



"This project is funded from Norway Grants in the Polish-Norwegian Research Programme operated by the National Centre for Research and Development"



Benthic Biomass Size Spectra

- a tool to identify biotic response to environmental change in the Arctic?

Maria Włodarska-Kowalczyk
Barbara Górską
Mikołaj Mazurkiewicz

INSTITUTE OF OCEANOLOGY
POLISH ACADEMY OF SCIENCES
Sopot, Poland



DWARF

Declining size - a general response to climate warming in Arctic fauna?



Toyama, 28.04.2015

SIZE matters!

'SIZE is a supreme regulator of all biological matters' – Bonner, 2006 – determines rates of an **organism basic processes (metabolism, generation time, longevity, locomotion speed, ...)**

SIZE structure in **communities and populations shapes ecosystem functioning (e.g. energy flows in food-webs, ...)**

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, Trimmer and Guy Woodward

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

SCIENTIFIC REPORTS



OPEN

Size matters: implications of the loss of large individuals for ecosystem function

SUBJECT AREAS:
BIOGEOCHEMISTRY
COMMUNITY ECOLOGY
BIODIVERSITY
ECOSYSTEM ECOLOGY

Alf Norkko^{1,2}, Anna Villnäs¹, Joanna Norkko¹, Sebastian Valanko^{1,2} & Conrad Pilditch³

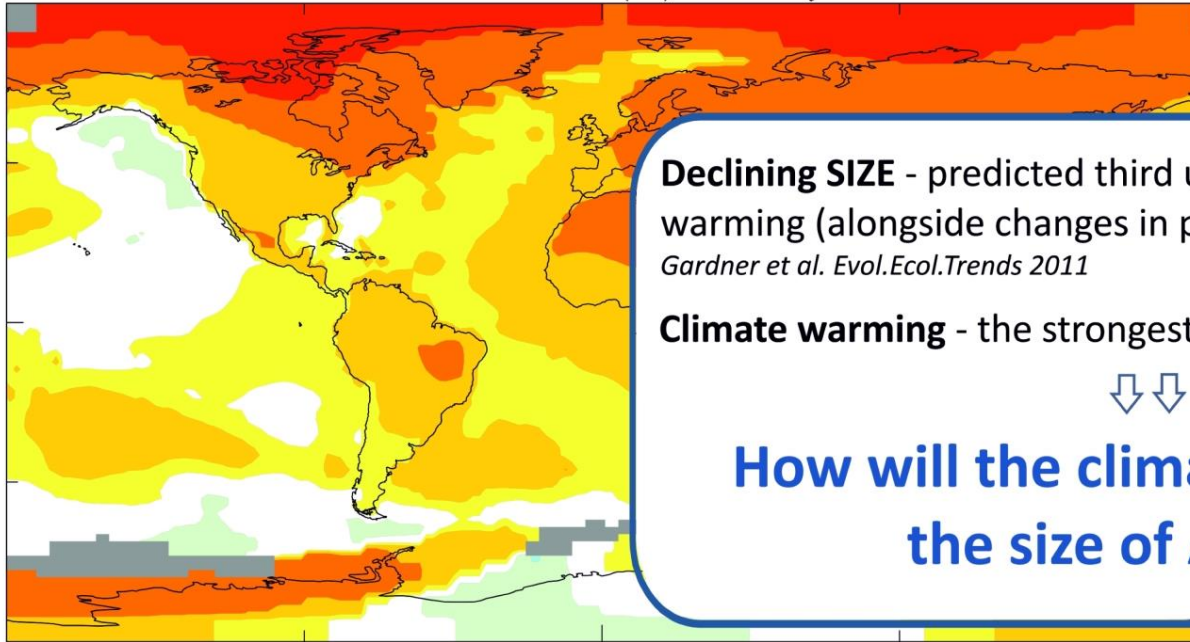
¹Tvärminne Zoological Station, University of Helsinki, FI-10900 Hanko, Finland, ²Marine Research Centre, Finnish Environment Institute, PO Box 140, FI00251 Helsinki, Finland, ³Department of Biological Science, University of Waikato, Private Bag 3105, Hamilton, New Zealand.



Annual J-D 2006-2012

L-OTI(°C) Anomaly vs 1951-1980

0.58



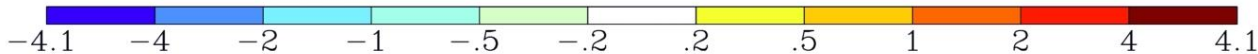
Declining SIZE - predicted third universal response to climate warming (alongside changes in phenology and species distributions)

Gardner et al. Evol.Ecol.Trends 2011

Climate warming - the strongest effects in **Arctic regions**



How will the climate warming affect the size of Arctic biota?



