NOORDZEEOVERLEG

MONS-Zooplankton proceSS studies (MonZooSS)

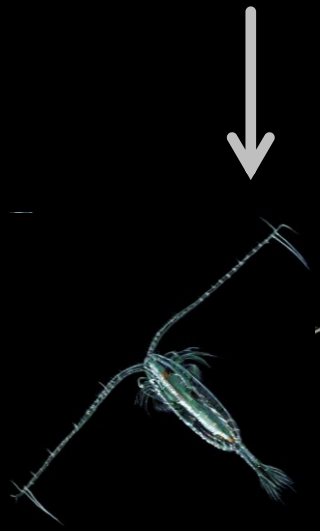
Ties Maris, Rebecca Büring, Hannah Kepner,
Dick van Oevelen, Karline Soetaert, Myron A. Peck, Lodewijk van Walraven, Robbert Jak, Reindert Nijland

NIOZ

25 maart 2025

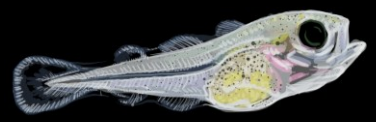
Herbivorous pelagic North Sea food web

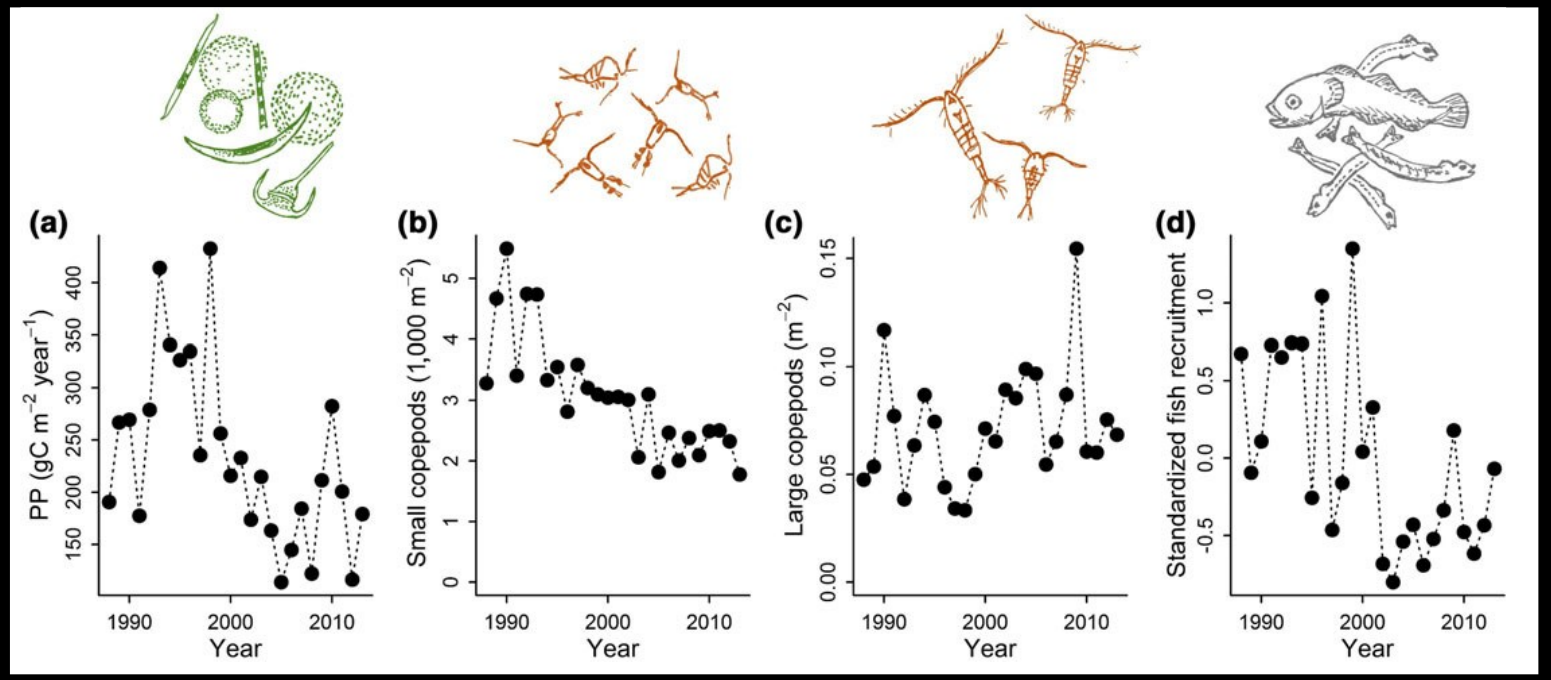
Phytoplankton



Zooplankton

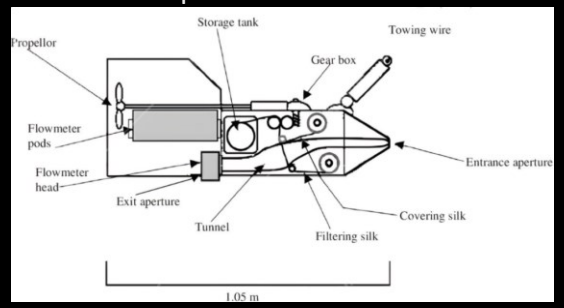
Fish (larvae)





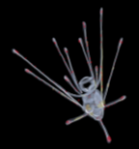
Capuzzo et al. 2017 GBC

Continuous plankton recorder



Multitrophic pelagic North Sea food web

Phytoplankton



Meroplankton

Holoplankton

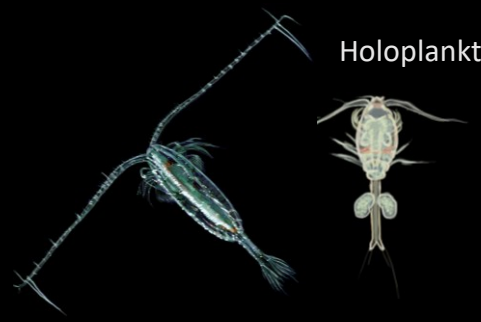
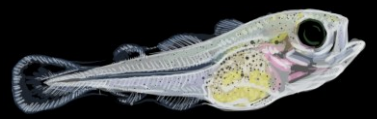


Table 1. Echinoderm larvae and copepods in the North Sea. Data are means (±SD) of annual total values in the Continuous Plankton Recorder (CPR) database for copepods and echinoderm larvae for five 5 yr periods within the area 51 to 61° N, 3° W to 11° E, from 1949 (first year for which data were available for echinoderms) to 2002

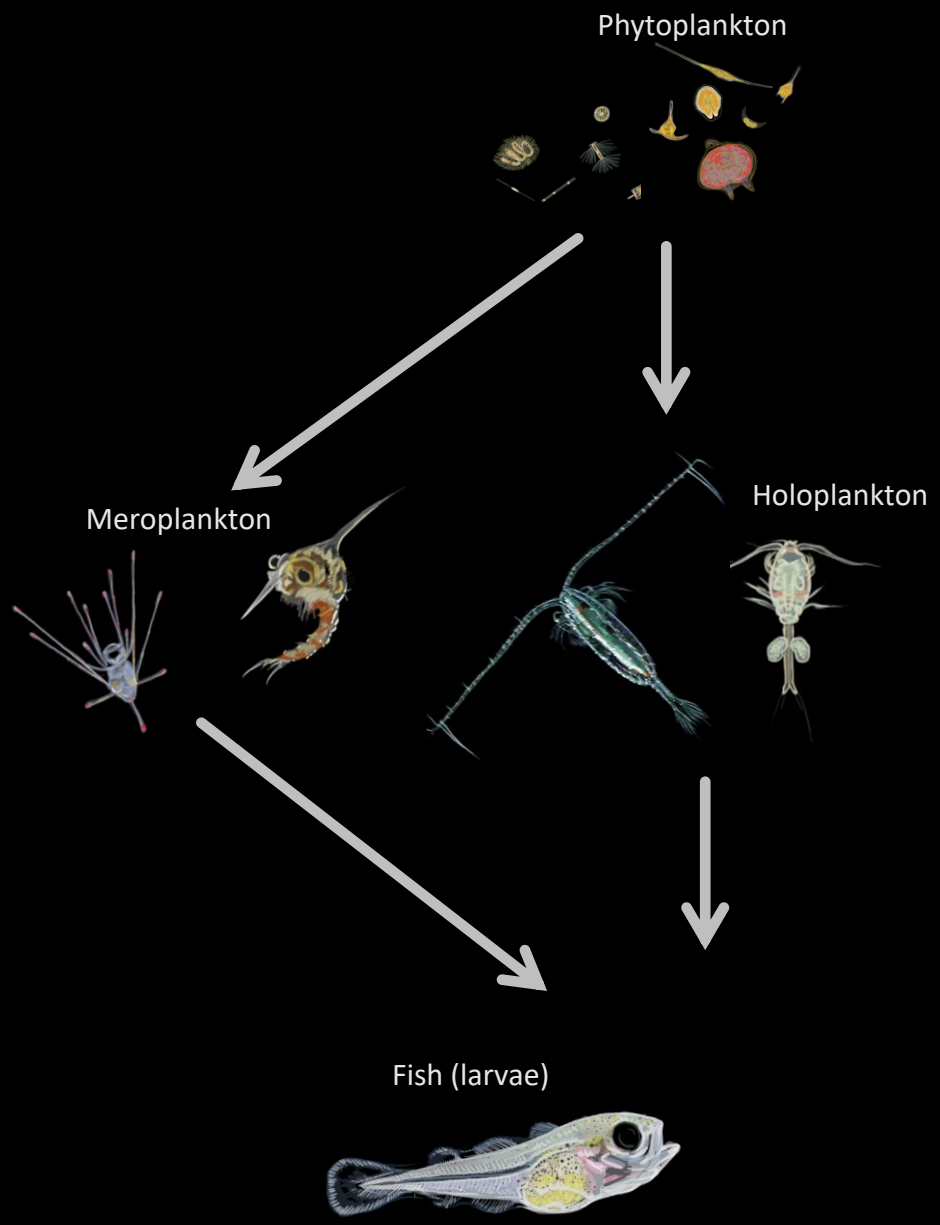
	Echinoderm larvae	Copepods
1949–1953	247.3 (57.9)	1231.4 (120.2)
1965–1969	174.5 (46.0)	646.6 (77.6)
1981–1985	220.1 (169.4)	534.5 (220.2)
1988–1992	268.4 (79.7)	629.0 (71.6)
1998–2002	620.2 (87.6)	457.6 (19.2)

Kirby et al. 2008 L&O

Fish (larvae)



