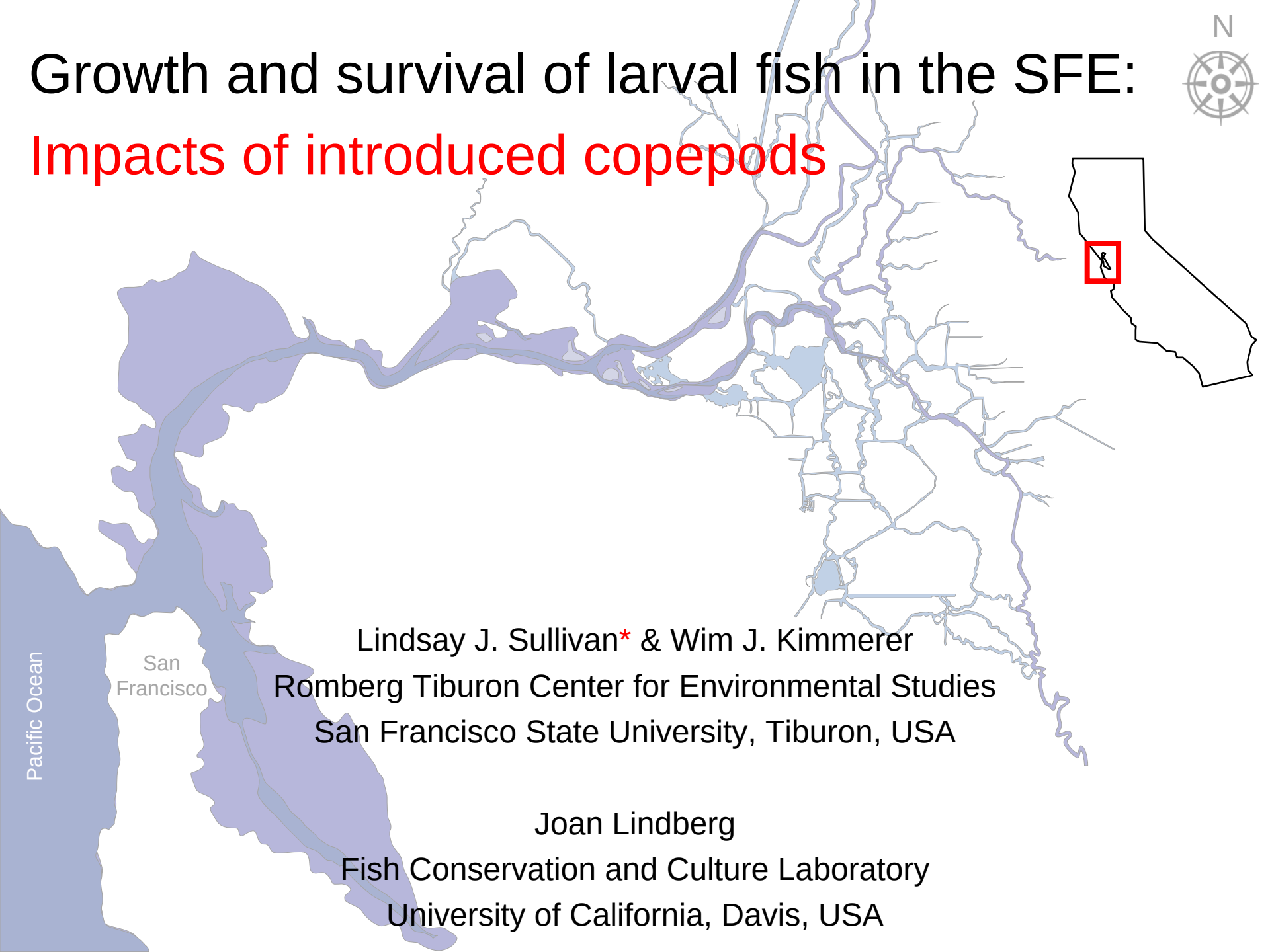
Growth and survival of larval fish in the SFE:

