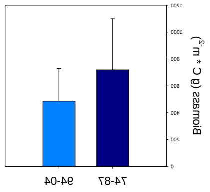
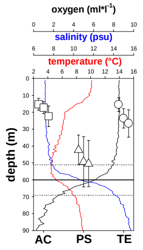
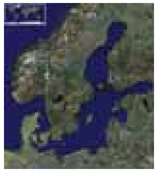
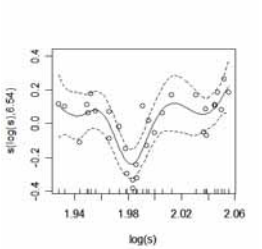
Ecosystem consequences of decadal changes in energy and carbon flows due to climate-induced changes in Baltic zooplankton

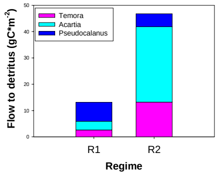
Christian Möllmann, Janna Peters, Rabea Diekmann, Maciej T. Tomczak & Georgs Kornilovs

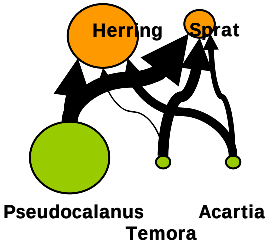












Background

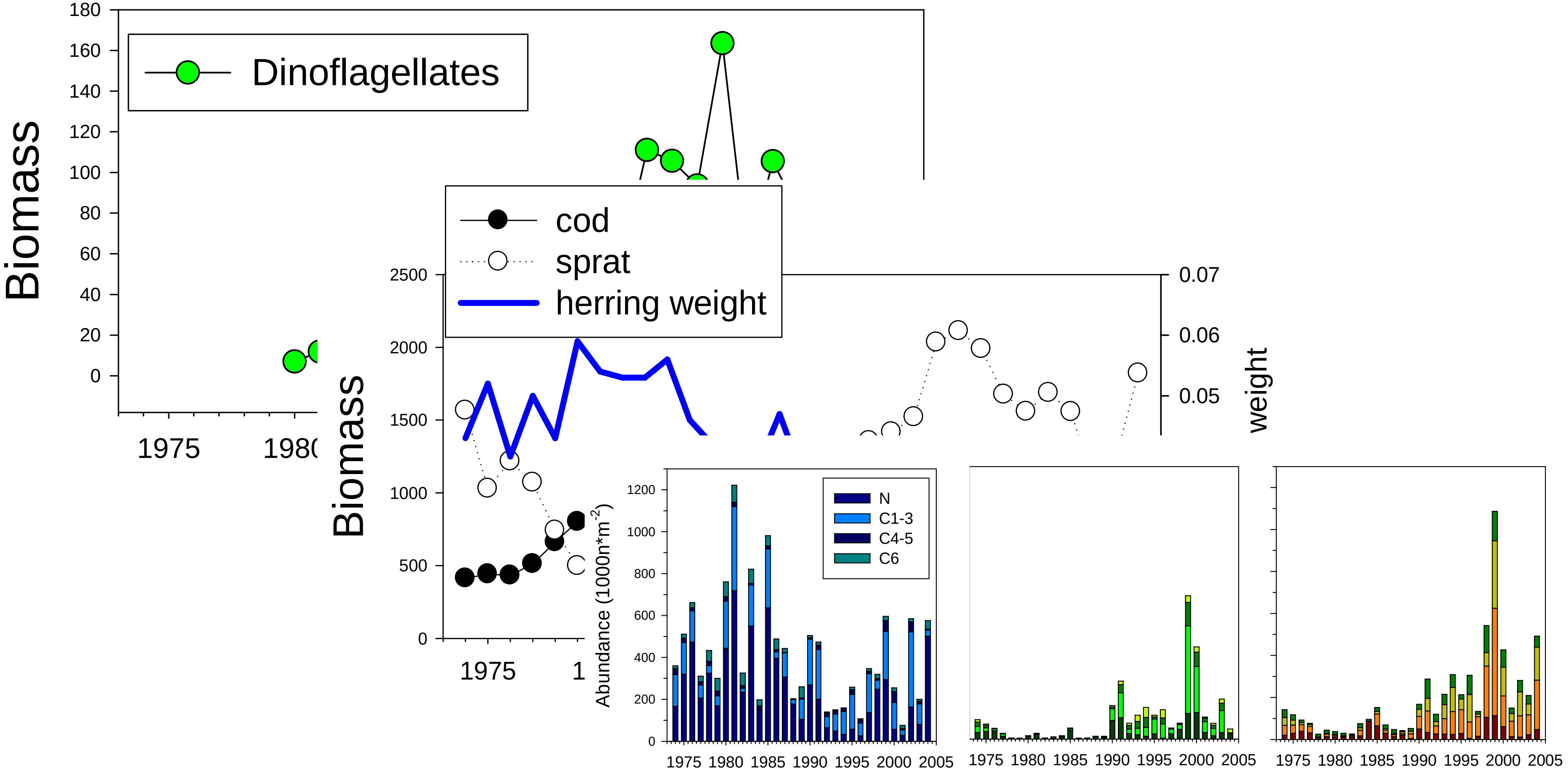
- Baltic ecosystem has undergone major reorganizations in **ecosystem structure and function**
- Major drivers for the changes were **CLIMATE and COD OVERFISHING**
- **Zooplankton** is an important component/driver of this changes as it mediates bottom-up effects and simultaneously suffers from a top-down trophic cascades

