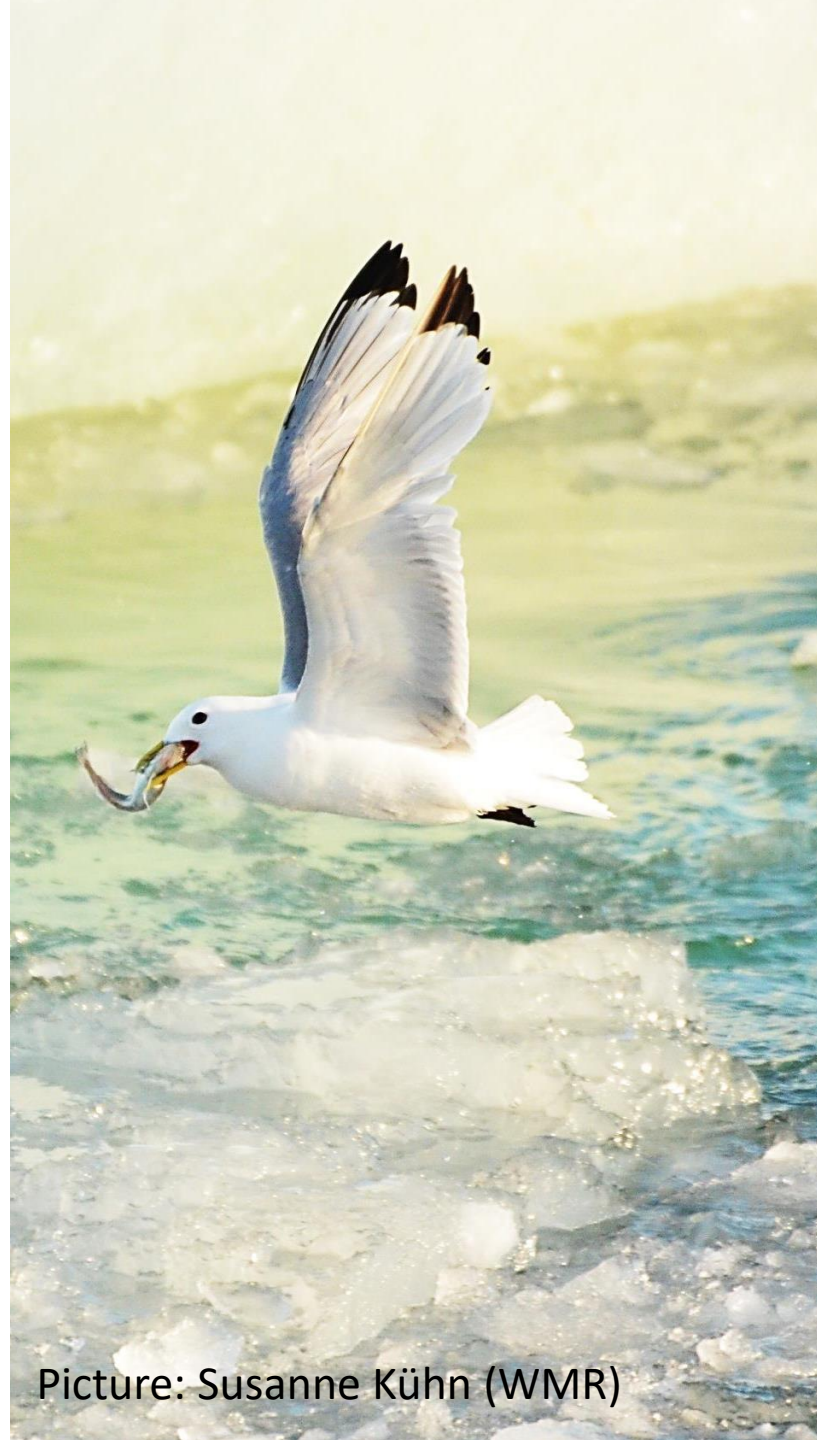


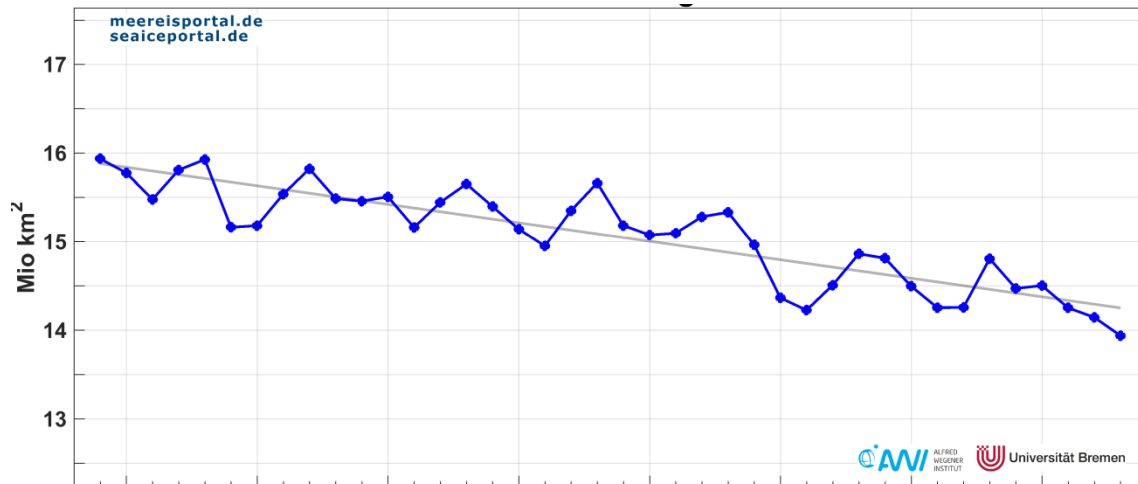
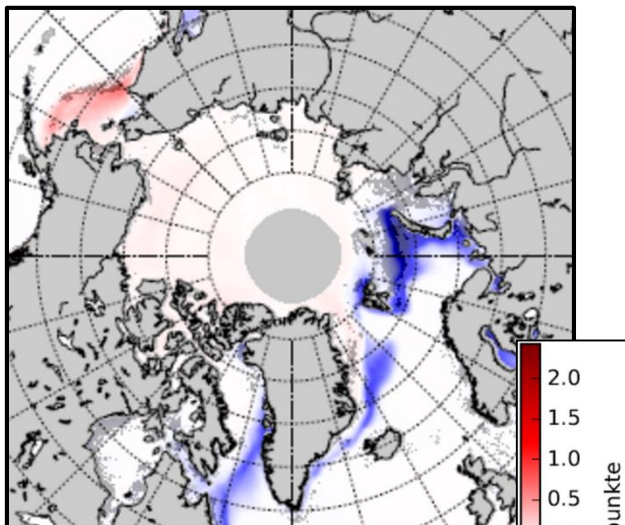
# Ice-fuelled food webs in the Polar Oceans

Hauke Flores, **Doreen Kohlbach**,  
**Fokje Schaafsma**, Martin Graeve,  
Carmen David, Benjamin Lange, Julia Ehrlich,  
Kristin Harge, Ilka Peeken, Benoit Lebreton,  
Barbara Niehoff, Thomas Krumpen,  
Benjamin Rabe, Kristina Kunz,  
Jan Andries van Franeker, Katja Metfies,  
Angelika Brandt

