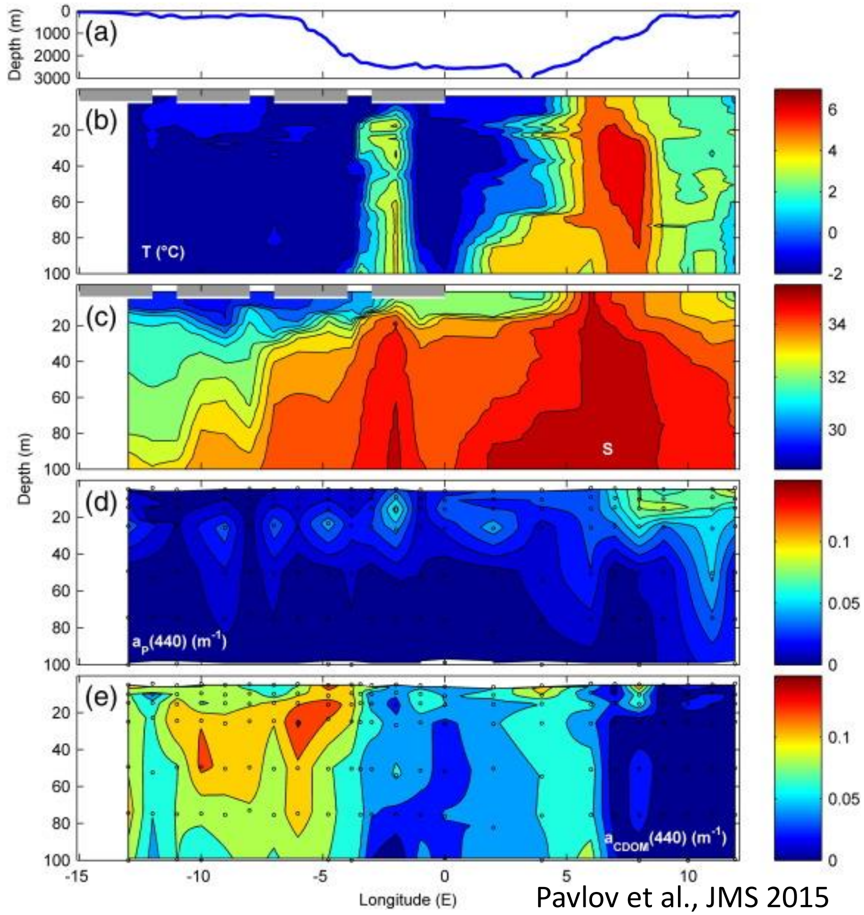
Latitudinal and vertical gradients in structure and distribution of size-fractionated plankton in the eastern Fram Strait region

Trudnowska Emilia
Sagan Slawomir
Basedow Sünnje
Zhou Meng
Blachowiak-Samolyk Katarzyna

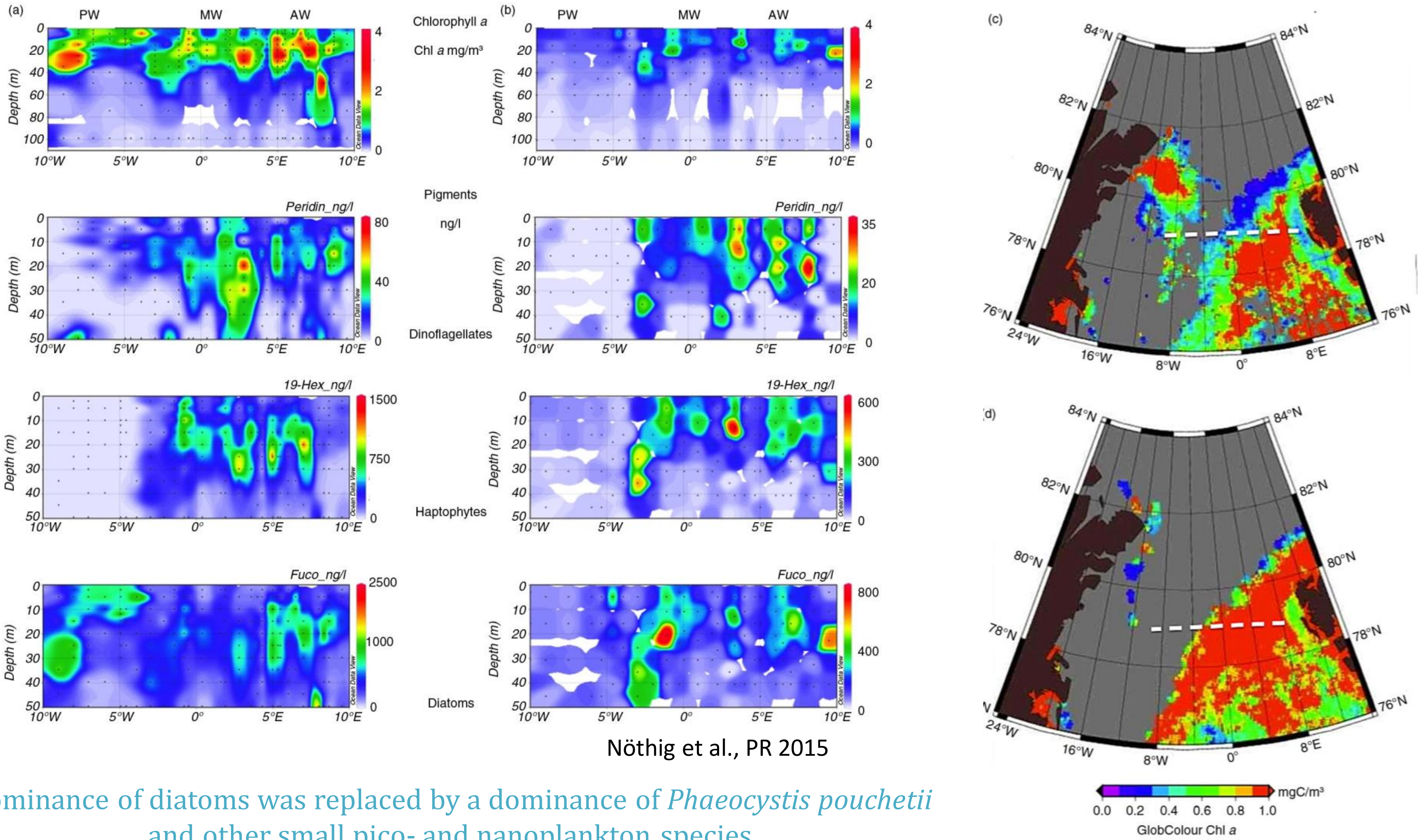
Climate change -- inflow of Atlantic Water -- Fram Strait

©2004, ACIA/ map ©Clifford Grabhorn



Pavlov et al., JMS 2015

Primary production & protists -- spatial variability --

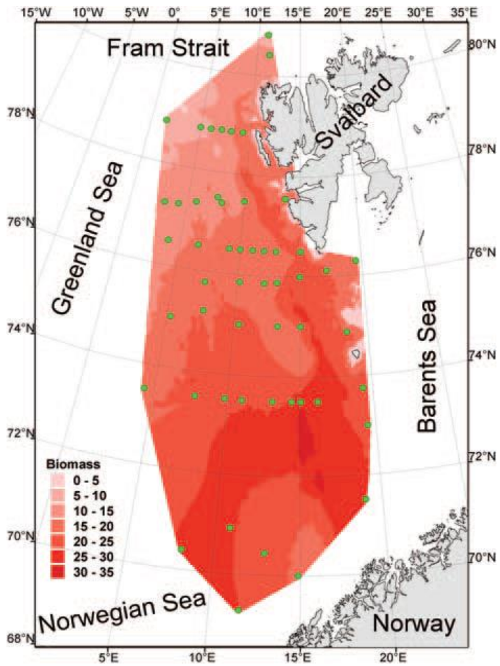


Nöthig et al., PR 2015

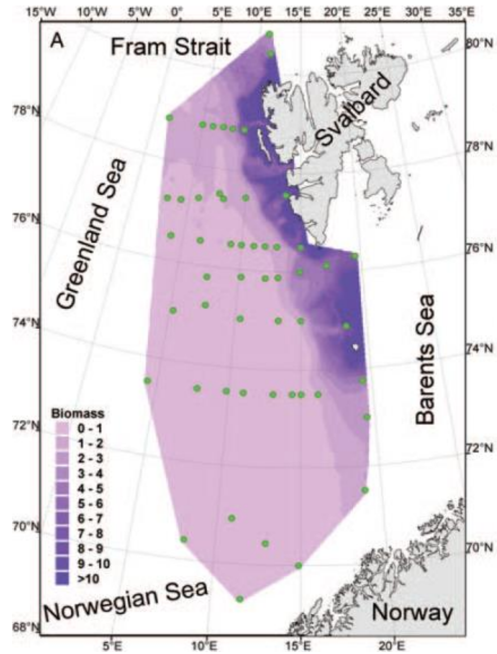
Dominance of diatoms was replaced by a dominance of *Phaeocystis pouchetii* and other small pico- and nanoplankton species

