Biological effects of arctic ocean acidification

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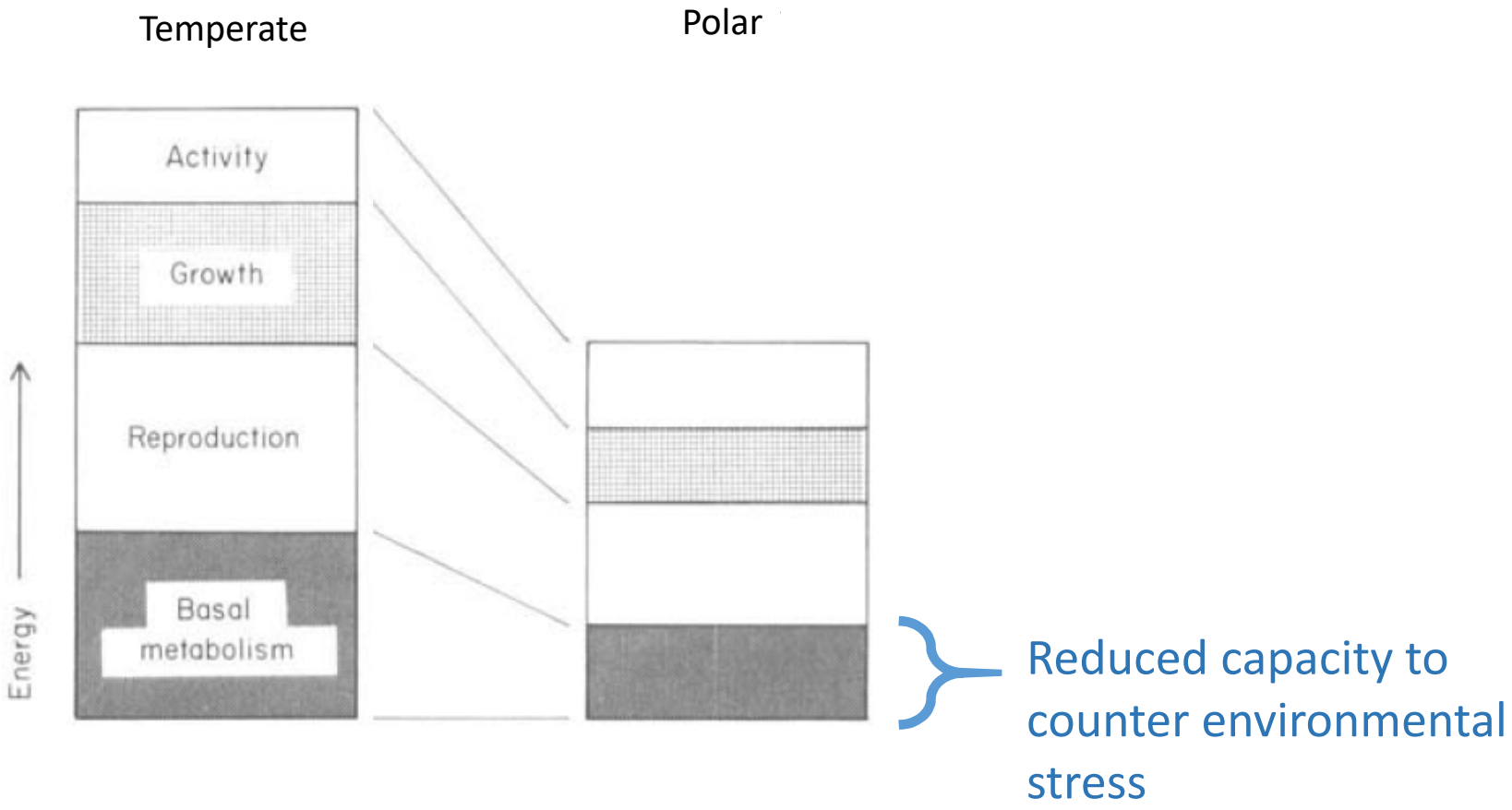
Björn Rost Alfred Wegener Institute
Kai G. Shulz GEOMAR, Helmholtz Centre for Ocean Research
Peter Thor Swedish Meteorological and Oceanographic Institute (Norwegian Polar Institute)

Arctic organisms are special



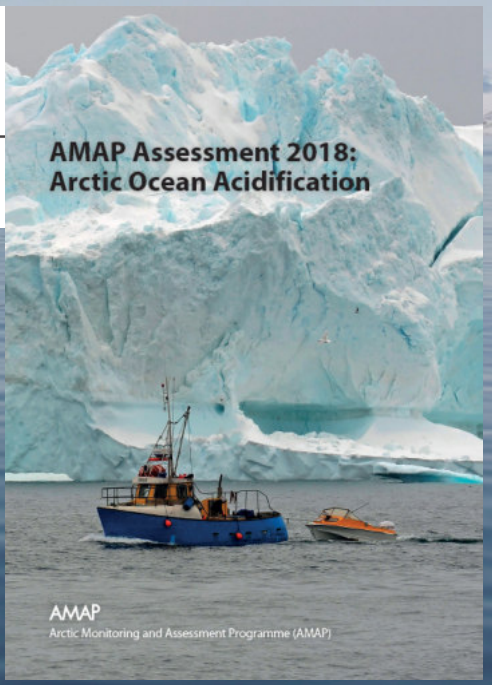
Modified from Clarke 1980

Sensitivity of arctic organisms and ecosystems

Arctic Ocean acidification 2018 Assessment, chapter 3:

3. Biological responses to ocean acidification

AUTHORS: LAURA J. FALKENBERG, ANDERS JELMERT, FELIX C. MARK, BJOERN ROST, KAI G. SCHULZ, PETER THOR



- Viruses
- Bacteria and archaea
- Phytoplankton
- Foraminifera
- Macroalgae
- Corals
- Mollusks
- Echinoderms
- Crustaceans
- Fishes
- Sea birds and mammals

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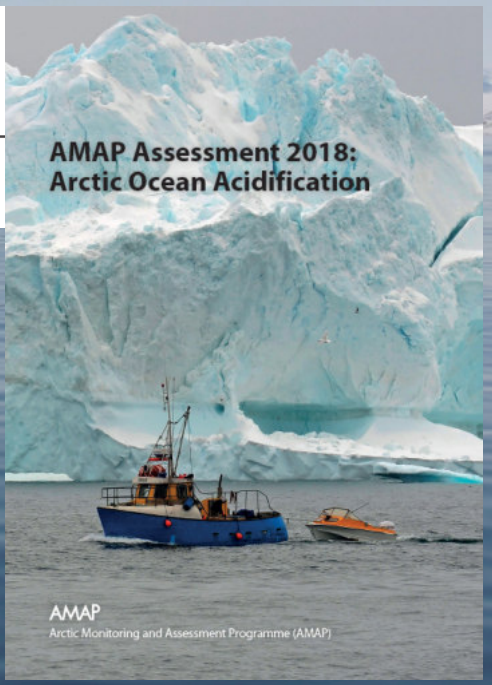

Corals

Phytoplankton

Crustaceans (copepods)

Fishes (cod)

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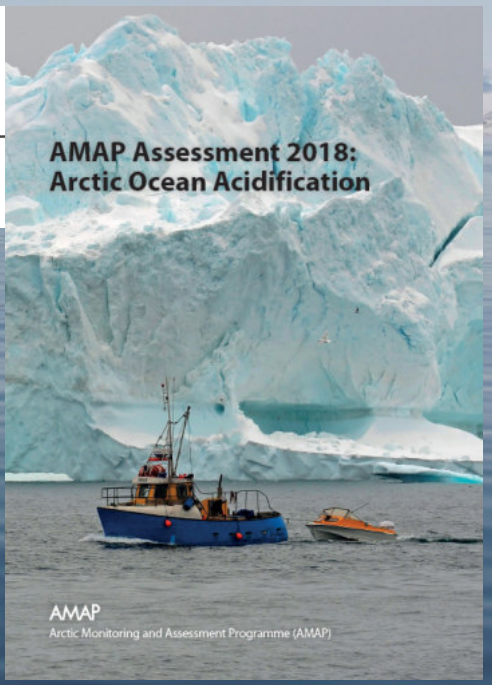
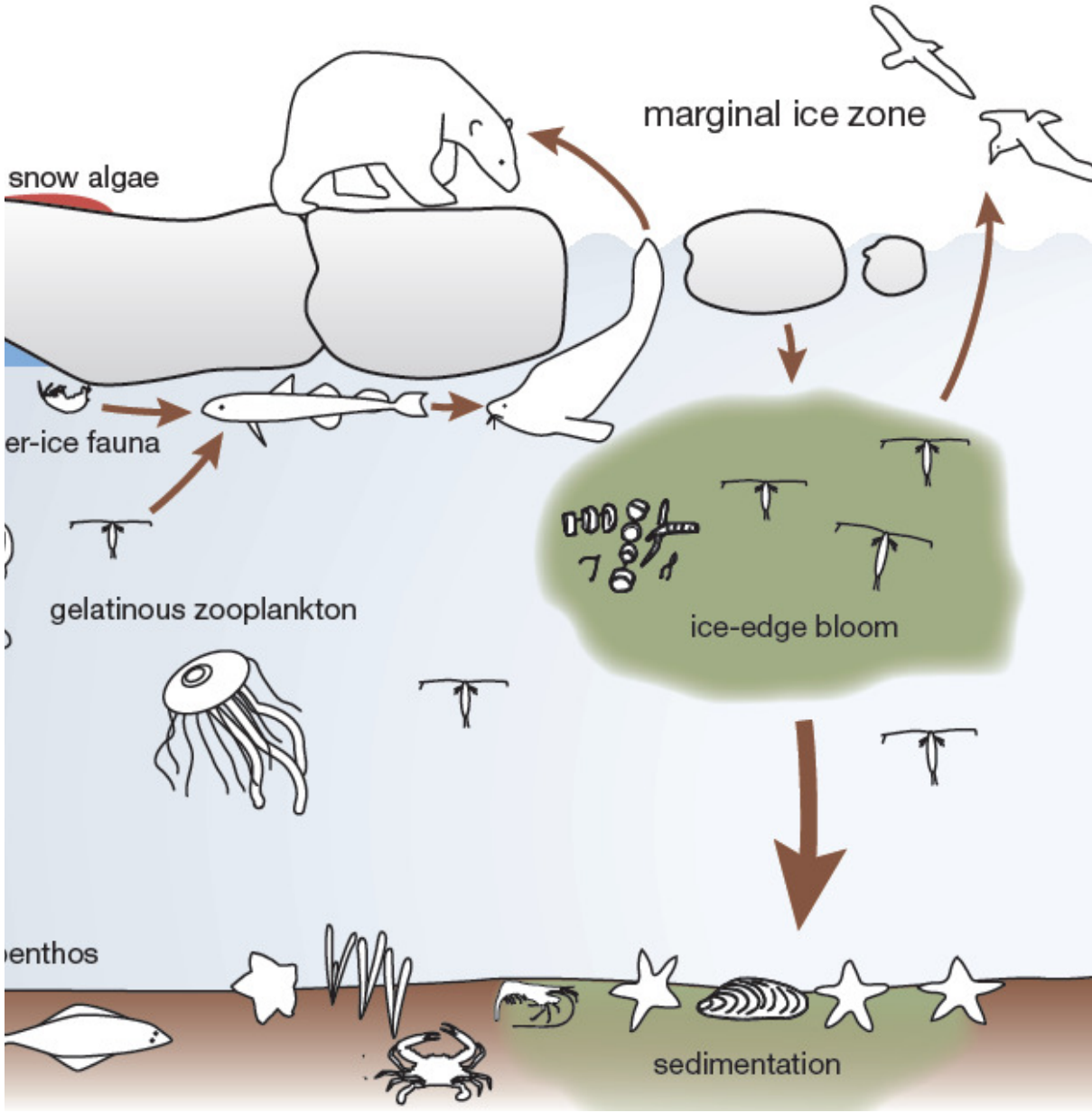


Will evolution come to the rescue?