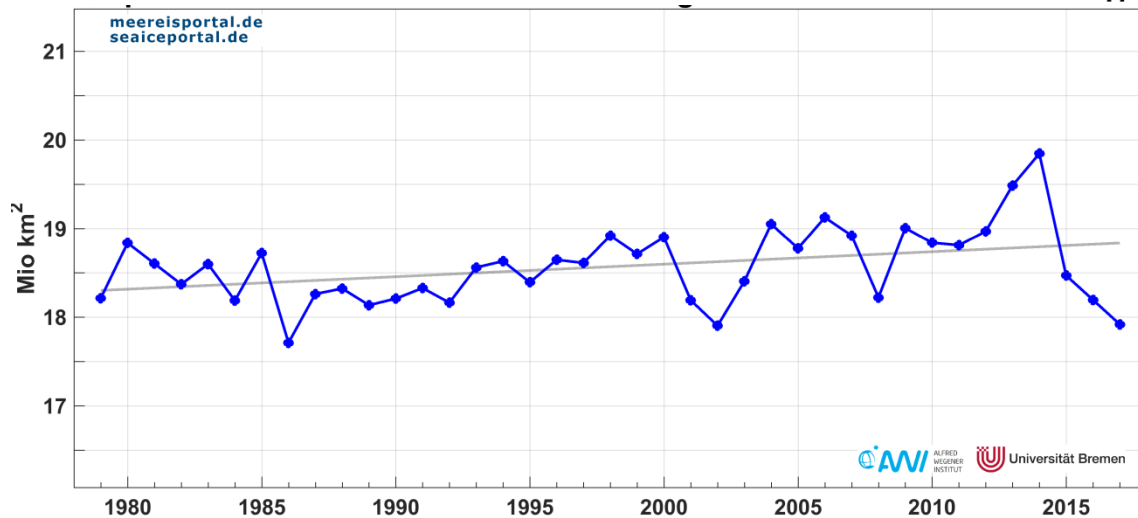
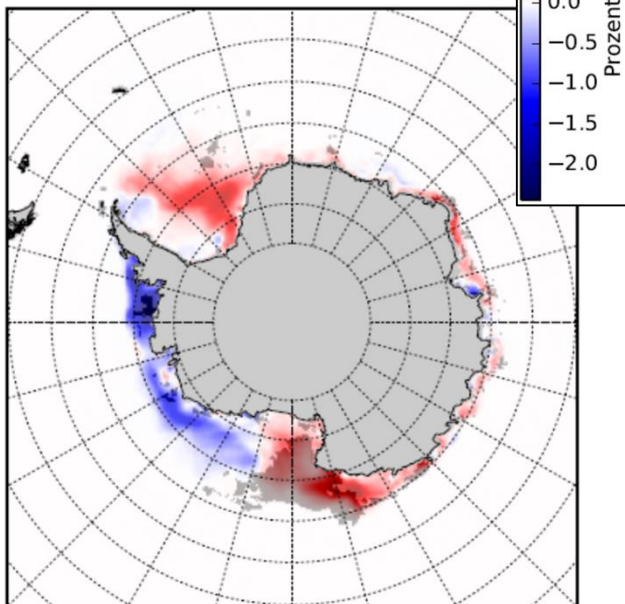


Picture: Susanne Kühn (WMR)