The Baltic Sea

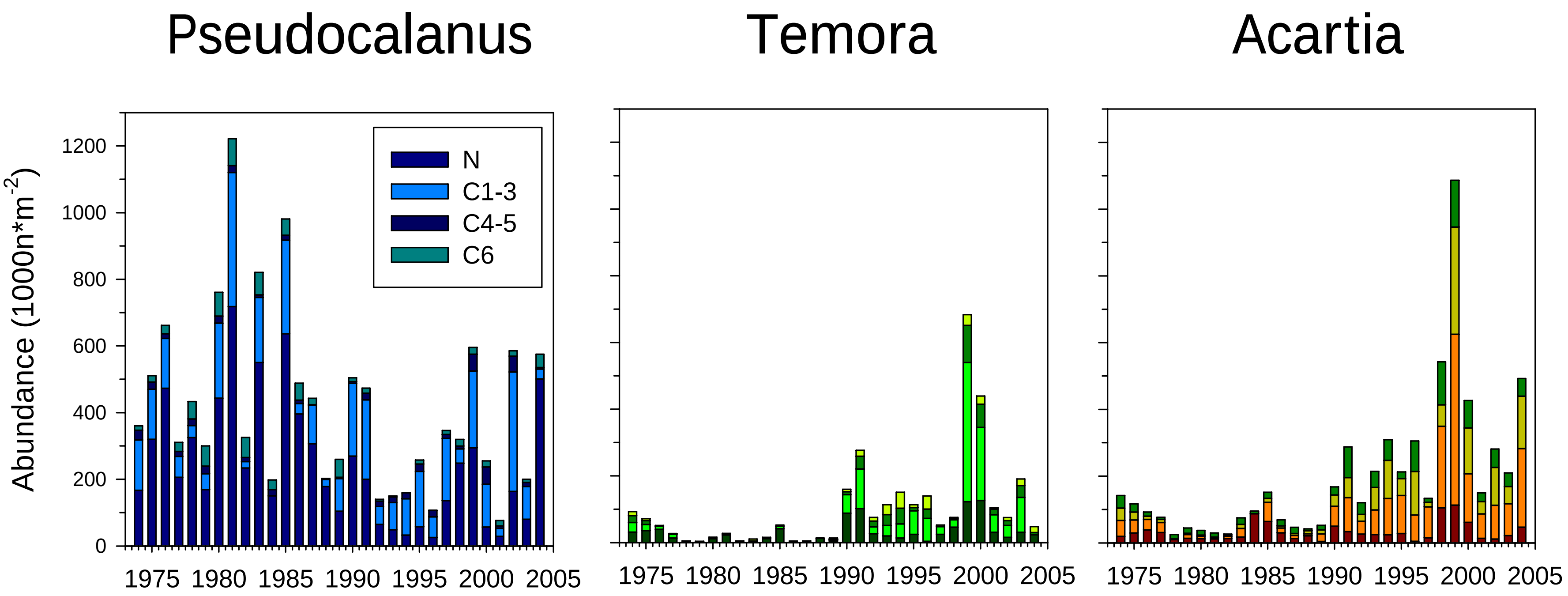
Characteristics

- large semi-enclosed brackish water body
- stratified water-column with a permanent halocline
- low diversity
- high productivity
- eutrophication
- high fishing pressure
- pronounced climate influence through variability in temperature & salinity

