Where does pelagic fish food come from?

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Premise

- Marsh provides physical habitat
- Marsh is a source of food

Fish are food limited

"If fish are the excuse, they should benefit*"

* D. Baltz, LSU, June 2013

Are Smelt Food Limited?

Probably, especially since *Potamocorbula:*

Decline in phytoplankton, zooplankton, mysids

Both smelt species:

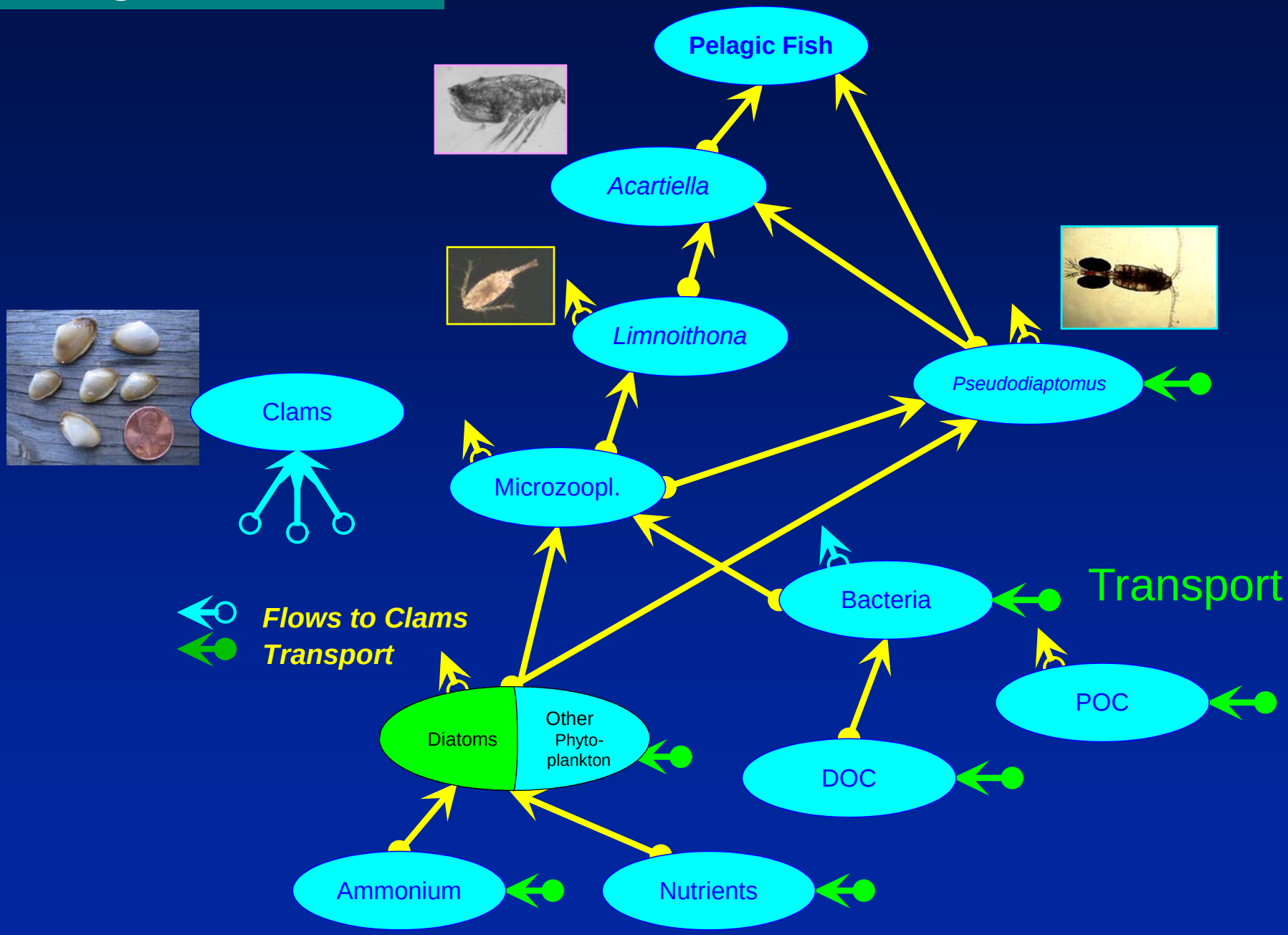
- Smaller and less abundant than 25 years ago
- Other fish species declined

Delta smelt:

- Statistical evidence
- Model studies
- Glycogen depletion
- Gut fullness
- Laboratory feeding studies

Fish Food?

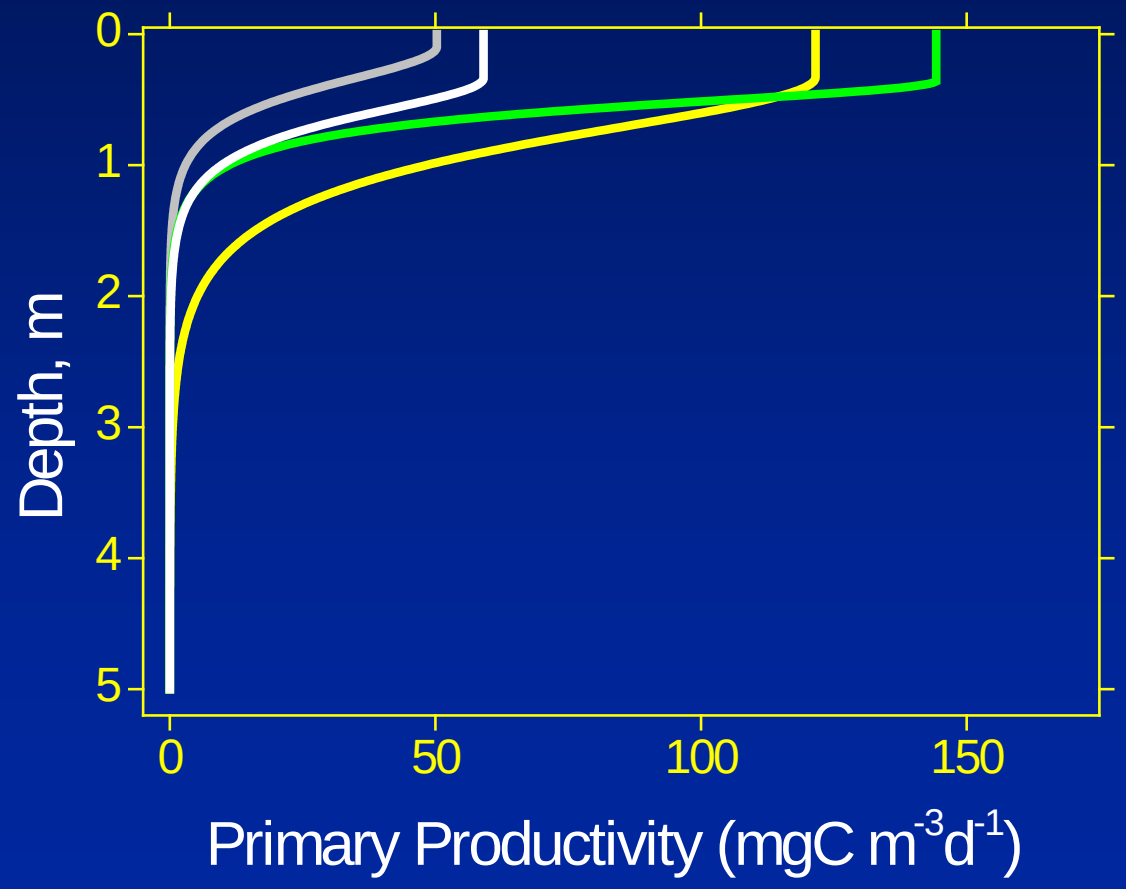
Pelagic foodweb



Topics

- Limits on plankton production
- Productivity in marshes vs. open waters
- Subsidies from marshes

