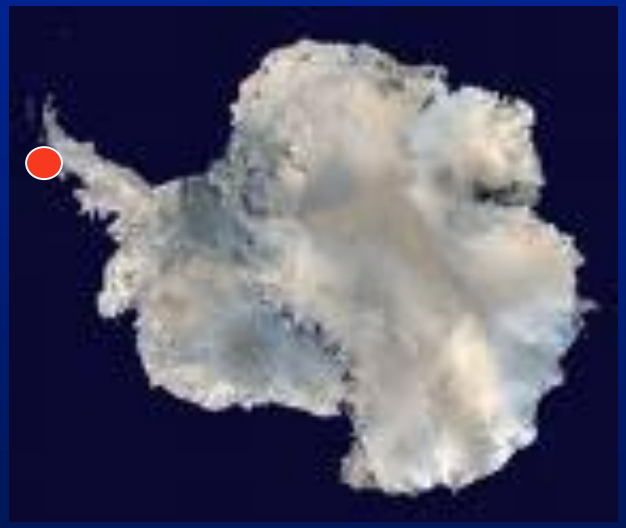
Long-term and regional effects of sea ice on zooplankton along the western Antarctic Peninsula



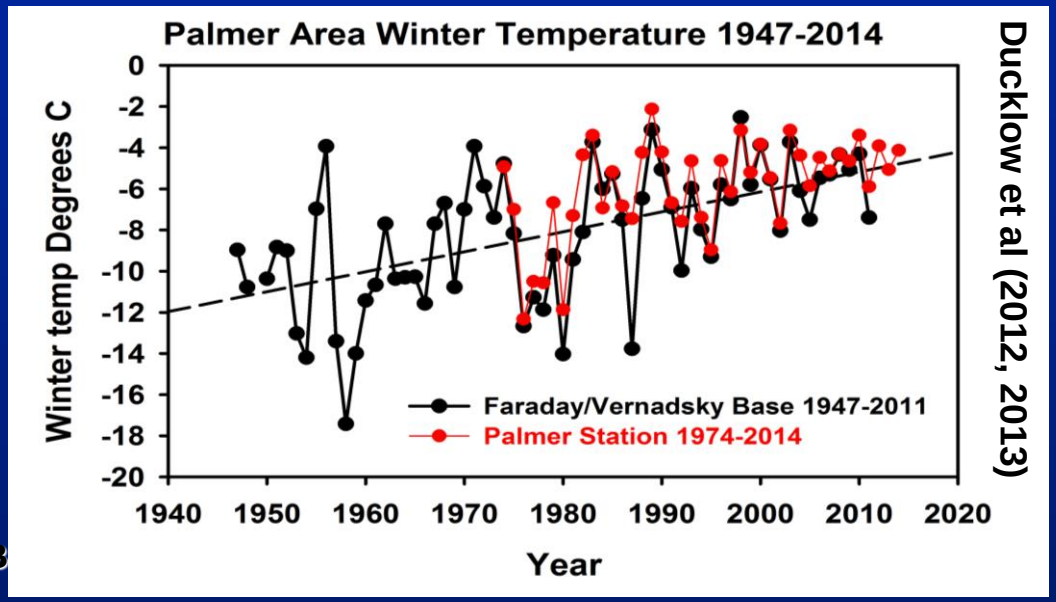
A. McDonnell

Deborah Steinberg, Patricia Thibodeau, & Sharon Stammerjohn

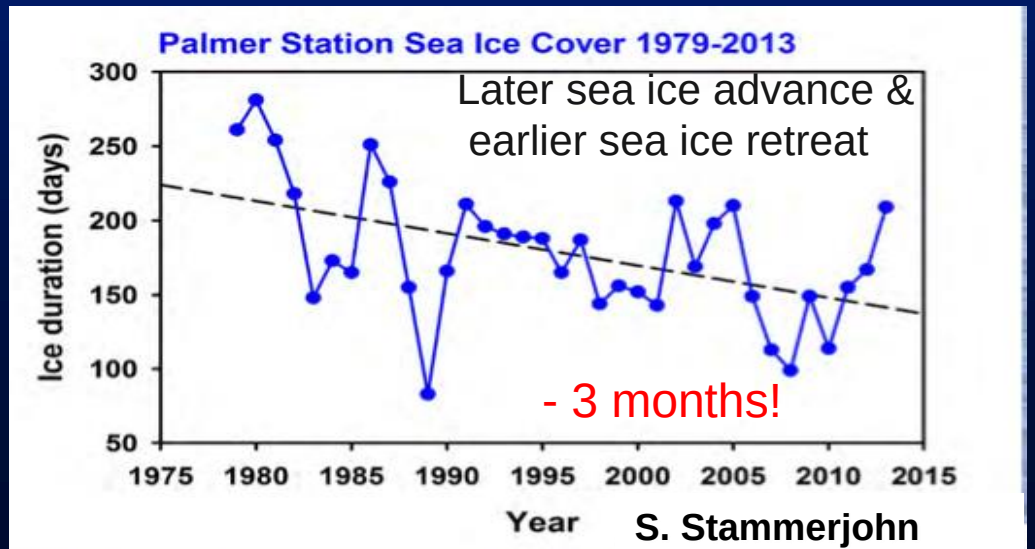
VIMS | William & Mary
Virginia Institute of Marine Science

Warming in the Western Antarctic Peninsula

Average winter (June-Aug.) temperature
+7°C since 1950 (1°C per decade) : 5x global ave.



Sea ice is declining



Palmer Antarctica Long Term Ecological Research

Study Region

700 x 200 km

N

S

Far S

Warmer, moister

Colder, drier

600

500

400

300

200

100

000

-100

200 180 160 140 120 100 080 060 040

slope

shelf

coast

Palmer Station (US)

Rothera Base (UK)

