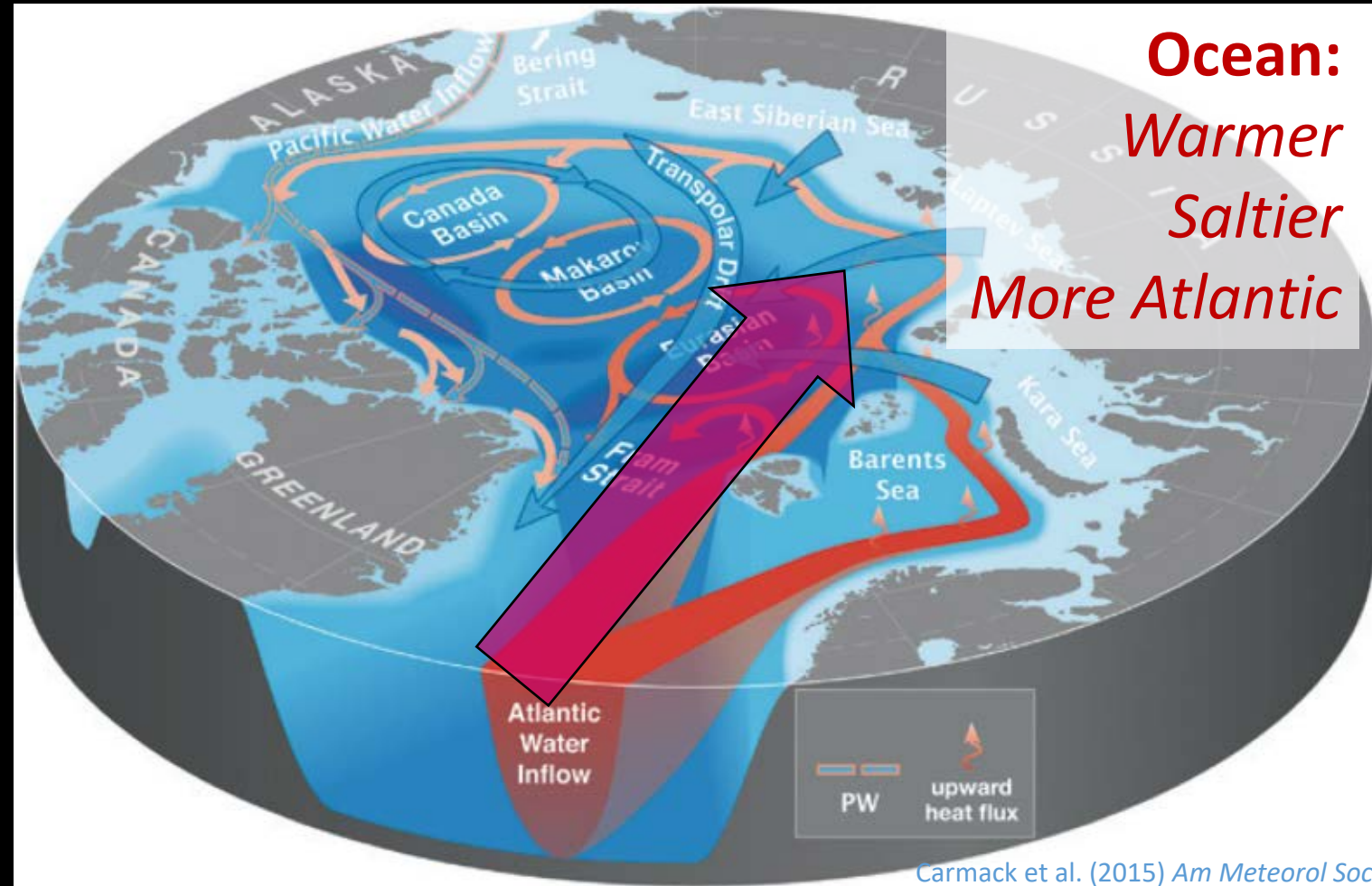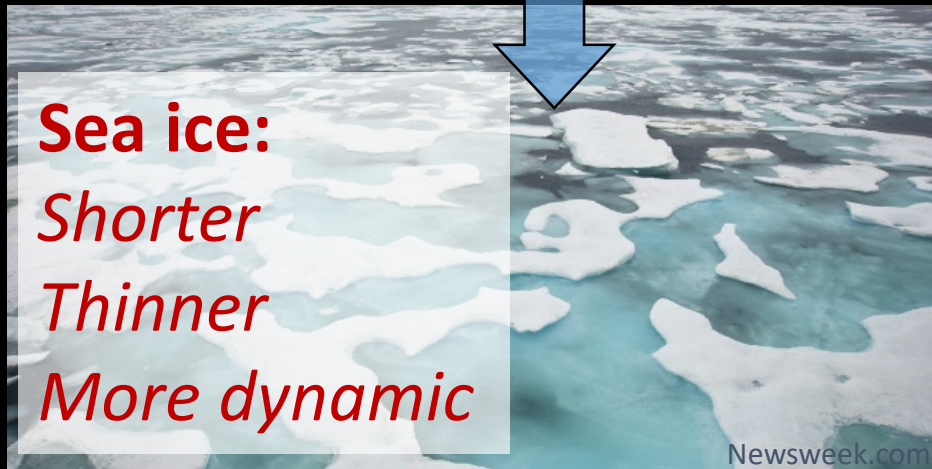# Dancing in the Dark
The never-resting ballet of animal life under the Arctic sea ice

Hauke Flores[1], Carin Ashijan[2], Robert Campbell[3], Giulia Castellani[1], Allison Fong[1], Jessie Gardner[4], Celia Gelfman[3], Martin Graeve[1], Charlotte Havermans[1], Nicole Hildebrandt[1], Ayla Murray[1], Barbara Niehoff[1], Dmitrii Pantiukhin[1], Fokje Schaafsma[5], Katrin Schmidt[6], Pauline Snoeijs-Leijonmalm[7], Katyanne Shoemaker[3], Serdar Sakinan[5], Anders Svenson[8]

[1] Alfred-Wegener-Institut Helmholtz-Institut für Polar- und Meeresforschung / Germany; [2] Woods Hole Oceanographic Institution / USA; [3] University of Rhode Island / USA; [4] The Arctic University of Norway / Norway; [5] Wageningen Marine Research / The Netherlands; [6] University of Plymouth / United Kingdom; University of Stockholm / Sweden; [8] Swedish University of Agricultural Sciences / Sweden

Rapid change of Arctic Ocean and sea ice

Caspar David Friedrich, 1824

Newsweek.com

Sea ice:
Shorter
Thinner
More dynamic

Ocean:
Warmer
Saltier
More Atlantic

Carmack et al. (2015) *Am Meteorol Soc*

Changing fauna

Less sympagic biota

Nematodes **Ice algae** **Ice copepods** **Ice amphipods** **Polar cod**

Melnikov (2018) Dokl. Earth Sci.
Ehrlich et al. (2020) Fr. Mar. Sci.
Kiko et al. (2017) Pol. Biol.
Steiner et al. (2019)
Nelson et al. (2014) [pictures]

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Kiko et al. (2017) Pol. Biol.
Steiner et al. (2019)
Nelson et al. (2014)