Limits on phytoplankton production: turbidity

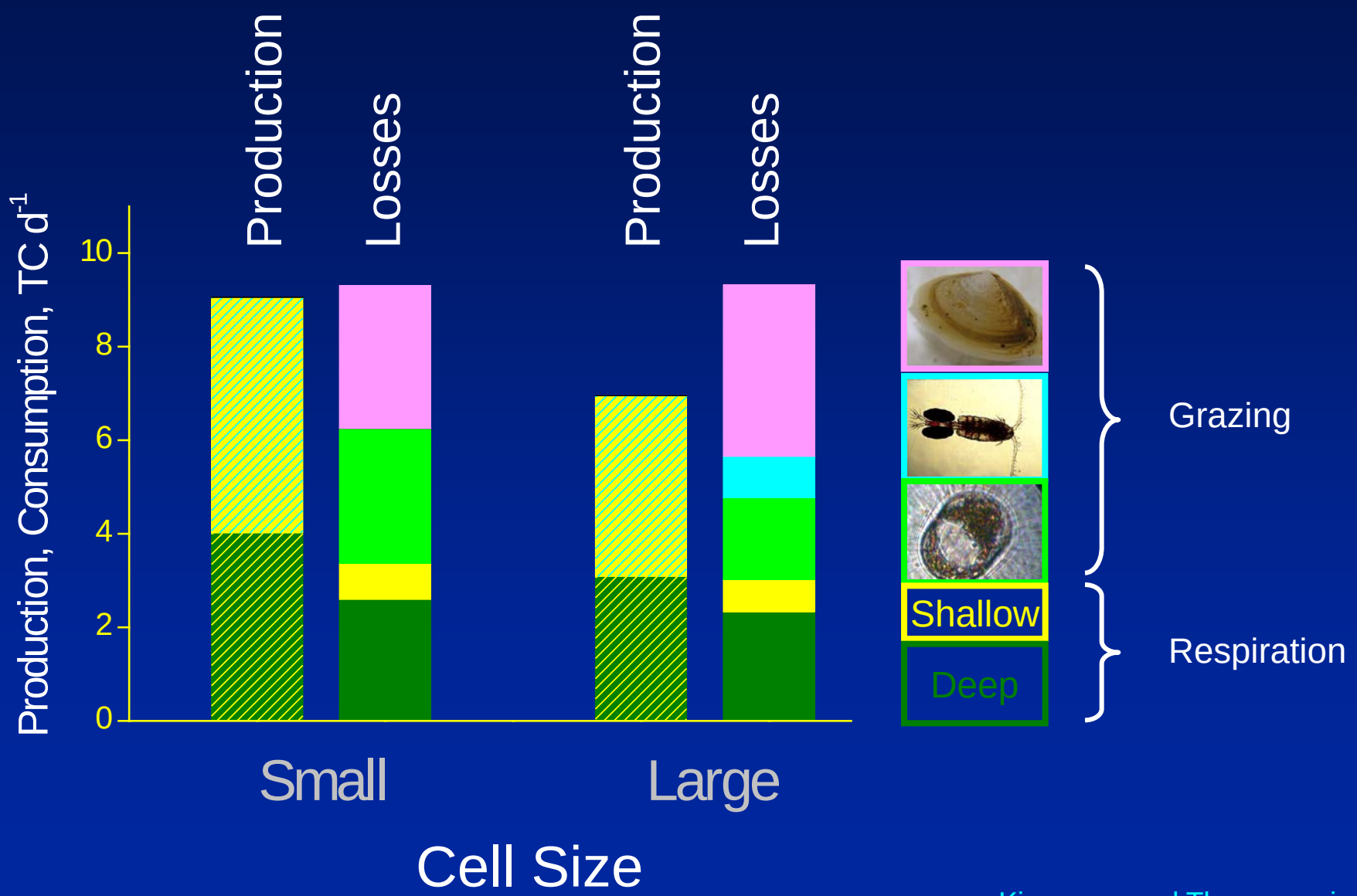


Primary production
Examples
LSZ 2006 - 2007

Limits on phytoplankton production: grazing

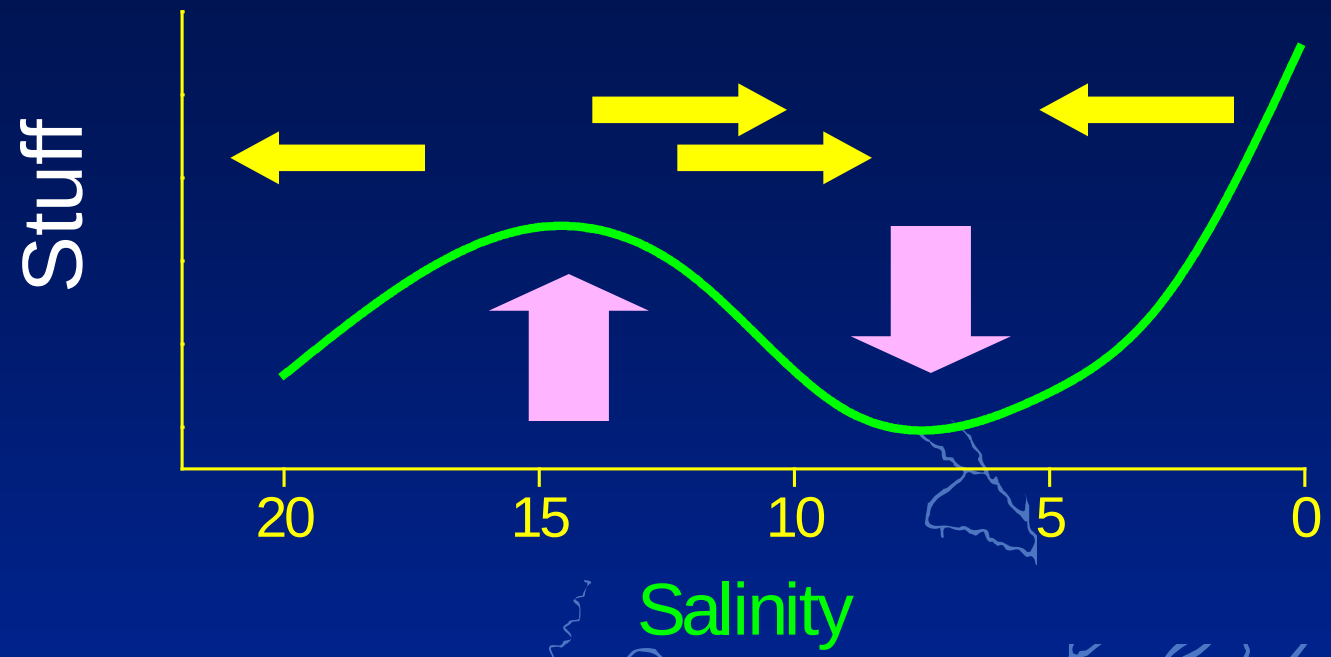
LSZ, Summer 2006

Grazers Rule!

