ARJEL

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Arctic Jellies
2019-2026

Atlantification = jellification?
Exploring the role of jellyfish in Tomorrow's Arctic Ocean

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LTER-D Jahrestagung – 18.05.2021

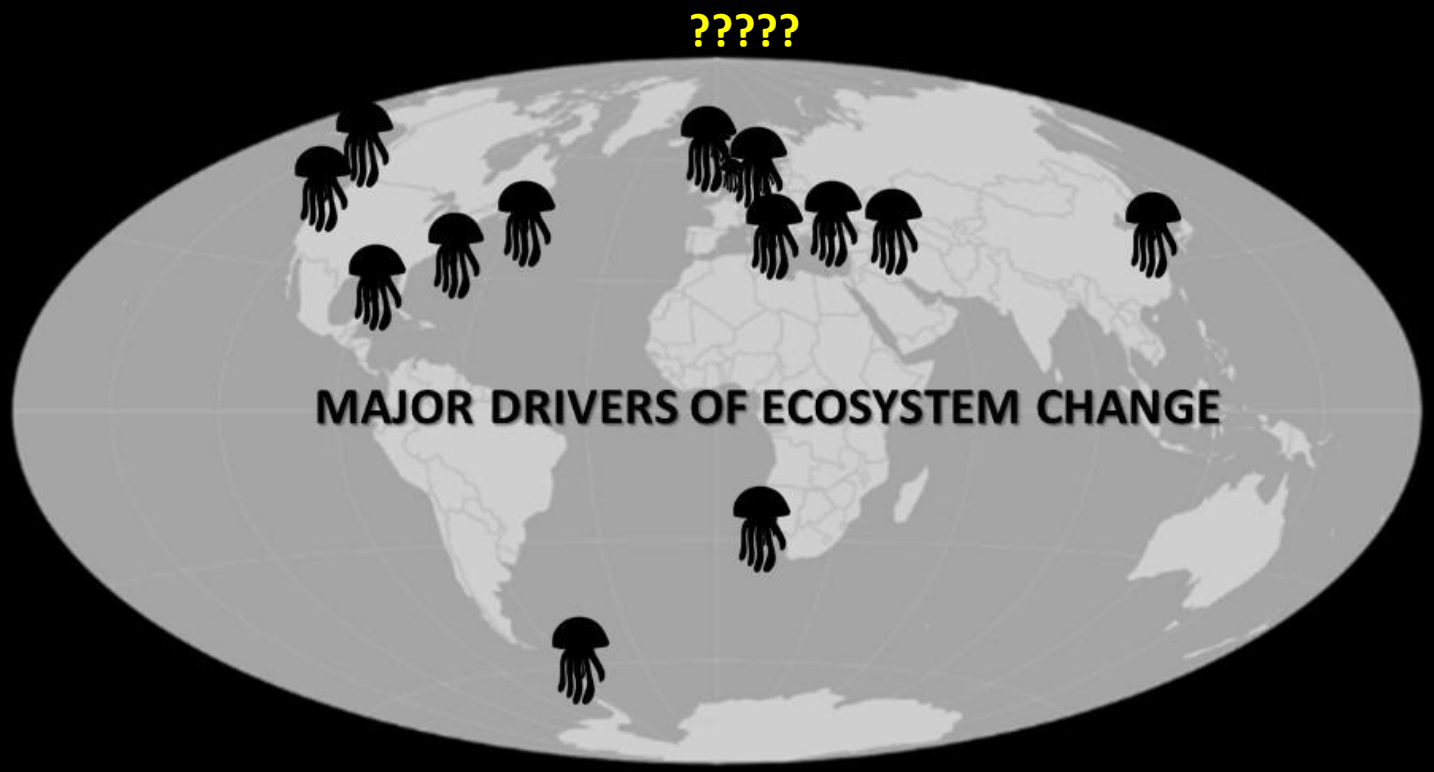
ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

Universität Bremen

Is Tomorrow's Ocean a gelatinous one?

- The jellific(a)tion paradigm: are jellies taking over the world oceans?
- Fake news? Lack of baseline studies and long-term datasets
- Gelatinous shifts: impact on ecosystem, biogeochemical cycles, interactions with fish stocks



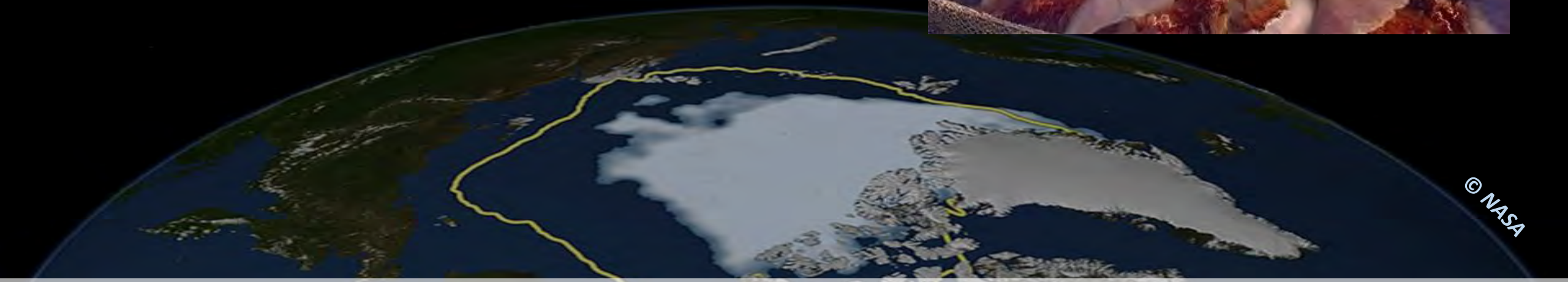
Recent increase of jellies* in biomass or range expansion

*Incl. scyphozoans, hydromedusae, ctenophores, tunicates

Some supporting literature: Mills 2001; Brodeur et al. 2008; Duarte et al. 2012; Purcell 2012; Condon et al. 2013; Atkinson et al. 2019.

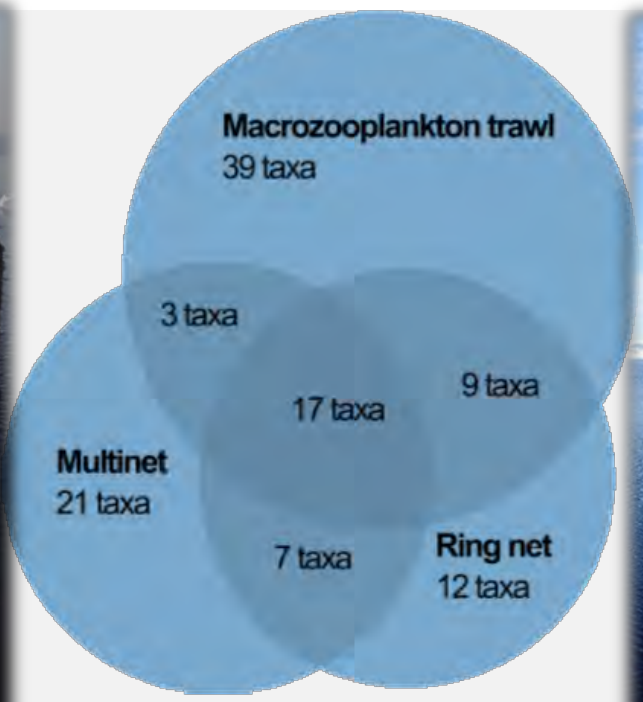
And in the Arctic?

- Sea ice is disappearing – loss of a unique habitat
- Arctic seas: 10% global fishery yield
- Atlantification: plankton and fish moving north
- Jellies have the potential to replace fish, but are largely understudied in the Arctic!



Jellies in the ecosystem and food web: overlooked and misunderstood

DIVERSITY, ABUNDANCE & BIOMASS?



