Abundance, composition and development of zooplankton in the subarctic Iceland Sea in 2006-2008

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Outline of talk

- Background and objectives
- Hydrography
- Seasonal abundance
- Diversity
- Community structure
  - Mesoplankton
  - Macroplankton
- *Calanus* spp. life history
- Conclusions

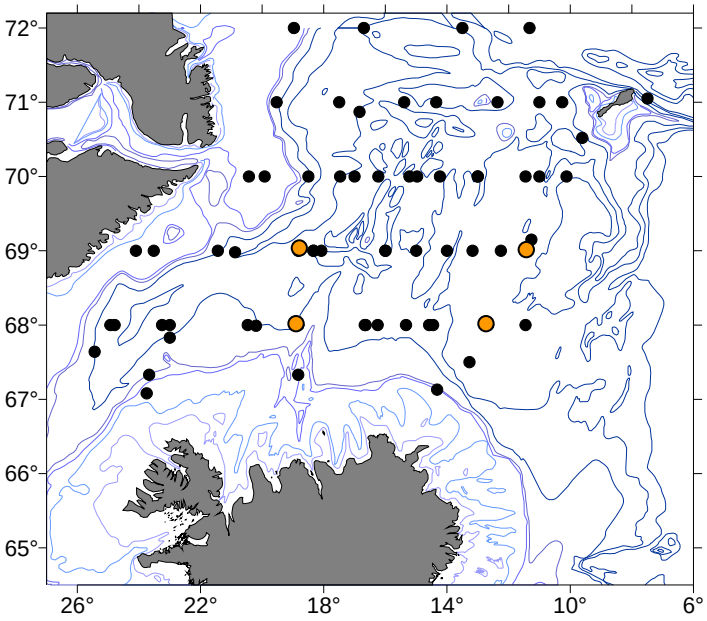
Background and objectives

- Iceland Sea important as feeding grounds for capelin
- Capelin important as fisheries resource and food for cod
- Capelin migration behaviour has changed
- Aim: Provide background information on the abundance and development of the zooplankton stocks in the Iceland Sea

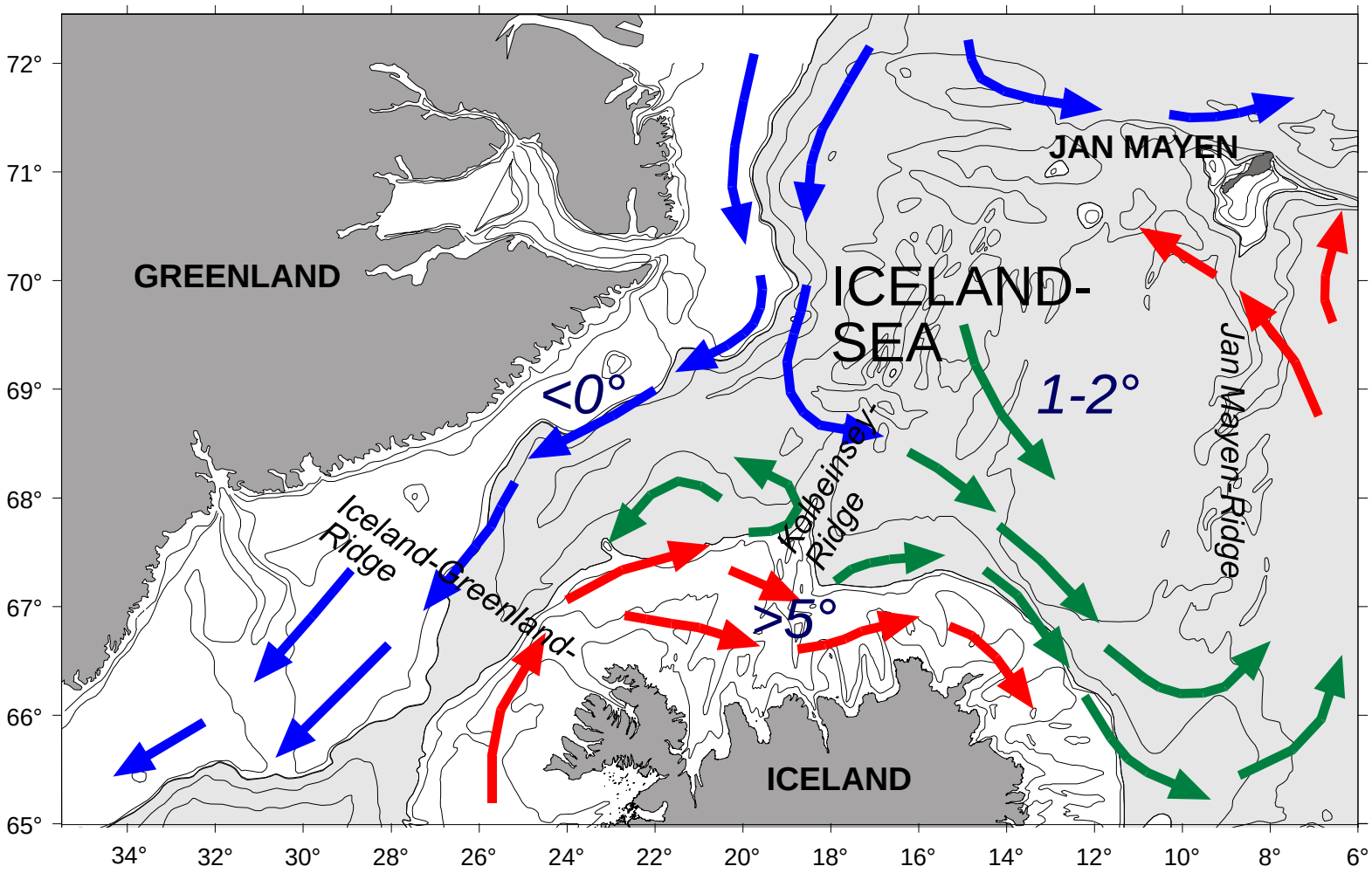
Methods

- Cruises
  - Large scale sampling in July-August 2006-2008
  - More frequent sampling at selected stations (seasonal stns)
- Activities
  - Hydro, Phyto
  - Mesozooplankton: WP2 & Multinet (200µ)
  - Macrozooplankton: Tucker (1000µ)
  - Fish (trawls, acoustics, stomach contents)
- NB! The seasonal data were not sampled chronologically within a year - we order the data by months although they were sampled in different years

Stns worked up for species compostion 2006-2008



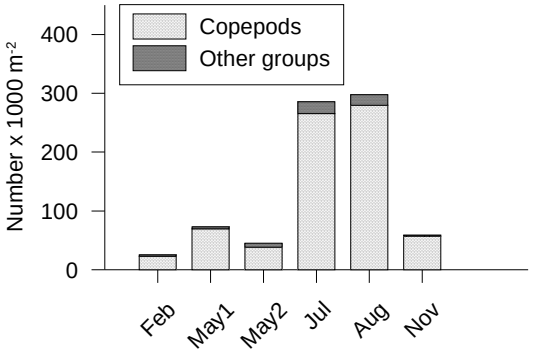
General circulation

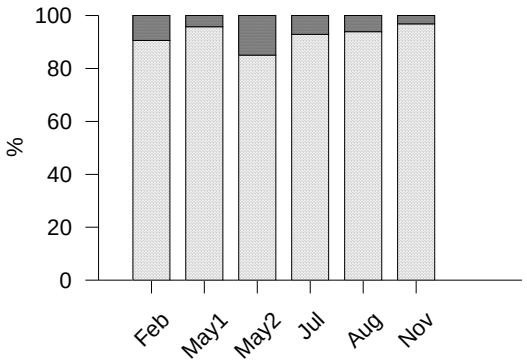


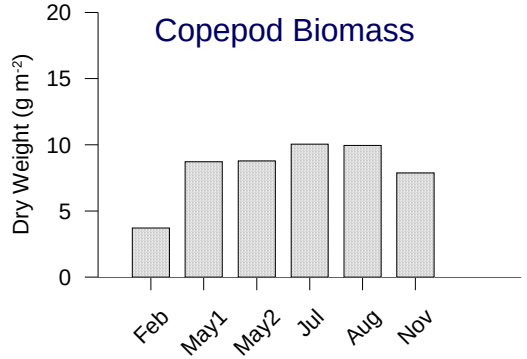
- Currents from south and north
- Advective system
- Iceland Sea as meeting place of Atlantic and Arctic species