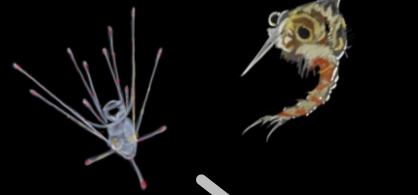
Multitrophic pelagic North Sea food web



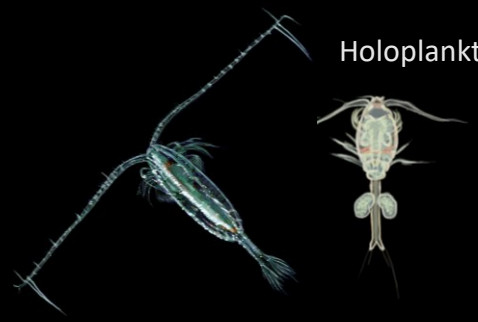
Multitrophic pelagic North Sea food web

Phytoplankton

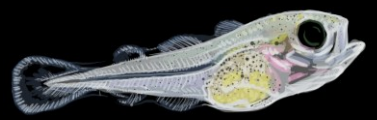
Meroplankton



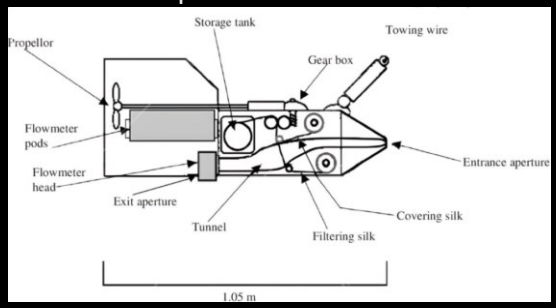
Holoplankton



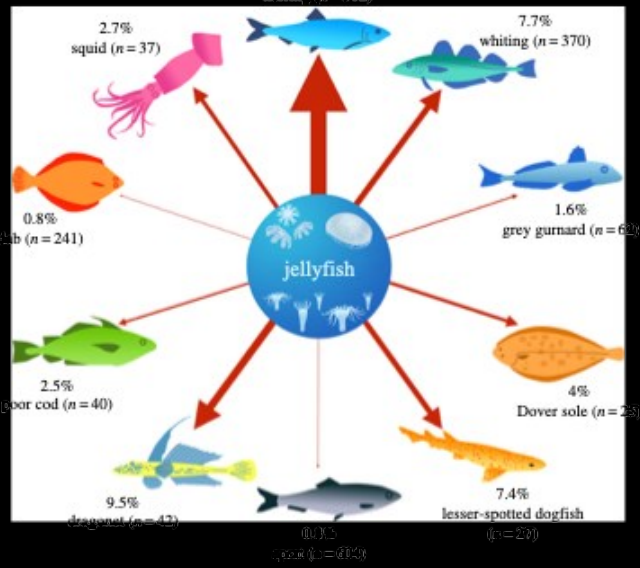
Fish (larvae)



Continuous plankton recorder

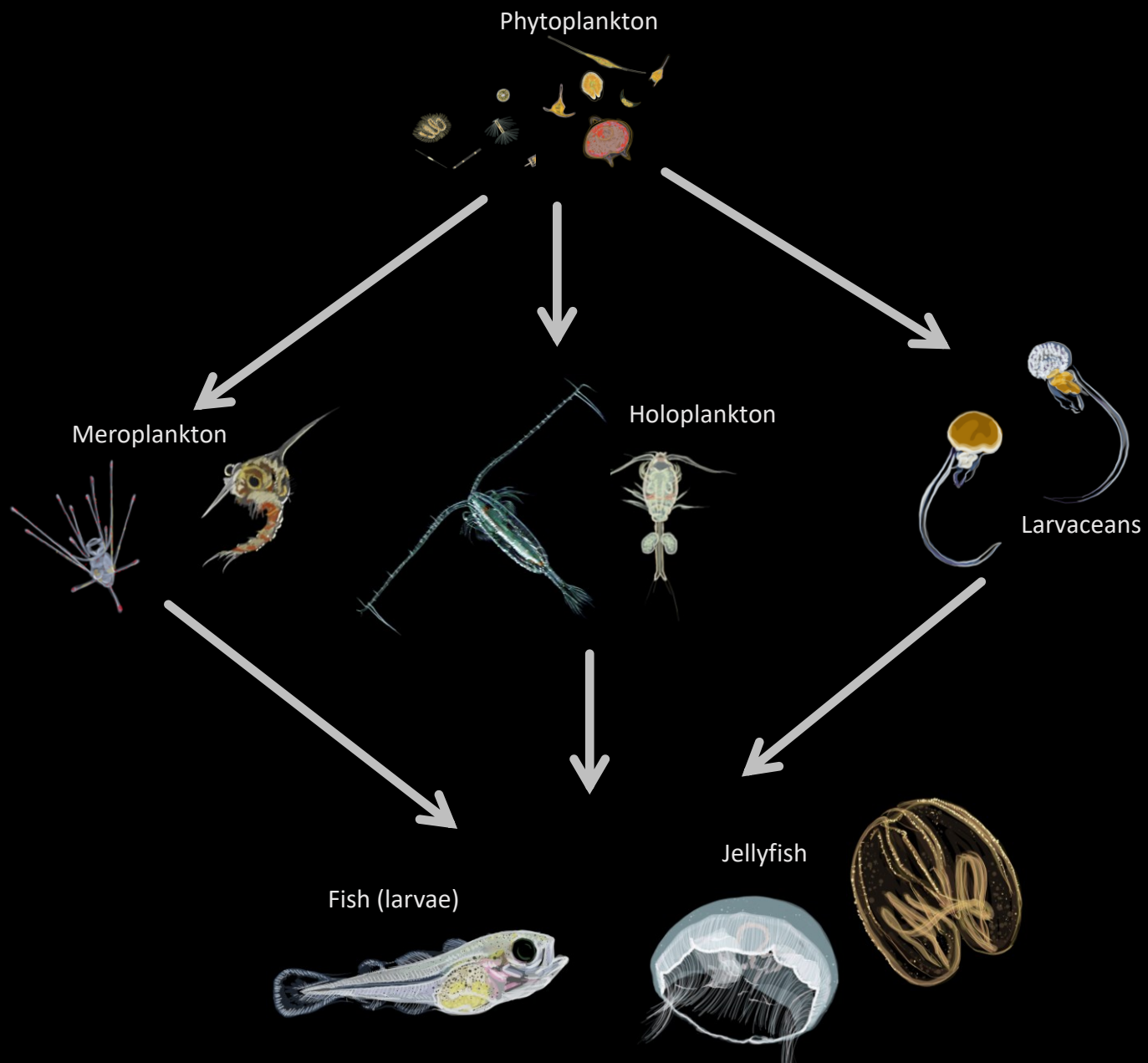


Holland et al. 2023 STE



Lamb et al. 2017 RS

Multitrophic pelagic North Sea food web



Designing a novel plankton monitoring programme

NOORDZEEOVERLEG

- **Integrate** zooplankton monitoring into existing monitoring programmes to **link data** with higher and lower **trophic levels:**

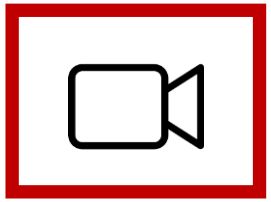
ICES CIEM

- **Match methodology with existing surveys** of neighbouring countries
- Using innovative techniques:

Microscope ID

Meta-barcoding

Sample scans



Onboard imaging

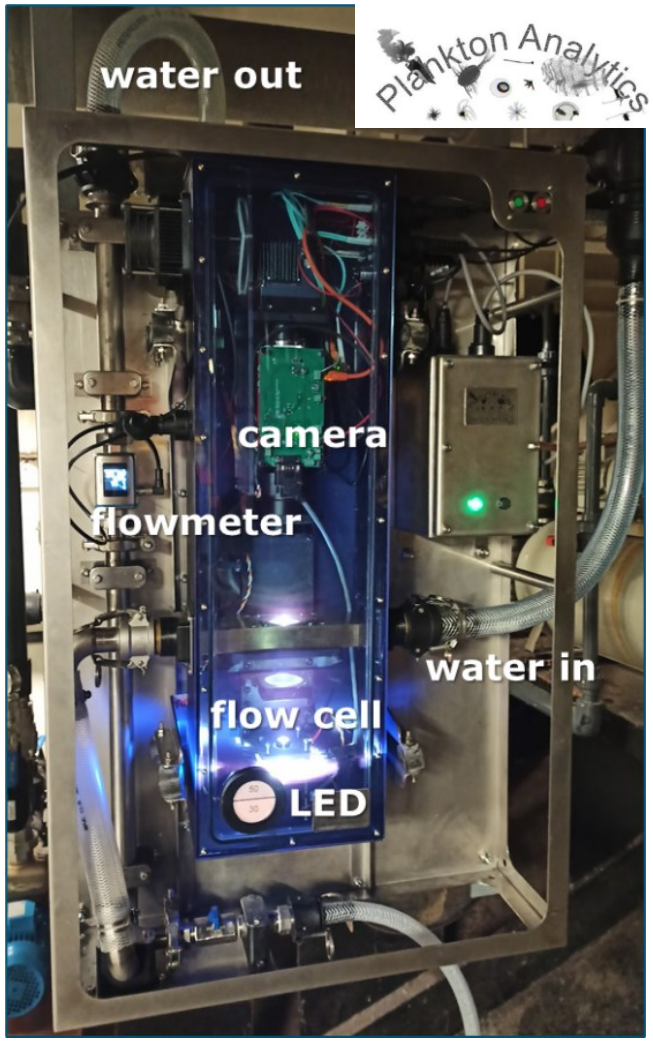
Onboard Plankton Imaging

NOORDZEEOVERLEG

- Plankton Imager (PI10) developed by Plankton Analytics with CEFAS
- Autonomous and continuous underway sampling of mesoplankton composition
- Does not interfere with ship operations
- Installed on:

2024 RV Tridens (fisheries)

2025/2026 RV Zirfaea (water quality)