Grid stations

Process Study Sites

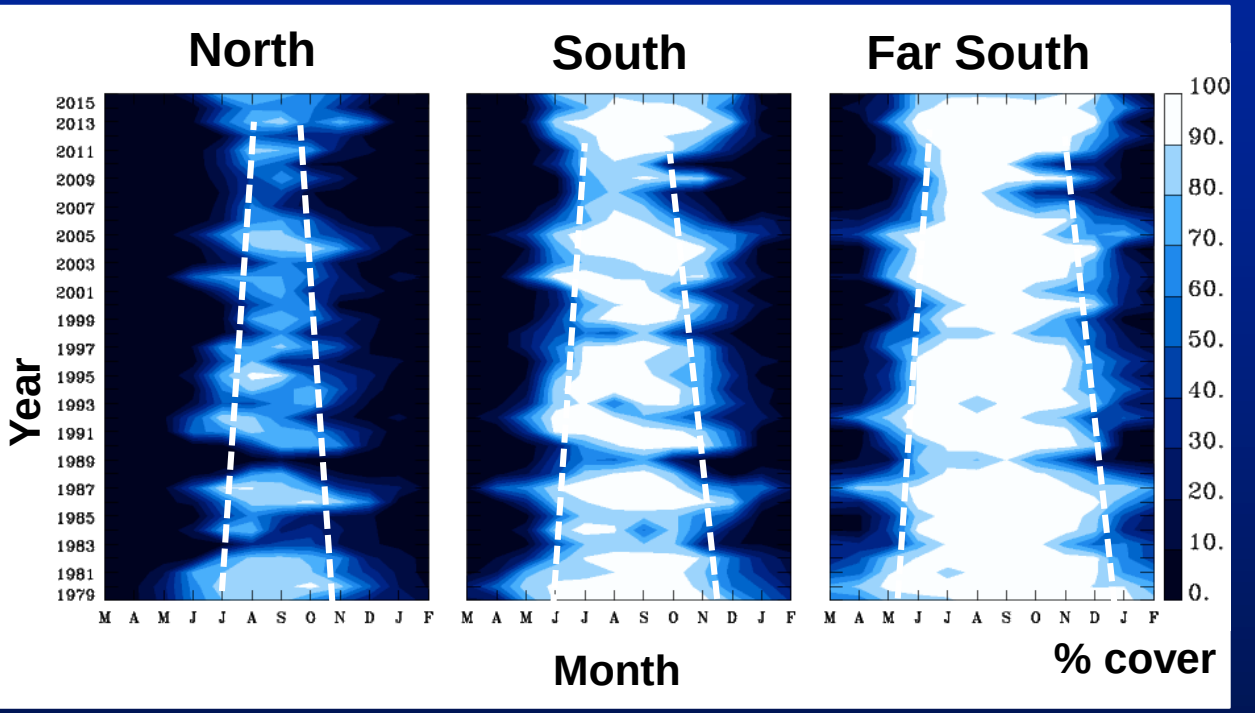
Hydrographic Moorings

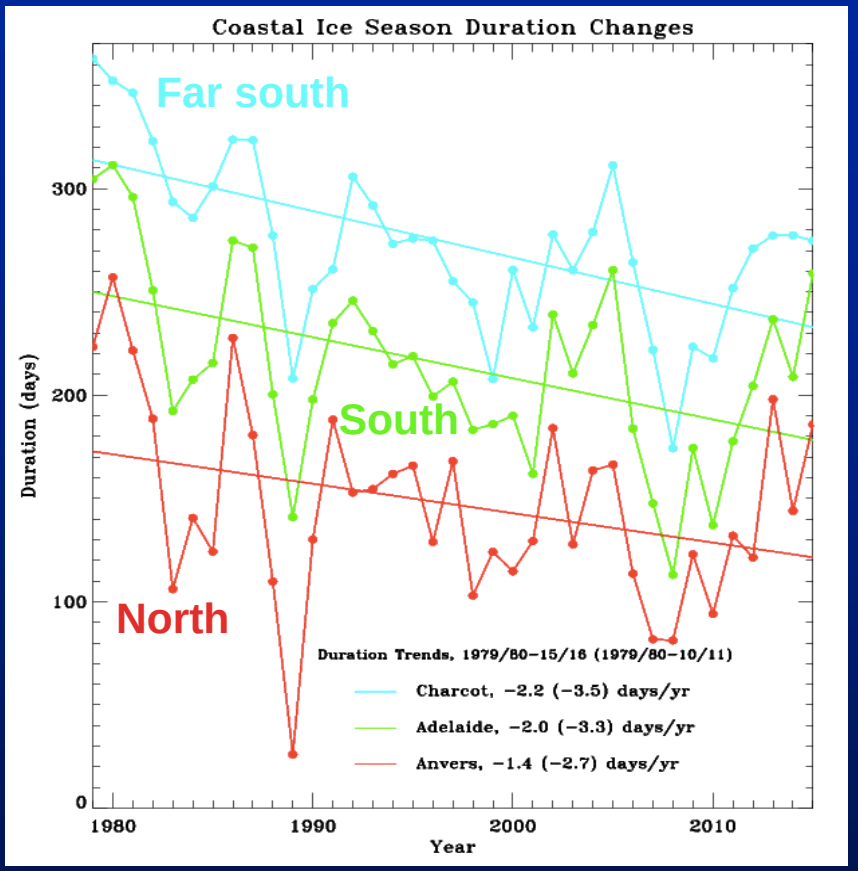
moored sediment trap

Adélie Penguin Colonies

SLOCUM Glider Base

Decreasing ice cover & duration along peninsula

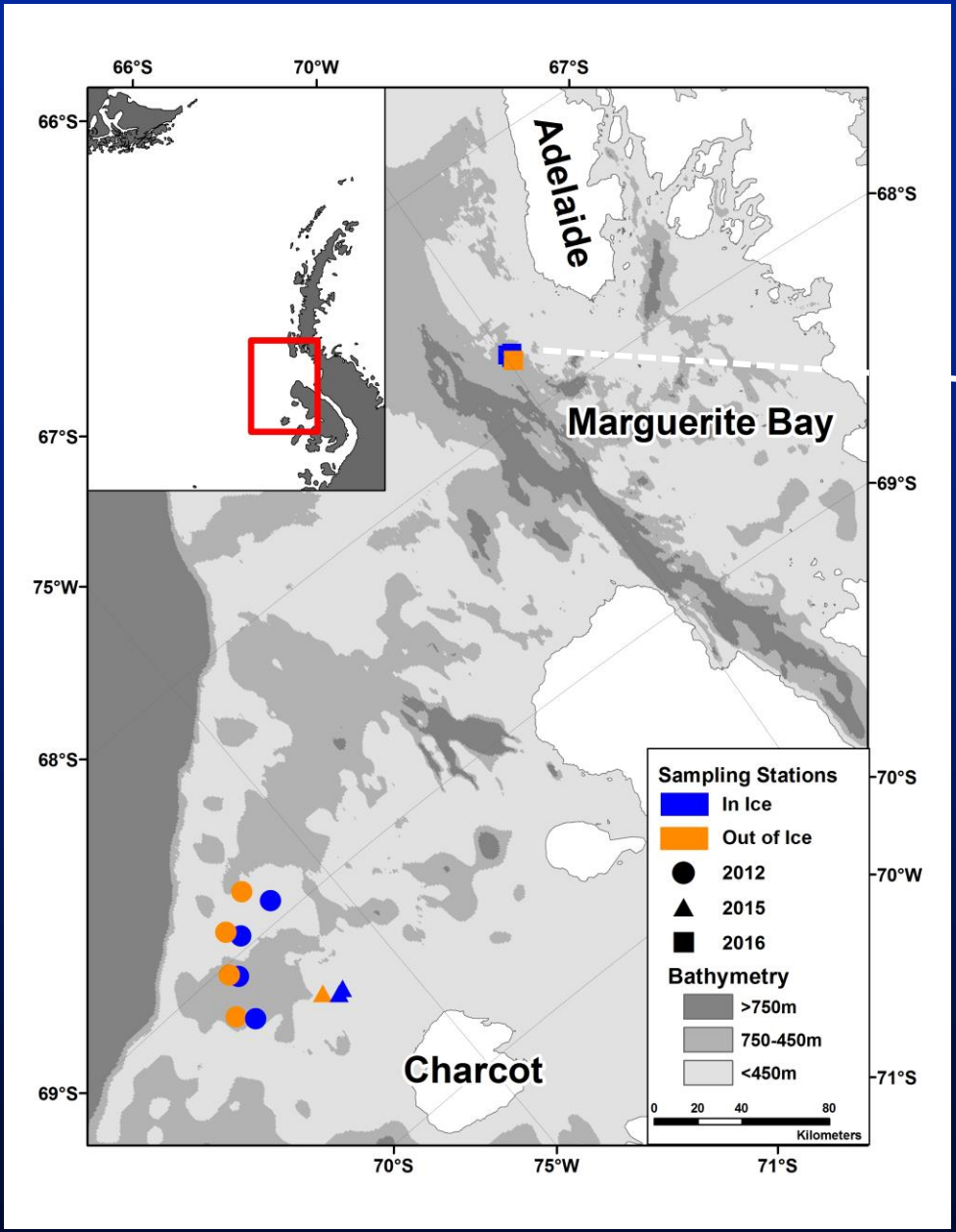


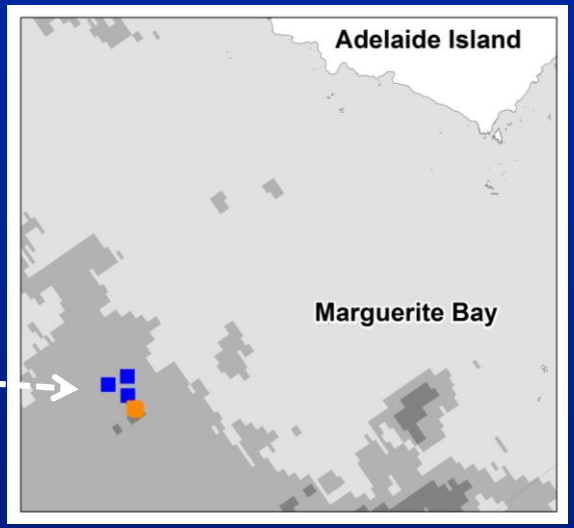


- Longer ice seasons to the south, shorter ice seasons to the north
- But similar interannual variability
- Reversal of decreasing trend since ~2010