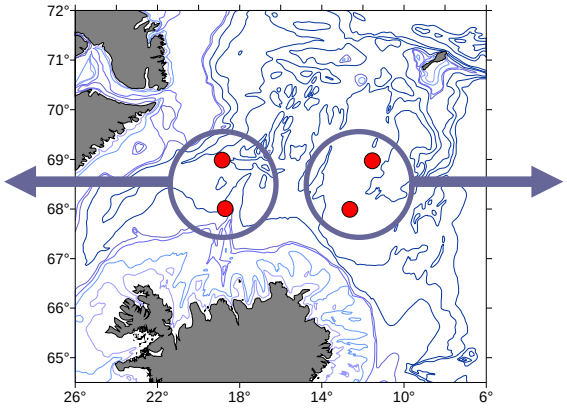
(Currents adapted from Valdimarsson and Malmberg 1999, Østerhus & Gammelsrød 1999)

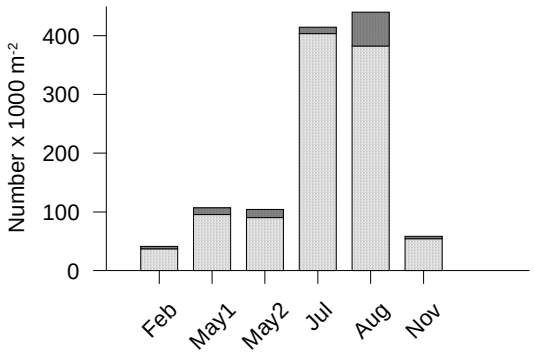
Seasonal abundance - mesozooplankton

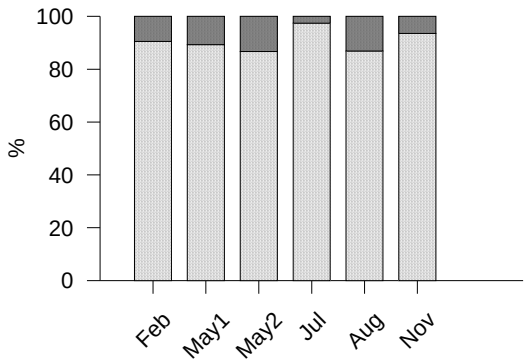


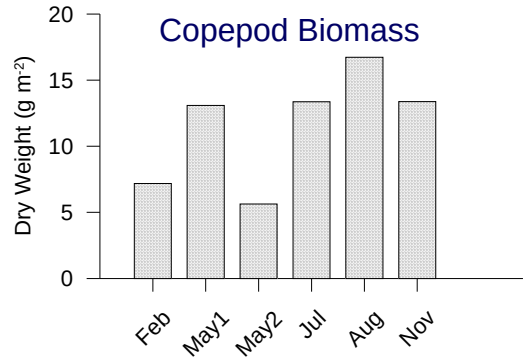








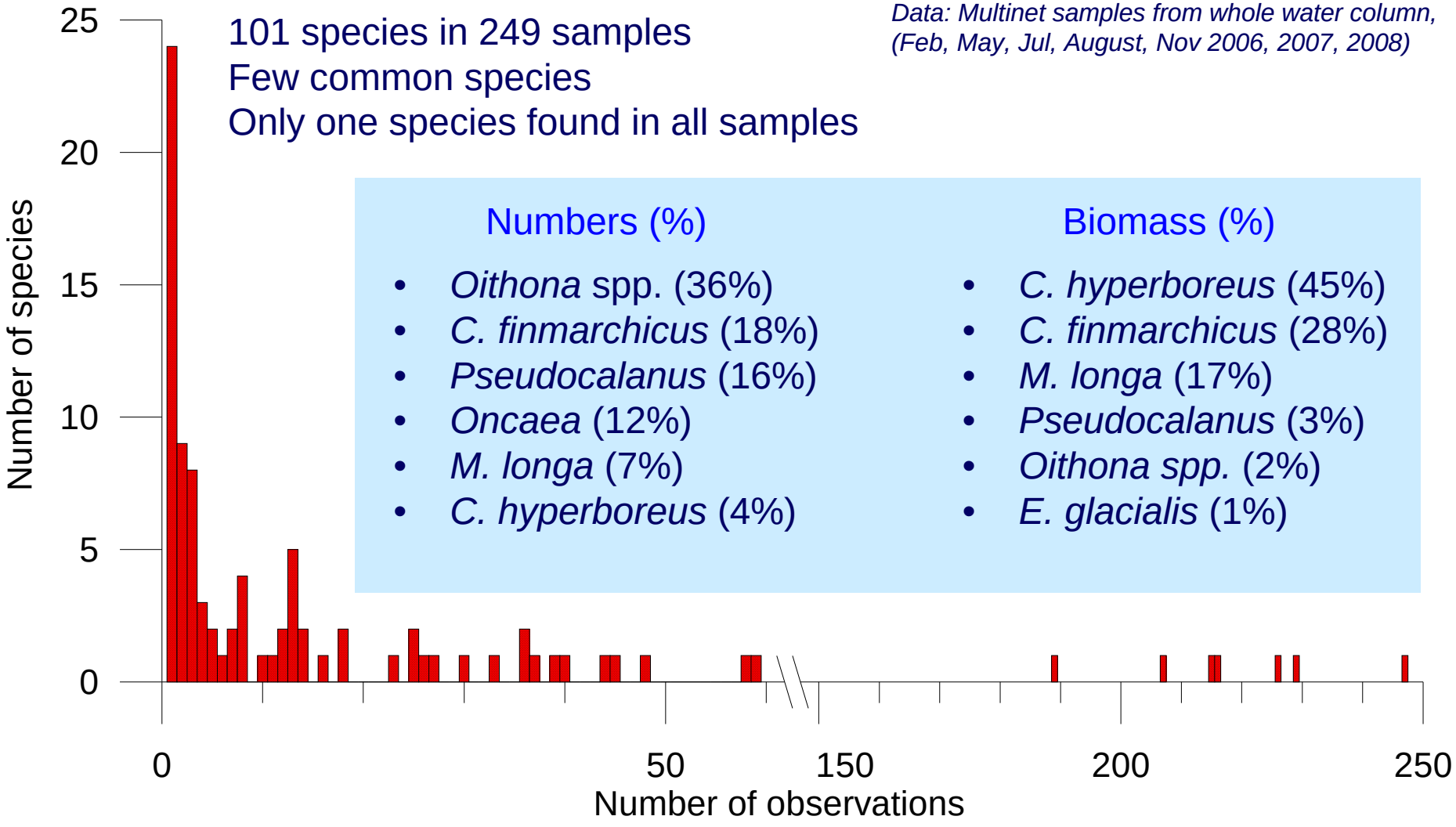




- Main increase in numbers: Jul-Aug
- Copepods main group
- Nos & biom. higher east of Ridge

Data: Multinet samples from whole water column, (Feb, May, Jul, August, Nov 2006, 2007, 2008)

Most abundant copepods



101 species in 249 samples
Few common species
Only one species found in all samples

Data: Multinet samples from whole water column, (Feb, May, Jul, August, Nov 2006, 2007, 2008)

Numbers (%)

- *Oithona* spp. (36%)
- *C. finmarchicus* (18%)
- *Pseudocalanus* (16%)
- *Oncaea* (12%)
- *M. longa* (7%)
- *C. hyperboreus* (4%)