OA effects combined with climate change

Ecosystem effects

- Top-down effects
- Bottom-up effects
- Effects on interspecific competition
- Effects on biogenic habitats
- Keystone species



Phytoplankton

nature climate change

ARTICLES

https://doi.org/10.1038/s41558-018-0142-9

Compensation of ocean acidification effects in Arctic phytoplankton assemblages

Clara Jule Marie Hoppe[1,2*], Klara K. E. Wolf[1], Nina Schuback[2,3], Philippe D. Tortell[2,4,5] and Björn Rost[1]

Biogeosciences, 14, 2407–2427, 2017
www.biogeosciences.net/14/2407/2017/
doi:10.5194/bg-14-2407-2017

Biogeosciences Open Access EGU

Impact of ocean acidification on Arctic phytoplankton blooms and dimethyl sulfide concentration under simulated ice-free and under-ice conditions

Rachel Hussherr[1], Maurice Levasseur[1], Martine Lizotte[1], Jean-Éric Tremblay[1], Jacoba Mol[2], Helmuth Thomas[2], Michel Gosselin[3], Michel Starr[4], Lisa A. Miller[5], Tereza Jarniková[6], Nina Schuback[6], and Alfonso Mucci[7]

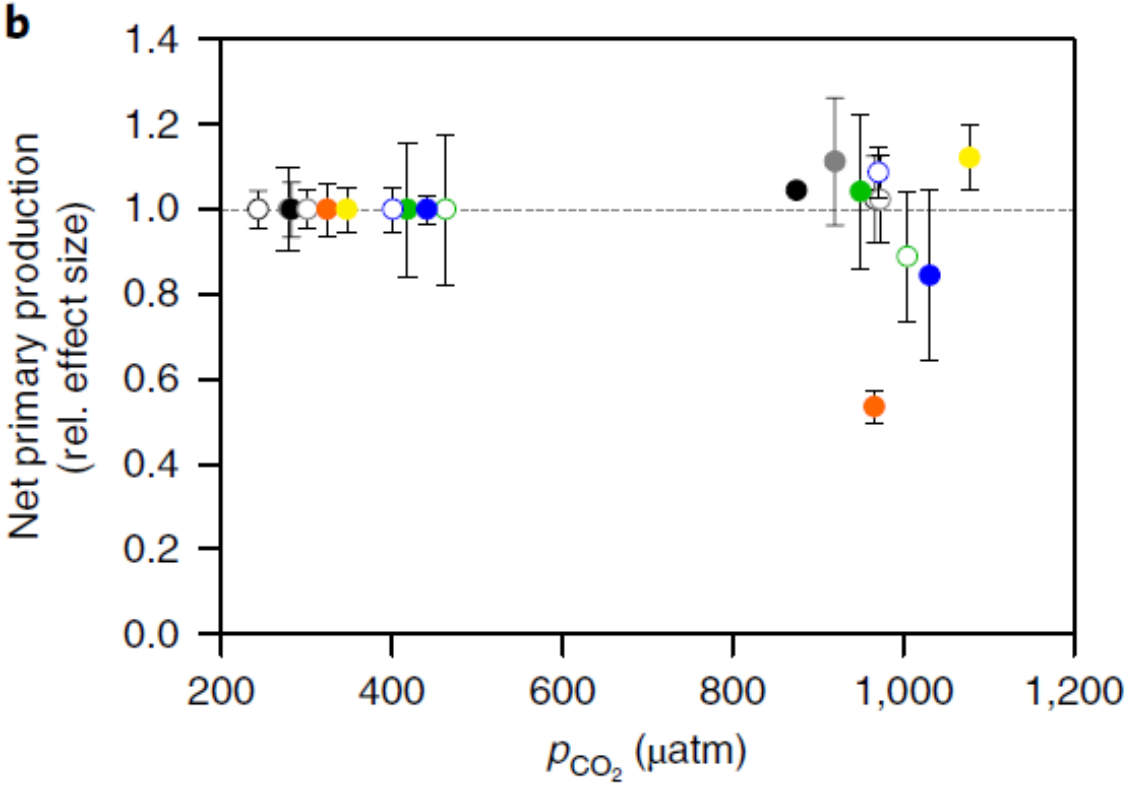
ı to be comparatively resilient to
roduction and little change in
*p*CO2 (Hoppe et al., 2017, 2018).

Kongsfjord

Baffin Bay

Davis Straight

Hoppe et al. 2018 Nature Climate Change



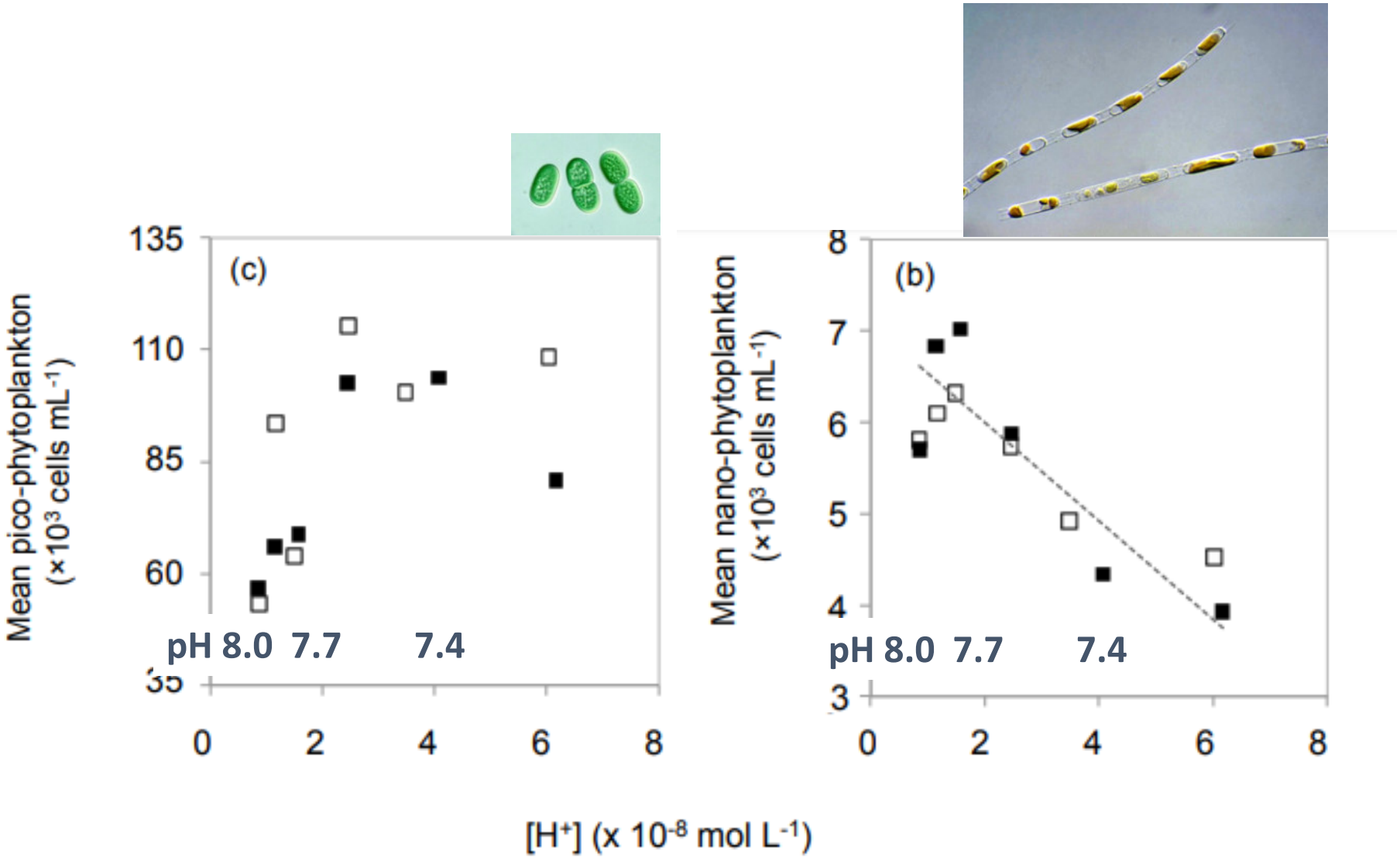
Hoppe et al. 2018 Nature Climate Change

Incubation	NPP change	Species shift	Dominant taxa and shifts
DS_1	No	Yes	*Fragilariopsis* to *Pseudo-nitzschia* under OA
DS_2	No	Yes	*Fragilariopsis* to *Pseudo-nitzschia* under OA
BB_1	No	No	*Chaetoceros*
BB_2	No	No	*Chaetoceros*
KFa_1	No	No	*Thalassiosira*, *Chaetoceros*, *Micromonas*
KFa_2	No	No	*Thalassiosira*, *Chaetoceros*, *Micromonas*
KFa_3	No	No	*Thalassiosira*, *Chaetoceros*, *Micromonas*
KFa_4	No	No	*Thalassiosira*, *Chaetoceros*, *Micromonas*
KFb_1	Yes	Minor	*Navicula*, *Nitzschia*, *Thalassiosira* (*T.* decreasing under OA)
KFb_2	No	No	*Navicula*, *Nitzschia*, *Thalassiosira*