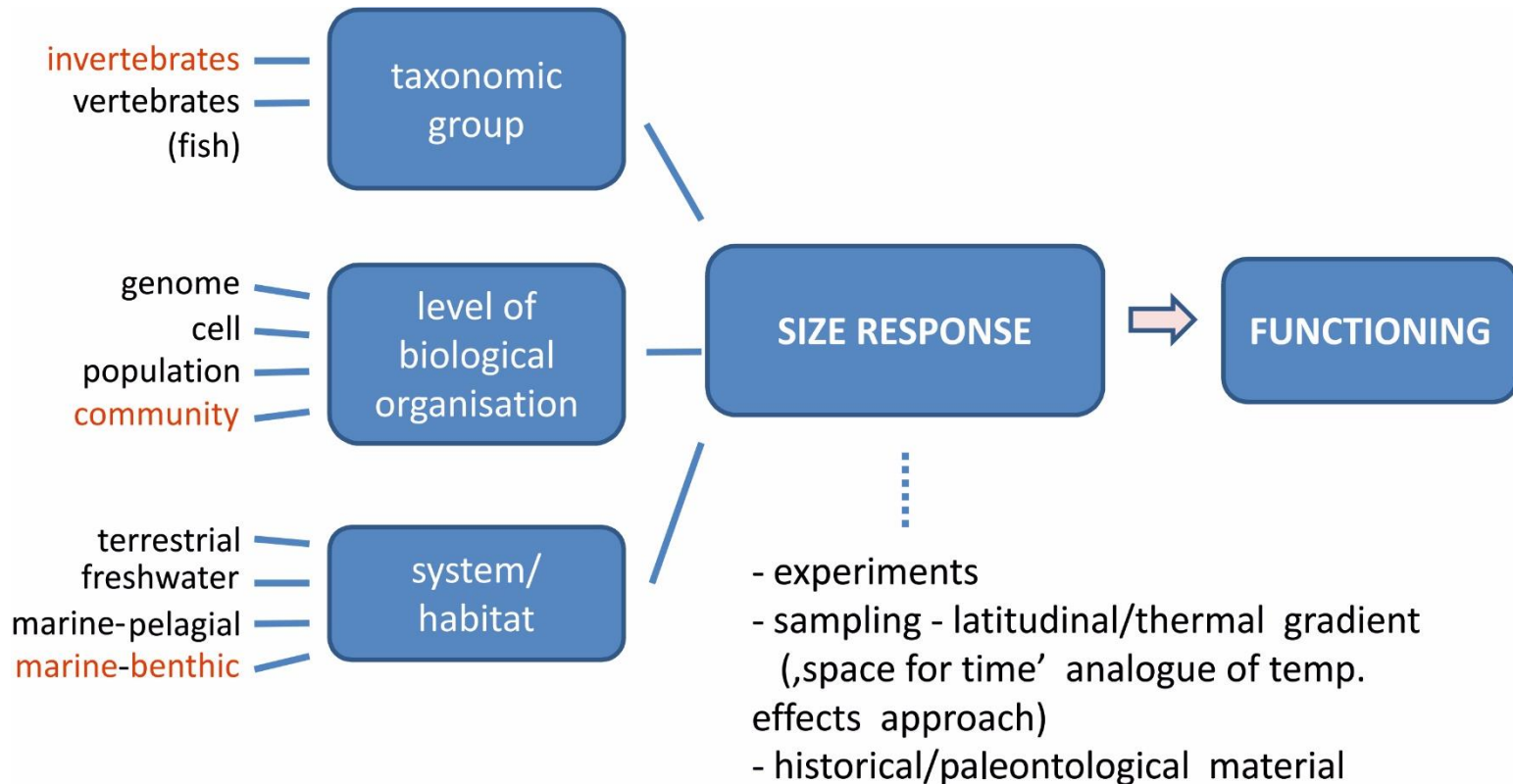
Average surface temperatures from 2006-2012 compared to a base period of 1951-1980.

courtesy of **NASA Goddard Institute for Space Studies**

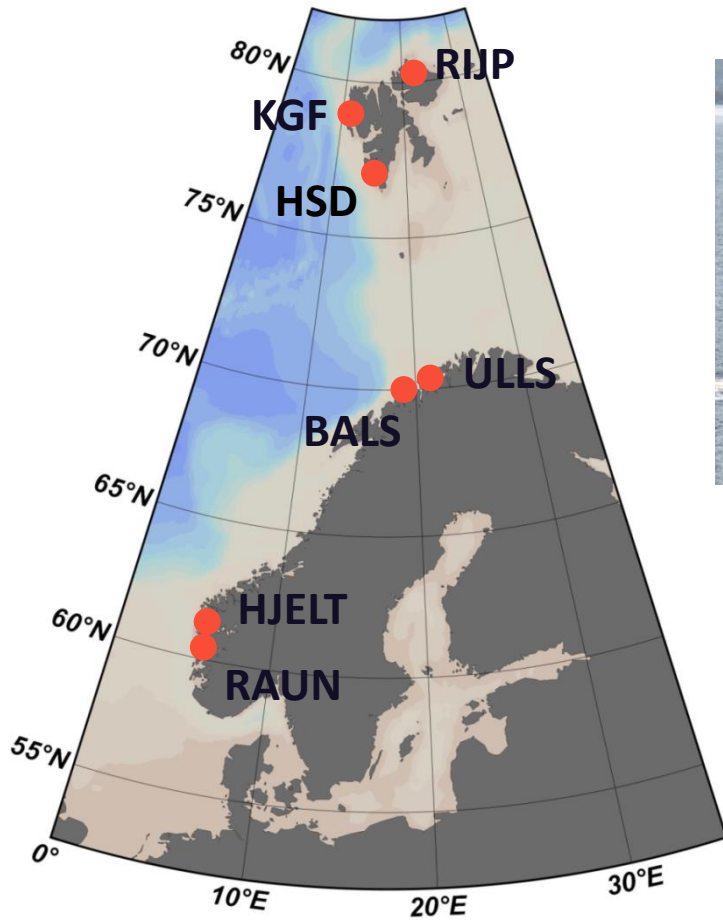


Declining size – a general response to climate warming in Arctic fauna? (DWARF)

Hypothesis: elevated temperatures will induce size reductions in large range of high latitude ectotherms



DWARF - benthic communities size structure - large scale survey 'space for time' analogue approach to study temp. effects