More Atlantic predators

Fossheim et al. (2015) PNAS
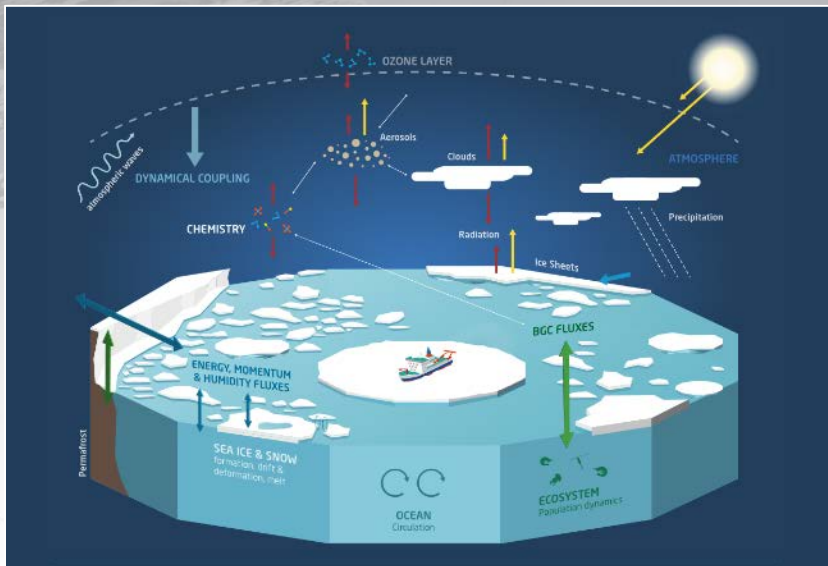*O'Correy-Crowe et al. (2016) Biol Lett*

Wikimedia.org

Kabeljau   **Orca**   **Jellyfish**

MOSAiC

Multi-disciplinary drift study
Following the Transpolar Drift
from start to end
- 312 days
- 4,300 km
- > 700 Scientists
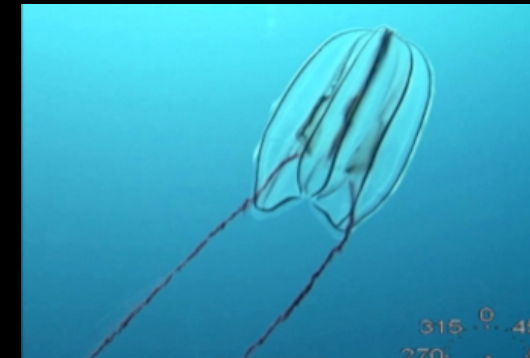
Holistic system approach:
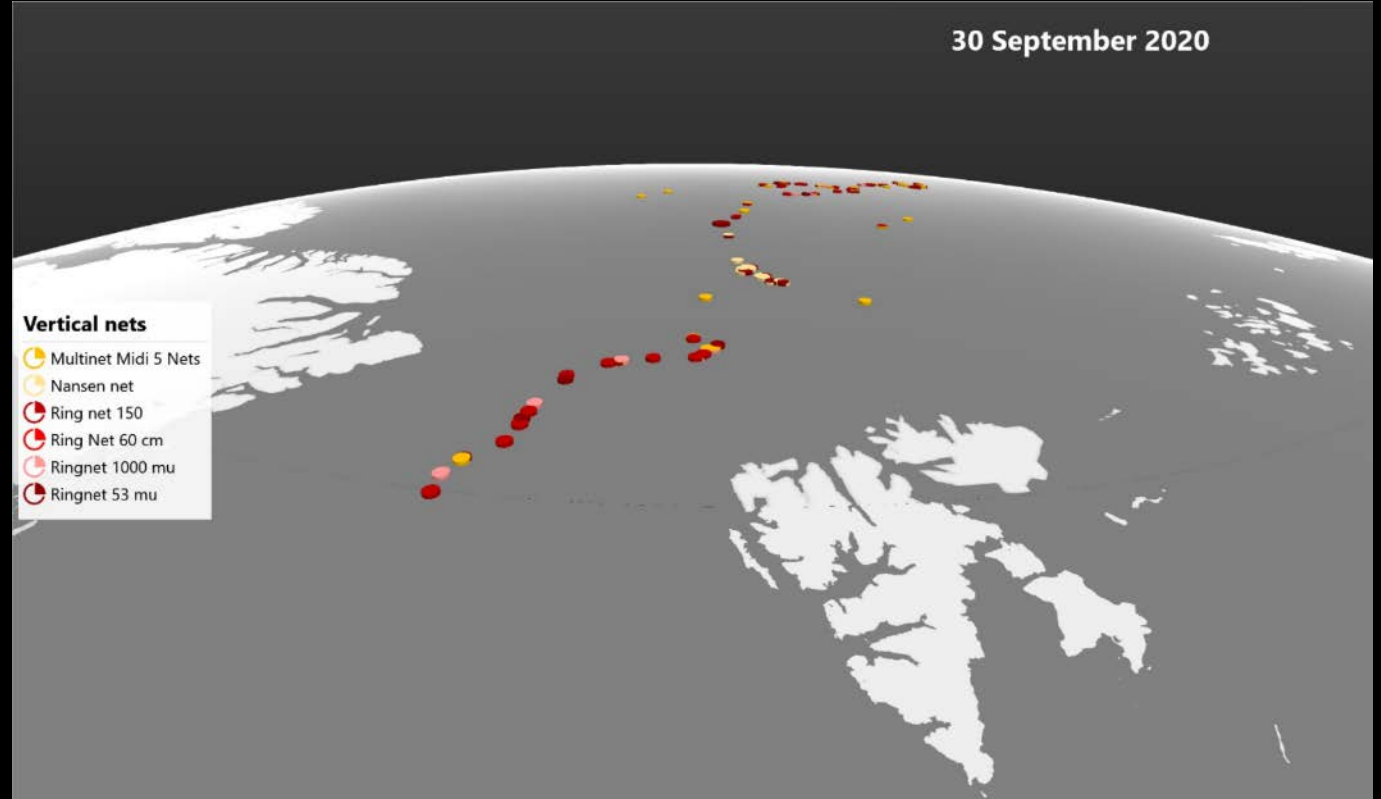- Atmosphere
- Ocean
- Sea ice
- Ecosystem

Objectives

Investigate the seasonal variability of:

