Potential changes in iron availability through long-term changes in zooplankton

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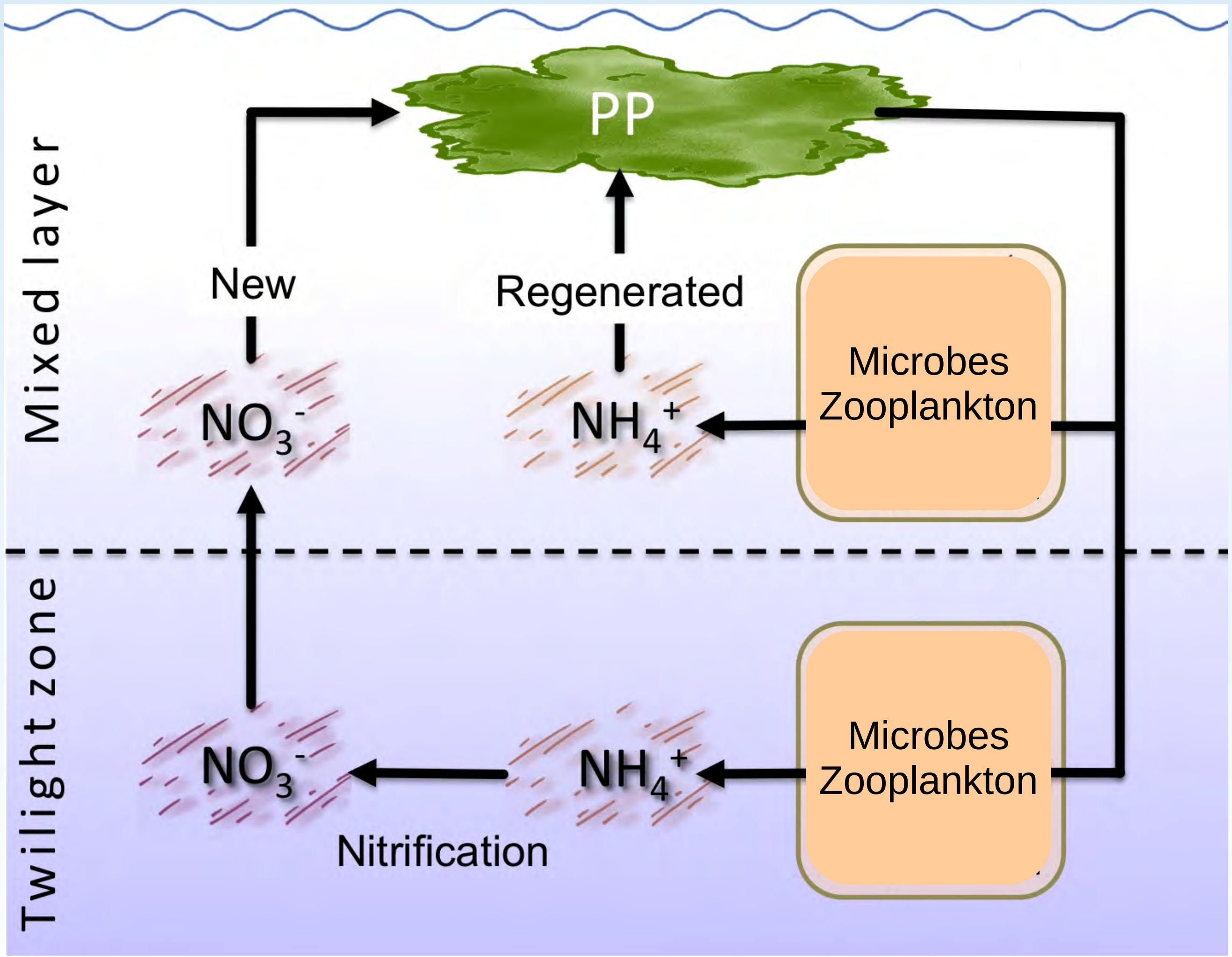
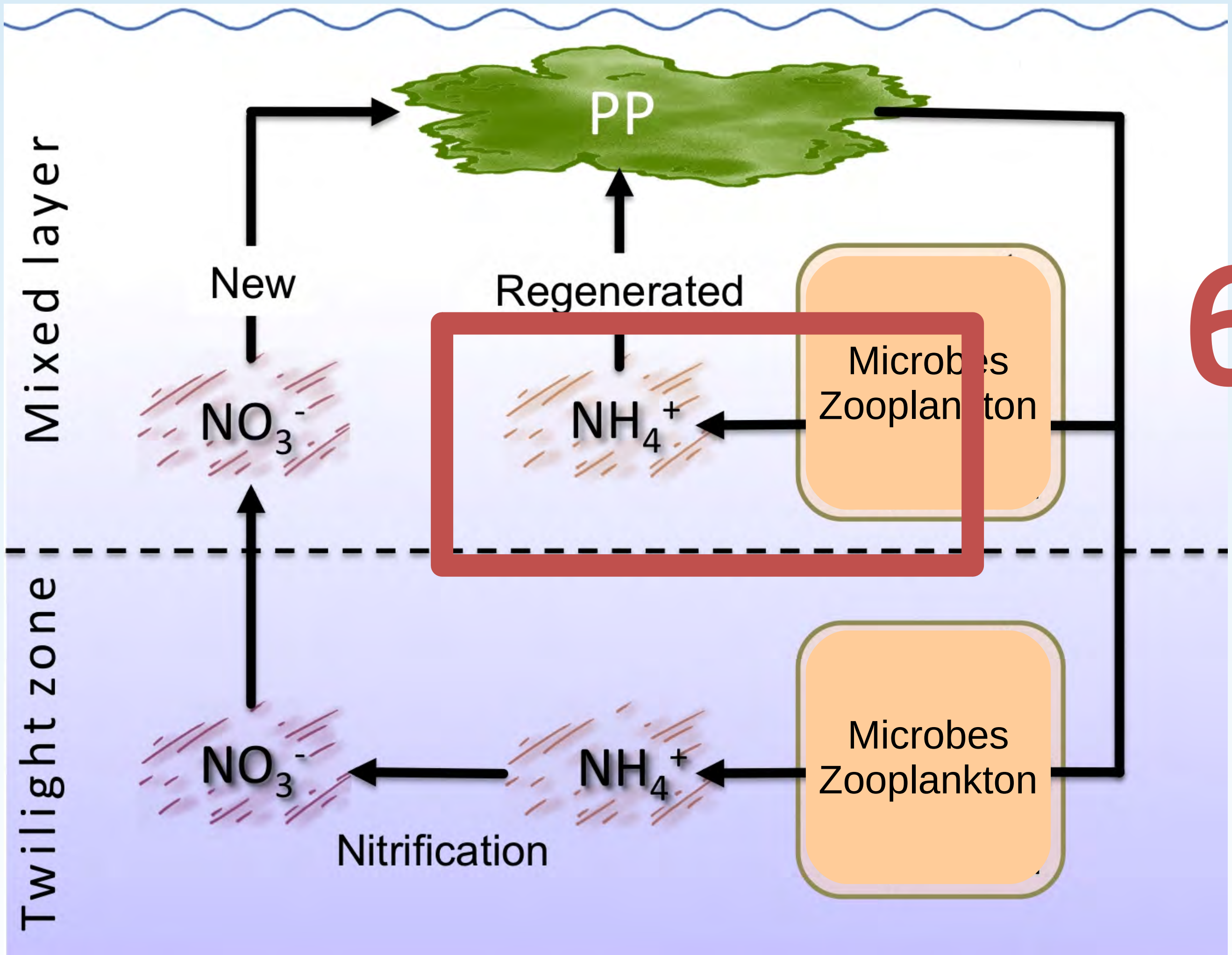
Recycling



PP
New
Regenerated
Mixed layer
NO_3^-
NH_4^+
Microbes
Zooplankton
Twilight zone
NO_3^-
NH_4^+
Microbes
Zooplankton
Nitrification