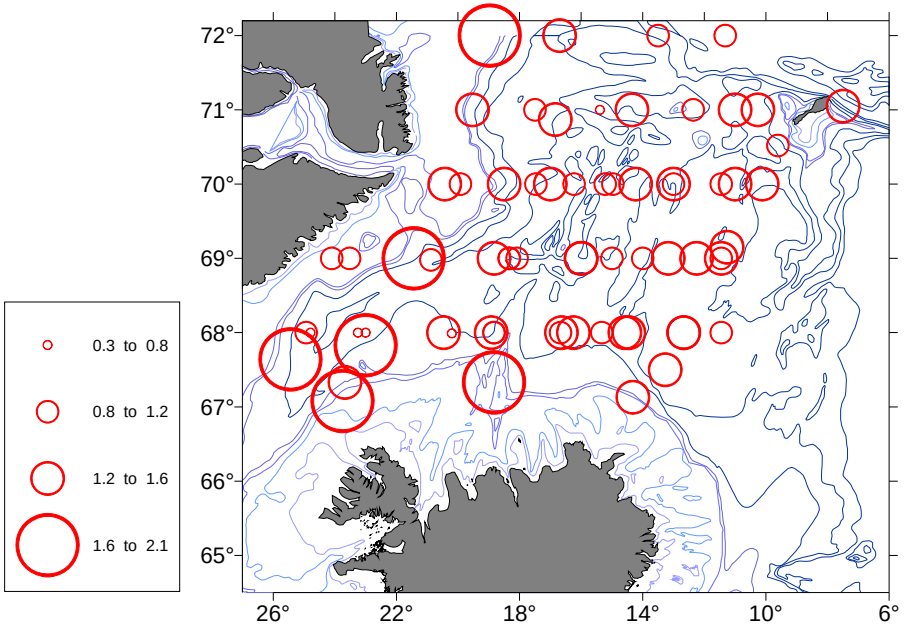
Biomass (%)

- *C. hyperboreus* (45%)
- *C. finmarchicus* (28%)
- *M. longa* (17%)
- *Pseudocalanus* (3%)
- *Oithona spp.* (2%)
- *E. glacialis* (1%)

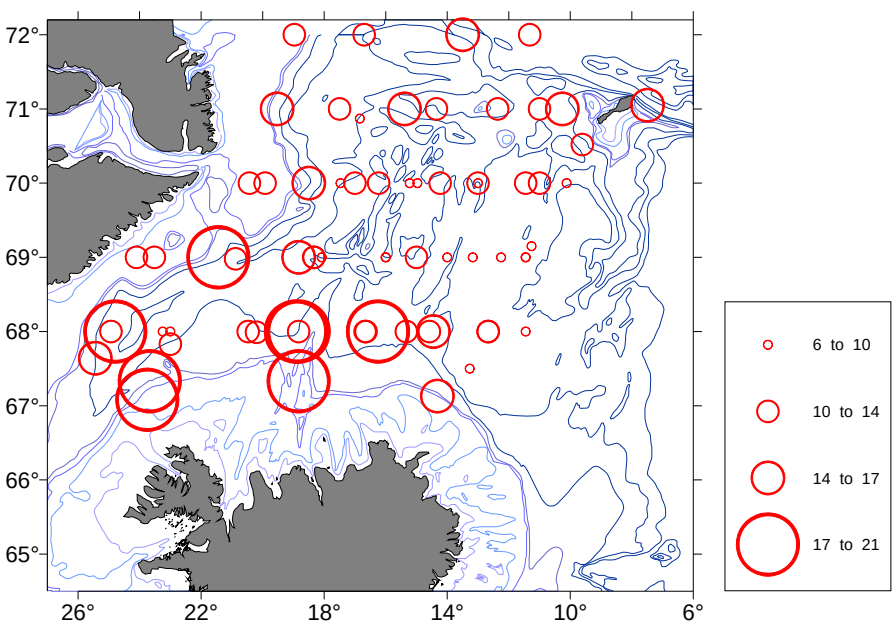
- 6 species made up ~93% of copepod numbers and ~96% of copepod biomass
- A mixture of Arctic associated (*C.hyp, M.long*) and N-Atlantic (*C.fin*) species

Diversity

Shannon-Wiener Index of Diversity (H)



Number of species

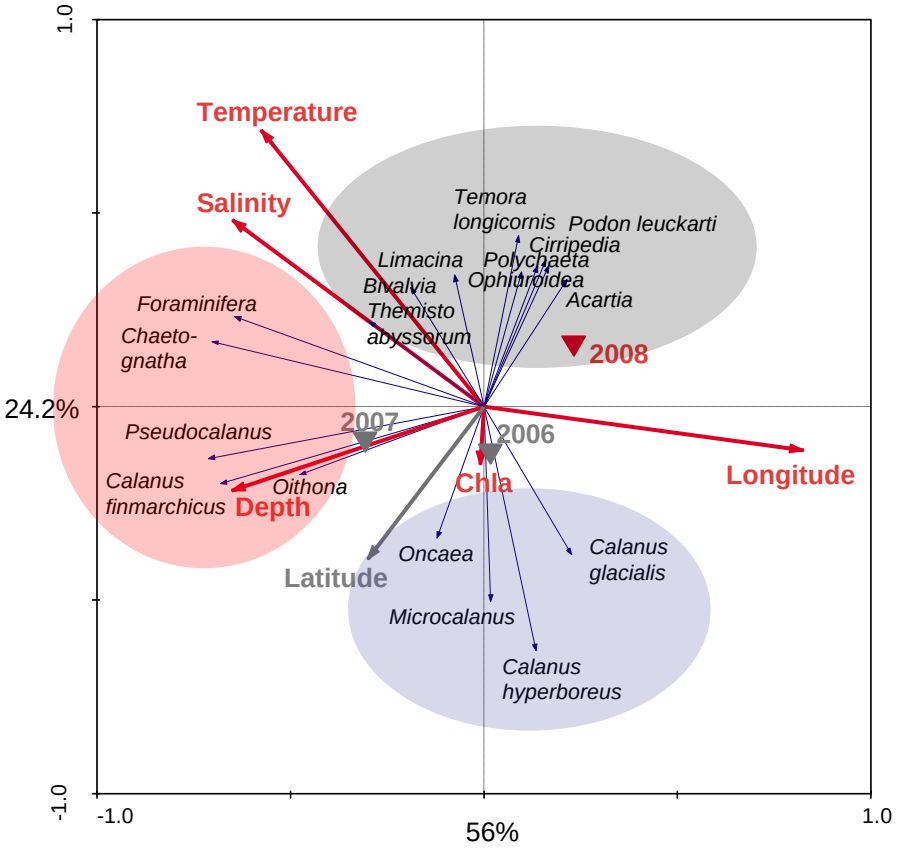


- Highest diversity over shelf edges
- Lowest diversity in Iceland Sea Basin

Data: Multinet samples from 0-50m (Jul, August 2006, 2007, 2008)

Factors affecting community structure

RDA MODEL:
Explanatory var.: Chla, temperature, salinity, latitude, longitude, bottom depth, year (categorial)
Covariables: Day number



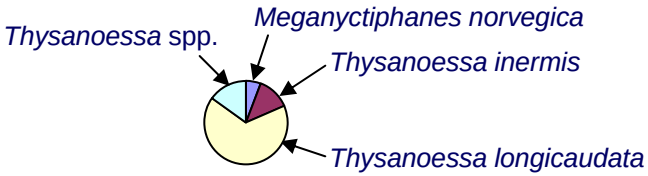
Ranking of environmental variables that significantly explained community structure (Monte Carlo permutation test)

Explanatory variables	Explained Variability (%)	p	F
Longitude	0.13	0.002	10.73
2008	0.06	0.002	5.78
Temperature	0.06	0.002	5,77
Depth	0.03	0.010	2.54
Chla	0.02	0.014	2.45
Salinity	0.02	0.032	1.91
Total	0.32		