- Animal biodiversity
- Vertical distribution
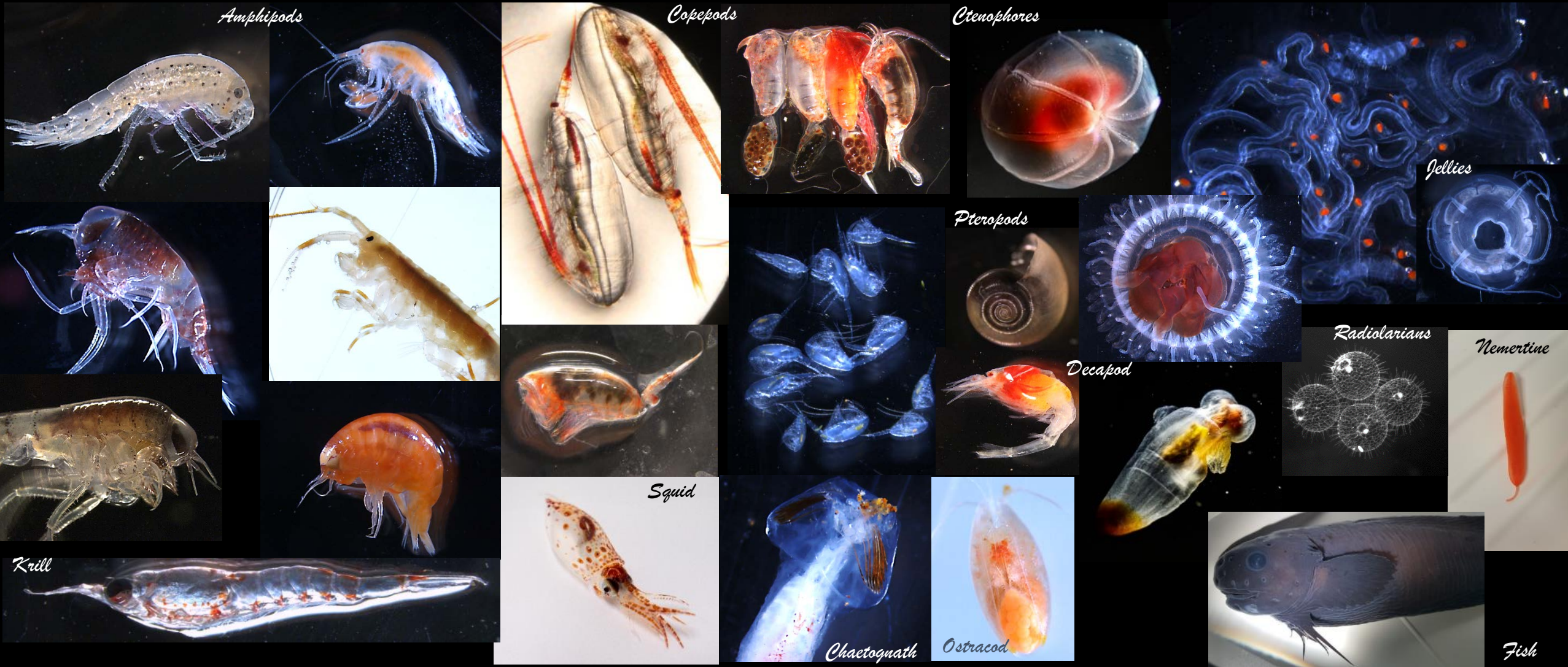- Biomass and production
- Their contribution to BGC cycles
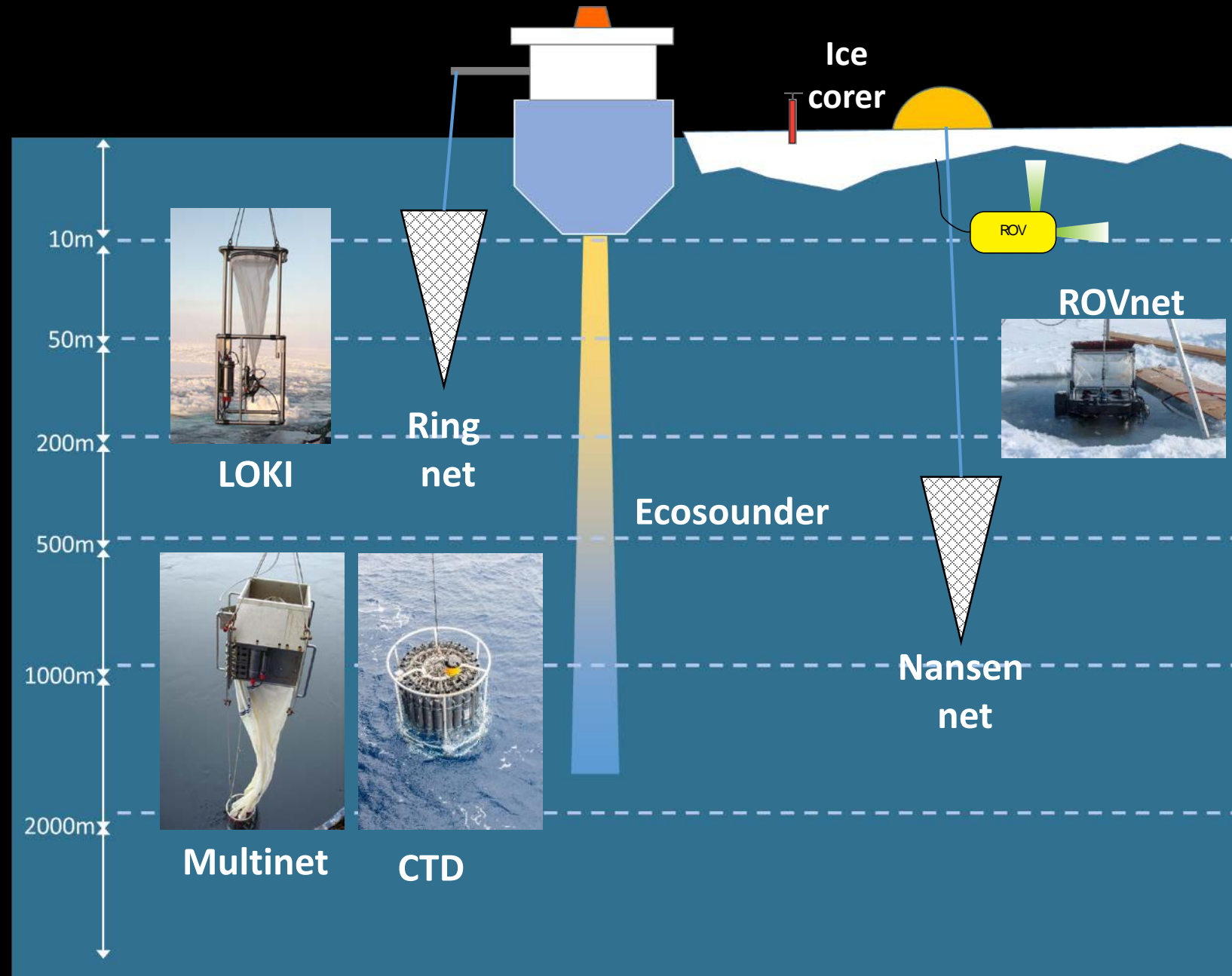
Distribution of sampling sites

- Multinet (5 strata, 0-2,000 m)
- Ring nets (50-2,000 m max. depth)
- Nansen net (0-200 m)
- Altogether 207 net deployments

Diversity of animals

Amphipods

Copepods

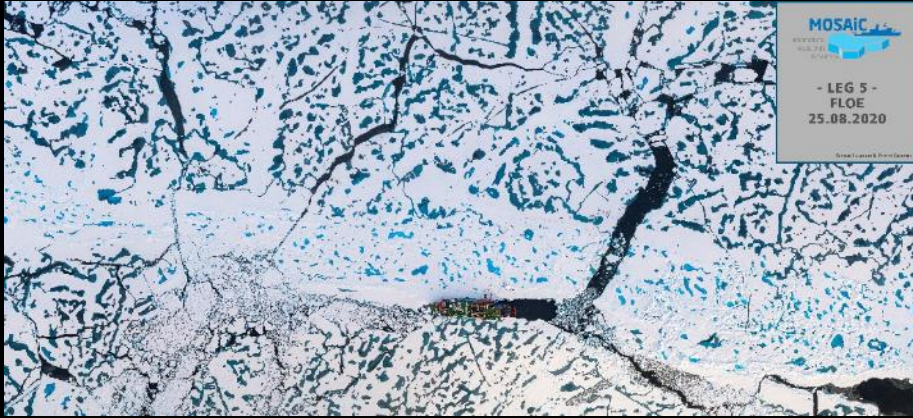Ctenophores

Jellies

Pteropods

Radiolarians

Nemertine

Decapod

Krill

Squid

Chaetognath

Ostracod

Fish

Freeze-up migration

25/8/2020

Image: Steffen Graupner

18/9/2020

Image: Steffen Graupner

Calanus hyperboreus

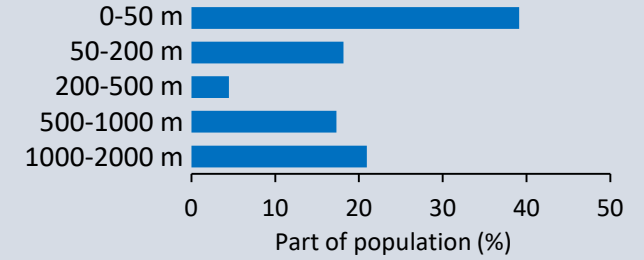**1.** Transect North   Gut fullness   Lipid reserves   Seasonal descent