S. Stammerjohn

Ice edge process study sampling sites





Macrozooplankton collection

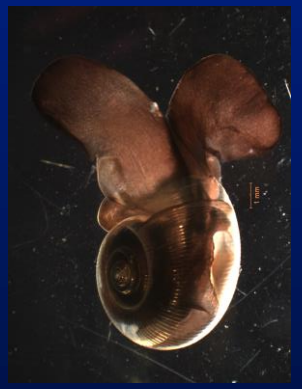
R/V *Laurence M. Gould*

Euphausia superba

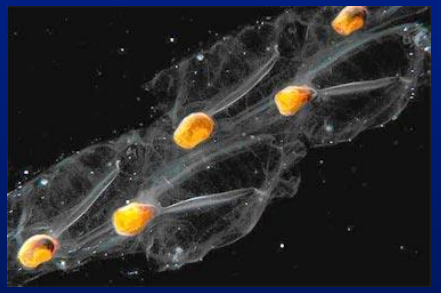
Calanus propinquus

2 m^2 frame,700 µm mesh
upper 120 m

Euphausia crystallarophias



Limacina helicina

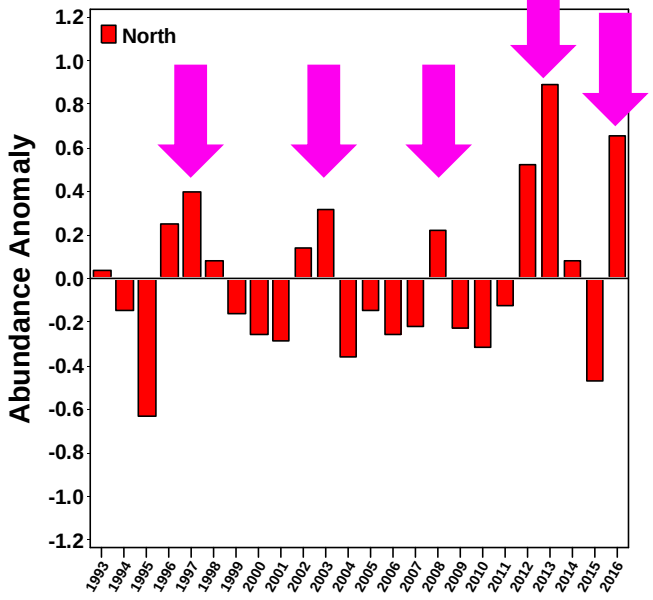


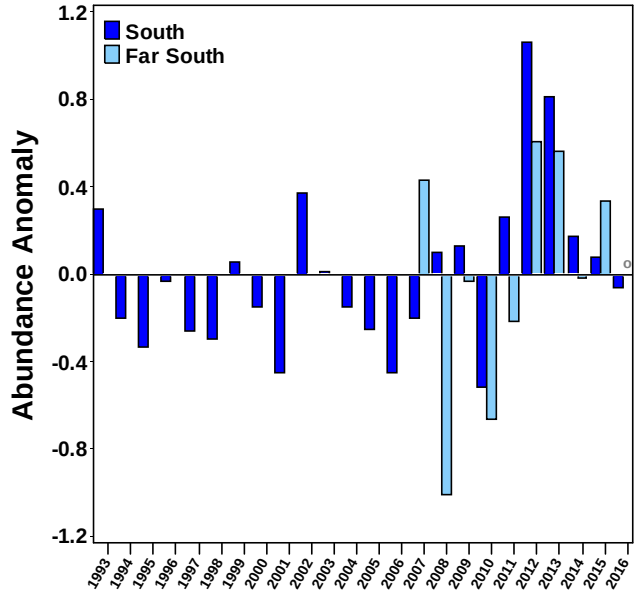
Salpa thompsoni