Zooplankton biomass -- *Calanus* copepods

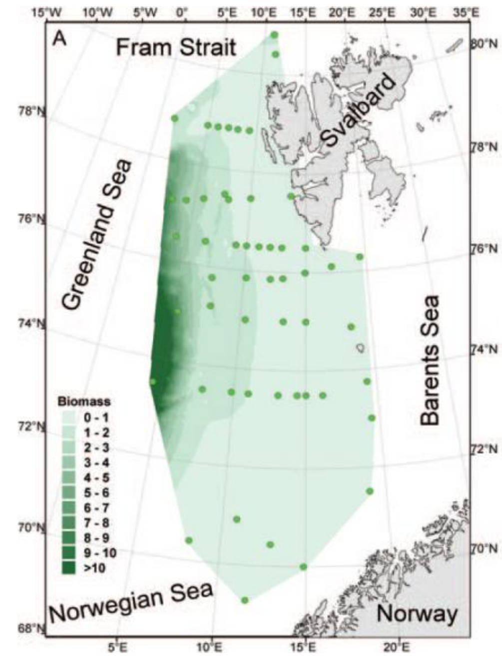
C. finmarchicus



C. glacialis

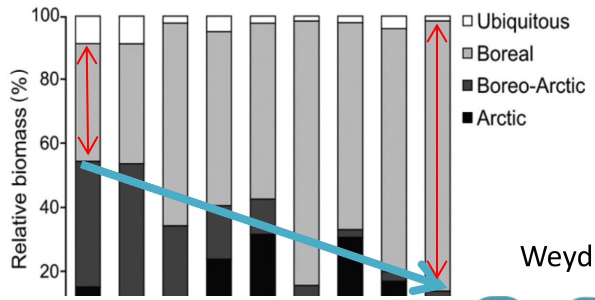


C. hyperboreus



Carstensen et al., JPR 2012

Shift towards the dominance of boreal species in the Arctic



Weydmann et al., MEPS 2014

Climate warming -- Size response

Global warming benefits the small in aquatic ecosystems

Martin Daufresne[a,b,1], Kathrin Lengfellner[a], and Ulrich Sommer[a]

[a]FB3–Marine Ökologie, Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR), 24105 Kiel, Germany; a
Cemagref, 13182 Aix-en-Provence, France

Edited by Stephen R. Carpenter, University of Wisconsin, Madison, WI, and approved June 3, 2009 (receiv

Smallest Algae Thrive As the Arctic Ocean Freshens

William K. W. Li,[1]* Fiona A. McLaughlin,[2] Connie Lovejoy,[3] Eddy C. Carmack[2]

PROCEEDINGS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Warming alters community size structure and ecosystem functioning

Matteo Dossena, Gabriel Yvon-Durocher, Jonathan Grey, José M. Montoya, Daniel M. Perkins, Mark Trimmer and Guy Woodward

Proc. R. Soc. B 2012 **279**, doi: 10.1098/rspb.2012.0394 first published online 11 April 2012

Opinion Cell PRESS

Declining body size: a third universal response to warming?

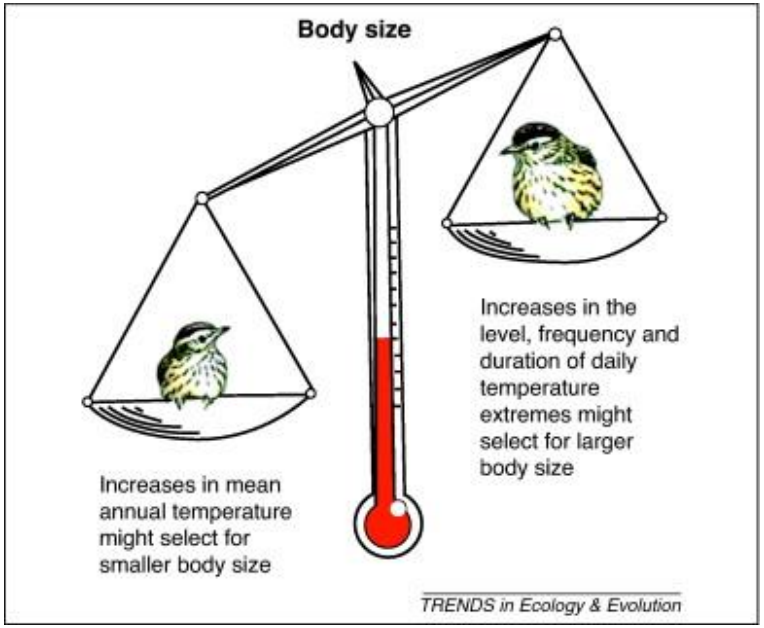
Janet L. Gardner[1], Anne Peters[2,3], Michael R. Kearney[4],
Leo Joseph[5] and Robert Heinsohn[1]

nature climate change PERSPECTIVE
PUBLISHED ONLINE: 16 OCTOBER 2011 | DOI: 10.1038/NCLIMATE1259

Shrinking body size as an ecological response to climate change

Jennifer A. Sheridan* and David Bickford*

expected consequences – various levels



Gardner et al., 2011

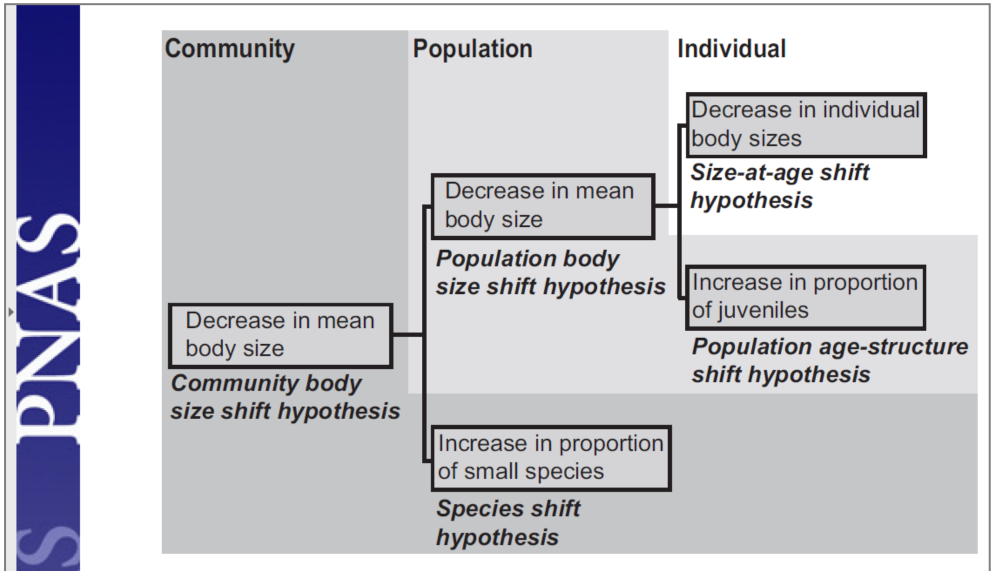
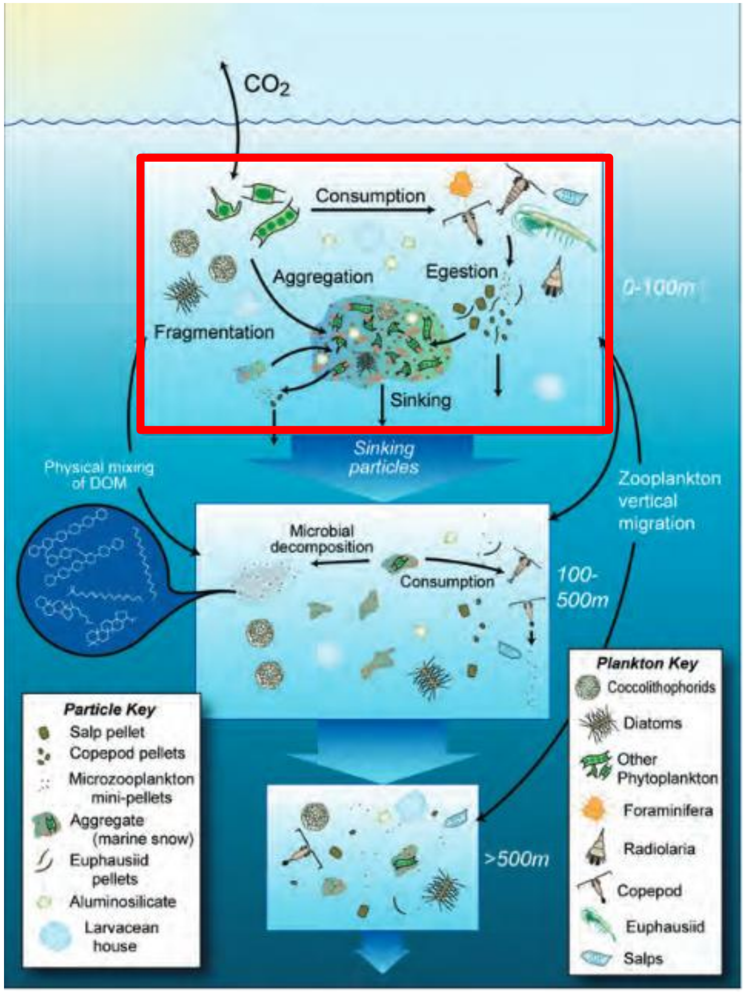


Fig. 1. The tested hypotheses regarding the impact of warming on body size at different biological scales.