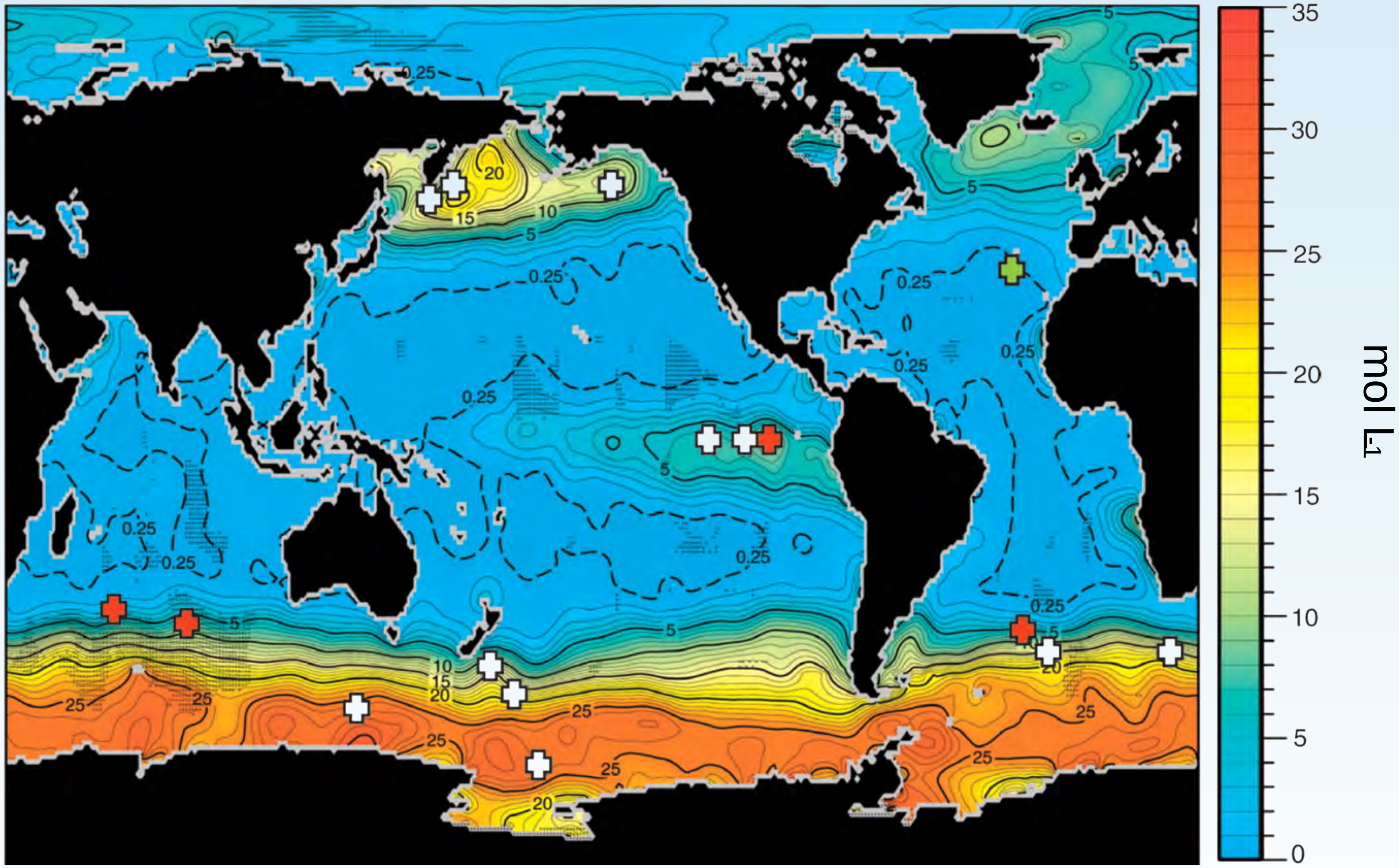
Recycling



6x!