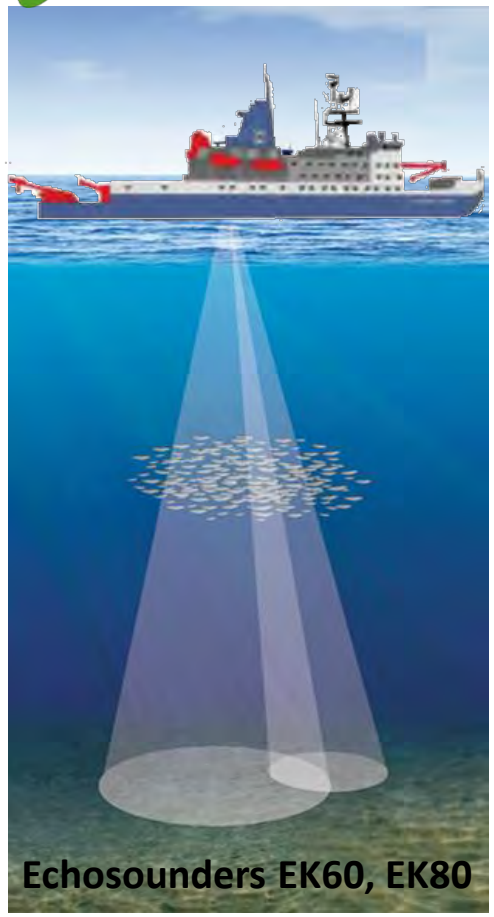
TROPHIC ROLE?

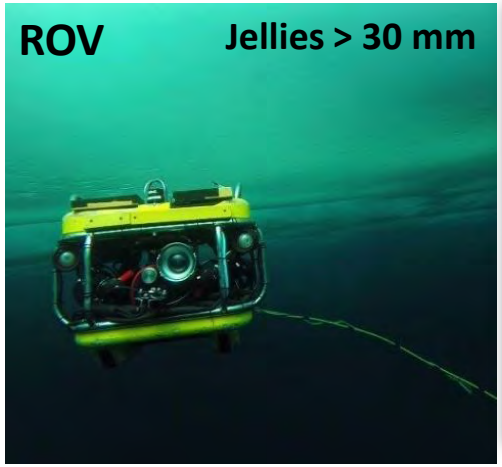
« trophic dead end »

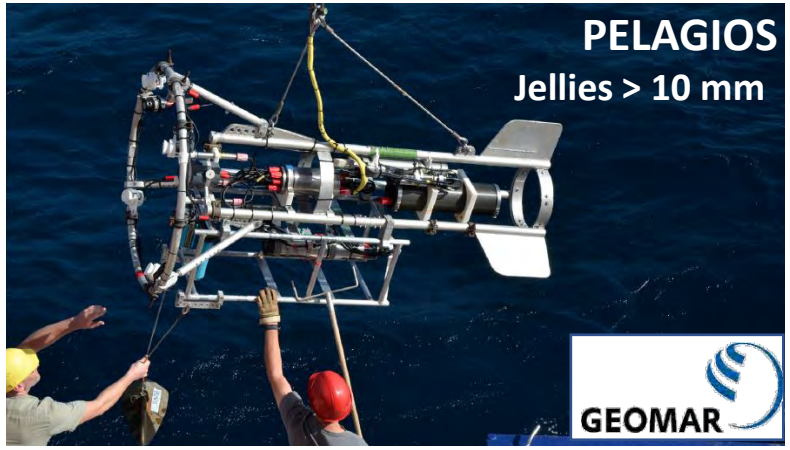
Net comparison for gelatinous zooplankton sampling: Hosia et al. 2017. Fish image from Huwer et al. 2014

Making the invisible visible

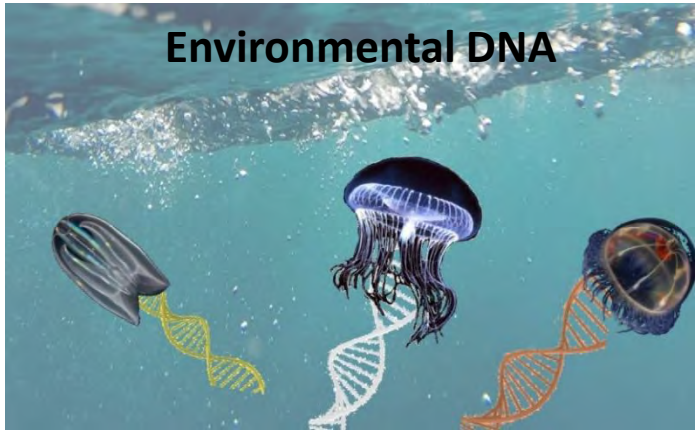
INTEGRATIVE SURVEYS WITH ACOUSTICS & OPTICS

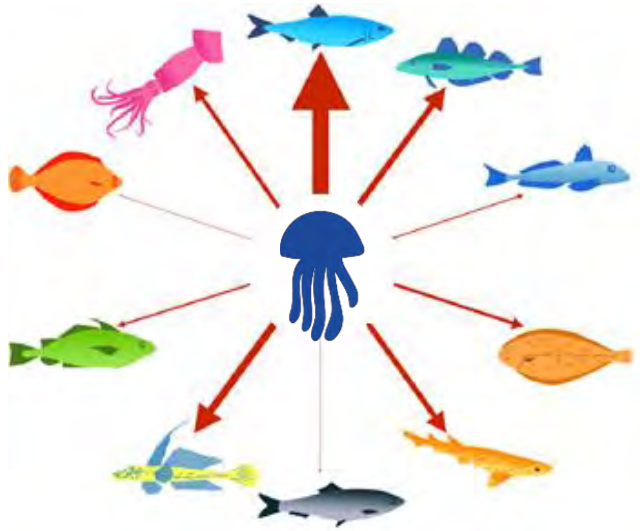






STATE-OF-THE-ART MOLECULAR ANALYSES





Metabarcoding of stomach contents

ROV – © C. Katlein, Pelagios – © Hoving et al. 2014. Food web – Lamb et al. 2017

Who is where, and how many of them?

- **Atlantification = jellification of the Arctic?**
- **Who will stay and who will go**

Aglantha digitale
©Hopcroft/UAF/NOAA/CoML

Optical methods
Acoustics
Environmental DNA
Species Distribution Modeling

Who eats whom?

DNA metabarcoding
Biomarker analyses

Beroe abyssicola
©David Wrobel Photography

- **Seasonal and spatial variation in jellies' diets**
- **Plankters and fish with a belly full of jelly?**

And in the new Arctic?

- **Can we detect newcomers?**
- **Who will shift in with warmer waters?**

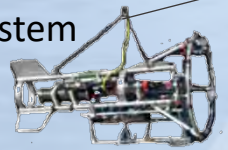
P. periphylla
©Erling Svensen (GRIND)