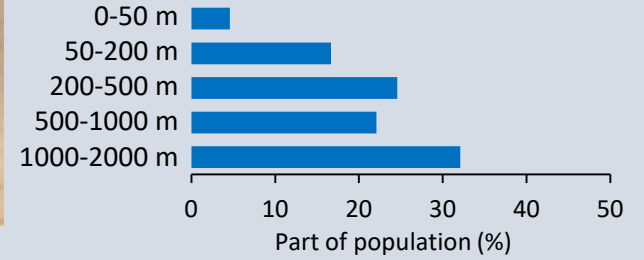
gut

lipids

+++   ++   +

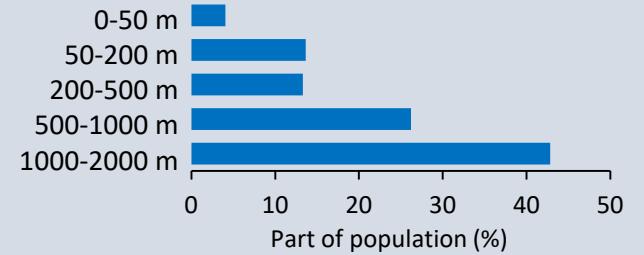Part of population (%)

2. Floe (early)

++   ++   ++

Part of population (%)
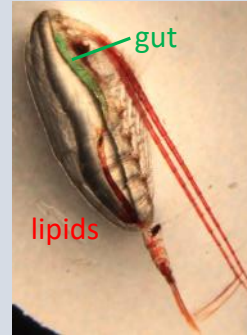
3. Floe (late)

+   ++   ++

Photos: Bob Campbell

Part of population (%)
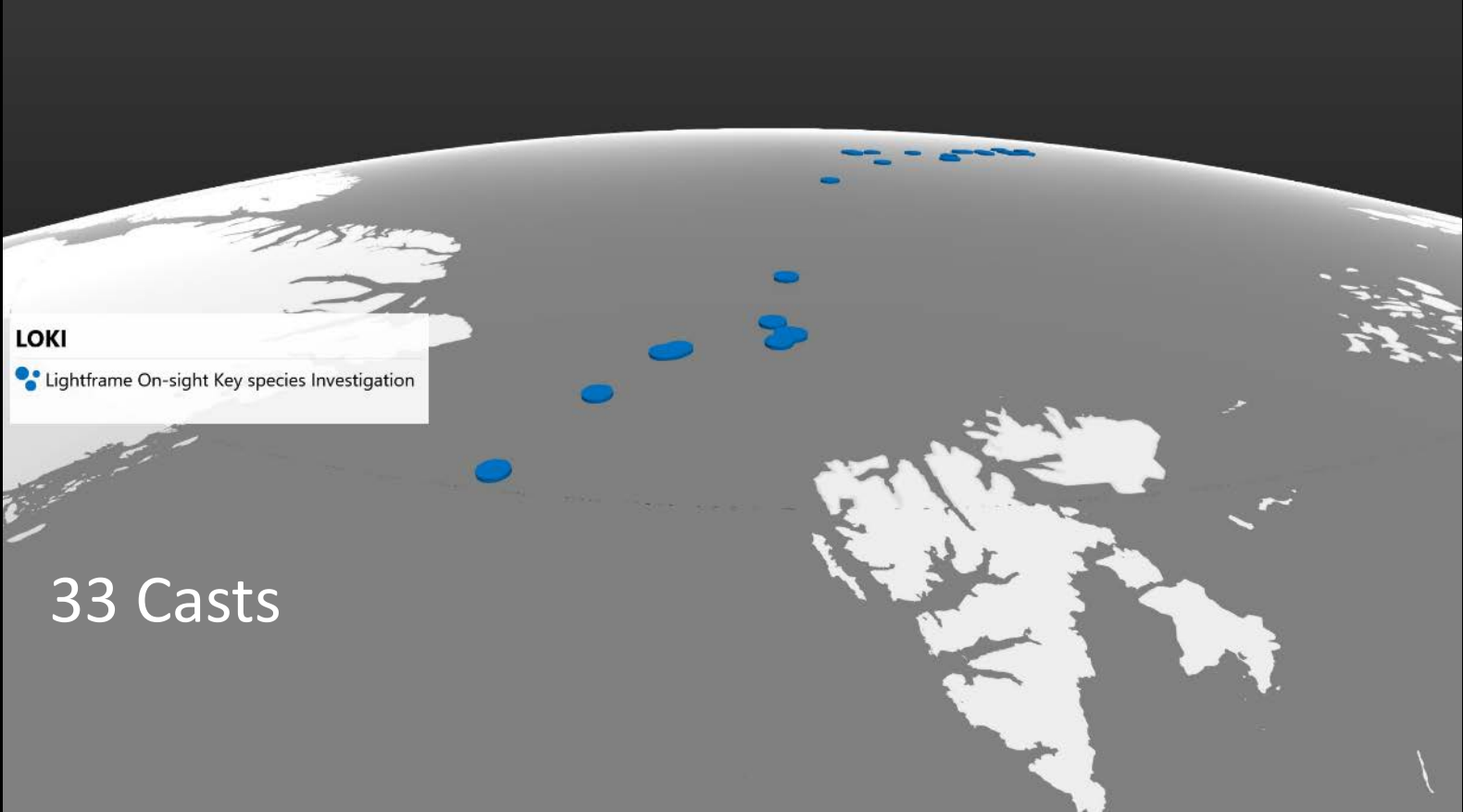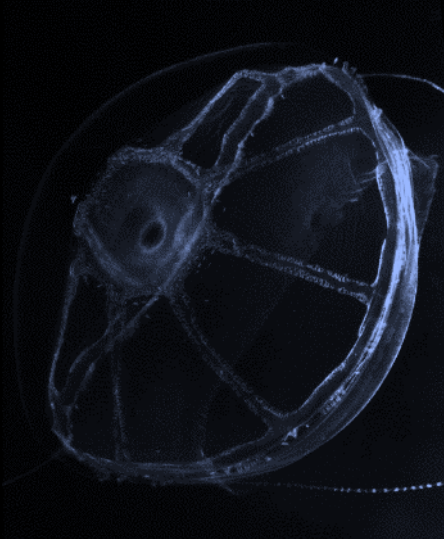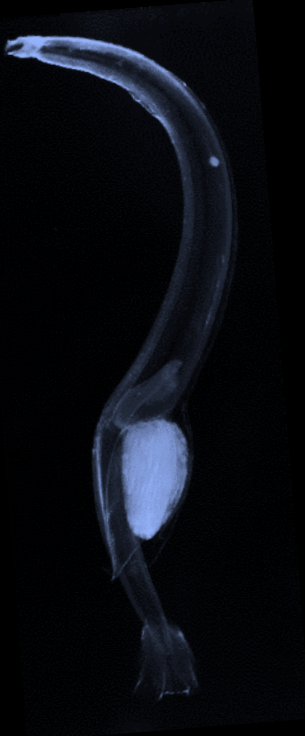
High resolution profiles of zooplankton distribution