## Mean Sea Ice Extent in February



## Mean Sea Ice Extent in September



# Sea ice food web



Polar bear



Polar cod



Ice amphipod



Ice algae

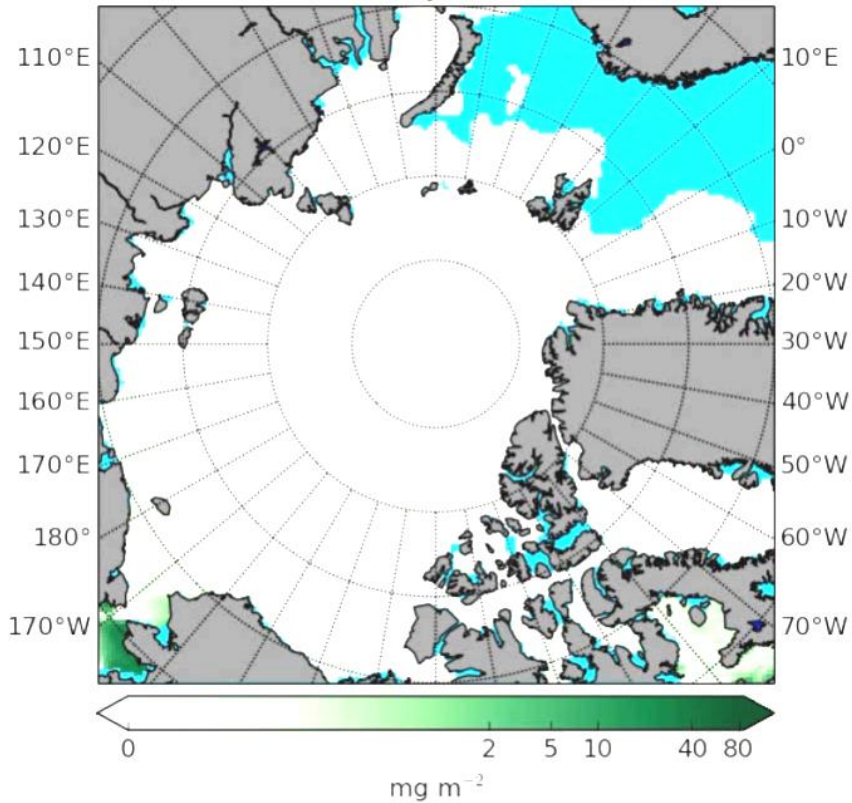
# Changing sea-ice habitats



# Seasonal variability

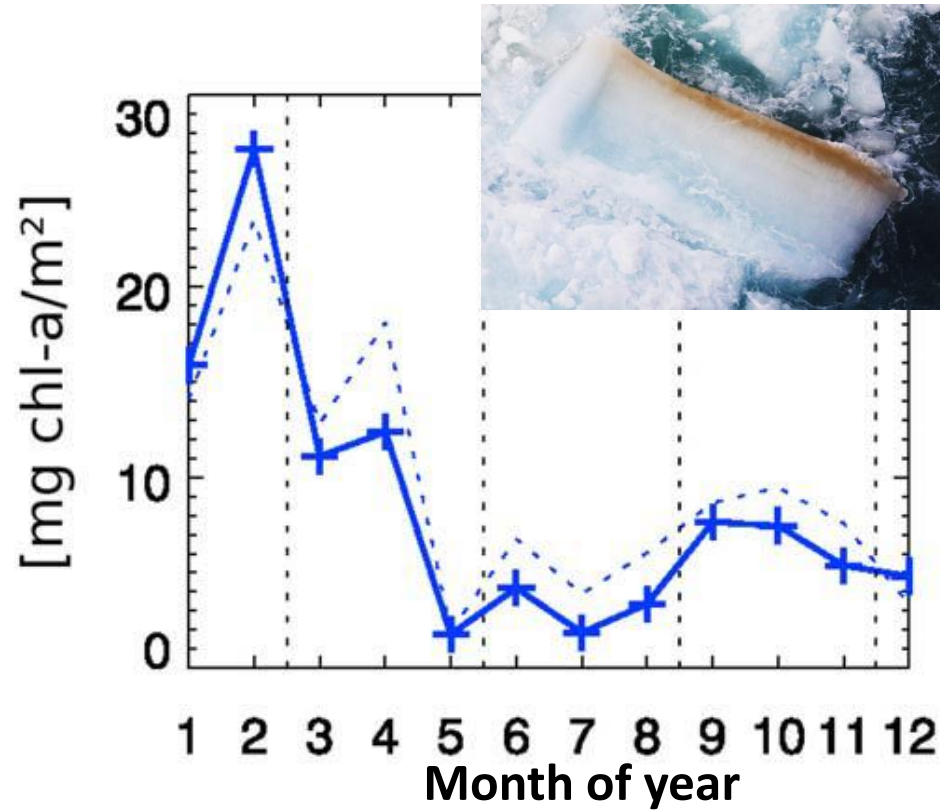
## Arctic Ocean

Day 60



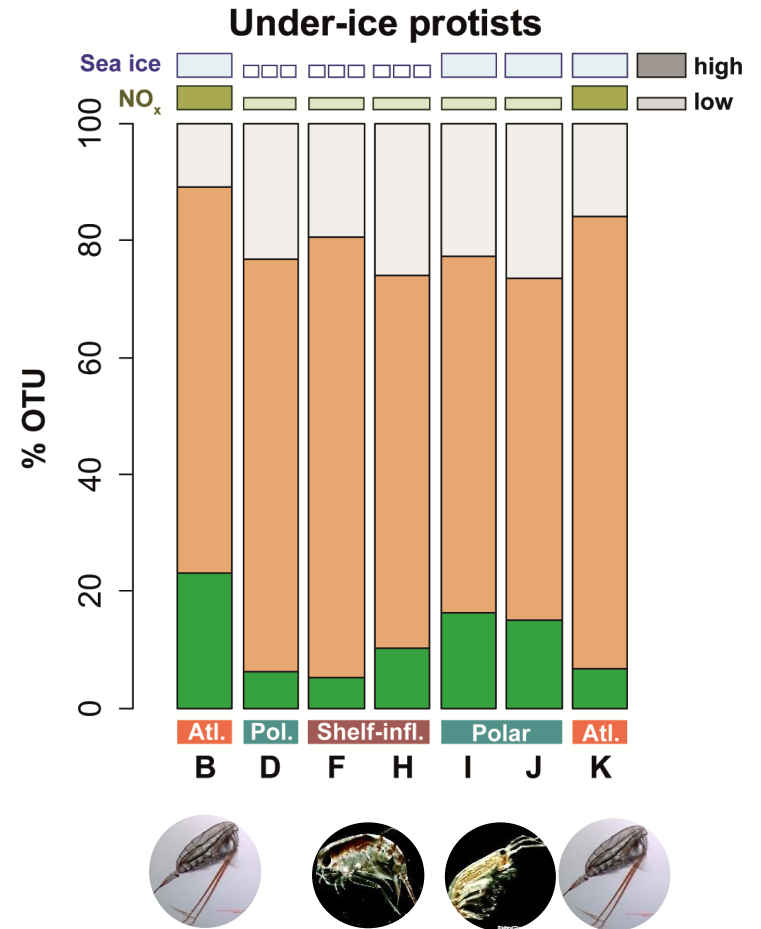
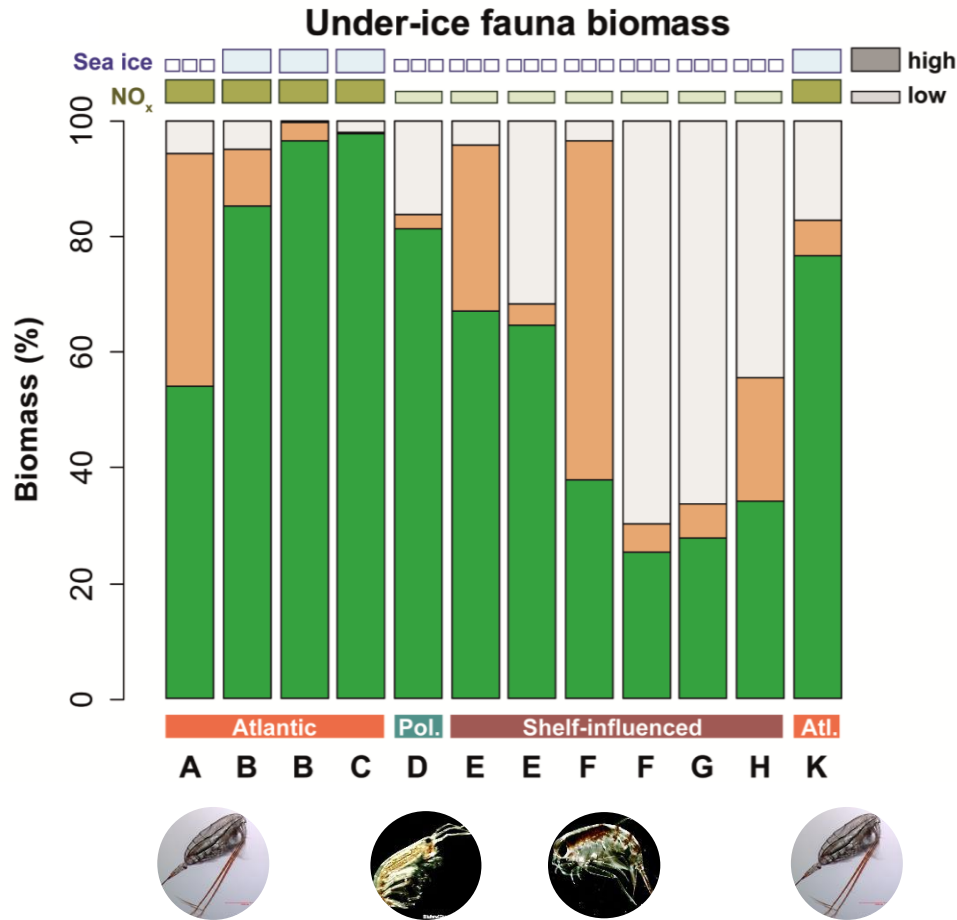
Castellani et al. (2017), JGR

## Southern Ocean

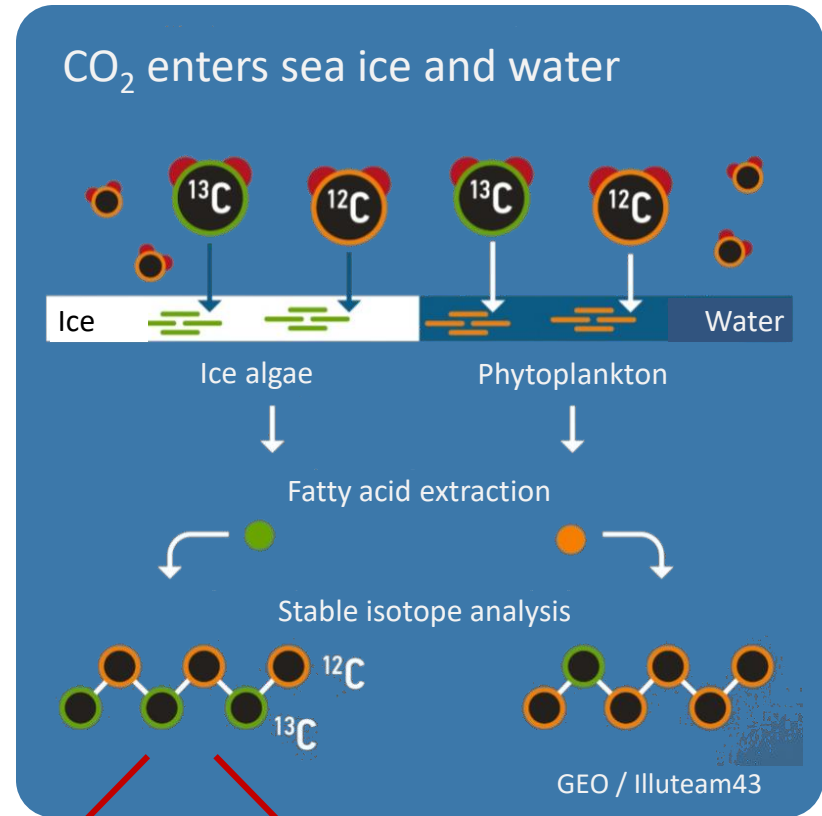
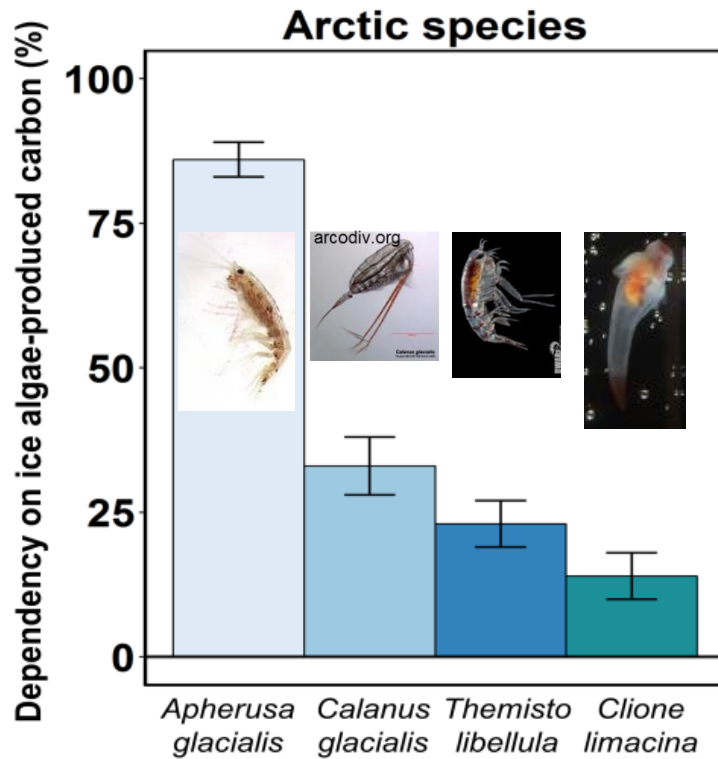