Hoppe et al. 2018 Nature Climate Change

Baffin Bay

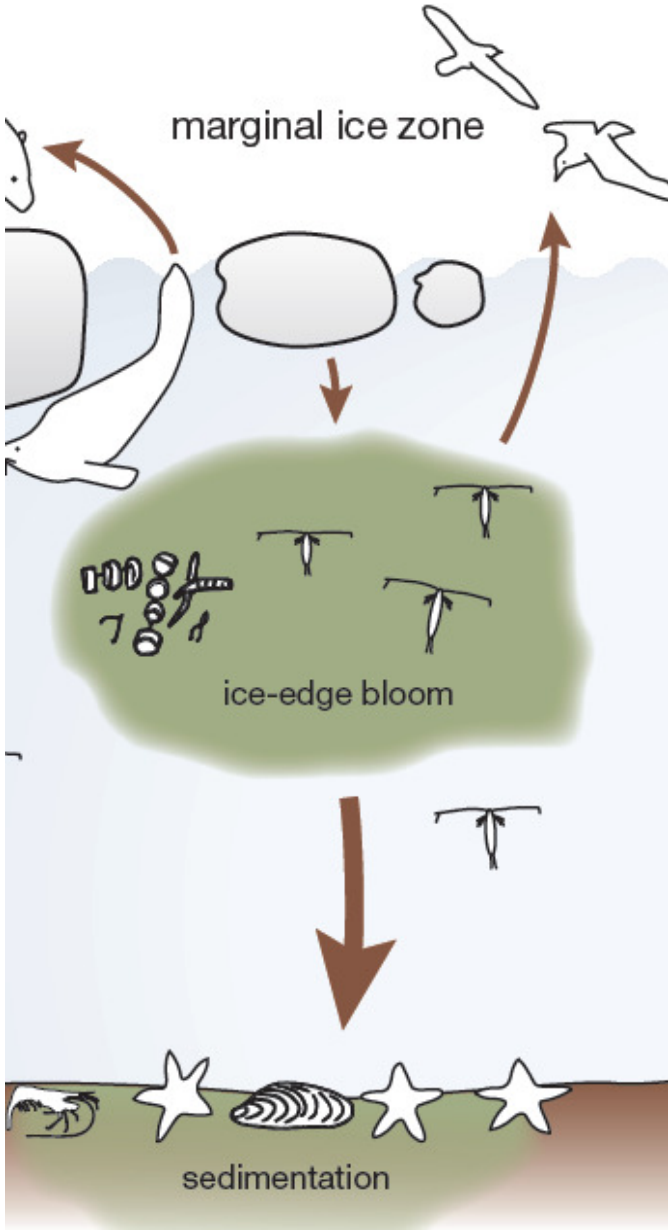
Hussherr et al. 2017 *Biogeoscience*



Hussherr et al. 2017 *Biogeoscience*

Ecosystem effects

- Bottom-up effect
- Effects on interspecific competition



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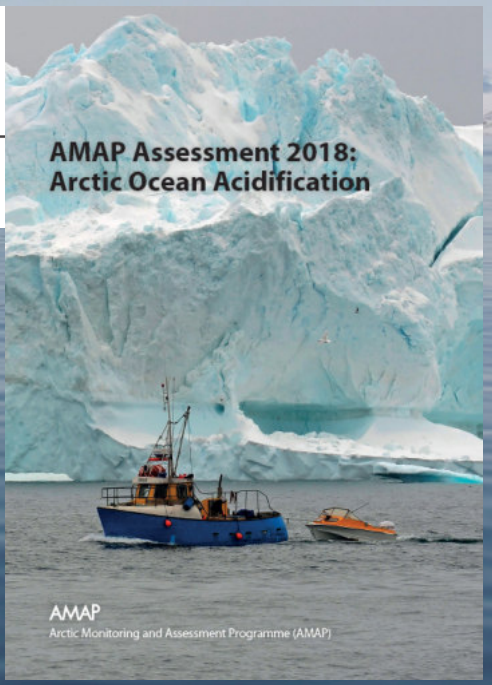
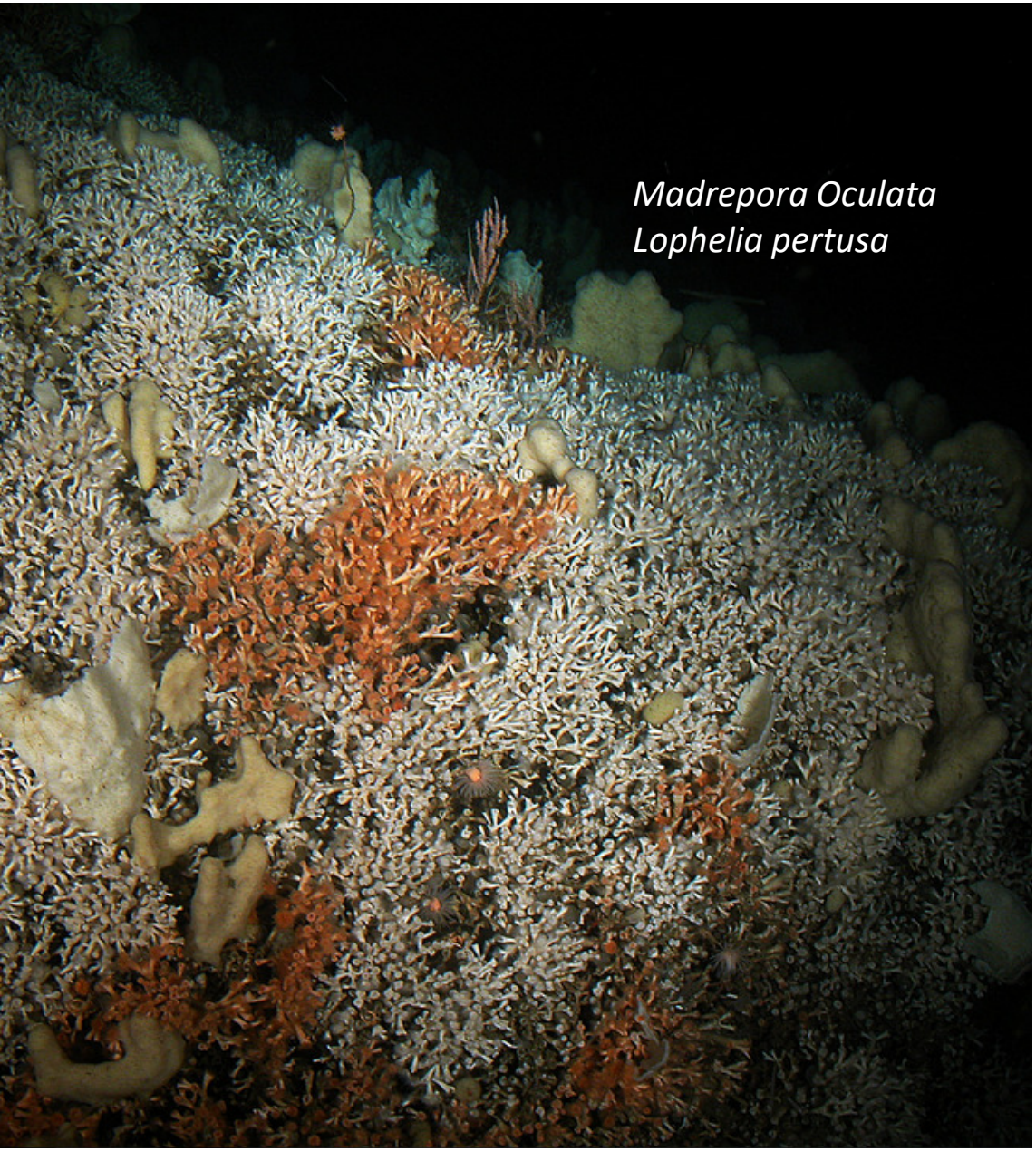


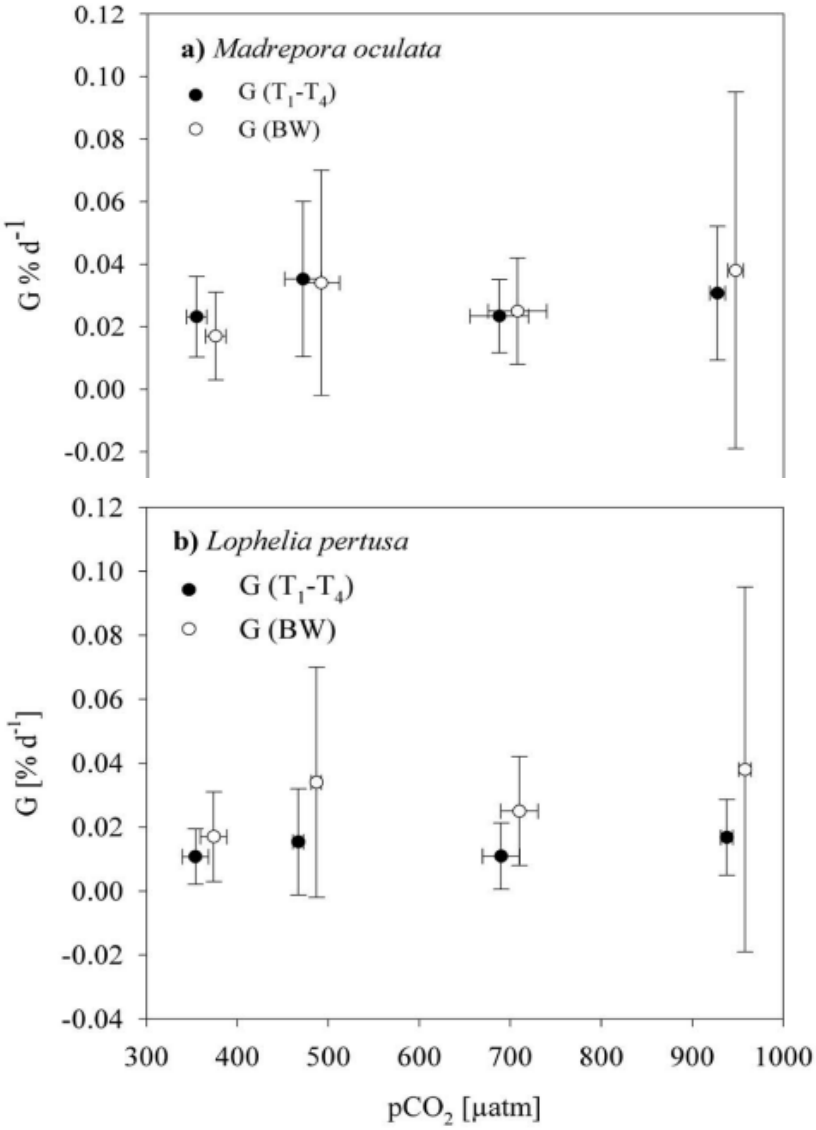
Corals

Phytoplankton

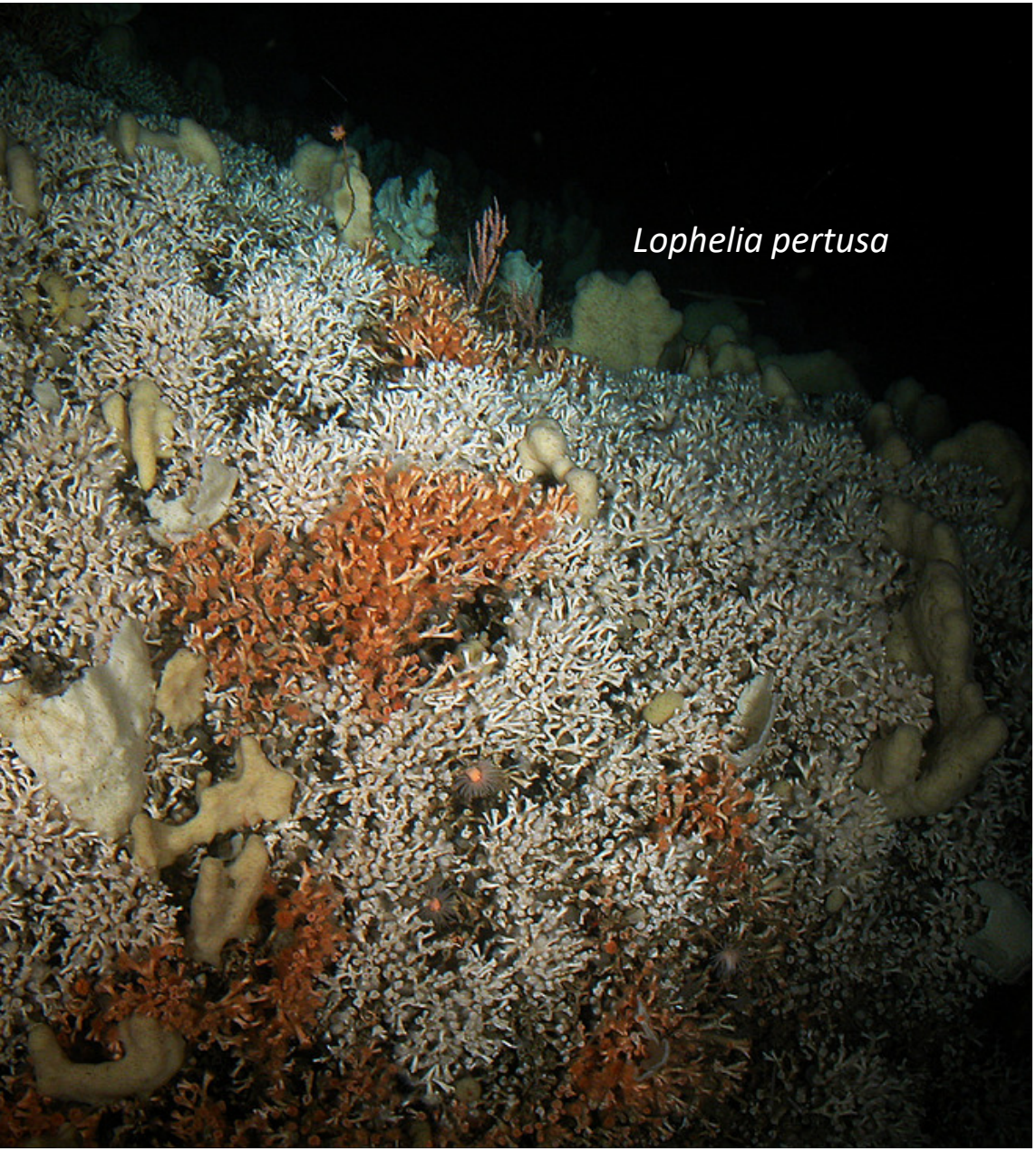
Crustaceans (copepods)