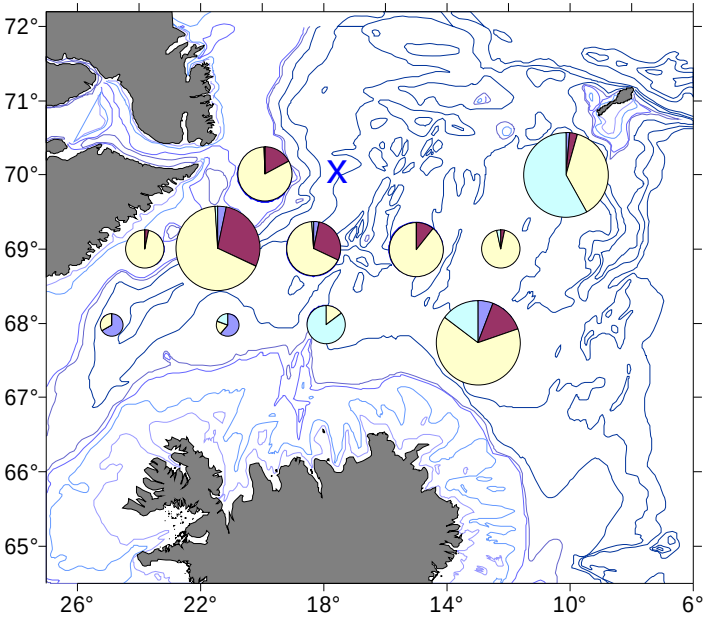
- 32% of variance explained by model
- Main gradient: E-W position (longitude)
- 2008 important as explanatory var
- 3 groups: Atlantic, Arctic, 'Coastal'

Data: Multinet samples from 0-50m (Jul, August 2006, 2007, 2008)

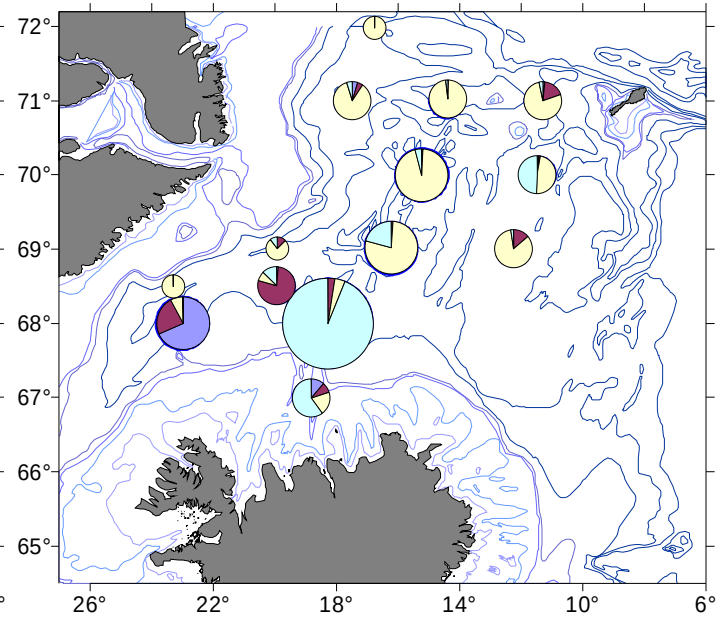
Euphausiids August

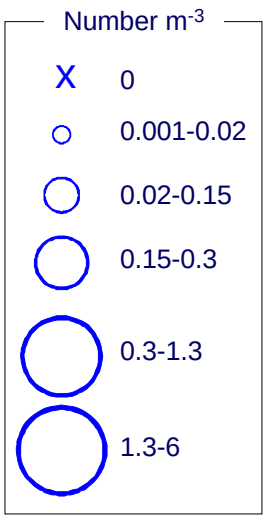


2007



2008

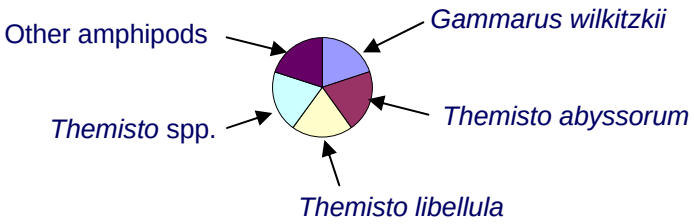




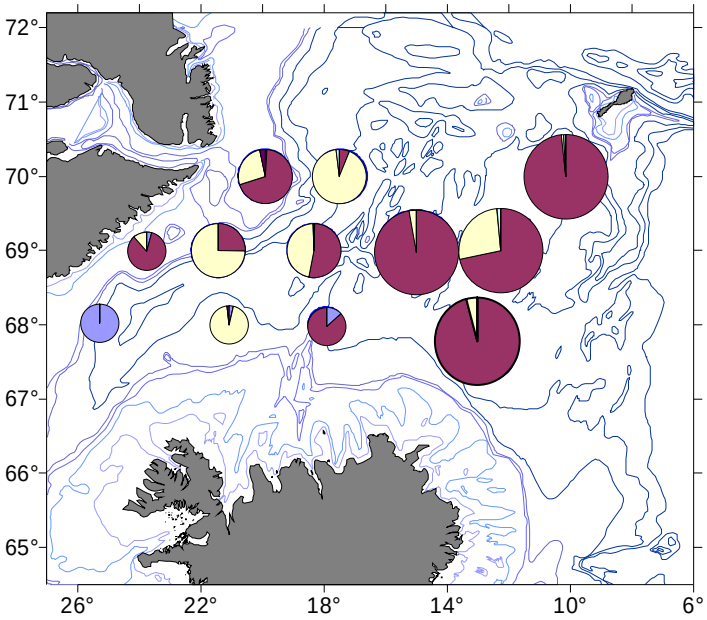
- 3 main species: *T. longicaudata*, *T. inermis*, *M. norvegica*
- *M. norvegica* only in southwest

Data: Tucker-trawl from 0-100m (August 2007, 2008)

