

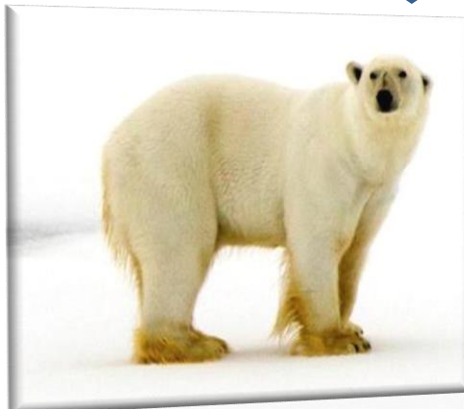
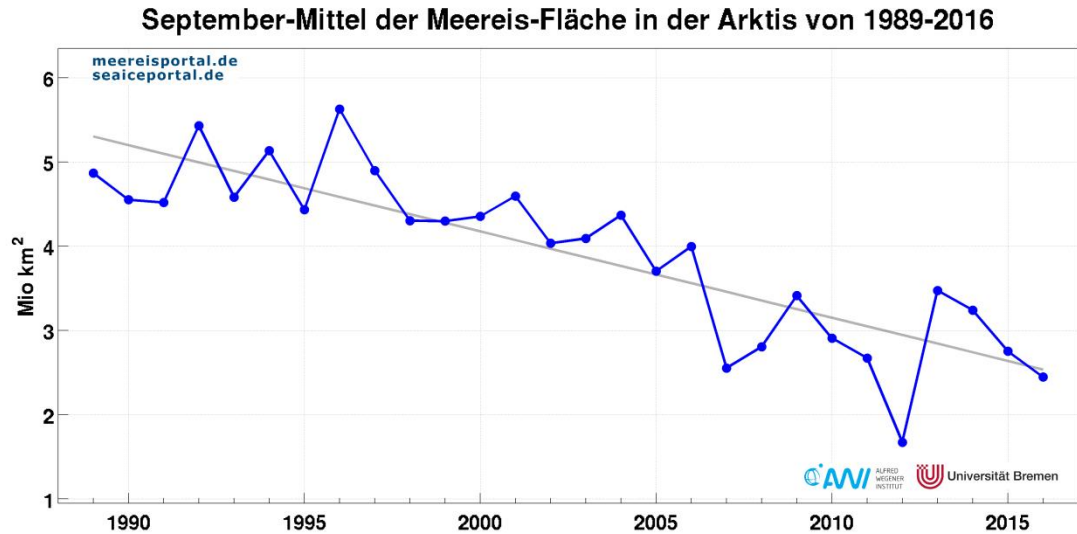
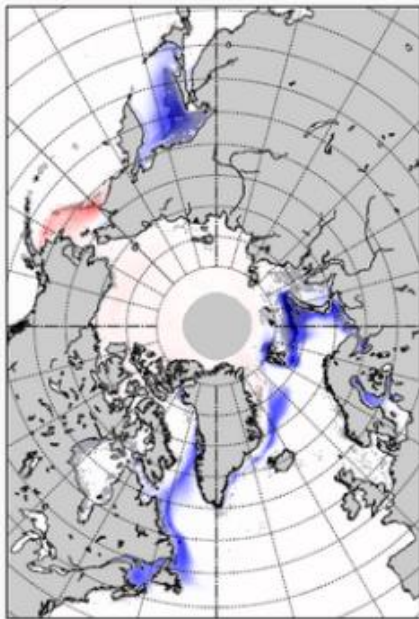
# *Where was all the fish?*



## **Sea-ice fauna, polar cod and all the rest during PS 106**

H. Flores, G. Castellani, F. Schaafsma, B. Lange, J. Ehrlich, Kim Vane, Bram Fey, Susanne Kühn, Elisa Bravo-Rebolledo, Michiel van Dorssen, André Meijboom, J.A. van Franeker, Erin Kunisch, Nadine Knüppel, M. Nicolaus, C. Katlein, T. Krumpfen, I. Peeken, Nils Koschnick, Jennifer Steffen, Magnus Lucassen, Erik Sulanke, B. Niehoff, Nicole Hildebrandt, Martin Doble, Jutta Wollenburg, a.m.o.