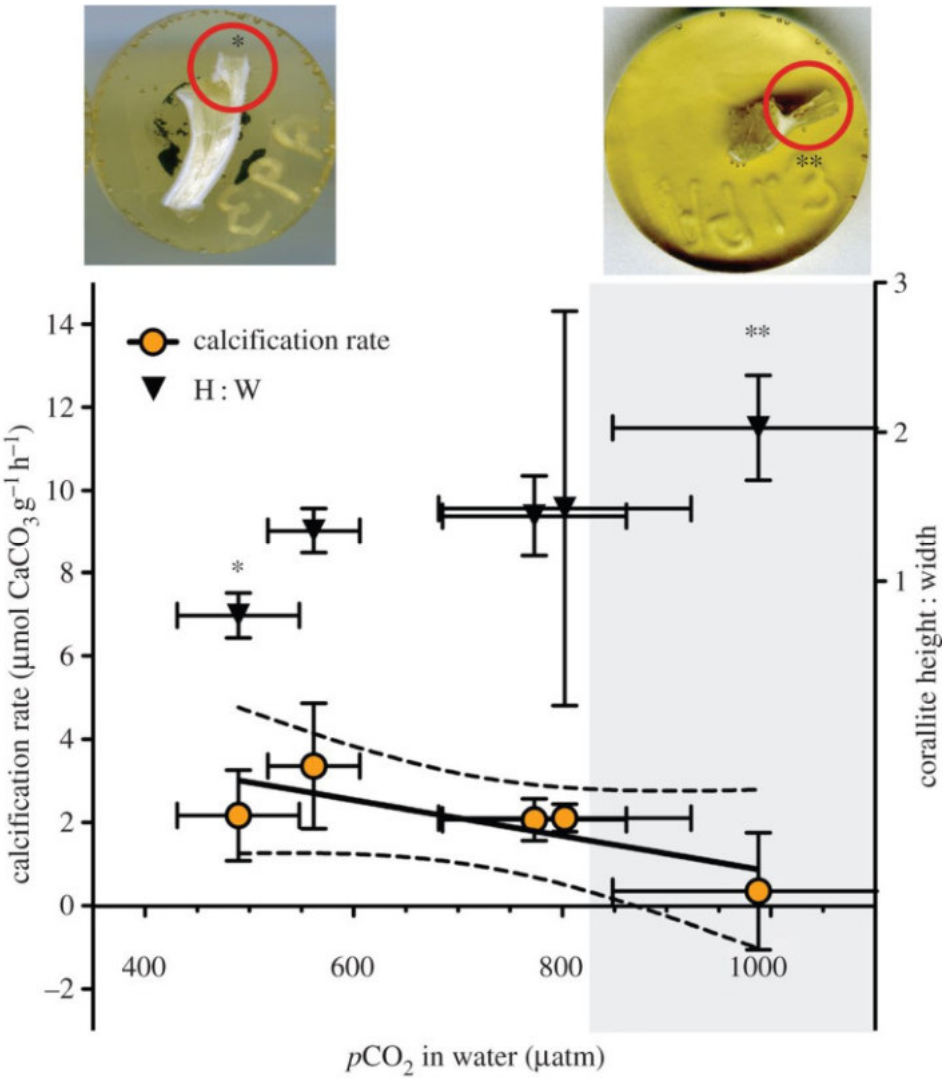
Fishes (cod)



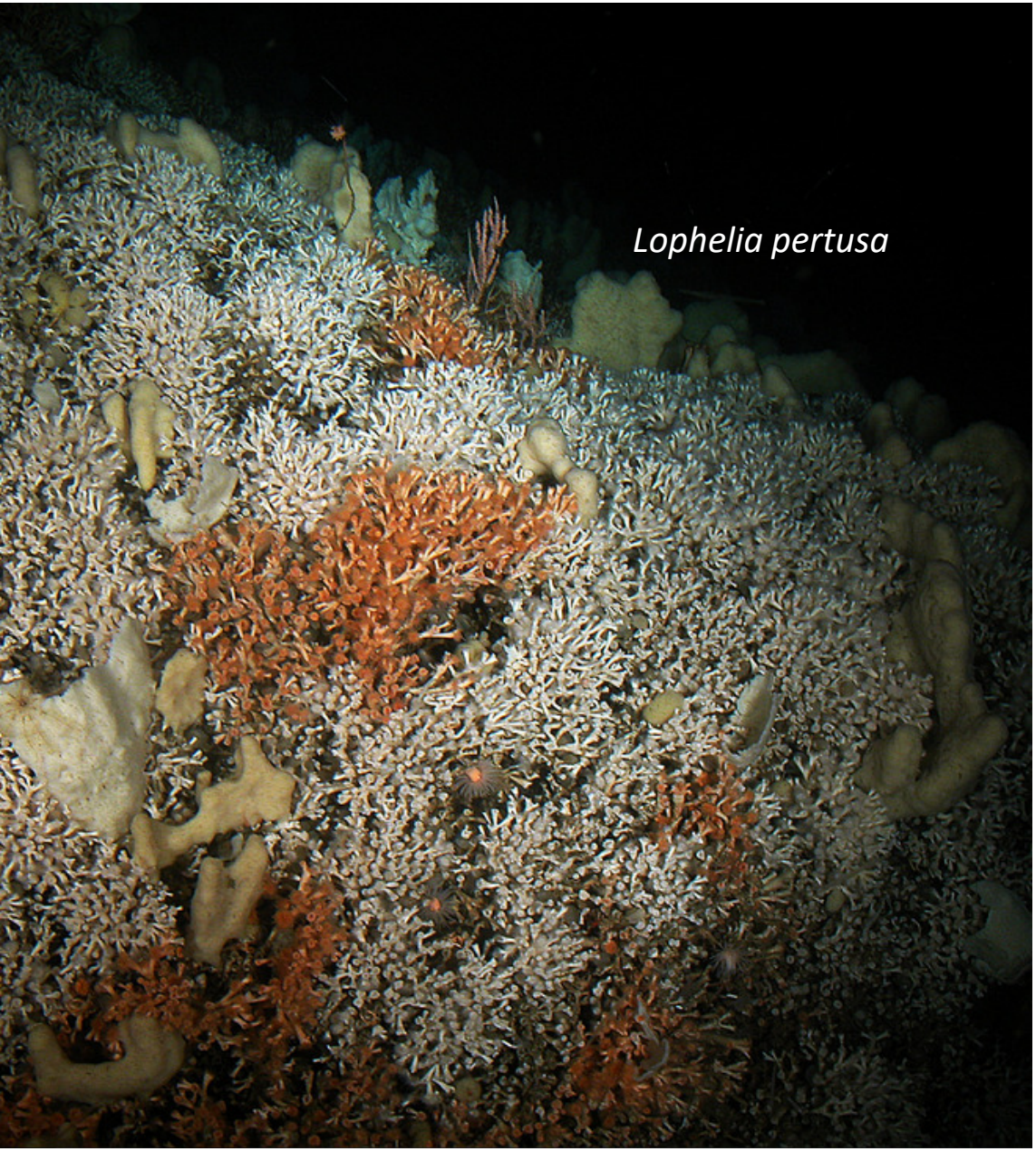


Maier et al 2013





Hennige et al. 2015

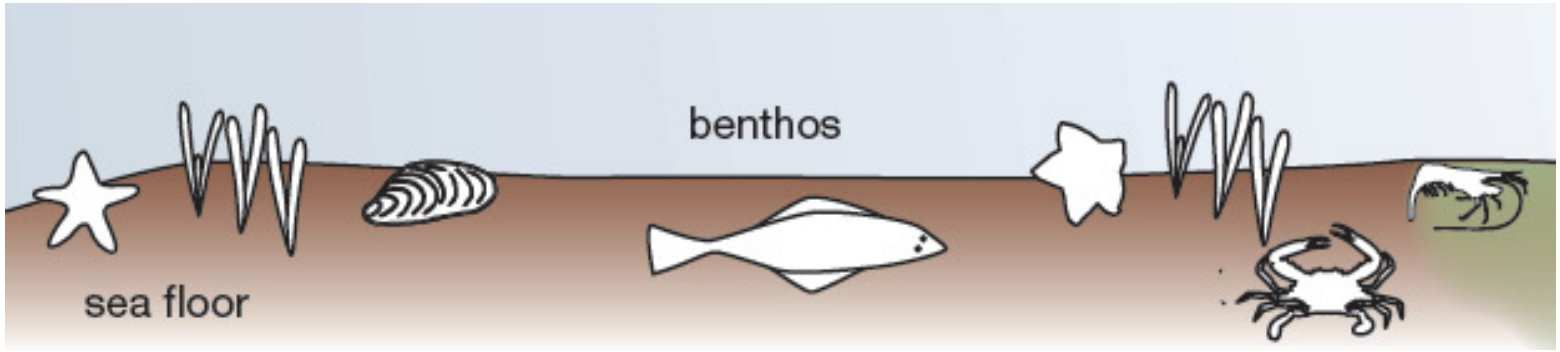


treatment	breaking force (*N*/(*D*/Wt))
9°C 380 ppm	25.9 (3.66)
12°C 380 ppm	22.1 (1.20)
9°C 750 ppm	17.2 (5.28)
12°C 750 ppm	20.0 (6.94)
9°C 1000 ppm	13.1 (3.78)