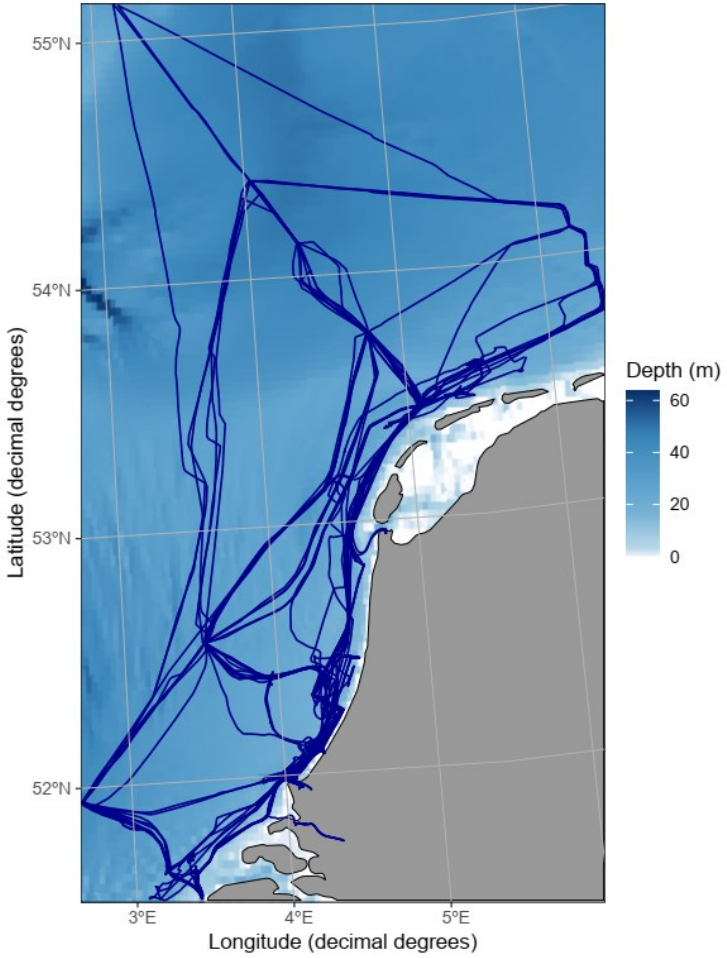


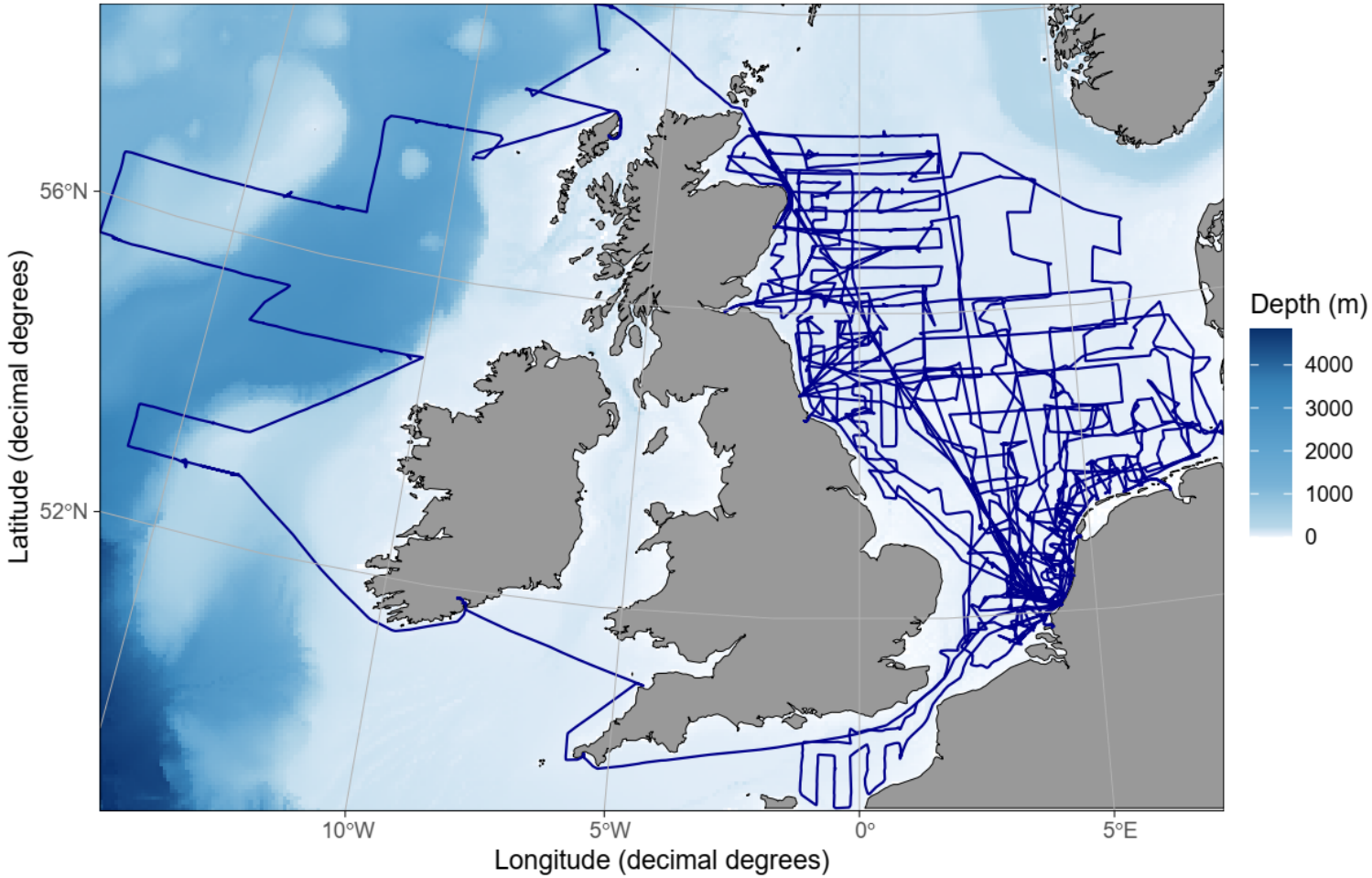
RV Zirfaea
(water quality)

Trajectories in 2023

RV Tridens
(fisheries)

NOORDZEEOVERLEG



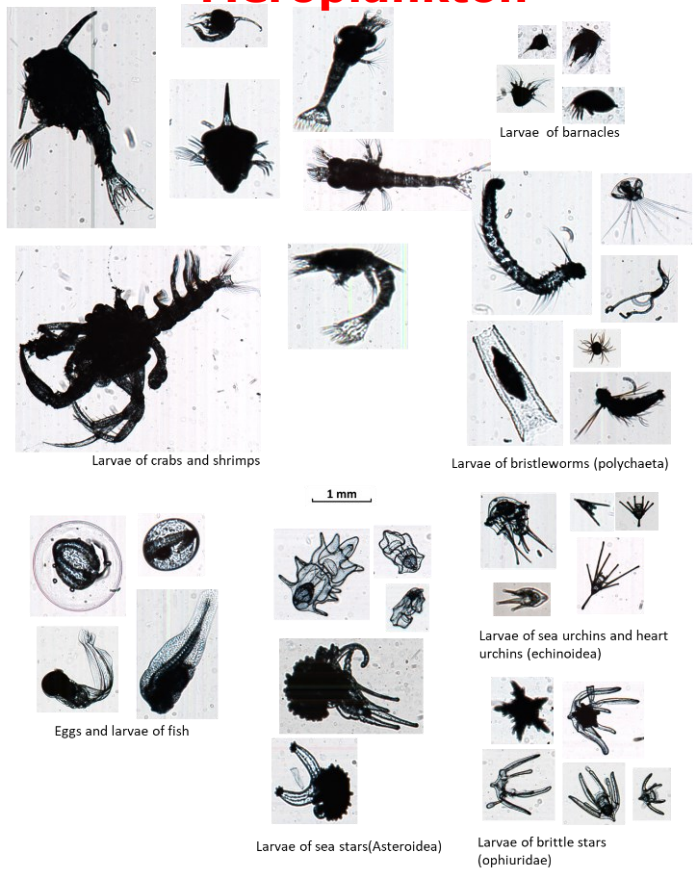


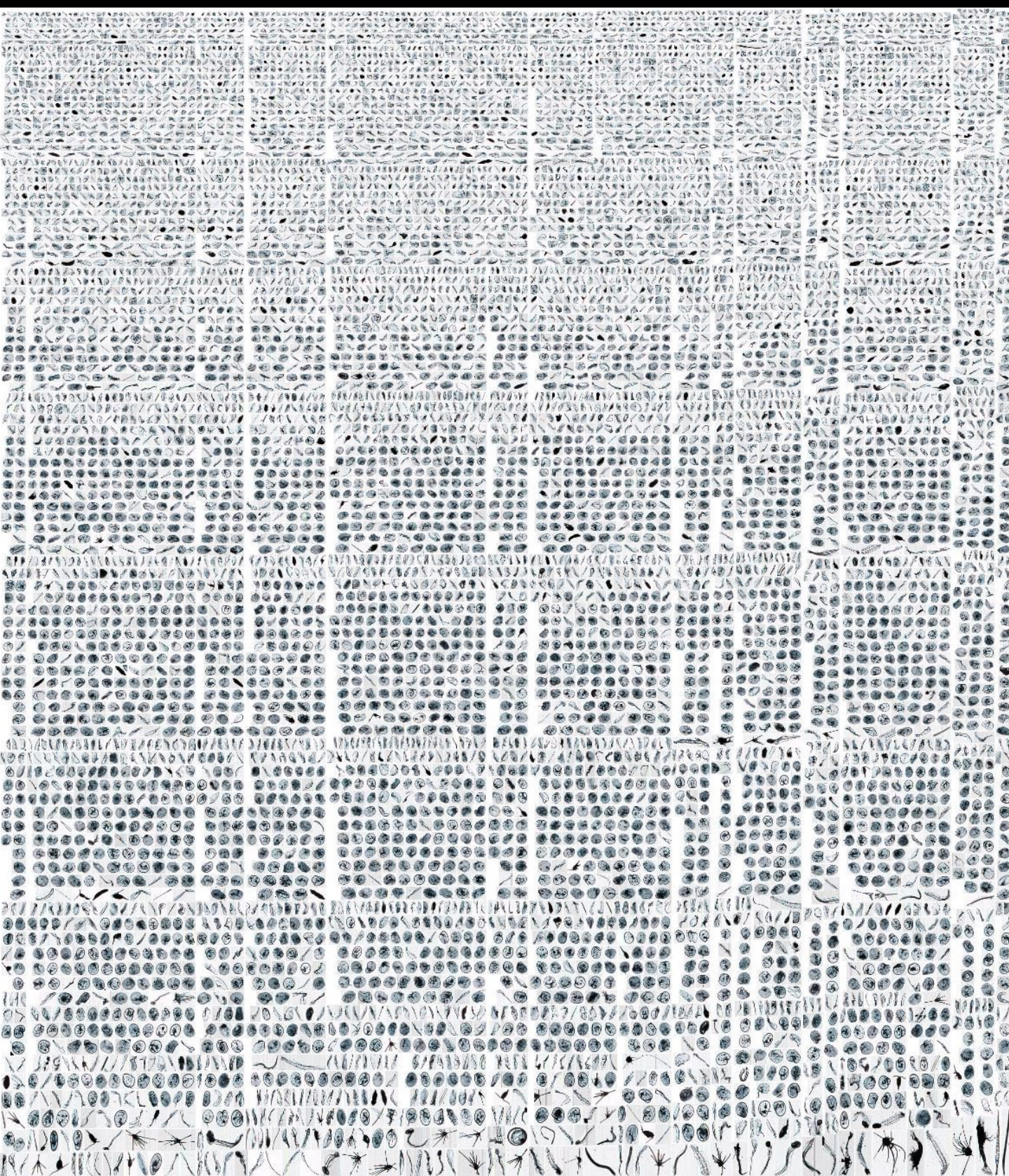
Onboard Plankton Imaging

NOORDZEEOVERLEG

Holoplankton (incl. gelatinous)