Daufresne et al., 2009

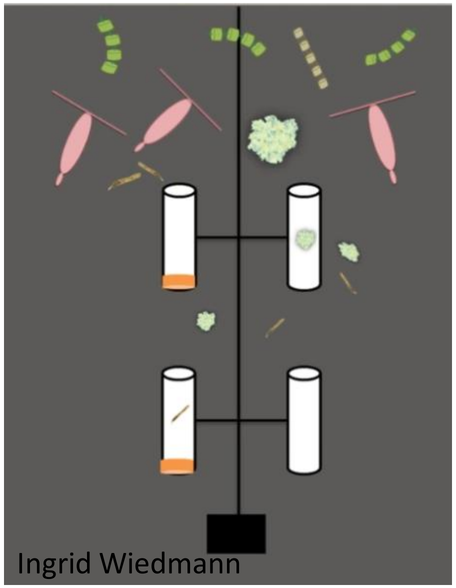
The changes within marine food webs in the Arctic have effects on the global biochemical cycles



Buesseler et al. 2007, JMR

Thus the studies of the relative roles of diverse plankton size fractions are now highly desirable

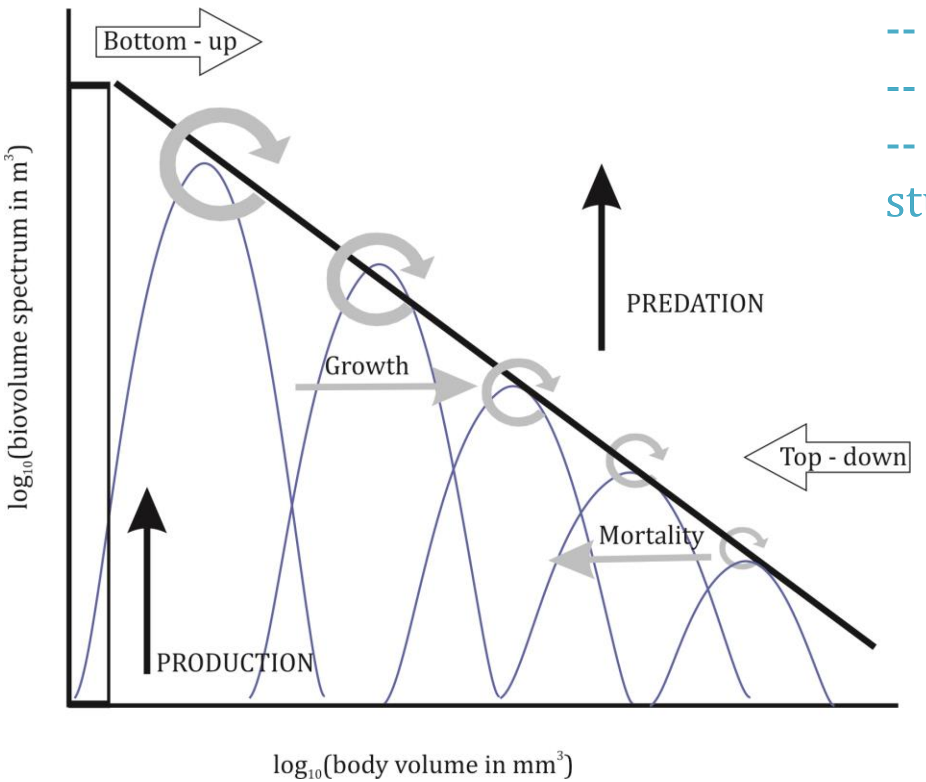
sediment traps



bottles

nets

Normalized Biomass Size Spectrum



Alternative approach to
-- taxonomic
-- production
-- trophic
-- response to perturbations
studies of pelagic ecosystems

High resolution -- automatic -- simultaneous measurements of size structure & CTD & chlorophyll fluorescence

LISST

Laser In Situ Scattering and Transmissometry

1 – 250 µm

LOPC

Laser Optical Plankton Counter

100 µm – 3.5 cm

Latitudinal and vertical gradients in structure and distribution of size-fractionated plankton in the eastern Fram Strait region

Trudnowska E.; Sagan S.; Basedow S.; Zhou M.; Blachowiak-Samolyk K.

Objective:

Size structure of particles and plankton

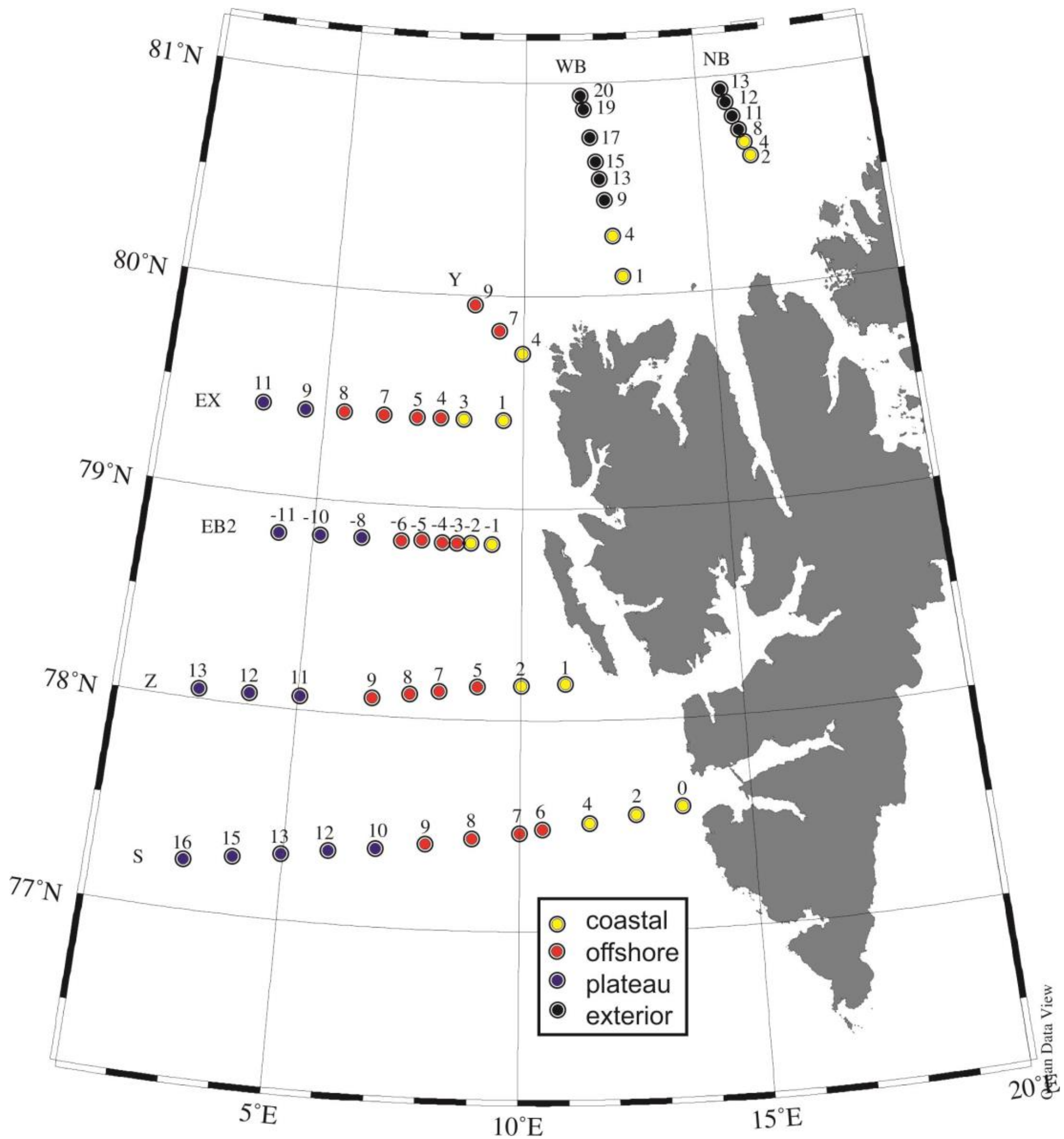
as a function of a few size metrics

analyzed along diverse gradients:

- environmental : water masses & chlorophyll
- spatial : latitudinal & regional & vertical

Methods: data collection

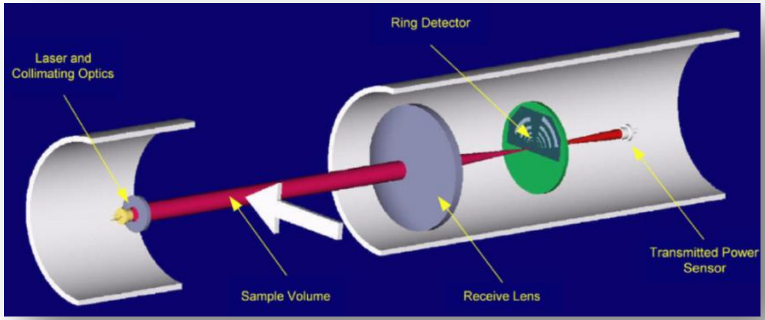
mid July 2013
RV *Oceania*
55 stations
7 sections
upper 100 m