Hennige et al. 2015

Ecosystem effects

- Effects on biogenic habitats
- Keystone species



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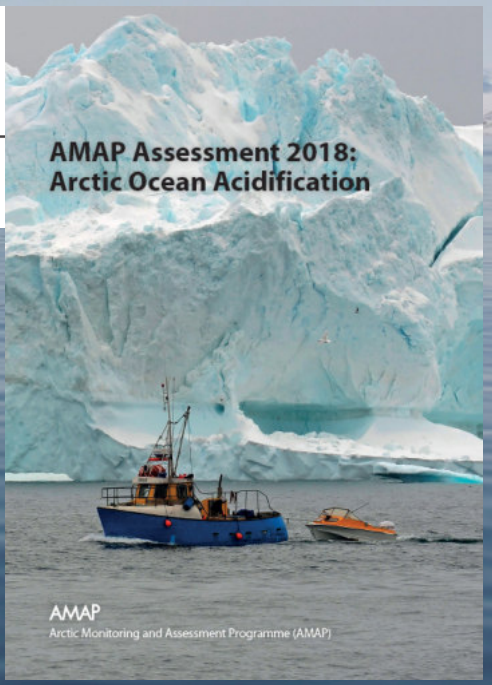


Corals

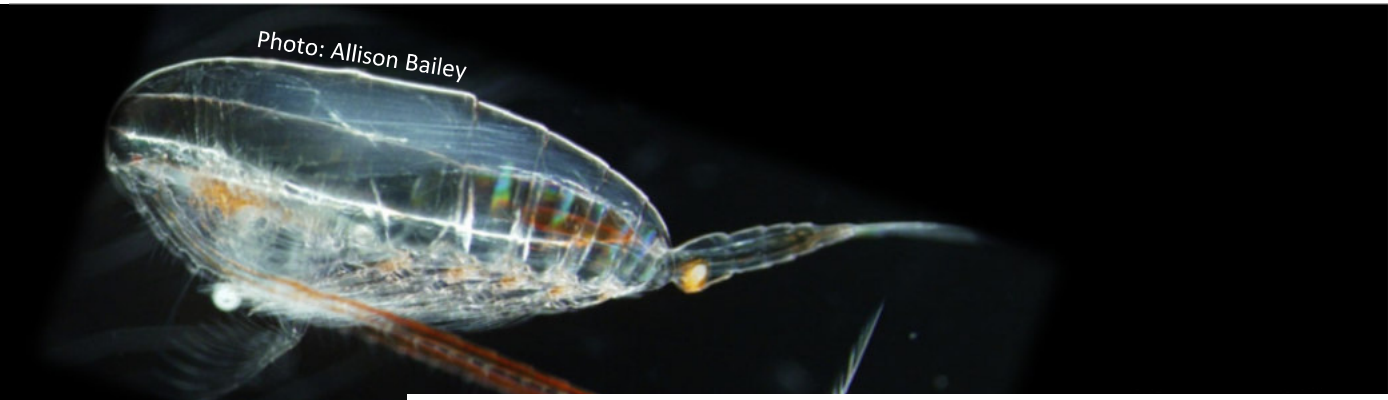
Phytoplankton

Crustaceans (copepods)

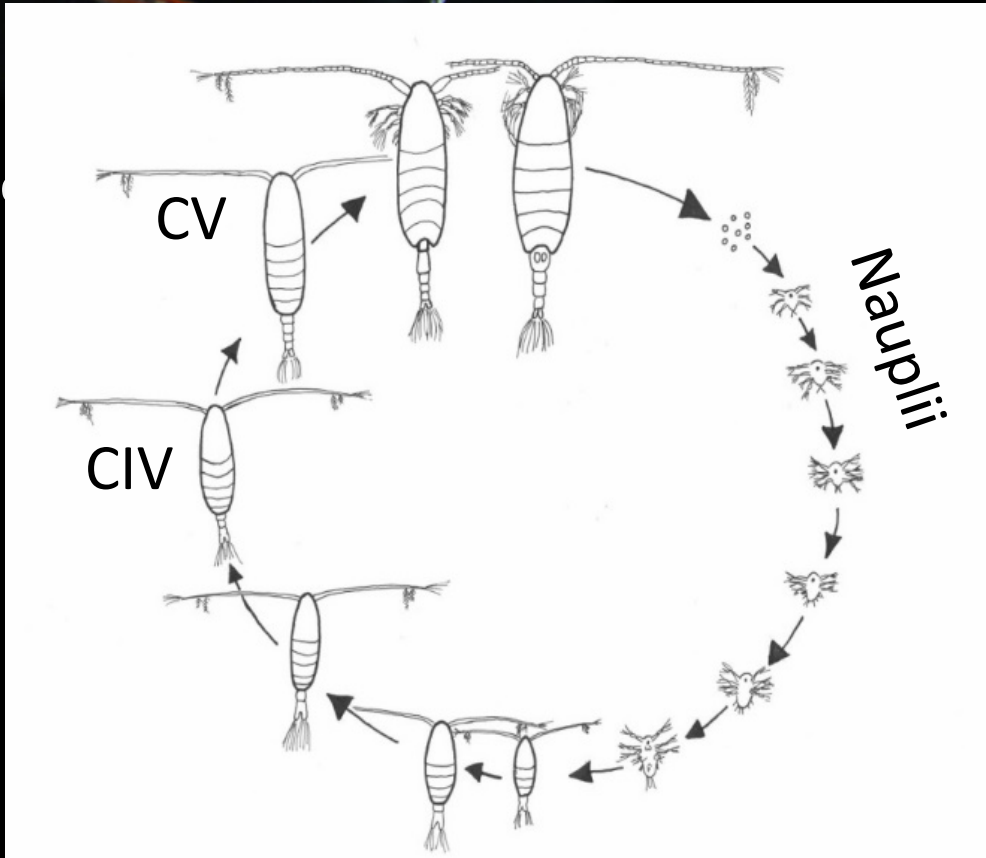
Macroalgae

Fishes (cod)

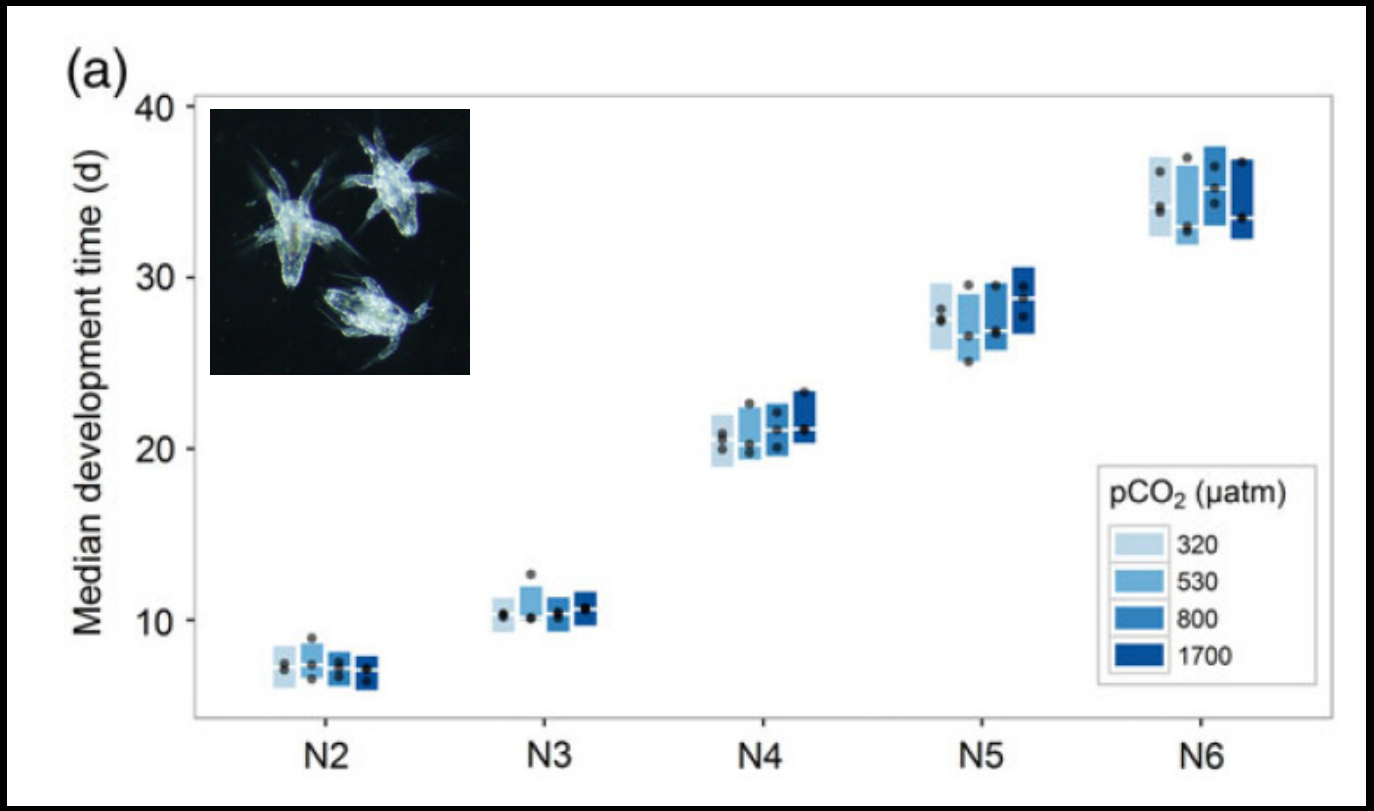
Calanus glacialis



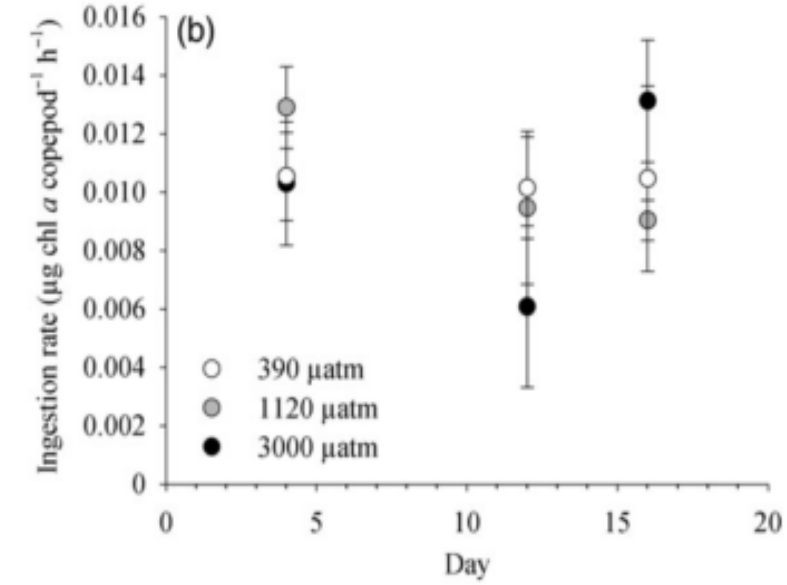
- Keystone arctic species
- 80% of the zooplankton biomass in Arctic shelf s
- Primary prey for larval and juvenile fish
- Important prey for whales and seabirds