Impacts of introduced copepods



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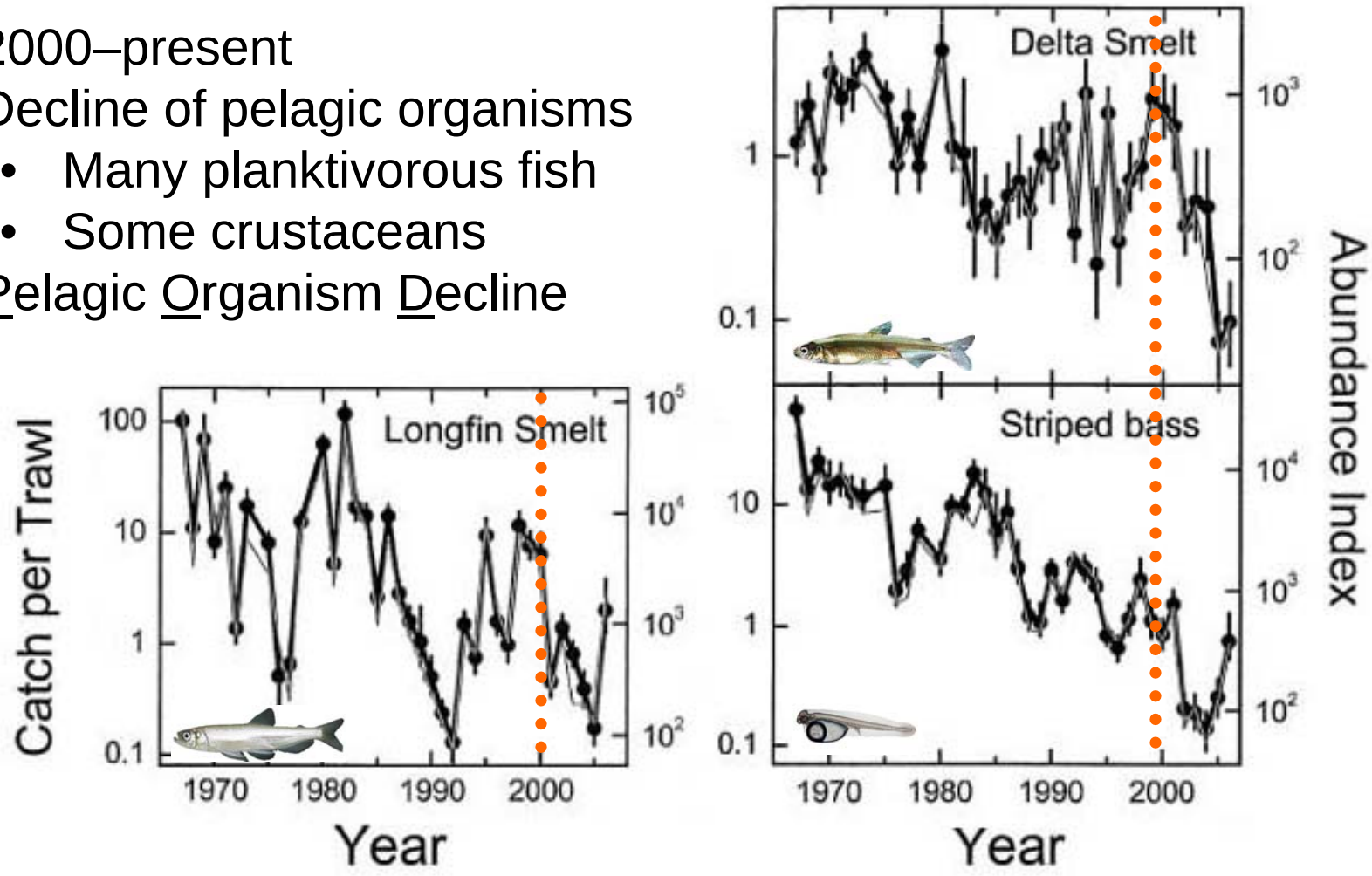
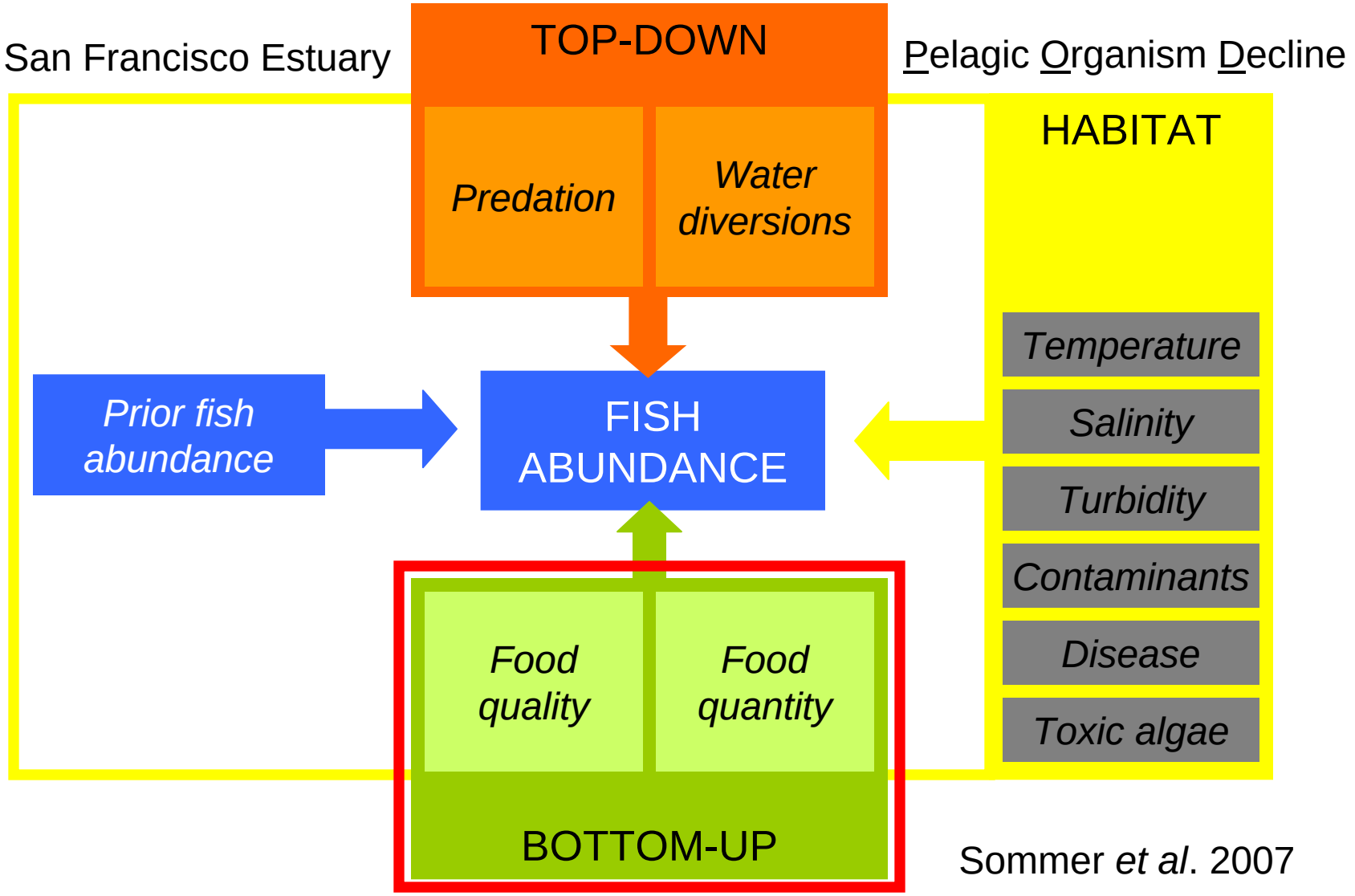
- 2000–present
- Decline of pelagic organisms
  - Many planktivorous fish
  - Some crustaceans
- Pelagic Organism Decline