eDNA calibration and surveys
Temperature experiments
Physiology
Gene expression

Jelly diversity, distribution and abundances – HAUSGARTEN studies in Fram Strait

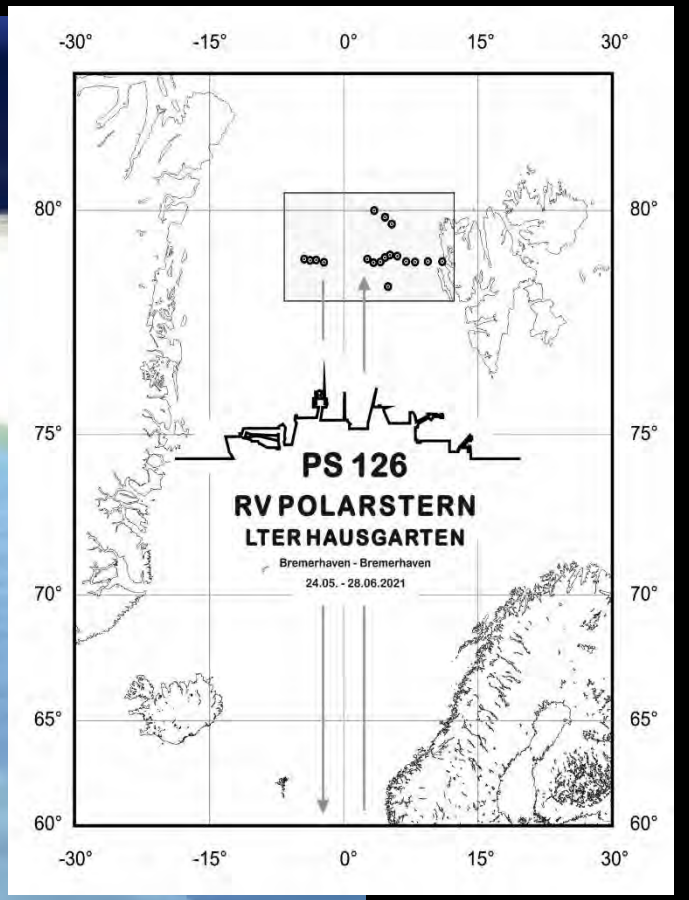
Integrative field surveys

Towed camera system

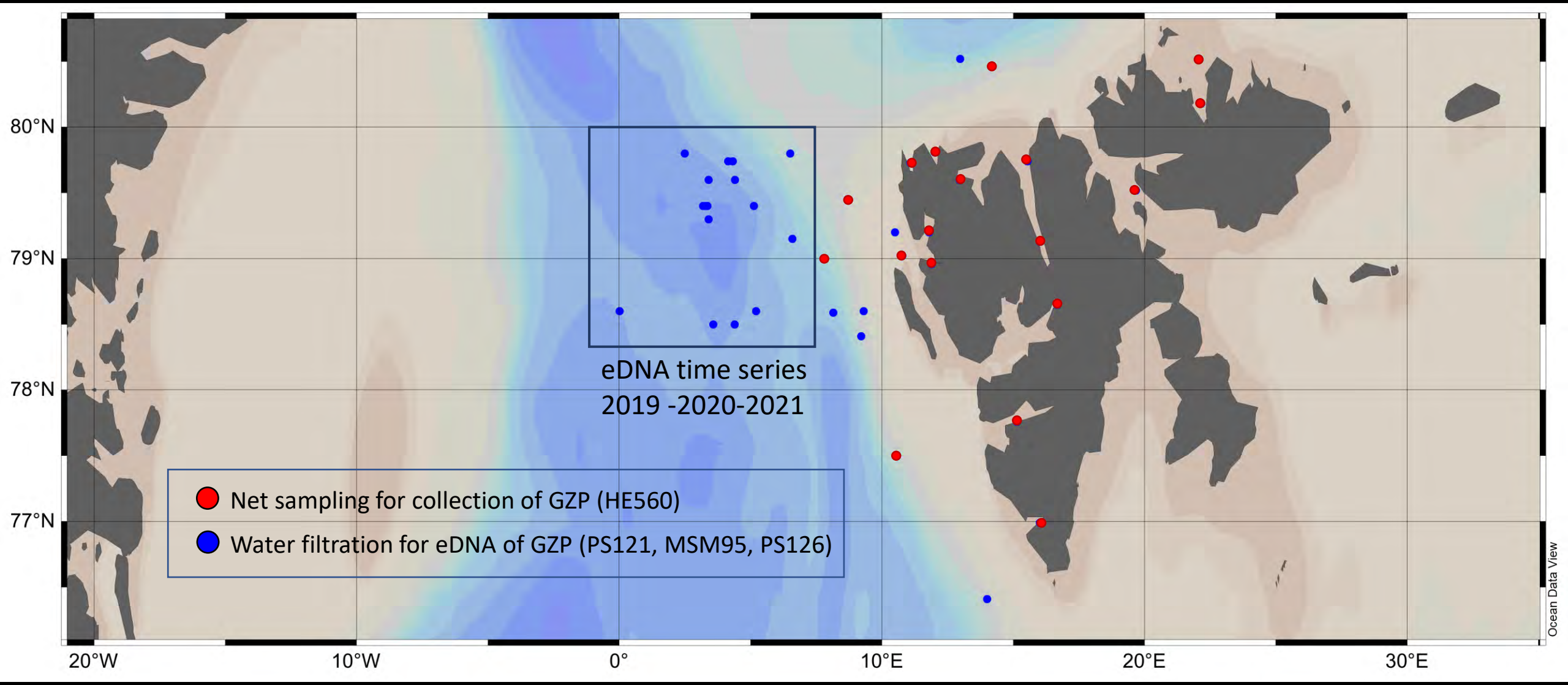


Multi-net

CTD rosette



Can we detect newcomers and community shifts? – eDNA time series



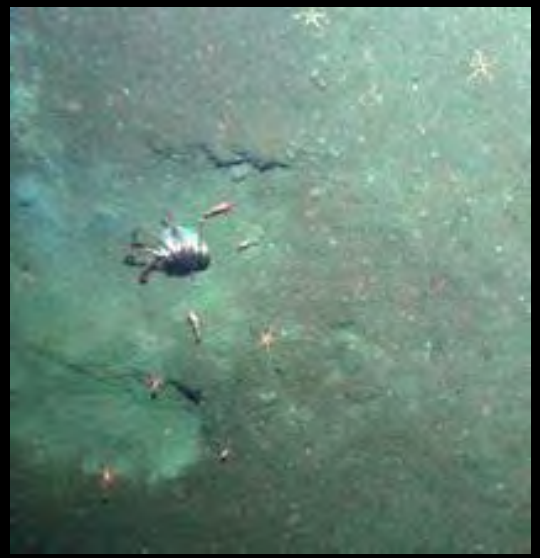
Can we detect newcomers and community shifts? – eDNA

- **eDNA experimental work and in-situ samples**

  - ✓ eDNA metabarcoding COI, 18S, group-specific primers → species composition
  - ✓ quantitative PCR specific primers/target taxon → relative abundances

P. periphylla recently appeared in Svalbard

→ sediment and water samples for eDNA

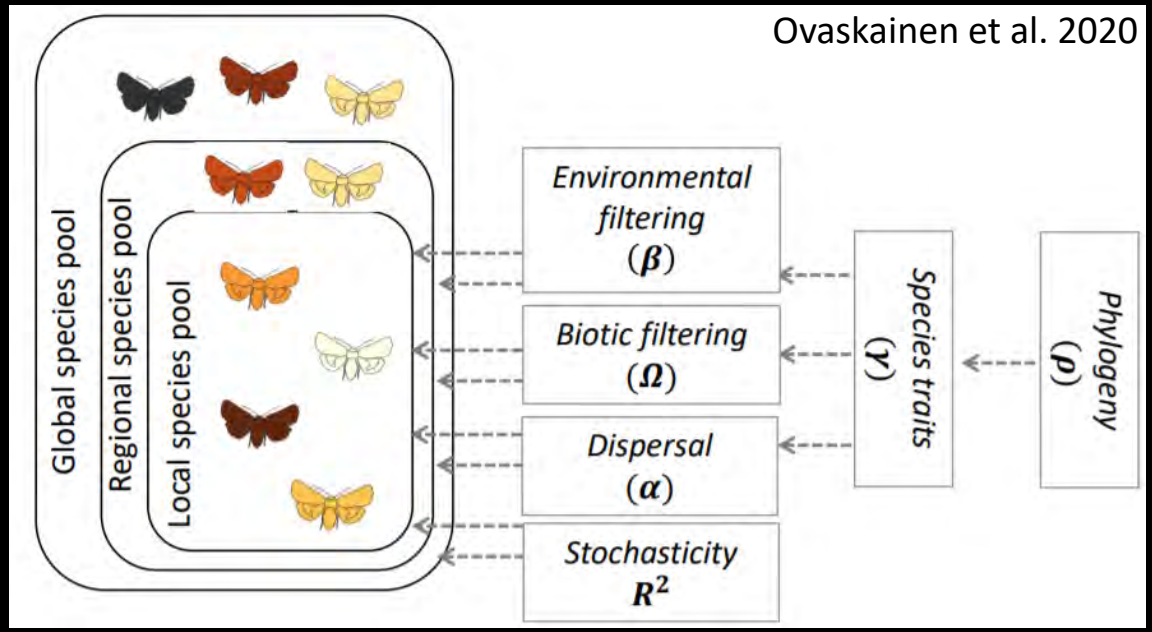


Who will stay and who will go? – Species and community distribution modeling

Hierarchical modelling of Species Communities (HMSC): (Ovaskainen et al. 2020)

- Partitions variation in species occurrence to components that relate to environmental filtering, species interactions, random processes

- Infers both at species and community levels



Who will stay and who will go? – Species and community distribution modeling

Observation data (presence/absence)