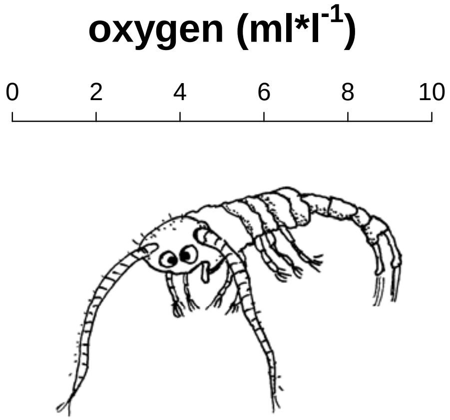
Ecosystem trends

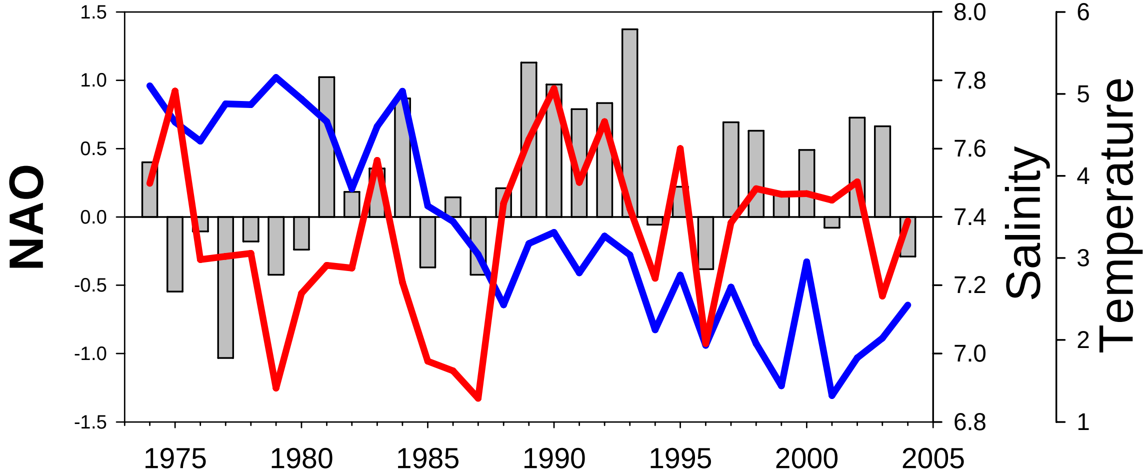


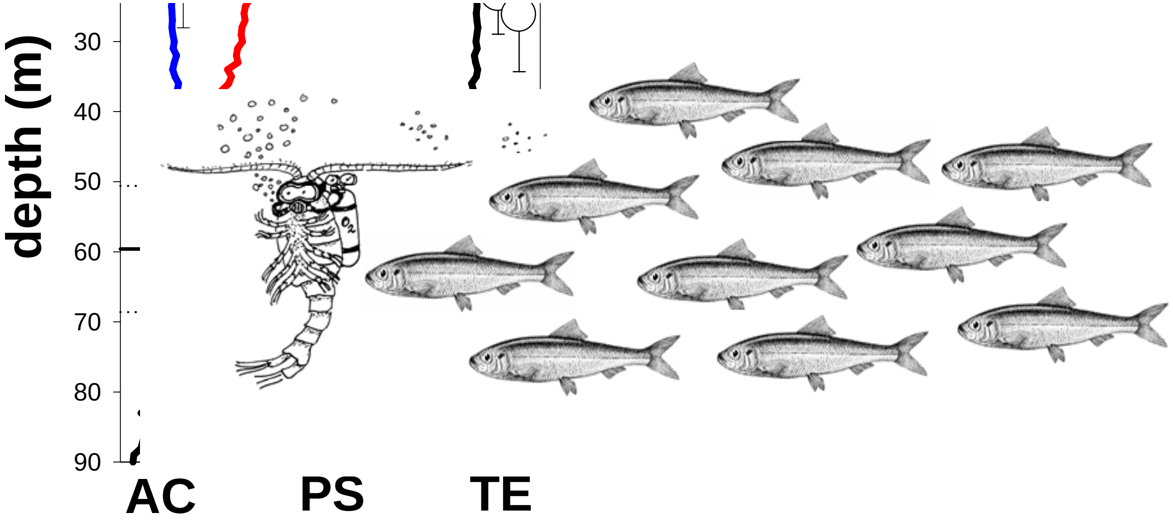
Zooplankton long-term trends



Vertical stratification & copepod distribution



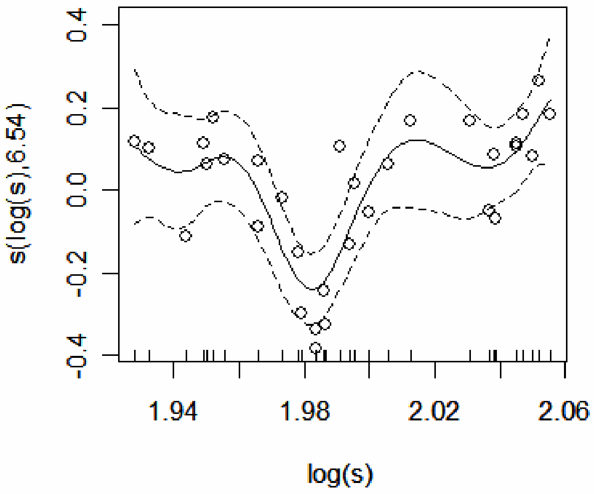




Zooplankton & Climate