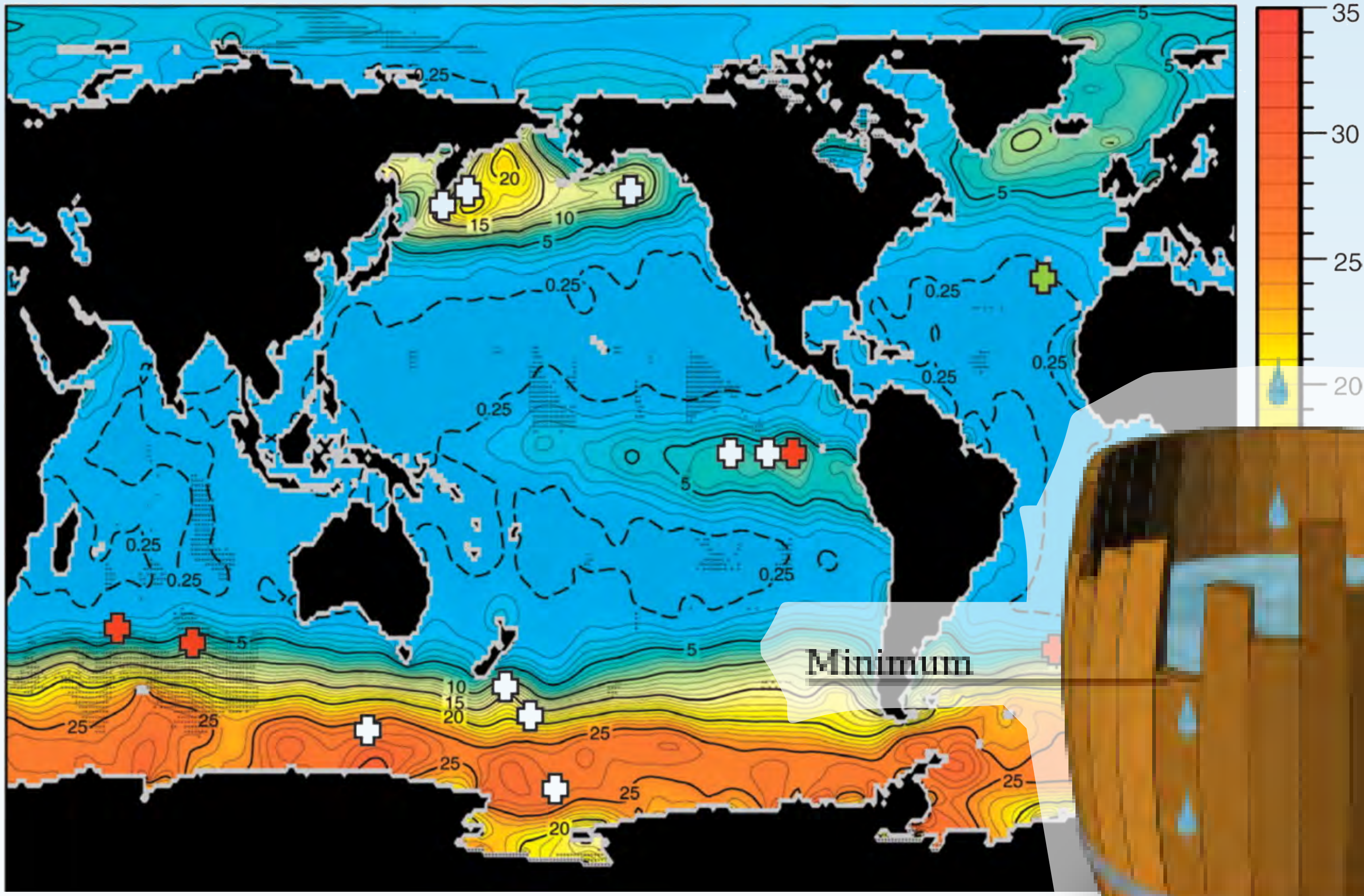
Banse 1995, Honjo et al. 2008

Annual nitrate concentrations



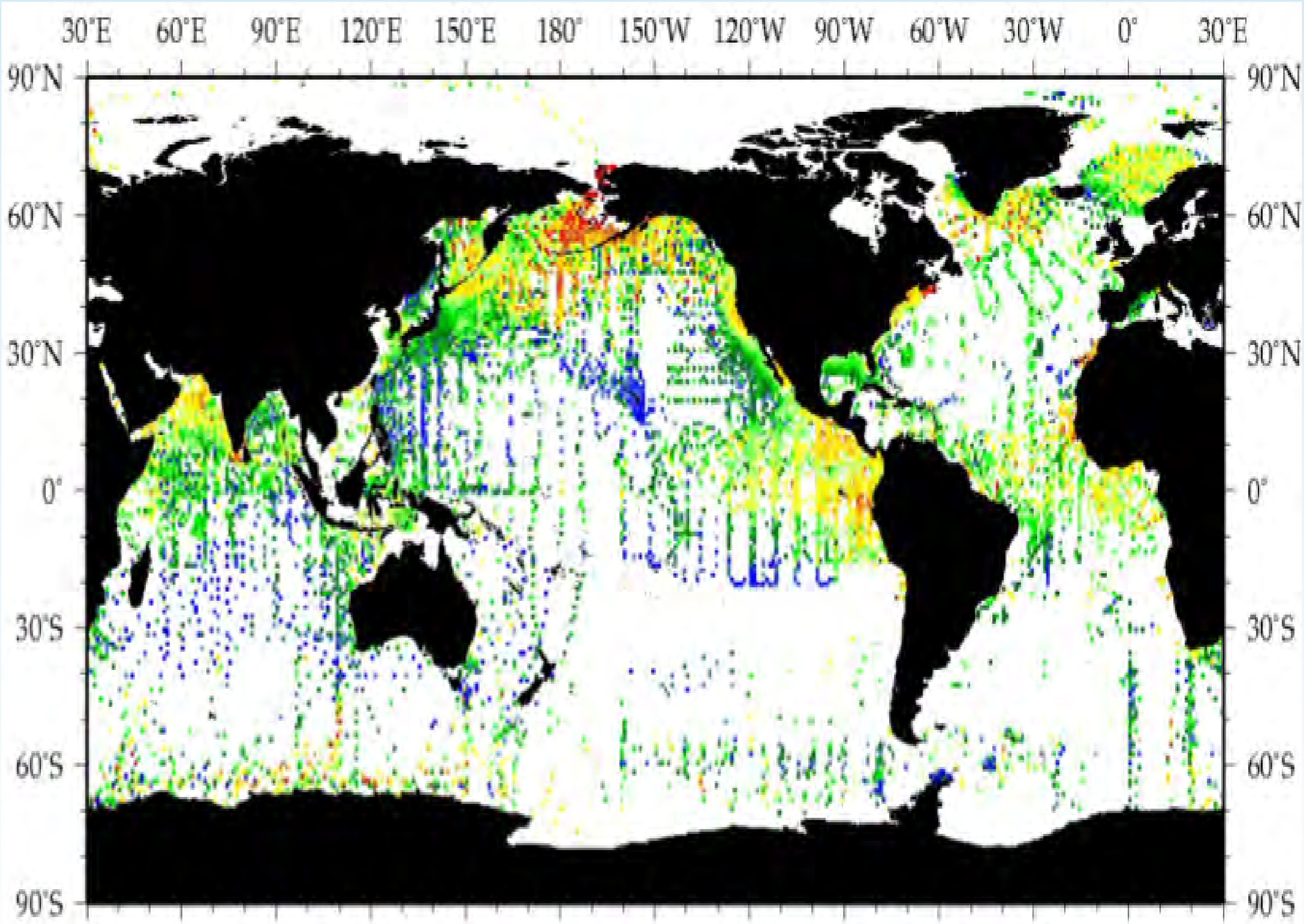
Boyd et al. 2007

Iron limitation?

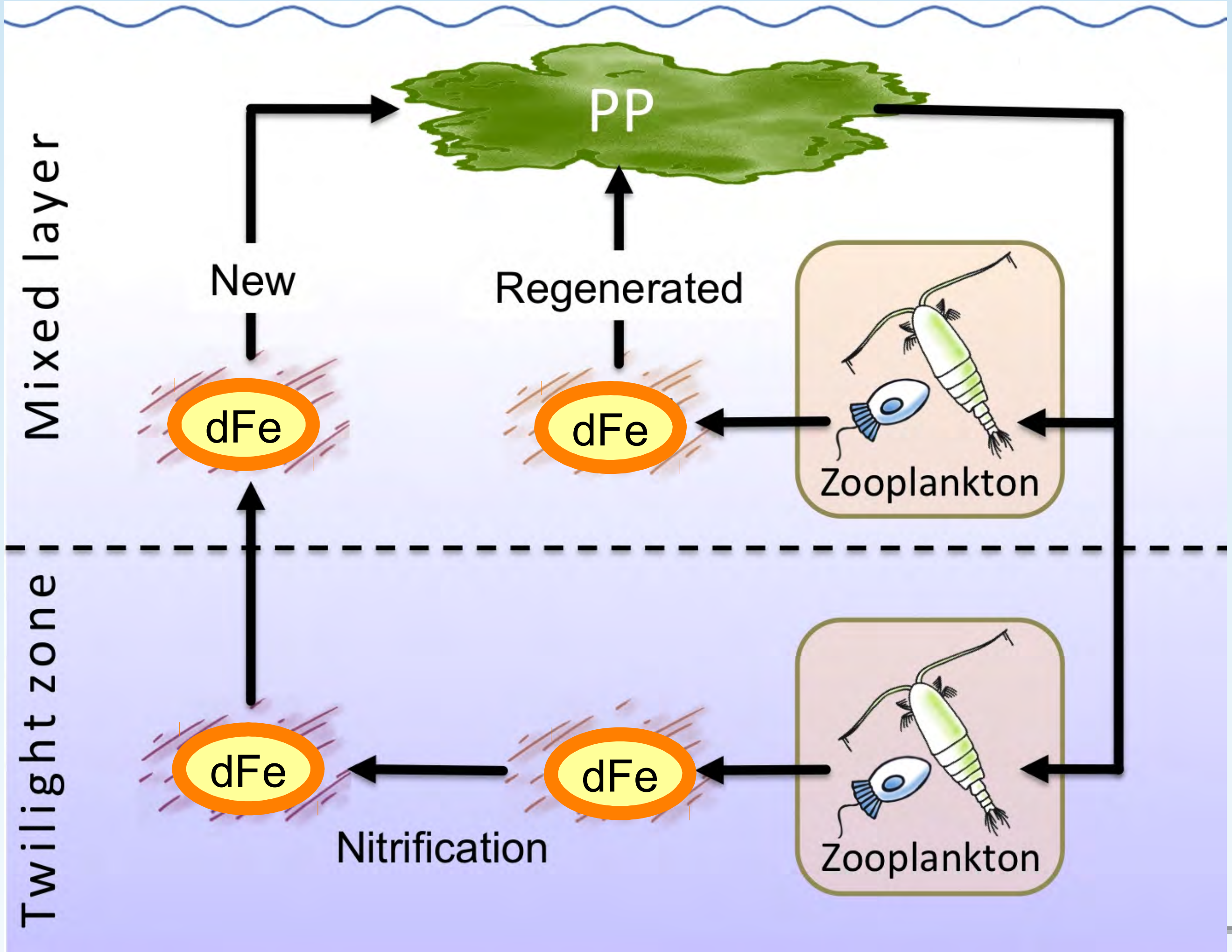


Fe?

Mesozooplankton biomass

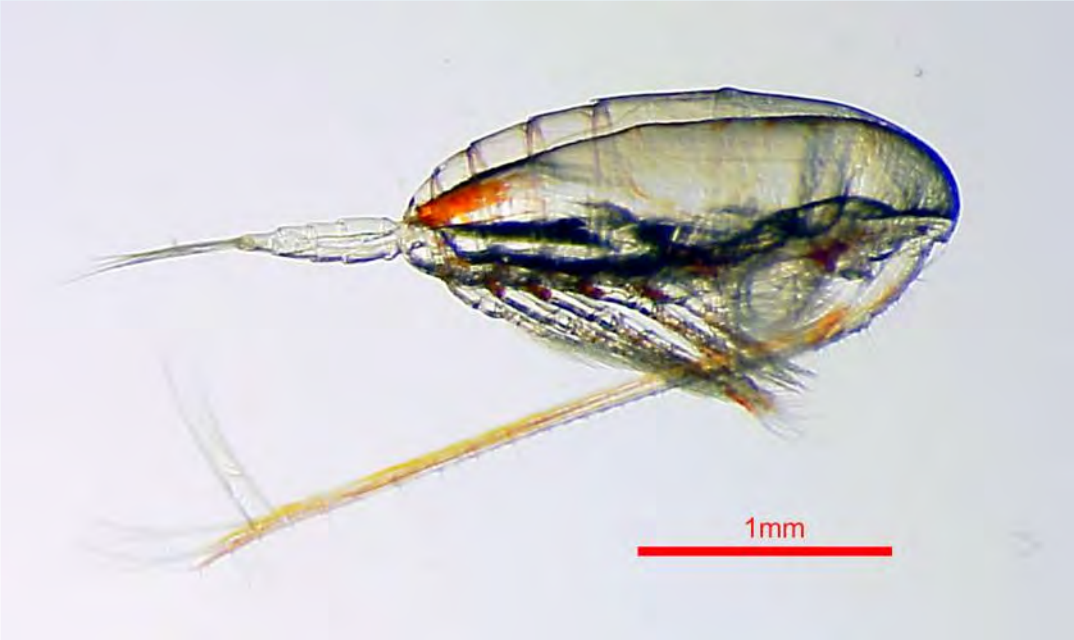


- Annual average mesozooplankton (> 333 μm) biomass
- (mg C m^{-3}) in the upper 200 m (Moriarty and O'Brien 2013)