# Changing sea ice habitats



Polar bear



Polar cod



Ice amphipod



Ice algae





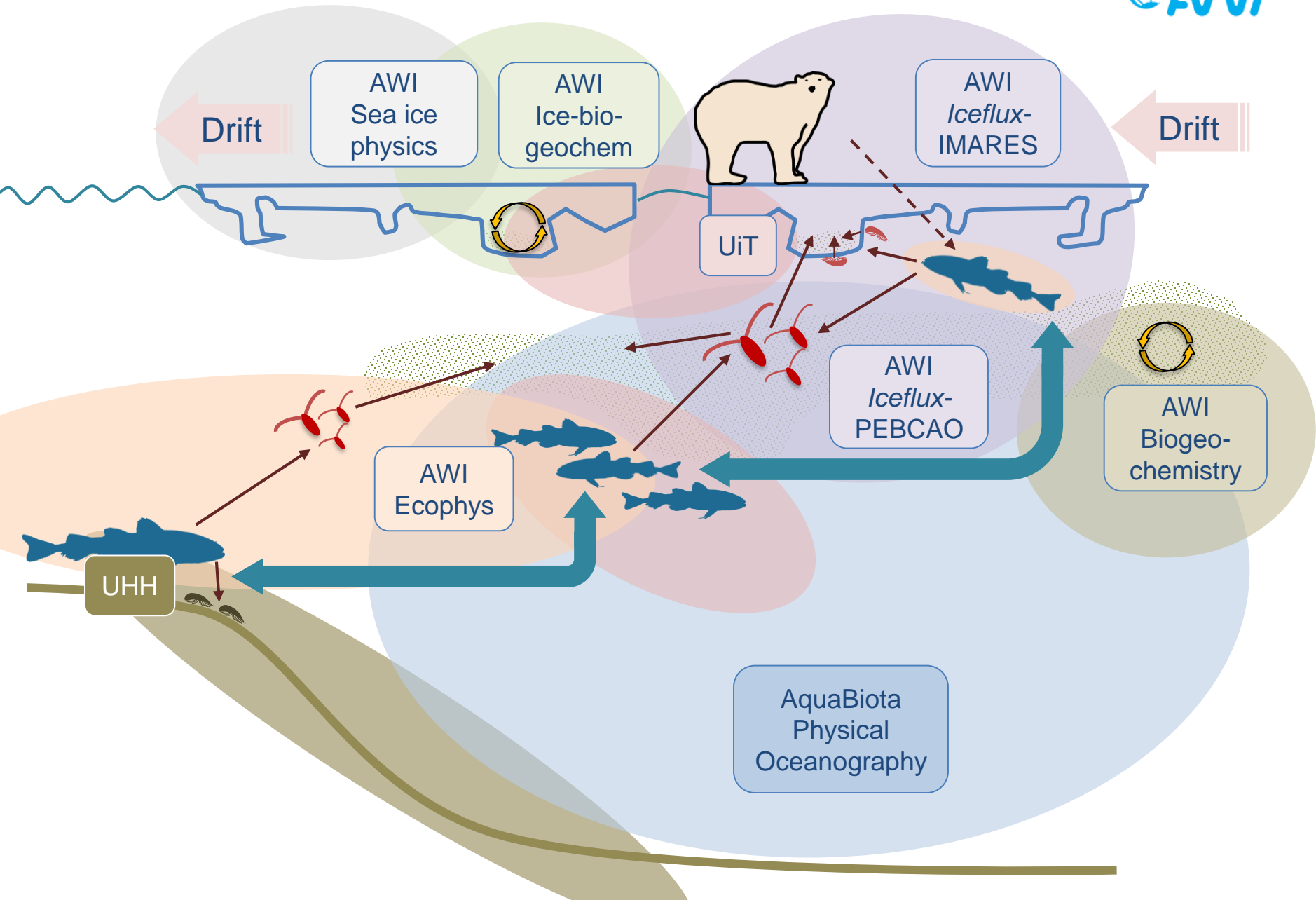
ALFRED-WEGENER-INSTITUT  
HELMHOLTZ-ZENTRUM FÜR POLAR-  
UND MEERESFORSCHUNG

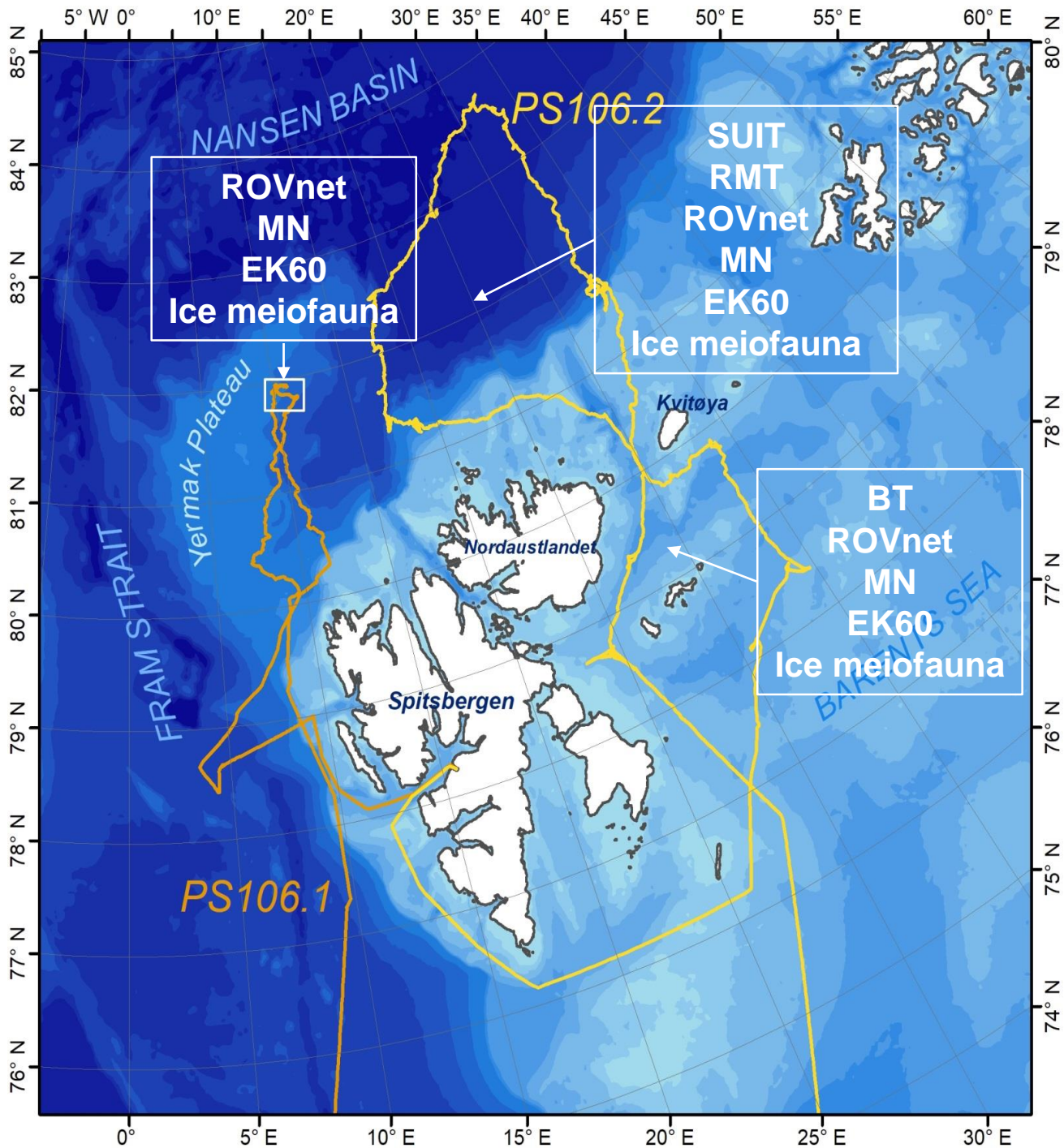
# SIPCA

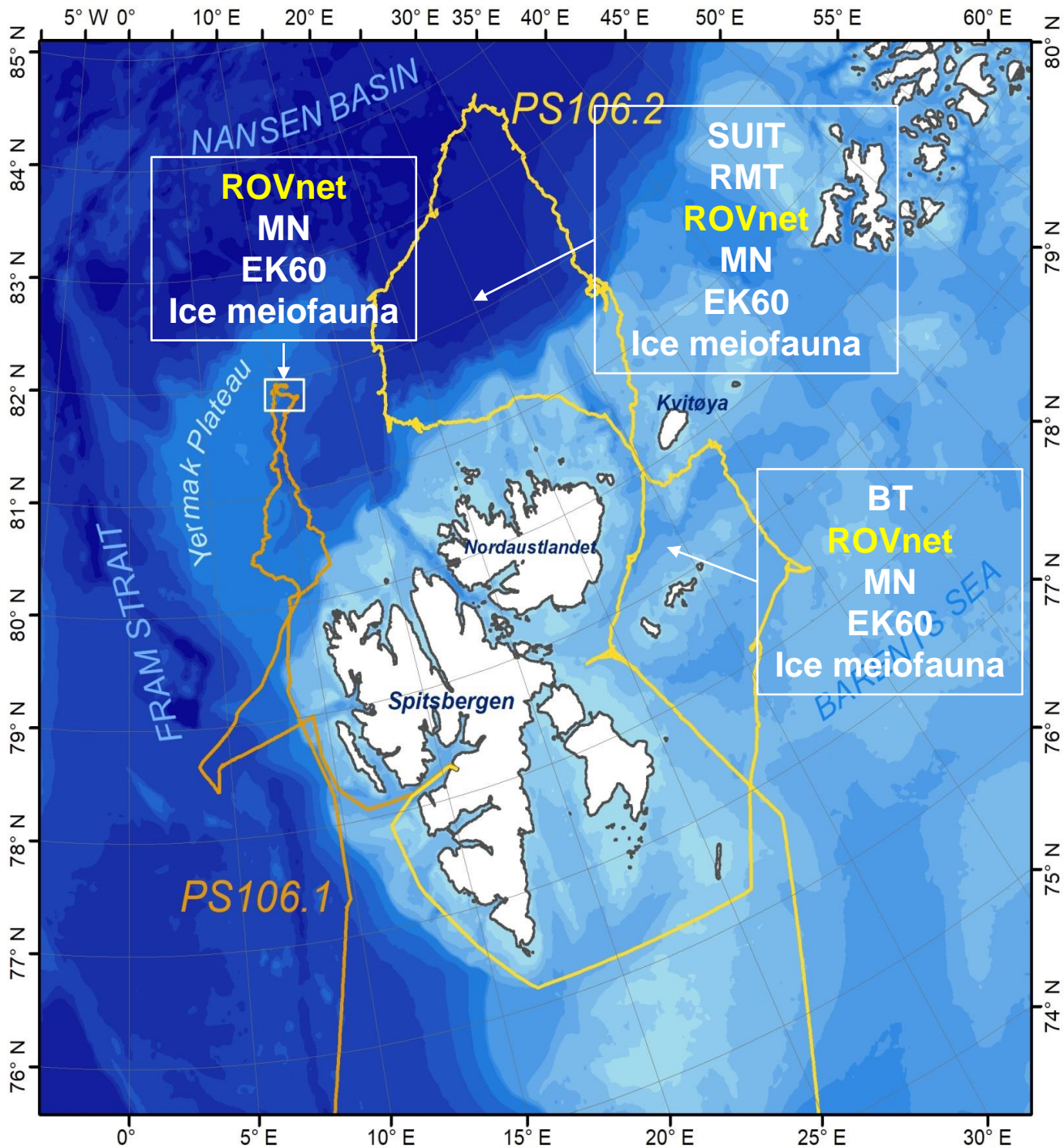


Survival of Polar Cod in a Changing Arctic Ocean

# SIPCA teams







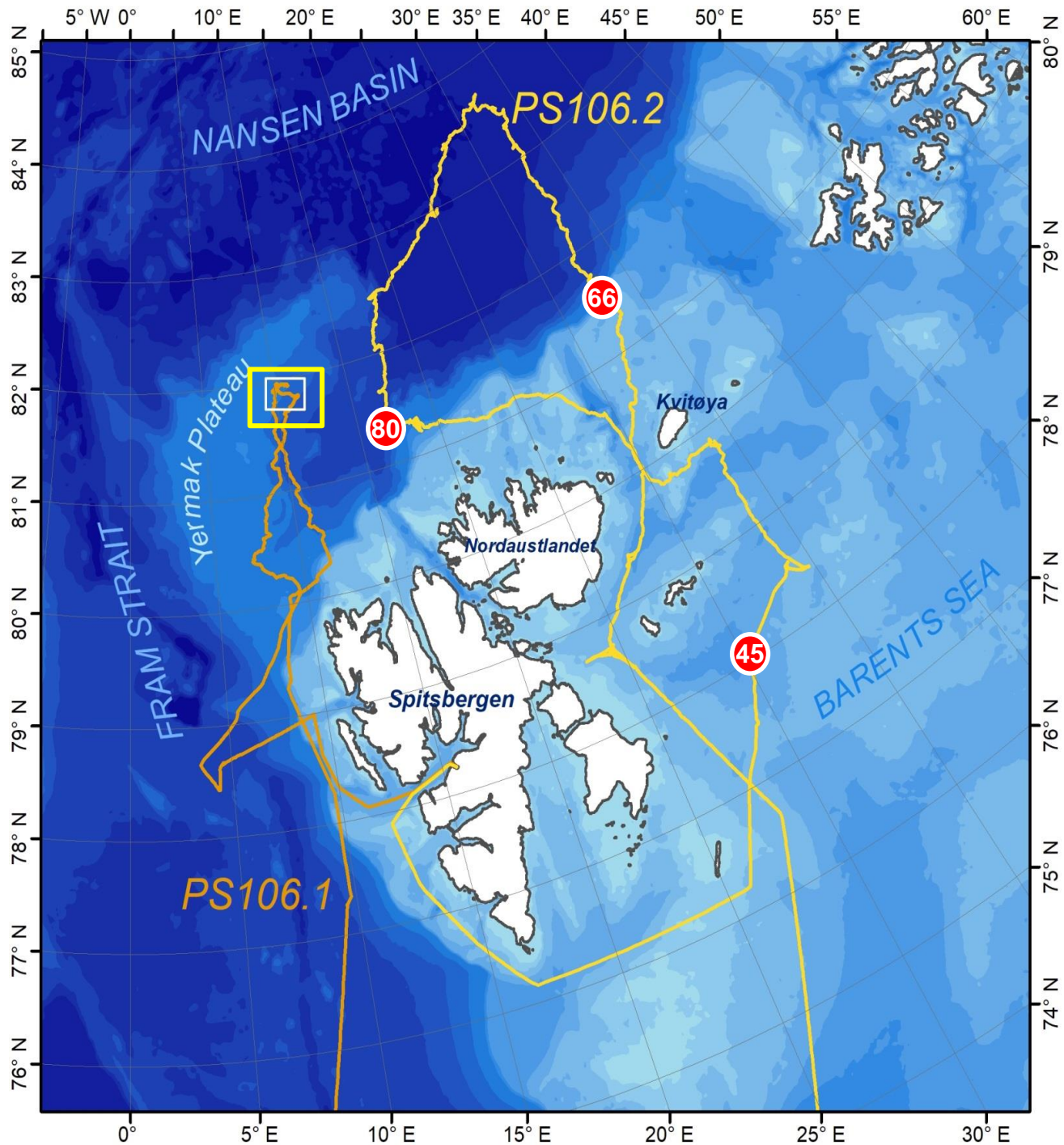
# ROVnet



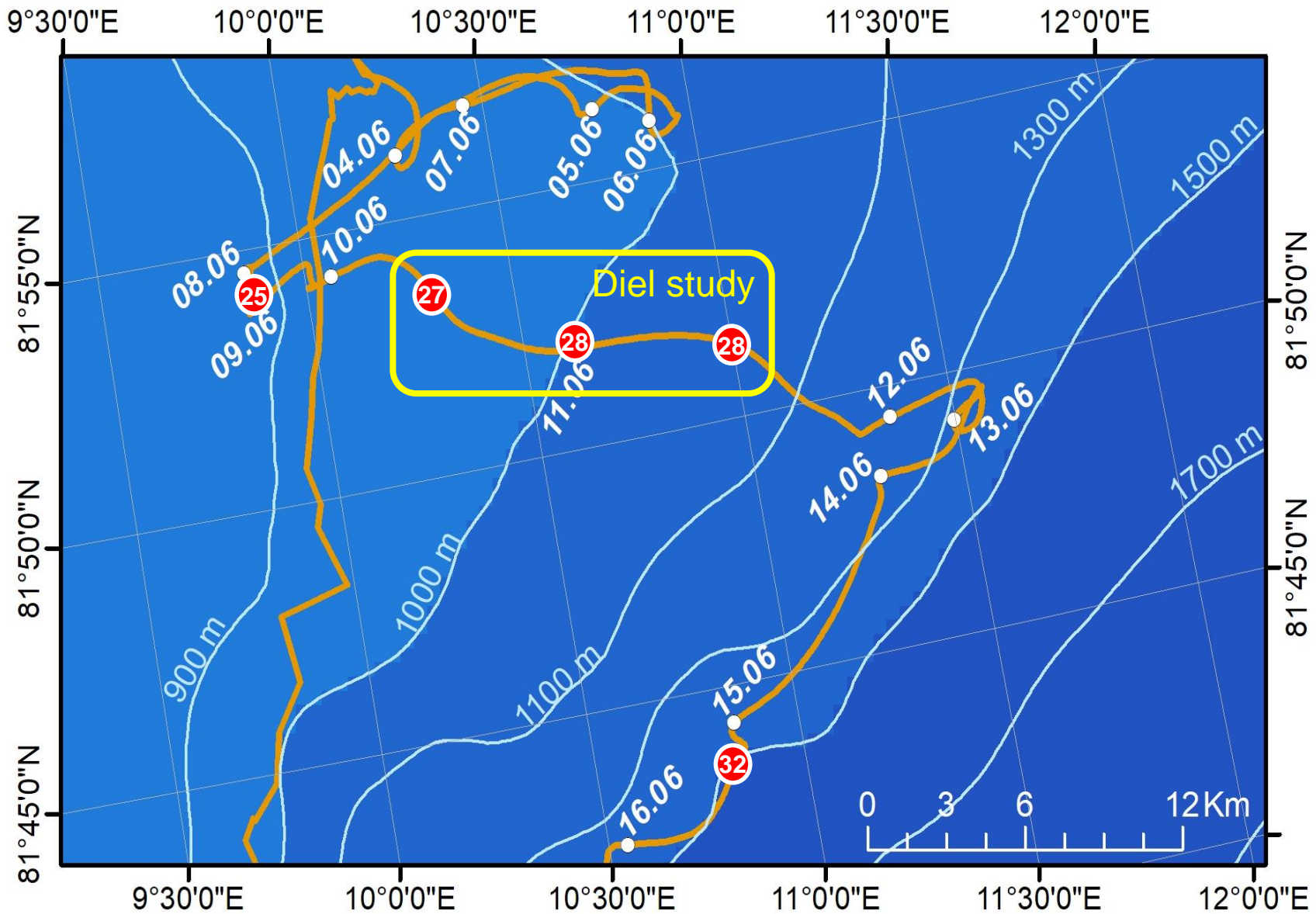
Frame size: 60 x 40 cm  
Net length: 5 m  
Mesh size: 0.5 mm  
Towing speed: 1-1.5 kn

Pictures by Marcel Nicolaus, Carolin Uhlir









# ROVnet – species composition (106/1)



25 (D), Under-ice



25 (D), Under-ice



27 (D), Under-ice



28 (N), Under-ice



28 (D), Under-ice

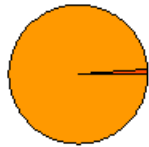


32 (D), Under-ice

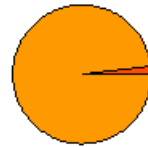


- A. glacialis
- C. hyperboreus
- Calanus spp.
- Chaetognath
- Gammarus wilkitzkii
- Hyperiid
- Paraeuchaeta spp.
- E. holmii
- C. limacina
- Amphipod
- A. laurentii
- L. helicina
- J. brevis
- Medusa
- Copepod
- Themisto spp.
- Onisimus spp.
- Thysanoessa spp.
- Sarsia spp.
- Appendicularian

27 (D), 5 m



28 (N), 5 m



28 (D), 5 m



32 (D), 5 m



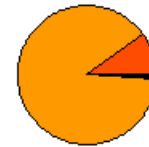
27 (D), 10 m



28 (N), 10 m



28 (D), 10 m



32 (D), 10 m



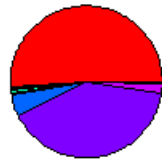
# ROVnet – species composition (106/2)