Meiners et al. (2012), JGR

# Spatial variability



# Carbon flux



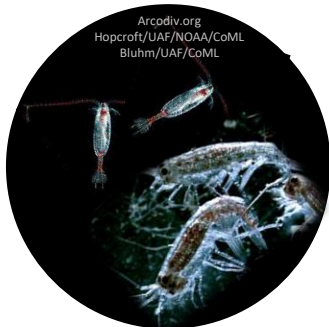
Long-term

Short-term

# Polar (Arctic) Cod *B. saida*



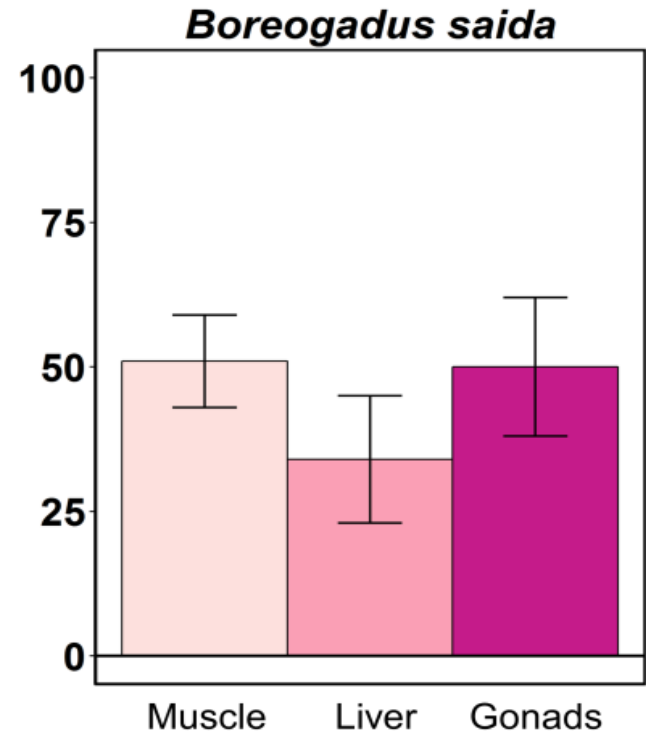
Human value  
Minor fishery  
Artisanal hunting



Prey  
Copepods  
amphipods

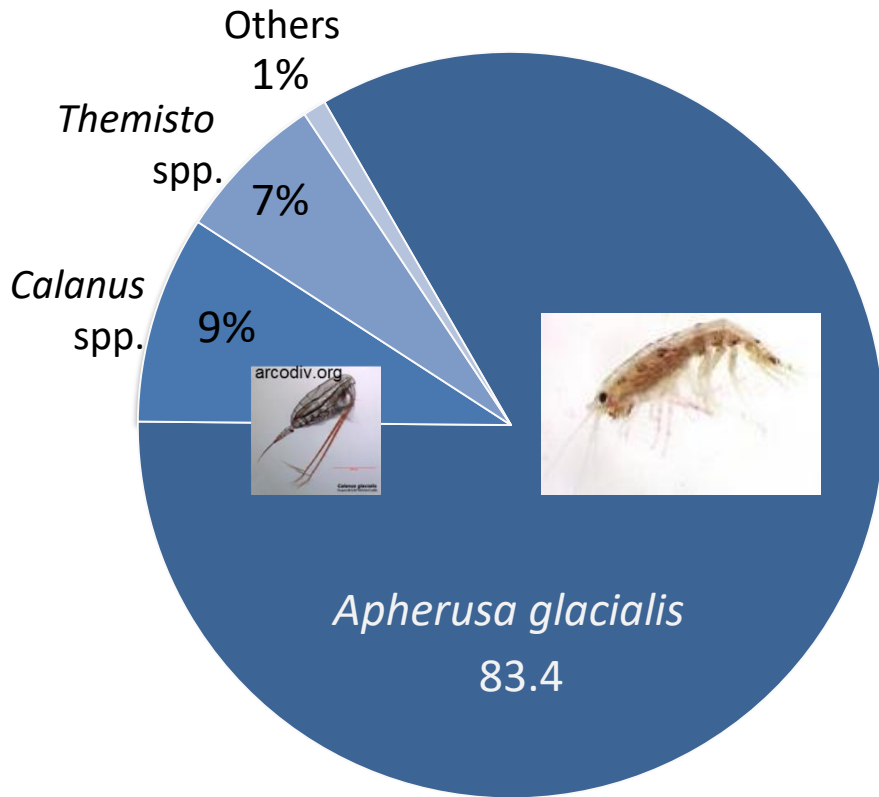


Predators  
Seals  
seabirds

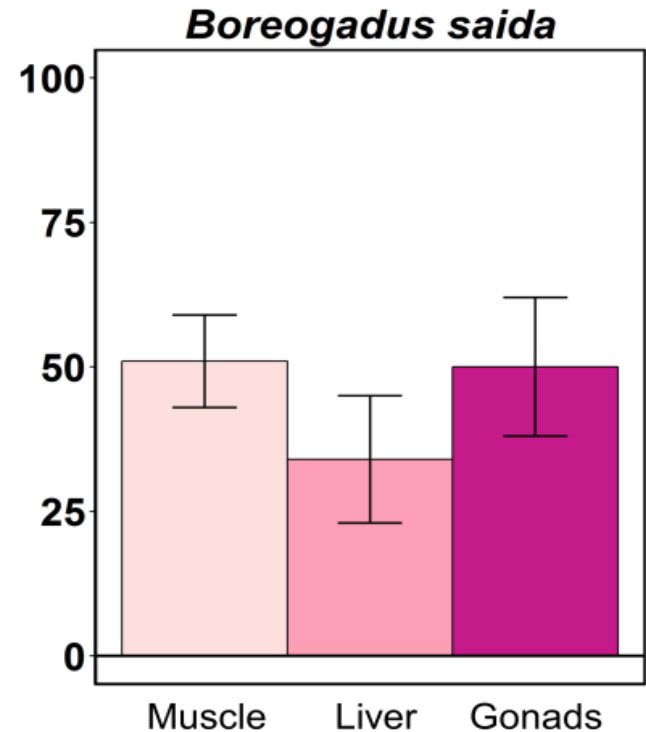




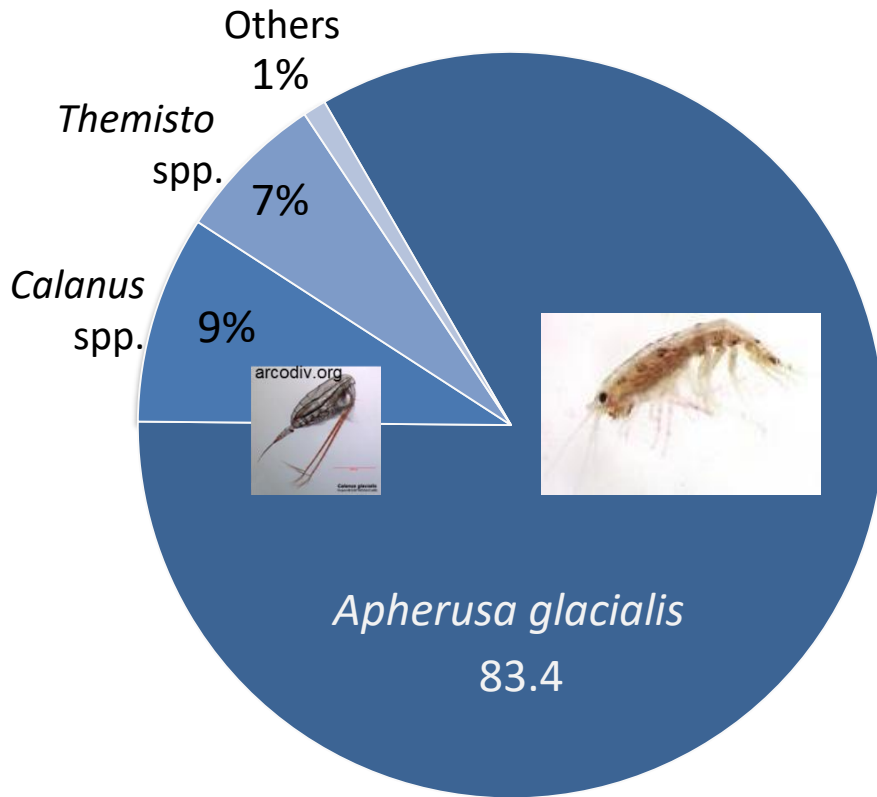
# Polar cod



Proportional diet composition  
by mass (%)