Additional photo credits: A. McDonnell, L. Madin

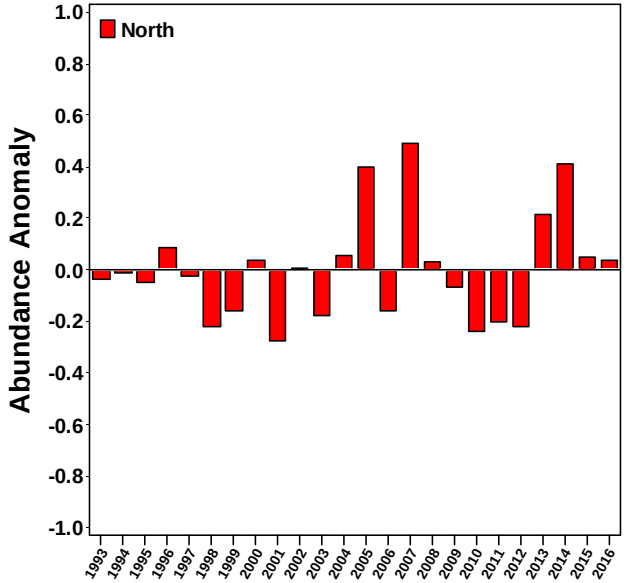
Long-term trends in abundance

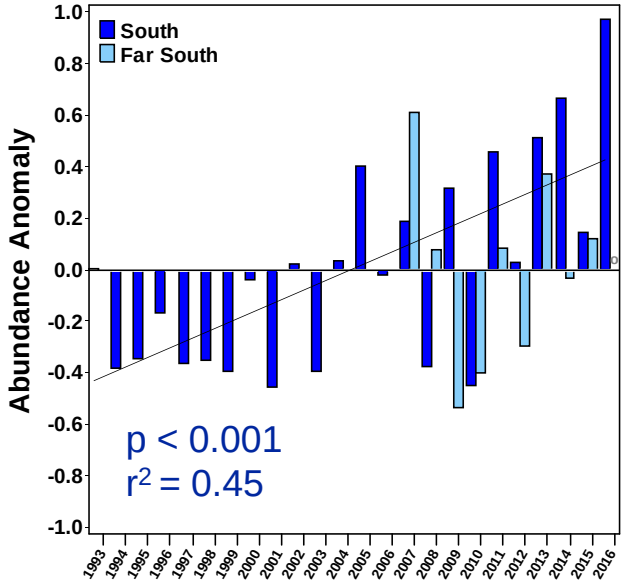
E. superba





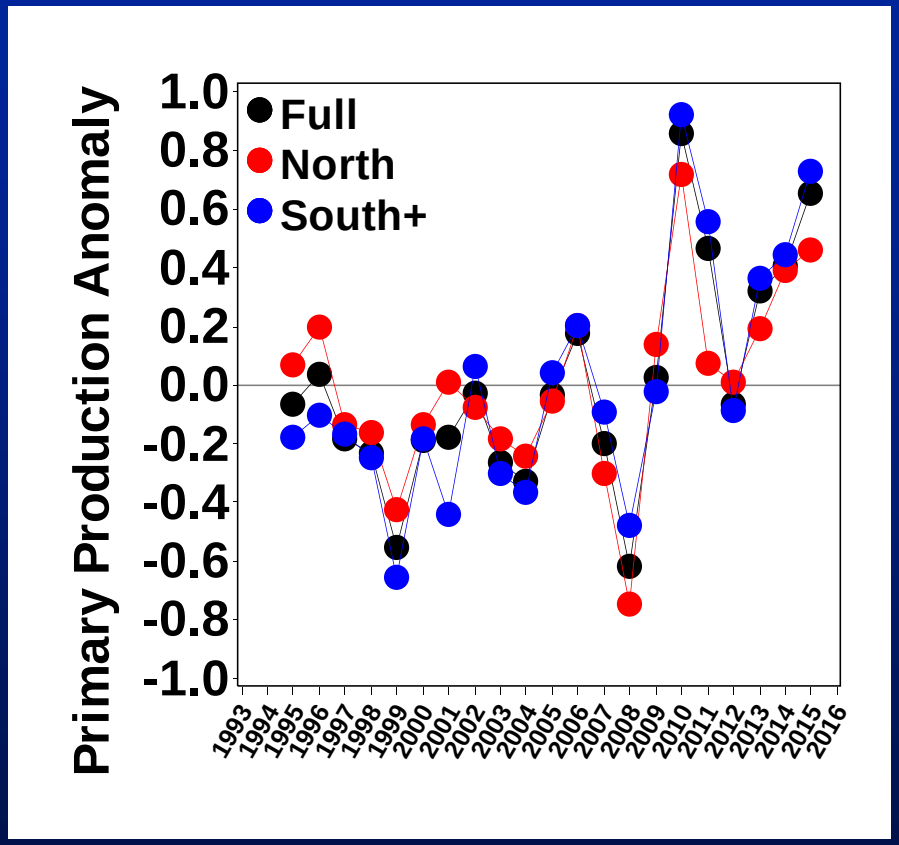
E. crystallorophias



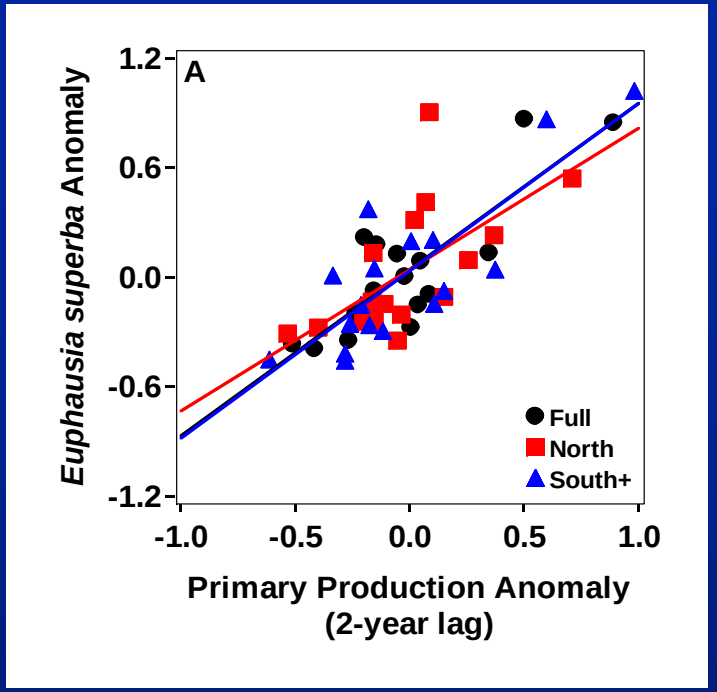


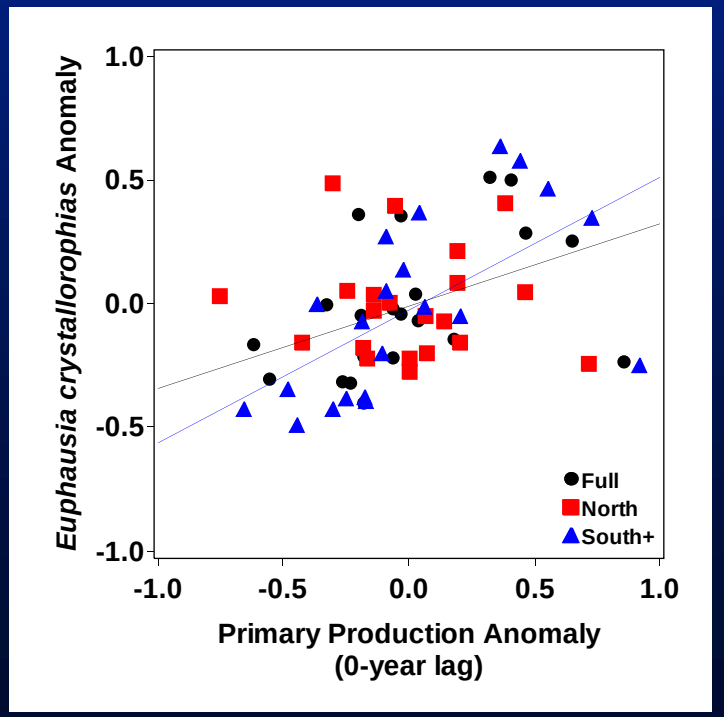
Steinberg et al. (2015) -updated

Long-term environmental drivers for euphausiids



Steinberg et al. (2015) - updated