Mixed layer
Twilight zone
PP
New
Regenerated
dFe
dFe
Zooplankton
dFe
dFe
Nitrification
Zooplankton

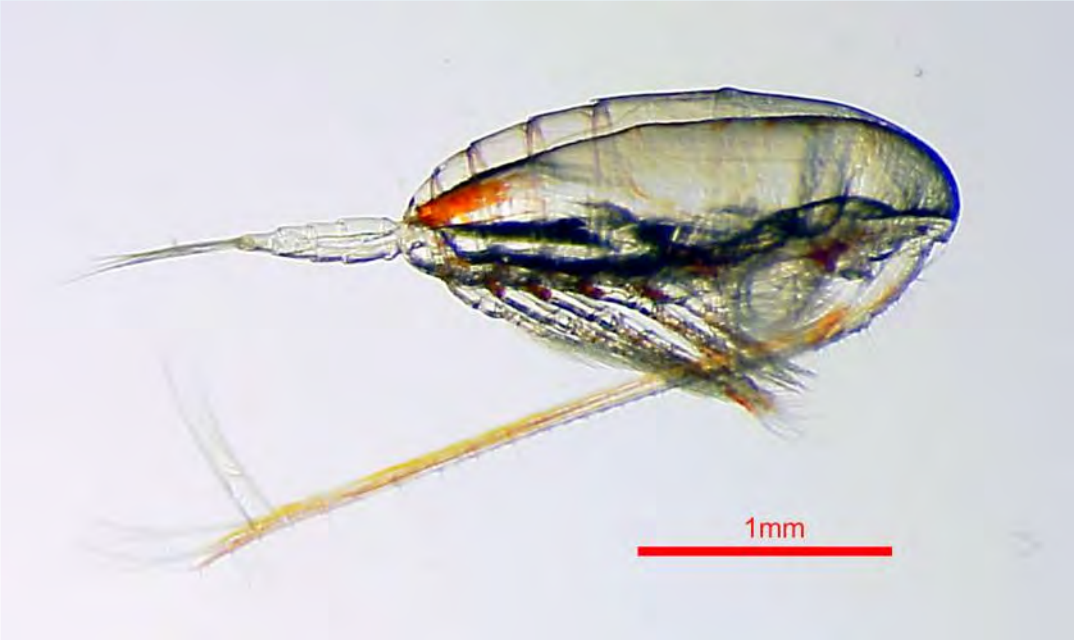
Why zooplankton?

- Physical disruption during digestion (Frey & Small 1979)
- Low gut pH: 5.4 – 6.7 (Tang et al. 2011)
- Lots of them!

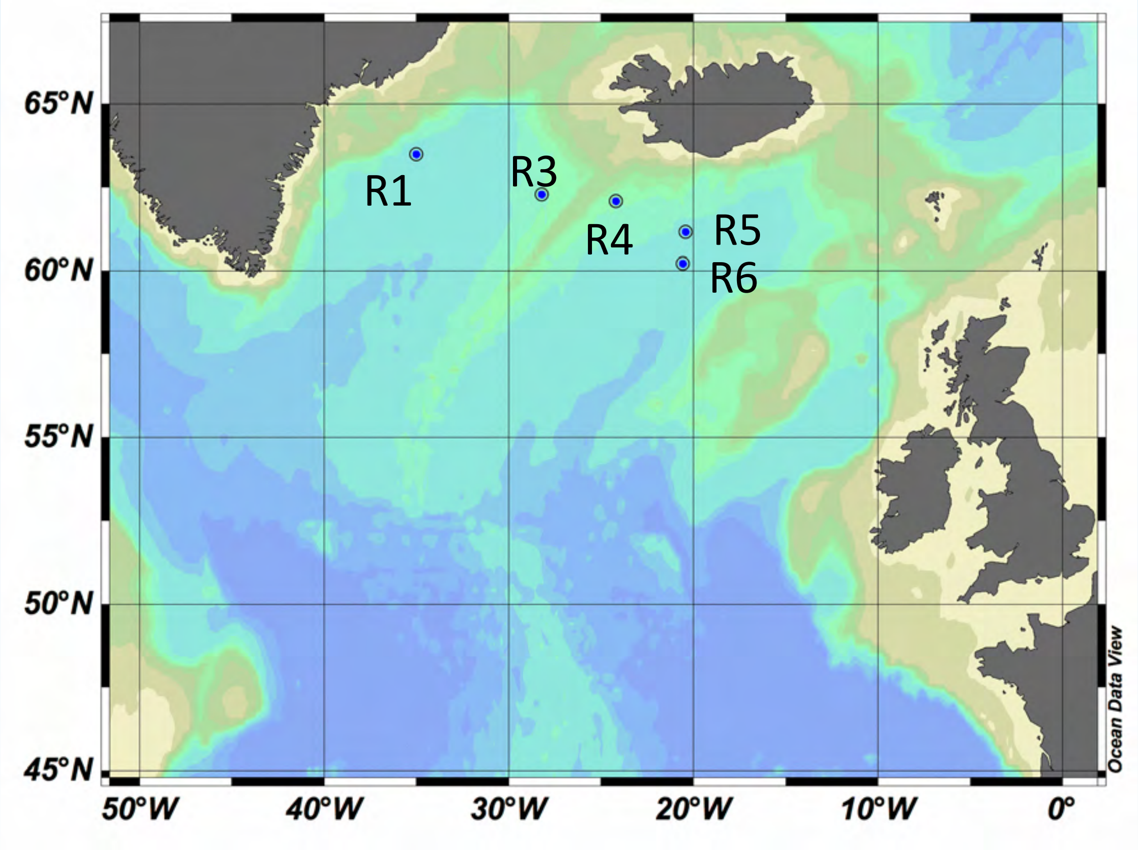


Idea:

Increased recycling of iron (Fe) relative to nitrogen (N) by zooplankton may help to sustain phytoplankton production in HNLC conditions