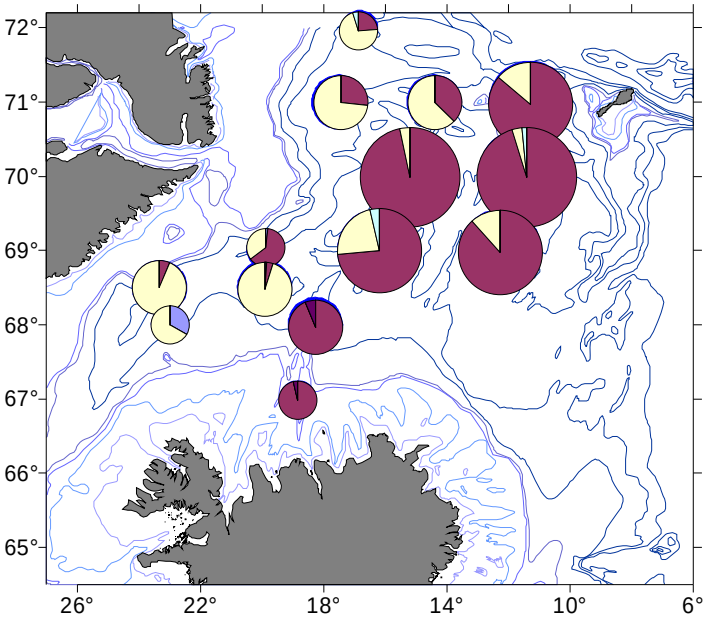
Amphipods August

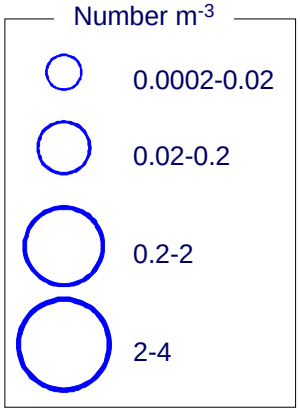


2007



2008



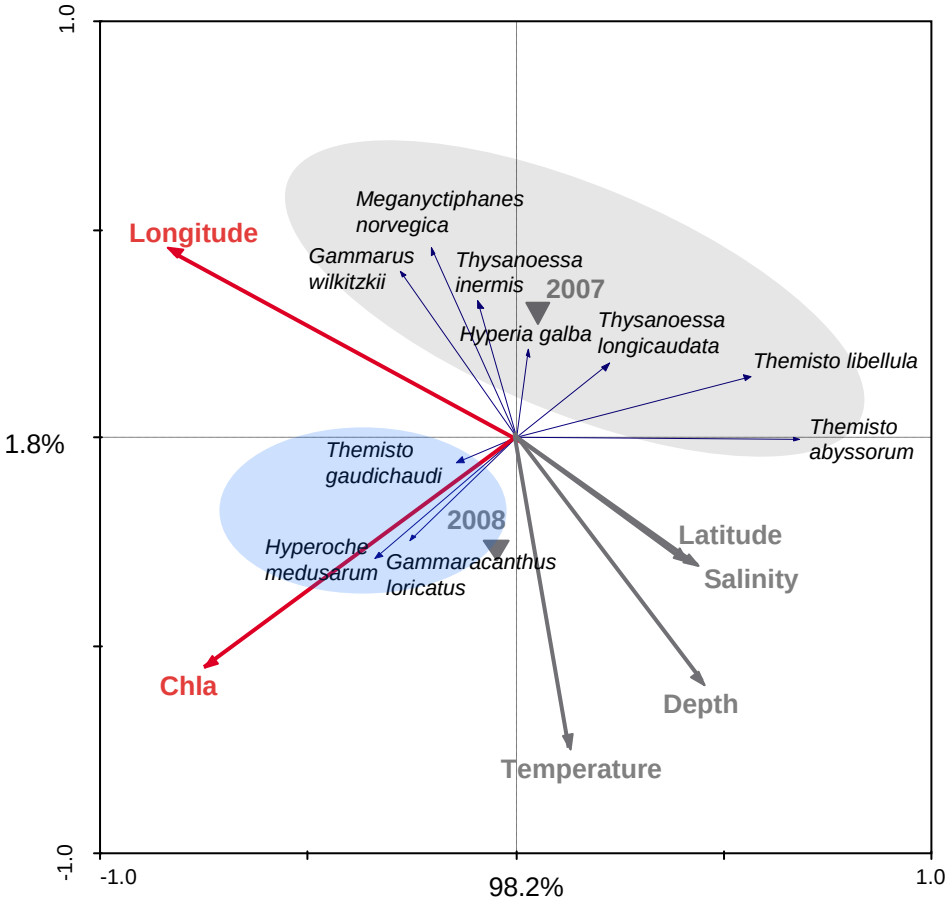


- 2 main species: *T. abyssorum* and *T. libellula*
- *T. abyssorum* (Atlantic) in warm water (east)
- *T. libellula* (Arctic) in cold water (west)

Data: Tucker-trawl from 0-100m (August 2007, 2008)

Macroplankton: relations with environment

RDA MODEL:
Explanatory var.: Chla, temperature, salinity, latitude, longitude, bottom depth



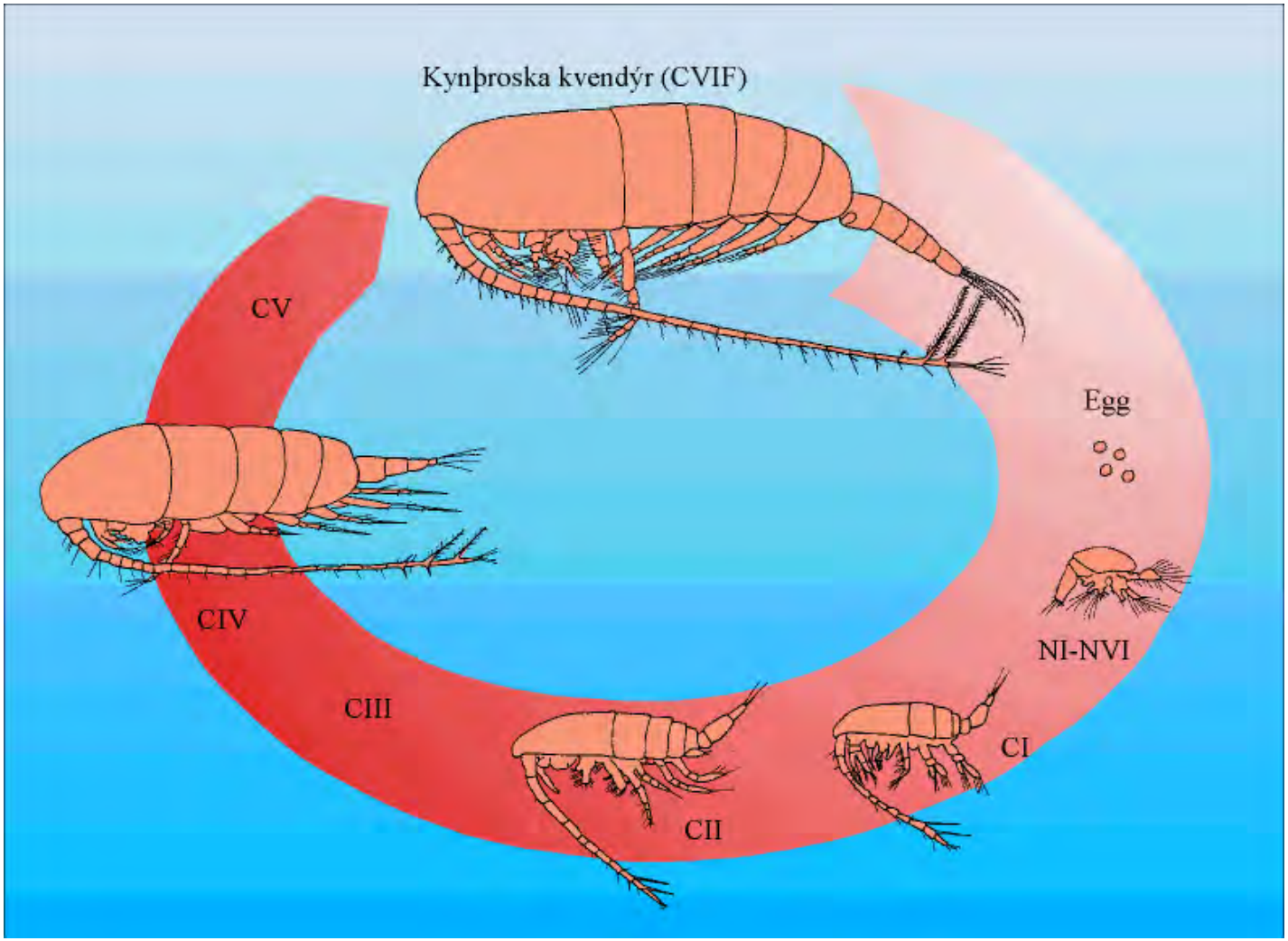
Ranking of environmental variables that significantly explained community structure (Monte Carlo permutation test)

Explanatory variables	Explained variability (%)	p	F
Longitude	0.32	0.002	12.37
Chla	0.10	0.038	4.50
Total	0.42	0.002	4.81