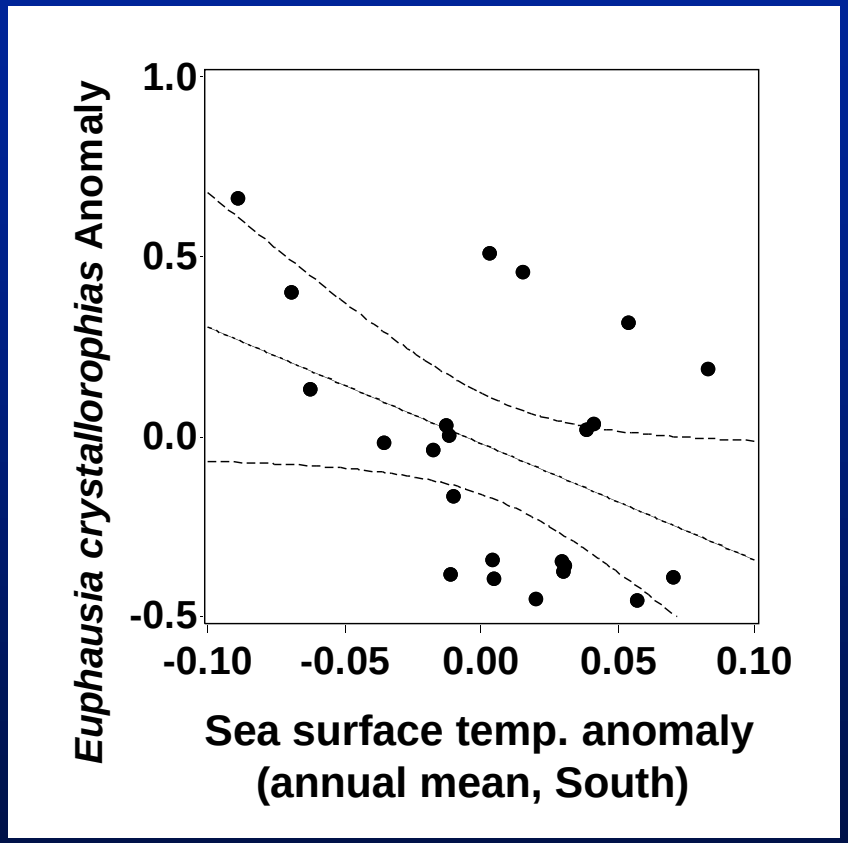




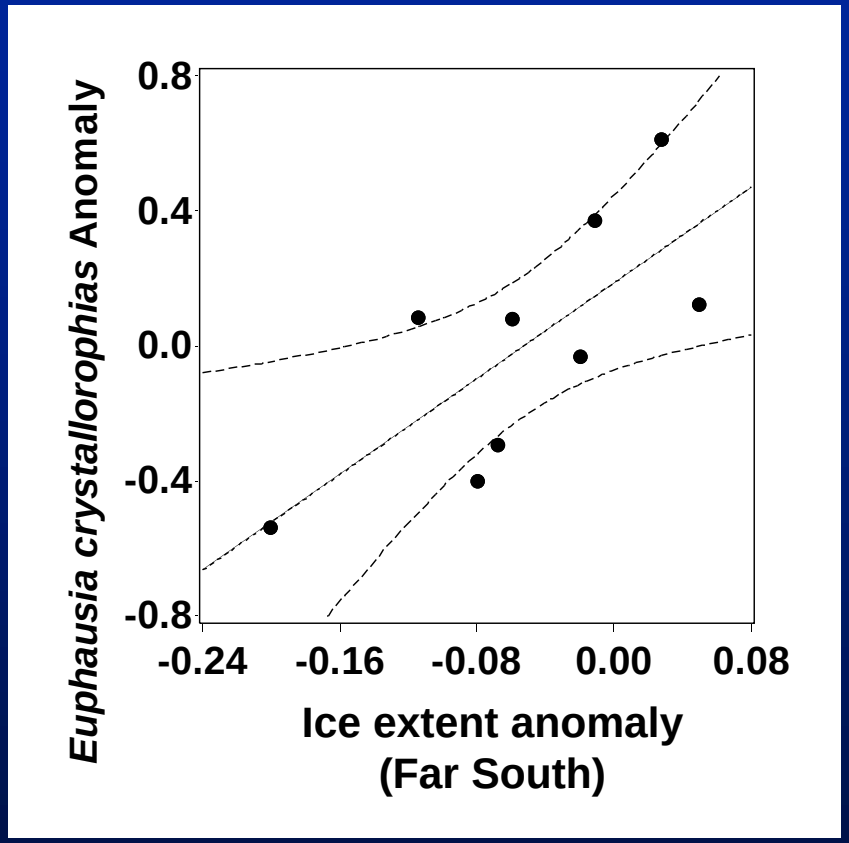
E. superba PP Model $R^2 = 0.71$ $p < 0.001$

E. crystal PP, SAM, Chl a; Model $R^2 = 0.48$ $p = 0.01$

Other environmental drivers- *E. crystal*

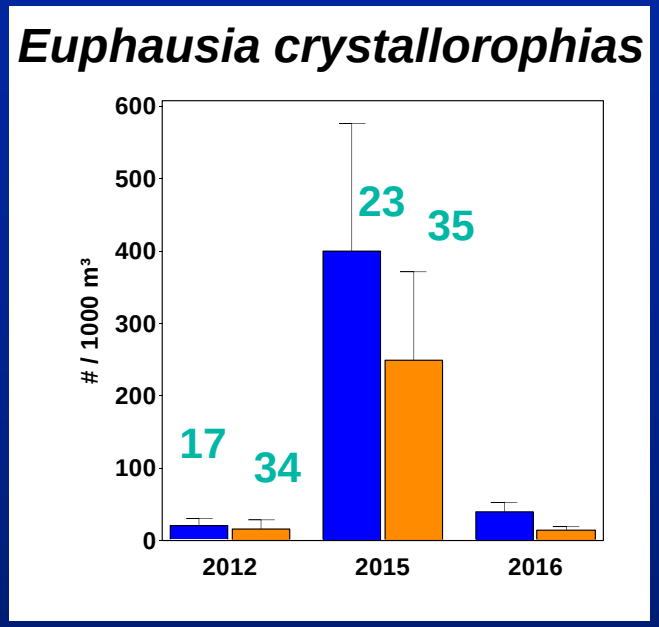


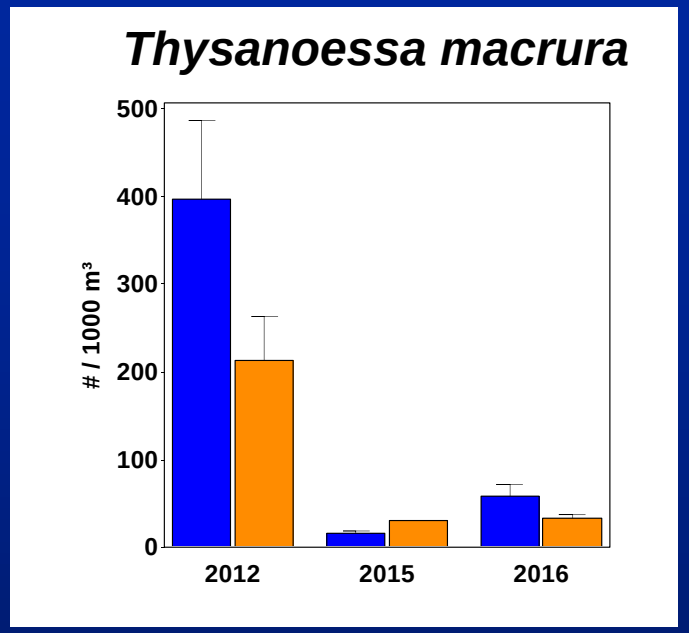
$r^2 = 0.17$
p = 0.04
n = 22



$r^2 = 0.54$
p = 0.02
n = 9

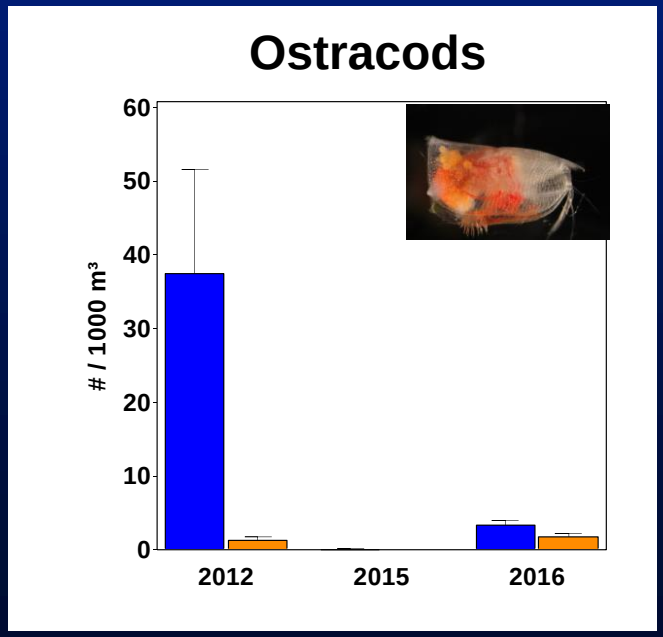
The ‘in’ groups (crustacea)