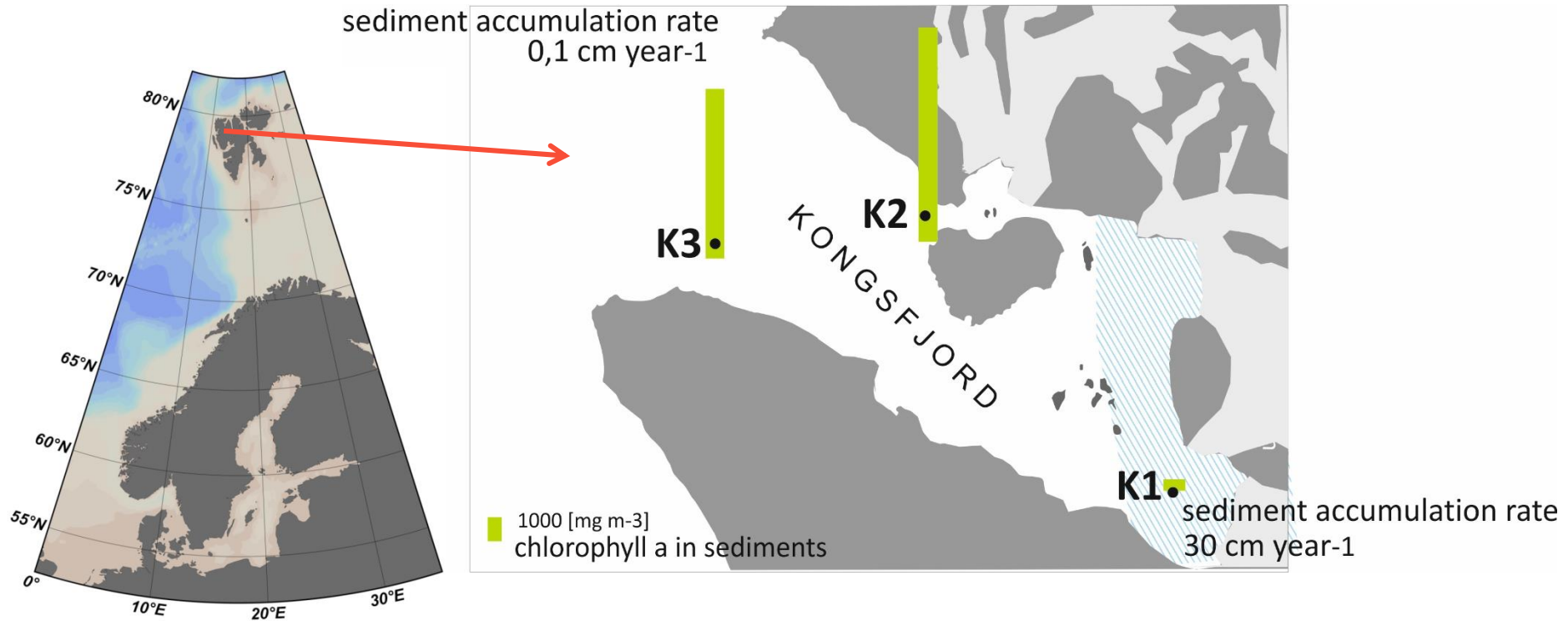


benthic communities size structure – local variability

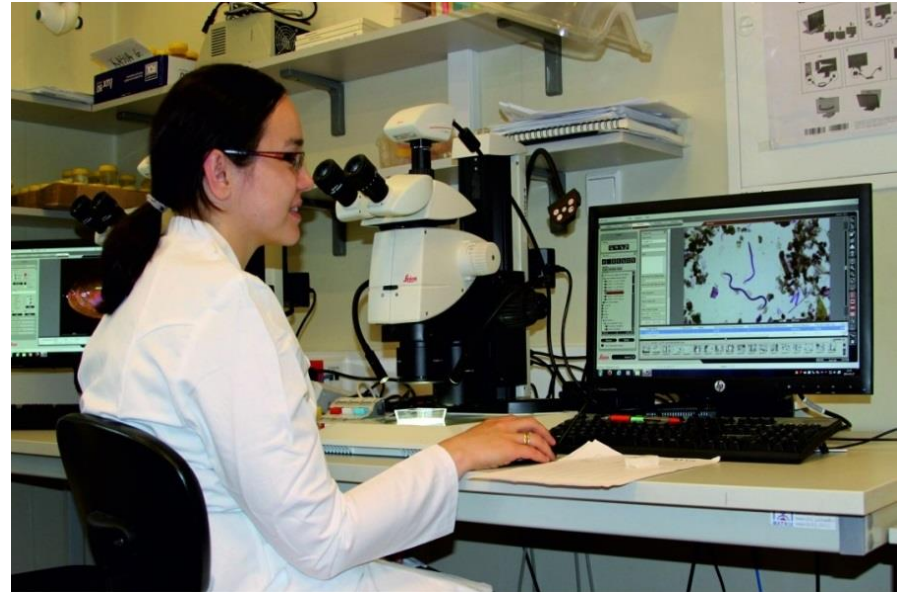
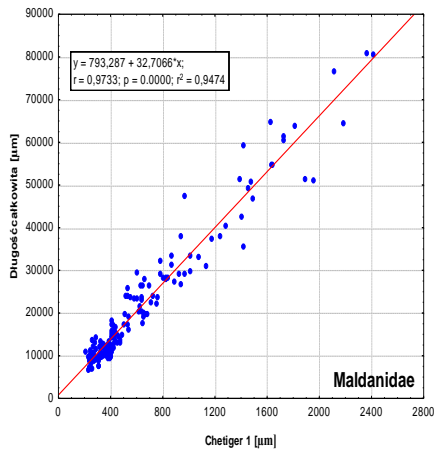
- BBSS are insensitive to differences in **grain size** or **salinity** (Duplisea & Drgas 1999, Warwick 1984, Dolbeth et al. 2014)
- no response to **organic enrichment** in salmon aquacultures (Duplisea & Hardgrave 1996), or increase of large size classes in eutrophic site (Vanreusel, 1995)
- Decline of larger organisms in response to **disturbance - anoxia** (Quiroga et al. 2005), **trawling** (Queiros et al. 2006)



local environmental variability in an Arctic glacial fjord - response in benthic size structure?