Pseudocalanus

GAM



<u>Predictors:</u> salinity, sprat, nao

<u>Deviance explained:</u> 81.6%

Temora & Acartia

GLM

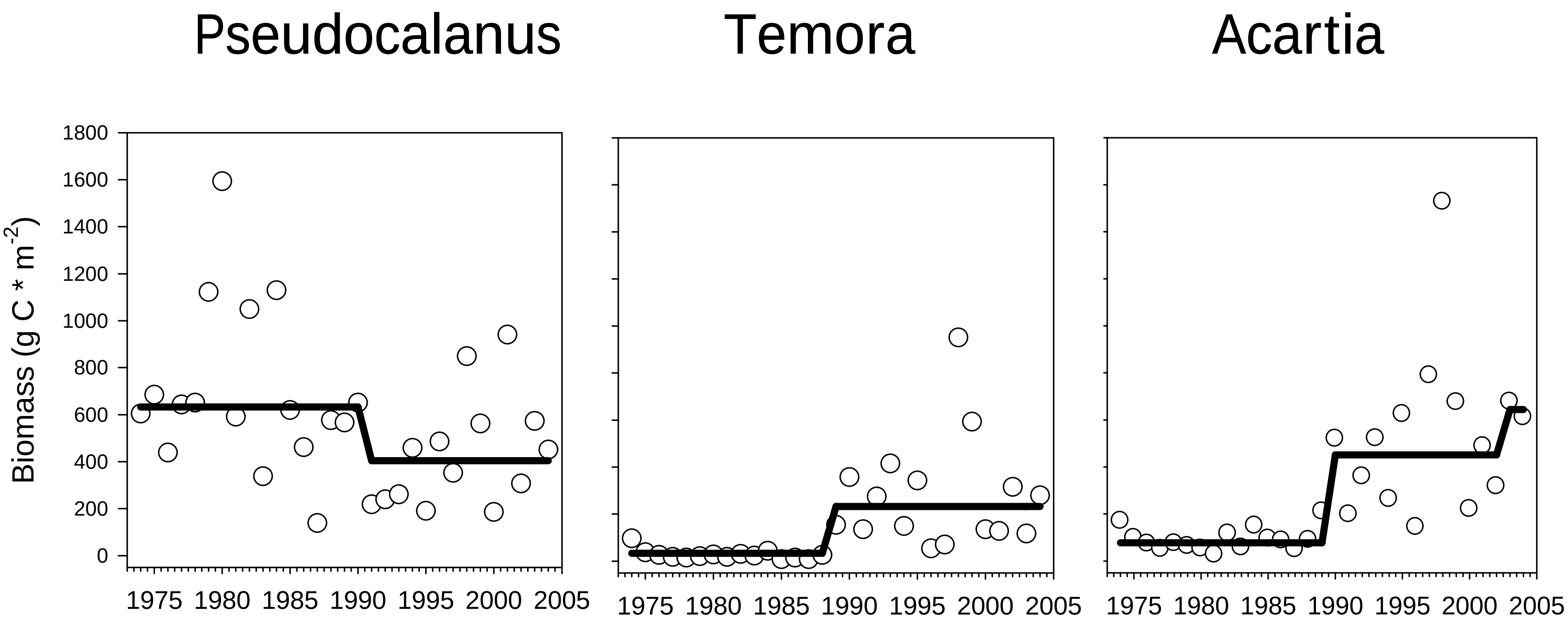
Species	Predictors	Period	r^2	p
TE	Temperature, Salinity, NAO	1974-2005	0.65	< 0.001
AC	Temperature, Dinoflagellates, NAO	1980-2005	0.92	< 0.0001