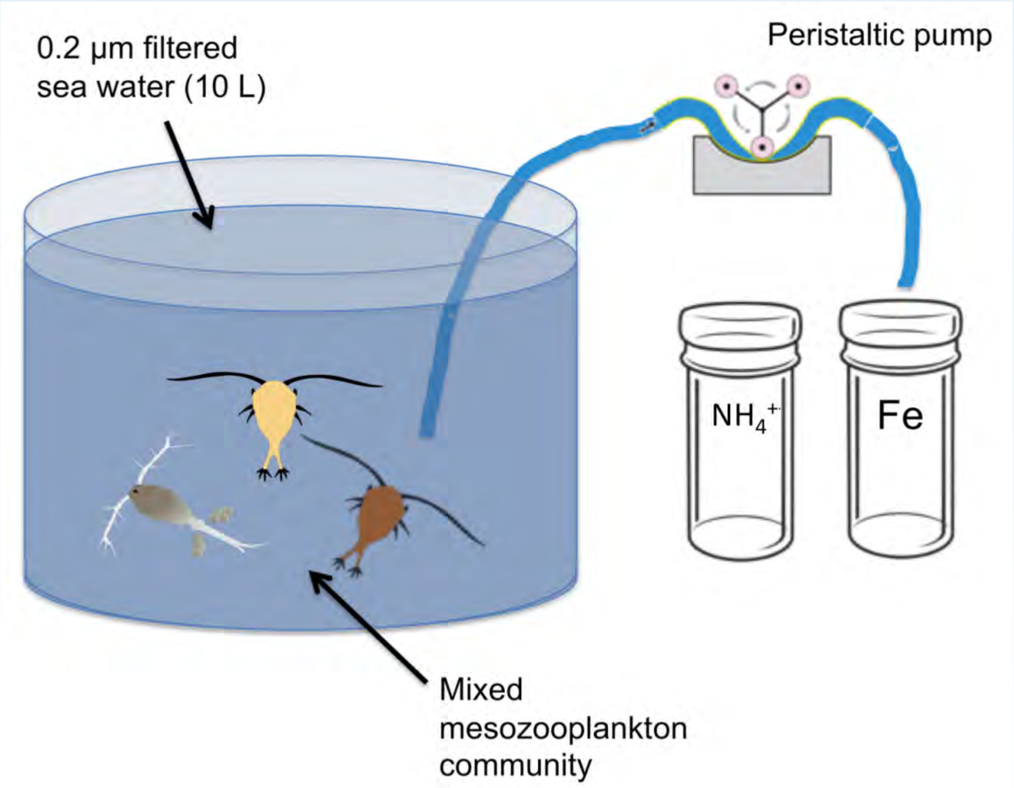


Irminger Basin in Jul/Aug 2010

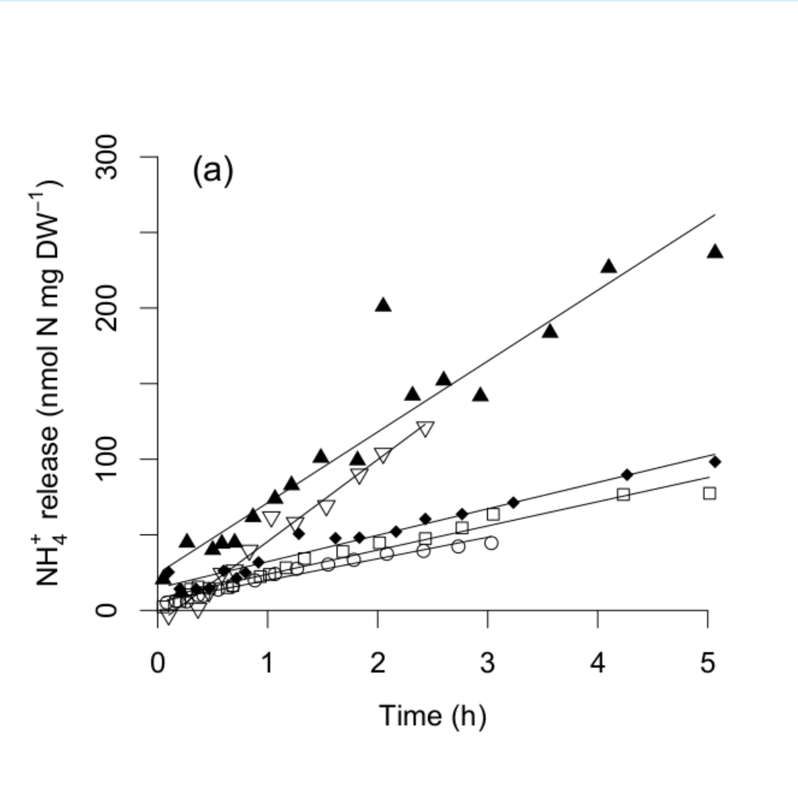


Experimental design

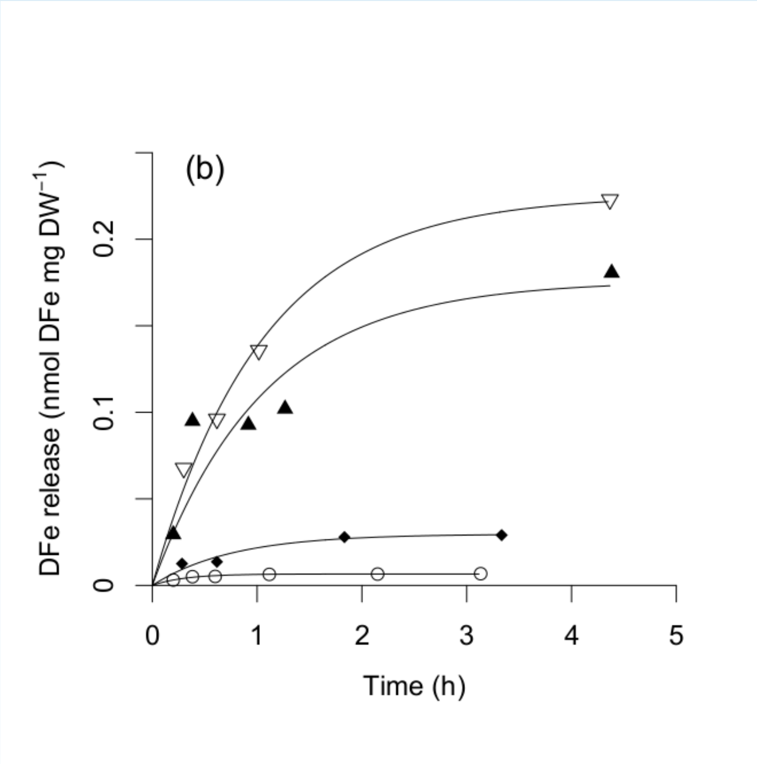
- Mixed zooplankton (>0.2 mm) community
- Controlled temperature lab (wet, windy, cold!) in the middle of the night...
- Sampling for NH_4^+ and DFe