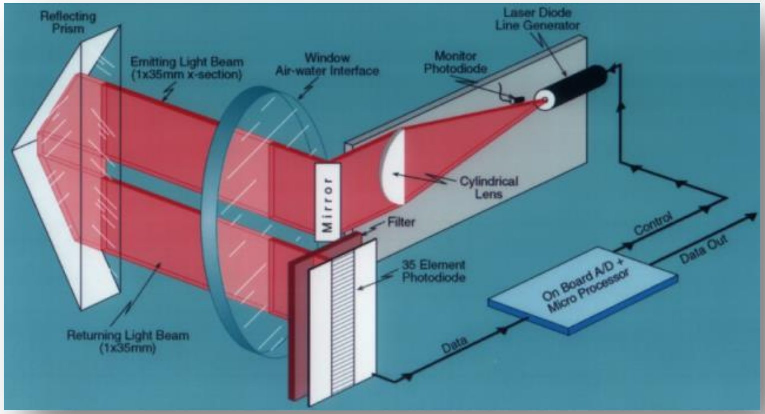
E. Trudnowska, IOPAS Poland

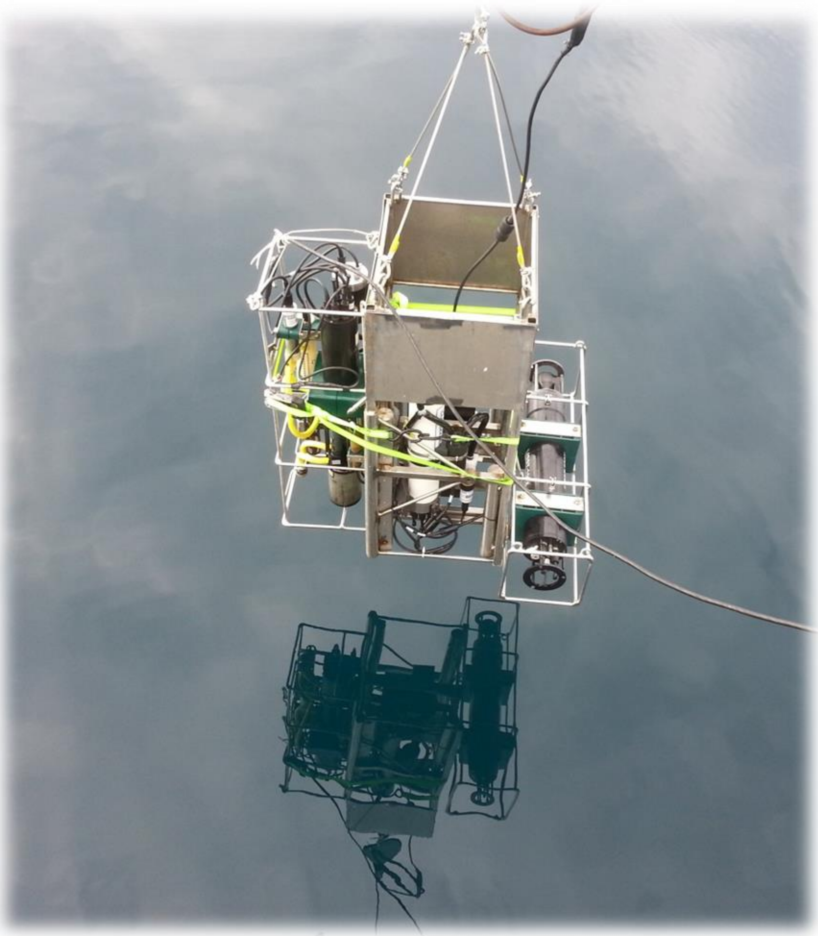
Methods: Instrumentation

LISST (1 – 250 µm) : sizes & volume (µL/L)



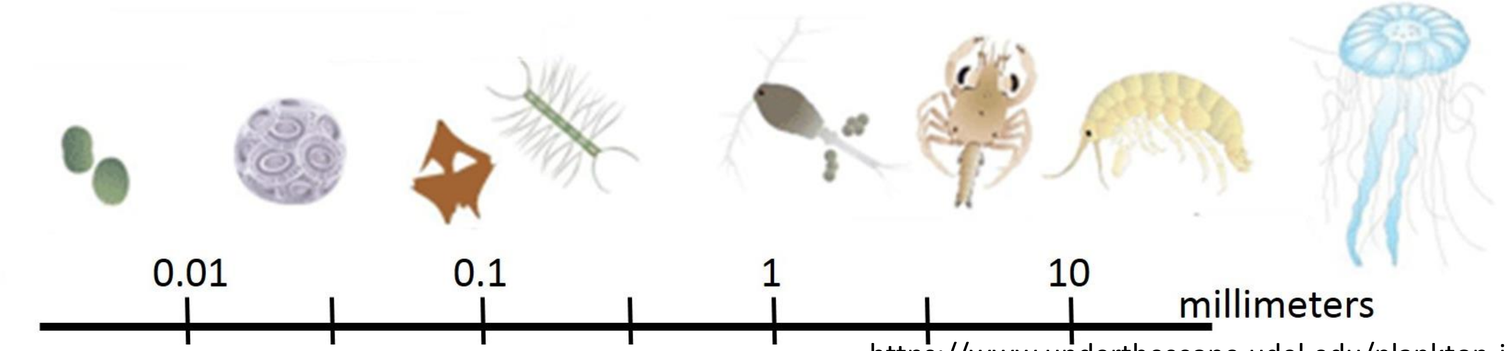
LOPC (100 µm – 3.5 cm) : sizes & counts (µm/m^3)





Coductivity – Temperature – Depth sensor
Fluorometer

Methods: size classification & size metrics

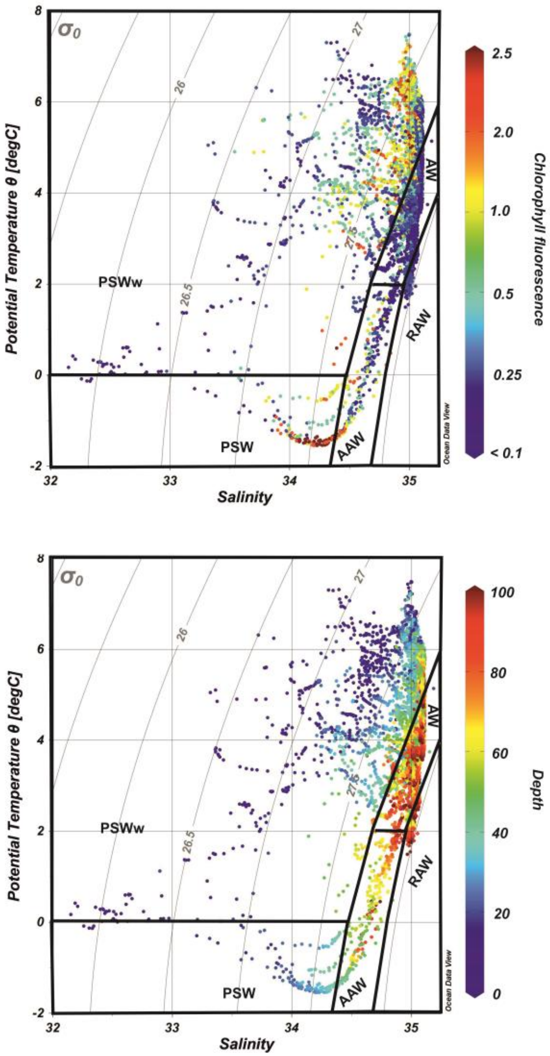


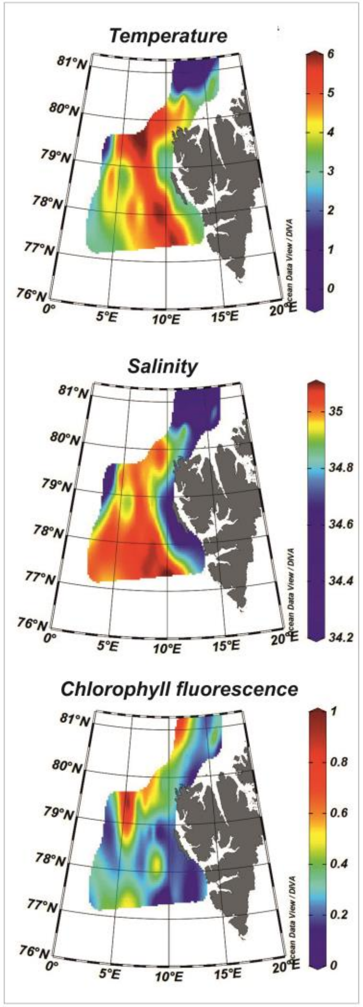
https://www.underthescope.udel.edu/plankton-information

nano-	3 – 20 µm ESD
micro-	20 – 200 µm ESD
small meso-	200 – 500 µm ESD
large meso-	500 – 5 000 µm ESD

- NBSS : slope & intercept
- TTE: trophic transfer efficiency
  (meso- / nano- + micro-)
- Mean size
- Size diversity

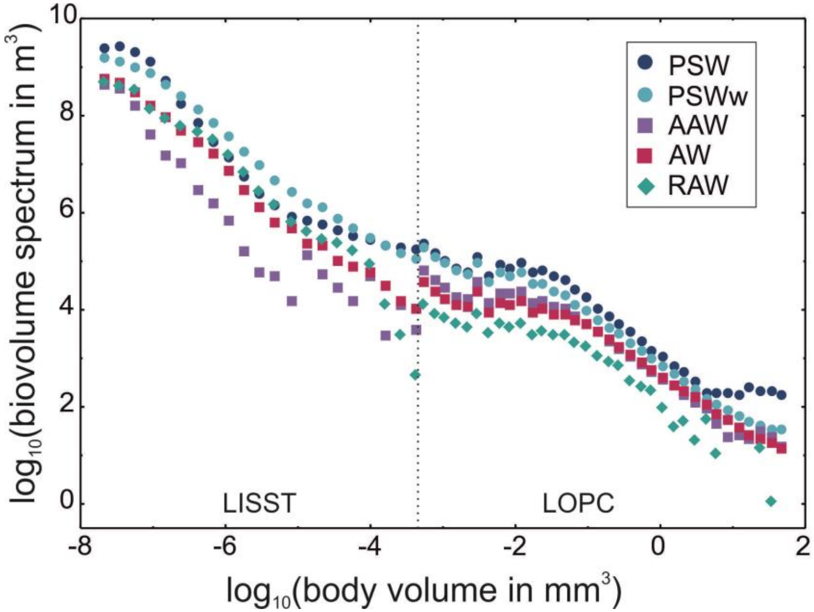
Results -- the environment – water masses & chlorophyll