LOKI

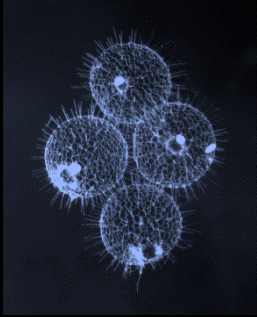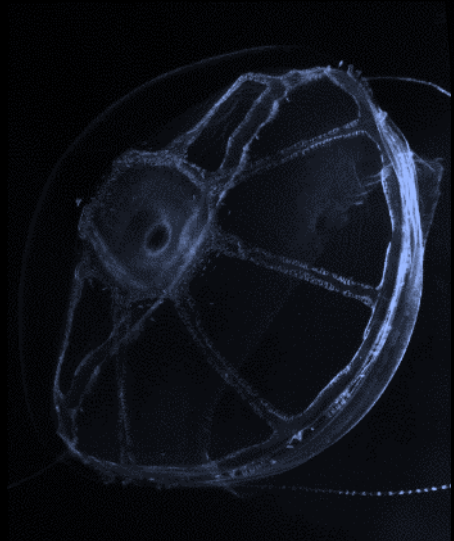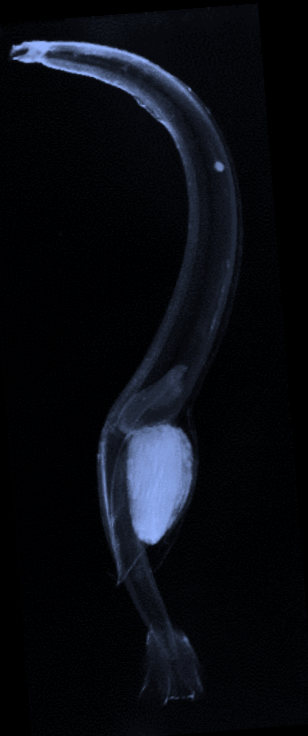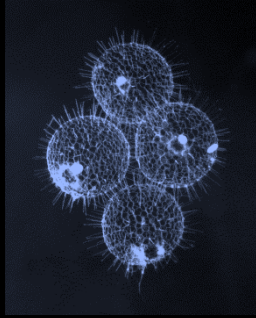Indication of reproducing *Calanus hyperboreus* and *Apherusa glacialis* in the Central Arctic Ocean in November/December
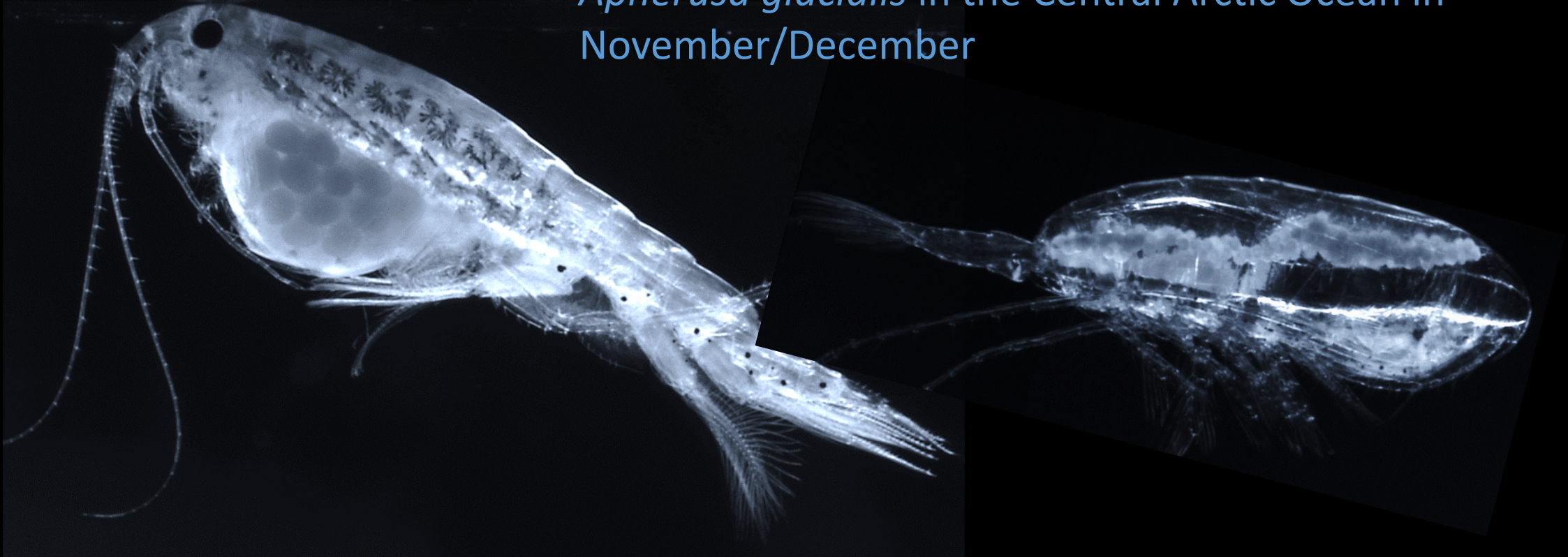
High resolution profiles of zooplankton distribution

LOKI

Lightframe On-sight Key species Investigation

33 Casts

High resolution profiles of zooplankton distribution

Preliminary data

LOKI profiles

Leg 1 (November)

Leg 5 (September)

Data calibration needed

Depth (m)

Picture count (uncorrected) — Temperature (°C) — Salinity (psu) — Fluorescence — Oxygen saturation (%)
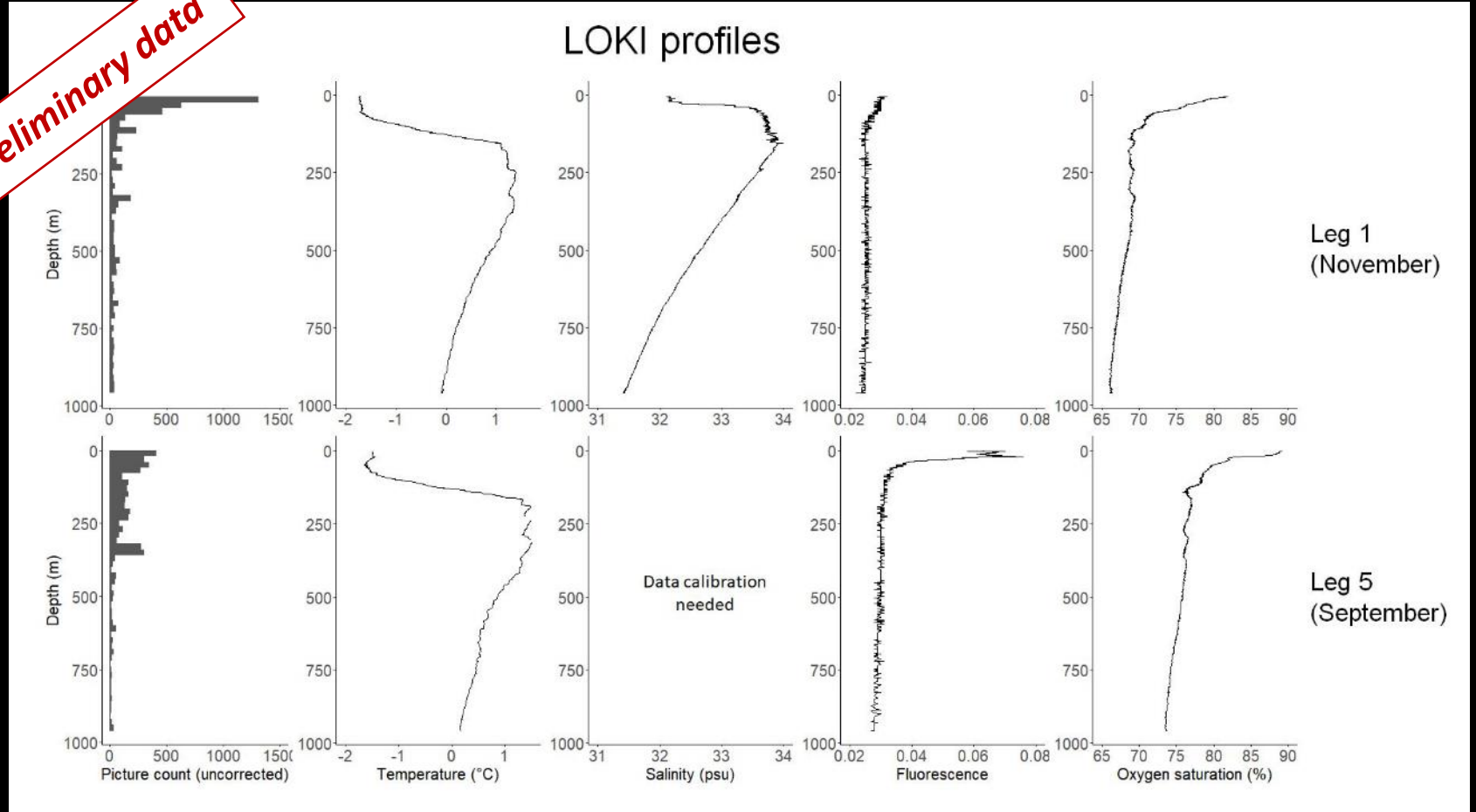
First trans-Arctic hydroacoustic survey