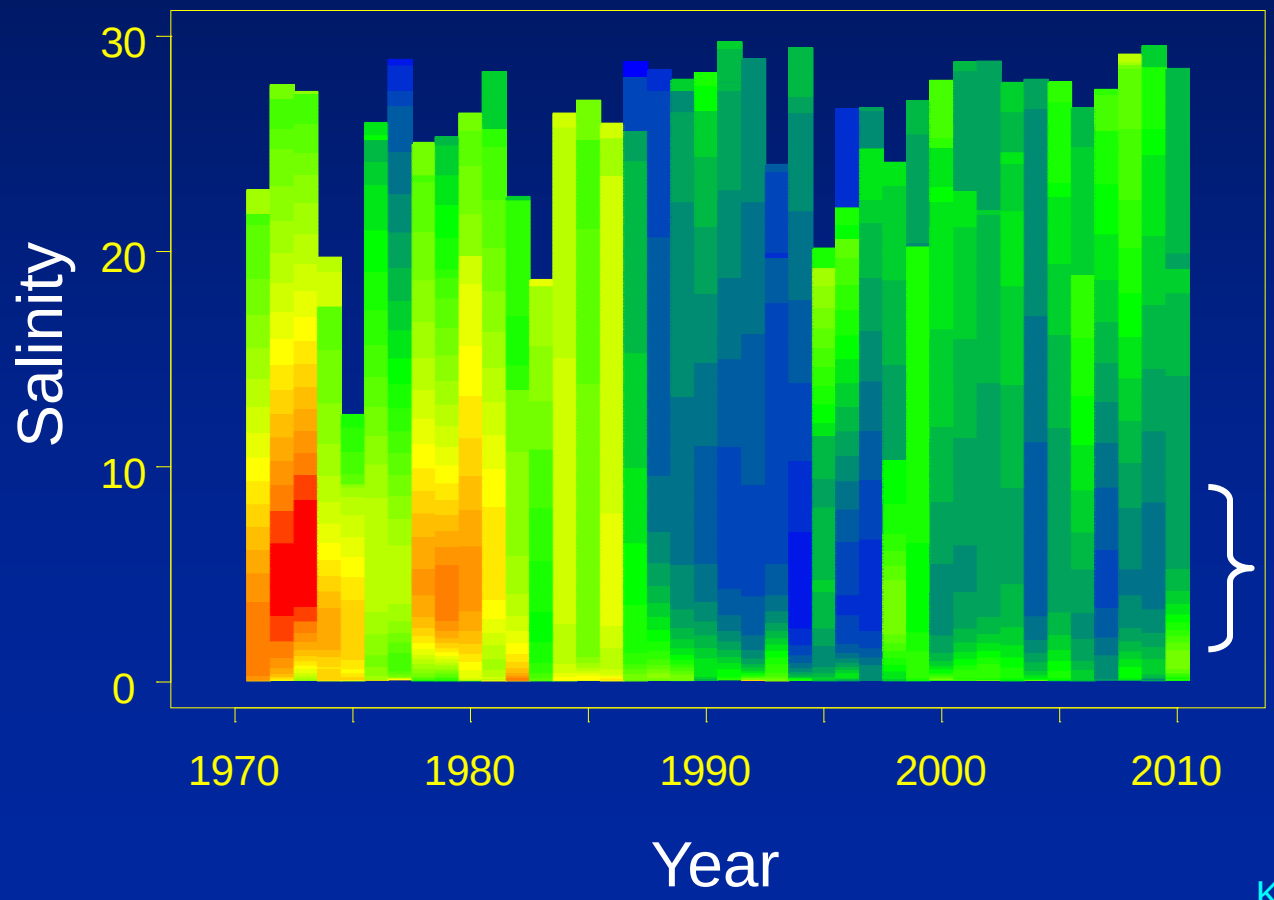


Kimmerer and Thompson in prep.

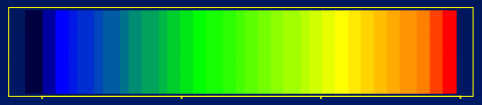
Subsidies between estuarine regions



Limits on phytoplankton biomass



May – October
Chlorophyll, mg m^{-3}

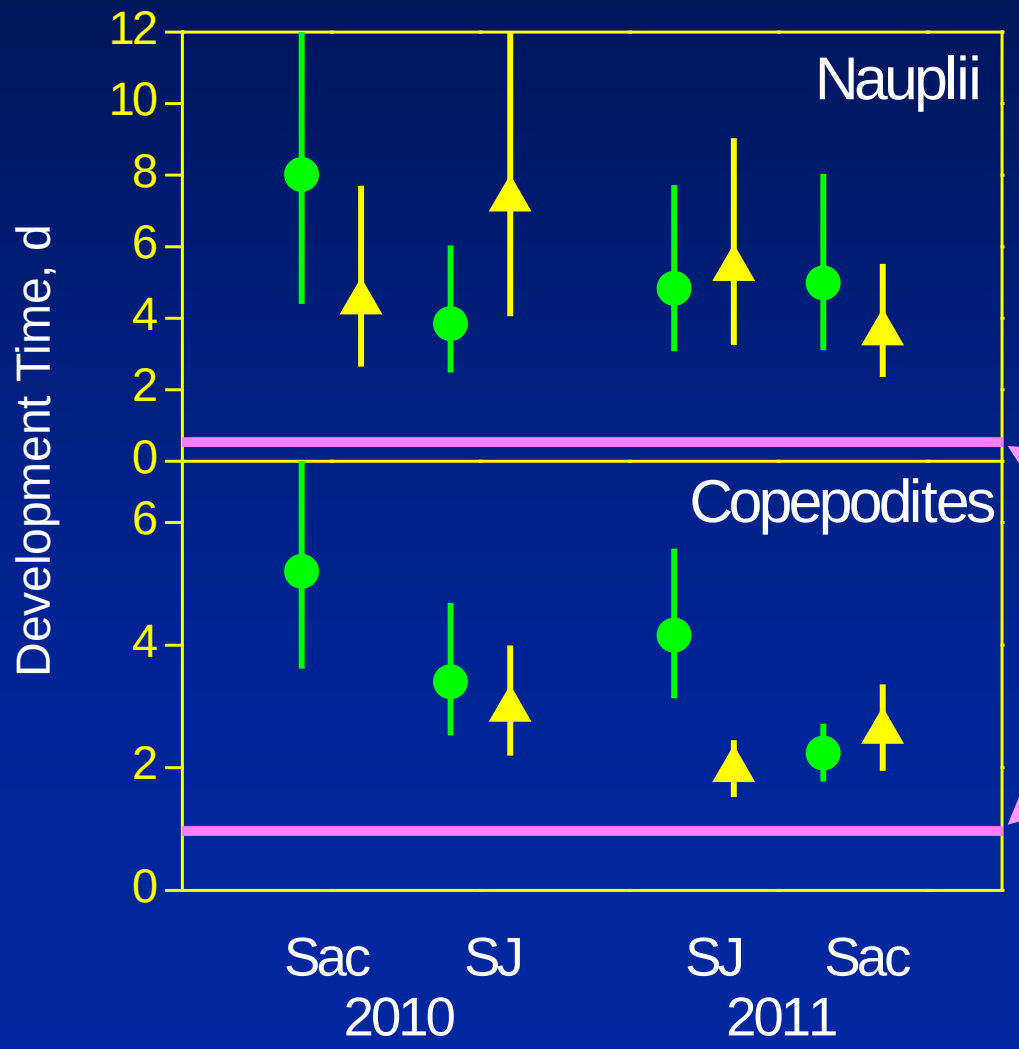


Subsidy

IEP monitoring data
Kimmerer and Thompson in prep.