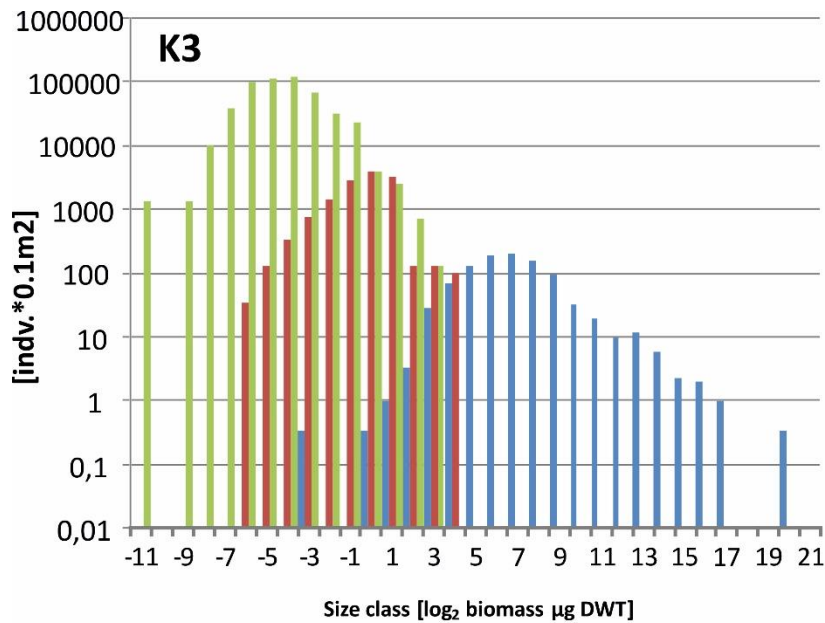
benthic biomass size spectra - methods



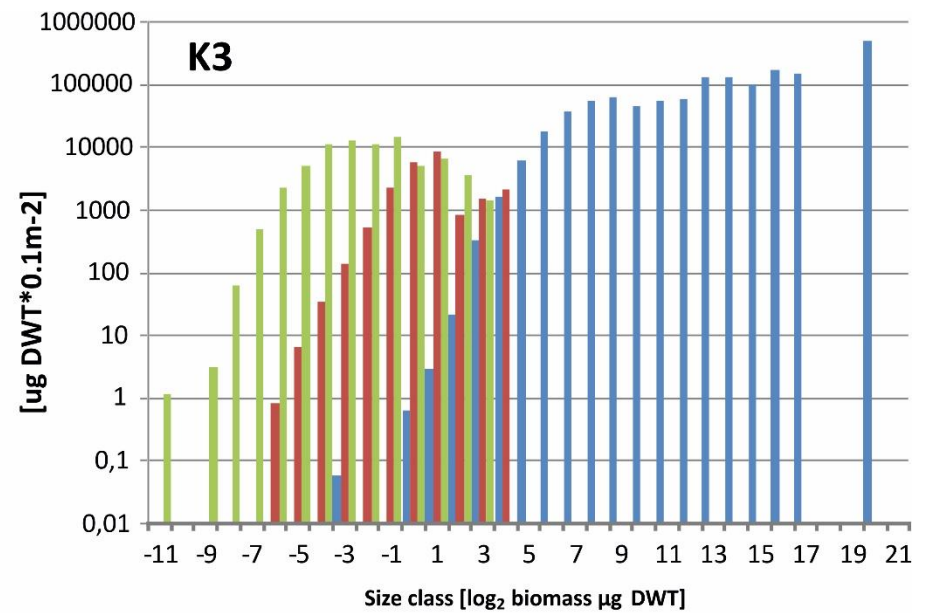
measurements of individuals
size → biovolume → biomass
Biomass Size Spectra



density size spectra



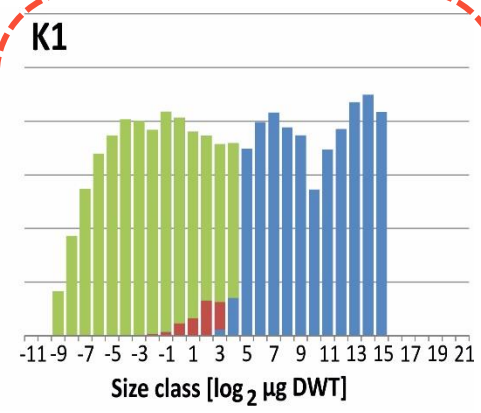
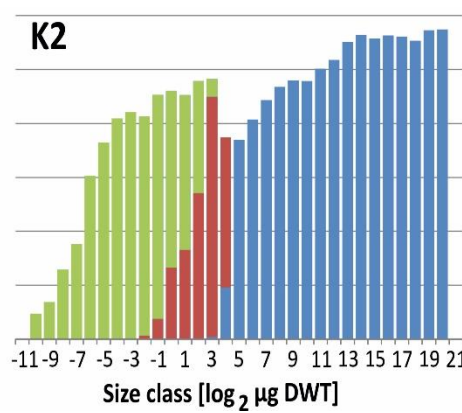
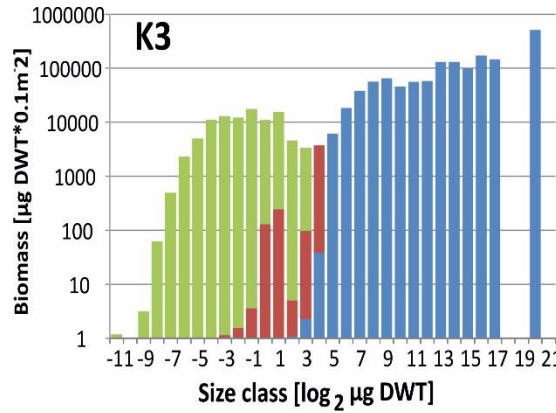
biomass size spectra