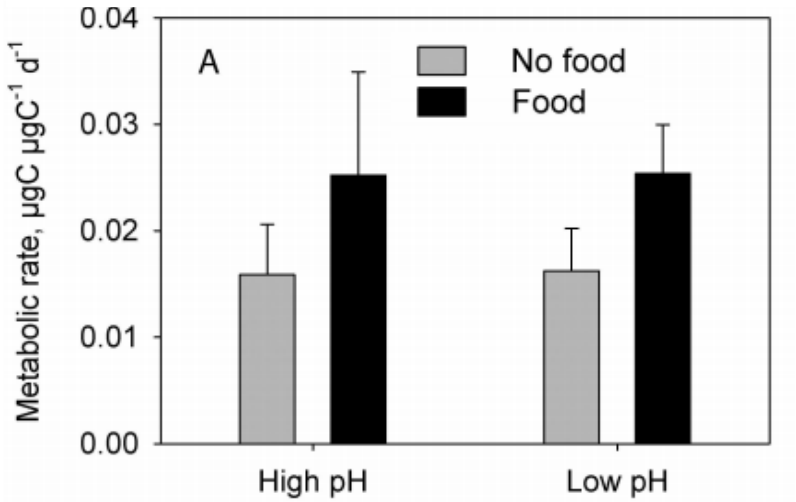


Calanus glacialis



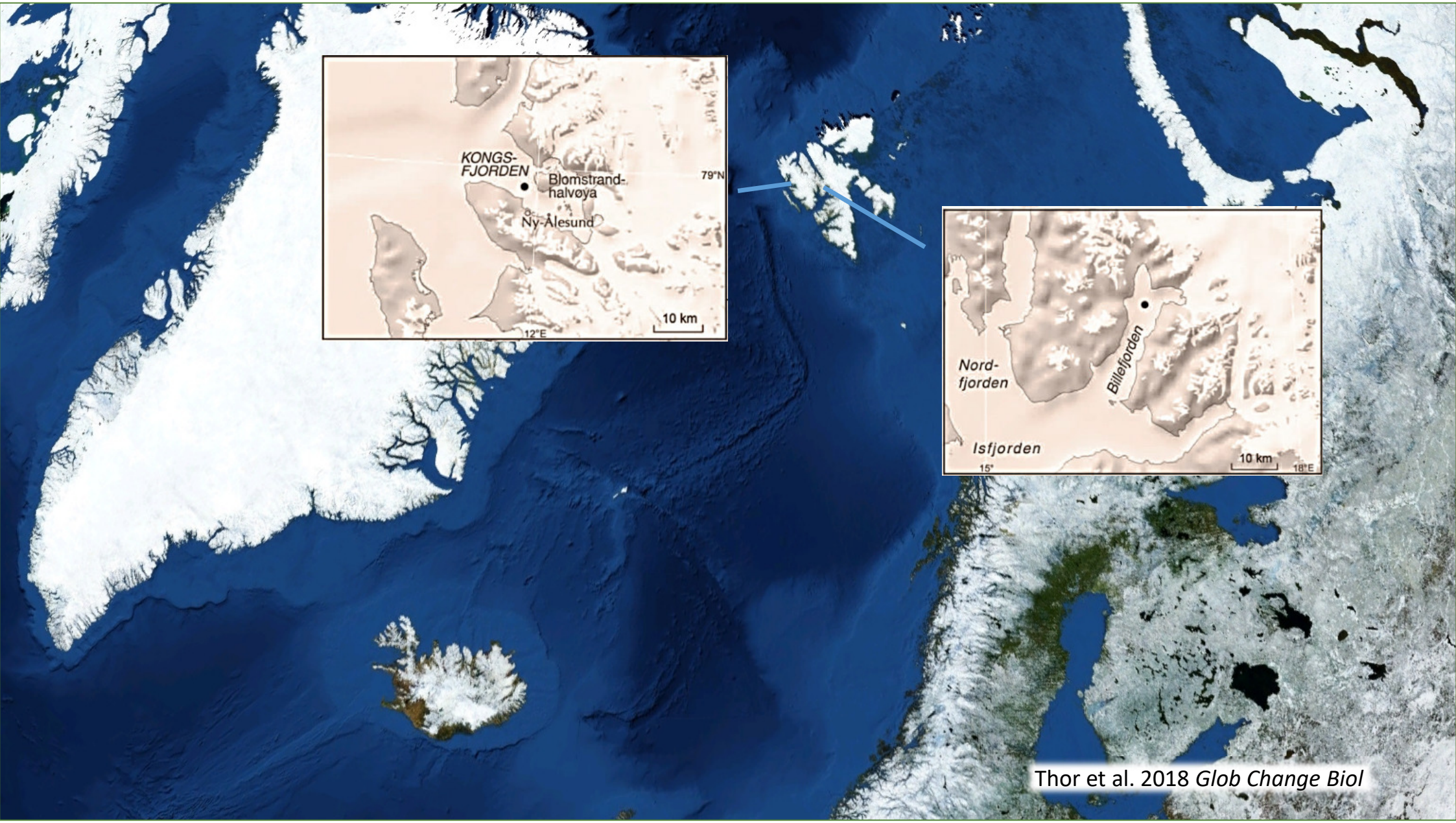
Bailey et al 2016 *ICES JMS*





Calanus glacialis CV

Hildebrandt et al 2016 *ICES JMS*
Thor et al. 2016 PLoS One


KONGS-
FJORDEN
Blomstrand-
halvøya
Ny-Ålesund
79°N
10 km
12°E
Nord-
fjorden
Billefjorden
Isfjorden
10 km
15°
18°E
Thor et al. 2018 *Glob Change Biol*

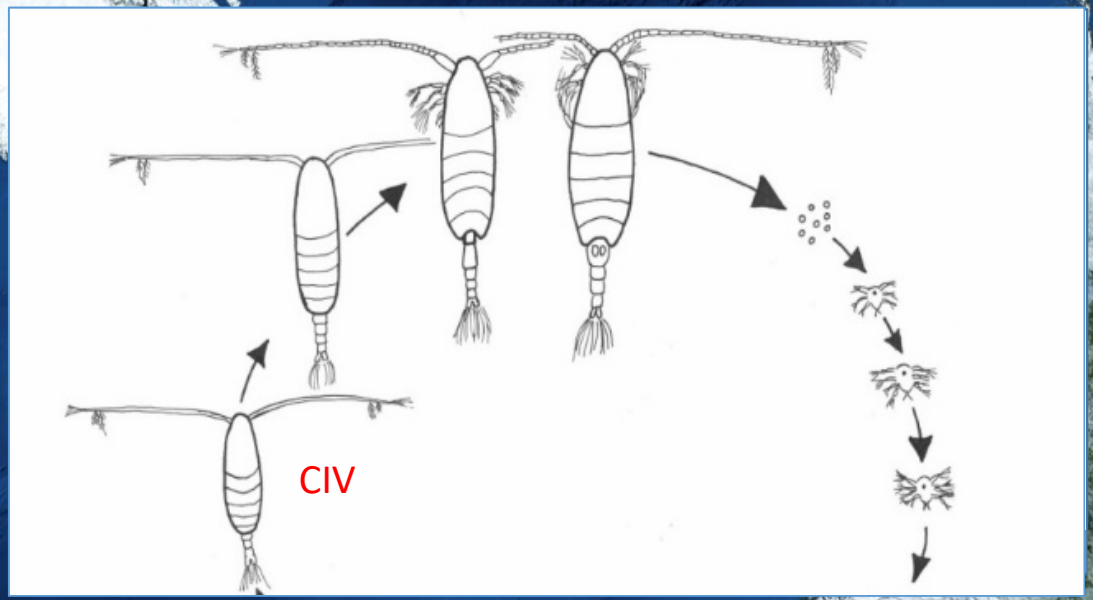
Calanus glacialis copepodite IV

Potential for developing to the next stage

Year 2100:

Kongsfjord
↓ 19%

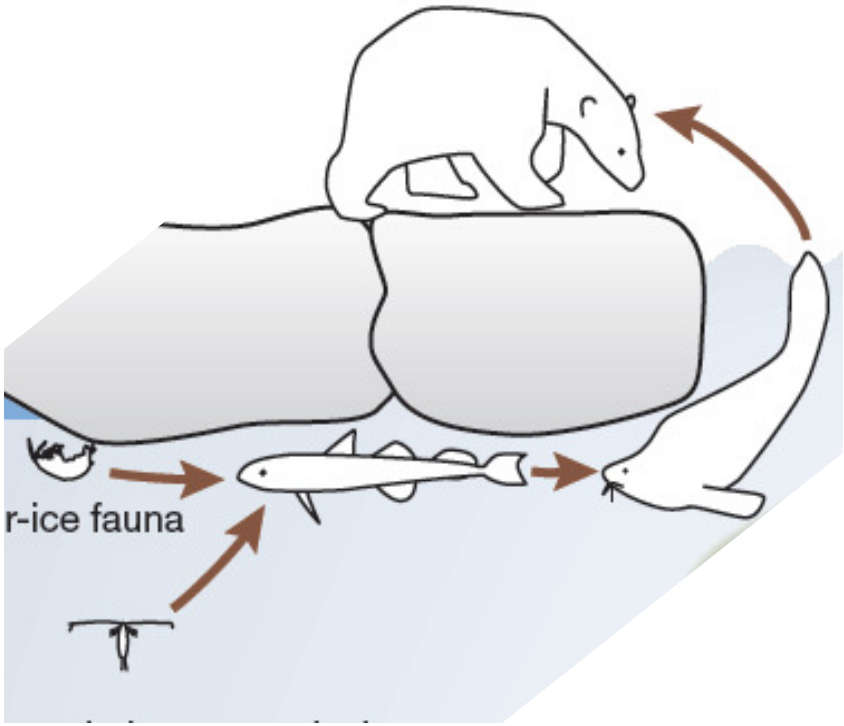
Billefjord
↓ 50 %



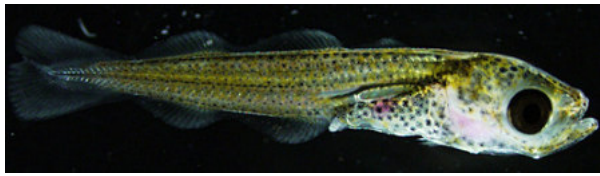
Thor et al. 2018 *Glob Change Biol*

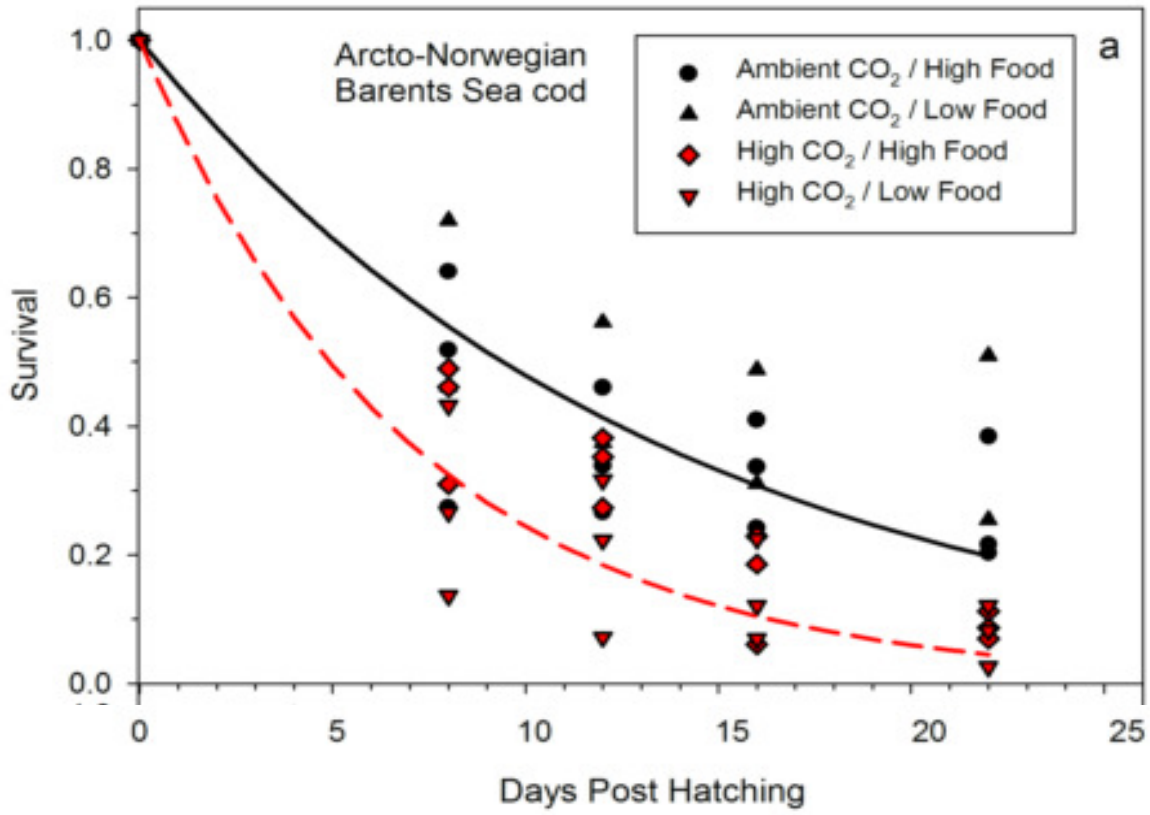
Ecosystem effects

- Bottom-up effects
- Keystone species



Fishes
Cod larvae



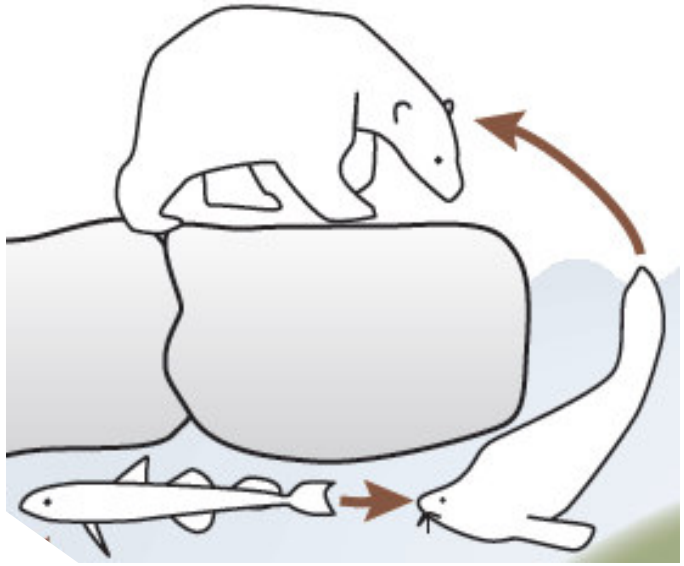


High = 1100 µatm CO2

Stiasny et al 2016 *PLoS One*

Ecosystem effects

- Bottom-up effects
- Socioeconomic effects



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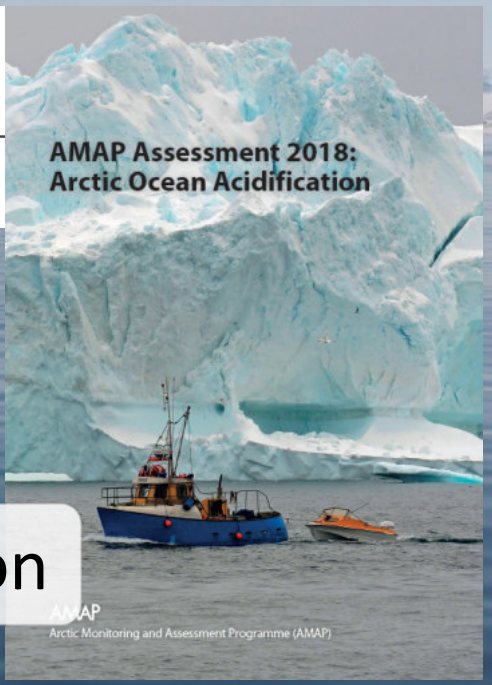
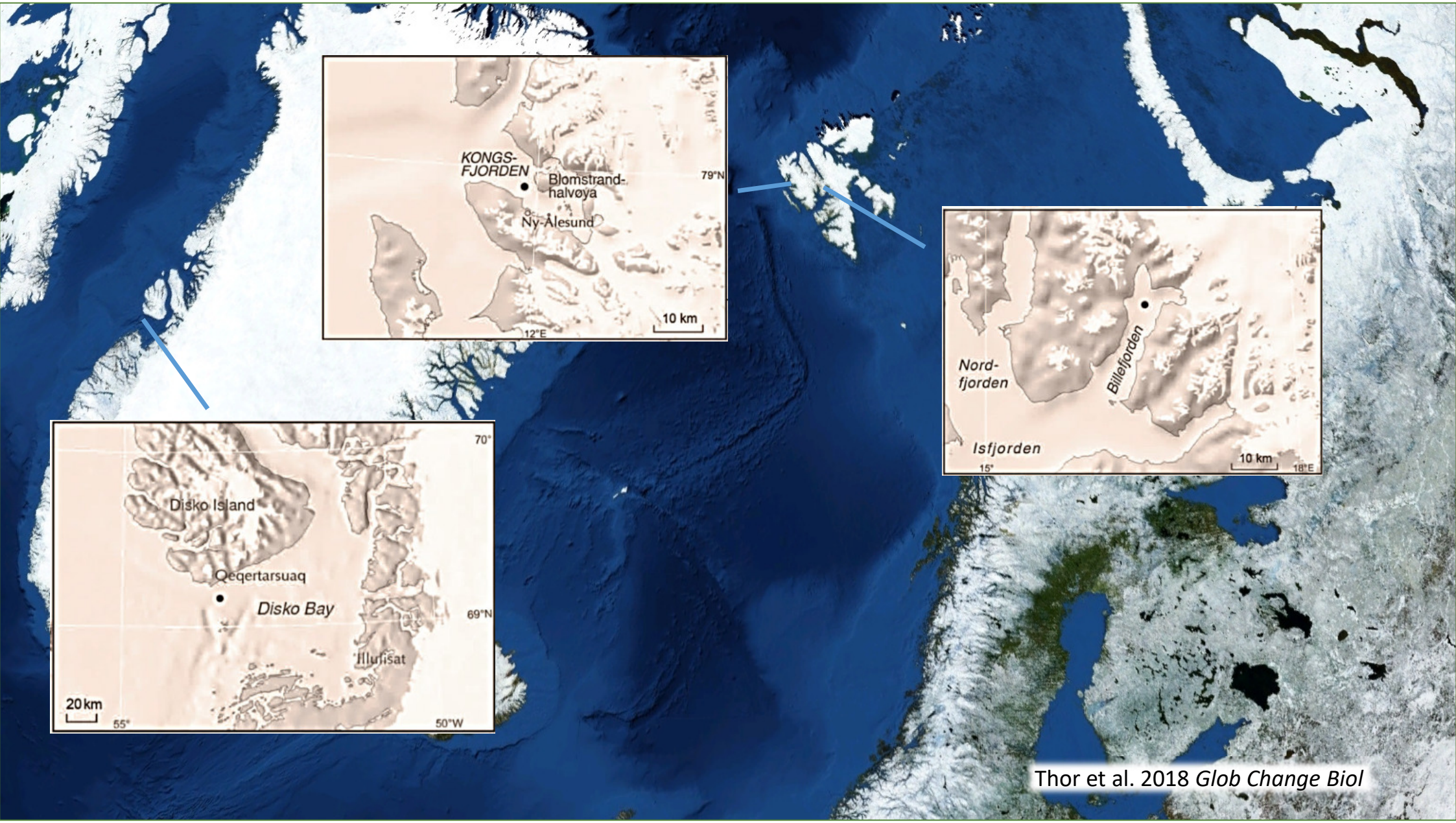


Will evolution come to the rescue?