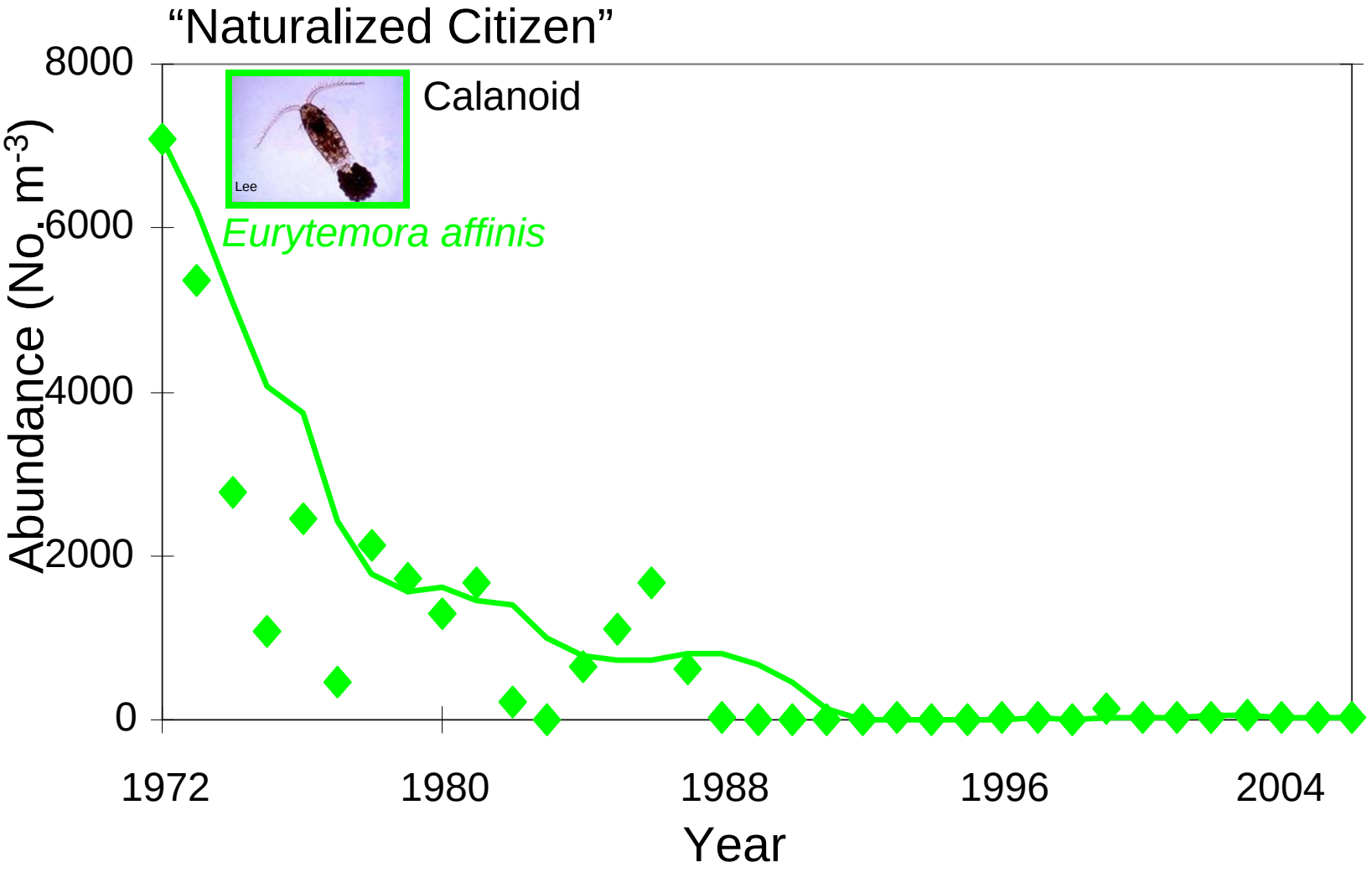


Sommer *et al*. 2007

Potential causes of POD

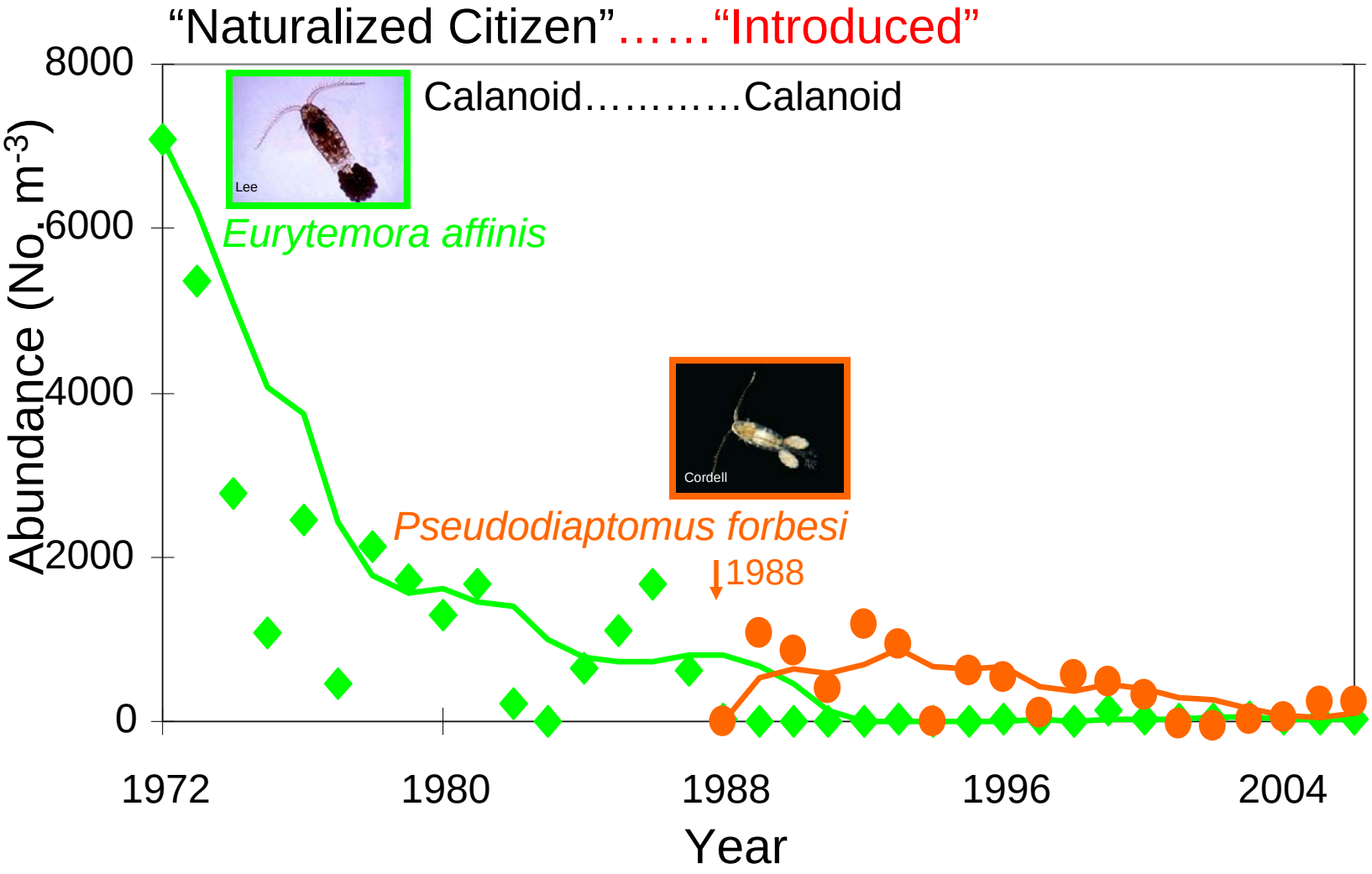


Changes: food quantity



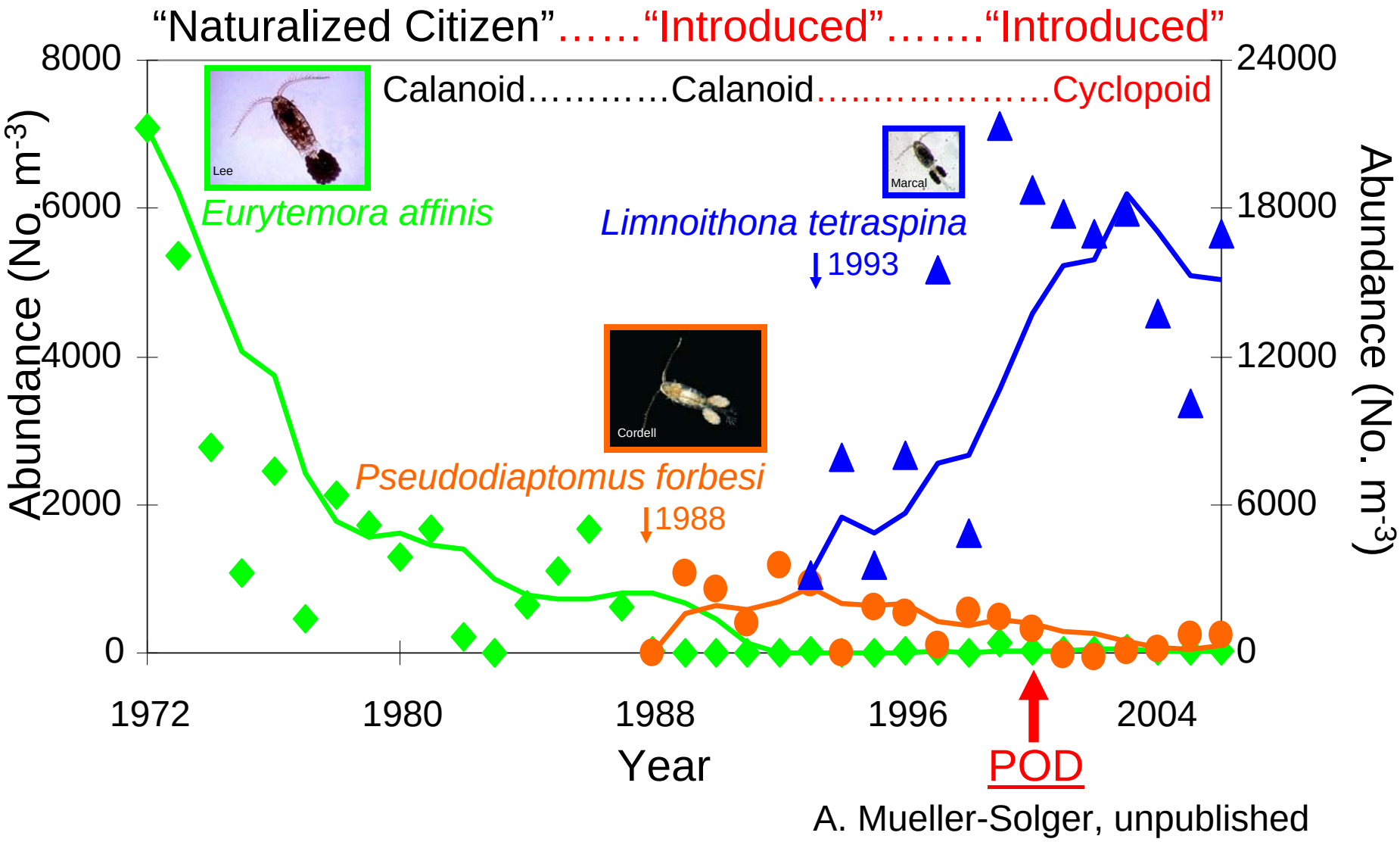
A. Mueller-Solger, unpublished

Changes: food quantity

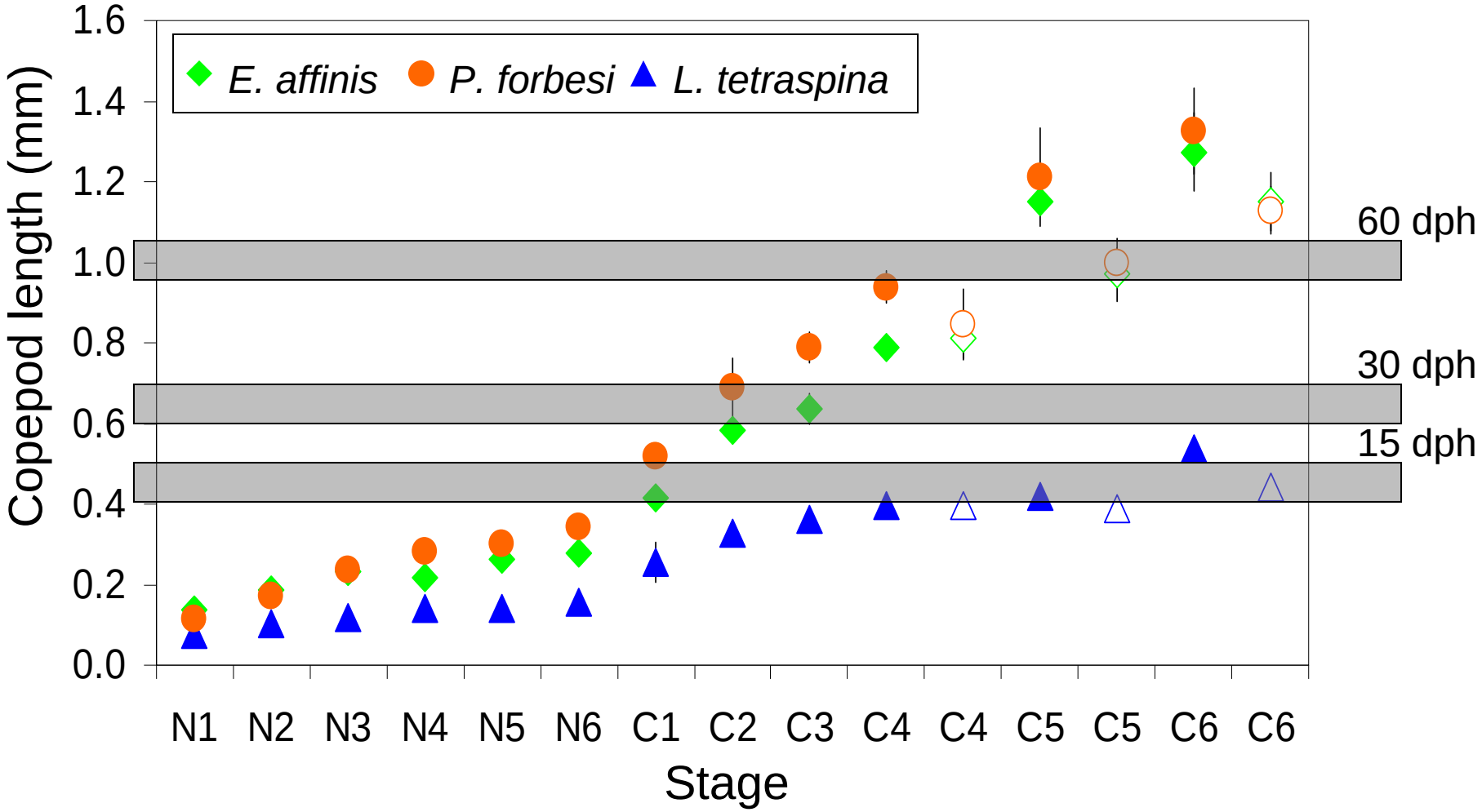


A. Mueller-Solger, unpublished

Changes: food quantity



Changes: food quality



Optimal prey size = Mouth width x 0.60 (Gill 2003)

Open symbols = male

Objectives

1. Do larval fish eat *Limnoithona tetraspina*?

   Yes!

2. Do larval fish select for or against *Limnoithona tetraspina*?

Prey selection

Prey species 1	Prey species 2	15 dph	30 dph	60 dph
E. affinis N	*E. affinis* C	EC	EC	EC
P. forbesi N	*P. forbesi* C	PC	PC	PC
L. tetraspina N	*L. tetraspina* C	LC	LC	LC