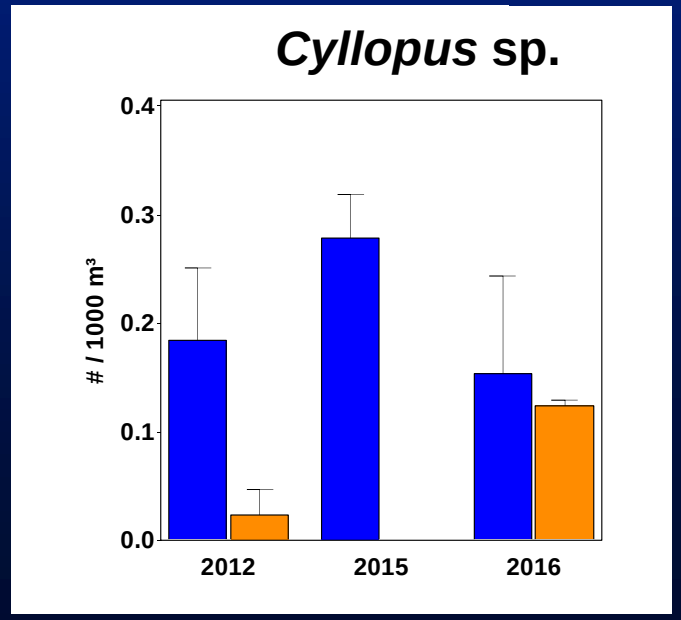




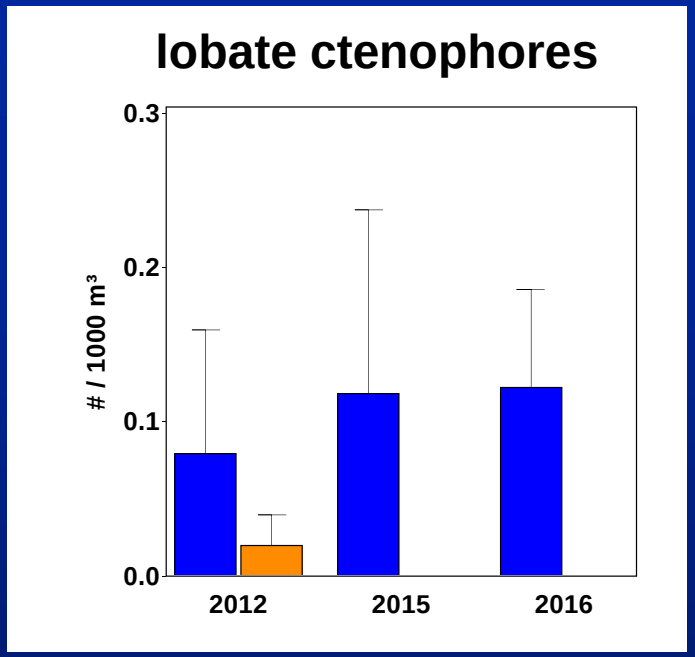
in
out

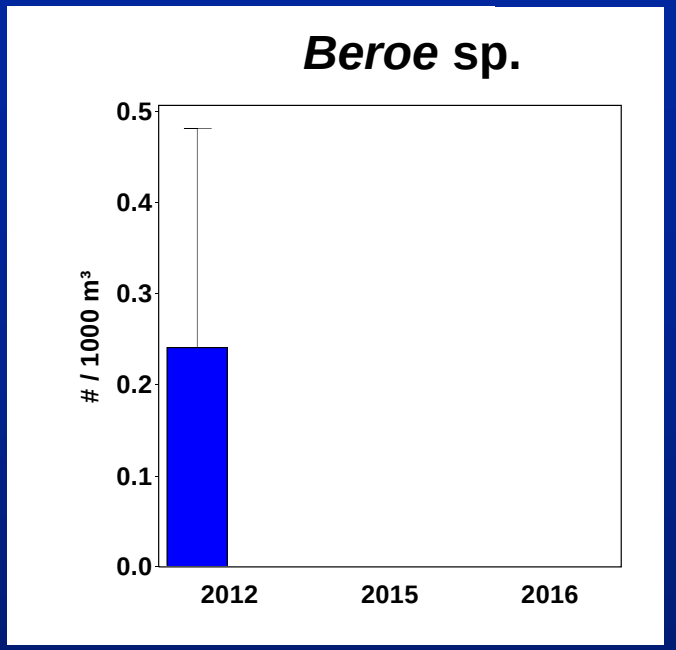
Chl *a* (mg m^{-2})
0-100m

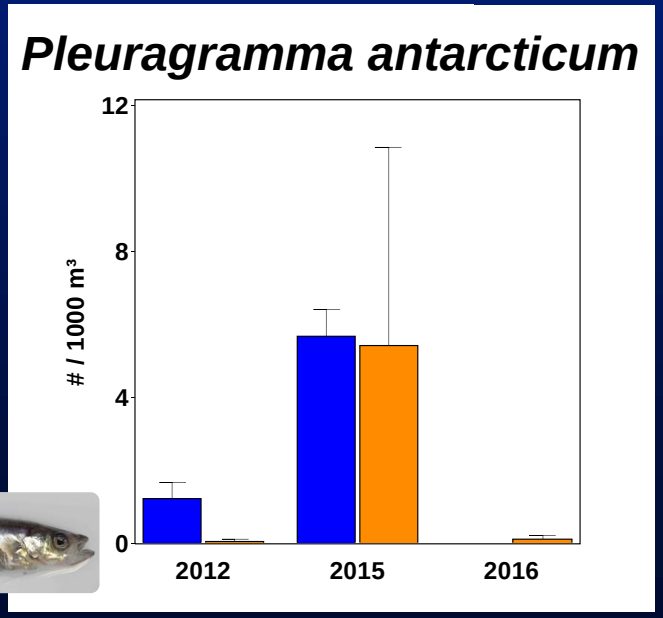


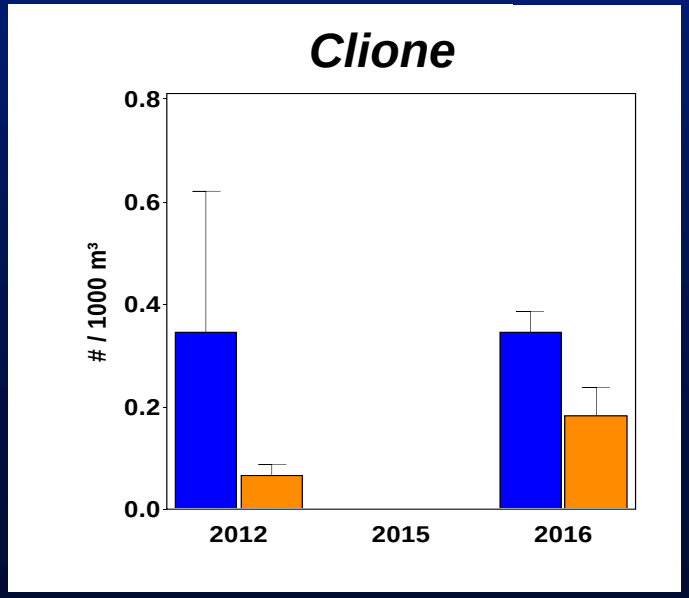


The ‘in’ groups (other)