&

Environmental data

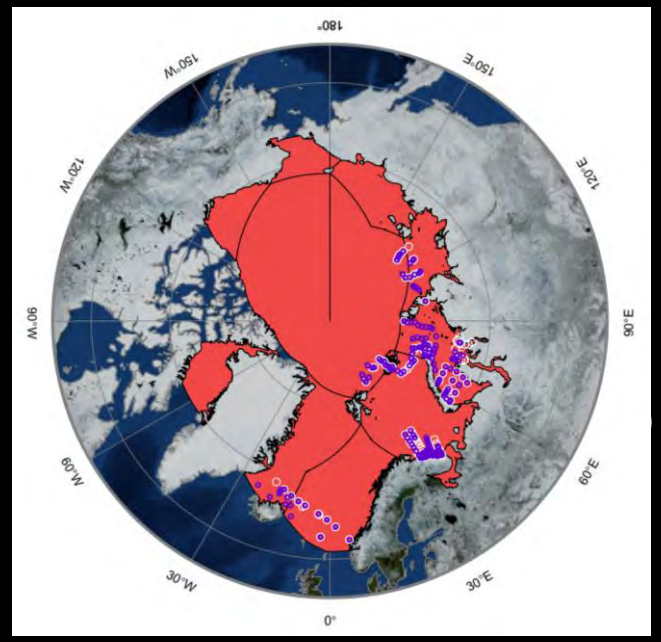
Collection of 98 datasets from PANGAEA with data on gelatinous plankton

GBIF Global Biodiversity Information Facility

JeDI (Jellyfish Database Initiative)

OBIS OCEAN BIODIVERSITY INFORMATION SYSTEM

PANGAEA.