- 9,000 km
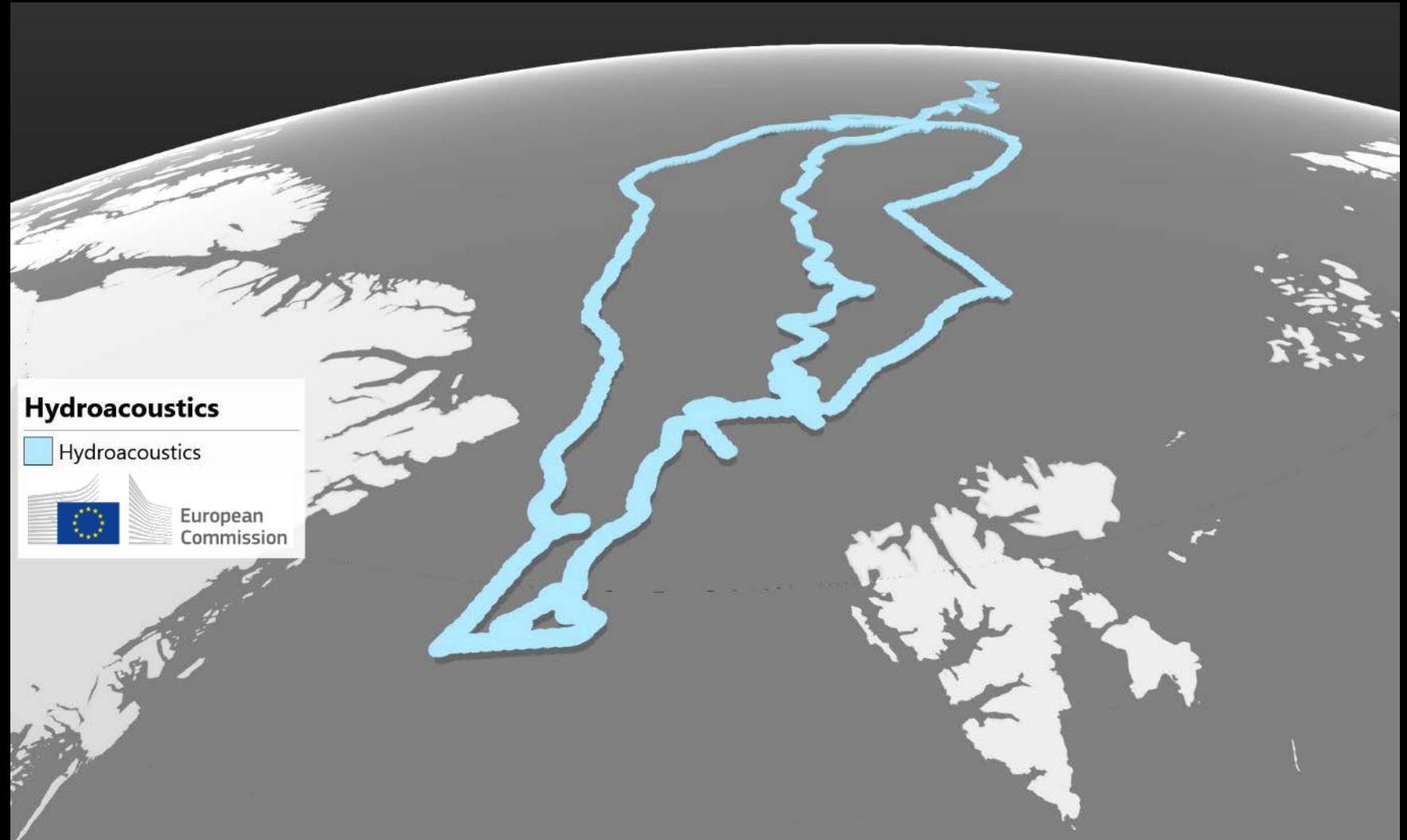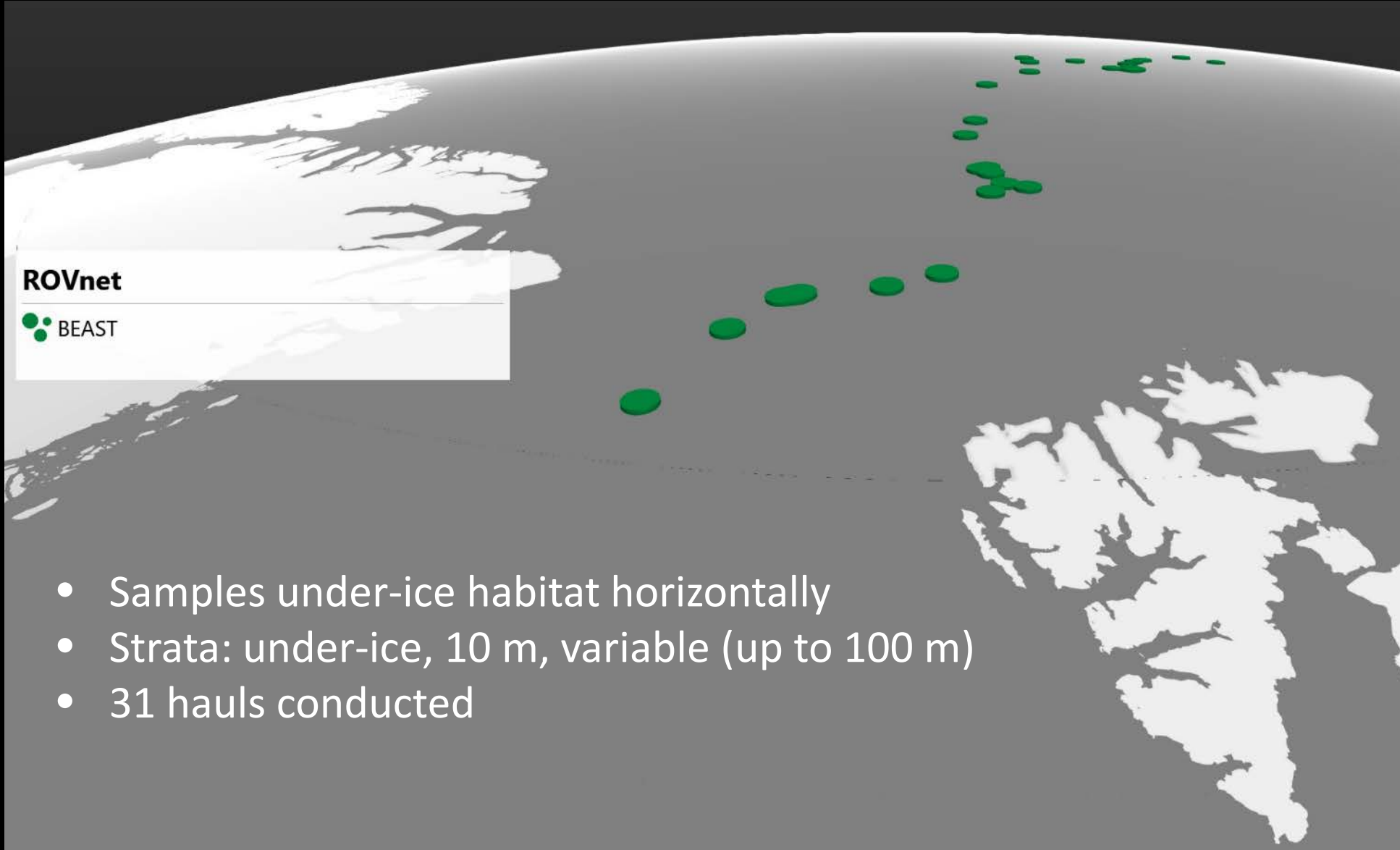- ~ 350 days
- 3 crossings of the Eurasian Basin
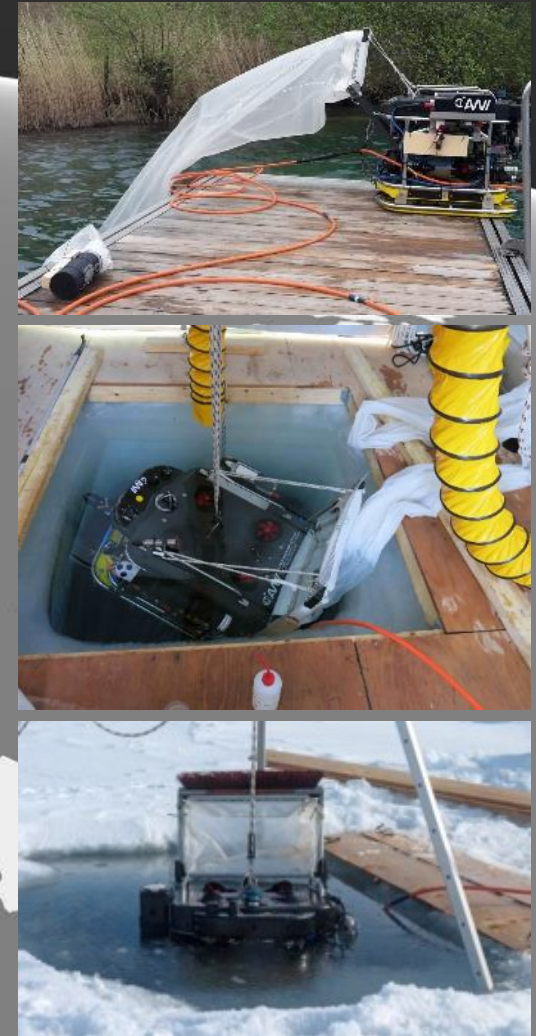
Sampling the sea-ice habitat