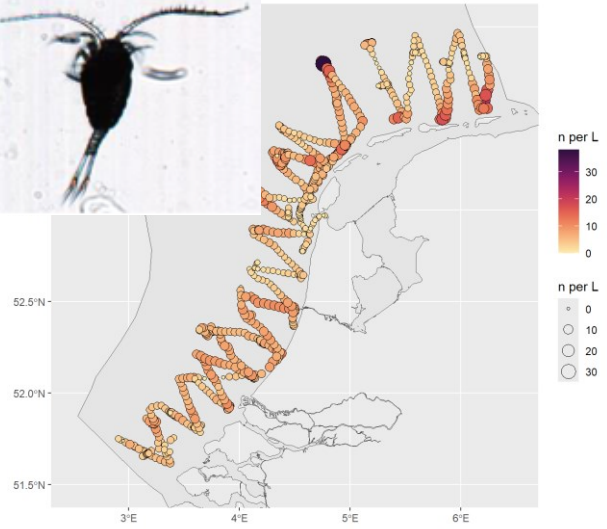
Meroplankton



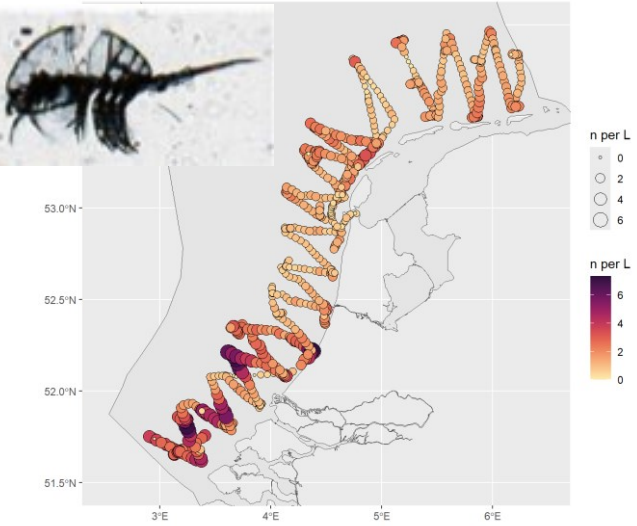


NOORDZEEOVERLEG

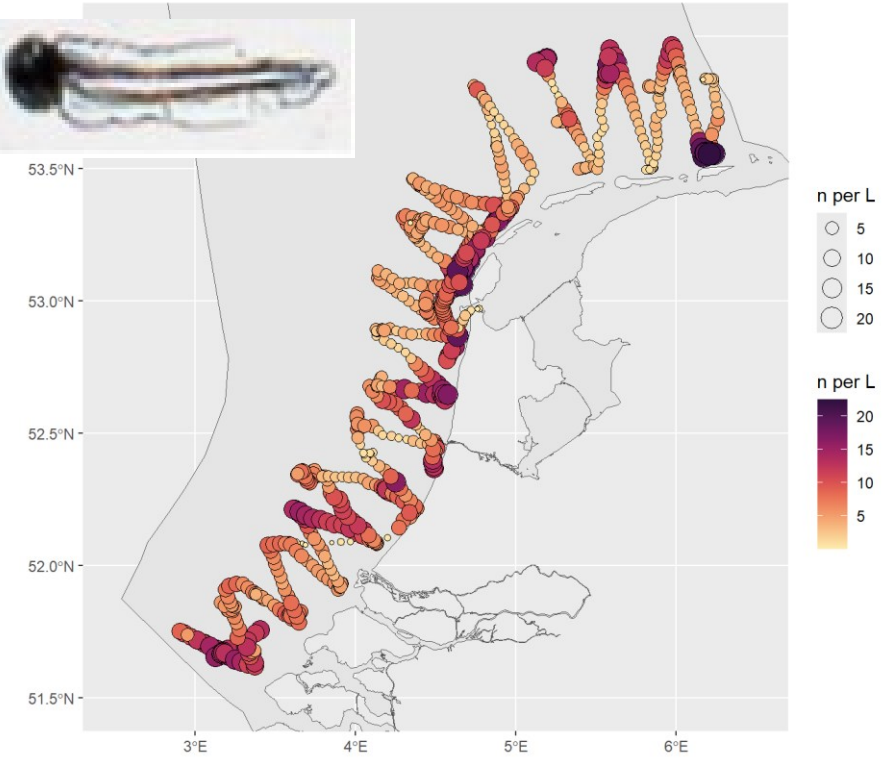
Copepods



Exuvia (empty skins)



Oikopleura



All Larvaceans: >40 ind L^{-1}

NOORDZEEOVERLEG

1. Monitoring container on-board Zirfaea

2. Additional net sampling during the Zirfaea monitoring cruises

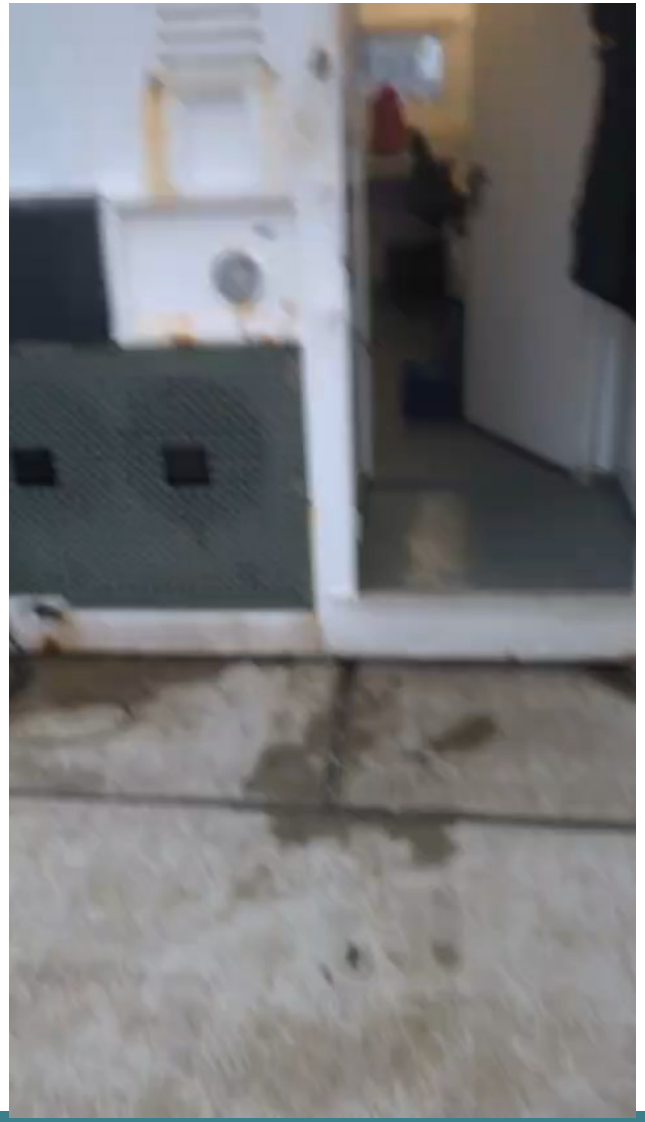
3. Zooplankton sampling at the NIOZ jetty (Marsdiep) for high temporal resolution