- *A. glacialis*
- *C. hyperboreus*
- *Calanus* spp.
- Chaetognath
- *Gammarus wilkitzkii*
- Hyperiid
- *Paraeuchaeta* spp.
- *E. holmii*
- *C. limacina*
- Amphipod
- *A. laurentii*
- *L. helicina*
- *J. brevis*
- Medusa
- Copepod
- *Themisto* spp.
- *Onisimus* spp.
- *Thysanoessa* spp.
- *Sarsia* spp.
- Appendicularian



45 (N), Under-ice



66 (N), Under-ice



80 (D), Under-ice



45 (N), 5 m



66 (N), 5 m



45 (N), 10 m



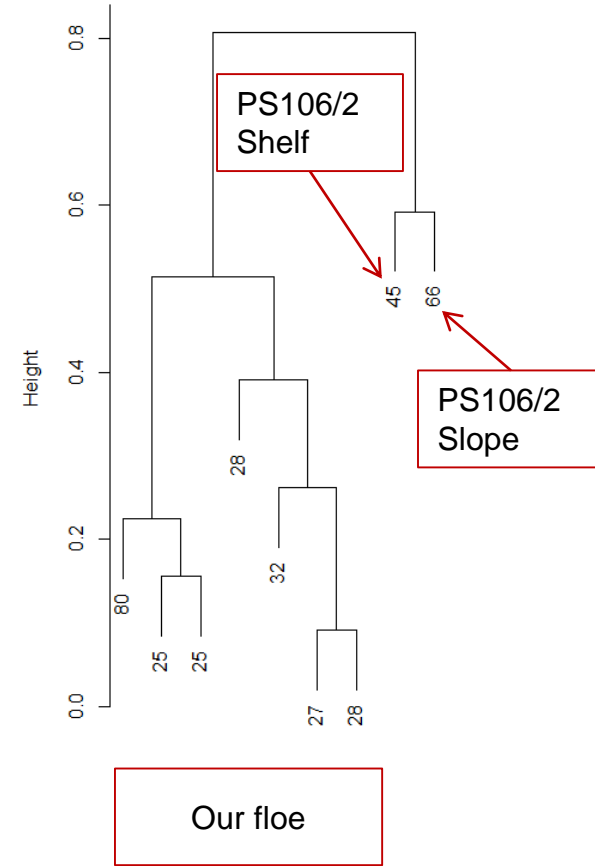
66 (N), 10 m



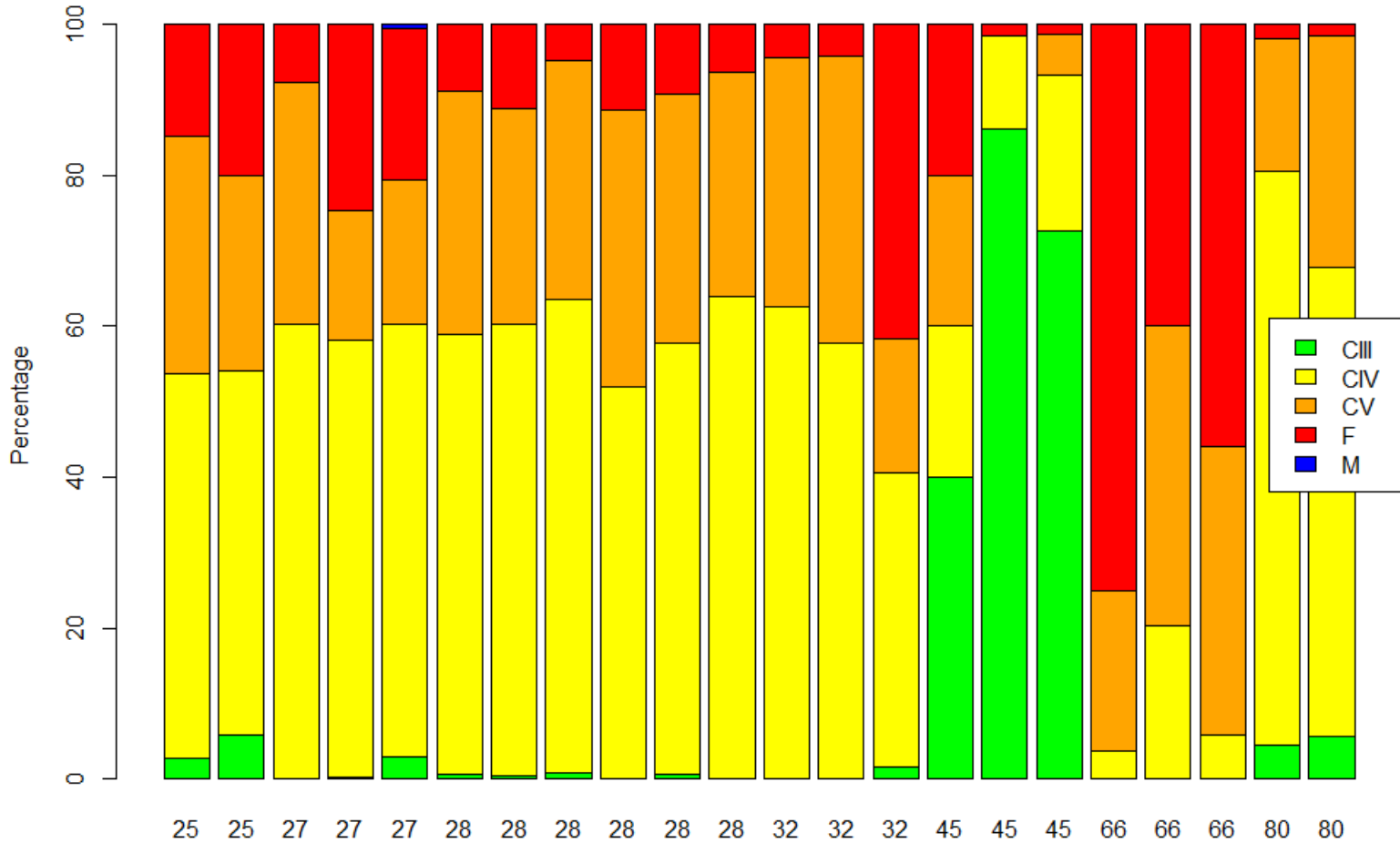
80 (D), 10 m



Cluster Dendrogram

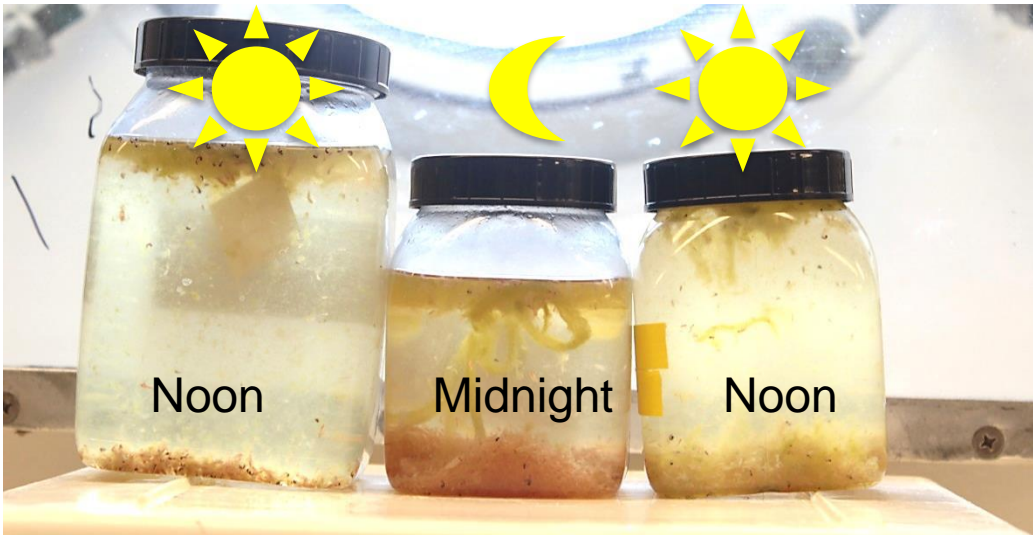


**Calanus spp. - stage composition**



PS106/1 (Our floe)	PS106/2 Shelf	PS106/2 Slope	Our floe
--------------------	---------------	---------------	----------

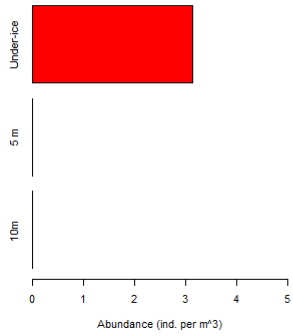
# ROVnet



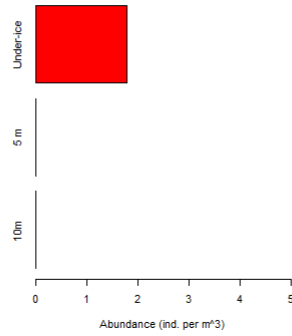
# ROVnet – DVM study



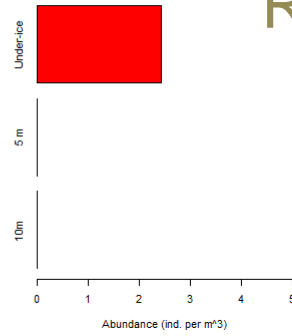
27 (D), *A. glacialis*



28 (N), *A. glacialis*

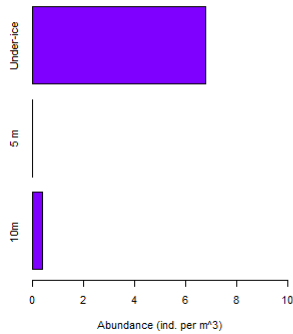


28 (D), *A. glacialis*

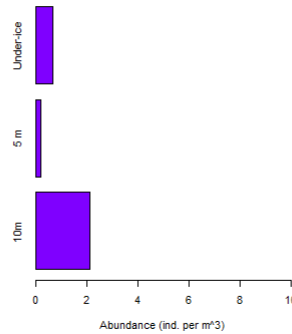


*Apherusa glacialis*

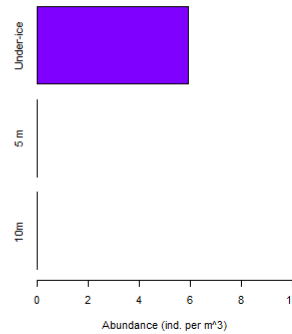
27 (D), *Themisto* spp.



28 (N), *Themisto* spp.

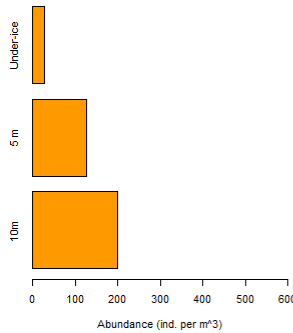


28 (D), *Themisto* spp.

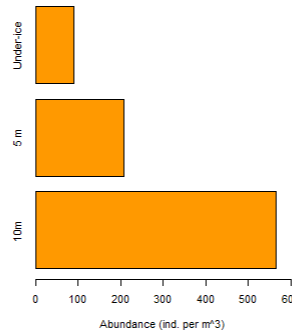


*Themisto* spp.

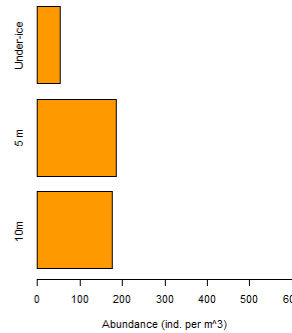
27 (D), *Calanus* spp.