P. forbesi N	*L. tetraspina* C	LC	LC	LC
E. affinis N	*L. tetraspina* C	LC	LC	LC
P. forbesi C	*L. tetraspina* C	NS	NS	NS
E. affinis C	*L. tetraspina* C	NS	EC	EC

Abbreviation key: N = Nauplii
C = Copepodites

NS = No selection ($p > 0.05$)

Video observations

Selection = Encounter + Attack + Capture + Ingestion

Prey species	Attack rate (min^{-1})	Capture Success (%)
Eurytemora affinis	**High**	Low
Pseudodiaptomus forbesi	**High**	Low
Limnoithona tetraspina	Low	**High**

Objectives

1. Do larval fish eat *Limnoithona tetraspina*?

   Yes!

2. Do larval fish select for or against *Limnoithona tetraspina*?

   Size-specific selection.

3. Does *Limnoithona tetraspina* support growth of larval fish?

4. How does this compare with growth on calanoid copepods?

Delta smelt

- Protected
- Collected in the field
  - Oct–Nov (Adults)
- Maintained in captivity
- Strip-spawned in the laboratory
  - Feb–May
- Eggs hatched in up-well incubators
- Larvae reared on cultured prey
  - Rotifers (*Brachionus plicatilis*)
  - *Artemia* sp.

Hypomesus transpacificus

Growth experiments

- 2 age groups of larvae
  - 0 dph (days post hatch)
  - 30 dph

1 dph, 5 mm

30 dph, 12 mm

60 dph, 18 mm

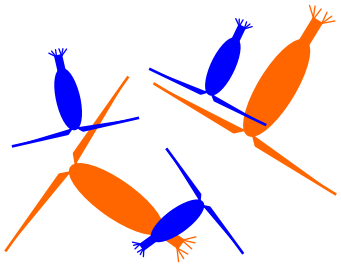
- 4–5 fish L^{-1} (275–350 fish in 70 L tanks)

- Larvae were fed 3 treatments
  1. Rotifers & *Artemia* sp. (= Control)
  2. *Pseudodiaptomus forbesi*
  3. *Limnoithona tetraspina*

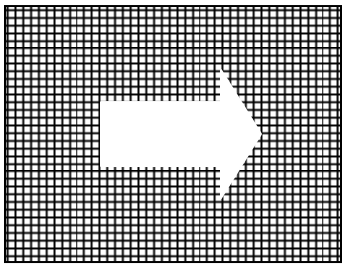
- Survival @ ~30 days
- Growth @ ~30 days

Prey standing stock

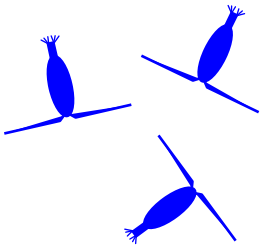
- Separated copepods with size fractionation