1. Monitoring container on-board Zirfaea

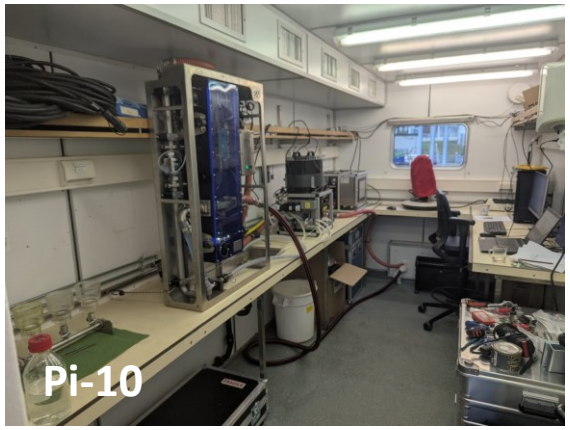
NOORDZEEOVERLEG

1. Monitoring container on-board Zirfaea

NOORDZEEOVERLEG




Filtration


Pi-10


Cytosense

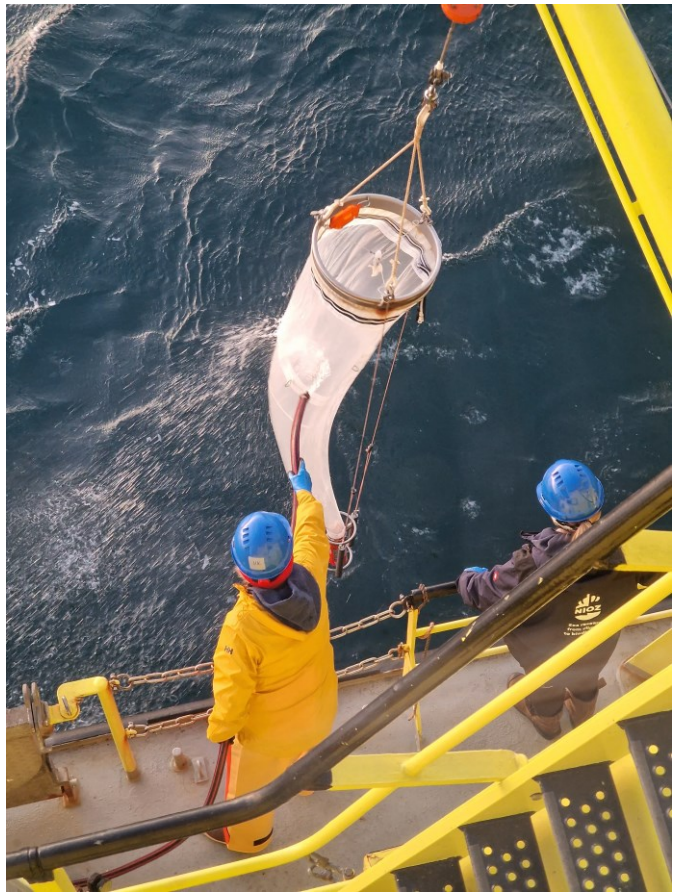

Pocketferrybox


Microscoop

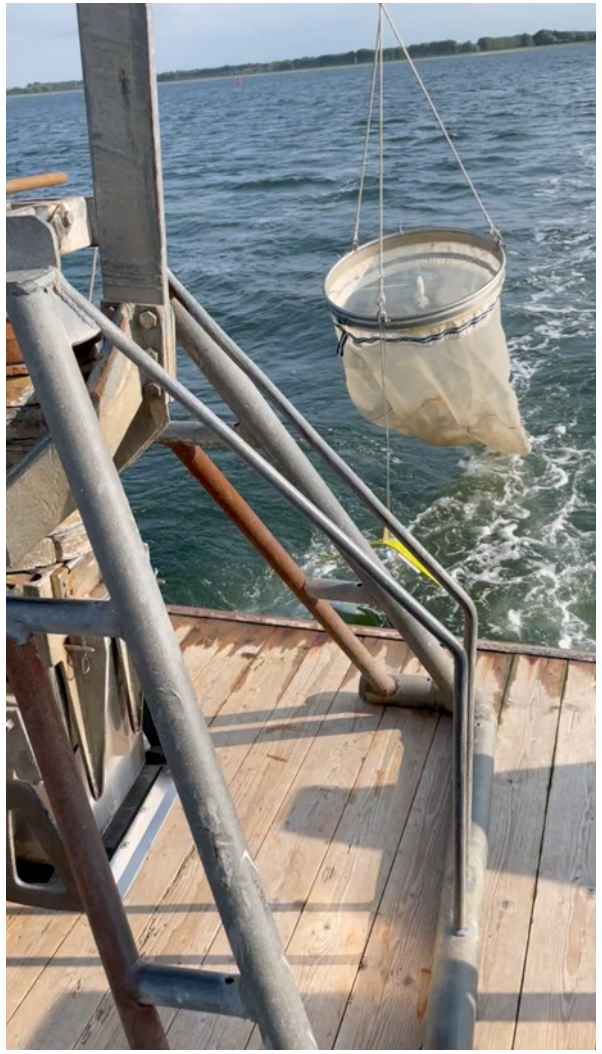

Computers

2. Additional sampling during the Zirfaea monitoring cruises

NOORDZEEOVERLEG



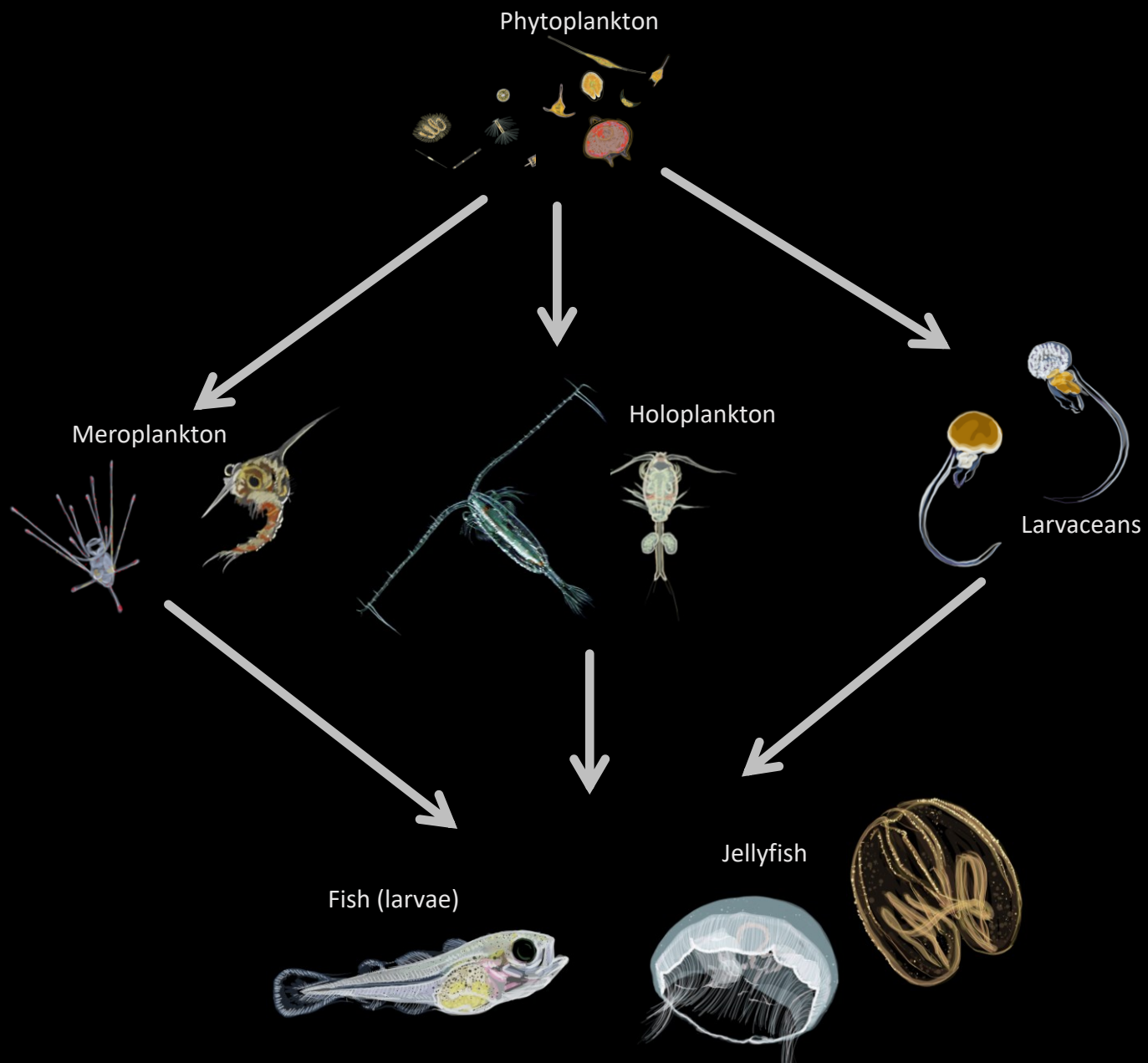
WP2 net for small zooplankton



Ring net for gelatinous zooplankton

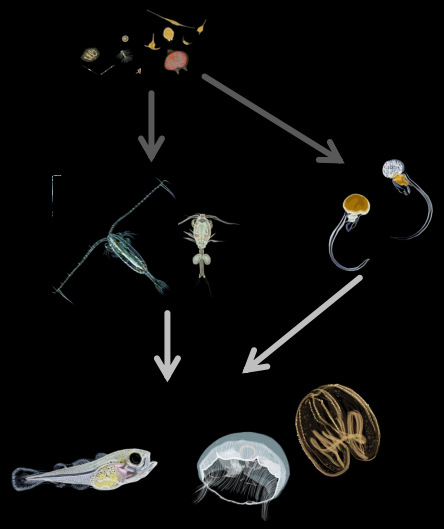
NOORDZEEOVERLEG

Multitrophic pelagic North Sea food web



PhD project

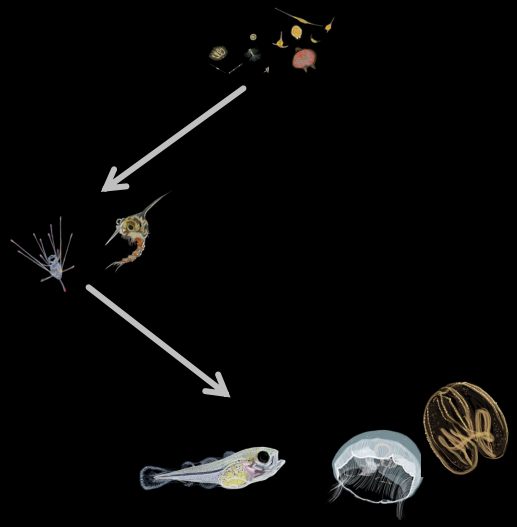
Transfer of zooplankton



Hannah Kepner

PhD project

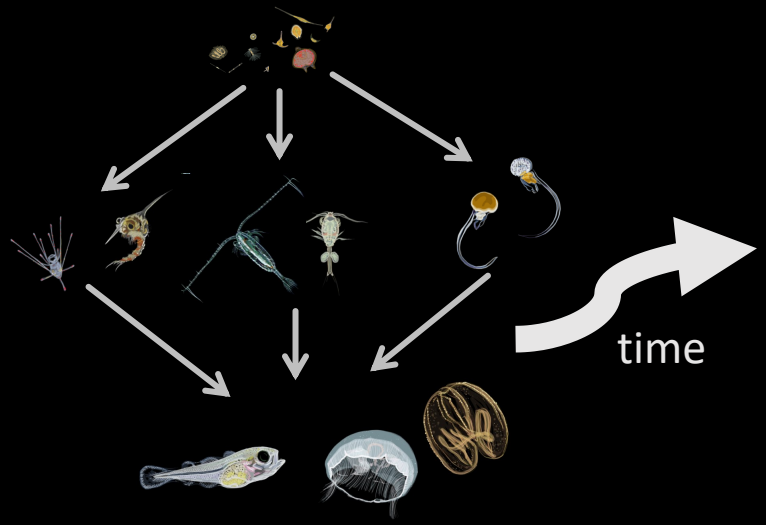
Role of meroplankton



Rebecca Büring

PhD project

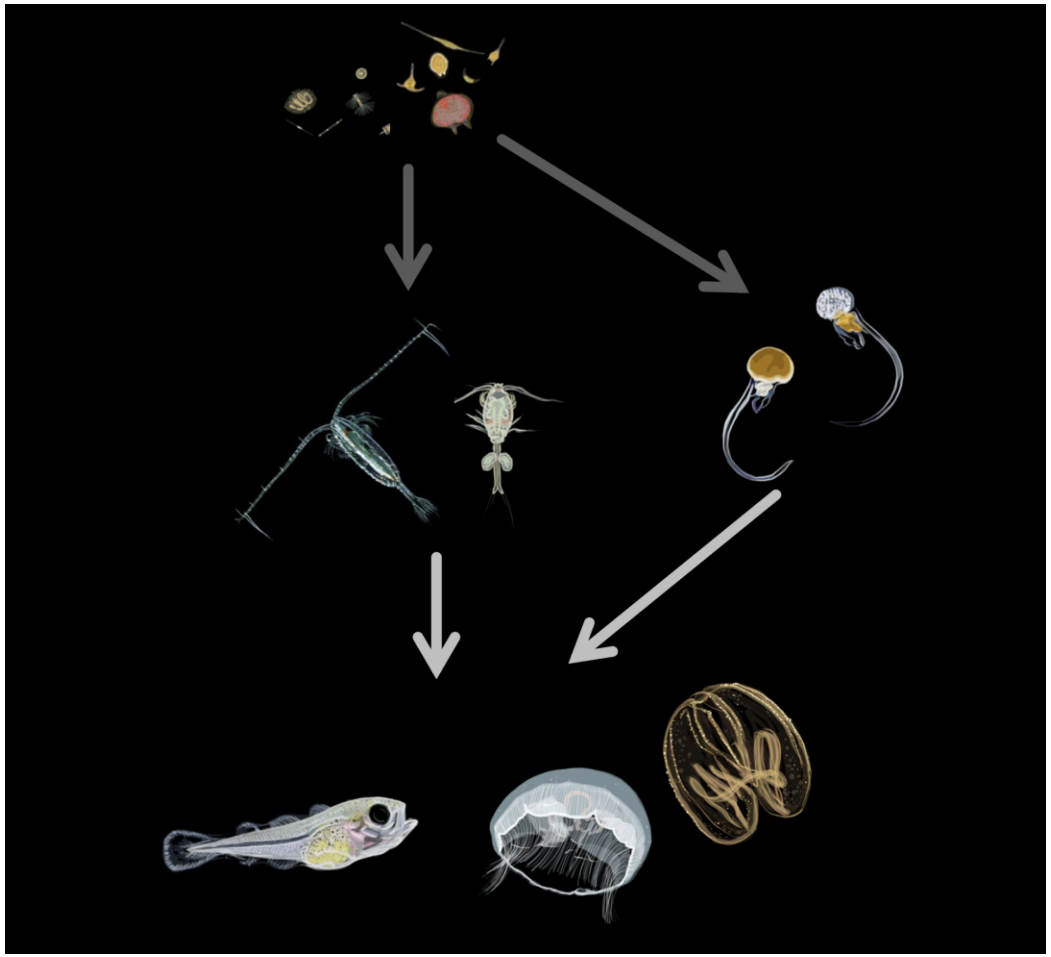
Future state



Ties Maris

Transfer of zooplankton biomass to higher trophic levels