e.g. Records of *Aglantha digitale*:
Presence – 568
Absence - 1064

Data sources

- Direct CTD measurements

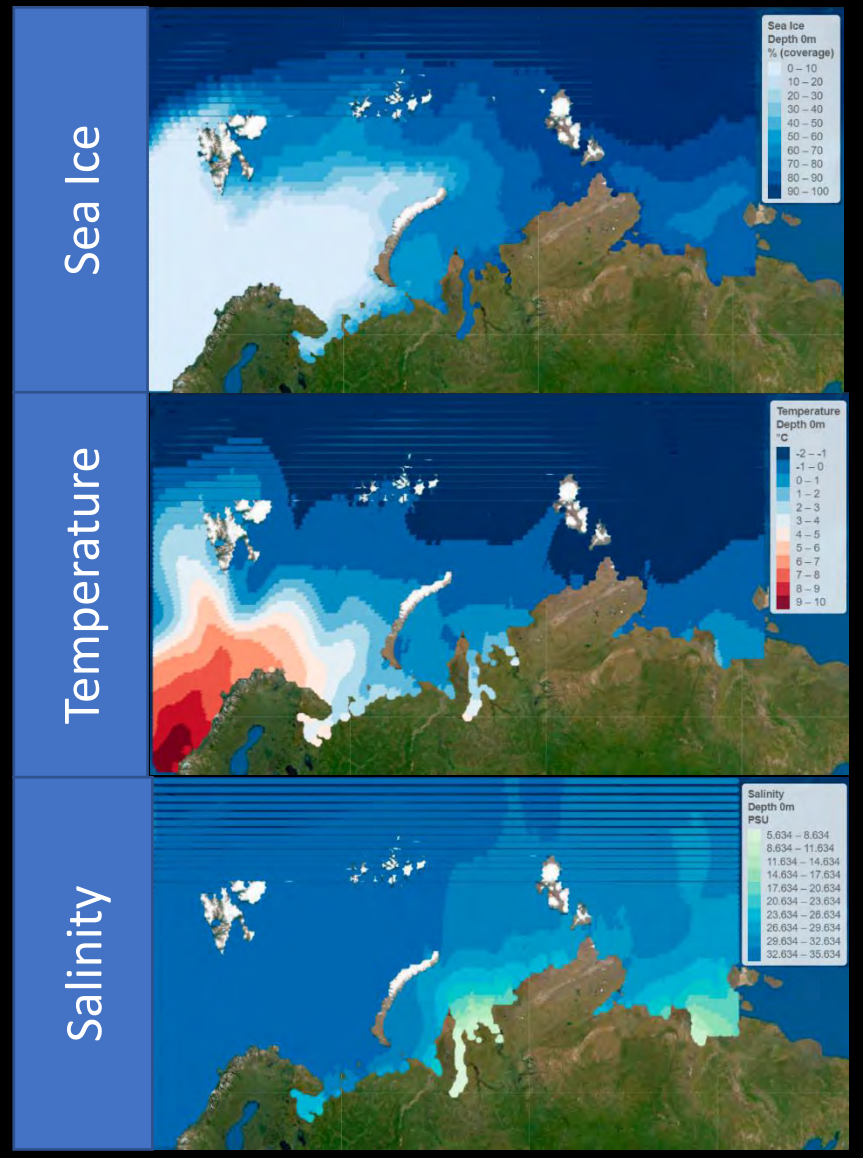
- World Ocean Atlas 2018

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

- Sea ice concentration

NSIDC National Snow and Ice Data Center

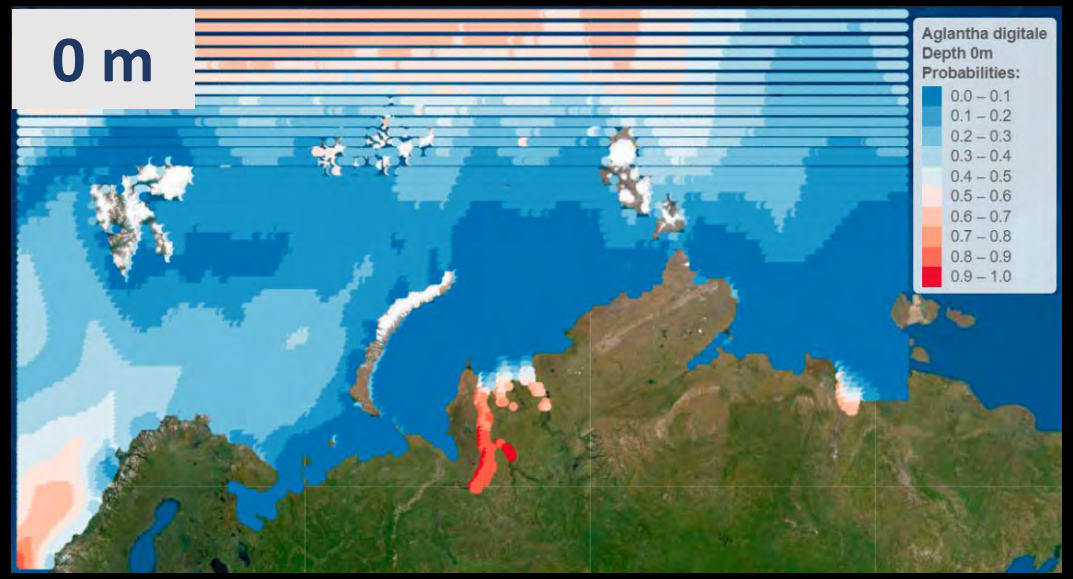
Data layers

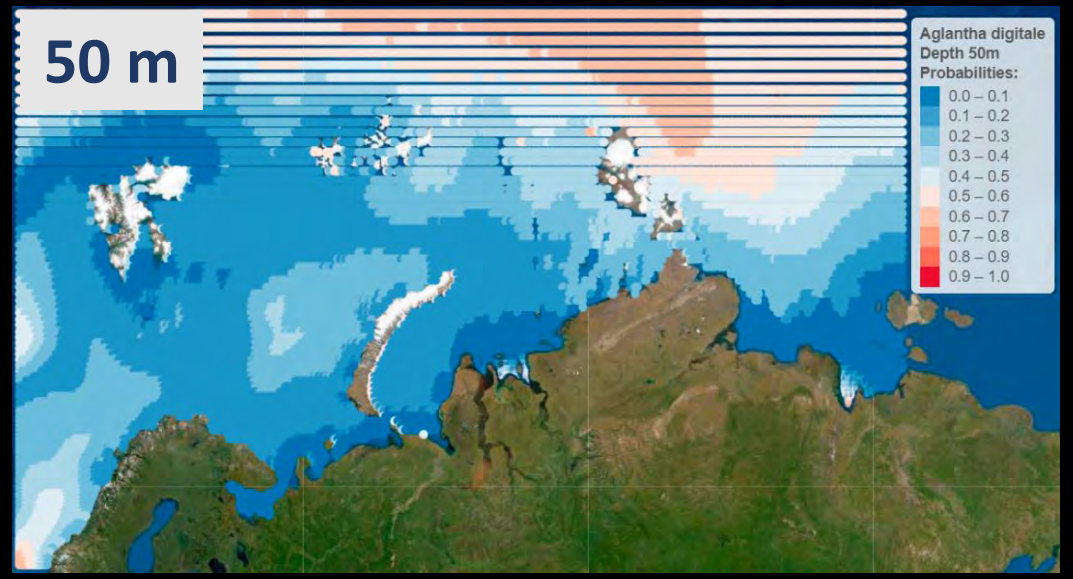


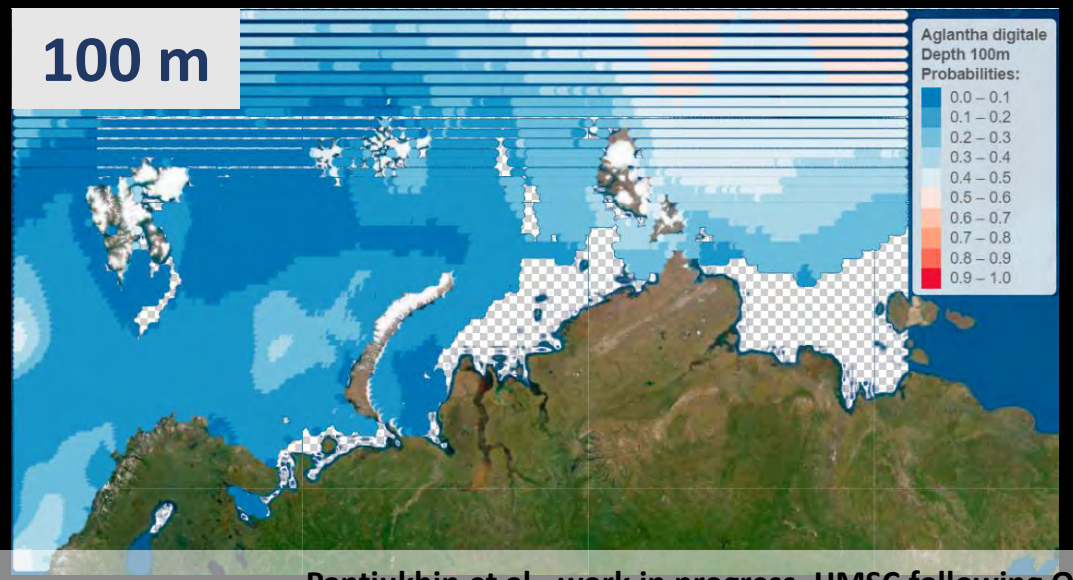
Who will stay and who will go? – Species and community distribution modeling

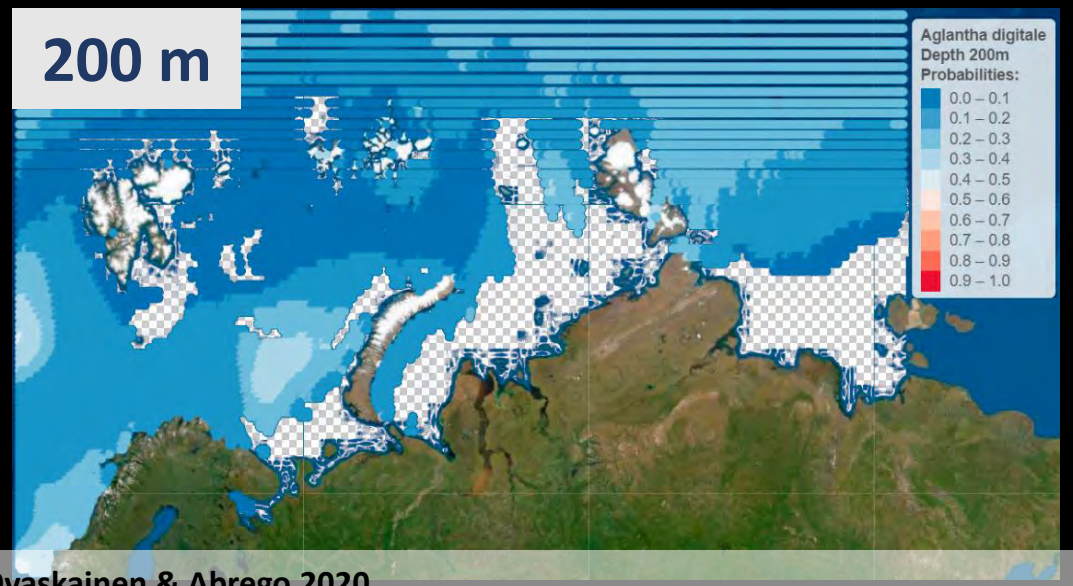
Based on decadal averages of sea ice, T° and salinity (World Ocean Atlas 2018)

Single-species HMSC model (Hierarchical Modelling of Species Communities) for *Aglantha digitale*







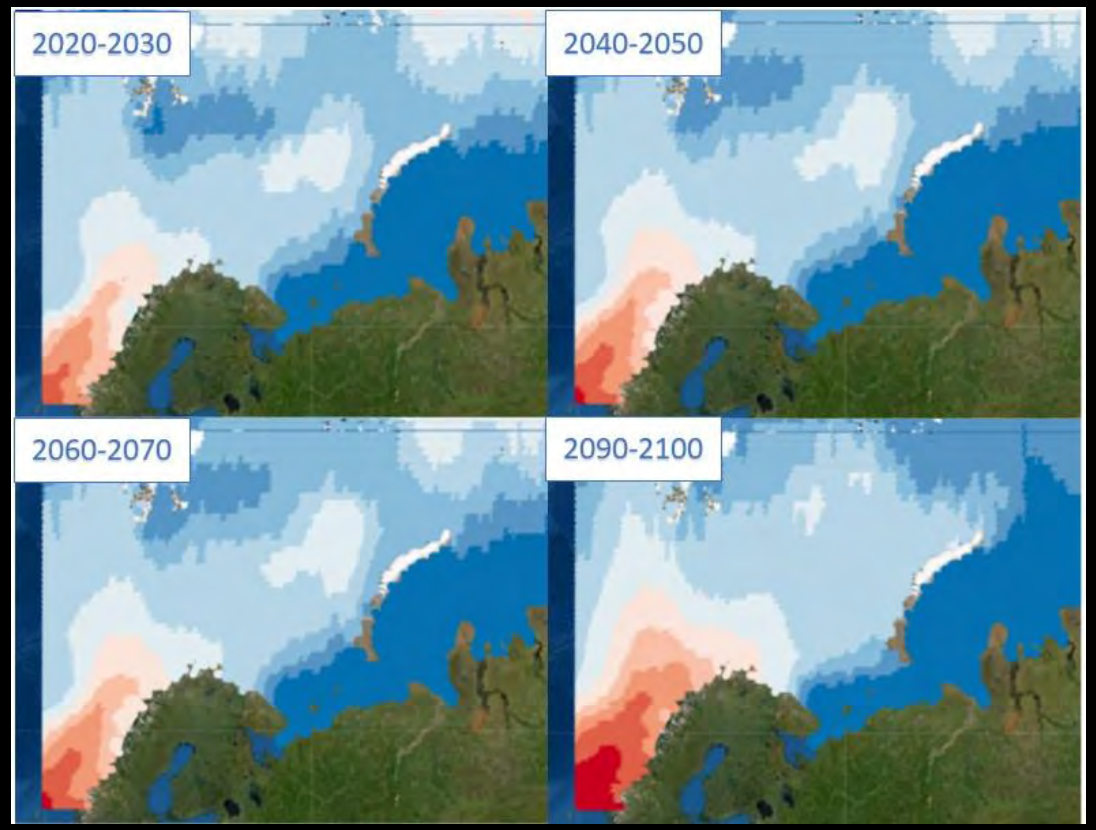


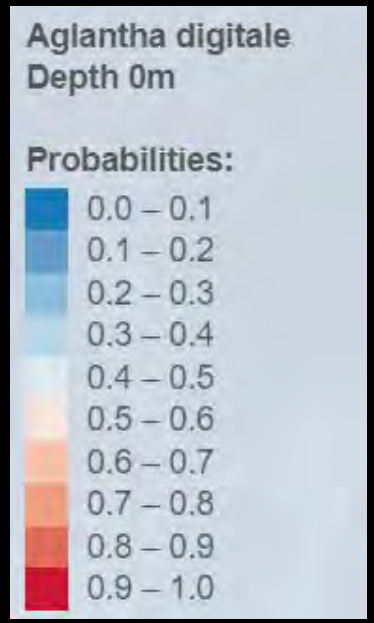
Pantiukhin et al., work in progress. HMSC following Ovaskainen & Abrego 2020