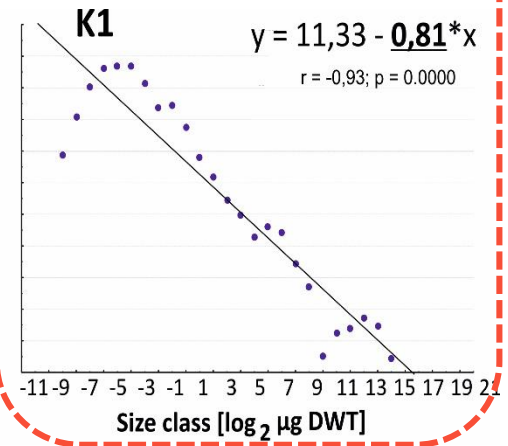
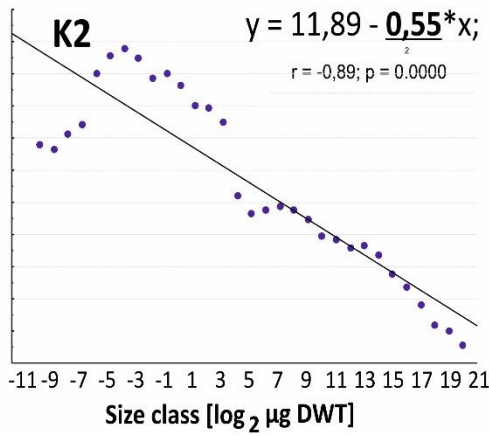
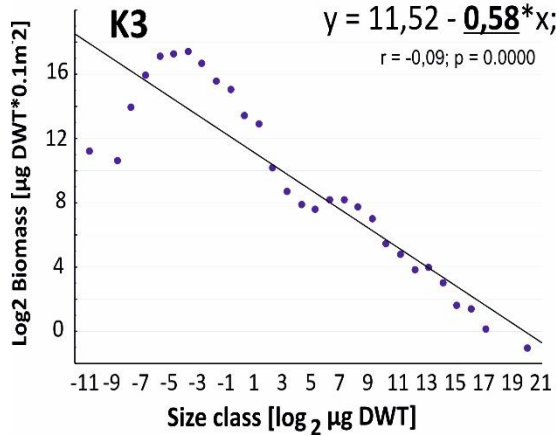
■ meiofauna ■ large Nematoda ■ macrofauna



benthic biomass size spectra



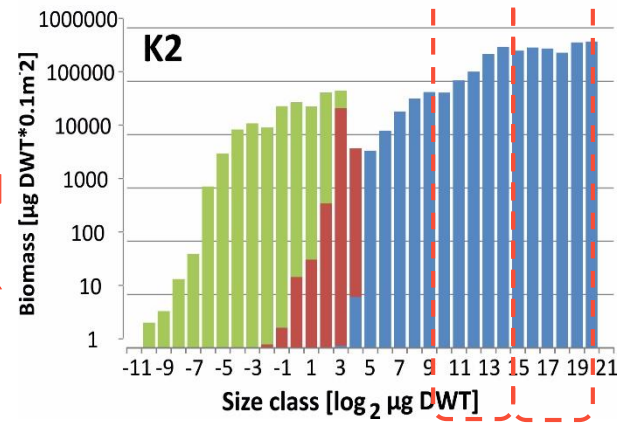
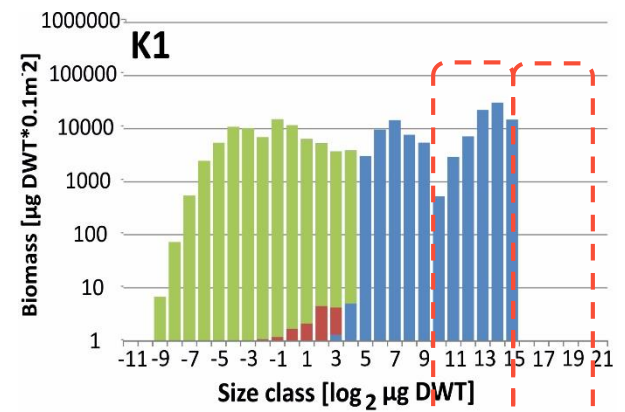
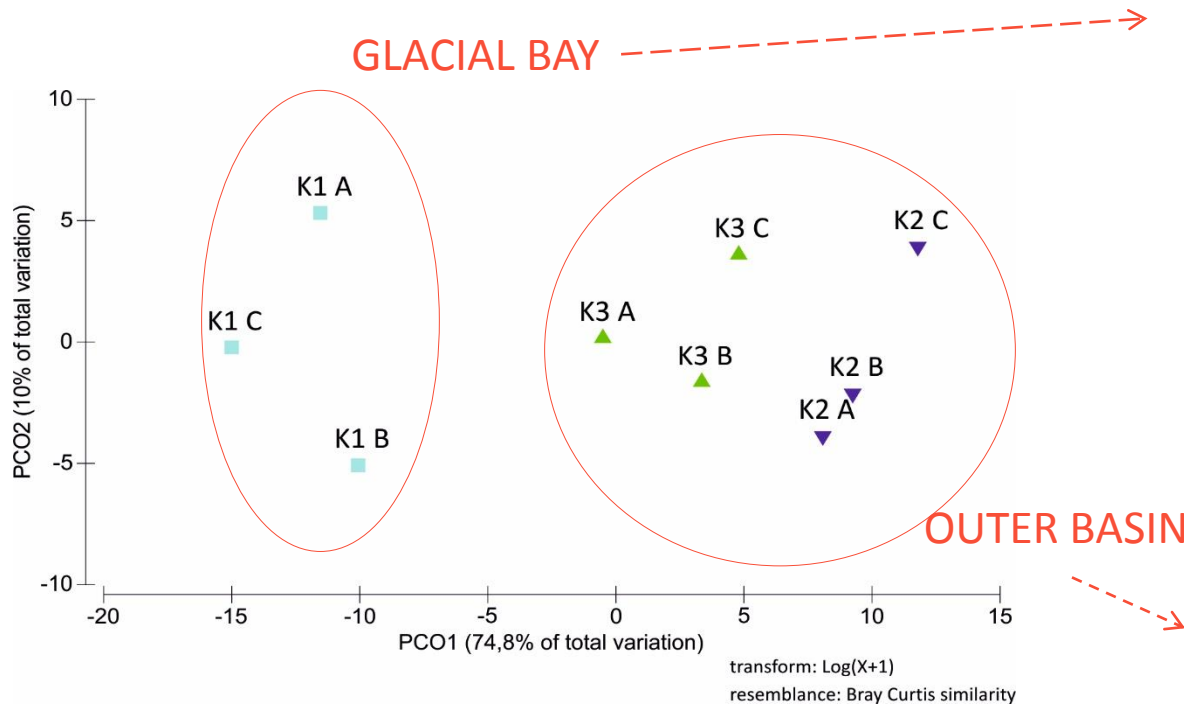
normalised BBSS