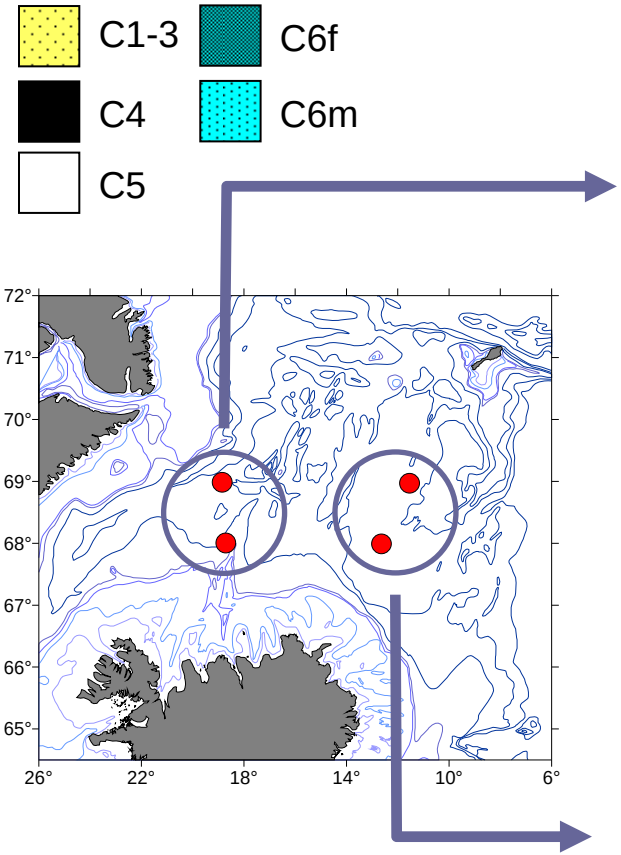
- 42% of variance explained by model
- Main gradient: E-W position (longitude)
- 2 groups?

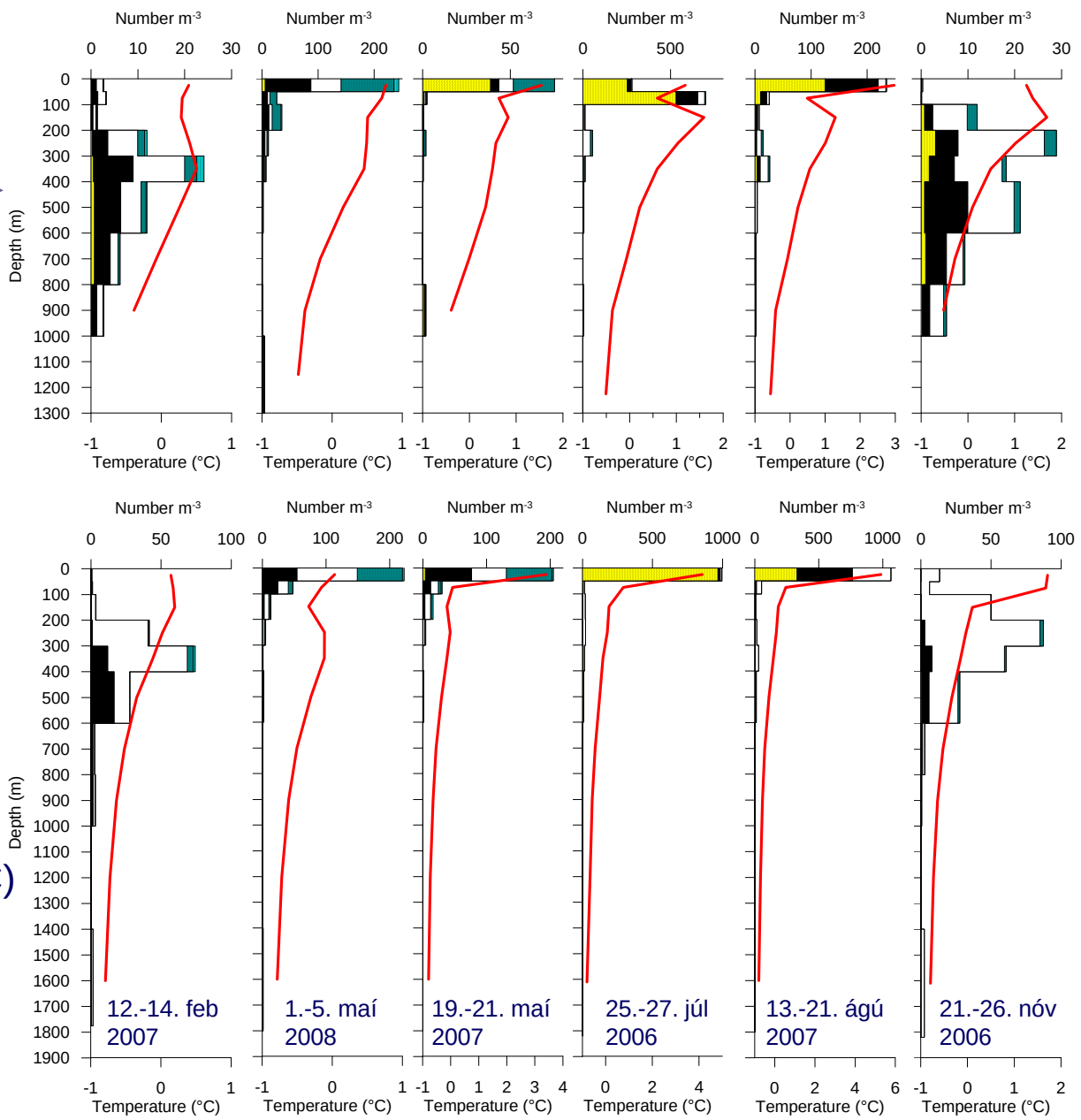
Data: Tucker-trawl from 0-100m (August 2007, 2008)

Calanus life cycle



C. finmarchicus: Seasonal abundance

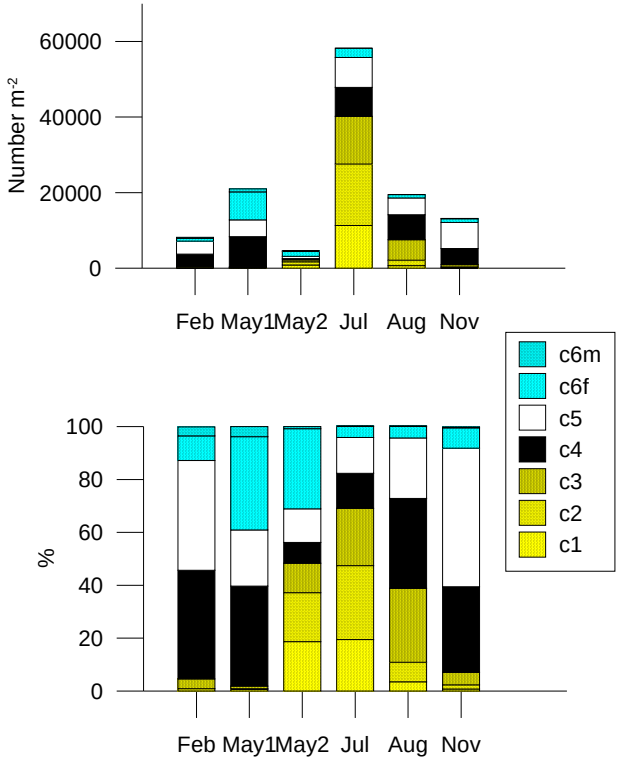


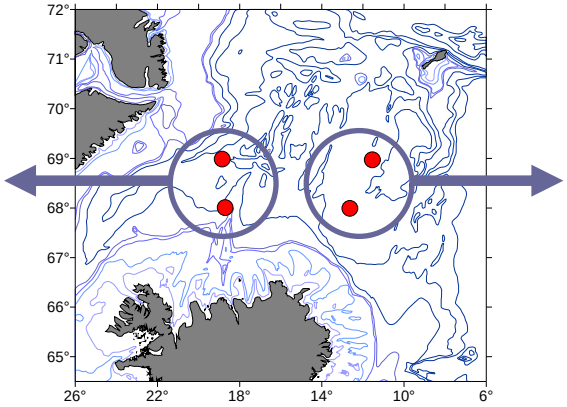


- Overwinter at ~200-800 (~0-1°C)
- Ascendance ~March-April
- In surface from ~May-August
- Descendance ~Sept-Oct