P. forbesi



150 µm

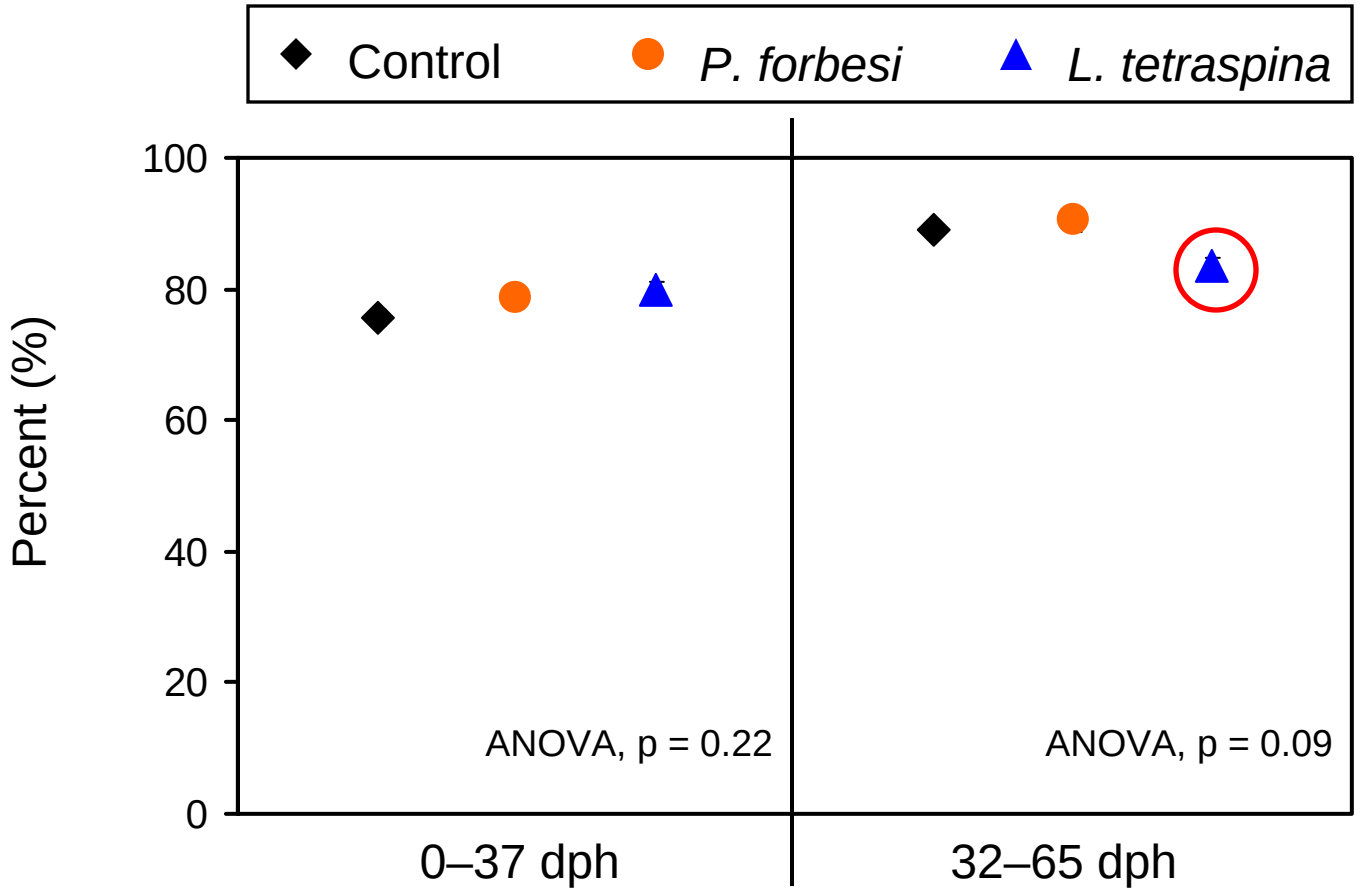


L. tetraspina

- Prey standing stock based on carbon biomass

Prey	Carbon (µg ind.$^{-1}$)	Abundance (No. L^{-1})	Standing stock (µg C L^{-1})
Rotifers	0.15	10,000	1500
Artemia sp.	0.75	100	75
P. forbesi	2.00	10	20
L. tetraspina	0.20	100	20