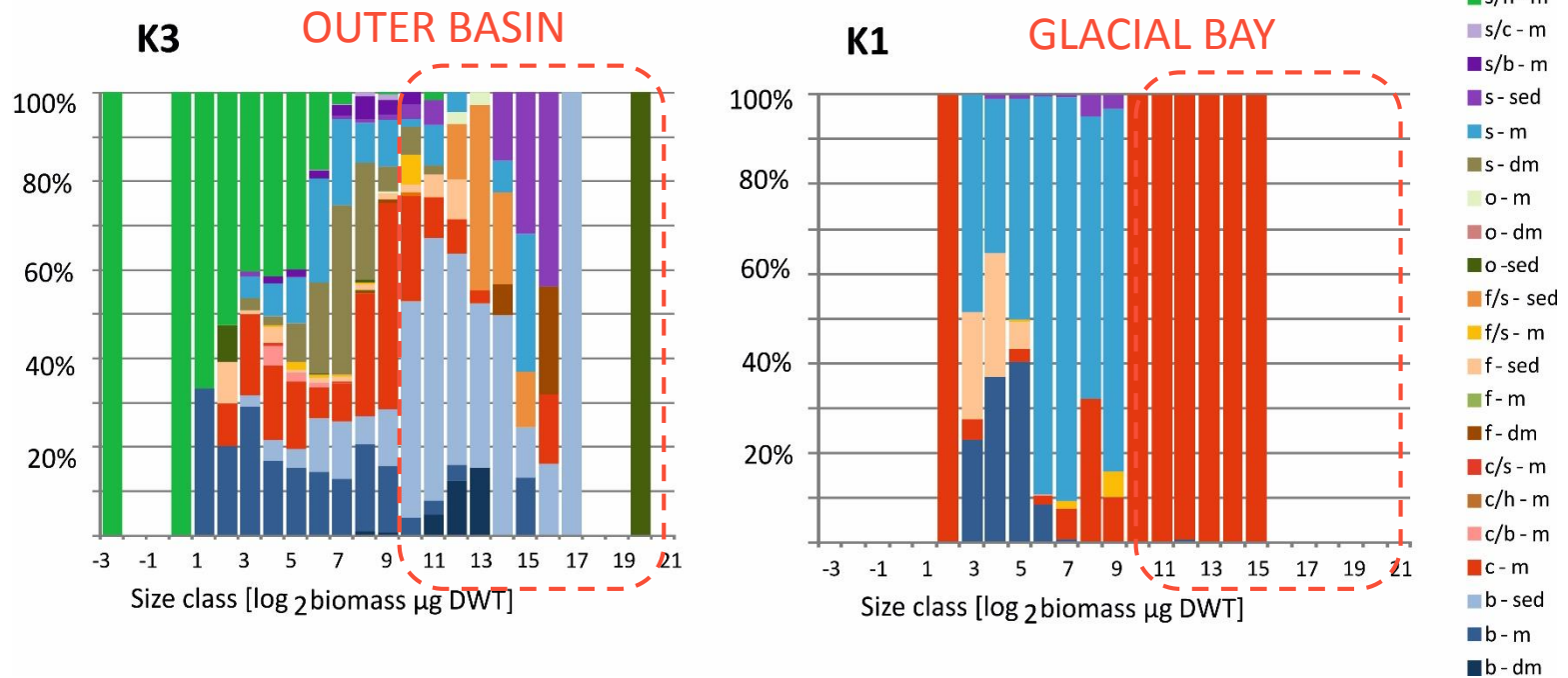
GLACIAL BAY



ordination of samples based on biomass in size classes



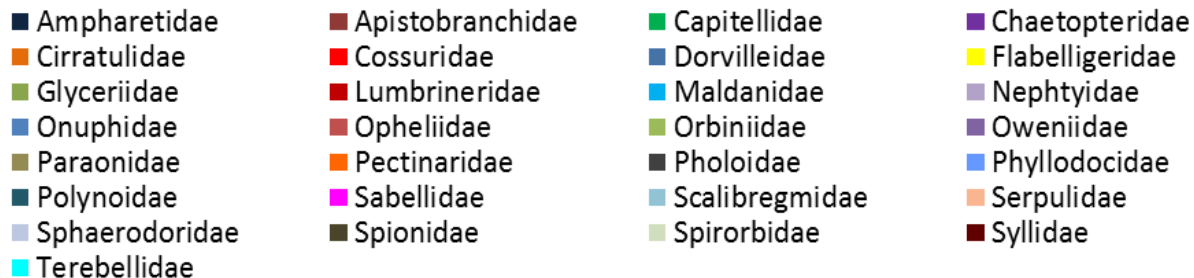
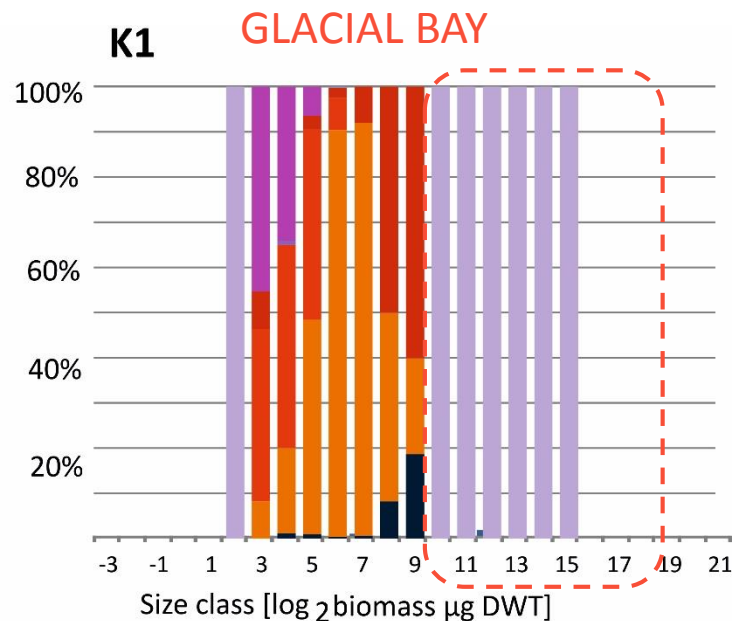
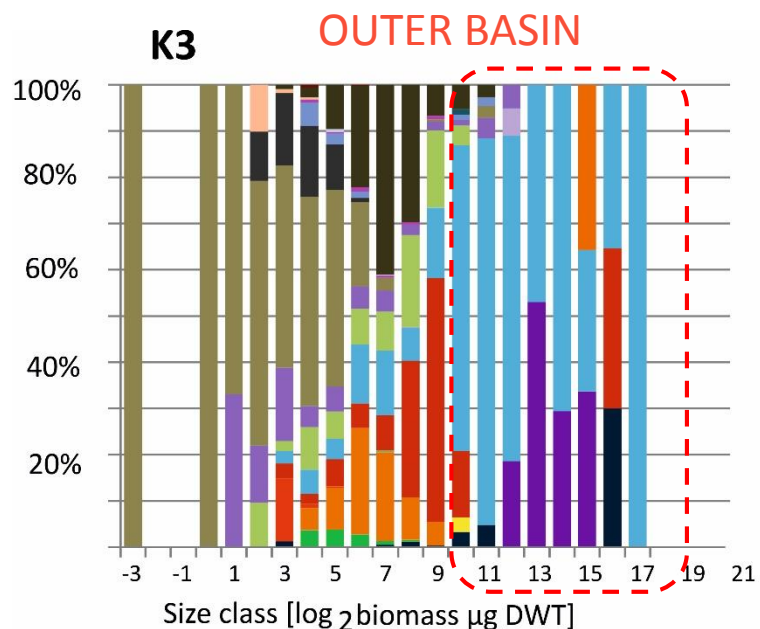
functional groups in size classes



b- subsurface deposit feeder; c – carnivorous; h – herbivorous; f – suspension feeder; o – omnivorous; s – surface deposit feeder; m – motile; dm – discretely motile; sed - sessile