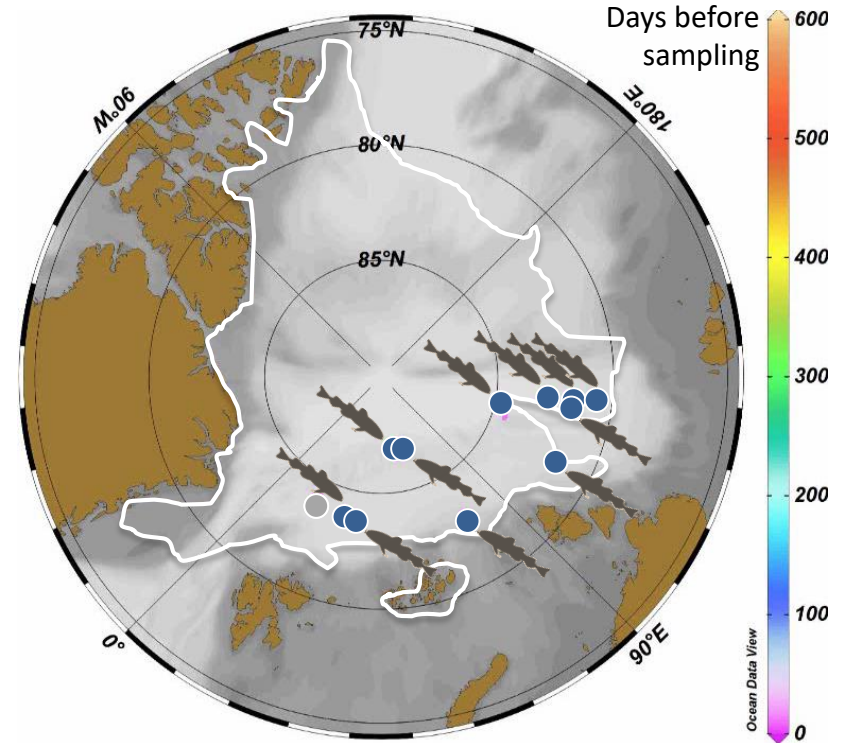


# Polar cod



Proportional diet composition  
by mass (%)

Kohlbach et al. (2017) *Progr Oceanogr*

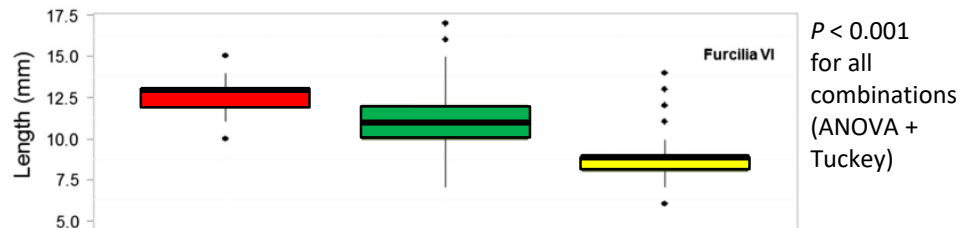
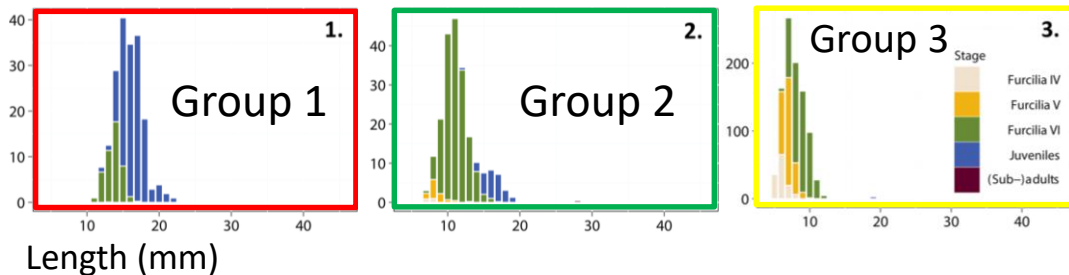
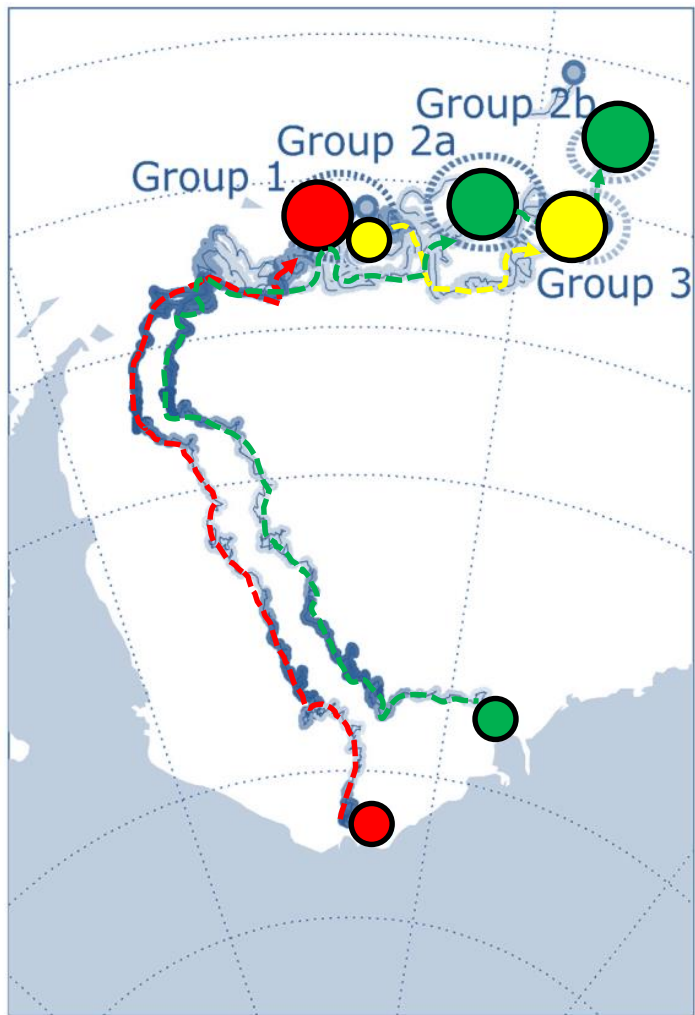


Sea ice back-tracking

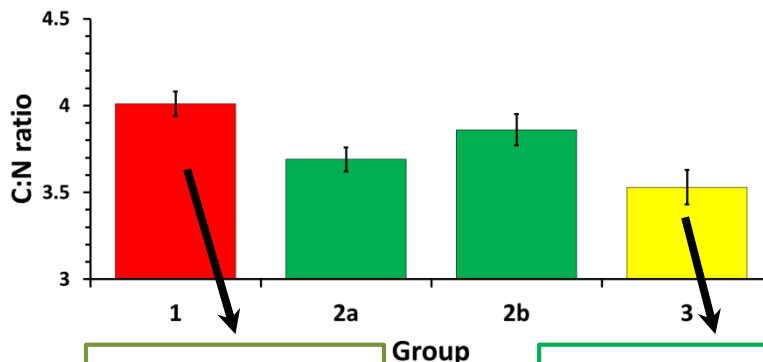
David et al. (2016) *Polar Biol*

# Antarctic krill

Schaafsma et al. (2017) *Mar Ecol Prog Ser*



$P < 0.001$   
for all combinations  
(ANOVA +  
Tuckey)