Who will stay and who will go? – Species and community distribution modeling

Forecasting future distributions

Single-species HMSC model (Hierarchical Modelling of Species Communities) for *Aglantha digitale*





- Scenario: RCP6.0 (mid-high greenhouse gas emission)

- Forecast made using decadal averages of sea ice, temperature, and salinity

- Environmental data from the Norwegian Earth System Model “NorESM1-M” (CMIP-5) *(sea-ice, temperature, salinity)*

Pantiukhin et al., work in progress, HMSC following Ovaskainen & Abrego 2020

Who will stay and who will go? – Species and community distribution modeling

Single species

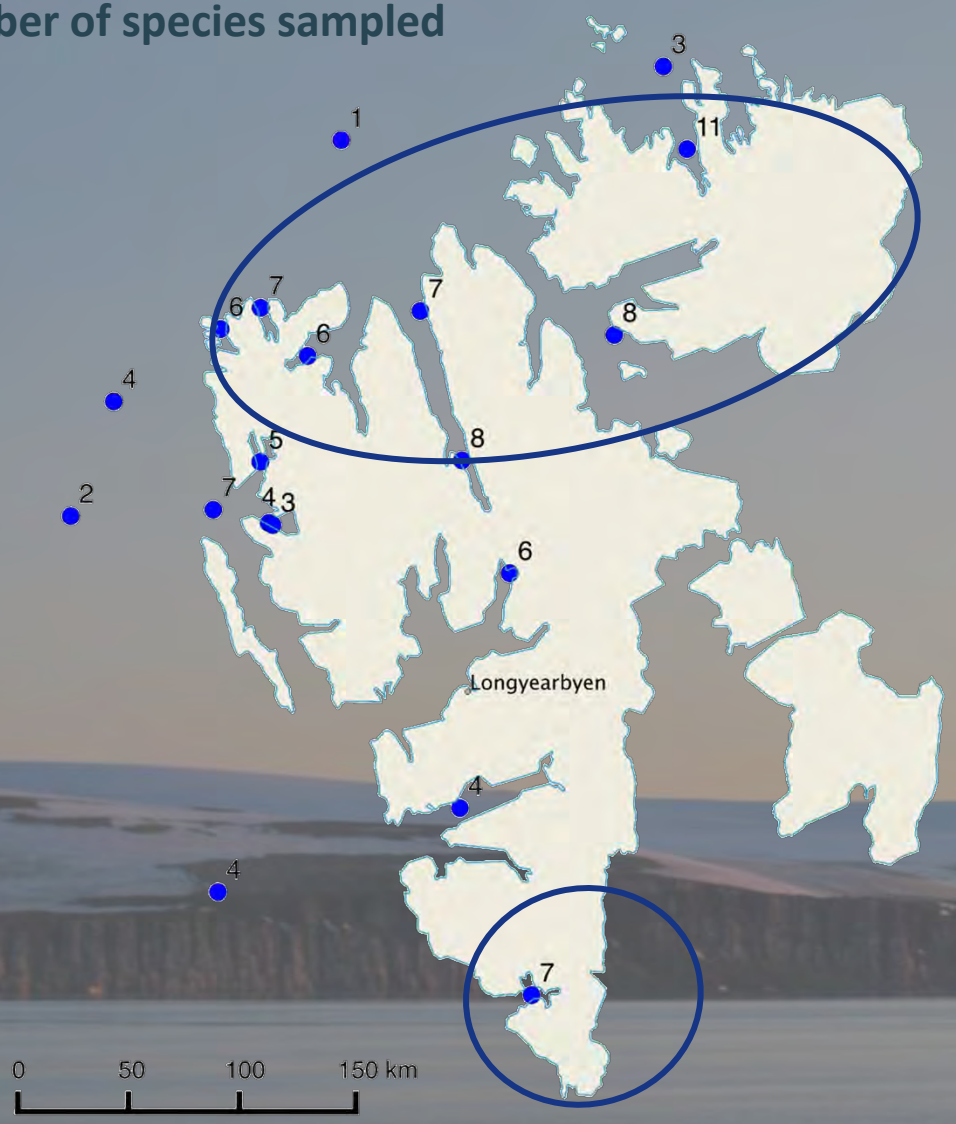
- Understand current patterns of species distributions and their realized niches
- Future projections: range shifts

Communities

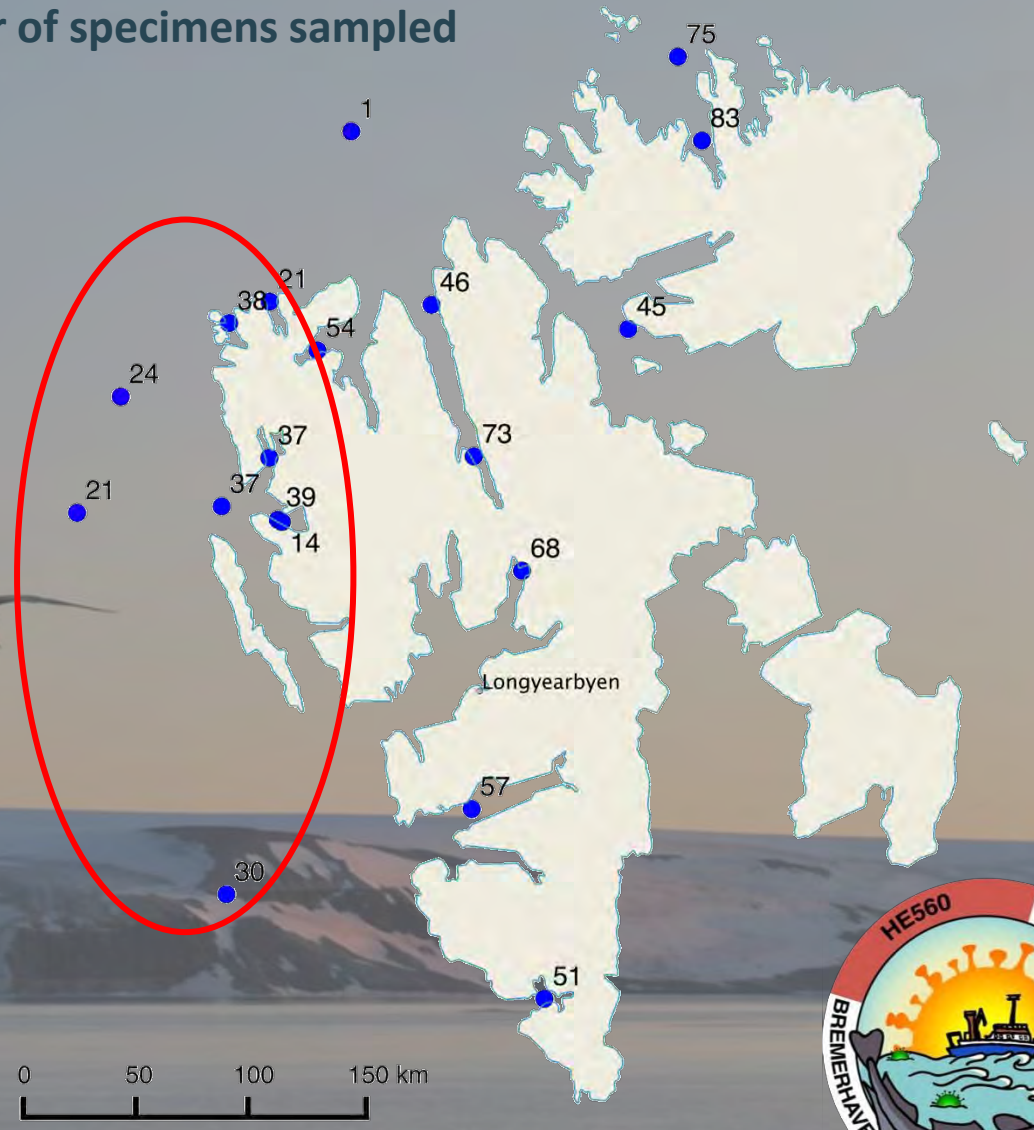
- Assess significance of environmental drivers on gelatinous ZP community structures
- Delineate boundaries of gelatinous ZP communities (bioregionalization) → hotspots jellification
- Reveal competitive relationships e.g., with dominant fish species