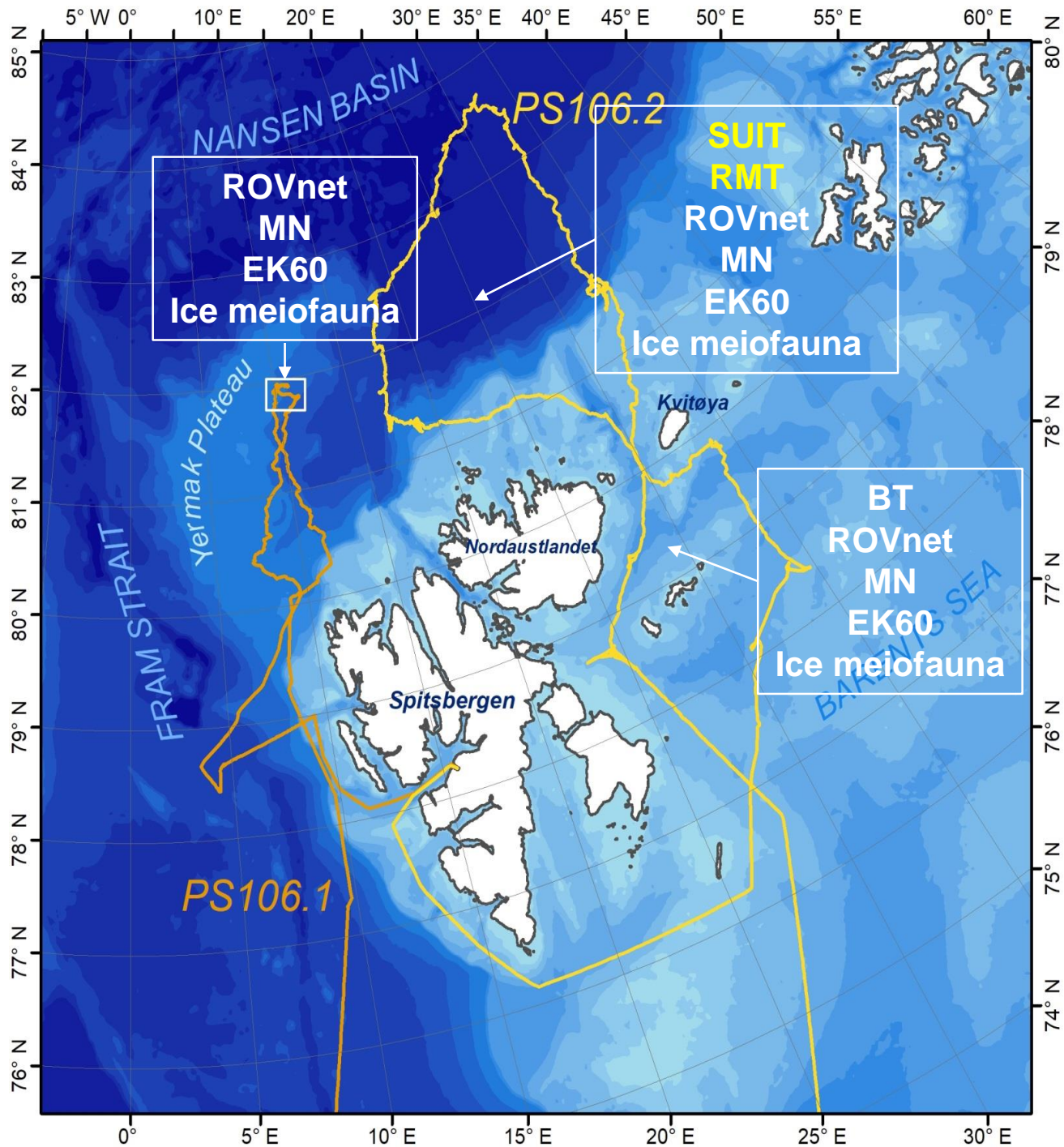
28 (N), *Calanus* spp.

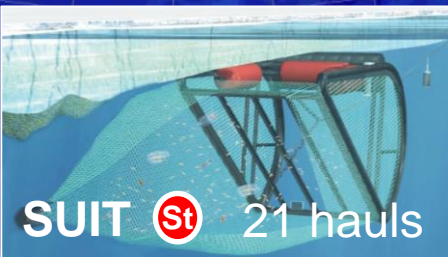
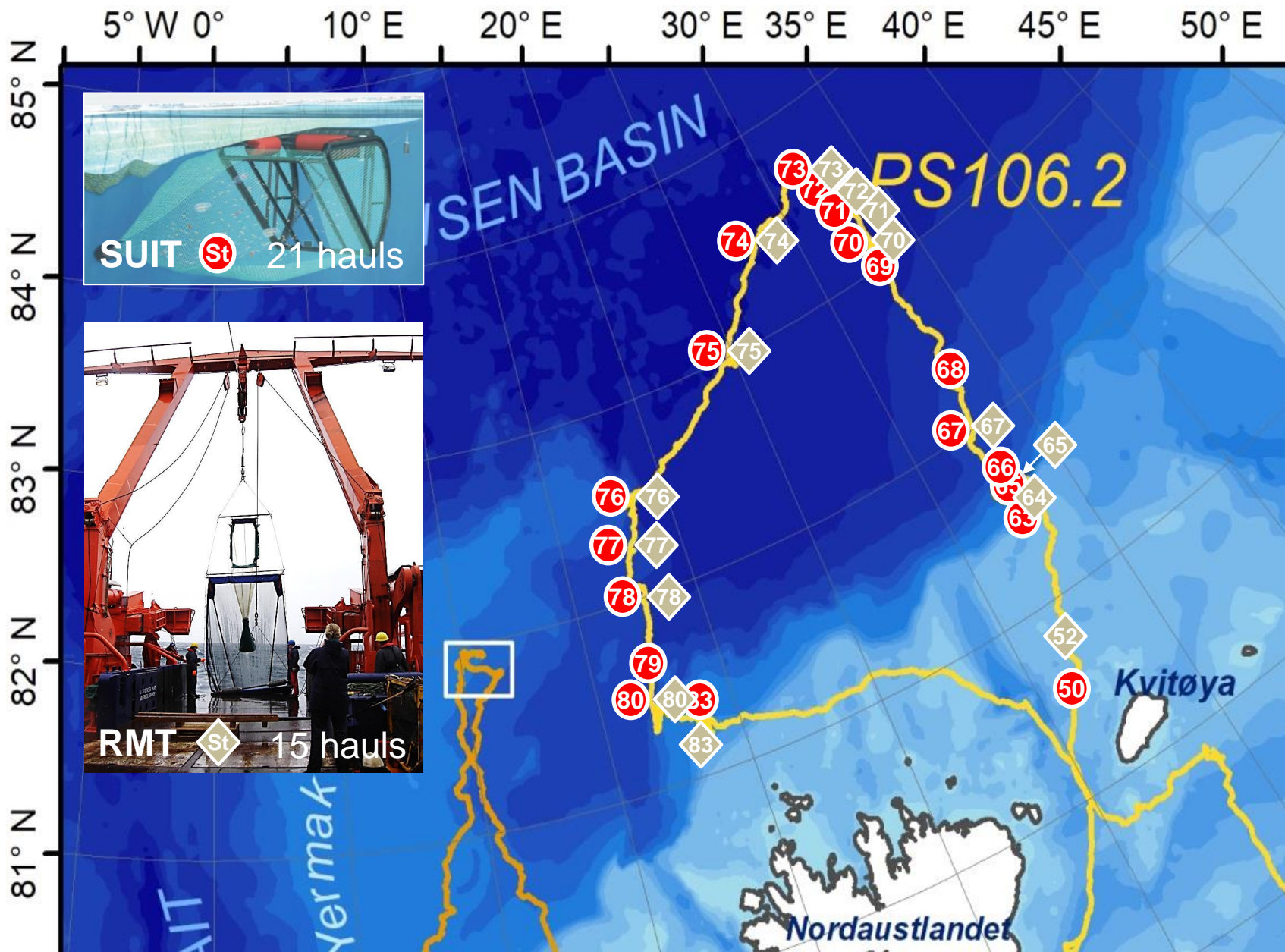


28 (D), *Calanus* spp.



*Calanus* spp.





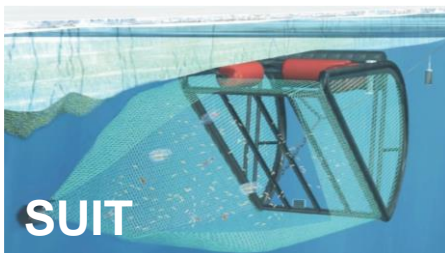
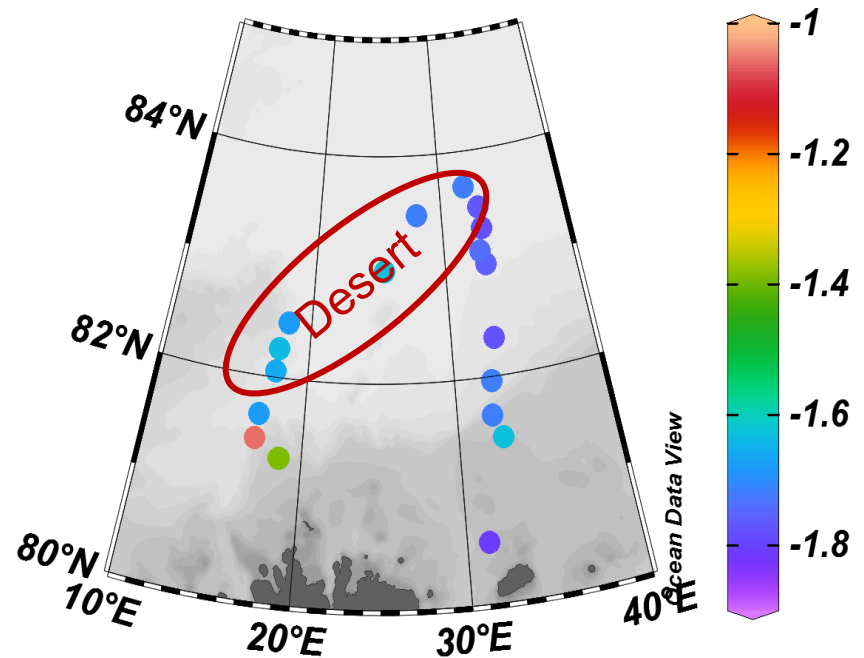
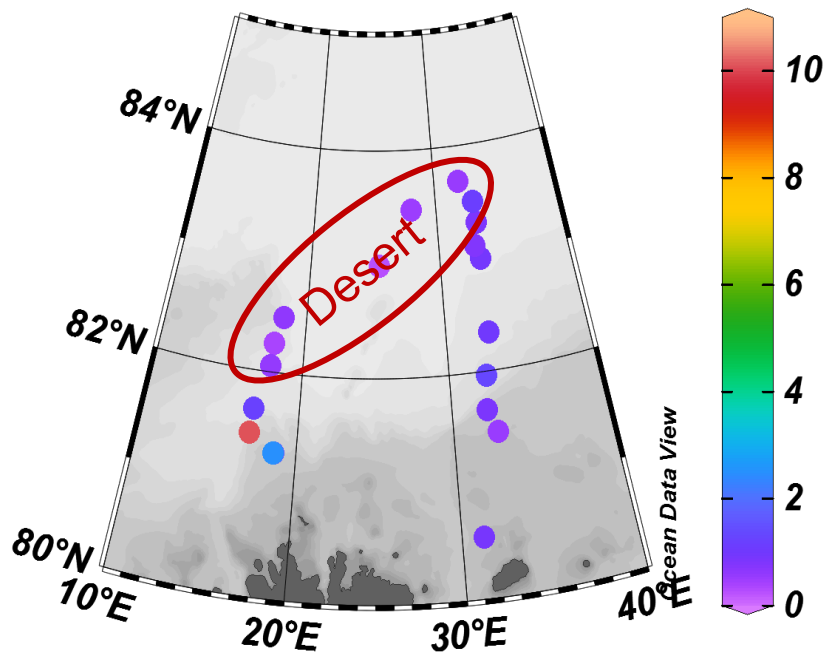


# SUIT sensor data



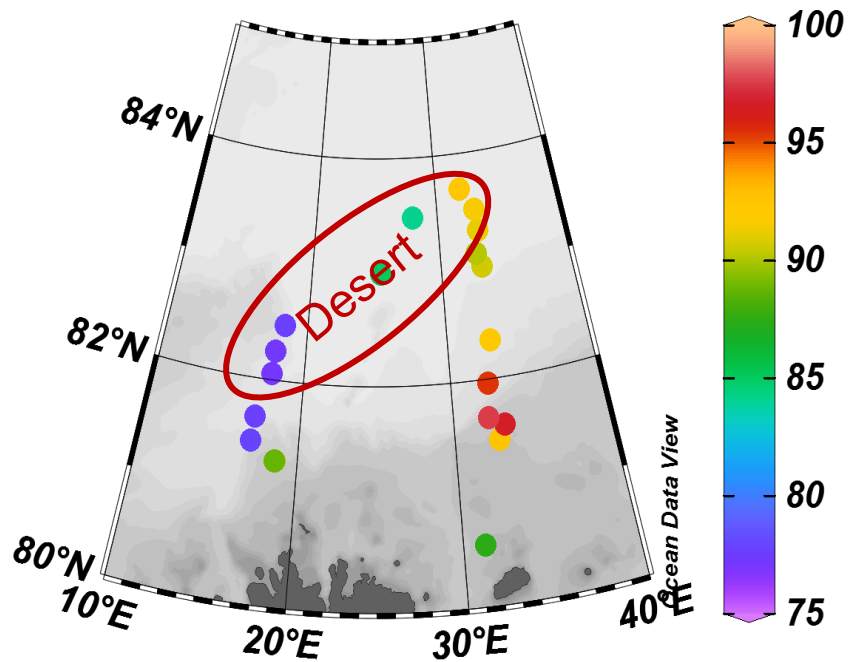
Surface wtr Chl *a* ( $mg\ m^{-3}$ )