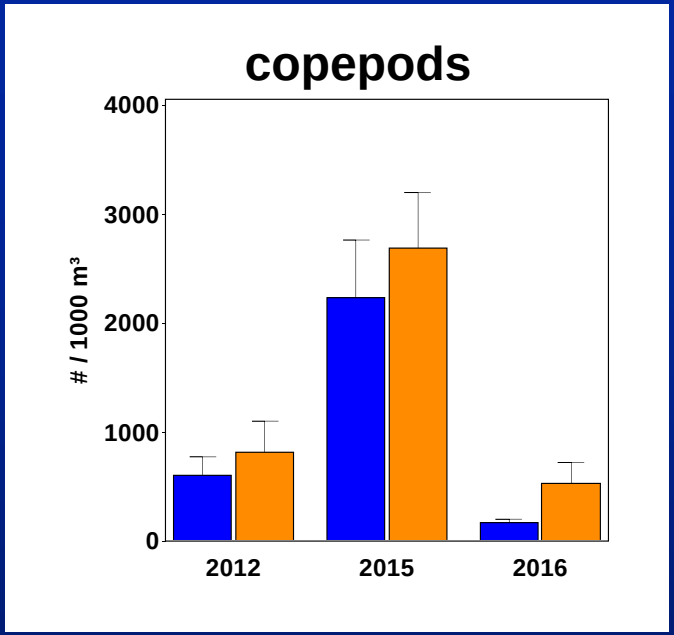


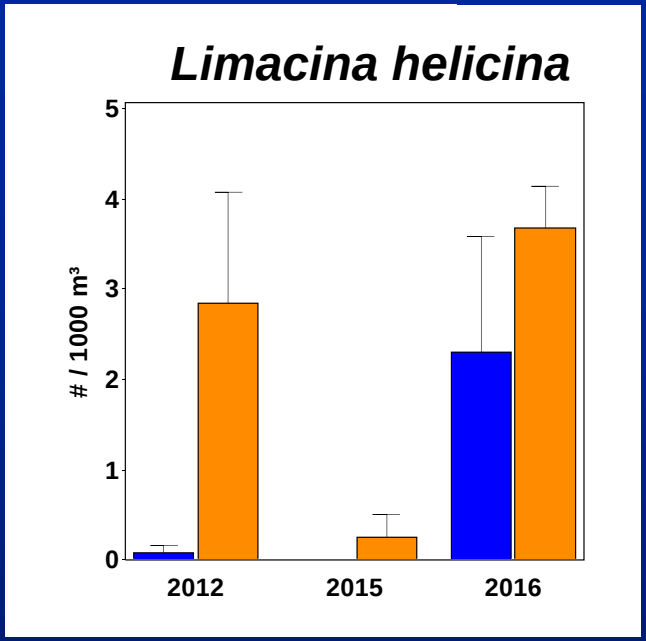


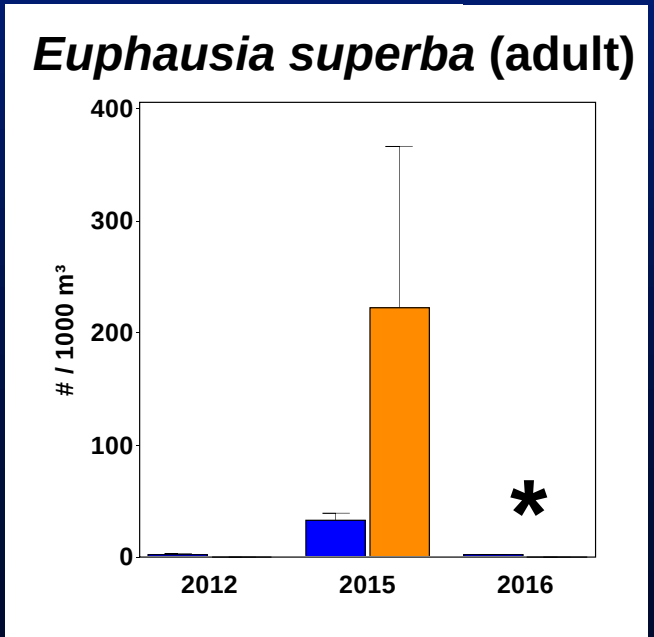


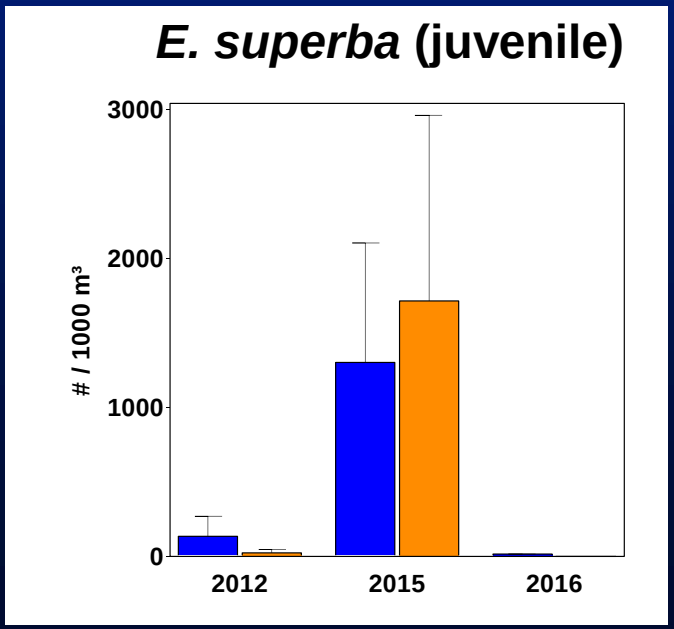
The ‘out’ groups

in & out

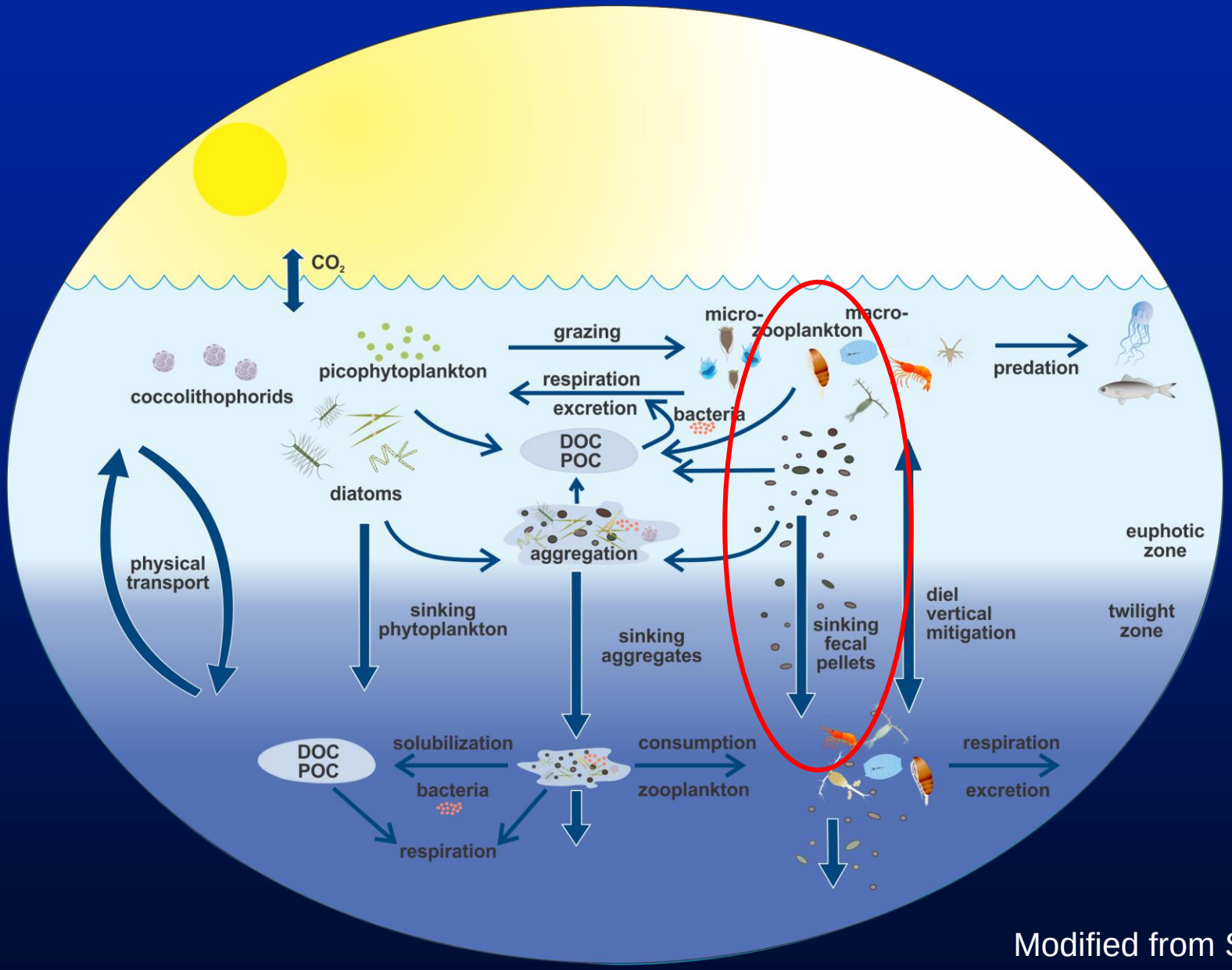








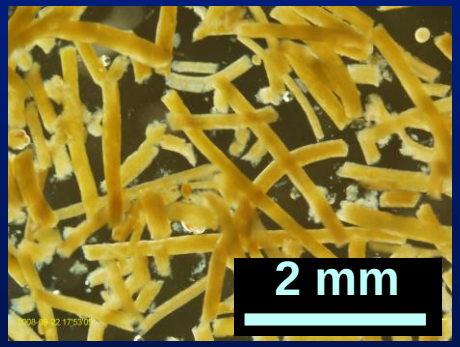
The biological pump



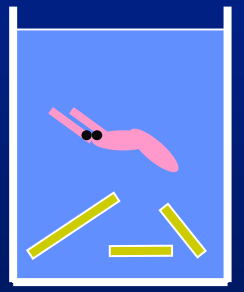
Modified from Steinberg, Buesseler & EXPORTS team