Atlantification ≠ jellification? The Svalbard fjords as case study

Number of species sampled



Number of specimens sampled



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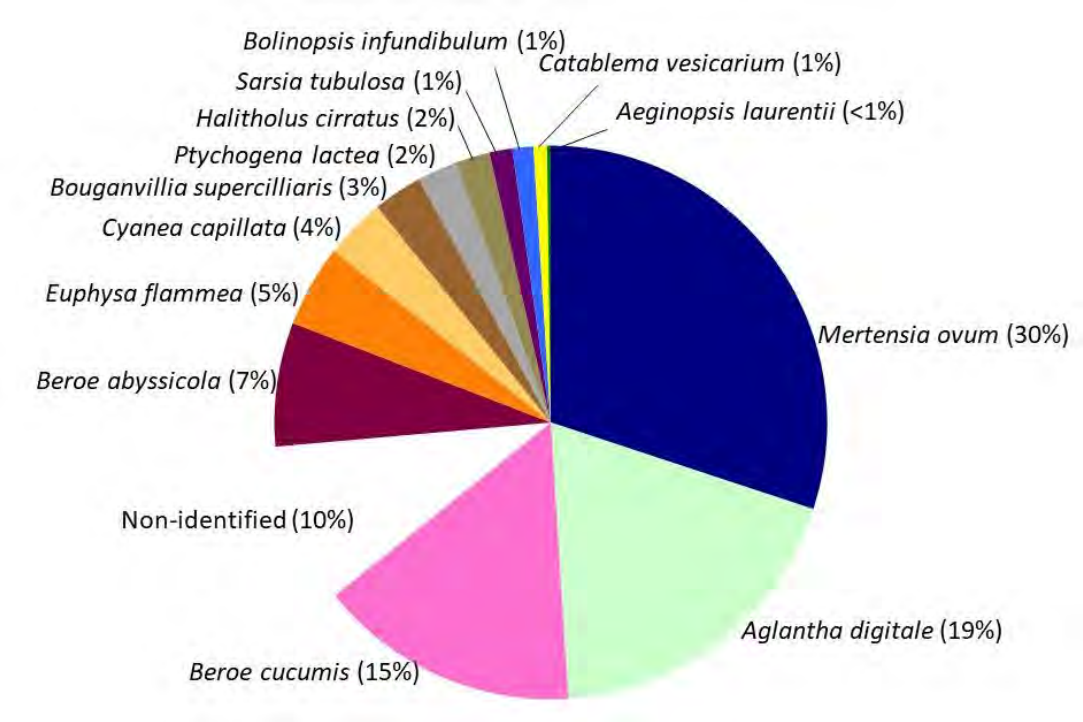
Preliminary results

Atlantification ≠ jellification? The Svalbard fjords as case study

Overall species composition (13 species, N = 898)



Ongoing and planned studies:

- **Comparison diversity and abundances of jellies in Atlantic vs. Arctic-influenced fjords**

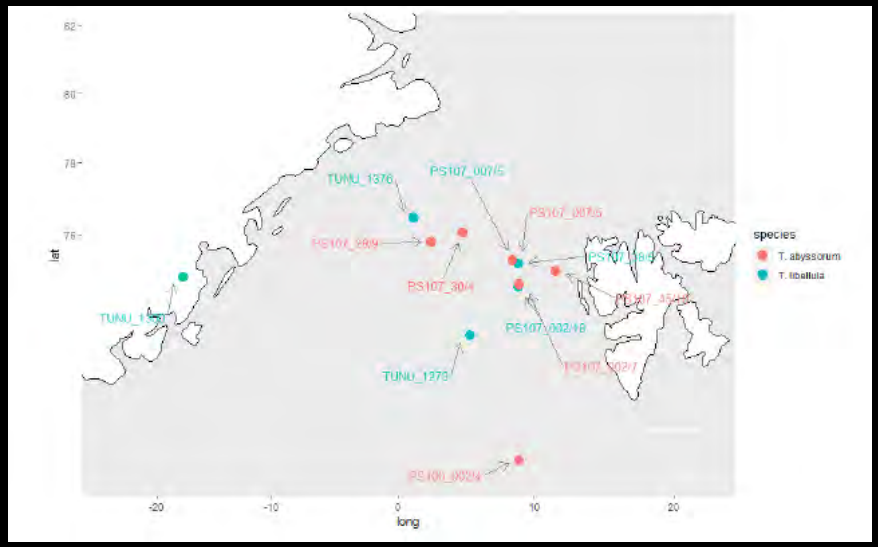
- Preliminary results – by Verhaegen & Murray

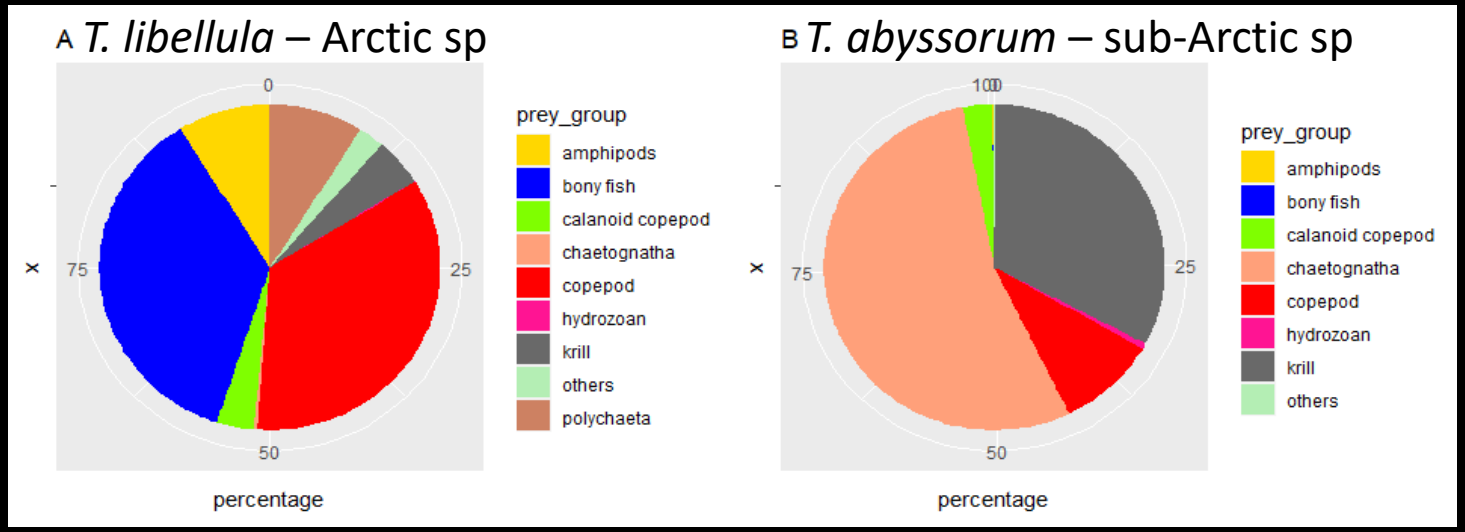
Plankters and fish with a belly full of jelly? – DNA metabarcoding studies

Diet of hyperiid amphipods *Themisto libellula* and *T. abyssorum*

- Leray COI fragment, 313 bp
- Pooling 8-25 stomachs, 3 replicates/station
- MiSeq illumina sequencing

  - Very diverse diet, no competition
  - Relative read abundances jellies are low
  - Primer bias for ctenophores?