NOORDZEEOVERLEG

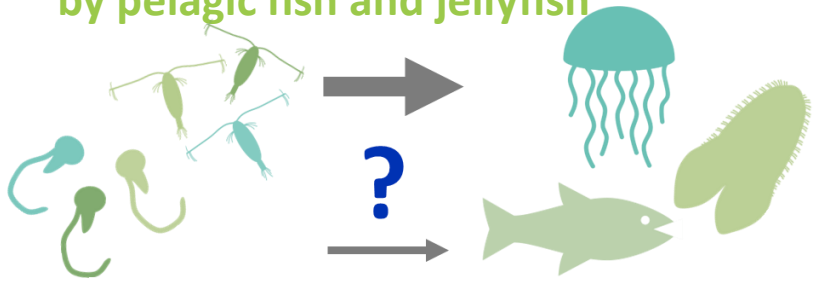


Hannah Kepner
hannah.kepner@nioz.nl

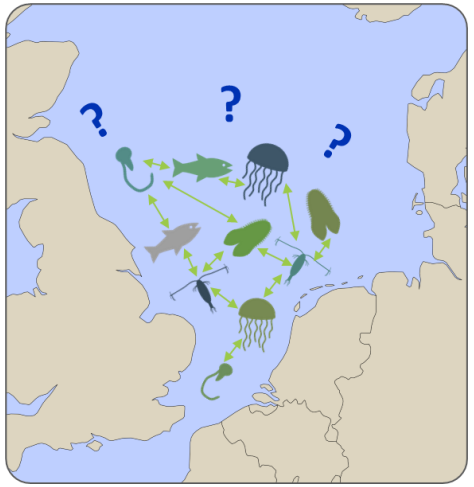
- **Step 1: Determine the trophic structure of zooplankton in the Dutch part of the North Sea**



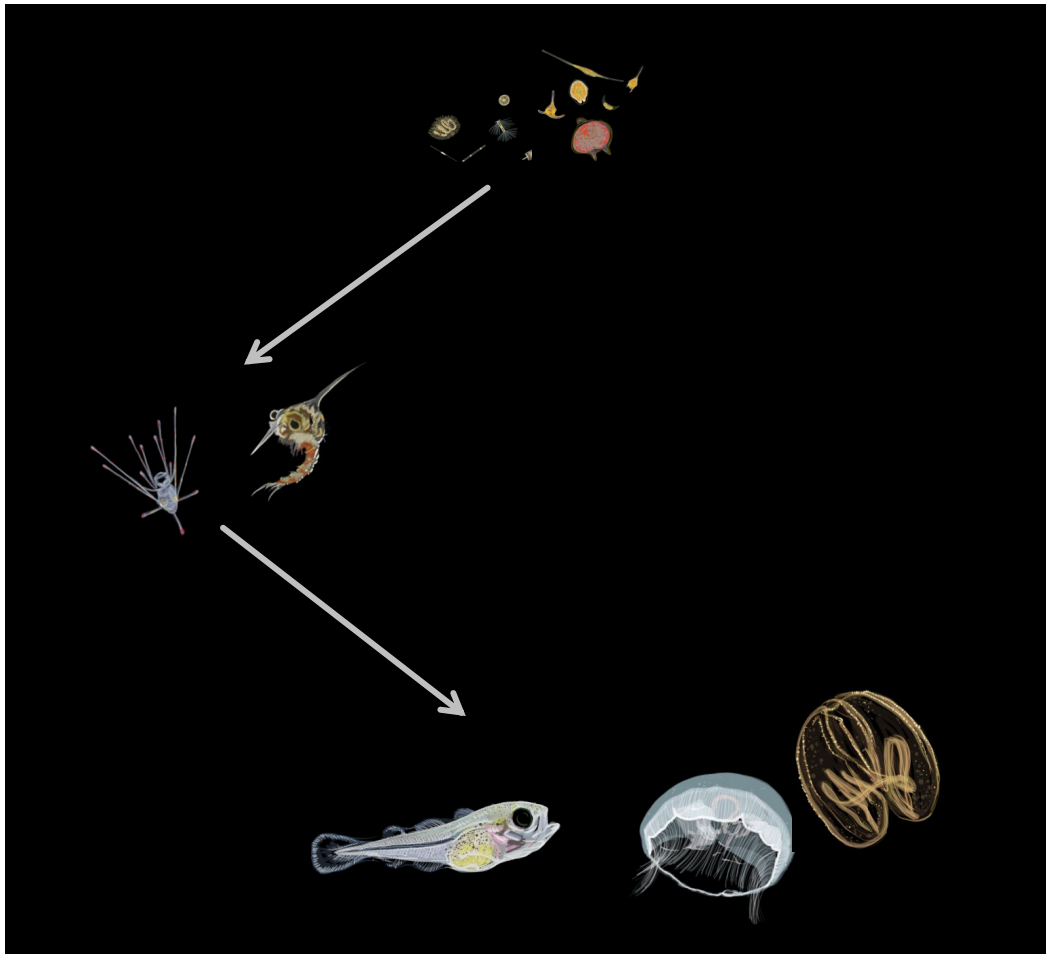
- **Step 2: Diet composition and predation of zooplankton by pelagic fish and jellyfish**



- **Step 3: Linking predator-prey distribution patterns and predation of zooplankton by pelagic fish and jellyfish**



Investigating the trophic role of meroplankton in the Dutch North ea

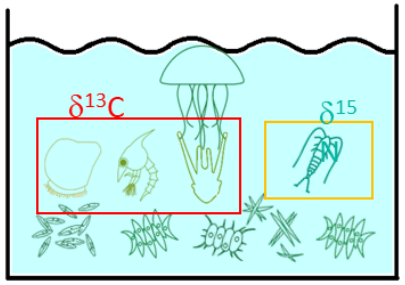


Rebecca Büring
rebecca.buring@nioz.nl

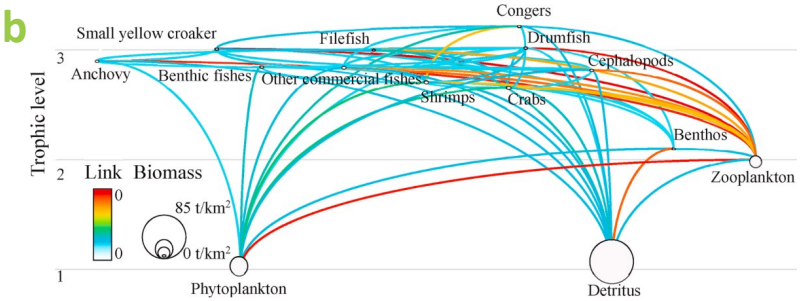
NOORDZEEOVERLEG

- **Step 1: Spatial and temporal mapping of meroplankton**

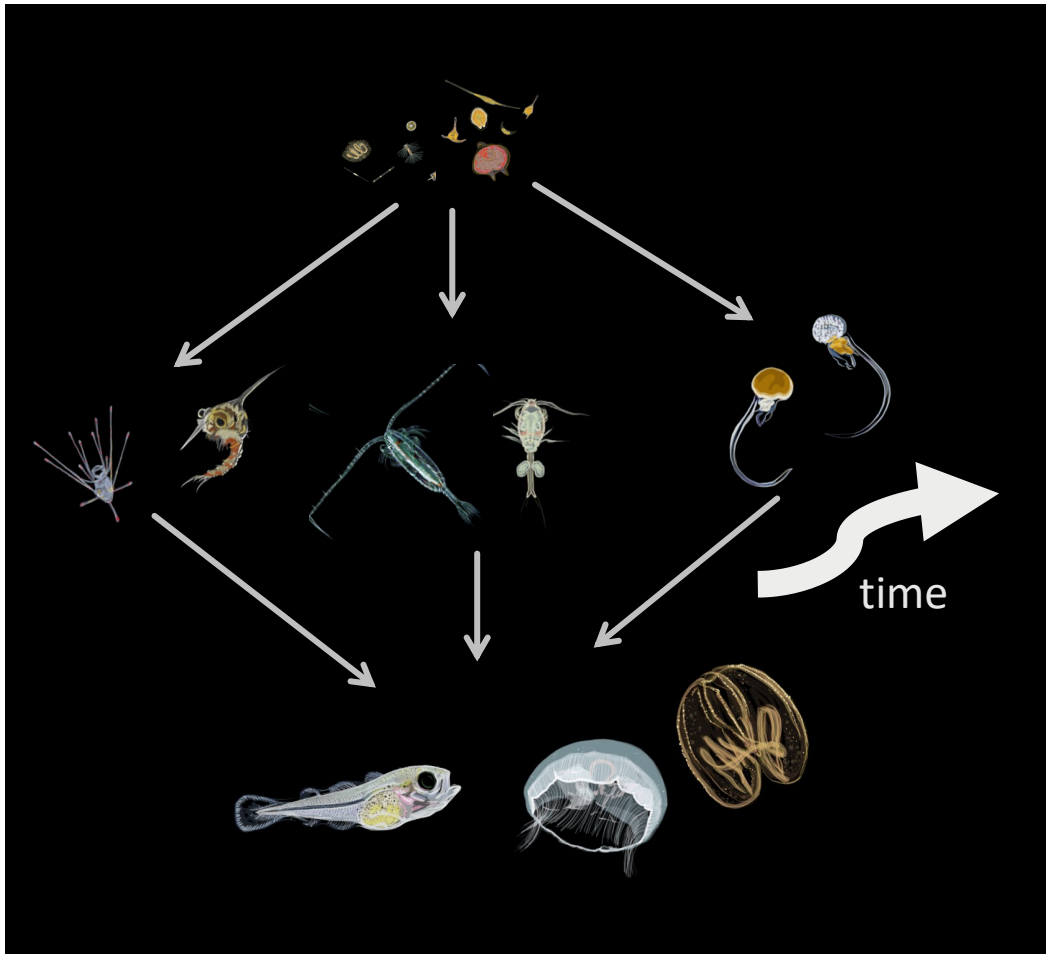
- **Step 2: Grazing rates on phytoplankton by meroplankton and trophic transfer to higher levels**