Wtr temperature ( $^{\circ}C$ )

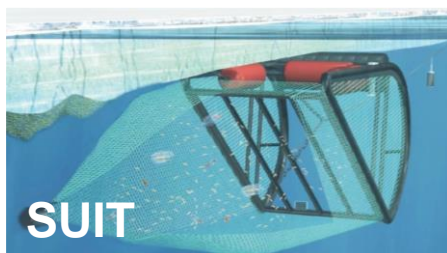
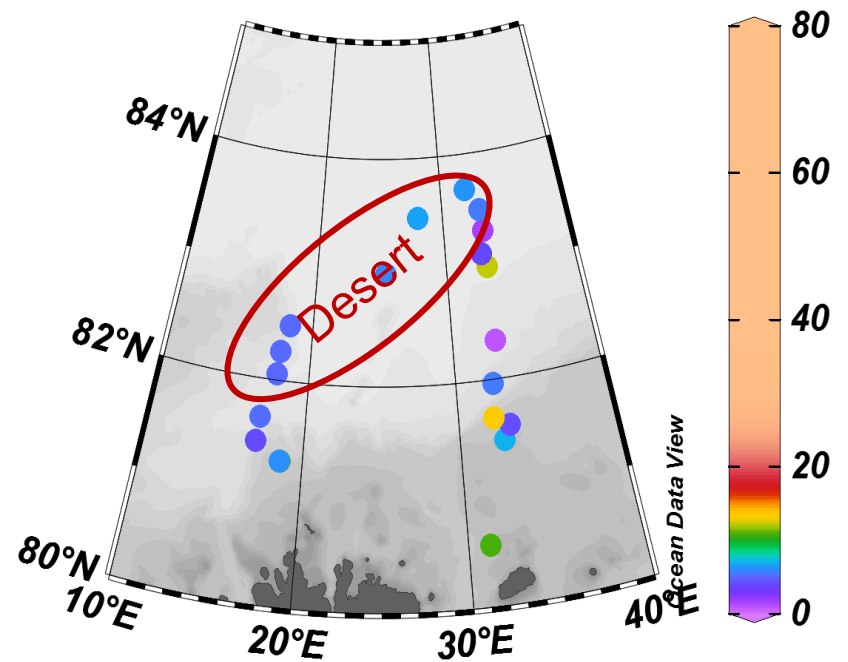


Castellani et al. (in prep.)

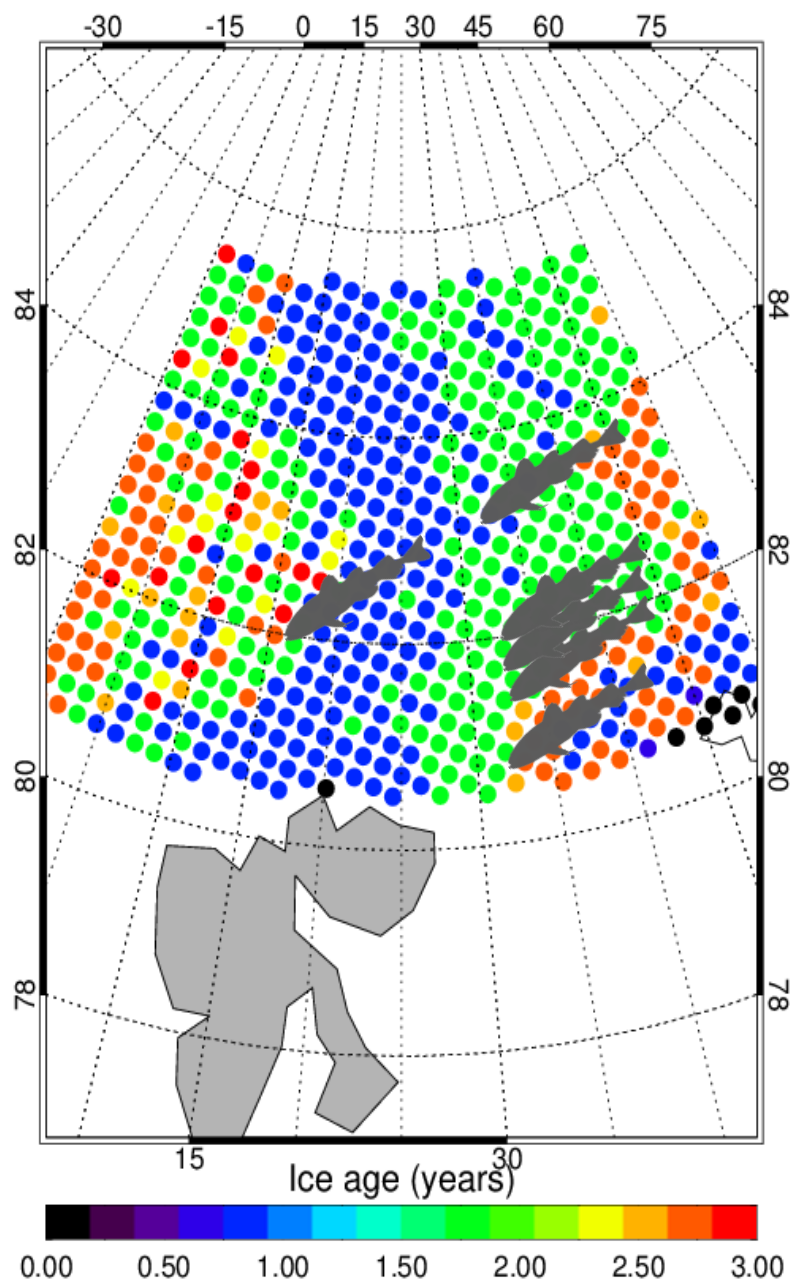
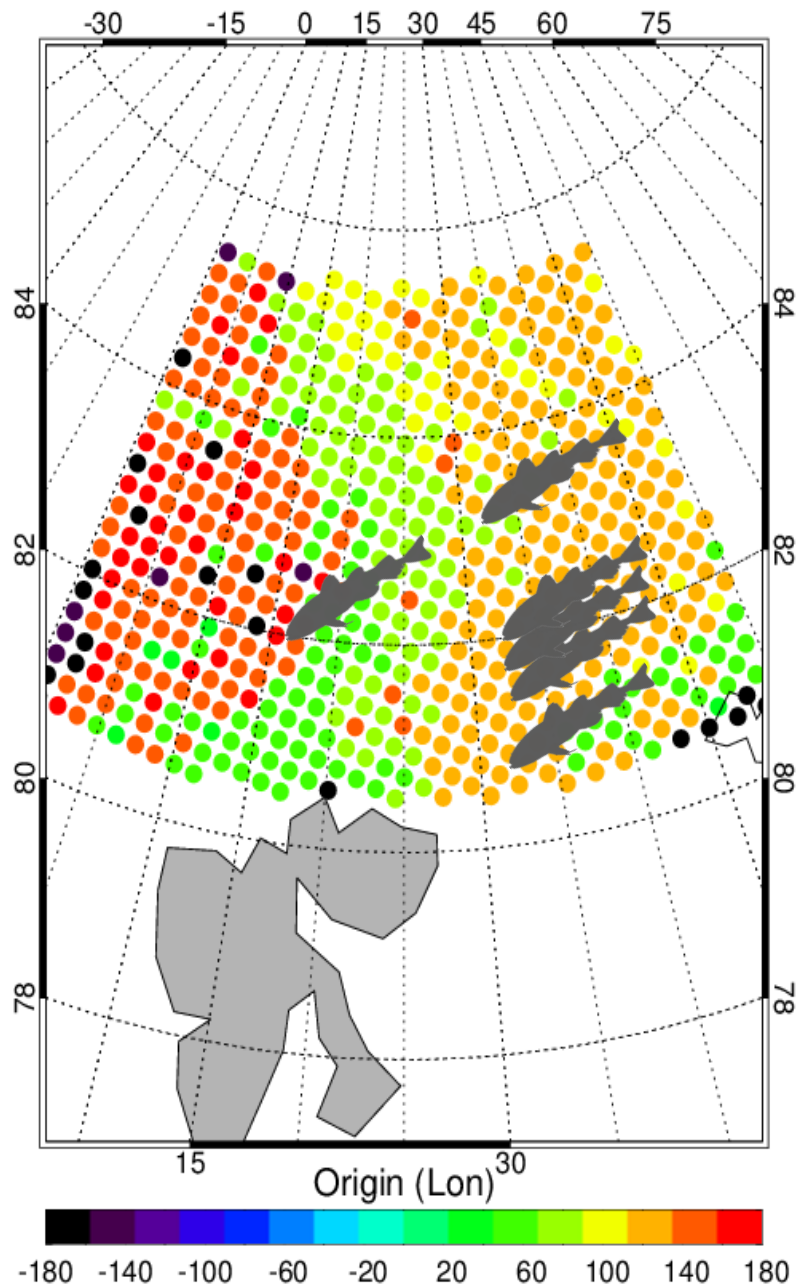
## Satell. ice cover (%)



## Ridge density (%)



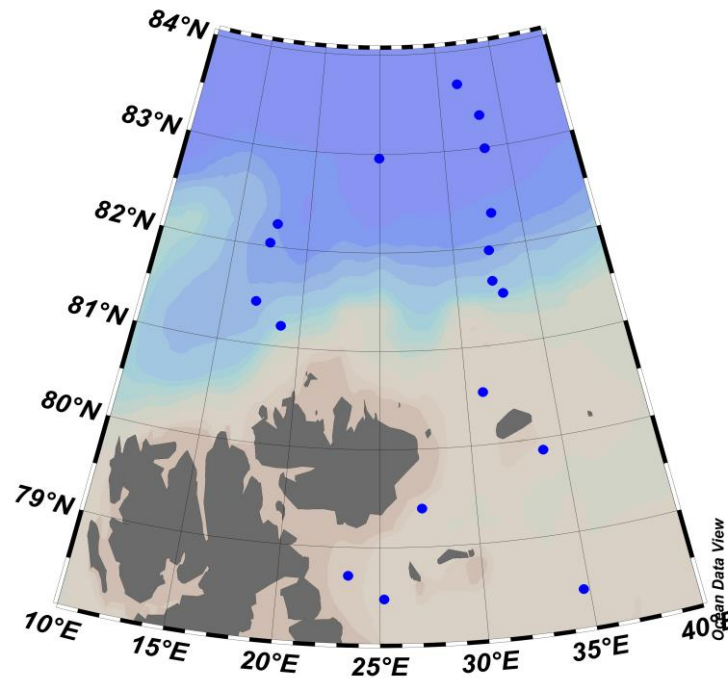
Castellani et al. (in prep.)