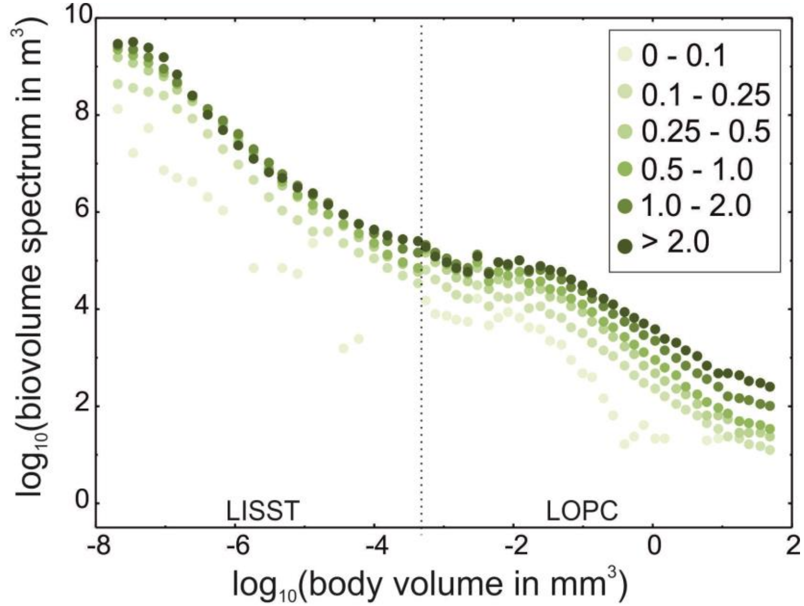




E. Trudnowska, IOPAS Poland

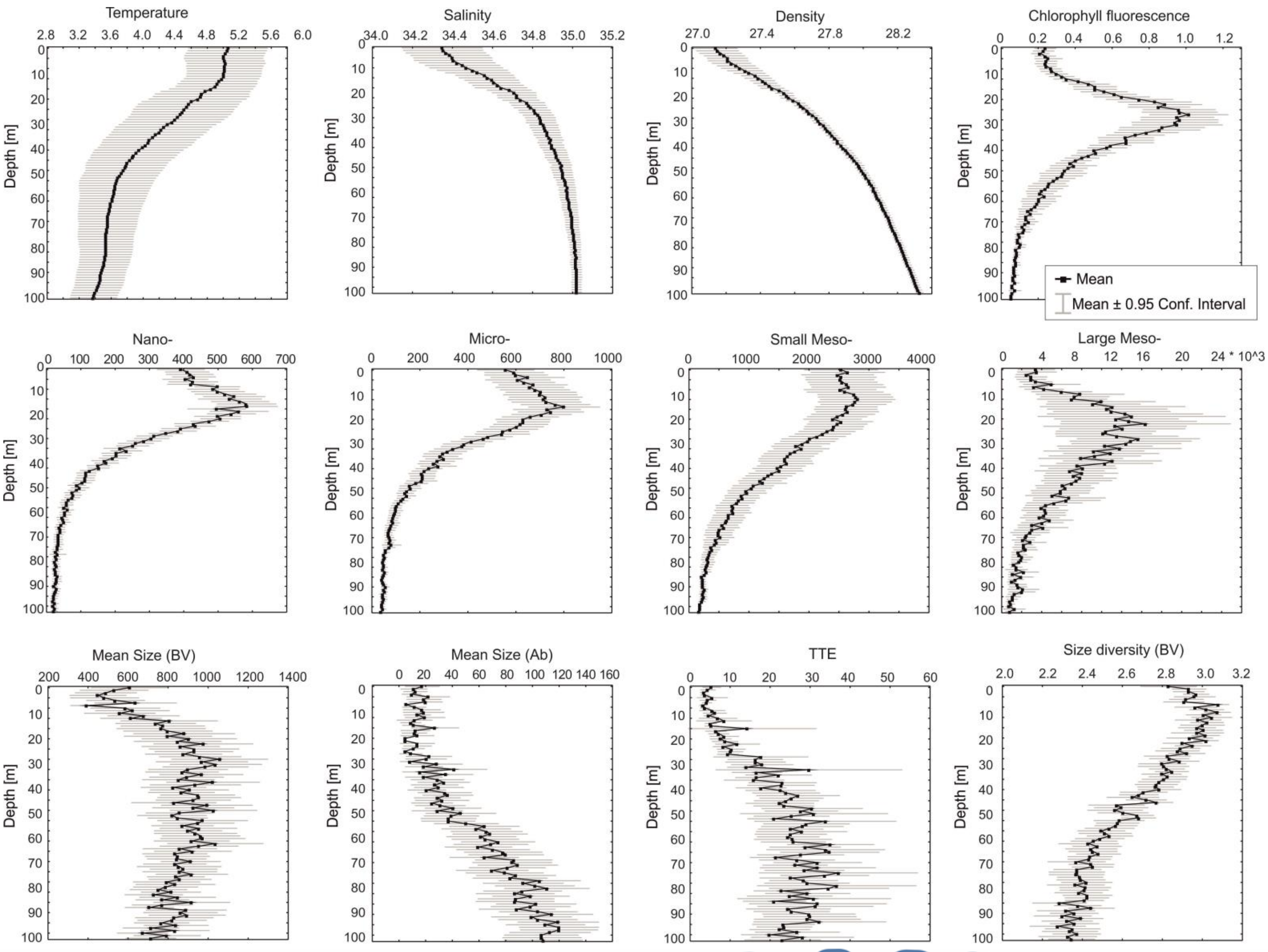
Results -- size metrics -- environment





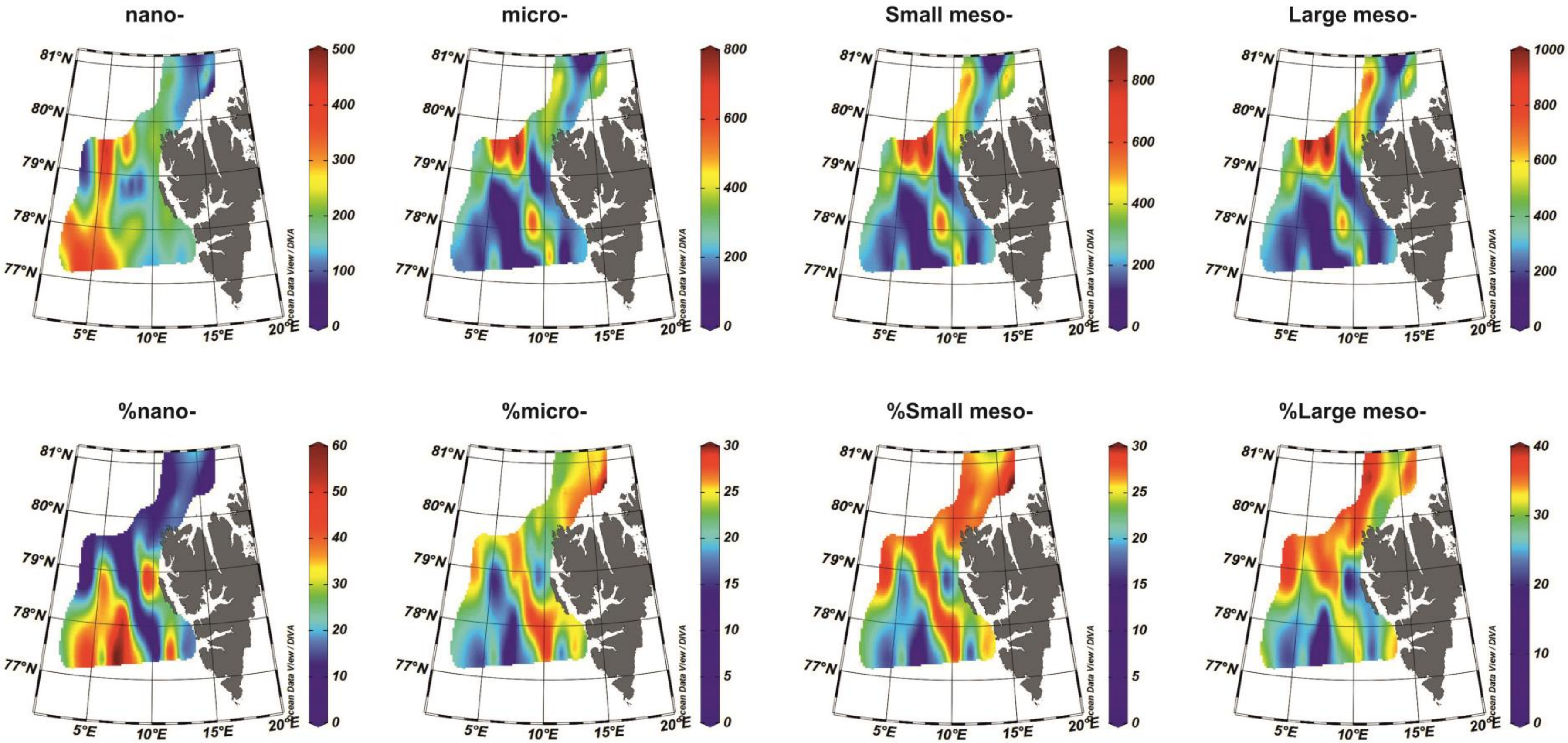
		slope	Intercept	TTE	MS (BV)	MS (Ab)	H'
Water Mass	PSW	-0.72	3.13	19.81	1 424	13	2.61
	PSWw	-0.80	2.83	10.09	732	31	2.67
	AAW	-0.63	2.51	17.21	820	130	2.38
	AW	-0.73	2.47	21.03	881	70	2.45
	RAW	-0.84	1.83	12.23	694	51	2.04
Chlorophyll fluorescence	0-0.1	-0.83	0.76	12.95	738	86	2.29
	0.1-0.25	-0.78	2.38	18.14	826	56	2.50
	0.25-0.5	-0.80	2.69	14.93	796	21	2.69
	0.5-1.0	-0.78	2.88	16.27	845	18	2.77
	1.0-2.0	-0.74	3.22	25.72	1 220	11	2.90
	>2.0	-0.69	3.45	41.41	1 812	20	2.90