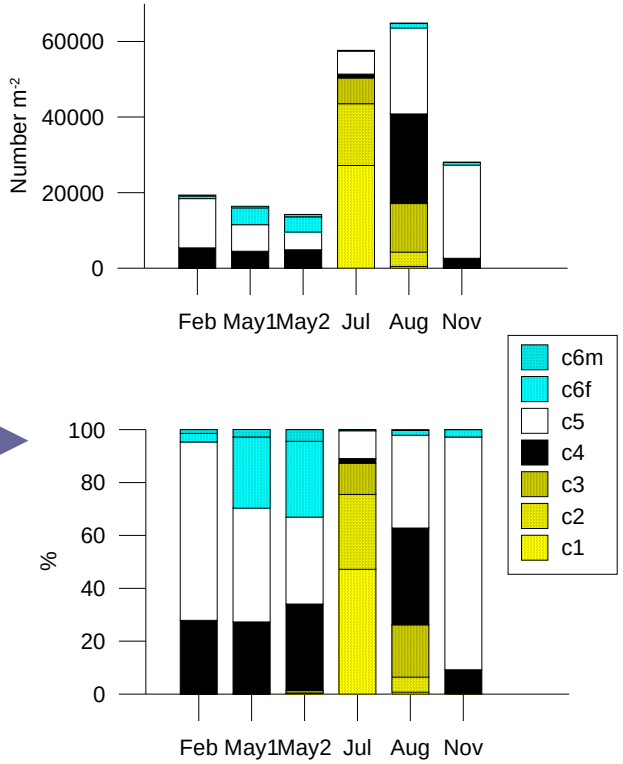
C. finmarchicus: abundance (per m^{-2})

West of Kolbeinsey Ridge





East of Kolbeinsey Ridge

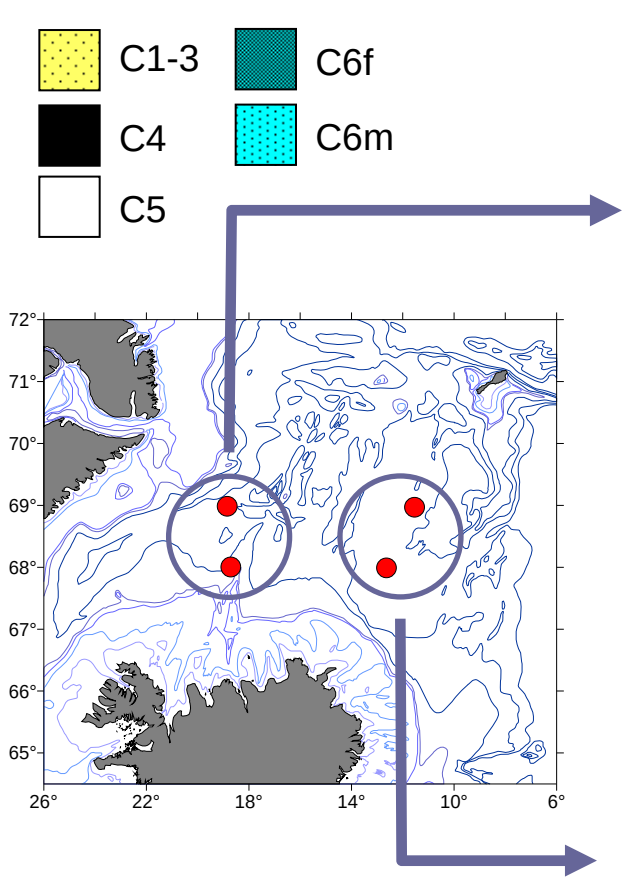


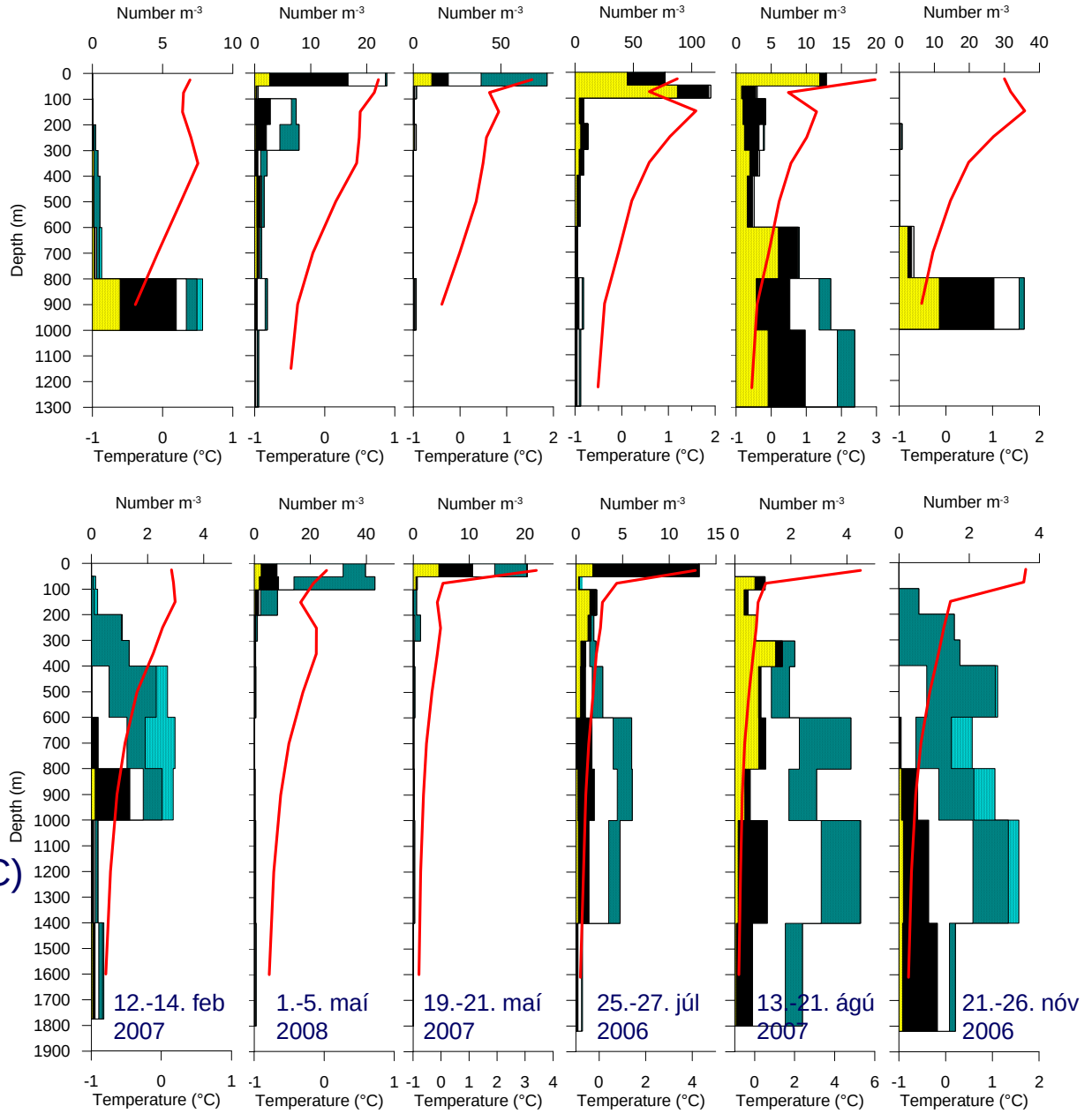
- Overwintering population: C4-5 (>90%)
- One peak in adults in May
- One peak in juveniles in July

} 1-year life cycle - reproduction mainly in May-June

- Recruitment to older stages more successful in east? …or advection?