Limits on zooplankton production: slow growth

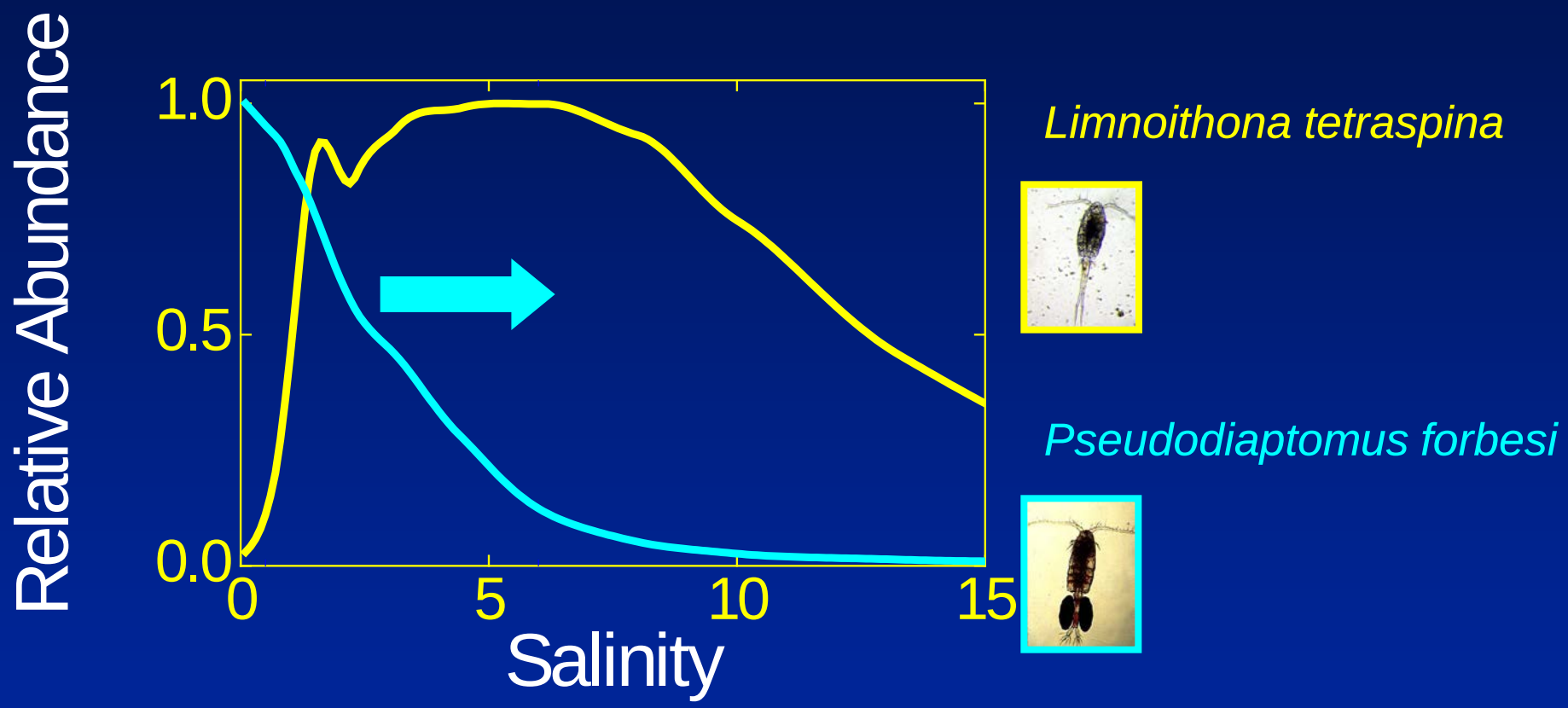
Pseudodiaptomus forbesi



Laboratory development times

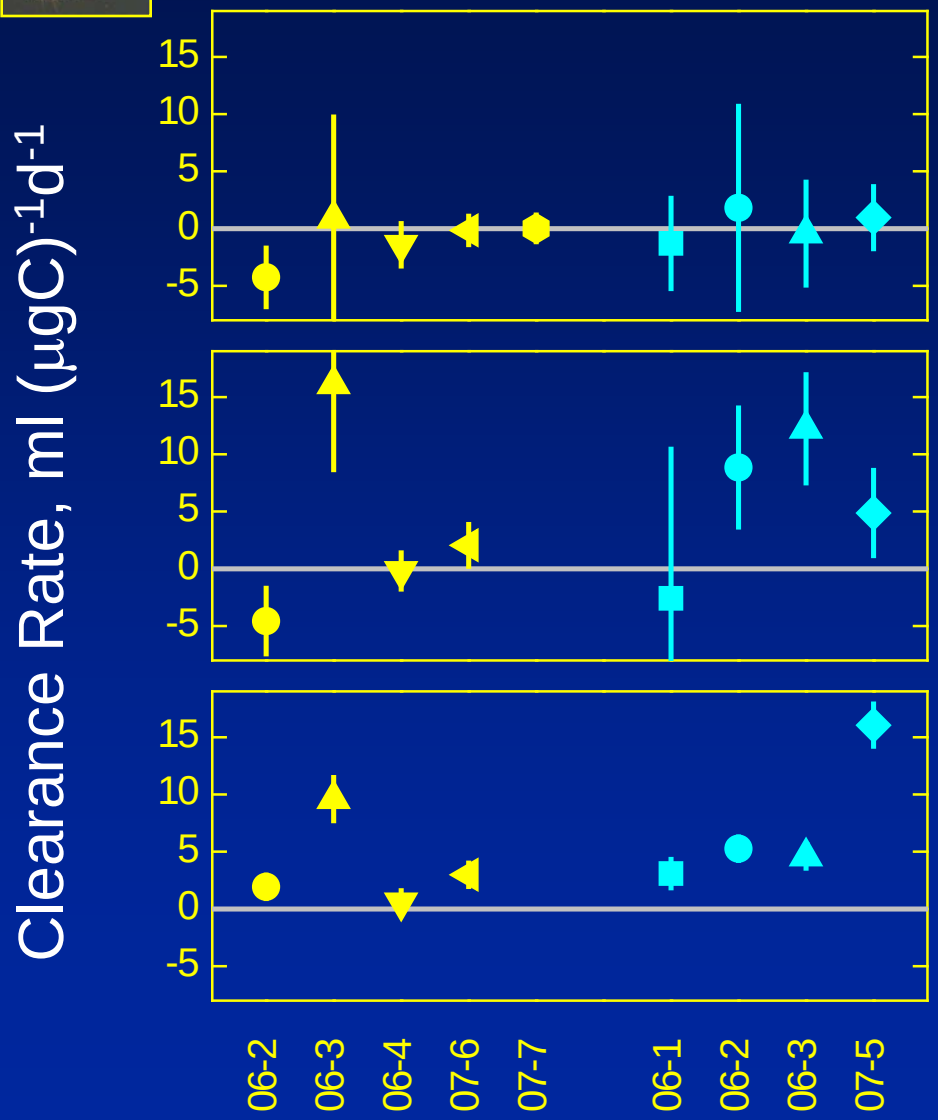
Growth Rate ∝ 1 / Development Time

Limits on zooplankton production: subsidies



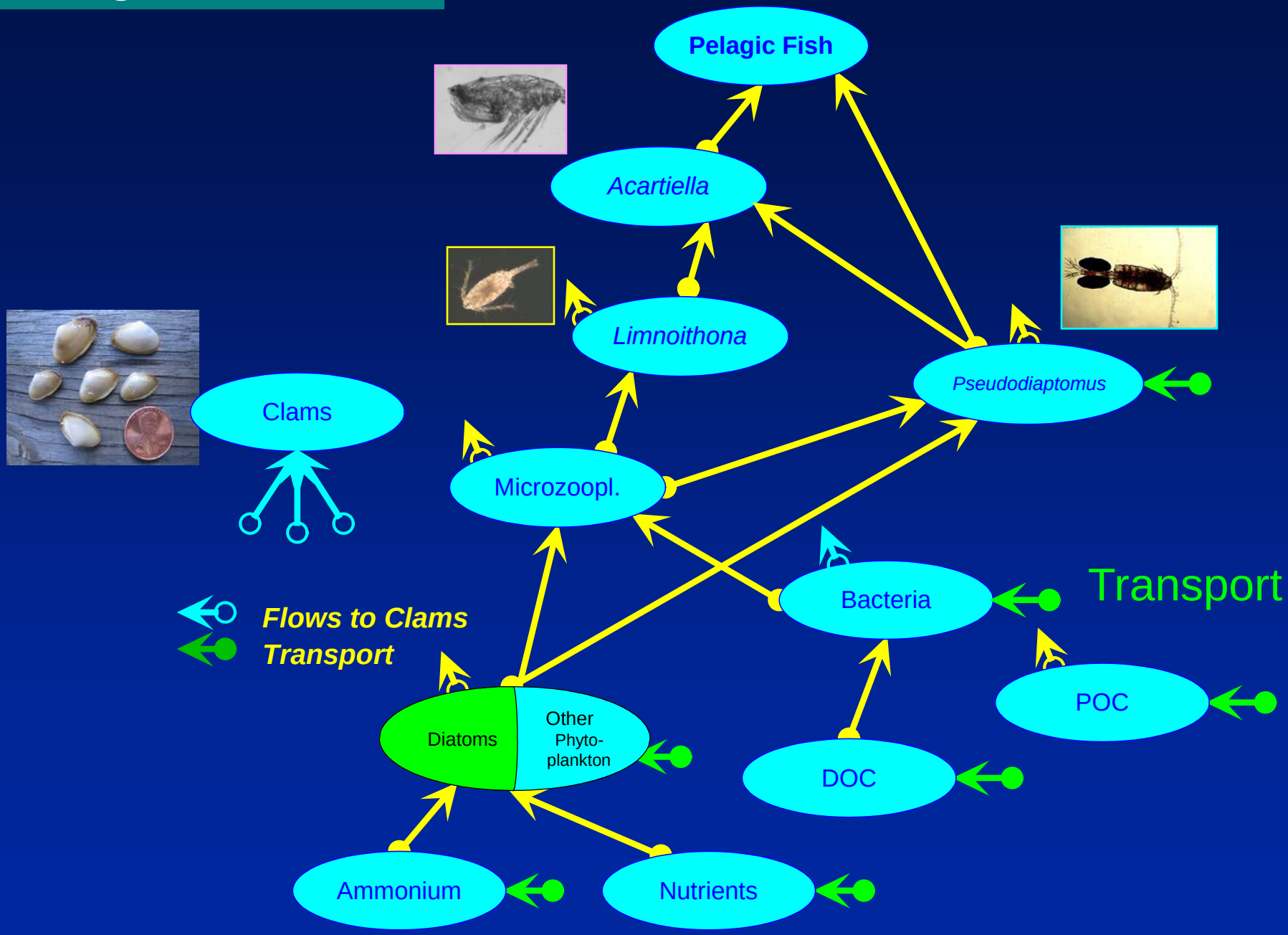
Limits on zooplankton production: food sources