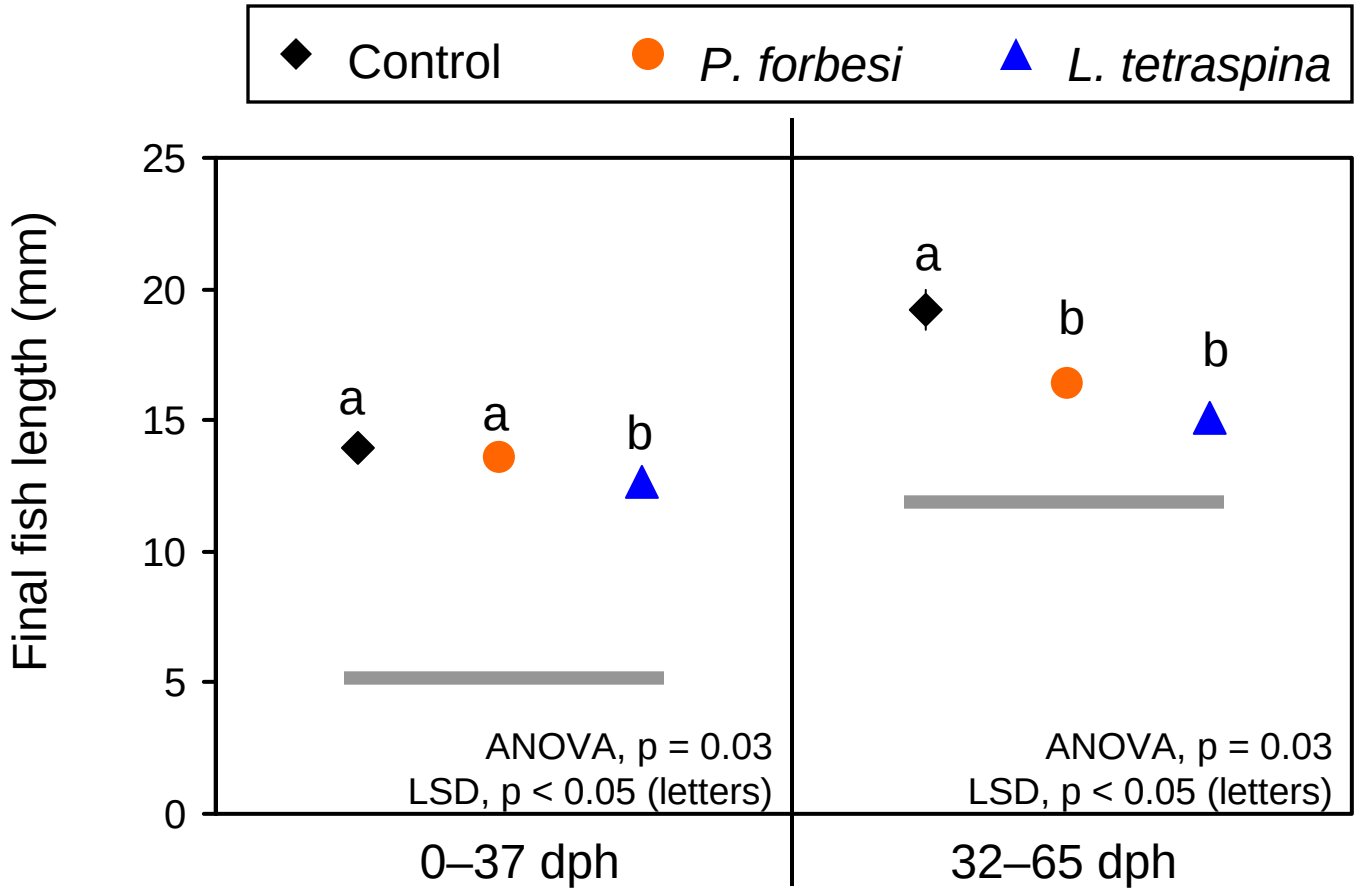
Larval survival



- No differences in survival

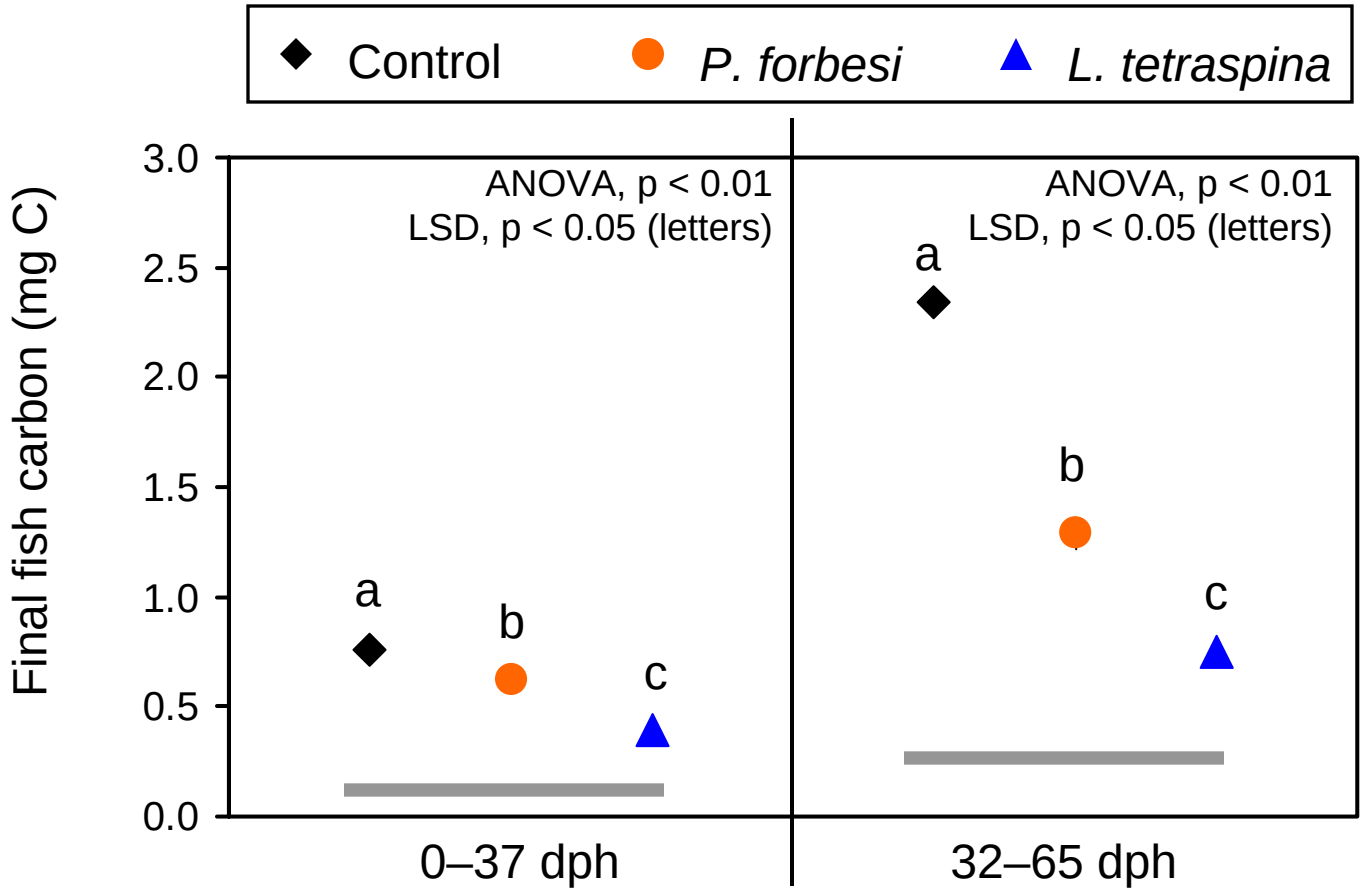
Mean (3 replicates) ± 95% CI

Larval growth (length)



- Age-specific differences in growth

Larval growth (carbon)



- Significant differences between diets

Summary

1. Do larval fish eat *Limnoithona tetraspina*?

   Yes!

2. Do larval fish select for or against *Limnoithona tetraspina*?

   Size-specific selection.