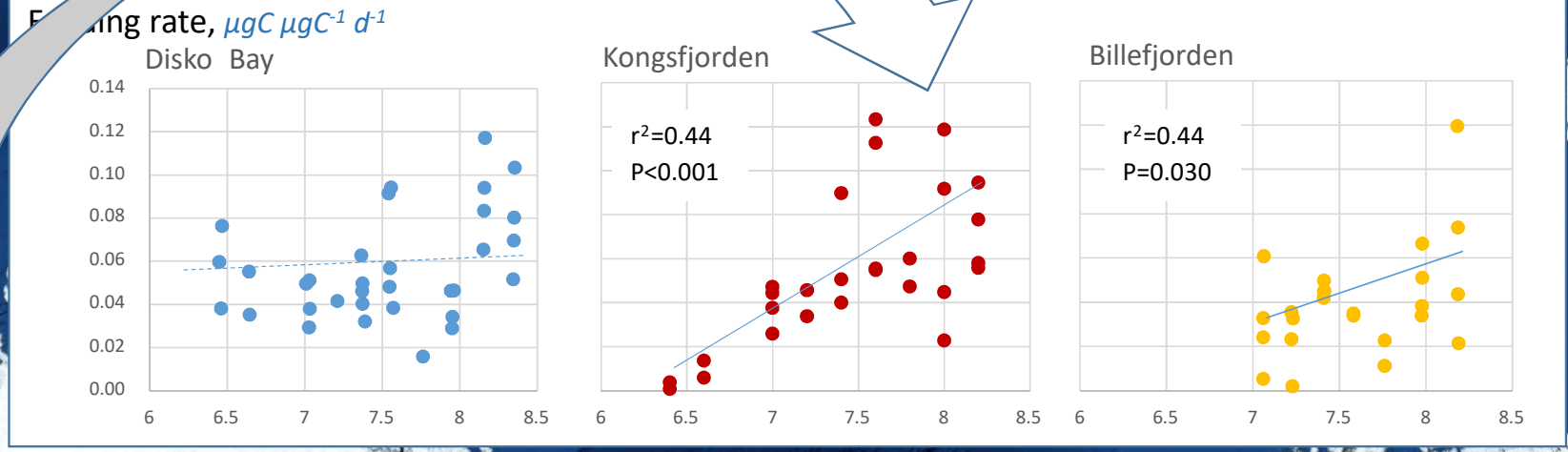
OA effects combined with climate change

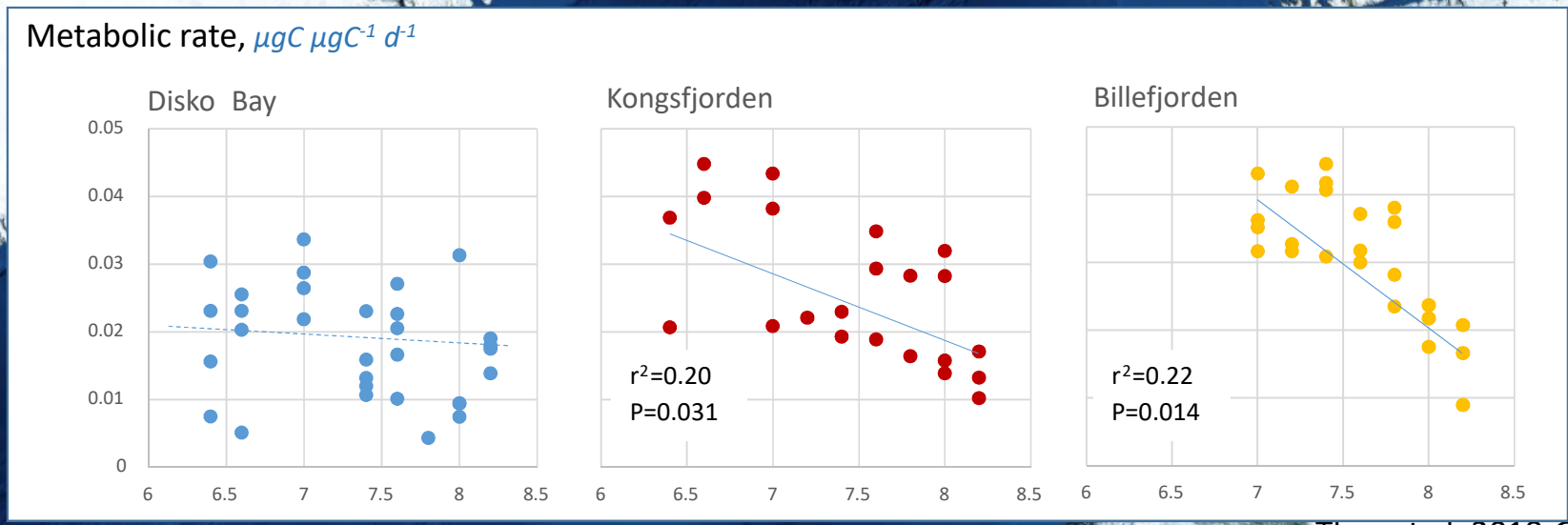
Mutation, migration, or selection



Thor et al. 2018 *Glob Change Biol*

Calanus glacialis
copepodite IV

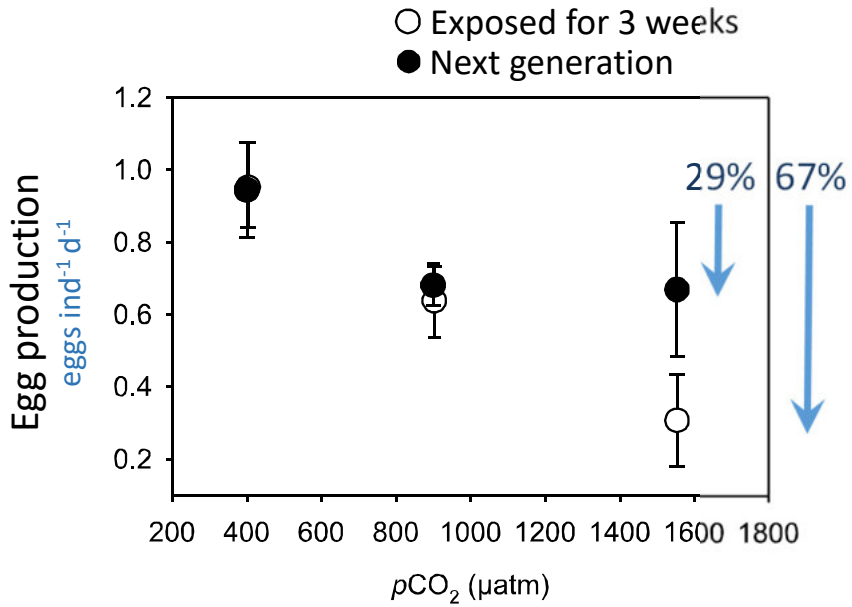




Thor et al. 2018 *Glob Change Biol*

pH_T

Evidence of adaptation to OA by natural selection



Adaptation caused by selection in genes responsible for energy production processes
=>
EVOLUTION

De Wit et al 2015 *Evol Appl*

Pseudocalanus acuspes

Thor and Dupont 2015 *Glob Change Biol*

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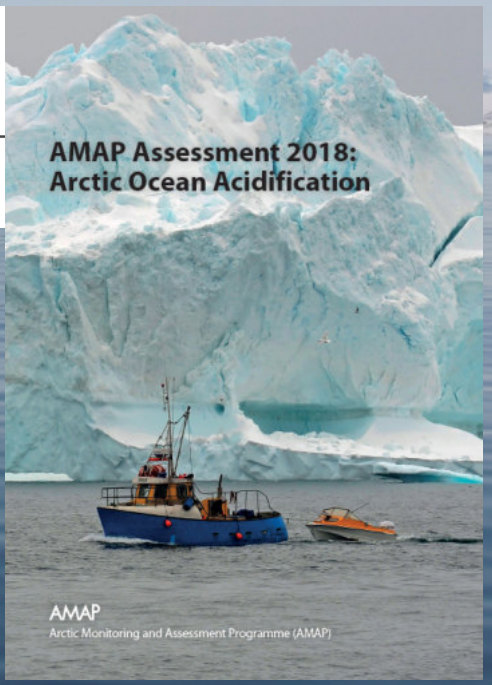

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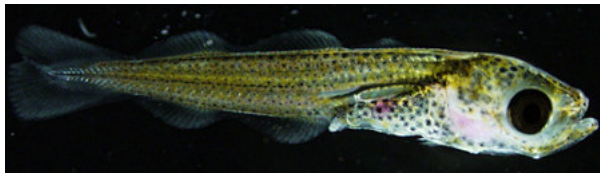
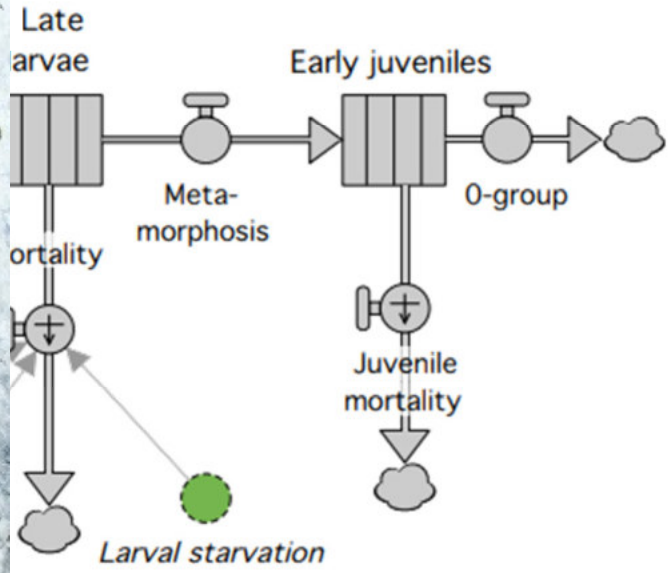
OA effects combined with climate change

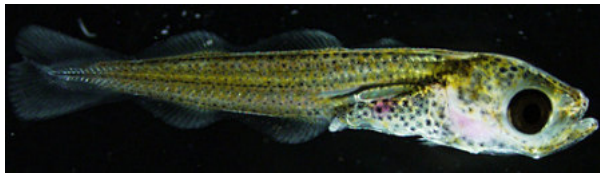
Barents sea cod recruitment

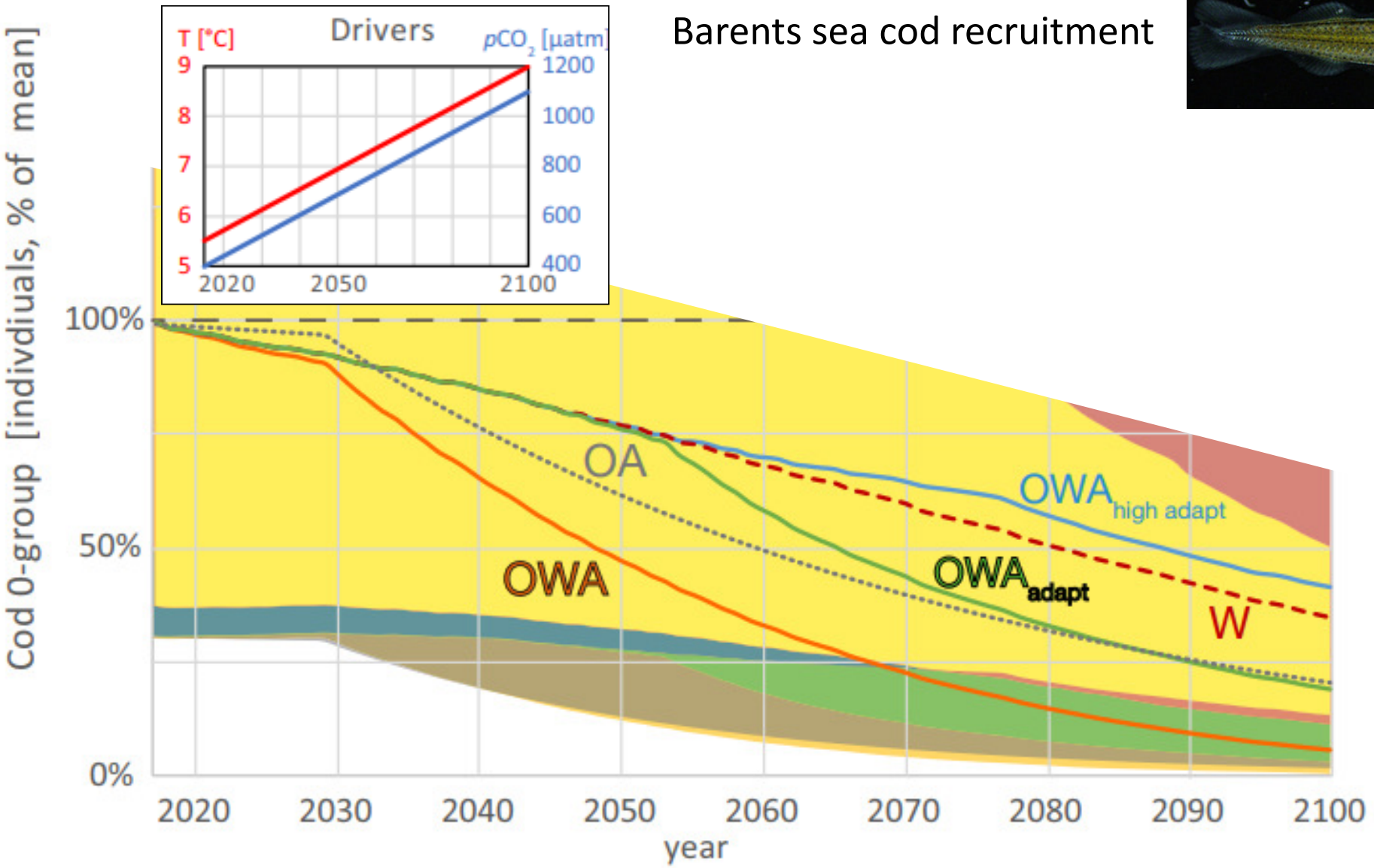




Koenigstein et al. 2017 *Glob Change Biol*

Barents sea cod recruitment





Koenigstein et al. 2017 *Glob Change Biol*


AMAP
Arctic Monitoring and Assessment Programme
NIVA
Norsk institutt for vannforskning
INSTITUTE OF MARINE RESEARCH
AWI
GEOMAR
SMHI
NORSK·POLARINSTITUTT