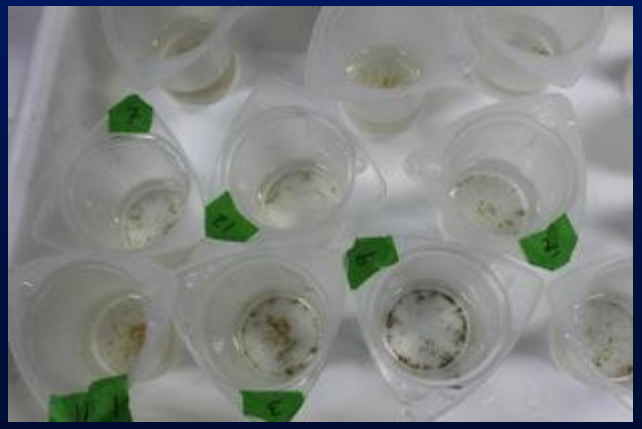
Fecal pellet production measurements

krill fecal pellets

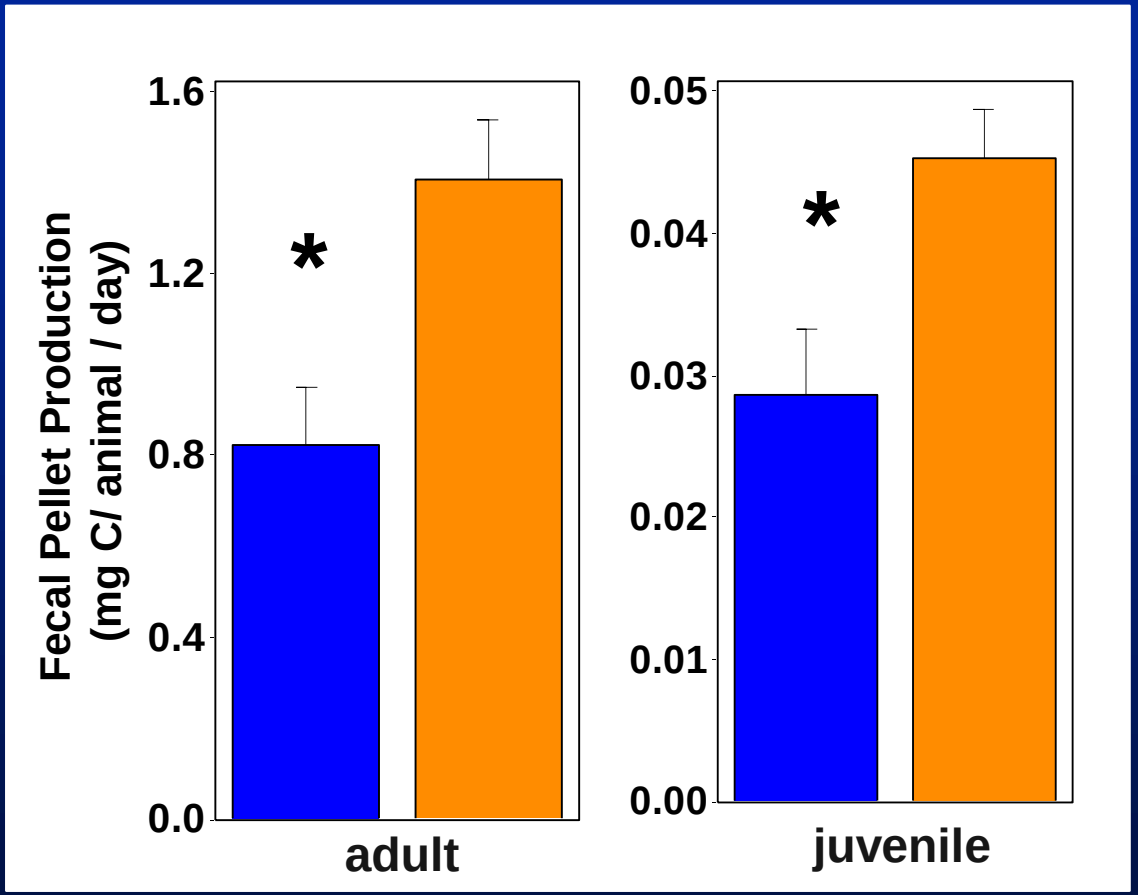


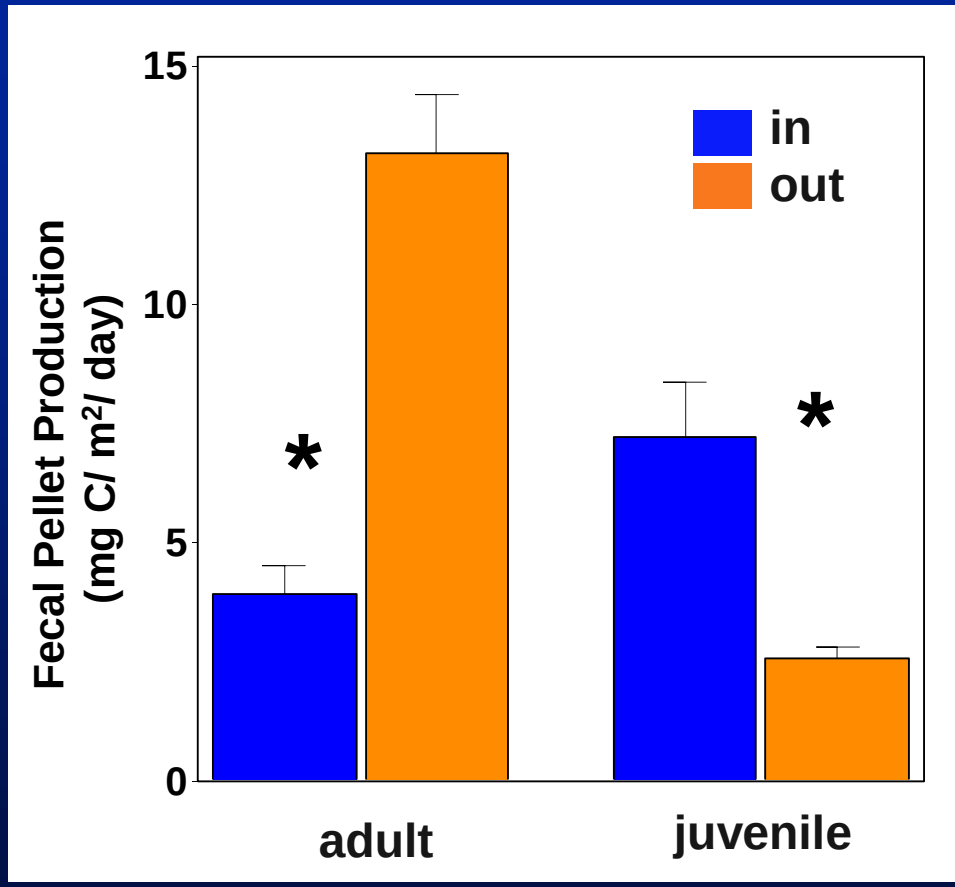
Fecal pellet production experiment





Fecal pellet production by *E. superba* In vs. out of ice (2015)





Chl *a* (mg m^{-2}) 23

35

Summary & Conclusions

- Warming leading to shorter ice season and decreased cover; south now opening up
- *E. crystallorophias* increase in south- increase in primary production as sea ice cover retreats earlier in the season, releasing phytoplankton from light limitation
- Inside (E*. crystal*, ostracods, ctenophores) & outside (copepods, *Limacina*) ice taxa, & both (*E. superba*)
- Fecal pellet production by *E. superba* adults and juveniles dependent upon [Chl a] and krill abundance
- Changes can impact biological pump as the climate warms

Acknowledgements

Pal LTER coauthors, collaborators, technicians, students, & volunteers

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High Latitude session conveners