Limnoithona *Pseudodiaptomus*



LSZ
2006-2007

Pelagic foodweb



Topics

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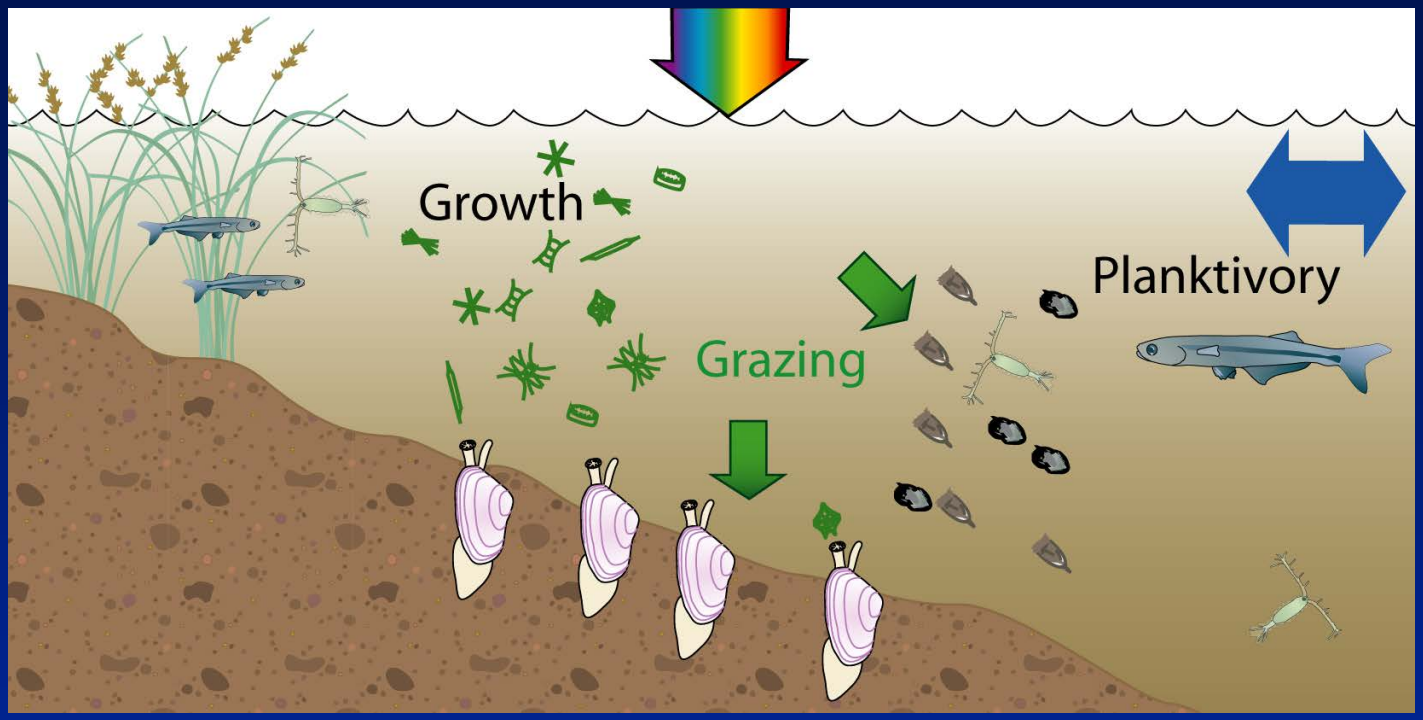
- Productivity in marshes vs. open waters
- Subsidies from marshes

Productivity in marshes: conceptual model



Shallow water:
High growth
Benthic grazing
Habitat for planktivores

Production:

Dissolved & particular OM	++
Phytoplankton	+?
Zooplankton	-?

Productivity in marshes: literature

- Lake zooplankton abundance low in shoals
- Marsh in NY a sink for zooplankton
- Australian tidal creek a sink for copepods
- Saltmarsh a sink for copepods, source for larvae
- China Camp: marsh a sink for mysids
- Liberty Island: source or sink
- Depends on grazing

Topics

- Limits on plankton production
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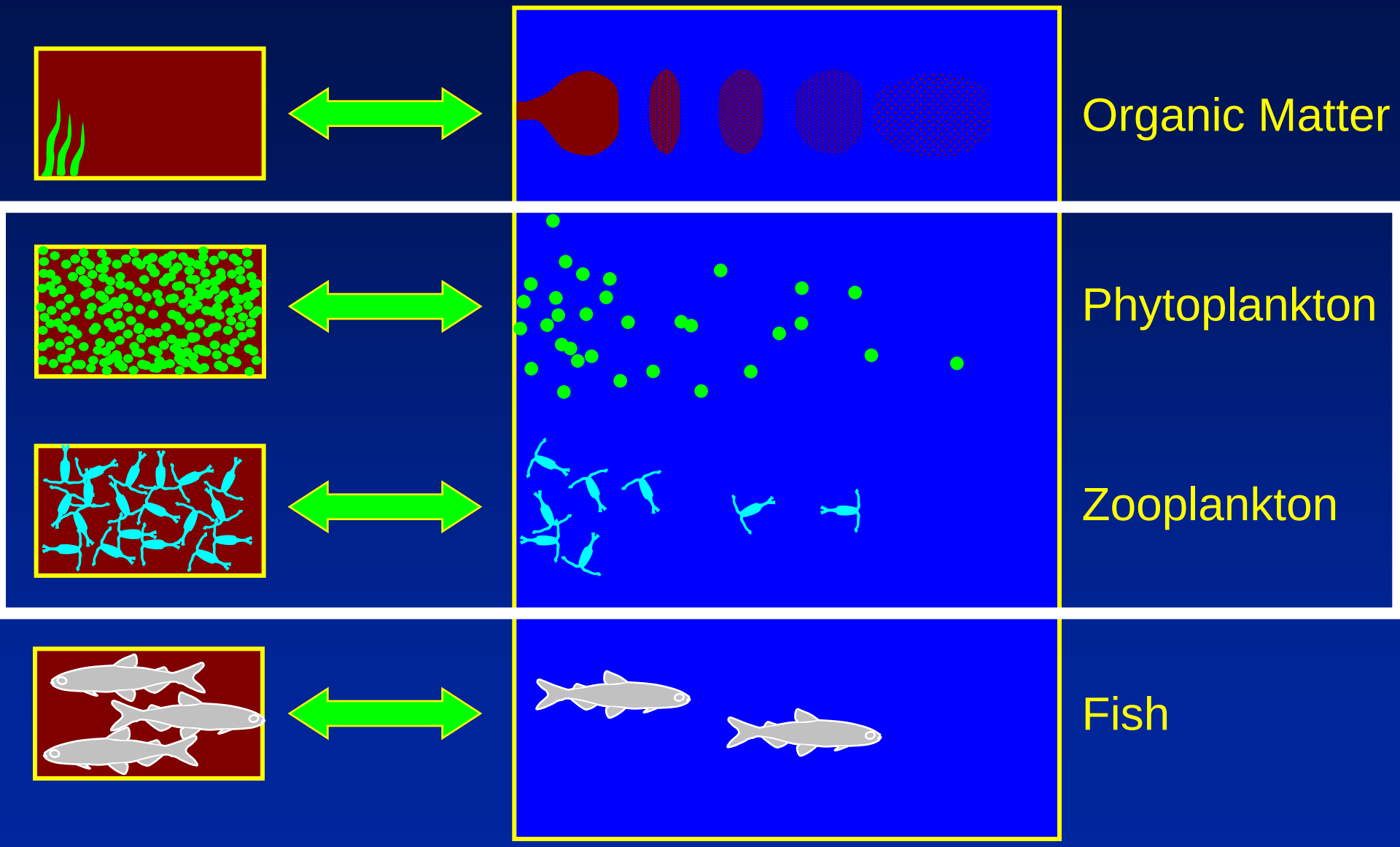
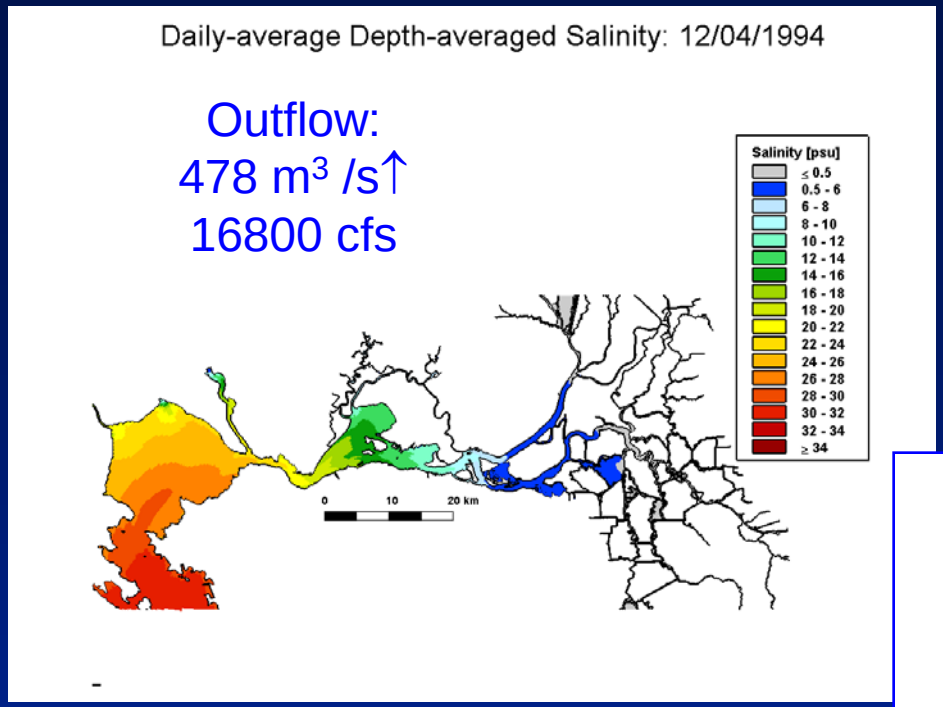
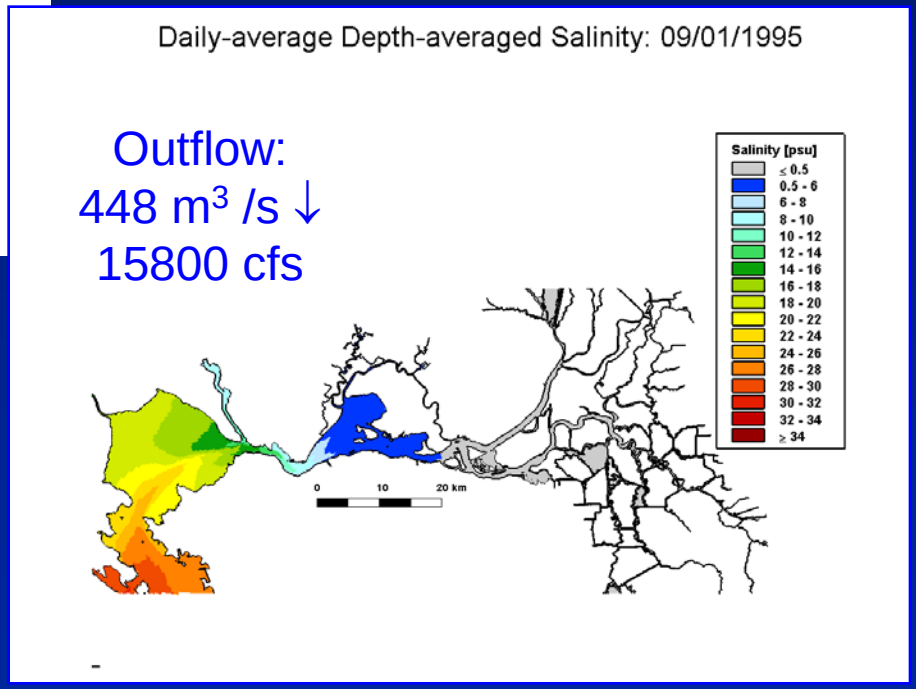
Subsidies from marsh