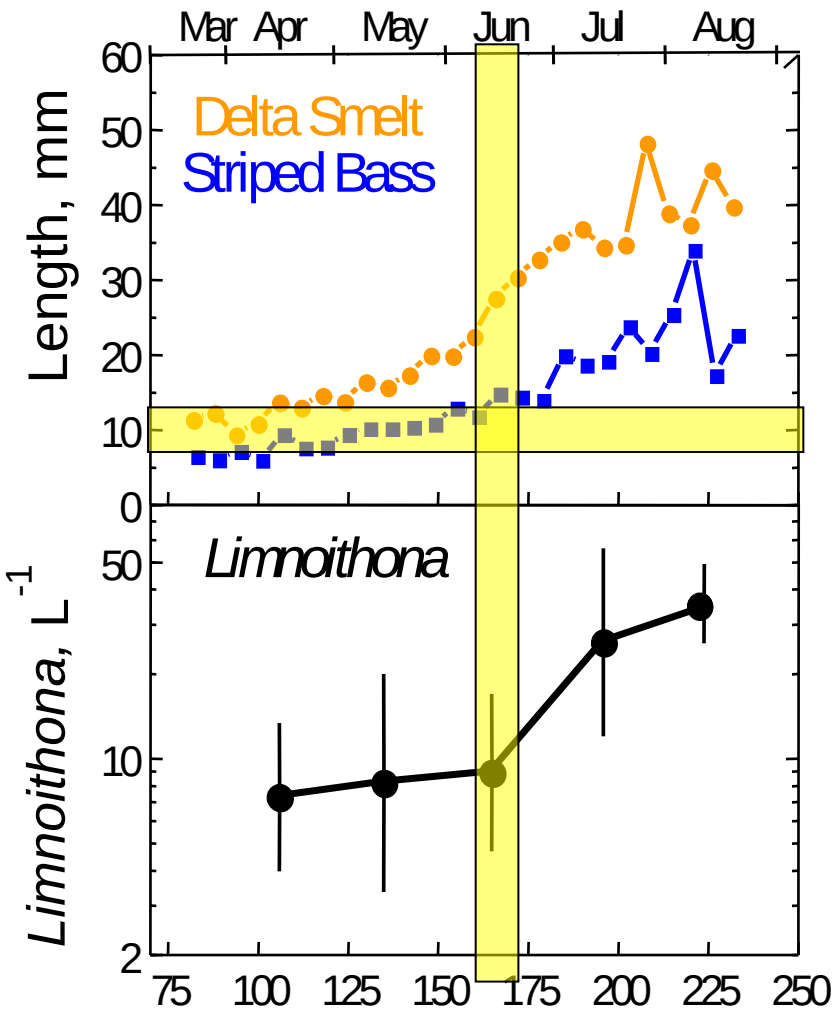
3. Does *Limnoithona tetraspina* support growth of larval fish?

   Yes!

4. How does this compare with growth on calanoid copepods?

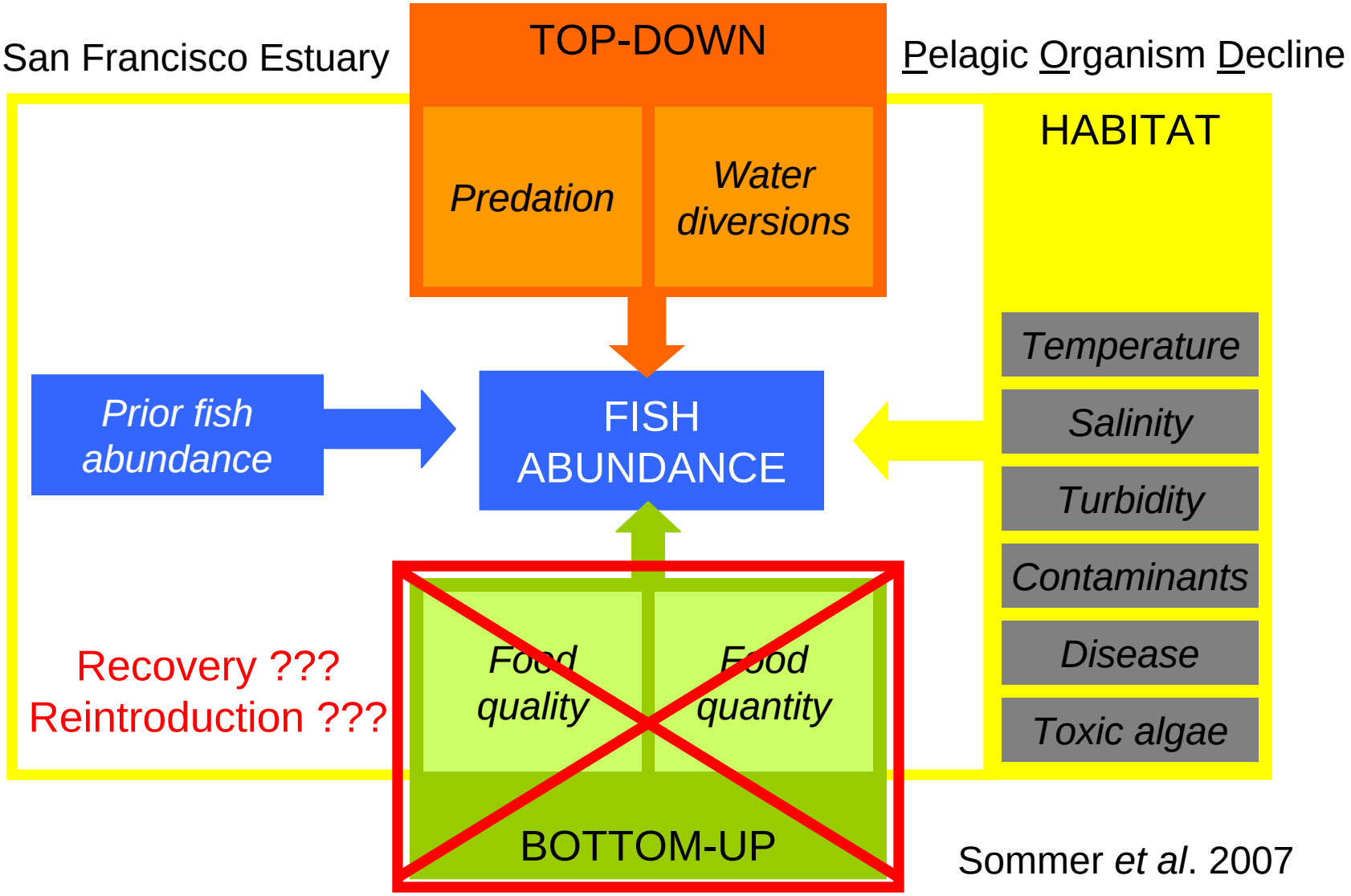
   Less!!!

Match-Mismatch



Kimmerer, unpublished

Conclusions



Future directions

- Bioenergetics model
  - Feeding
  - Growth
  - Metabolism
  - Excretion

- Model smelt populations
  - Wim Kimmerer, SFSU
  - Kenny Rose, LSU

- Food quality (fatty acids)
  - Susan Lang, UCSD

- Stress (genetic markers)
  - Richard Connon, UCD