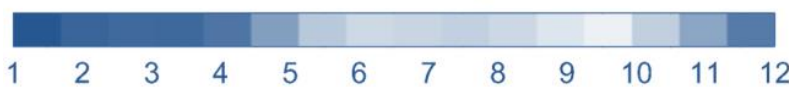


$P < 0.05$   
for all combinations  
(ANOVA +  
Tuckey)

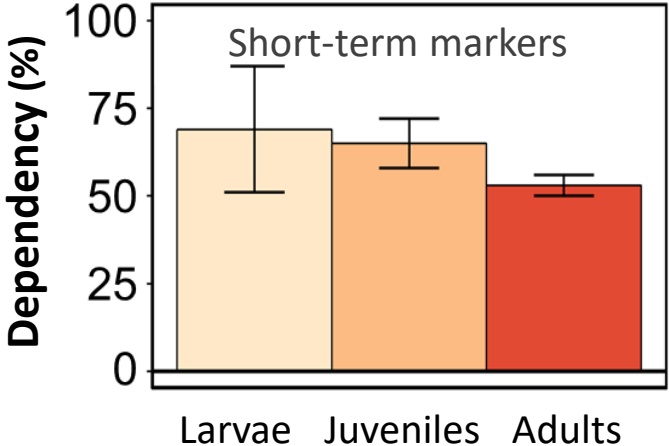
- Group 1**
- Diatom-dominated
  - Low  $\delta^{15}\text{N}$
  - Higher Chl  $a^1$
  - Older ice

- Group 3**
- More Flagellates
  - High  $\delta^{15}\text{N}$
  - Lower Chl  $a^1$
  - Younger ice

Month of the year

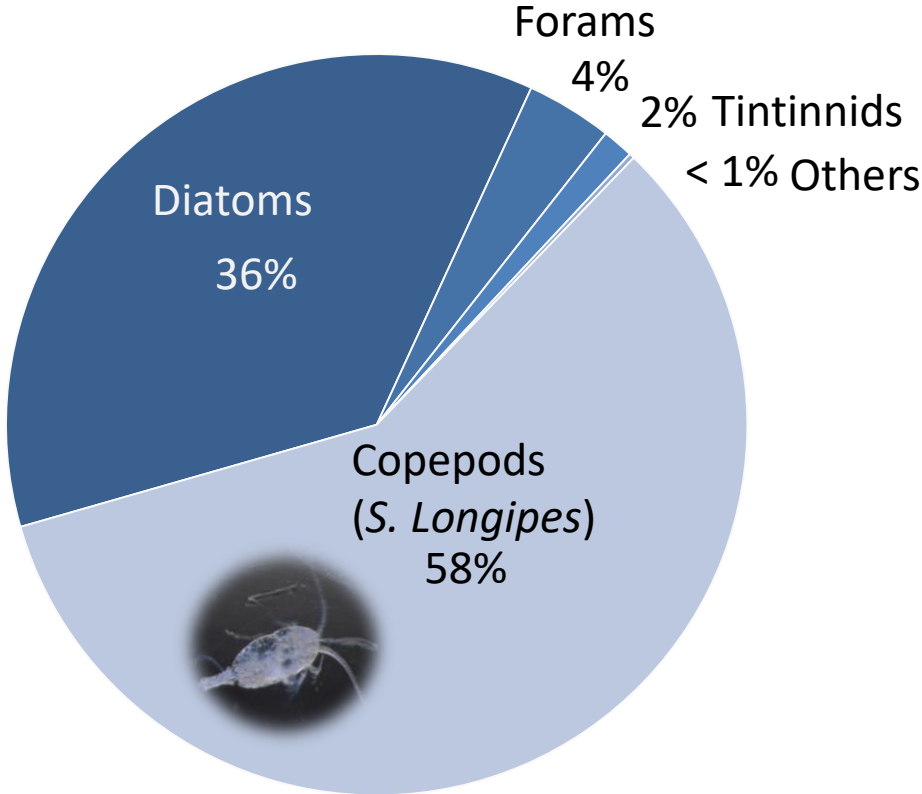


# Antarctic krill



Dependency on ice algae-produced carbon in overwintering krill

Kohlbach et al. (2017) *Front Mar Sci*

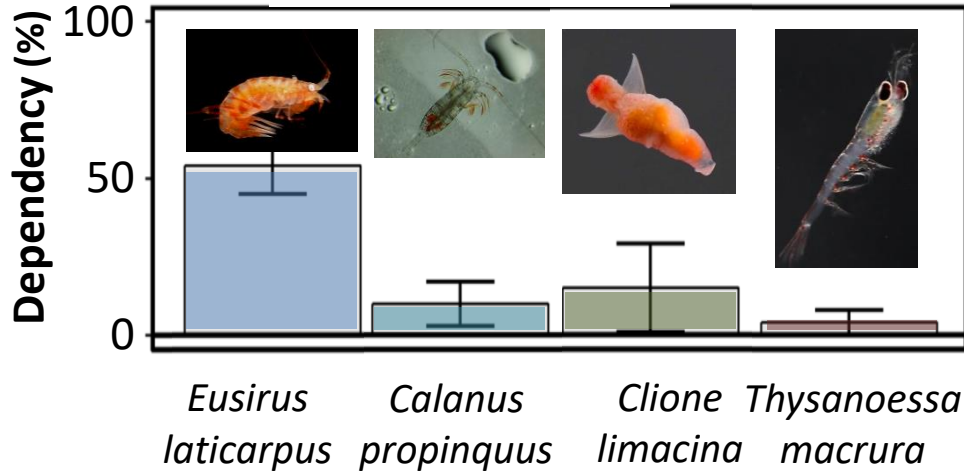


Proportional diet composition of Age-class 0 krill by volume (%)

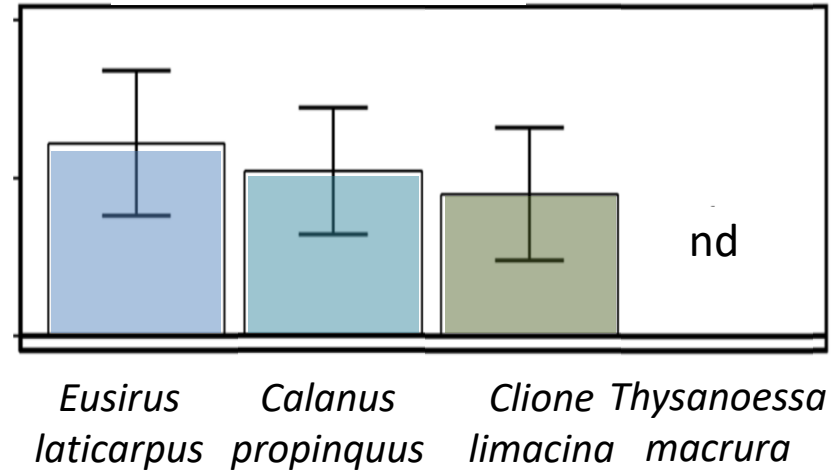
Schaafsma et al. (2017) *Mar Ecol Prog Ser*