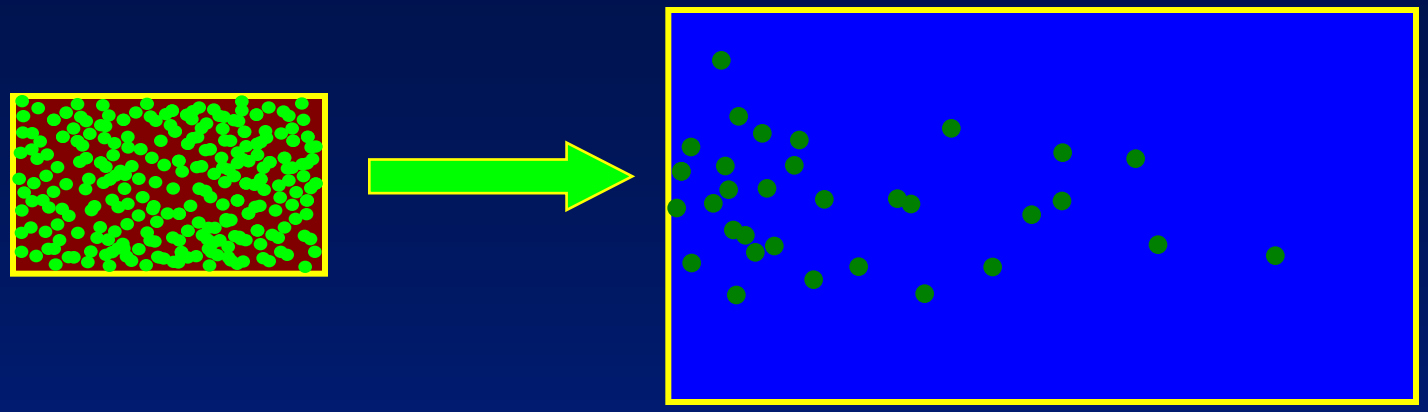
Subsidies from marsh: where is the LSZ?