Start date: 21 JUN 2017

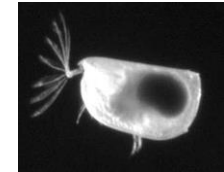
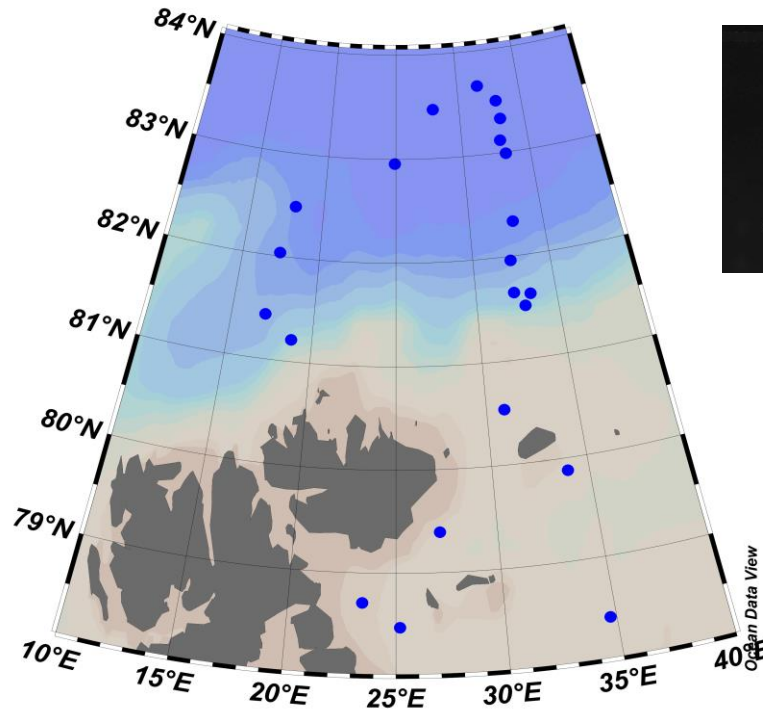
Thomas Krumpfen

# Multinet



- 18 stations from the shelf to the deep Arctic Ocean
- 5 depth layers (0-50-200-500-1000-1500 m), 150  $\mu\text{m}$  mesh size
- Samples preserved in formalin
- Species determination under stereo microscope

# LOKI / Aquascat

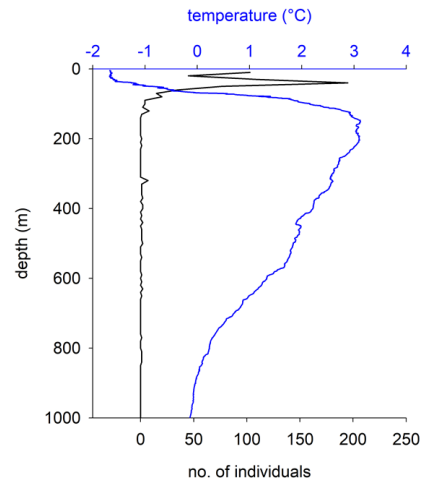


- 22 stations from the shelf to the deep Arctic Ocean
- 0-1000 m (or bottom) depth, 150  $\mu\text{m}$  mesh size
- 18 pictures  $\text{sec}^{-1}$
- CTD,  $\text{O}_2$ , fluorescence
- Acoustic backscatter at 0.5, 1, 2 and 4 MHz

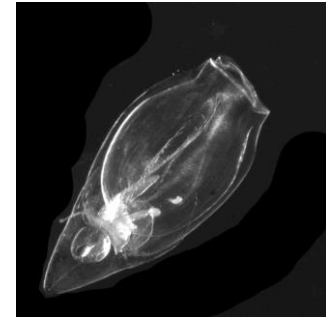
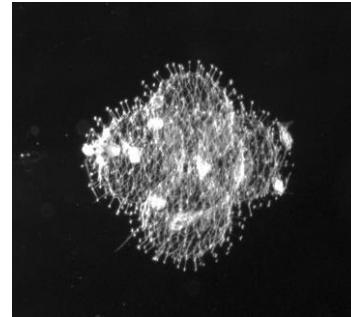
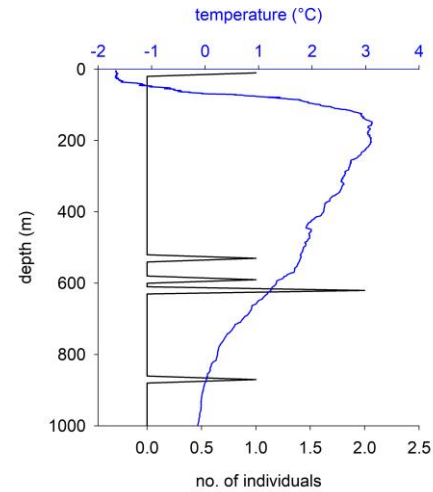
*Barbara Niehoff, Martin Doble & Nicole Hildebrandt*



Total *Calanus* spp. abundance



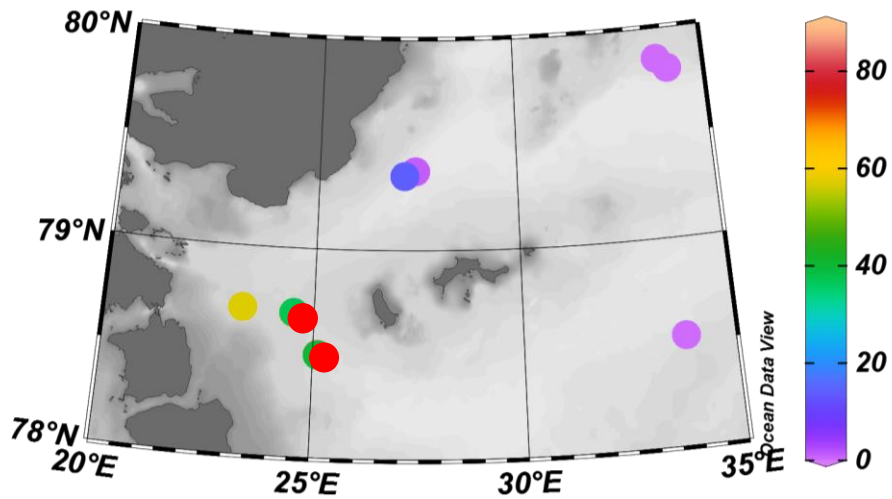
Total *Themisto* sp. abundance



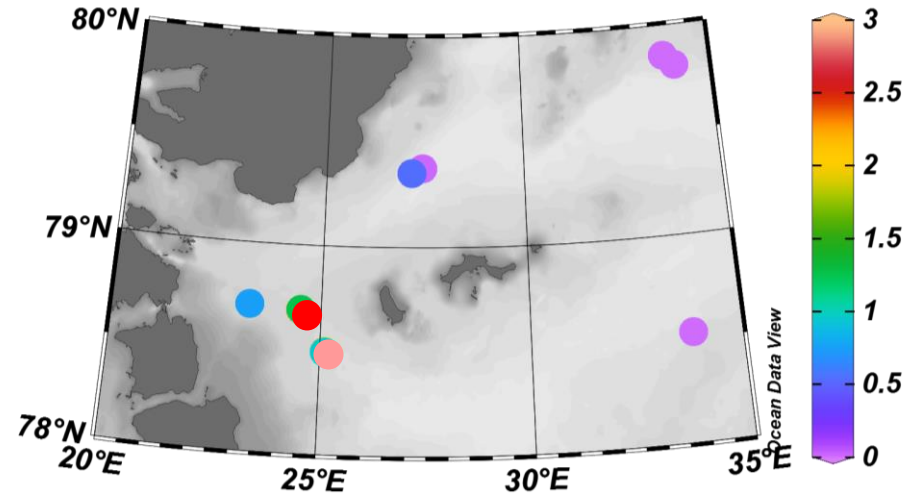
# Bottom Trawl – Polar cod



No of fish caught



Abundance (n 1000m<sup>-2</sup>)



*Total: 321 fish from 10 stations*

*Nils Koschnick, Jennifer Steffen, Magnus Lucassen, Erik Sulanke, Kim Vane,...*

# More animals!

*Microsetella* sp.

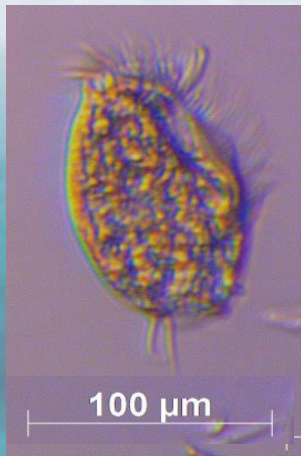


Sea-ice meiofauna  
Julia Ehrlich

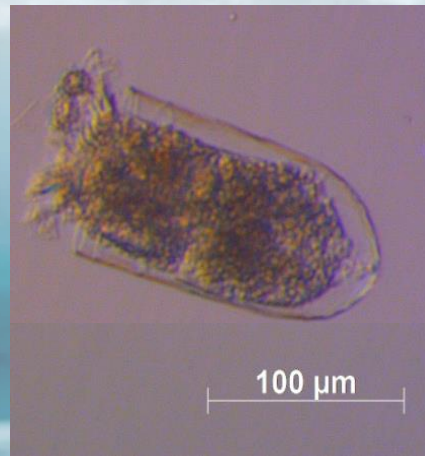


Top predators: J.A. van Franeker,  
Suse Kühn, Bram Fey...

*Ciliata*



*Tintinnina*



Benthos  
Carolin Uhlir



# Conclusions / Outlook

- **Under-ice fauna composition quite stable at a given ice floe over weeks**
- **Diel patterns may be present during summer, but are probably weak**
- **During PS 106/2 the research area had at least 3 major regimes which are reflected in under-ice fauna composition and polar cod presence under sea-ice, with a „desert“ in very young ice**
- **We have an almost complete ecosystem survey from phytoplankton to top predators!**

# Conclusions / Outlook

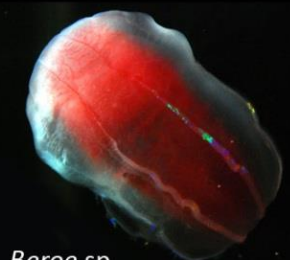
## **Interdisciplinary linkages**

- Role of zooplankton and under-ice fauna (especially jelly-type) for aerosols, gas exchange and particle transport
- Advection processes of zooplankton versus ice drift advection

## **MOSAIC-related**

- Seasonal variability of sea-ice fauna and DVM
- Linkage of under-ice communities and deeper hi-res profiles (LOKI / MN / hydroacoustics)
- Distributed network: Variability related to ice origin
- Might not be a bad place to sample polar cod!

# Thank you!



*Beroe* sp.



*Calanus glacialis*



*Clione limacina*



*Gammarus wilkitzkii*



*Beroe* sp.



*Boreogadus saida*



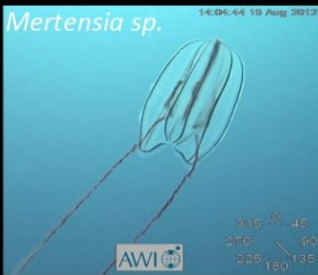
*Limacina helicina*



*Calanus hyperboreus*



*Aethotaxis mitopteryx*



*Mertensia* sp.



*Eusirus microps*



*Clione limacina antarctica*



*Euphausia superba*



*Salpa thompsoni*



*Tomopteris* sp.

## ARCTIC AND ANTARCTIC UNDER-ICE FAUNA

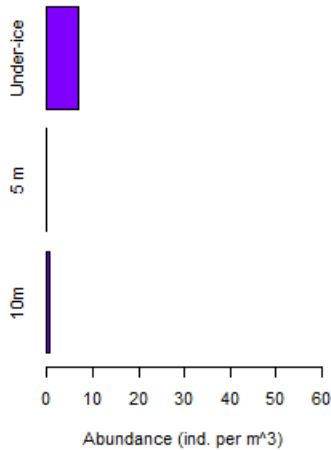
Photos: Carmen David, Christian Katlein, Jan Andries van Franeker, Julia Ehrlich, Hauke Flores



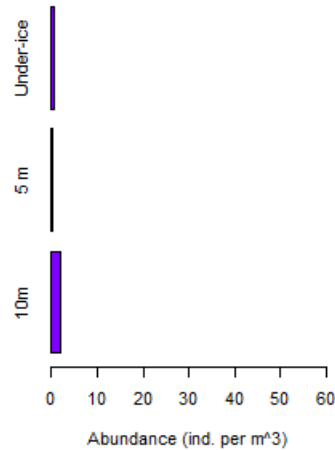
# ROVnet – depth distribution

PS106/1

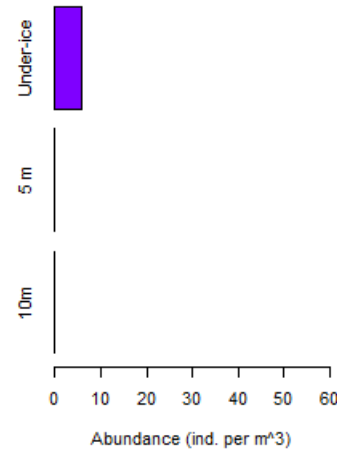
27 (D), Themisto spp.



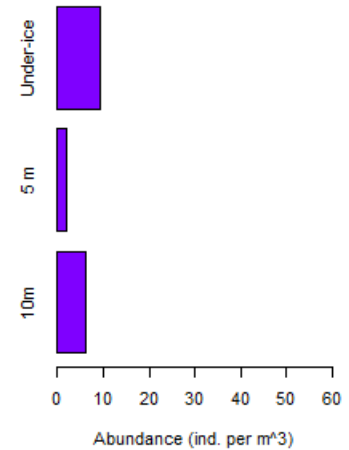
28 (N), Themisto spp.