- **Step 3: Assess the trophic role of meroplankton in the pelagic food web**



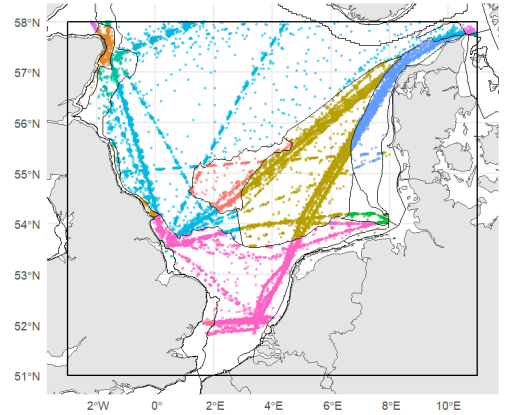
Predicting the composition of zooplankton in the future North Sea



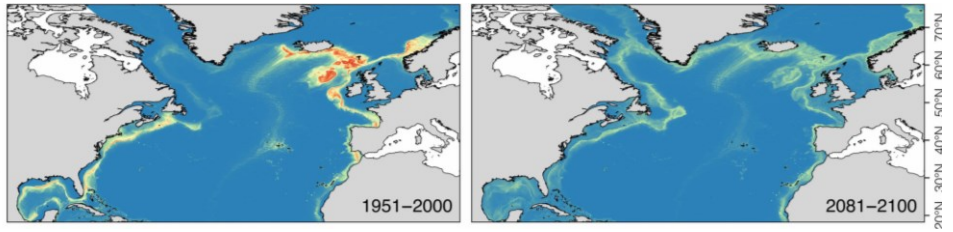
Ties Maris
ties.maris@nioz.nl

NOORDZEEOVERLEG

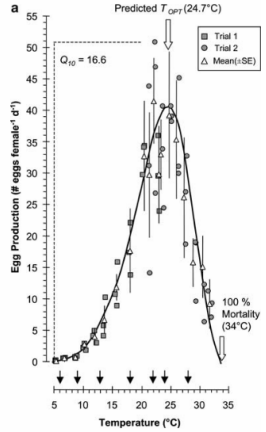
- **Step 1: Find out which predictors most influence zooplankton species distribution, using historical data and experimental work**



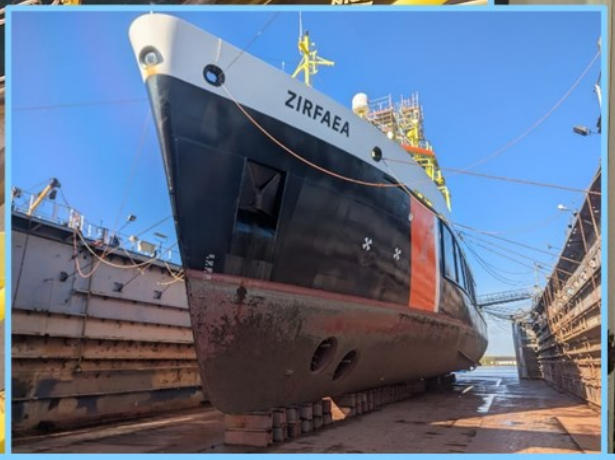
- **Step 2: Create habitat suitability maps for key zooplankton species to predict their distribution in the future North Sea**



- **Step 3: Estimate the impact of marine heatwaves**




NIOZ
Sea research
rom climate
biodiversity


ZIRFAEA

Appendix

NOORDZEEOVERLEG

Transfer of zooplankton biomass to higher trophic levels

Step 1: Determine the trophic structure of zooplankton in the North Sea

- Goal: estimate zooplankton community composition, biomass, trophic structure

- distribution, abundance, biomass:
  - plankton nets, PI-10, ISIIS
- community composition:
  - metabarcoding, Zooscan
- trophic position:
  - stable isotope signatures (bulk SI, CSIA)

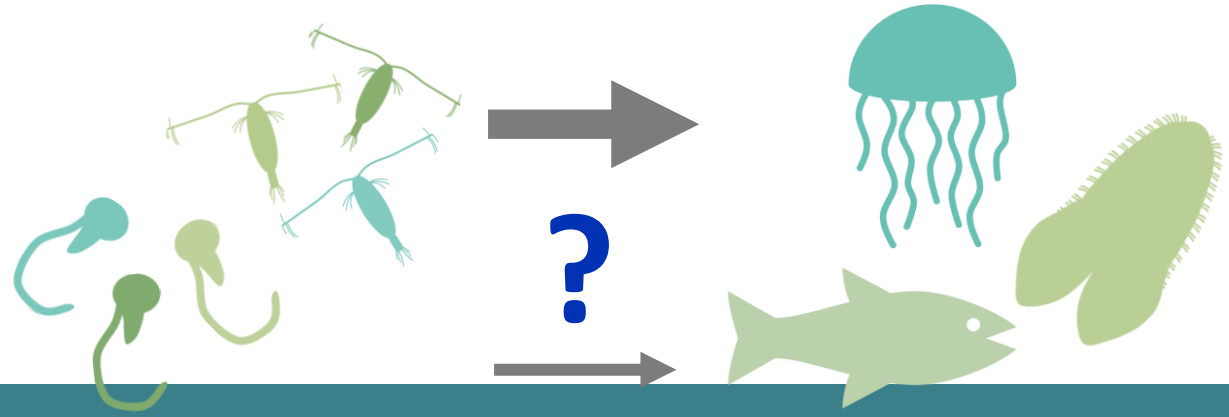
Step 2: Diet composition and zooplankton predation by pelagic fish and jellyfish

NOORDZEEOVERLEG

Goals: describe taxonomic composition of fish and gelatinous zooplankton diets:

Fish and jellyfish samples:

- diet composition
  - gut contents (metabarcoding)
- trophic position:
  - tissue samples (stable isotope)



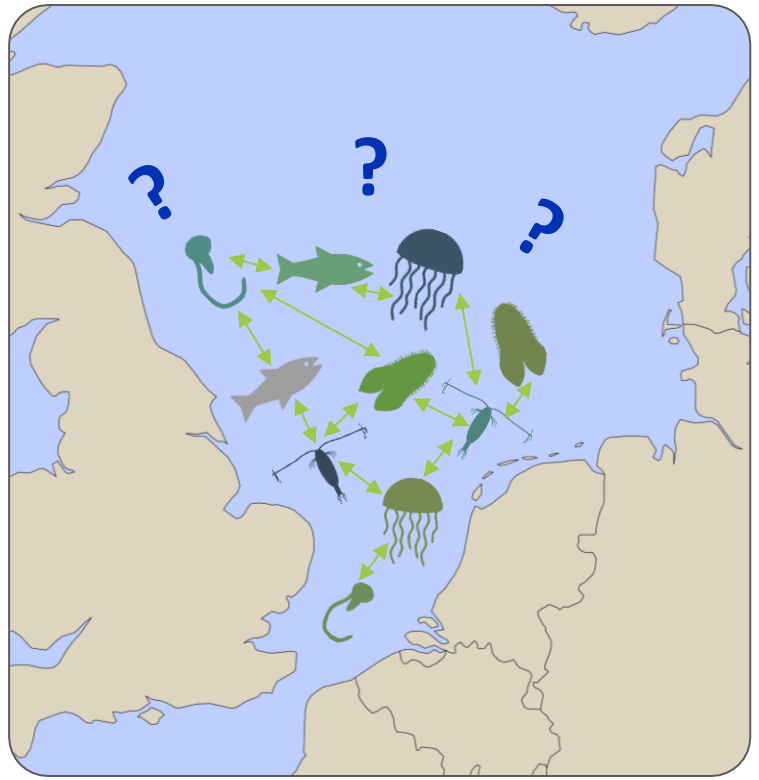
Transfer of zooplankton biomass to higher trophic levels

NOORDZEEOVERLEG

Step 3: Linking predator-prey distribution patterns and predation of zooplankton by pelagic fish and jellyfish

- How is carbon/energy transferred in a multitrophic food web?
  - prey ↔ predator spatiotemporal overlap
    - abundance/ biomass
  - transfer efficiency from phytos → fish
    - predator-prey body mass ratios (PPMRs)

- **Goals: Quantify energy fluxes within the North Sea multitrophic food web**



Hannah Kepner
hannah.kepner@nioz.nl

Investigate the trophic role of meroplankton in the Dutch North Sea

NOORDZEEOVERLEG

Step 1

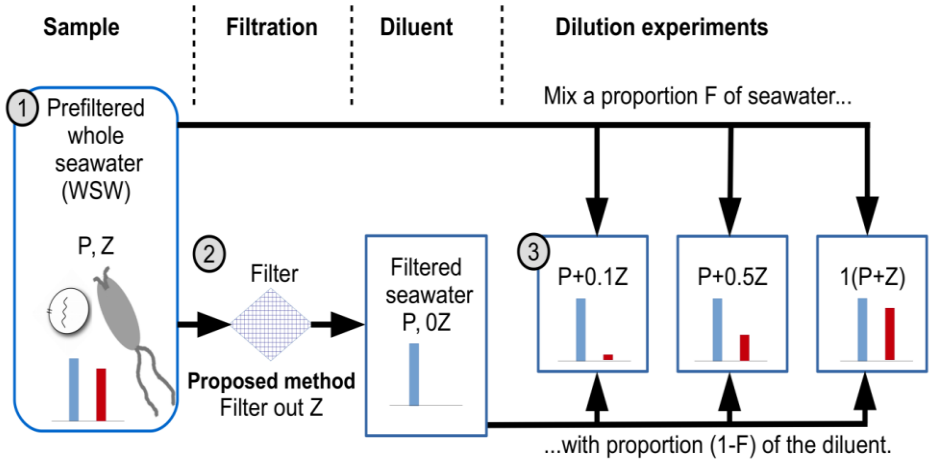
- Which are main meroplankton species?
- How is the seasonality of meroplankton biomass?
- Where is main area of meroplankton?
- Do meroplankton groups vertical migrate?

➢ Field sampling (metabarcoding; AI image recognition)

Step 2

- How much phytoplankton is cleared by meroplankton?