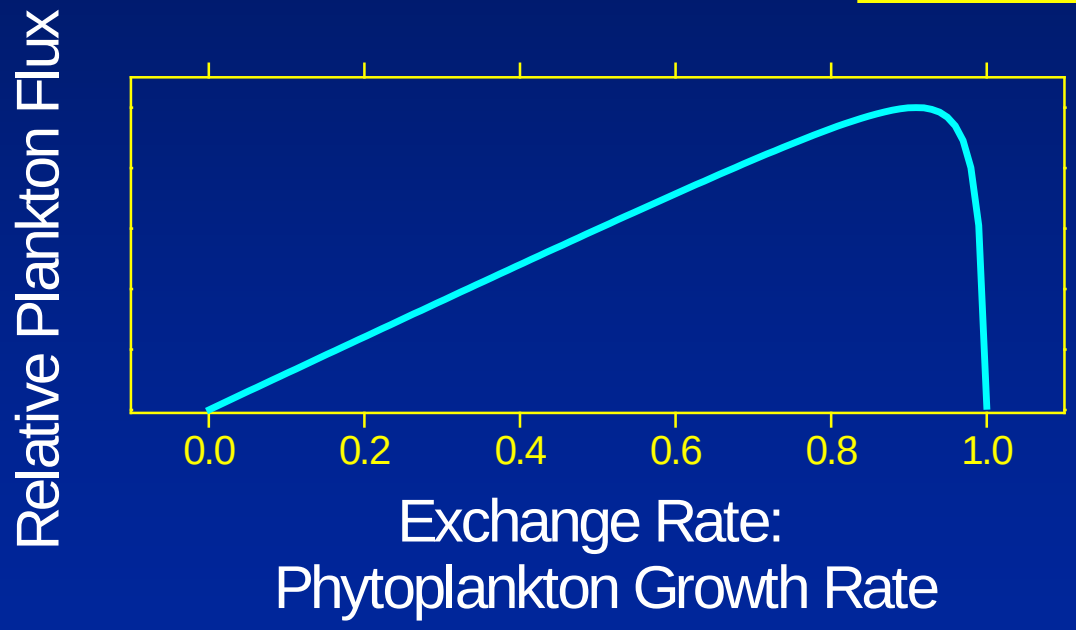




Maps: UnTRIM Model
Michael MacWilliams

Subsidies from marsh vary with exchange



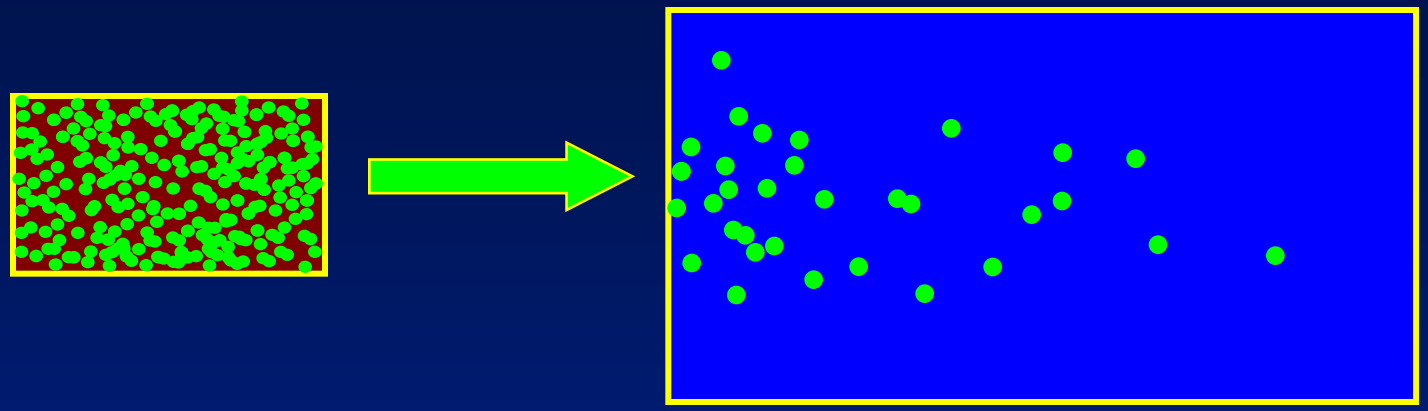


Model

Steady state
Single limiting nutrient
Saturating uptake
No grazing
Negligible phytoplankton conc. in estuary

Exchange rate = Daily exchange volume / marsh volume
= 1 / Residence time of marsh

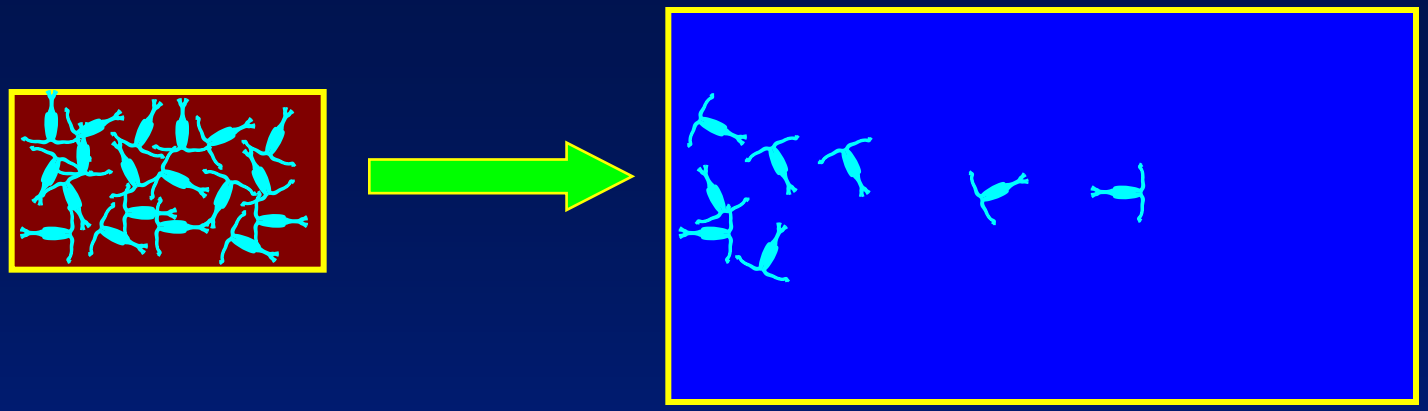
Subsidies from marsh: phyto model



Area	1000 ha	Volume	0.5 km^3
Depth	2m	Phytoplankton	73 mgC m^{-3}
Phytoplankton	900 mgC m^{-3}		
Growth rate μ	0.86 d^{-1}		
Microzoo grazing	60% μ		
Residence time	10d		

Resulting subsidy:
5% of existing phytoplankton biomass d^{-1}

Subsidies from marsh: copepod model

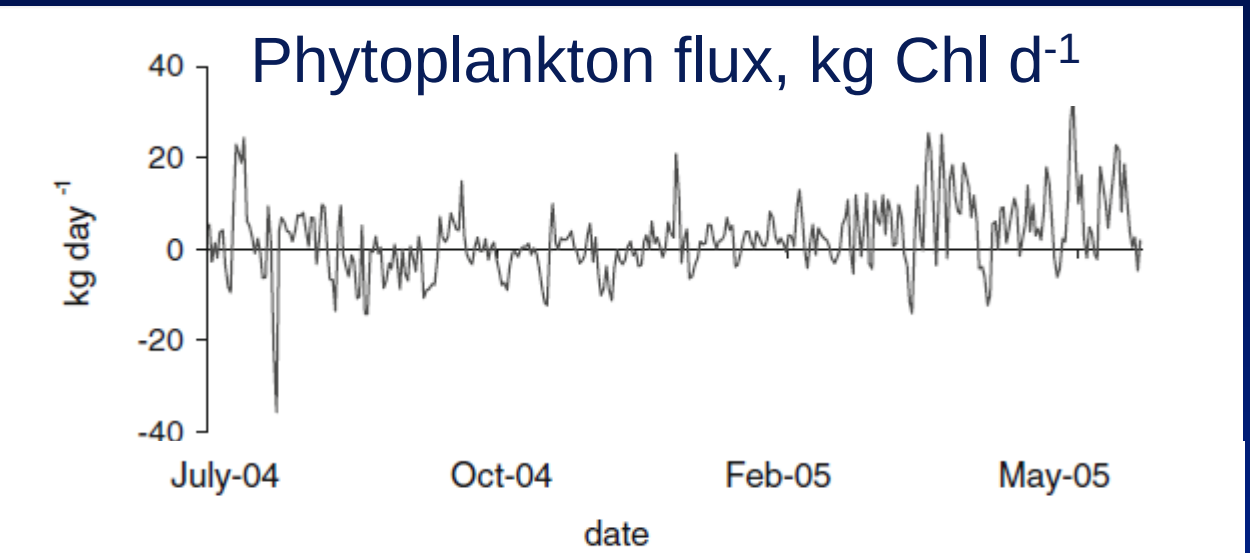


Area	1000 ha	Volume	0.5 km^3
Depth	2m	Copepods	3 mgC m^{-3}
Copepods	23 mgC m^{-3}		
Growth rate μ	0.1 d^{-1}		
Residence time	10d		

Resulting subsidy:
3% of existing copepod biomass d^{-1}

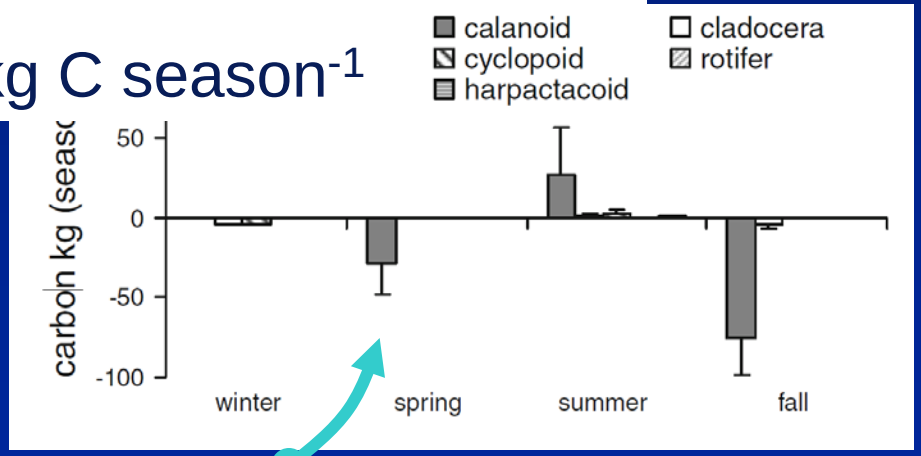
Subsidies from marsh: Liberty Island

From Lehman et al. 2010 Aquat. Ecol.