Nutrient release

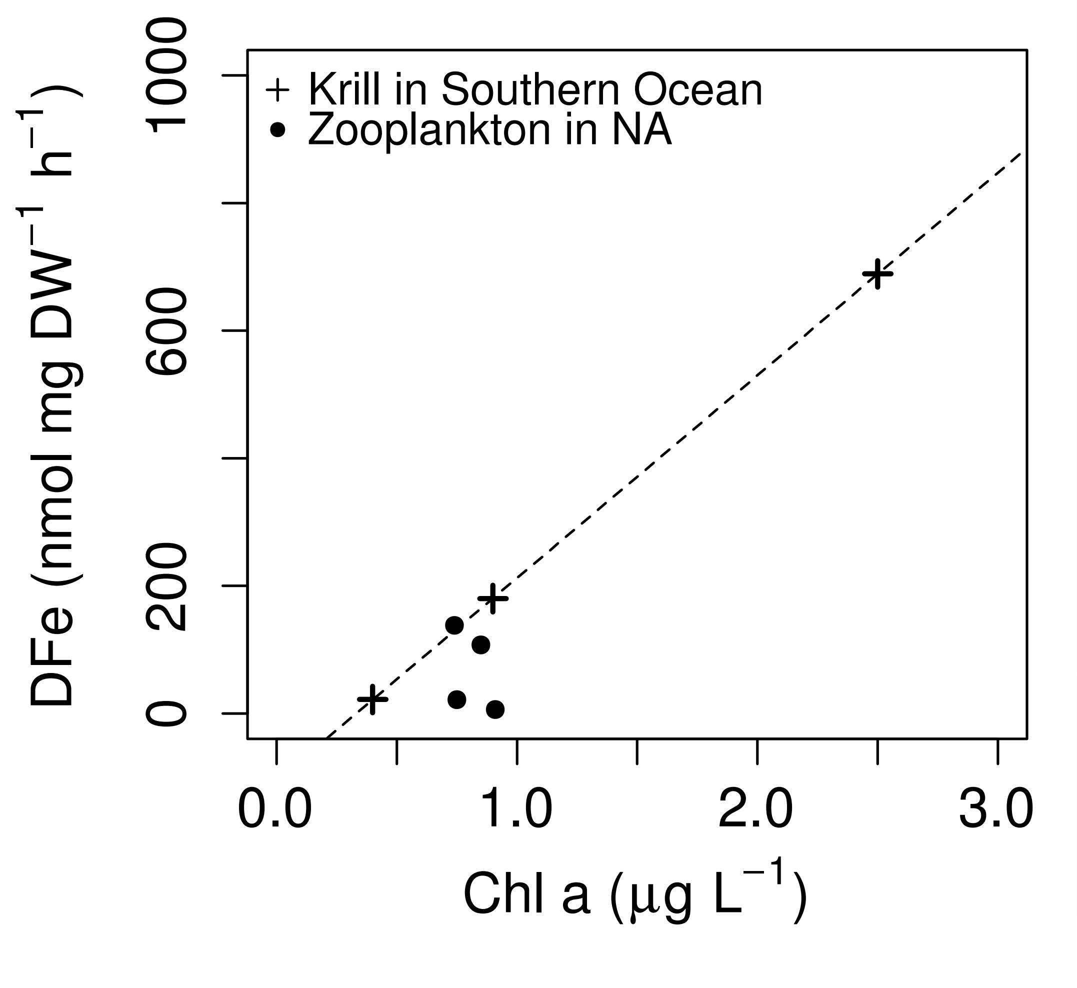


Metabolic waste product



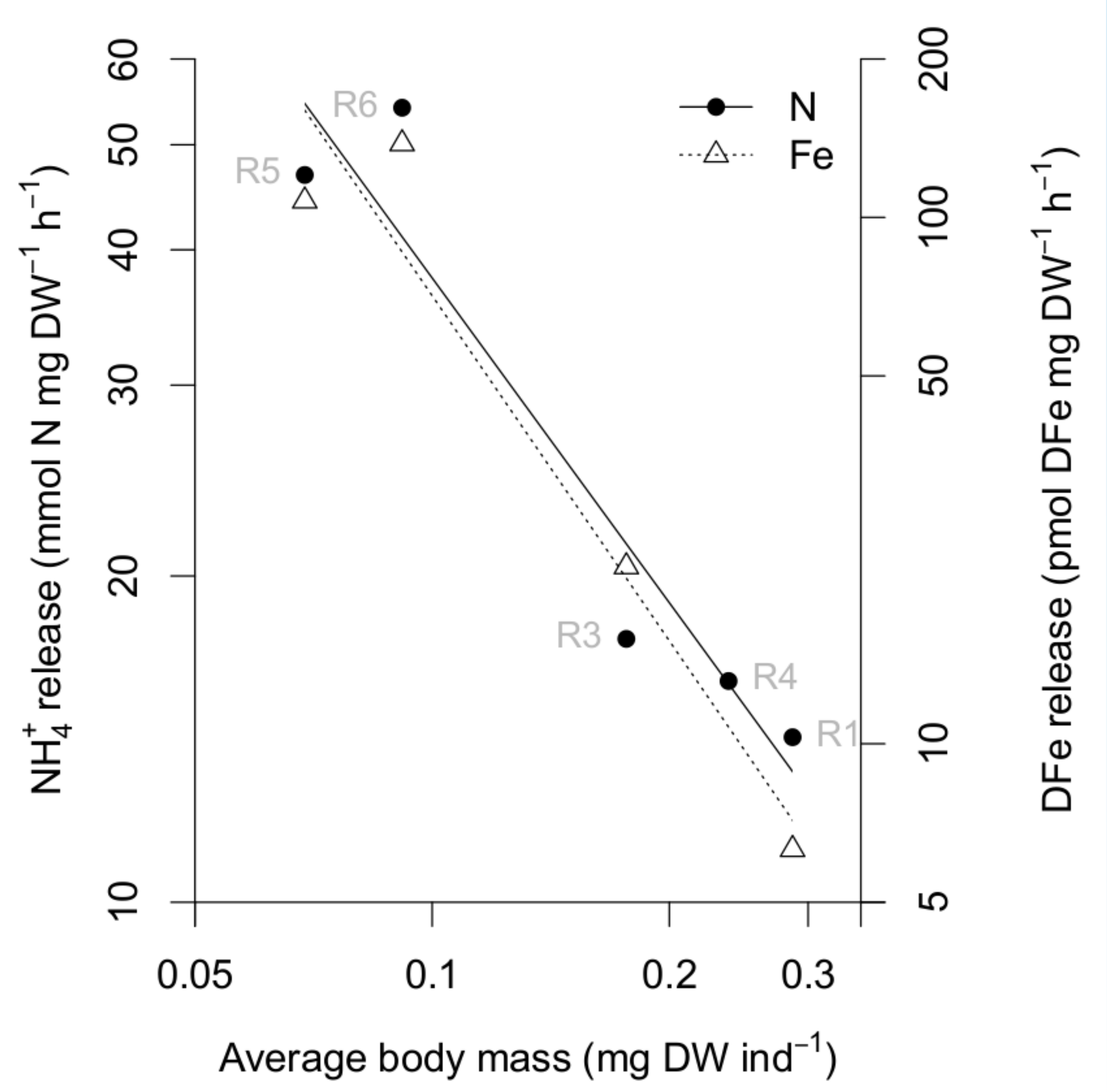
Digestion-derived

What governs the rate of release?



Tovar-Sanchez et al. 2007

What governs the rate of release?

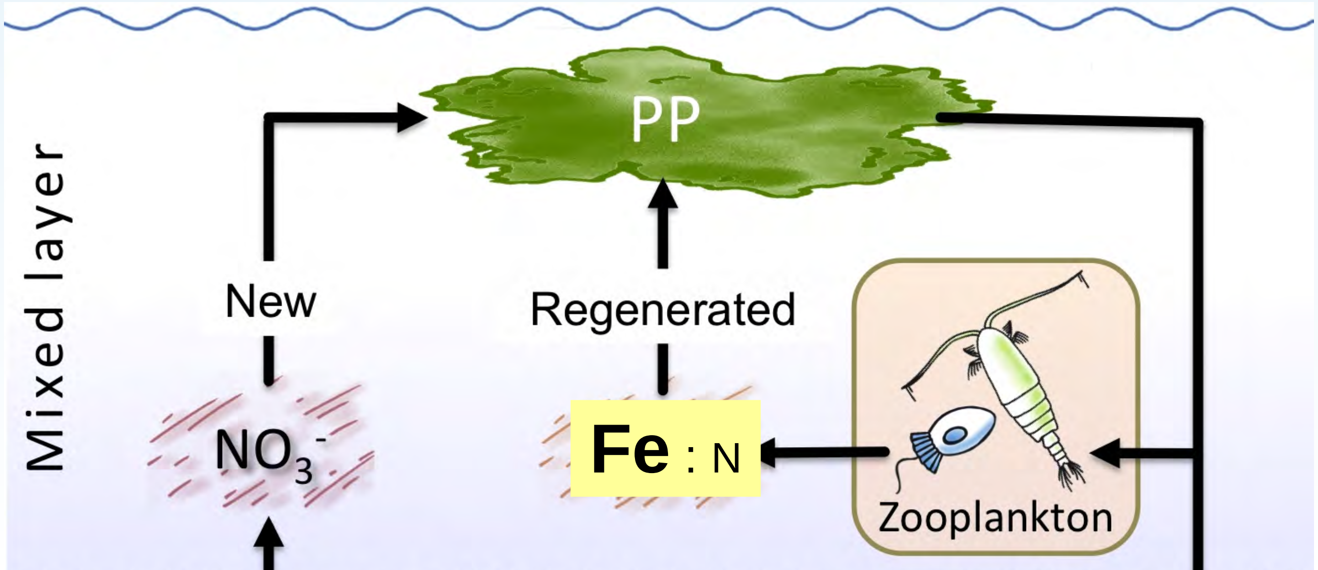


So, how important is nutrient release by mesozooplankton?

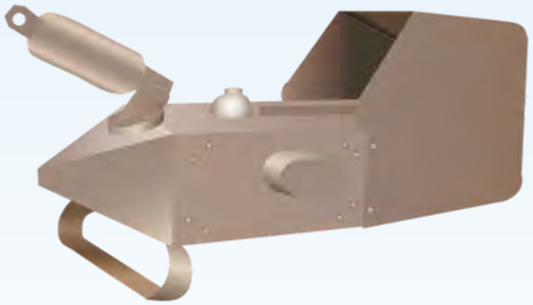
	NH_4^+	DFe
Release by zooplankton (µmol m^{-3} d^{-1})	1-45	0.001 – 0.022
Uptake by phytoplankton (µmol m^{-3} d^{-1})	300-400	0.010 – 0.013
Release/Uptake (%)	0.2-13 %	6-59 %

- Uptake
  measurements and assuming that
- C:N ratio of 106:16 mol mol^{-1}
- Fe:C ratio of 4.3 µmol mol^{-1}