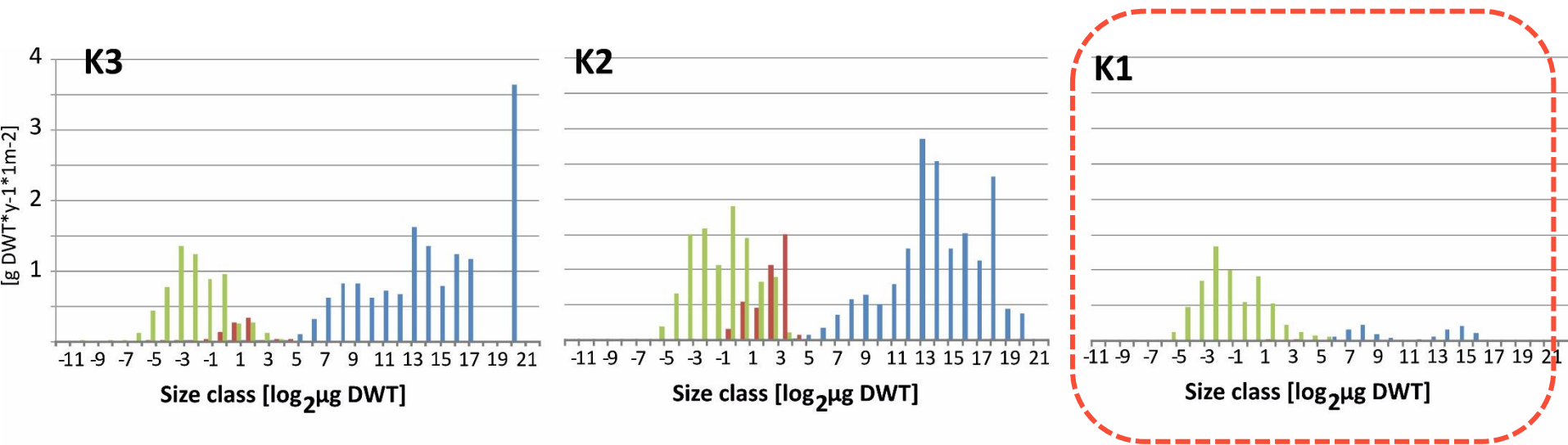


Polychaeta families in size classes



production in size classes

- meiofauna - estimated based on individual biomass (Schwingjamer et al., 1986)
- macrofauna - estimated based on individual biomass, temperature, depth, taxon, feeding & mobility type (Brey, 2012)

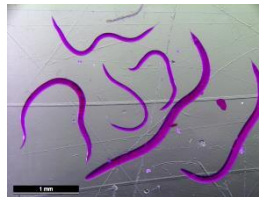


■ meiofauna

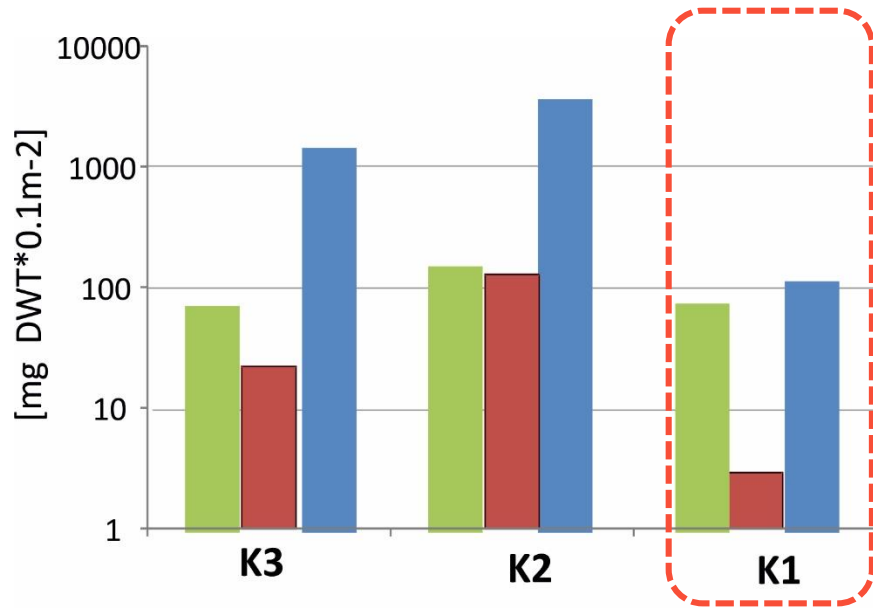
■ large Nematoda

■ macrofauna

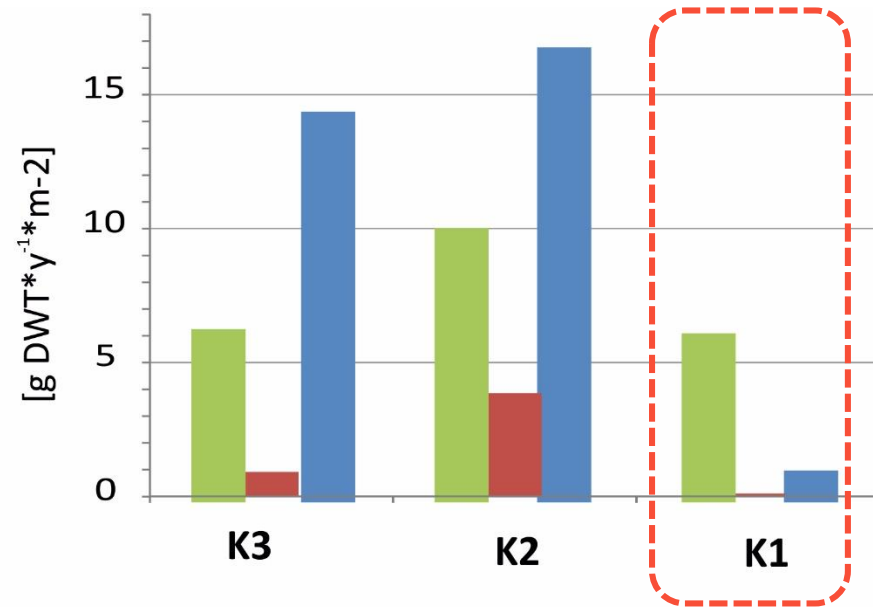
GLACIAL BAY



biomass



production

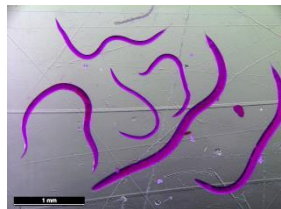


GLACIAL BAY

meiofauna

big nematodes

macrofauna



Conclusions

- **BBSS respond to glacial disturbance produced in Arctic fjords**
- **smaller individuals/taxa are less sensitive to disturbance**
- **the changes in size spectra are coupled with changes in taxonomic and functional composition**
- **in stable sediments ,big nematodes' make a significant part of benthic infaunal biomass and production**
- **in terms of secondary productivity glacial bays infauna turns into ,small biota dominated system'**
- **small scale variability needs to be considered in large scale comparative surveys**



Thank you