Results: vertical variability



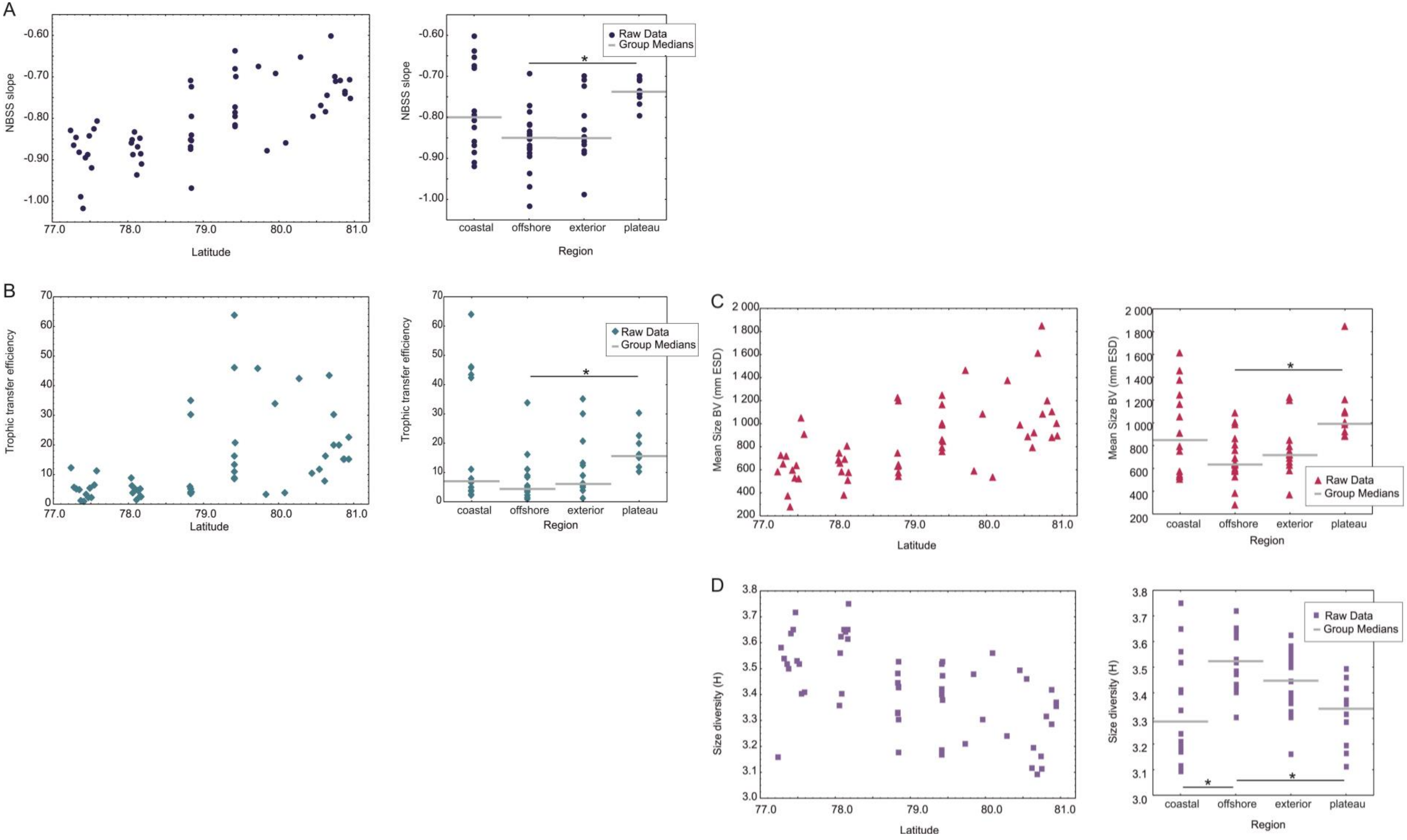
E. Trudnowska, IOPAS Poland

Results: horizontal distribution



E. Trudnowska, IOPAS Poland

Results: horizontal variability

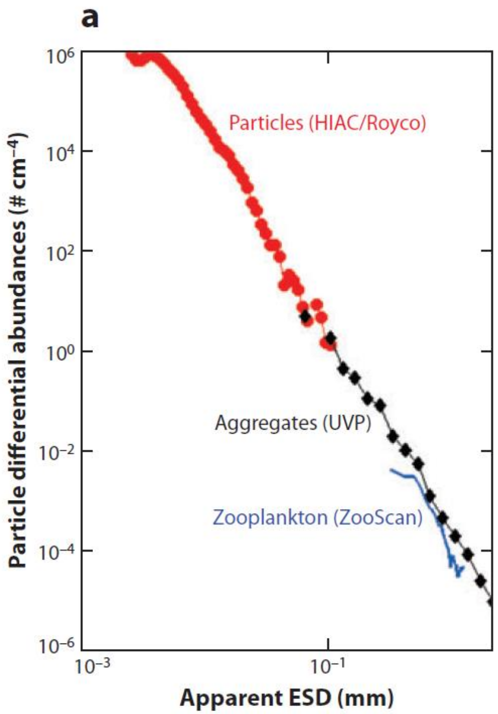


E. Trudnowska, IOPAS Poland

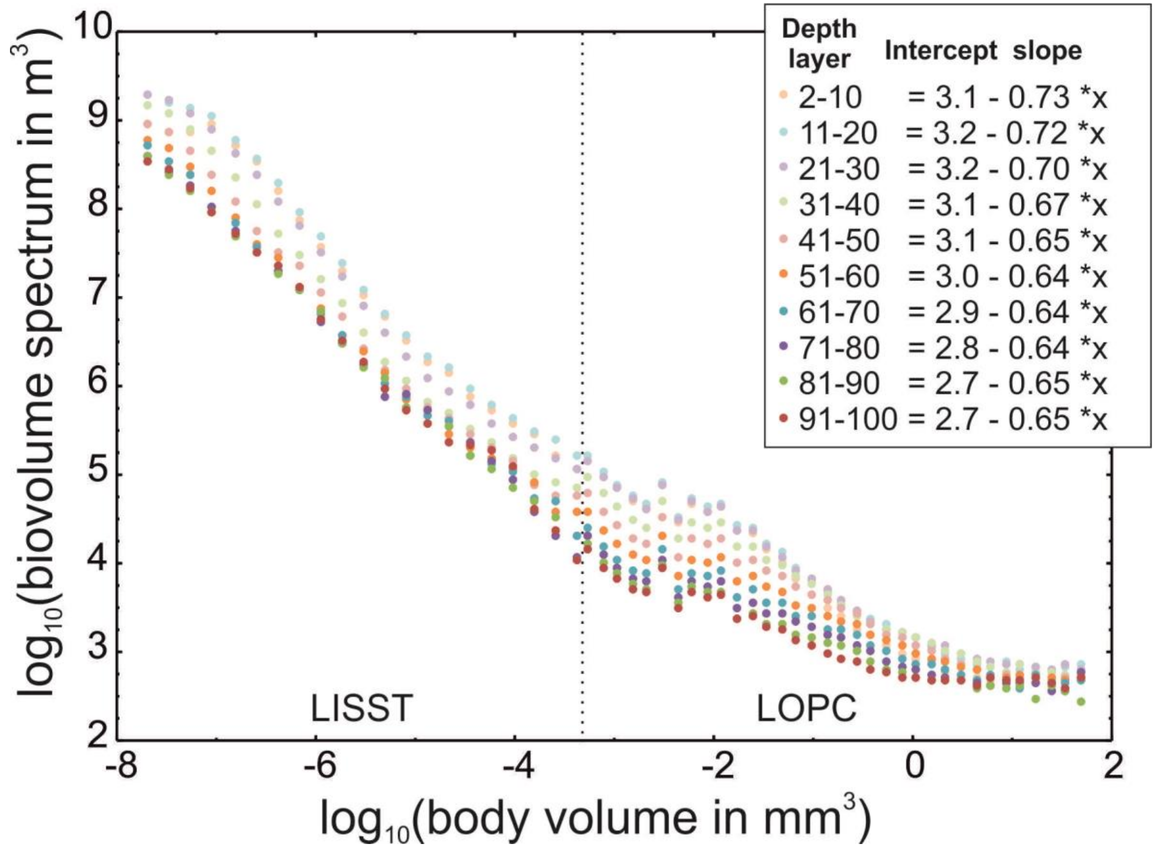
summary

- the spatial gradients (vertical and latitudinal) were more significant in terms of the variability in the size structure of P&P than the environmental gradients (chlorophyll fluorescence, water masses)
- although Polar-origin waters were more productive and contained bigger organisms than Atlantic-origin waters, the trophic interactions were similar among all different types of water masses
- small and diverse organisms in the uppermost layers were separated from bigger organisms below that effectively utilized the phytoplankton standing stocks.
- the importance of the nano- fraction was higher at exterior and coastal locations compared to the offshore and plateau stations.
- a positive trend of most of the P&P size metrics (NBSS slope, mean size, ratio between mesozooplankton fraction to nano- and micro- fractions) towards northern locations reflect the changes in P&P size structure along the pathway of AW passage to the Arctic Ocean.