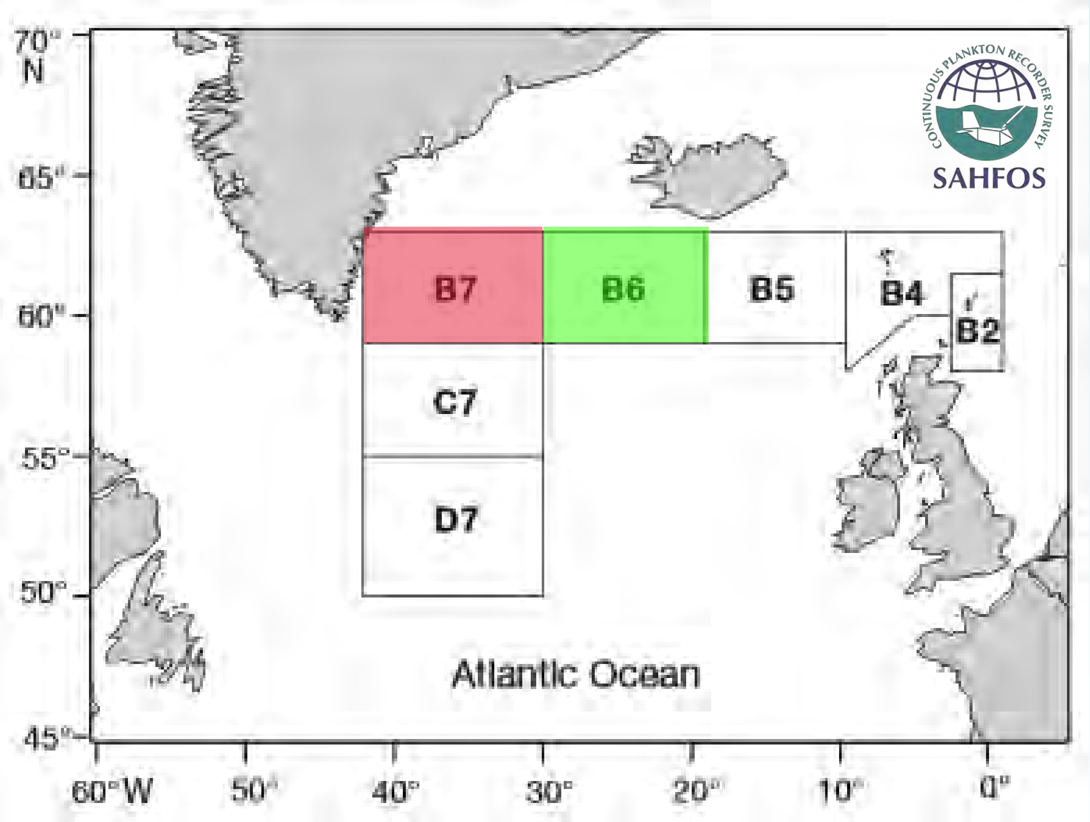
Could iron recycling have been altered through changes in the abundance & distribution of mesozooplankton (known responses to climate change)?



- Coupled to historic abundance data of mesozooplankton in the Irminger Basin from 1958-2007

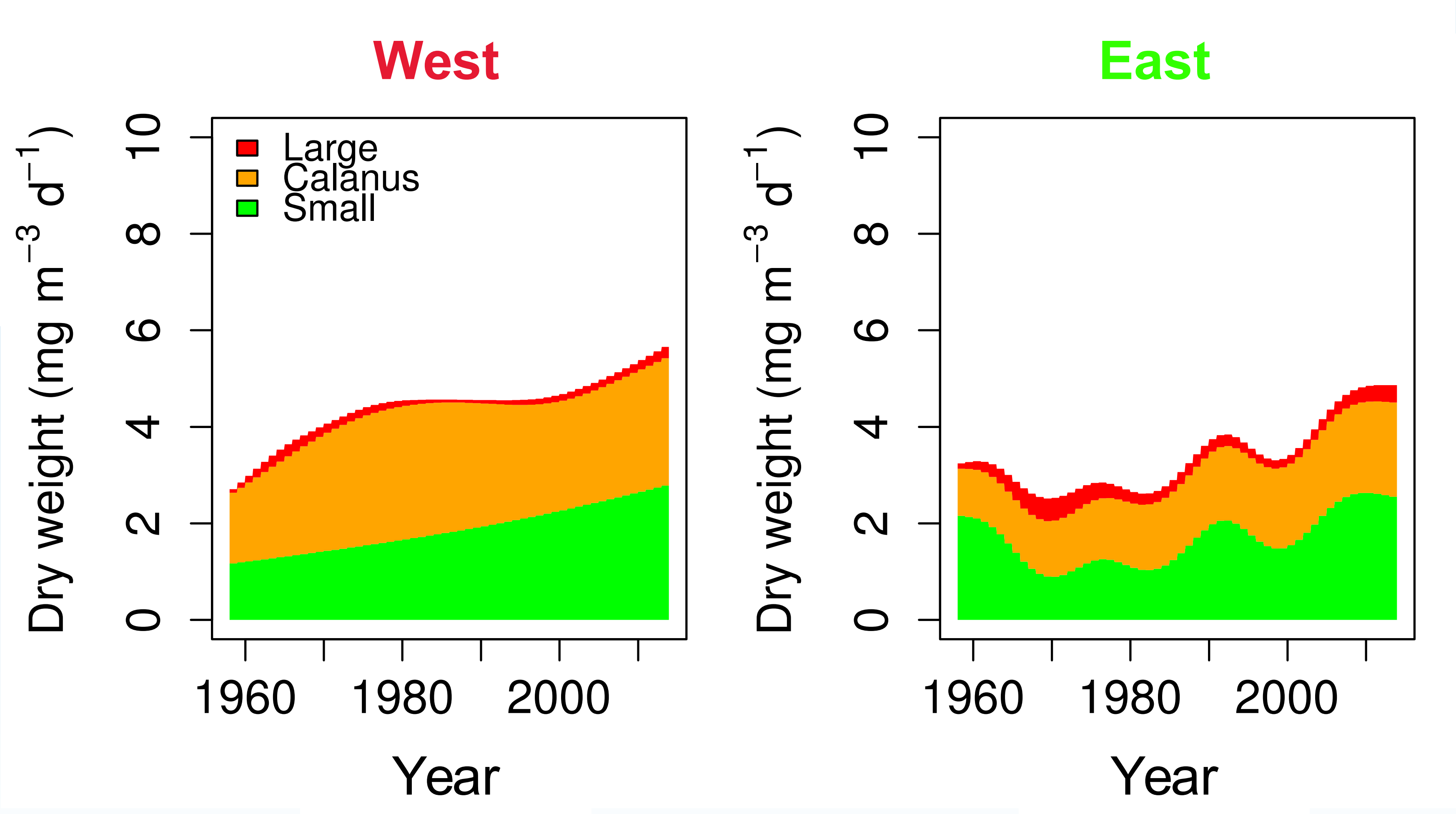


Continous Plankton Recorder (CPR) - SAHFOS



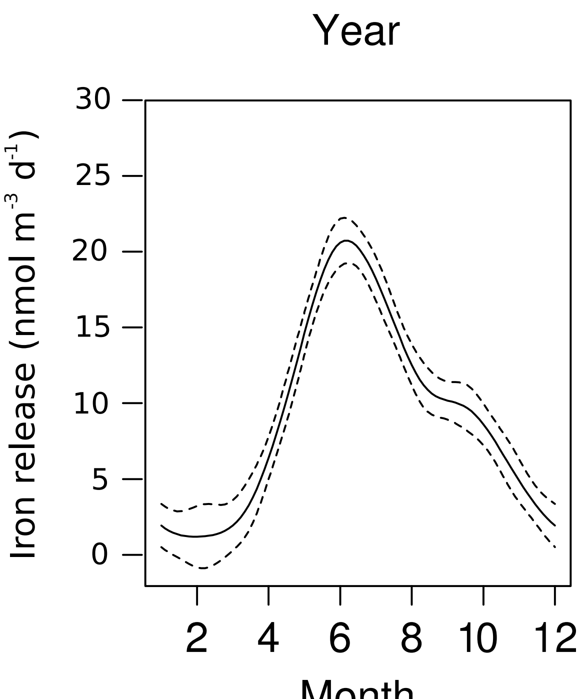
CPR standard areas (Feng et al. 2014)