# Carbon flux

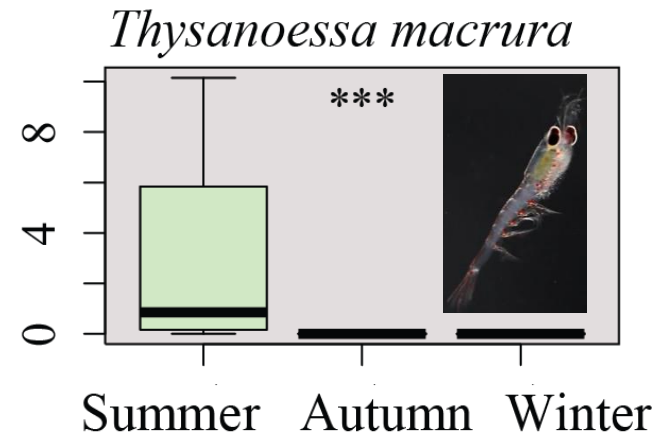
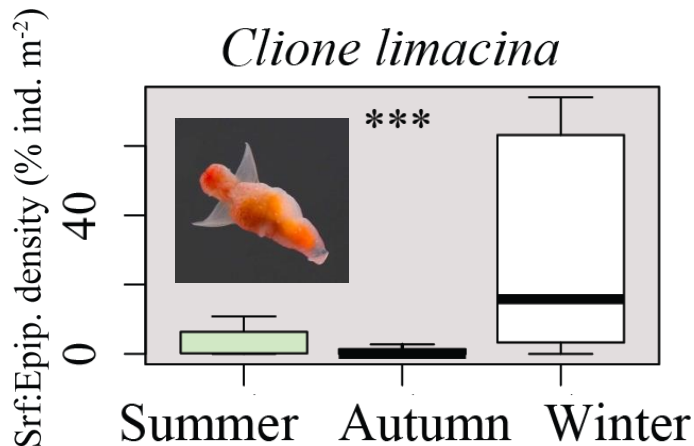
Long-term marker



Short-term marker

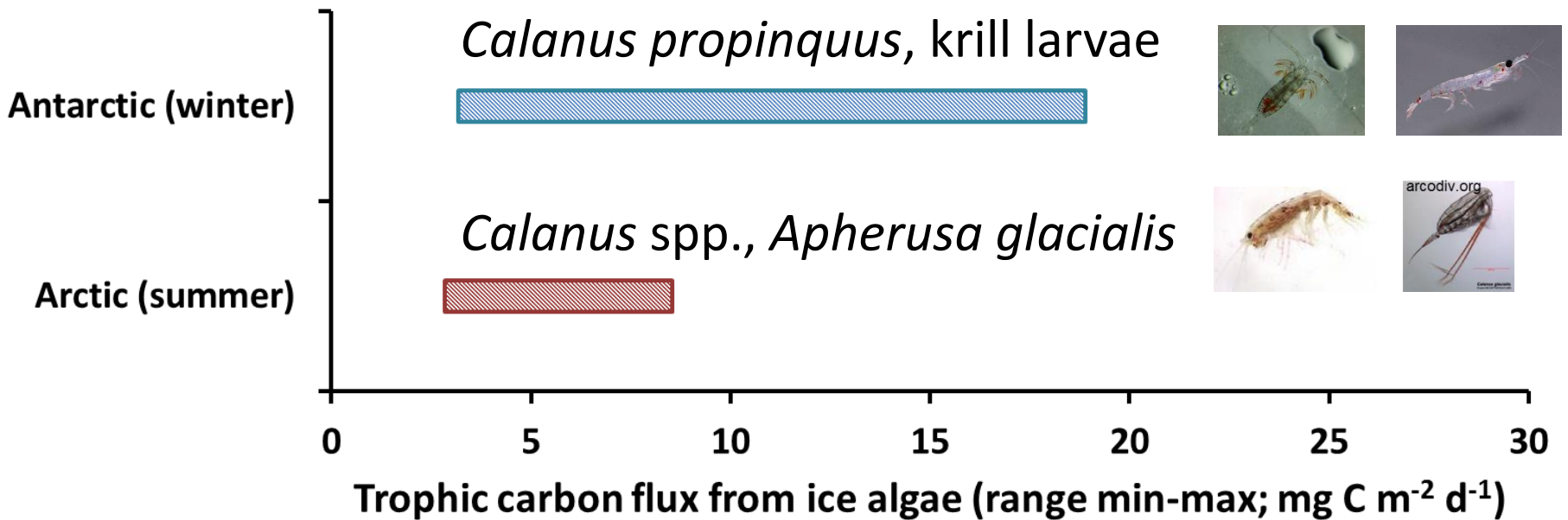


Kohlbach et al. (in press) *Glob Ch Biol*



Flores et al. (2014) *DSR I*

# Carbon flux

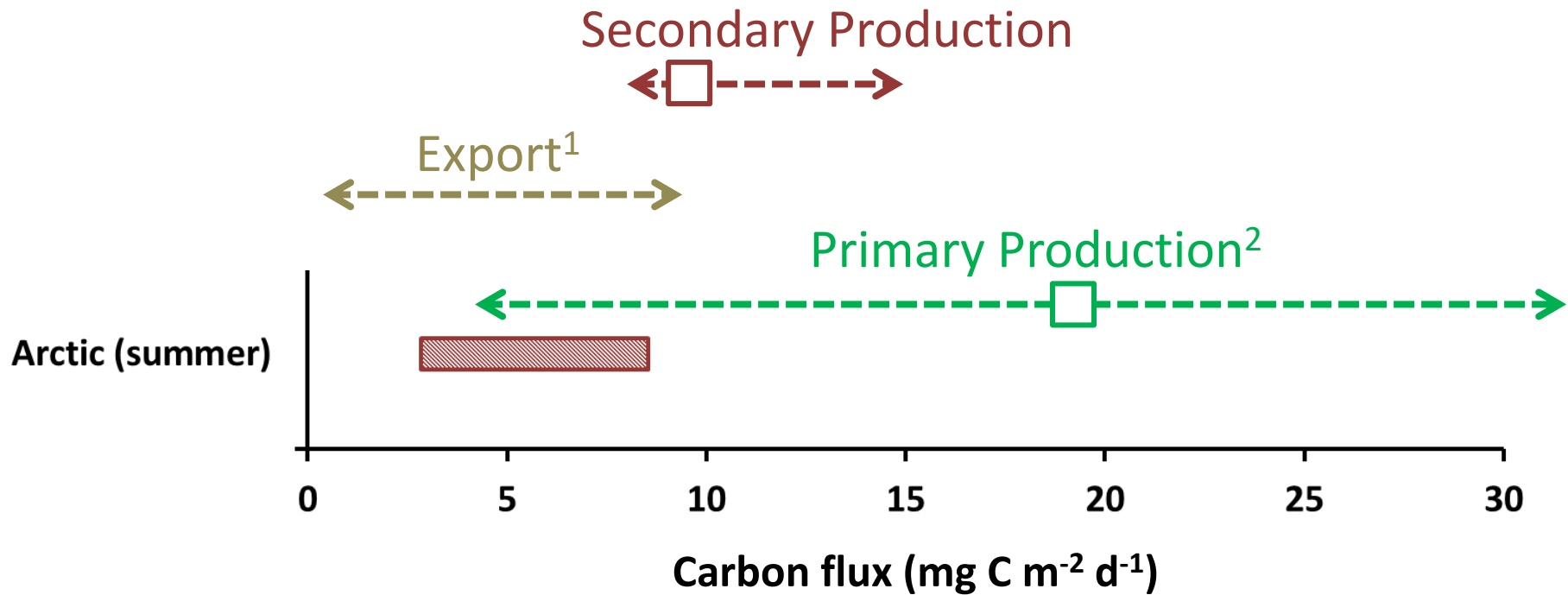


Kohlbach et al. (2017) *Front Mar Sci*

Kohlbach et al. (in press) *Glob Ch Biol*

Kohlbach et al. (2016) *Limn Oceanogr*

# Carbon flux



<sup>1</sup>Fernandez-Mendez et al. (2015) *Biogeosc*

<sup>1</sup>Roca-Marti et al. (2016)

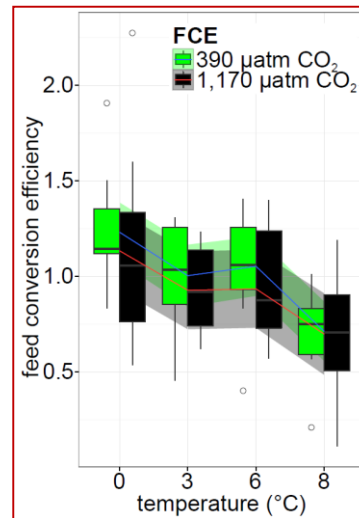
# Conclusions

- Sea ice is an important, and temporarily critical, **carbon source** in ecosystems of both hemispheres
- Effects of declining in sea ice habitats on ecosystem processes will **vary seasonally and regionally**
- There will be **winners** who can adapt to new conditions and **losers** facing increasing difficulties, leading to a new equilibrium
- Impact on the key species **Antarctic krill and polar cod** will affect resource availability and management
- Ecological and economic effects **of biodiversity loss/change** are potentially significant, but unaccounted