28 (D), Themisto spp.

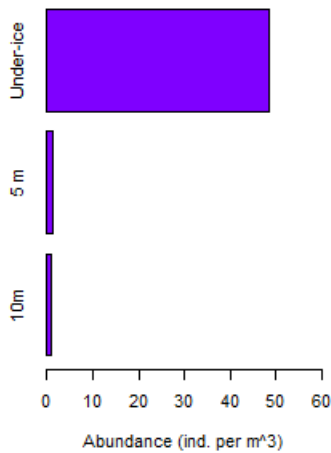


32 (D), Themisto spp.

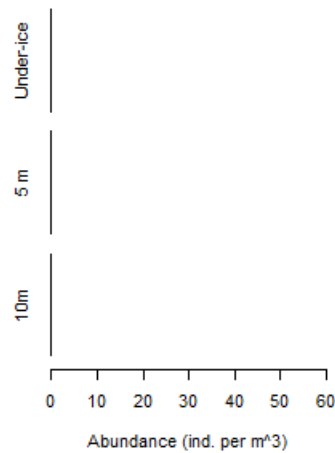


PS106/2

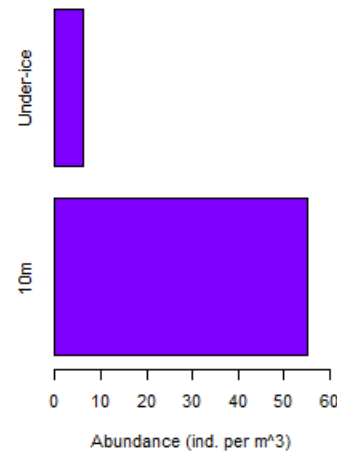
45 (N), Themisto spp.



66 (N), Themisto spp.



80 (D), Themisto spp.

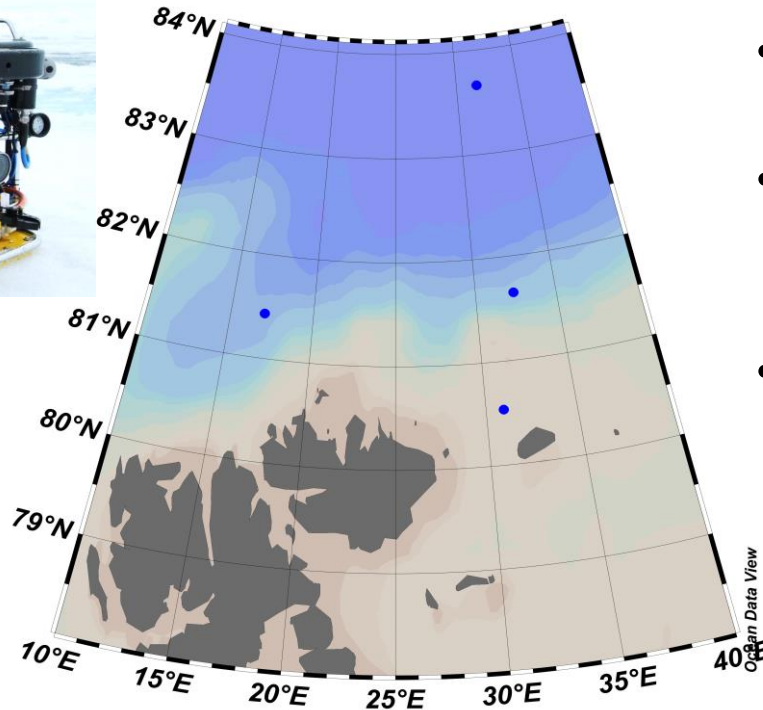


# ROVnet



Video by BEAST and C. Katlein

# LOKI-ROV

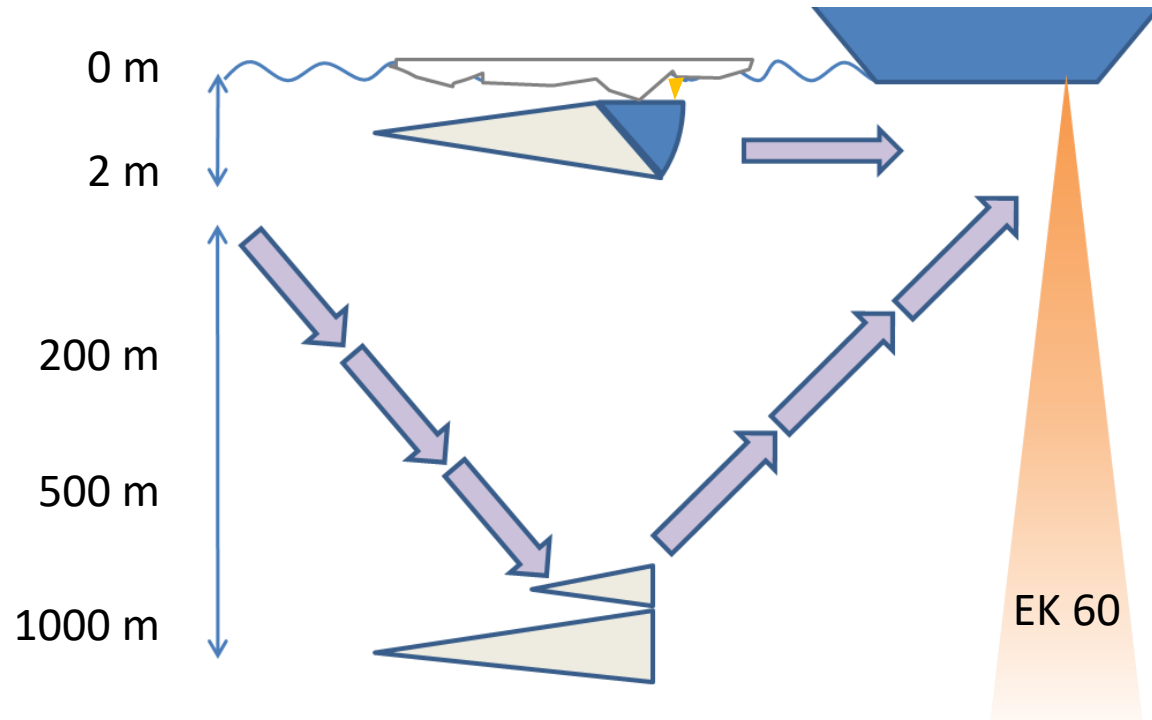


- 4 stations (first test run of the device)
- Horizontal transects at 0-20 m depth, 150  $\mu$ m mesh size
- Test with different net openings (5, 10, 20 cm)

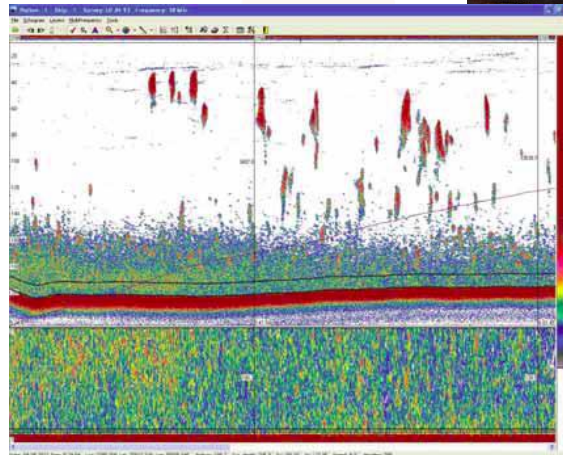
→ *mainly small nauplii photographed* → *larger net needed to capture bigger animals*

Barbara Niehoff, Martin Doble & Nicole Hildebrandt

# Synoptic sampling



# Rectangular Midwater Trawl (RMT)



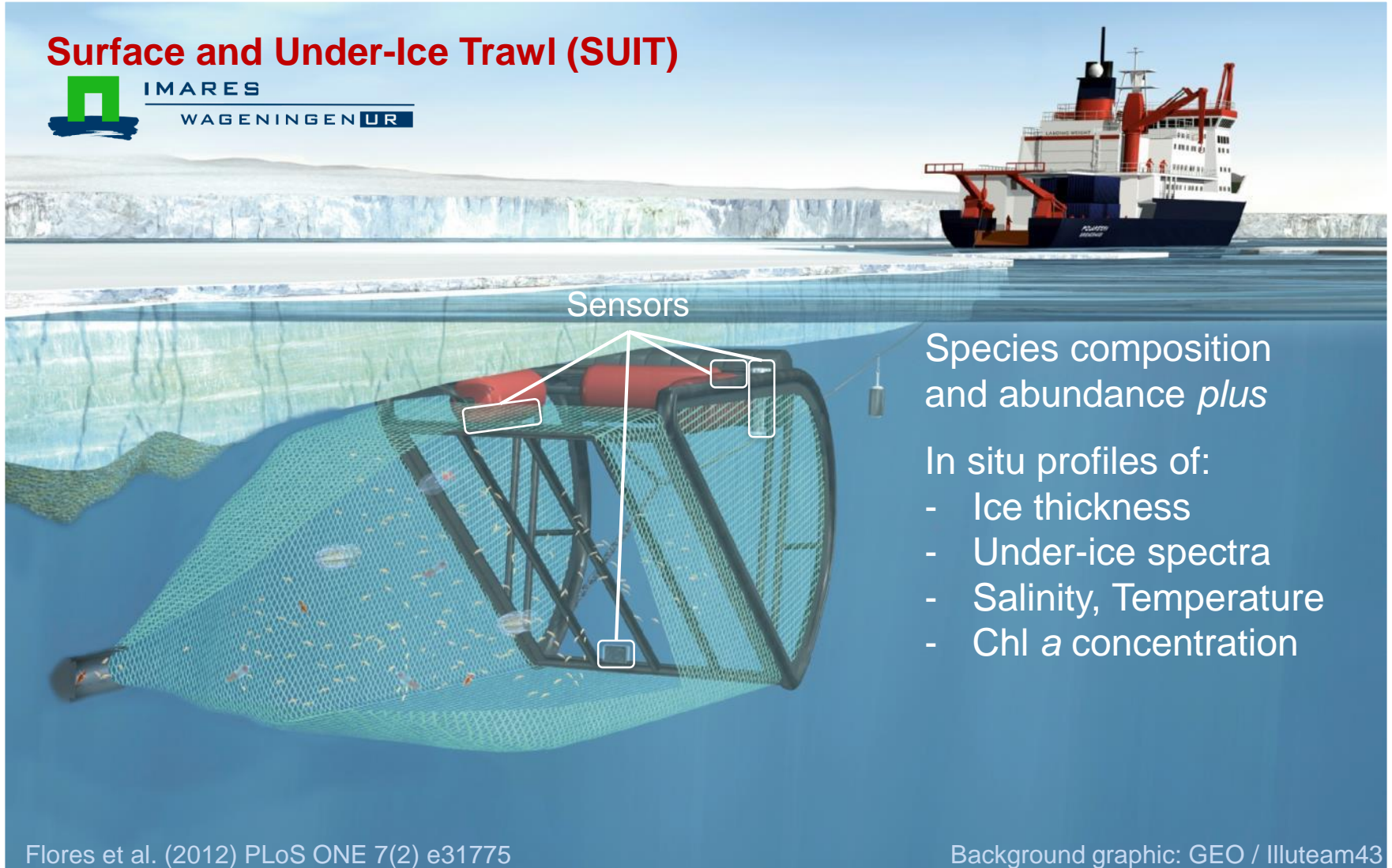


# Thank you



# Bio-environmental sampling

## Surface and Under-Ice Trawl (SUIT)



Species composition  
and abundance *plus*

In situ profiles of:

- Ice thickness
- Under-ice spectra
- Salinity, Temperature
- Chl a concentration

Flores et al. (2012) PLoS ONE 7(2) e31775

Background graphic: GEO / Illuteam43

# Epibenthic studies: gears

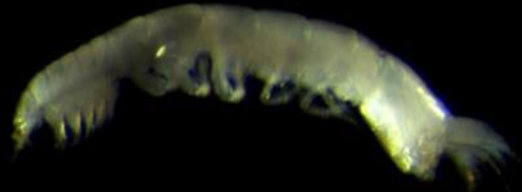


**Epibenthic sledge**



**Box corer**

# Epibenthic studies: animals



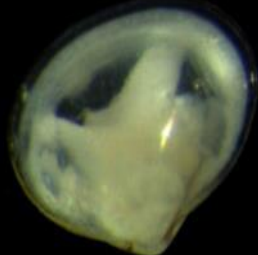
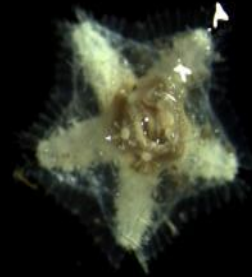
#24-5 EBS Crustacea