Import

Export



Import

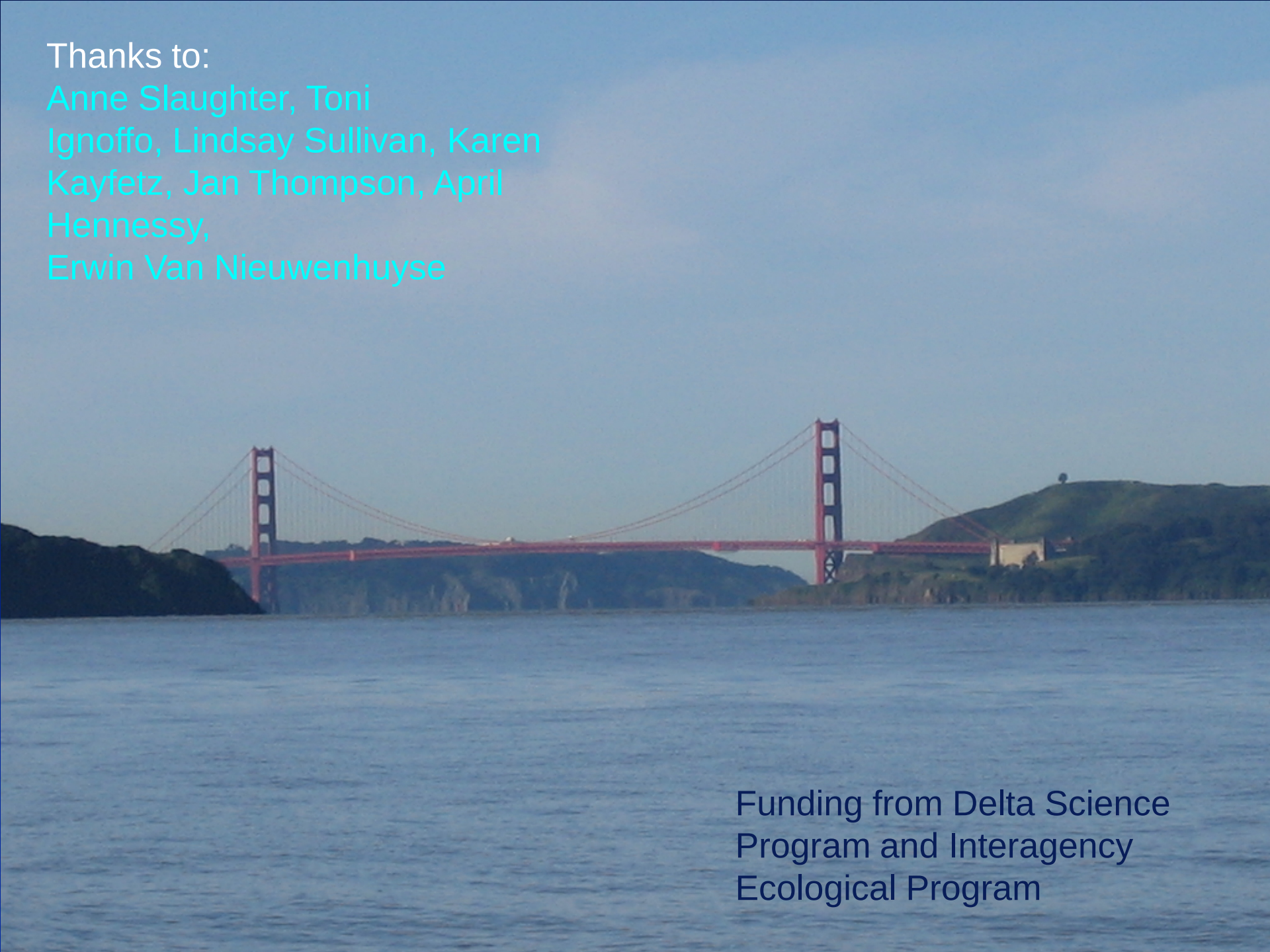
Export

Not much

~0.1% / d of biomass in LSZ

Conclusions

- Estuarine production
  - Light limited and controlled by grazing
  - Severe food limitation
- Marsh production
  - High light, long residence time
  - Clams? SAV?
  - Zooplankton production usually low
- Subsidies of plankton from marsh
  - Phytoplankton subsidies possible
  - Zooplankton subsidies negligible
- What do we do?
  - Modeling and analysis
  - Experimental restoration & management



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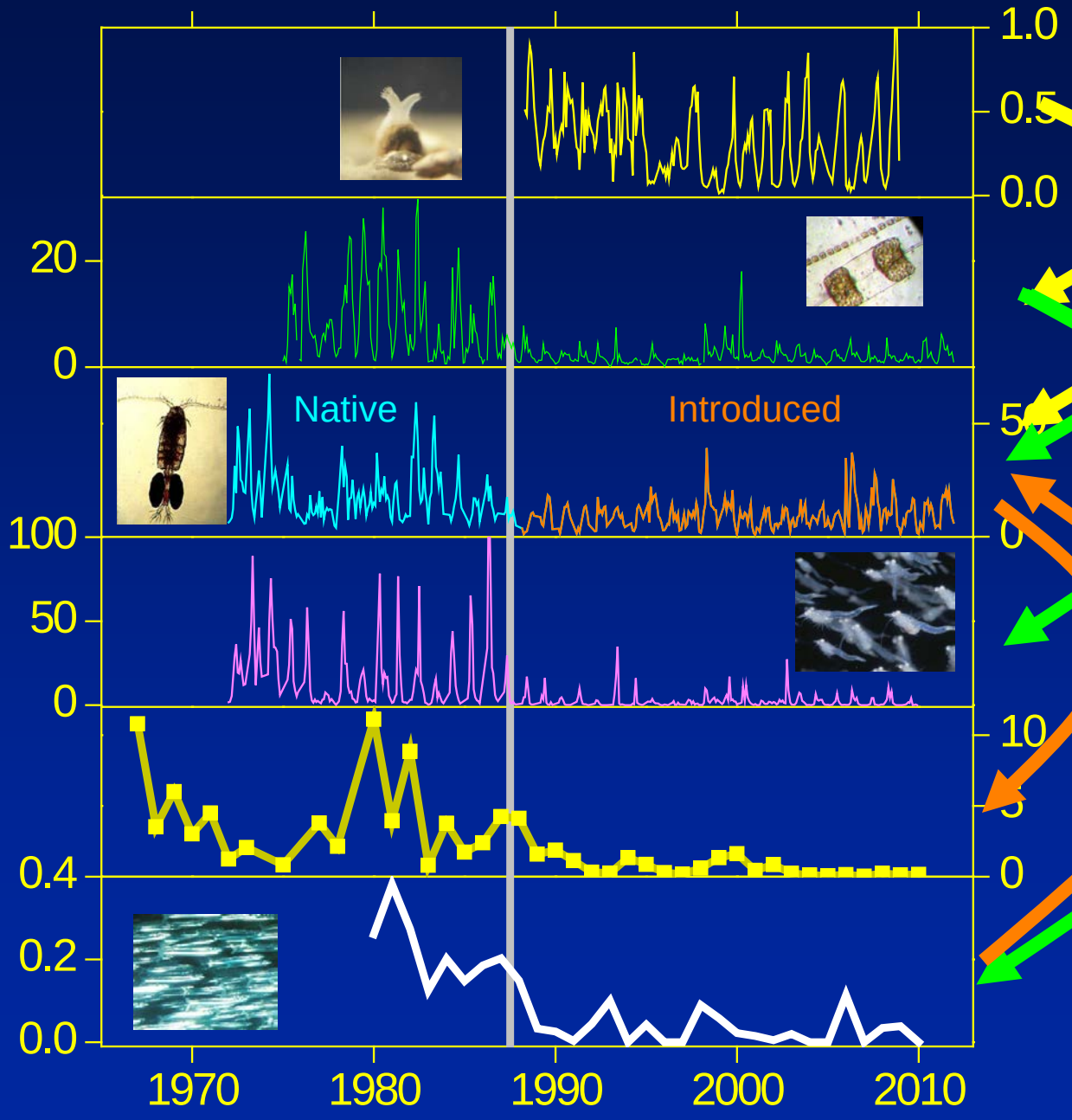
Long-term Trends



Grazing by *Potamocorbula* in LSZ: Fraction / d

Phytoplankton Biomass in LSZ: mg Chlorophyll / m^3

Copepod Biomass In LSZ: mgC / m^3

Mysid Biomass In LSZ: mgC / m^3

Longfin Smelt Abundance Index Residual from X2

Anchovy in summer Ratio LSZ:HSZ

IEP Monitoring Data
Kimmerer and Thompson in prep.