# Cumulative stressors

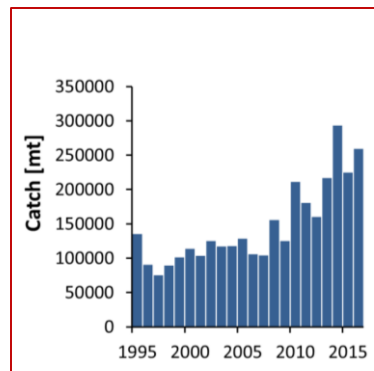
- Sea ice decline
- *Ocean warming*
- Ocean acidification
- Competition
- Pollution, *microplastics*
- Traffic (accidents)
- *Fishery*
- Tourism



*Polar cod*  
*Feed conversion efficiency*

Kunz et al. (2016) *Polar Biol*


*Krill fishery*  
*(Southern Ocean)*



CCAMLR  
(2018)

Polar Biology  
<https://doi.org/10.1007/s00300-018-2283-8>

ORIGINAL PAPER

 CrossMark

Plastic ingestion by juvenile polar cod (*Boreogadus saida*) in the Arctic Ocean

Susanne Kühn<sup>1</sup> · Fokje L. Schaafsma<sup>1</sup> · Bernike van Werven<sup>2</sup> · Hauke Flores<sup>3</sup> · Melanie Bergmann<sup>3</sup> · Marion Egelkraut-Holtus<sup>4</sup> · Mine B. Tekman<sup>3</sup> · Jan A. van Franeker<sup>1</sup>



An underwater photograph showing a vast, healthy coral reef. The water is a deep, clear blue, and the coral consists of numerous white, branching structures that create a dense, textured field. The lighting is bright, highlighting the intricate details of the coral.

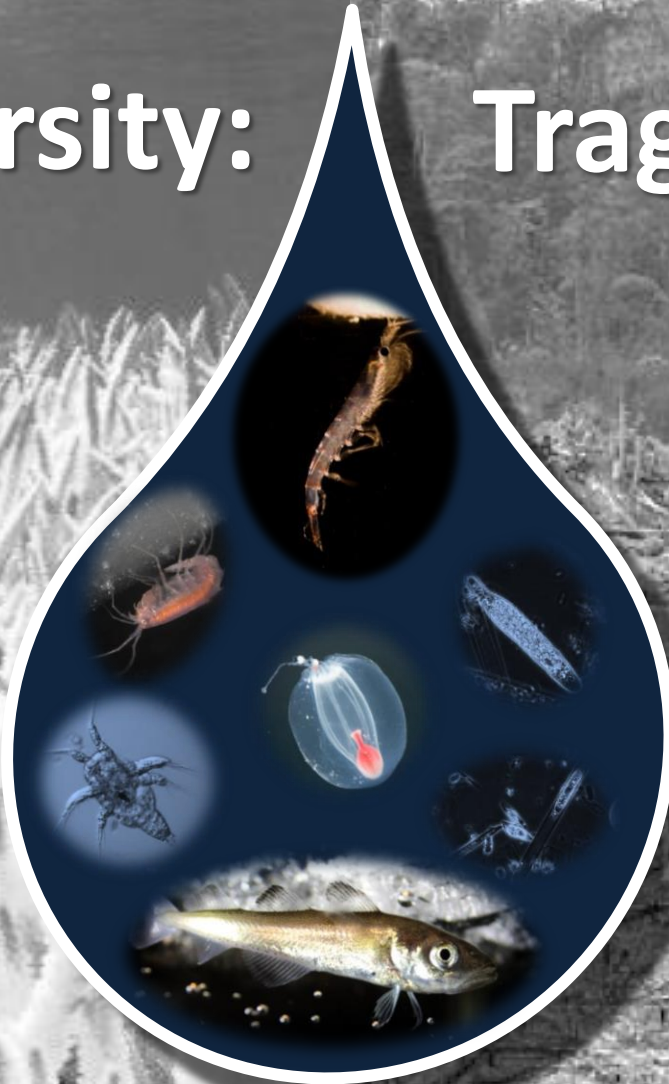
**Biodiversity:**

A landscape photograph showing a stark contrast between a deforested area in the foreground and a dense forest in the background. The foreground is filled with a chaotic pile of cut logs and branches, with sparse, low-lying vegetation. The background features a thick stand of tall, thin trees under a clear sky.

**Tragedy I & II**

**Biodiversity:**

**Tragedy III**



Sea ice fauna credit:  
Jan Andries van Franeker,  
Julia Ehrlich

# More interesting stuff

Friday, 17:00 A Seehorn Erin Kunisch et al.:

## Exploring Life-cycle Adaptations in a Sympagic Amphipod: Is it Truly Sympagic?

Today, 11:15 Here Giulia Castellani et al.:

## Scales of Variability of Sea-ice Algae in Spring: Observations and Model Results

Today, 10:00 C Sanada II Fokje Schaafsma, Anton Van de Putte et al.:

## Energetic Value of Zooplankton and Nekton of the Southern Ocean: A Review

ART initiated TRANSSIZ - Transitions in the Arctic Seasonal Sea 94

**Ice Zone - cruise**

Peeken, Ilka<sup>1</sup>; Babin, Marcel<sup>2</sup>; Blais, Marie-Angélie<sup>2</sup>; Dybwad, Christine<sup>3</sup>; Flores, Hauke<sup>4</sup>; Huot, Yannick<sup>4</sup>; Janout, Markus<sup>5</sup>; Kattain, Christian<sup>6</sup>; Kedra, Monika<sup>5</sup>; Kowalczyk, Piotr<sup>5</sup>; Anne Kraemer<sup>4</sup>; Krumpen, Thomas<sup>5</sup>; Loewemark, Ludvig<sup>7</sup>; Massicotte, Philippe<sup>2</sup>; Matthiessen, Jens<sup>1</sup>; Michel, Christine<sup>8</sup>; Morta, Nathalie<sup>9</sup>; Nikolopoulos, Anna<sup>10</sup>; Allyson Tassin<sup>11</sup>; Jean-Éric Tremblay<sup>3</sup>; Jutta Wollenburg<sup>1</sup>, All shipboard party<sup>12</sup>

**AWI** ALFRED-WEGENER-INSTITUT  
HELMHOLTZ-ZENTRUM FÜR POLAR-  
UND MEERESFORSCHUNG

**Overall goal: To link past and present sea-ice transitions in the Arctic Ocean**

TRANSSIZ - Transition in the Arctic Seasonal Ice Zone

**Organic carbon budget of the ice-covered Arctic Ocean during late spring – preliminary results**

Monika Kędra<sup>1</sup> (kedra@iopan.gda.pl), Marcel Babin<sup>2</sup>, Christine Dybwad<sup>3</sup>, Hauke Flores<sup>4</sup>, Piotr Kowalczyk<sup>1</sup>, Christine Michel<sup>5</sup>, Nathalie Morata<sup>6</sup>, Barbara Oleszczuk<sup>1</sup>, Marit Reigstad<sup>3</sup>, Monika Zabłocka<sup>1</sup>, Ilka Peeken<sup>4</sup>

Observatoire Océanologique de  
Polar-Française

**cnrs**

**Lipid dynamics and trophic patterns of Antarctic silverfish in the Weddell Sea**

Jilda Alicia Caccavo<sup>1</sup>, Marc Boutoute<sup>2</sup>, Doreen Kohlbach<sup>3,4</sup>, Hauke Flores<sup>3,4</sup>, Patrick Mayzaud<sup>2</sup>

UNIVERSITÀ DEGLI STUDI DI PADOVA