➢ Grazing experiments



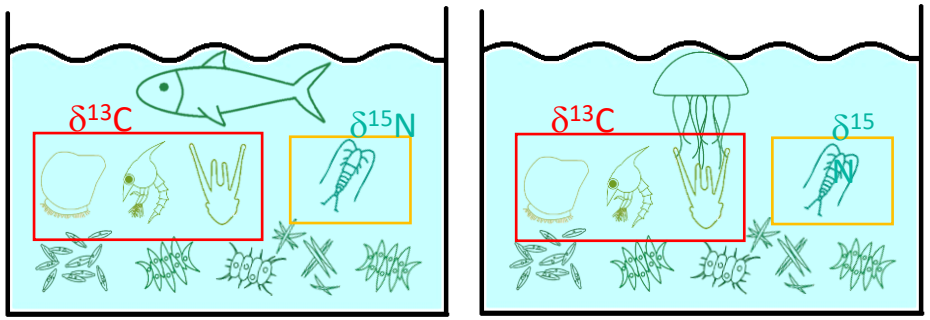
Beckett & Weitz 2017

Investigate the trophic role of meroplankton in the Dutch North Sea

NOORDZEEOVERLEG

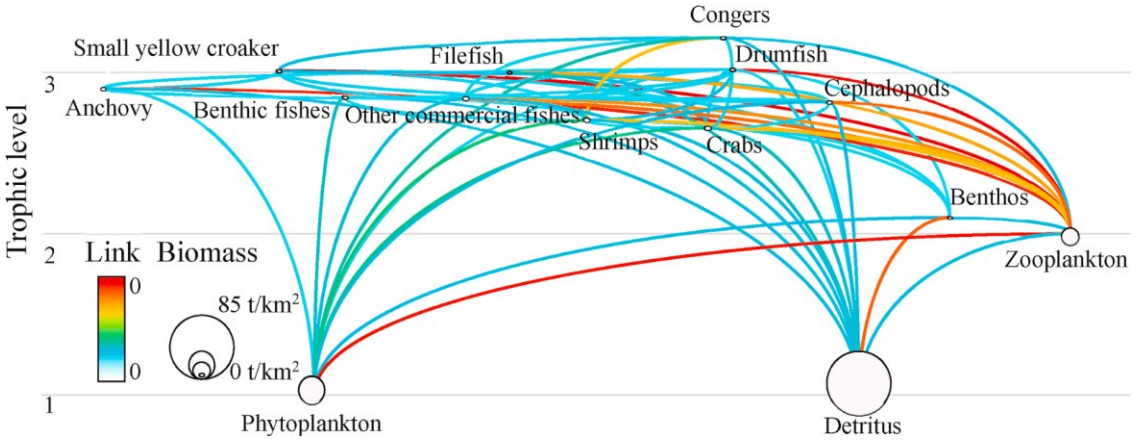
Step 3

- How efficient is the transfer of om through meroplankton?
- How does zooplankton composition influence the transfer?
- ➢ Mesocosm experiments
- ➢ Stable isotope tracers



Step 4

- Is meroplankton an important food source for fish and gelatinous predators?
- Which trophic level does meroplankton inhibit?
- ➢ Gut content analysis
- ➢ Stable isotope analysis
- ➢ Linear inversed modelling



Gao et al. 2021

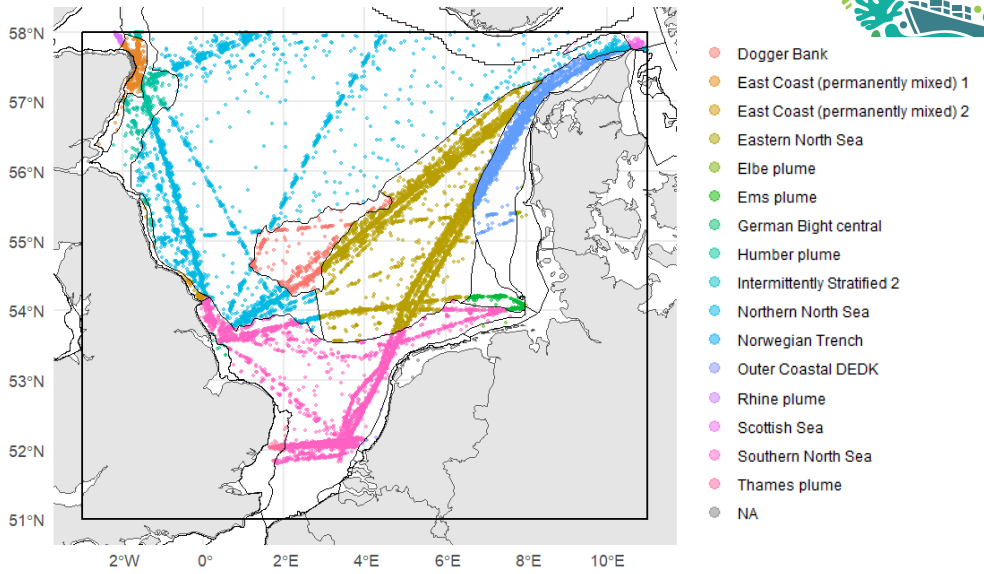
Predicting the compositon of zooplankton in the future North Sea

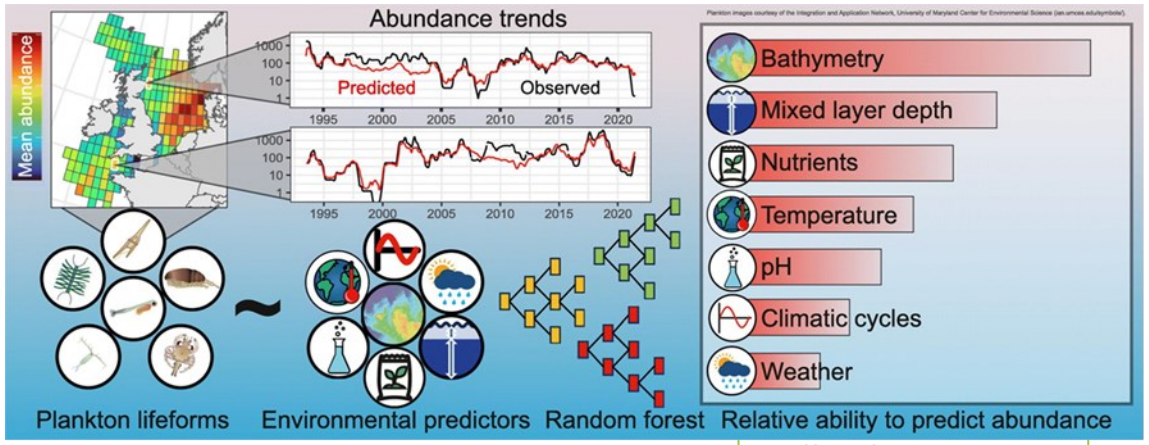
NOORDZEEOVERLEG

- Important predictors for zooplankton spatial distribution will be determined based on historical zooplankton data from the **C**ontinuous **P**lankton **R**ecorder (1995-2021)

- Also looking at the ability of image-based monitoring data to create statistical models!

CPR data (1995-2021) in North Sea Subregions





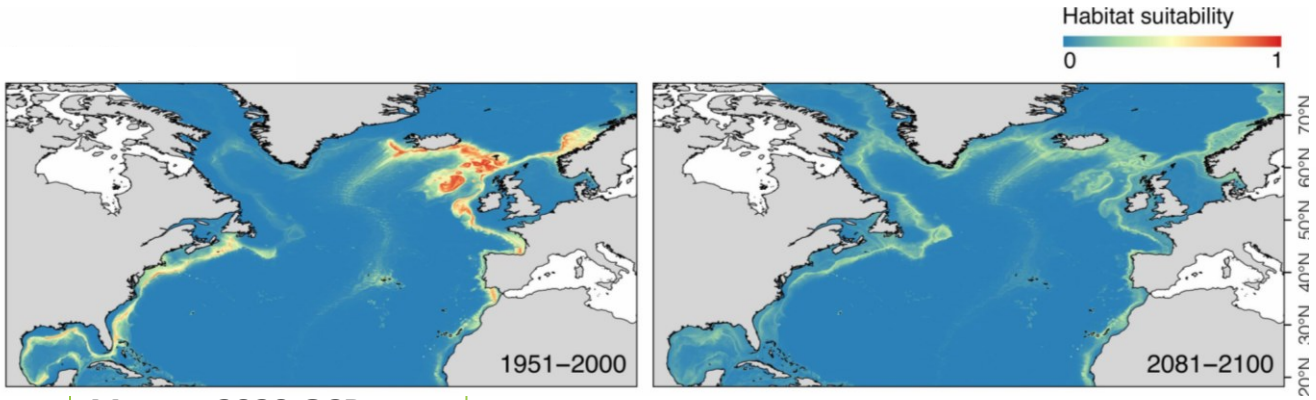
Holland 2024 STE

Predicting the compositon of zooplankton in the future North Sea

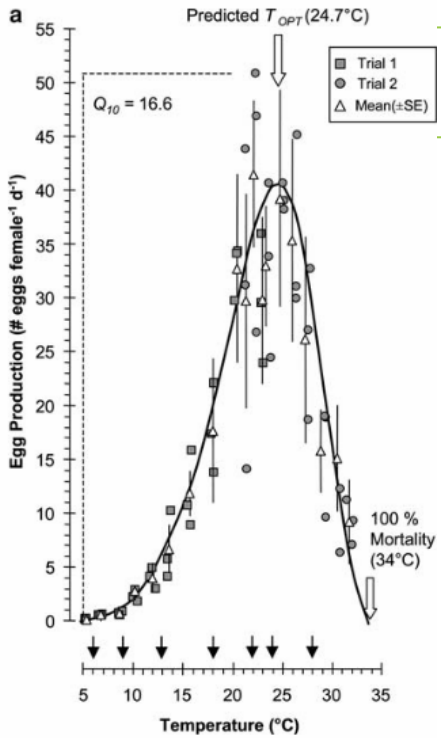
Ties Maris

NOORDZEEOVERLEG

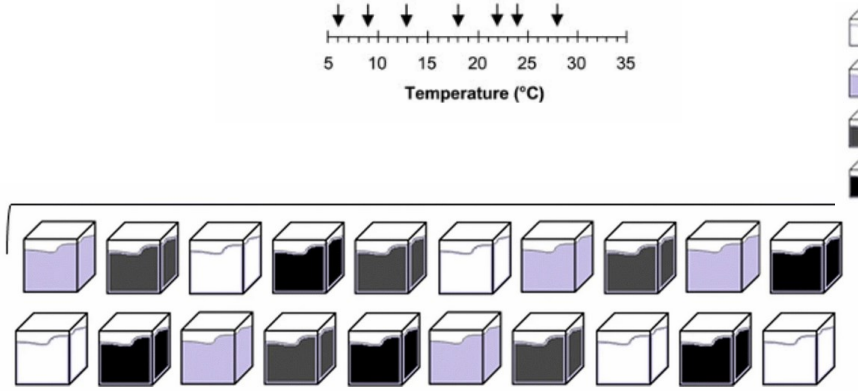
- Predictive models will be supplemented with other methods of determing species habitat suitability, such as
  - Literature review
  - Mesocosm experiments
  - Heatwave experiments
- Combining these methods allows us to predict future suitable habitat for key zooplankton species



Morato 2020 GCB



Holste & Peck 2006 MB



Machado 2018 HB

NOORDZEEOVERLEG

Susanne Wilken
Phytoplankton

Eleonora Puccinelli
Phytoplankton grazing

Dick v Oevelen (3)
Zooplankton & gelatinous

Bram v Prooijen
Water column particles

Peter Kraal
Nutrient exchange