- Ice coring (meiofauna, trophic biomarkers)

- ROVnet

- Creative methods

Sampling the sea-ice habitat

ROVnet

• BEAST

- Samples under-ice habitat horizontally
- Strata: under-ice, 10 m, variable (up to 100 m)
- 31 hauls conducted

Polar cod in ice crack

Picture: Matt Boyer
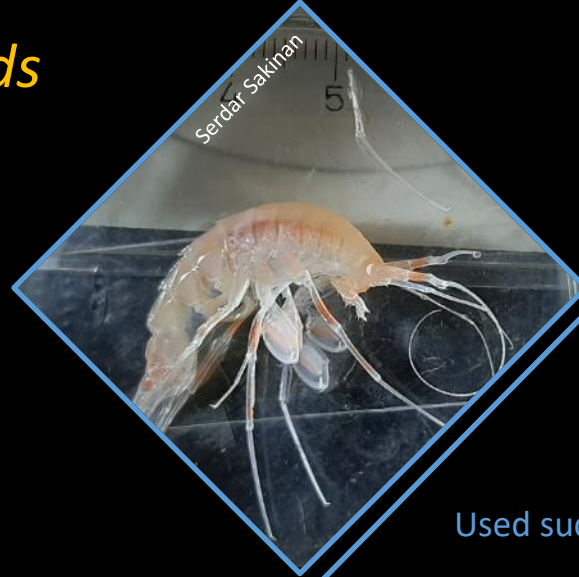
Sampling the sea-ice habitat

unusual but successful sampling methods

Castellani stick-and-scoop method

Used succesfully to sample 15 polar cod from holes in the ice

Opportunistic collection by hand
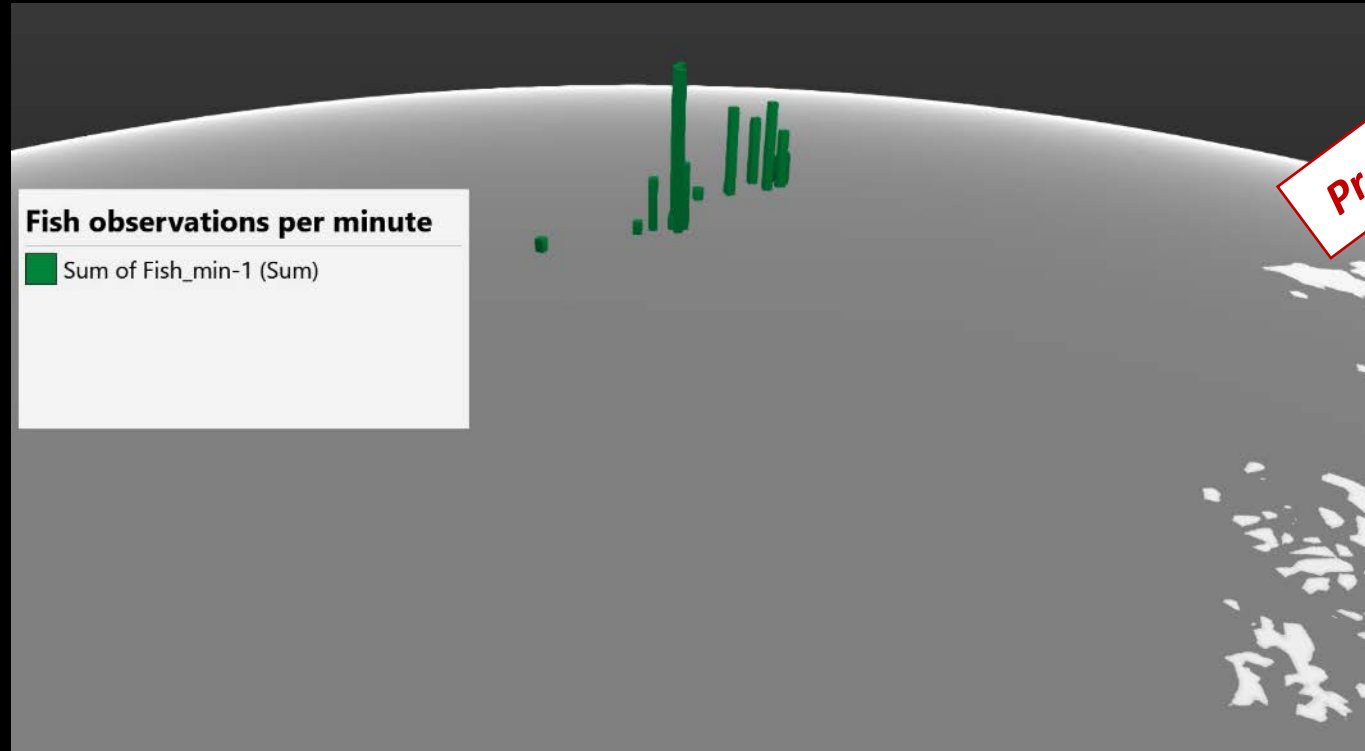
Used succesfully to collect large amphipods from underneath the sea ice