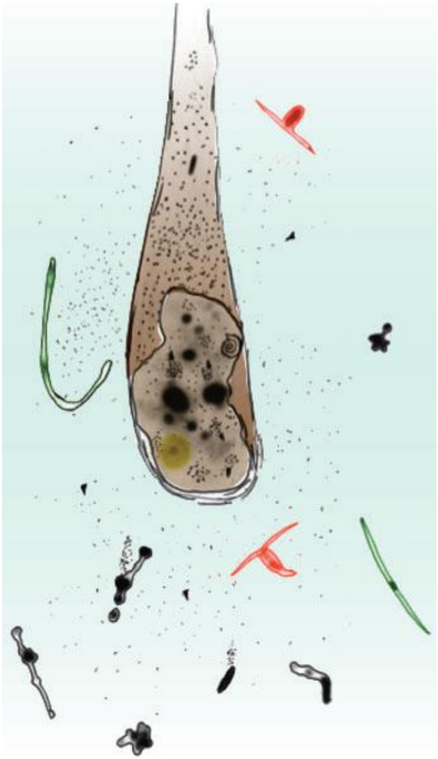
Discussion: methodological challange

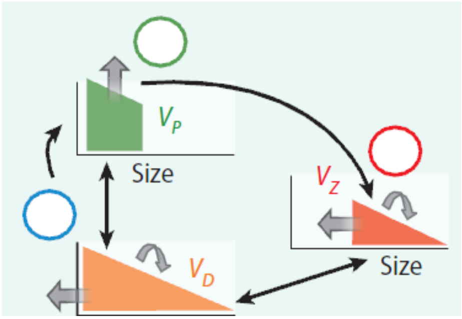


Stemmann & Boss, 2012

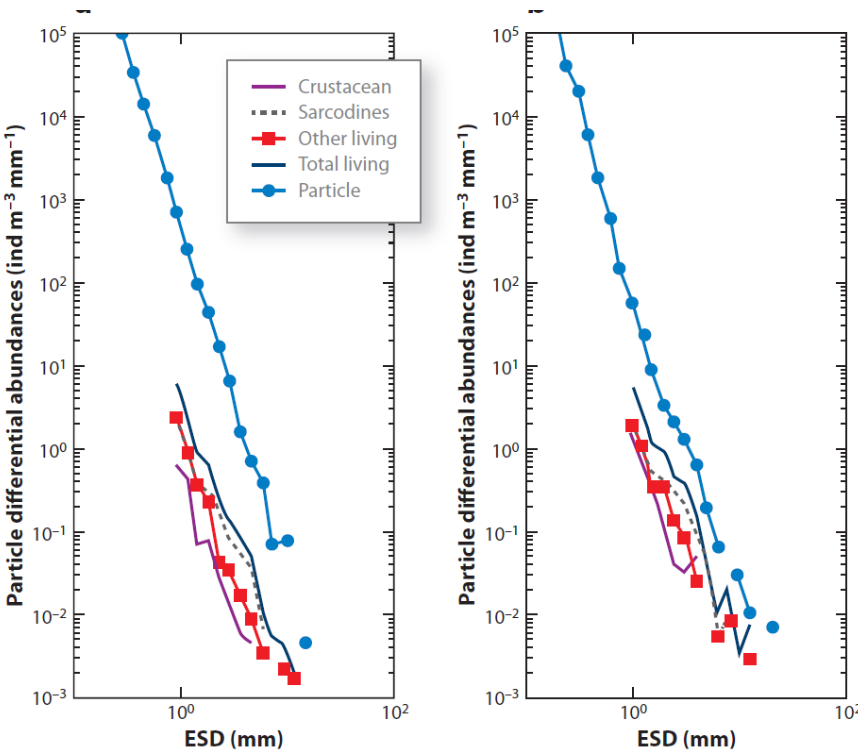


Discussion: diverse players



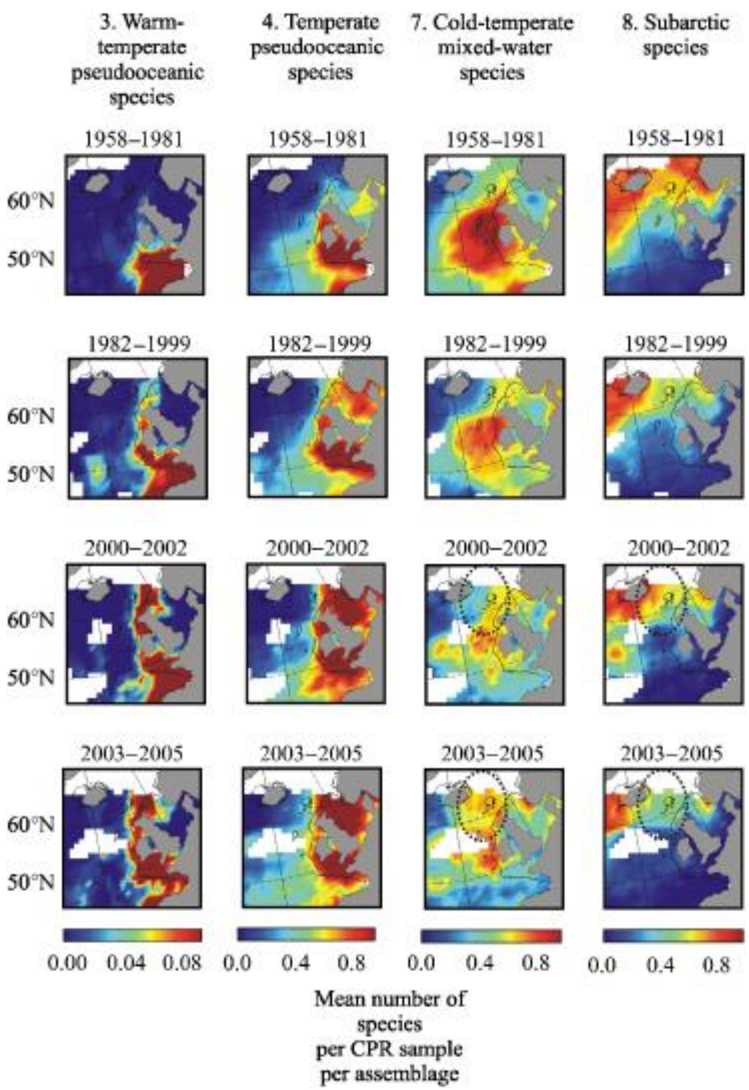


Volume spectrum of
Vp – phytoplankton
Vz - zooplankton
Vd - detritus

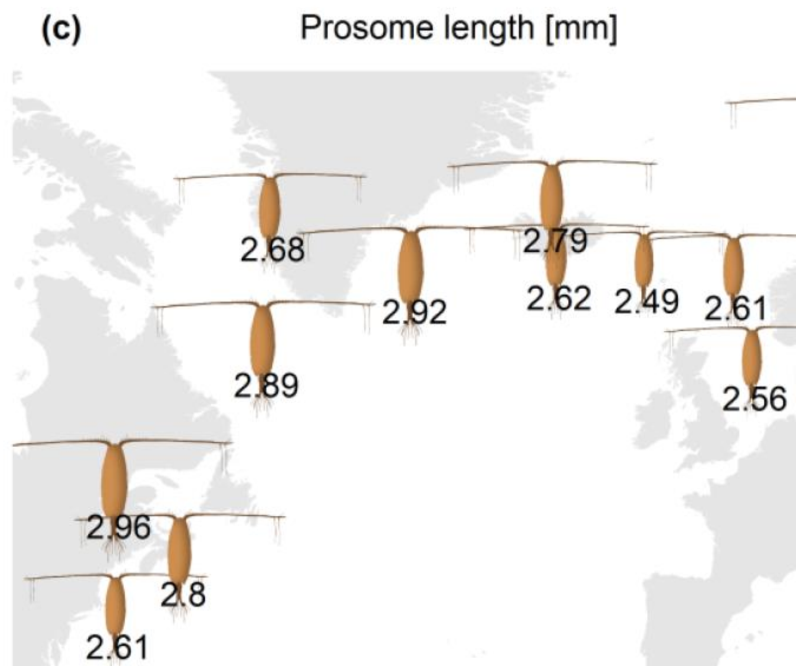


Stemmann & Boss, 2012

Discussion: species exchange & individual size response

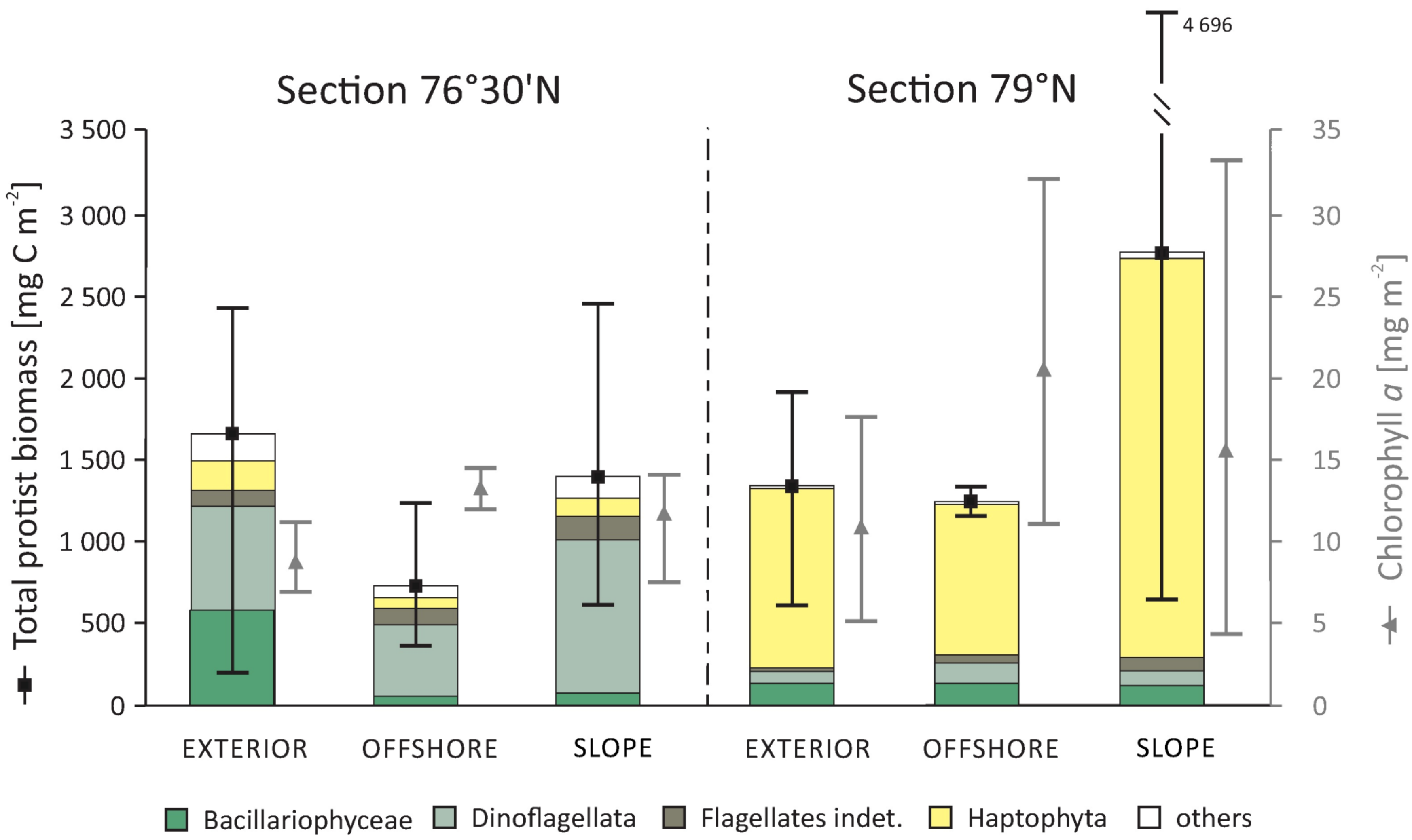


Beaugrand et al., Global Change Biology 2009



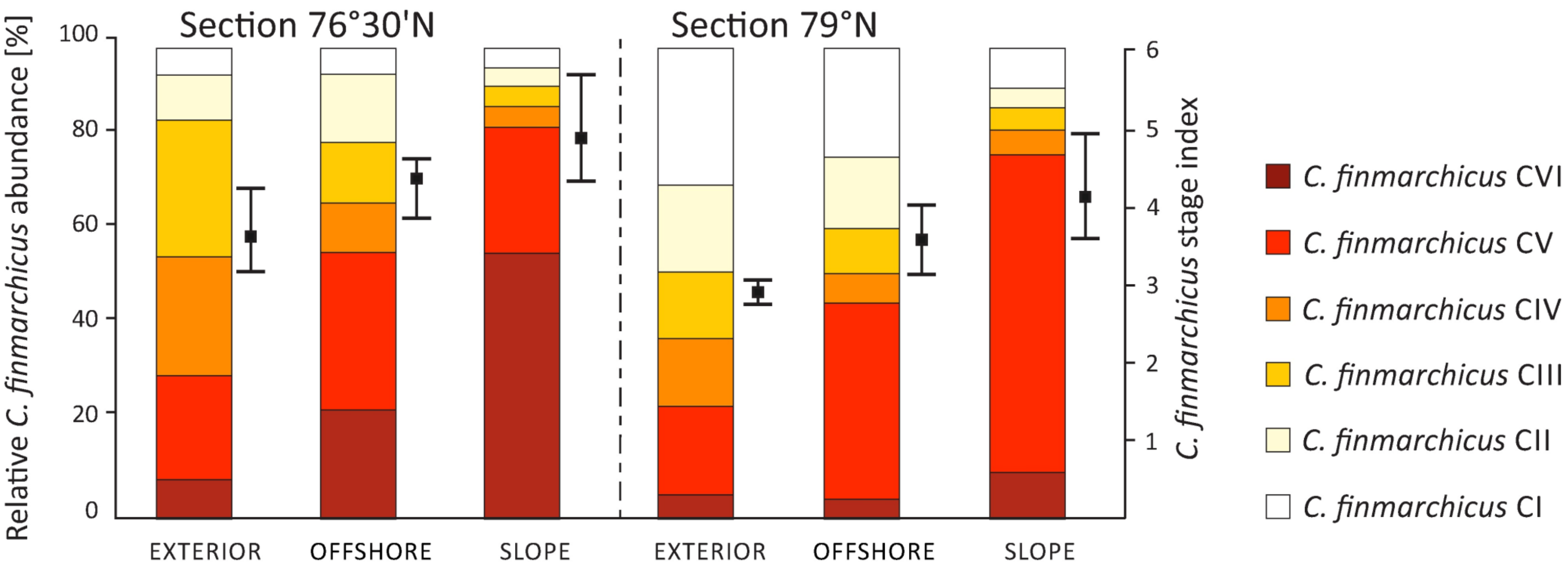
Brun et al., Earth Syst. Sci. Data Discuss 2016