C. hyperboreus: Seasonal abundance

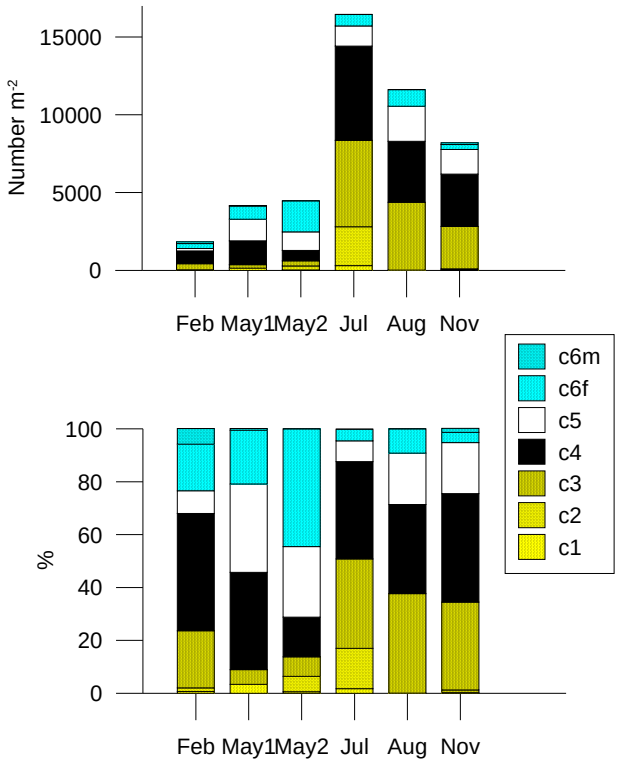


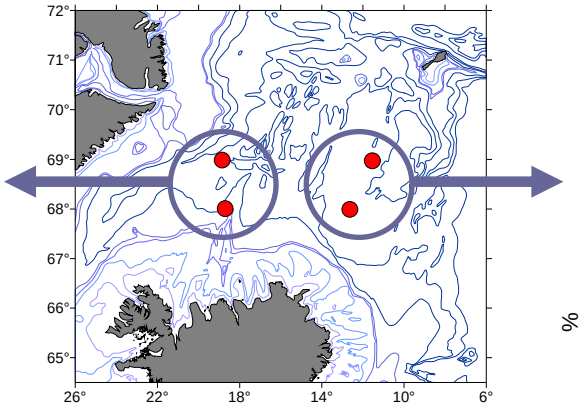


- Overwinter at ~400-1000 m (~0°C)
- Juveniles at depth in winter
- Ascendance ~March-April
- In surface from ~May-July
- Descendance ~Aug-

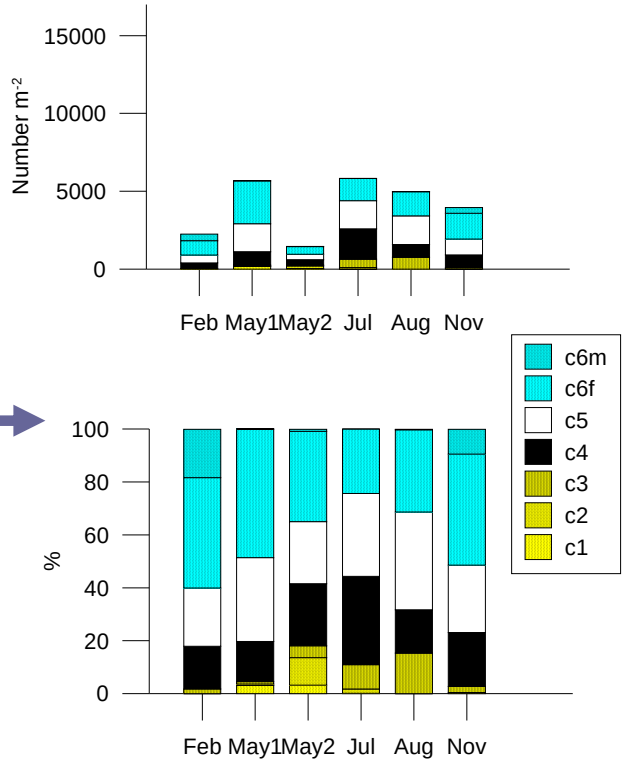
C. hyperboreus: abundance (per m^{-2})

West of Kolbeinsey Ridge





East of Kolbeinsey Ridge



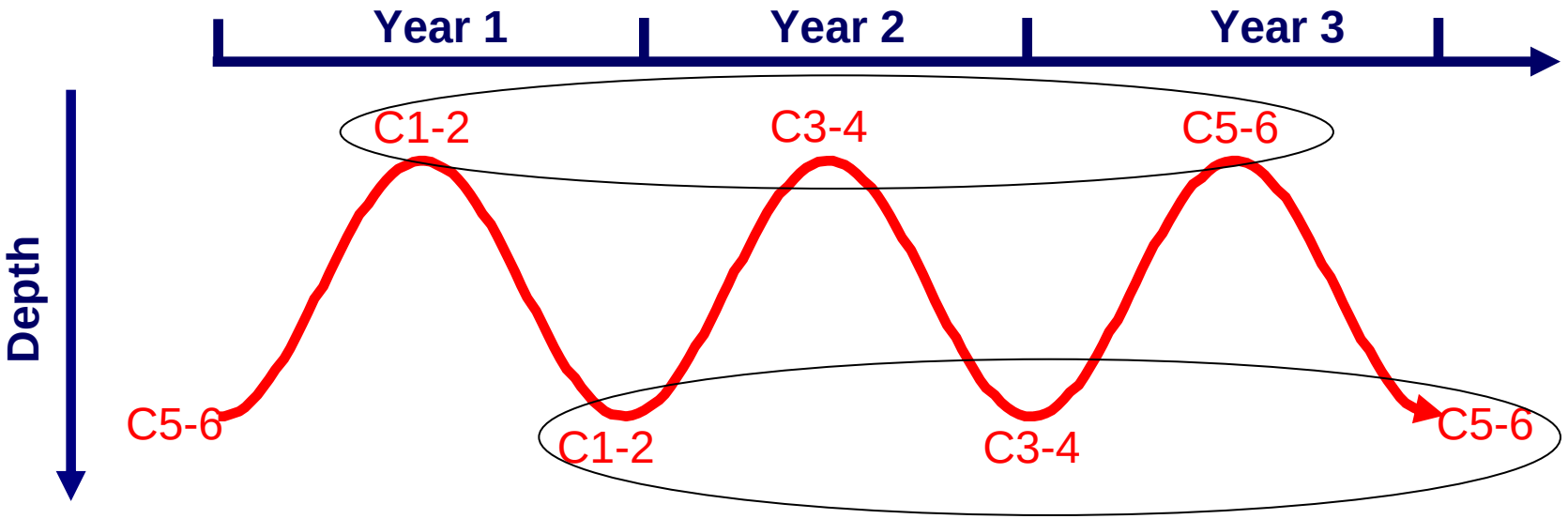
- Males in winter only – in deep samples
- Youngest copepodites (C1-3) deep during winter

} Reproduction at depth in winter

- Abundance higher in west than east – advection from Greenland Sea?

C. hyperboreus: Length of life cycle

Observation: Mixture of stages during all seasons => 2-3 year life cycle?



Rather get big and produce large lipid storages (to survive unproductive season and produce eggs) than grow fast

Conclusions

- Abundance at maximum in July & August
- Diversity …
  - few common species (~8)
  - highest near the shelf edges (in the frontal areas)
- Community structure …
  - mixture of Atlantic and Arctic species
  - mainly influenced by E-W position (longitude)
  - different in 2008 (relatively high abundances of species with coastal affinities) compared with 2006 and 2007
- *Calanus* spp. as key species in the system:

		C. finmarchicus	*C. hyperboreus*
Vertical distribution	winter	200-800m	400-1400
	summer	0-50m	0-50m
Spawning season		May-June	Feb-
Length of life cycle		1 year	2-3 years
Growing period (in surface)		May-August	May-July

Thanks …

- Stefán Þór Þórsson
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- et al.