134 individuals were collected, mainly of the species *Eusirus holmii*

Serdar Sakinan

Hauke Flores

Video observations of predators under sea ice (Leg 1&2)
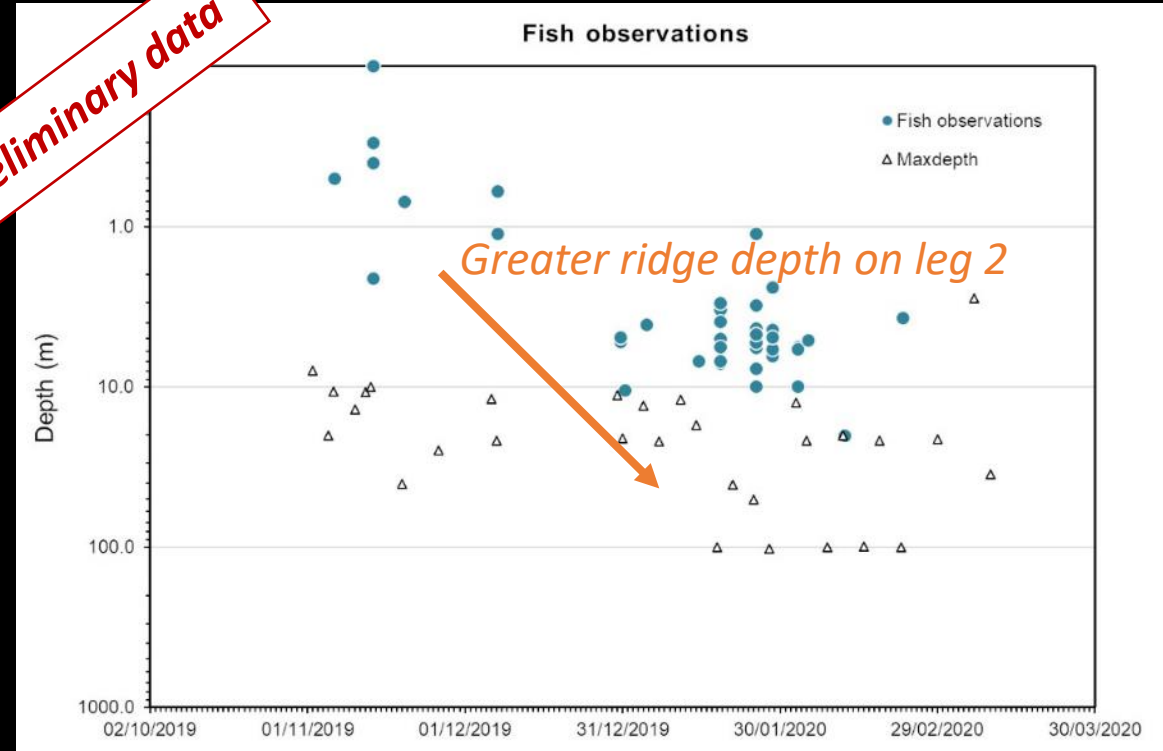
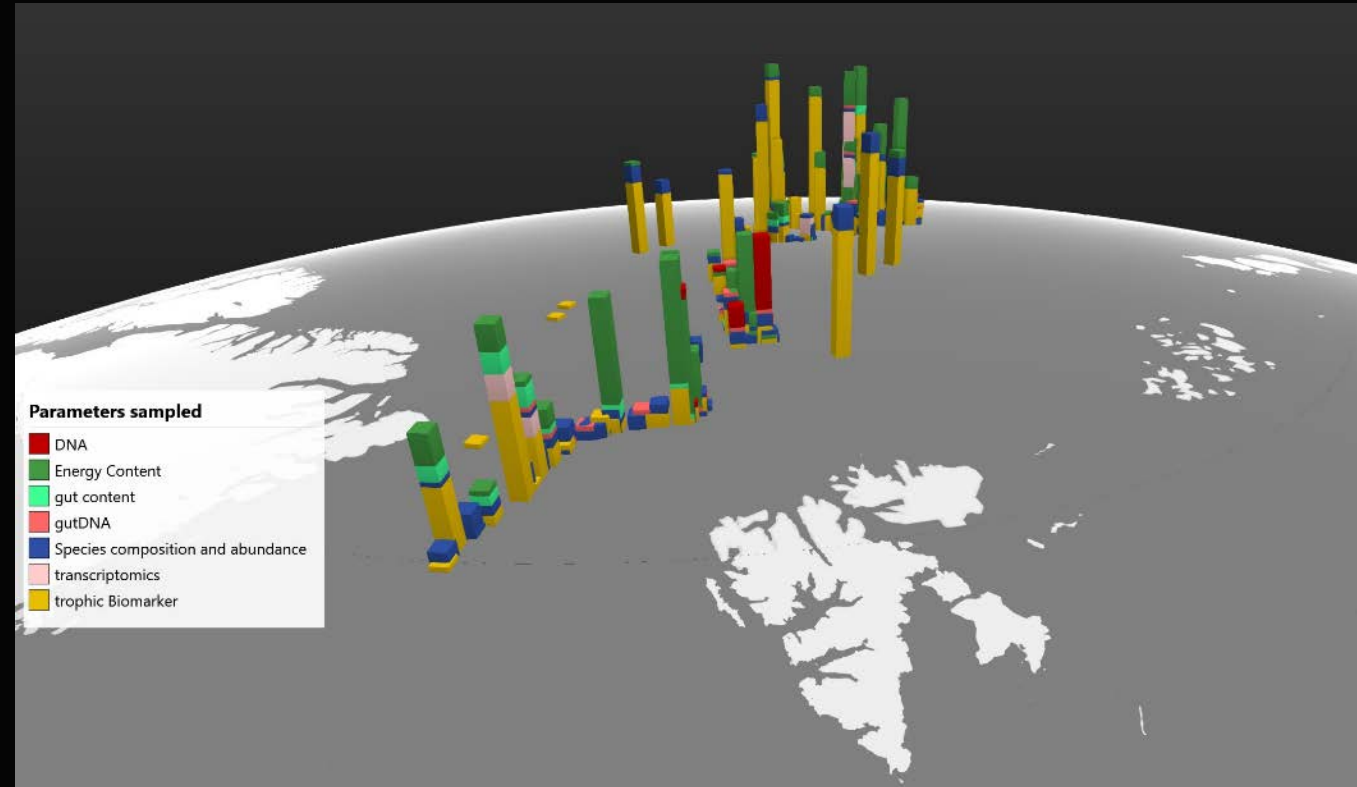# What we took home

- Year-round observations of zooplankton using net sampling, hydroacoustics, imaging profilers and under-ice video surveys

- ~ 9,000 samples of 20 parameters for analyses including microscopy, trophic biomarkers, genomics, and AI

Parameters sampled
- DNA
- Energy Content
- gut content
- gutDNA
- Species composition and abundance
- transcriptomics
- trophic Biomarker

3 reasons to hypothesize „more" life in the CAO than thought before:

- There is more biomass not seen by traditional sampling (macrofauna)

- Animals are more active all year (feeding and reproduction)

- There are more predators (jellyfish, squid and finfish)

M. Hoppman

M. Hoppman

Implications and impact

- New sampling technology enabled a more comprehensive view on diversity, life-cycles and biogeochemical functions of pelagic fauna

Guiding questions for future work:

- Do high metabolic and reproductive activity during winter imply highly efficient heterotrophic resource utilisation, independent of primary production?

- Does this high activity and the year-round presence of predators suggest that the food web in the CAO may be more productive than previously assumed?