Long-term change in copepod biomass



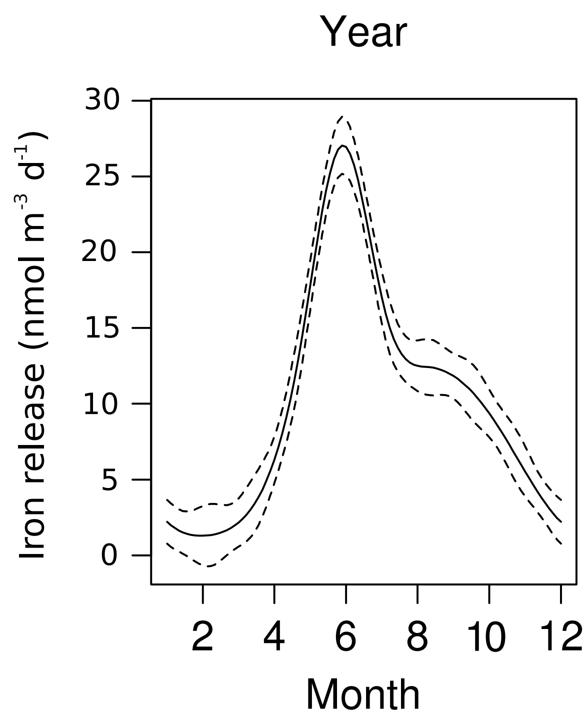
Small: < 0.2 mm

West



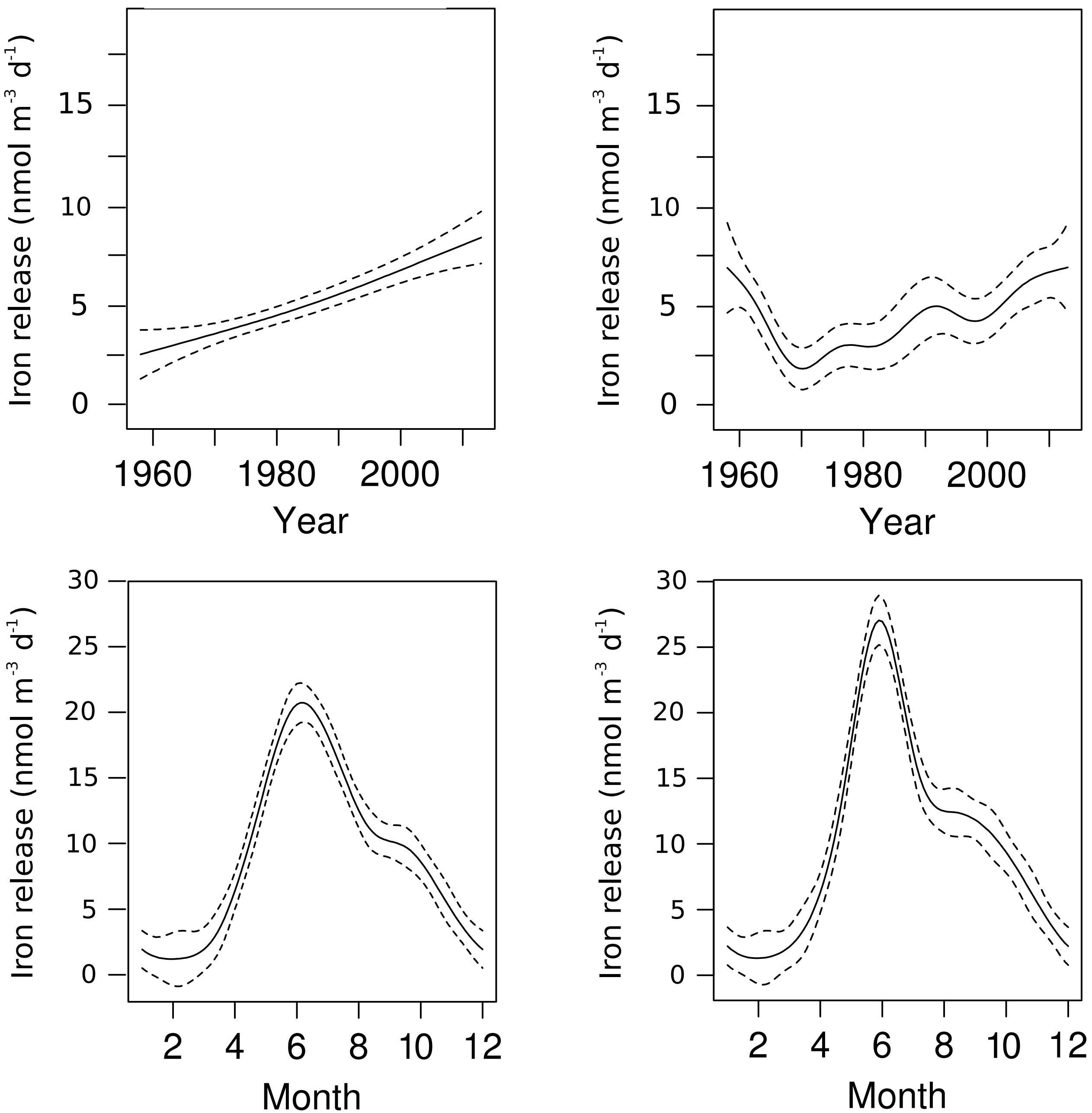
Year
Iron release (nmol m-3 d-1)
0
5
10
15
20
25
30
2
4
6
8
10
12
Month

East



Year
Iron release (nmol m-3 d-1)
0
5
10
15
20
25
30
2
4
6
8
10
12
Month

West **East**

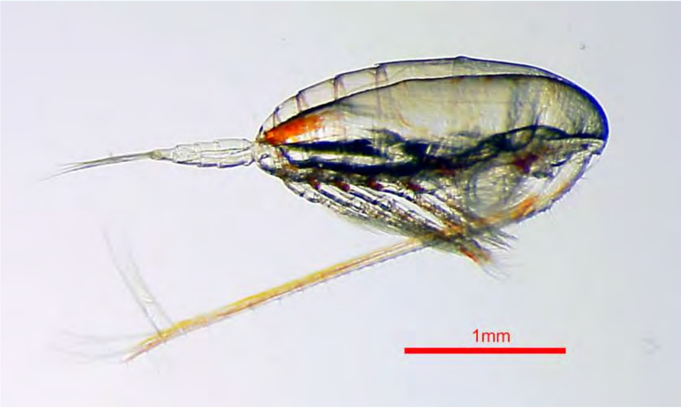

Iron release (nmol m-3 d-1)
0
5
10
15
1960
1980
2000
Year
0
5
10
15
20
25
30
2
4
6
8
10
12
Month

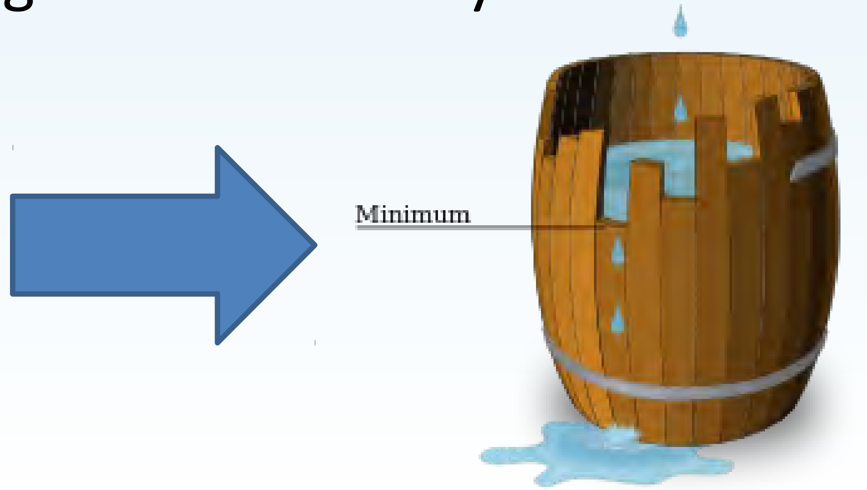
Conclusion

- DFe:N regeneration ratio: 5–26 times larger than in phytoplankton requirements

- Fe:N decoupling –> more Fe being available to support primary production

- Changes in zooplankton abundance and community composition will affect nutrient ratios and therefore the biogeochemical functioning of marine ecosystems





Thank you.

- Captain & crew of *RRS Discovery*
- J. Klar, M. Villa-Alfageme, scientists of cruise D354
- M. Moore, A. Poulton, A. Atkinson
- Sahfos & D. Johns for CPR data (doi: 10.7487/2015.63.1.889)
- Funding bodies

Geophysical Research Letters, Vol 39, L12608, 2012
doi:10.1029/2012GL051776