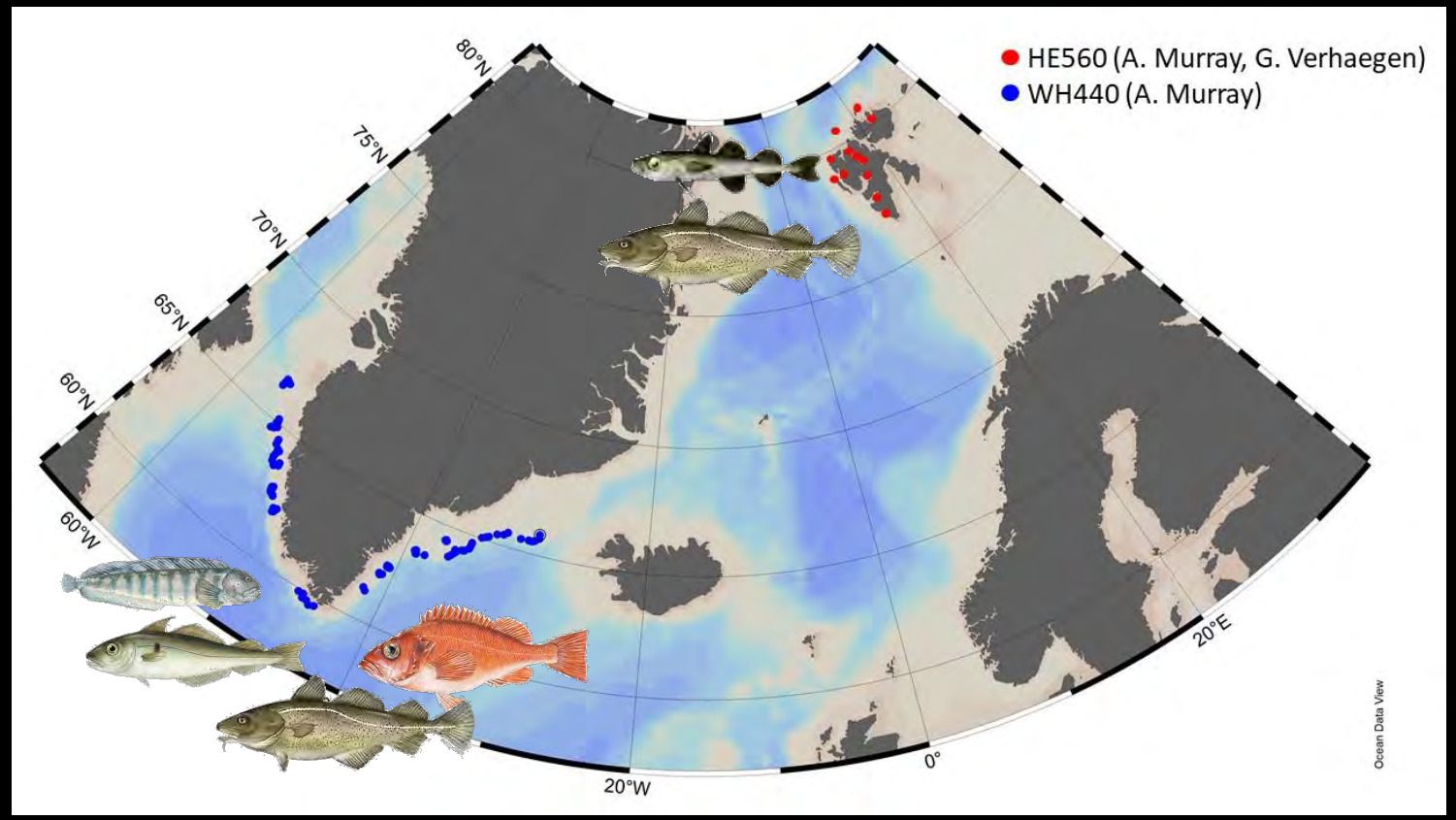


Jelly species found: Aglantha digitale, Nanomia cara, Catablema vesicarium, Physophora sp.

Aglantha digitale

Catablema vesicarium

Plankters and fish with a belly full of jelly? – DNA metabarcoding studies



Next:

✓ Fish as predators of gelatinous ZP

- Svalbard fish: Atlantic vs polar cod diet

- Southern Greenland fish diets:
  - Redfish
  - Wolffish
  - Atlantic cod
  - Haddock

Jelly predation?
- → Juveniles vs adults
- → Regional differences

✓ Utilization of « jelly-falls » by benthic scavengers

Jellyfish diets? – Biomarker and DNA metabarcoding studies

- **Jelly feeding ecology:** biomarkers, DNA metabarcoding of gastric pouch contents & oral arms

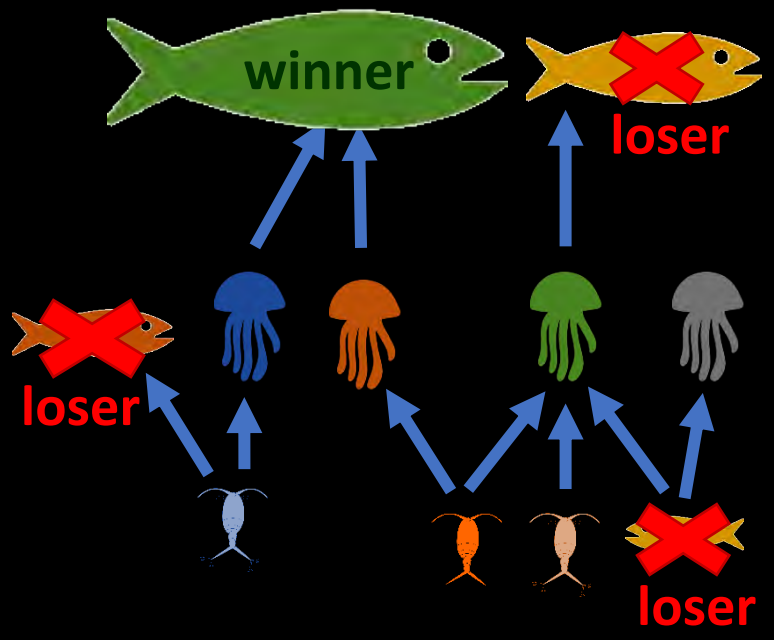
  ✓ Feeding on ichthyoplankton?

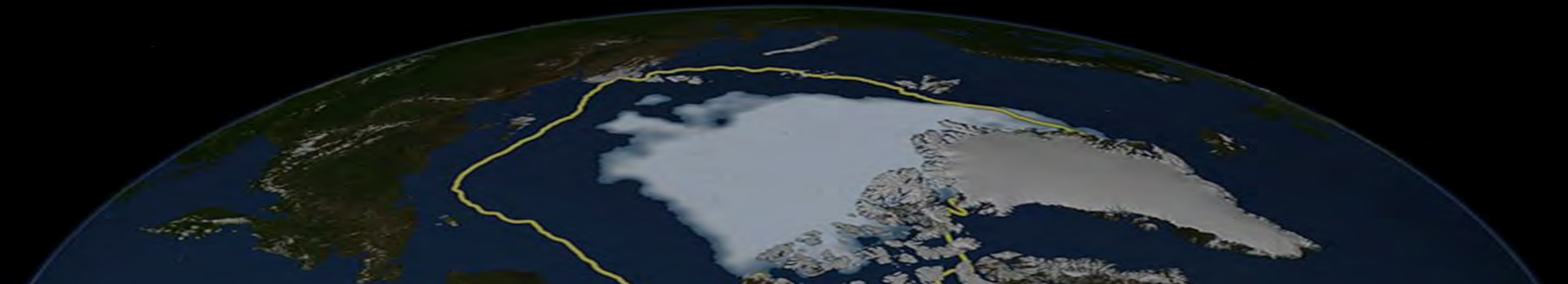
  ✓ Overwintering jellies

  ✓ Dependency on sea-ice production?

  → Predict impacts of sea-ice retreat

Outlook: An ecosystem perspective to forecast changes



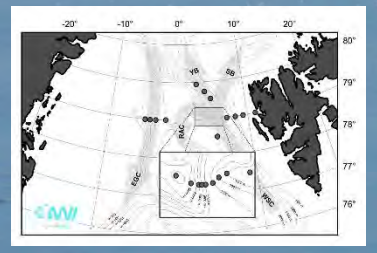


Thank you for your attention!

Thanks to

Scientists and crew of:

PS121



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