Discussion: horizontal variability of protists



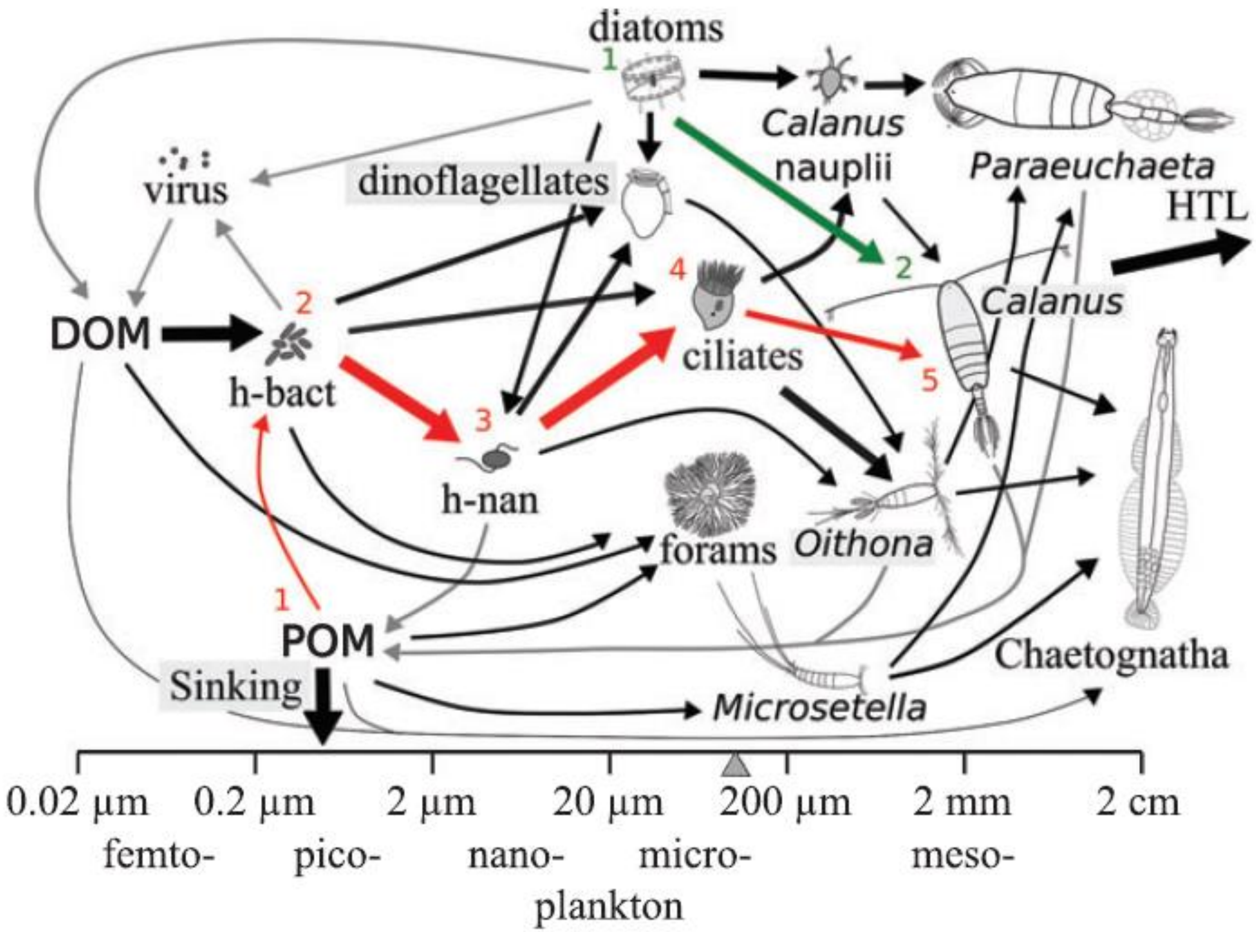
Gluchowska et al., PlosONe, accepted

Discussion: not only differences in taxa, but also in succession & ontogeny



Gluchowska et al., PlosONe, accepted

Discussion: trophic consequences



Basedow et al., 2016 JPR

DWARF
norway grants
Narodowe Centrum Badań i Rozwoju
Polish-Norwegian Research Programme
NATIONAL SCIENCE CENTRE
POLAND

Latitudinal and vertical gradients in structure and distribution of size-fractionated plankton in the eastern Fram Strait region

Trudnowska Emilia
Sagan Slawomir
Basedow Sünnje
Zhou Meng
Blachowiak-Samolyk Katarzyna