#24-5 EBS Chelicerata



#22-3 BC Echinoidea

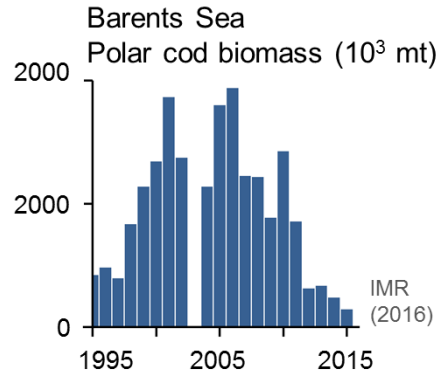


#24-5 EBS Bivalvia



#24-5 EBS Polychaeta

# Polar cod



## Stock size (Barents Sea)

Mean: 766,000 mt  
2015: 148,000 mt



### Prey

Copepods  
amphipods



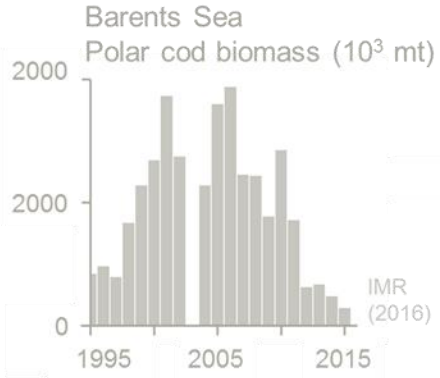
### Predators

Seals  
seabirds



Human value  
Minor fishery  
Artisanal hunting

# Polar cod



Stock size  
(Barents Sea)  
Mean: 766,000 mt  
2015: 148,000 mt

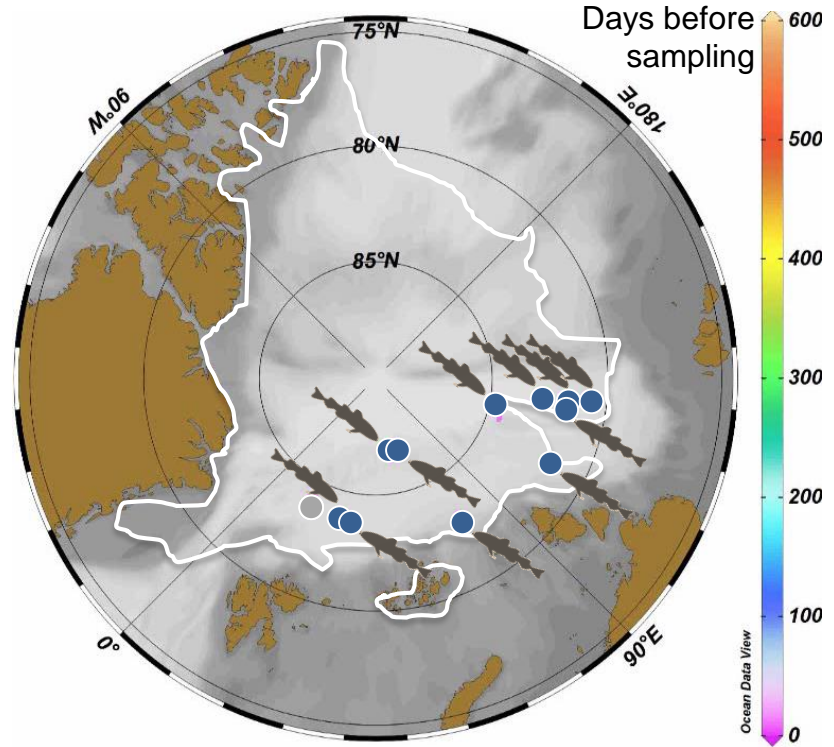


Prey  
Copepods  
amphipods



Predators  
Seals  
seabirds

Human value  
Minor fishery  
Artisanal hunting



Sea ice back-tracking

# ROVnet

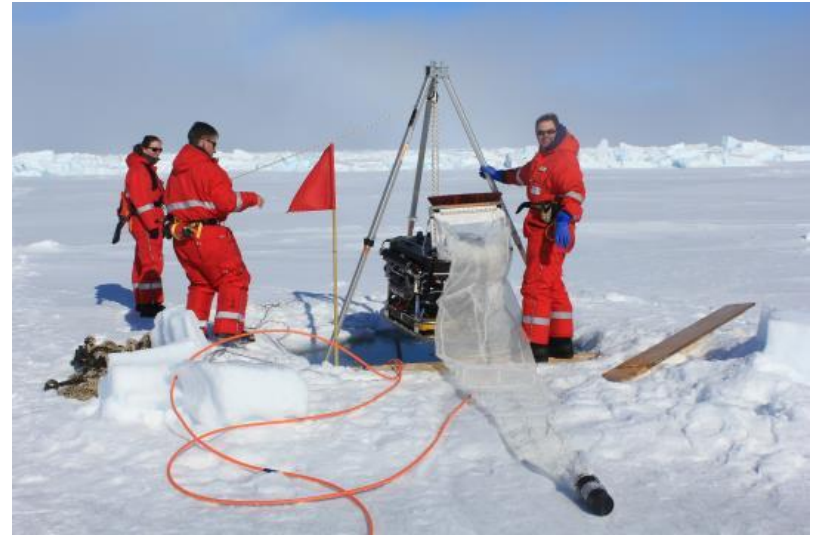


Foto: Erin Kunisch

# Hypothesis / Approach

**Distribution, association with habitat properties, fish community:**  
Fishing nets, acoustics



**Survival, migration:**  
Trophics, DNA, otoliths, physiology

**Hypothesis:**

*Sea ice constitutes a unique survival strategy and a genetic vector critical for the viability of polar cod populations around the AO*

**Prey field, Predators:**  
Zoopl. nets, acoustics, TP census



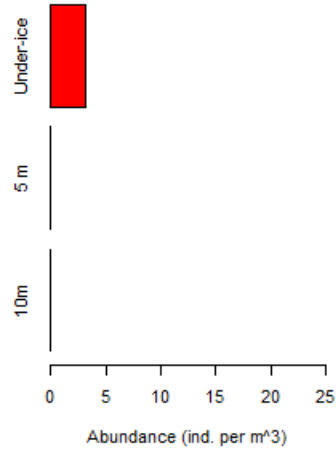
**Environment, productivity:**  
Hydrography, sea ice properties, PP, biogeochemistry



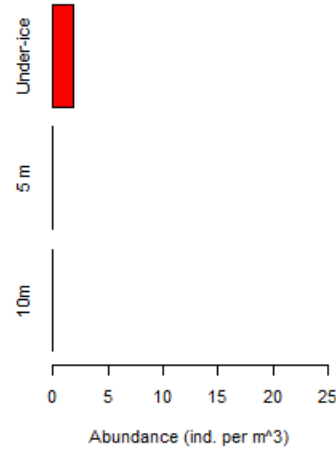
# ROVnet – depth distribution

PS106/1

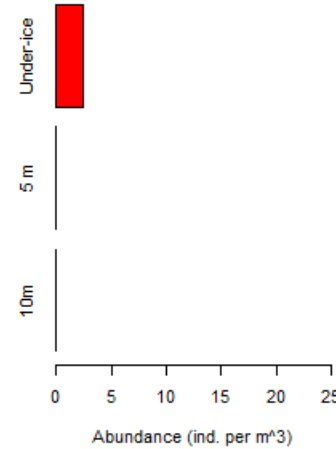
27 (D), *A. glacialis*



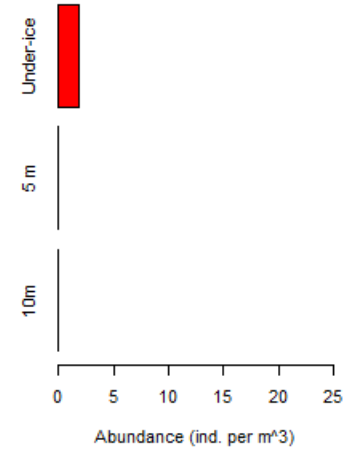
28 (N), *A. glacialis*



28 (D), *A. glacialis*

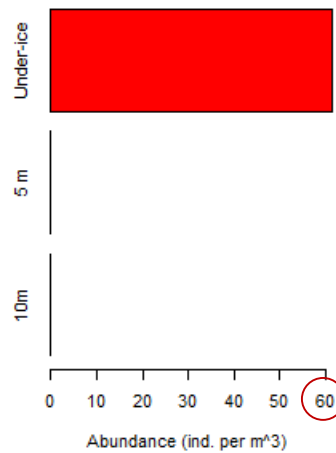


32 (D), *A. glacialis*

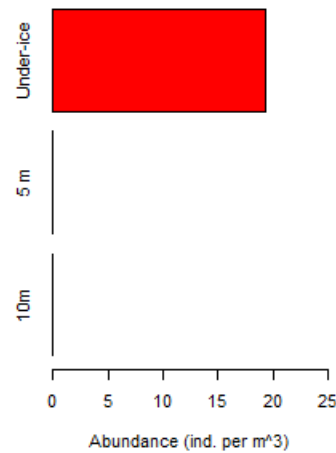


PS106/2

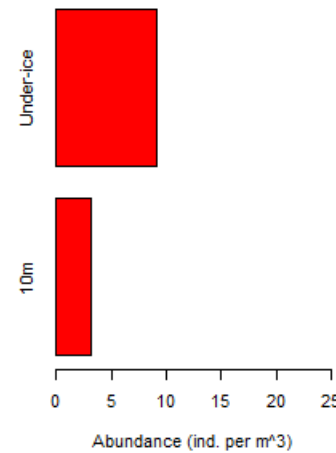
45 (N), *A. glacialis*



66 (N), *A. glacialis*

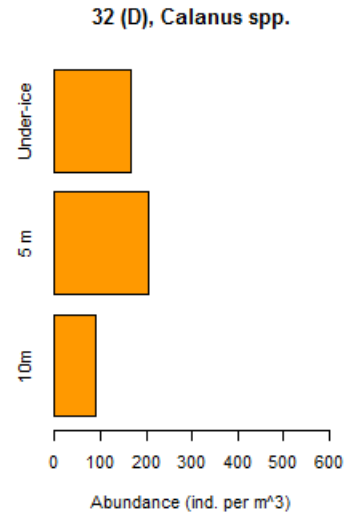
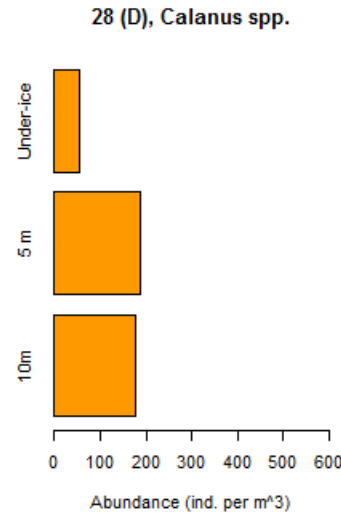
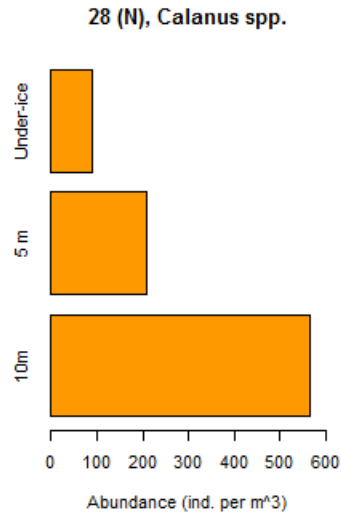
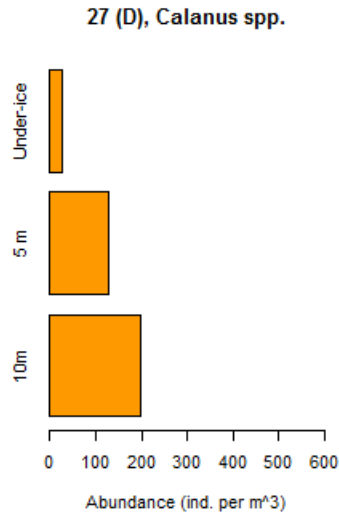


80 (D), *A. glacialis*



# ROVnet – depth distribution

PS106/1



PS106/2