Model selection based on GCV & AIC
Möllmann et al. 2008

Hypotheses & **Approach**

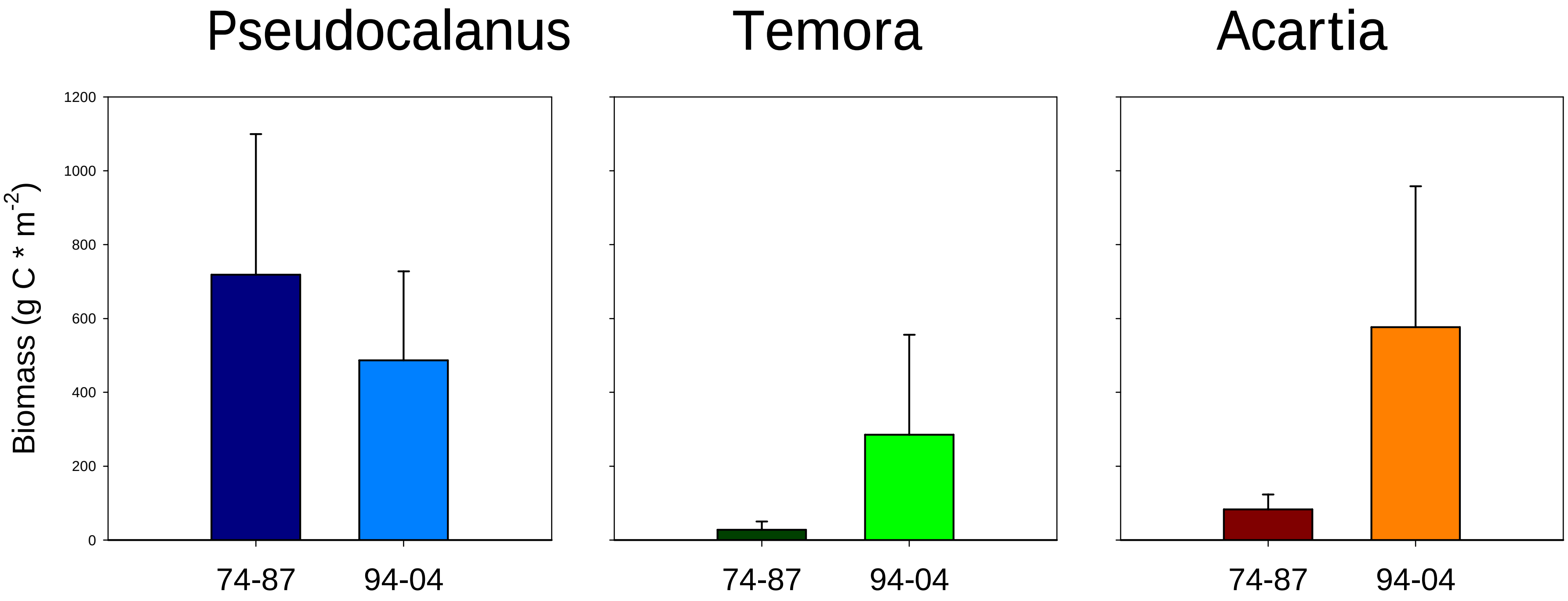
- changes in ecosystem structure might have altered trophic interactions in the food-web and hence carbon and energy flows
- potential for carbon export out of the food-web
- important consequences for the energy and matter transfer to higher trophic levels, mainly commercially important fish populations
- **construct mass-balance food-web models for pre- and post regime shift periods to evaluate changes in ecosystem structure and function, especially carbon and energy flows**

Zooplankton regimes



Regime Shifts detected by *Sequential Regime Shift Analysis* (Rodionov 2004)

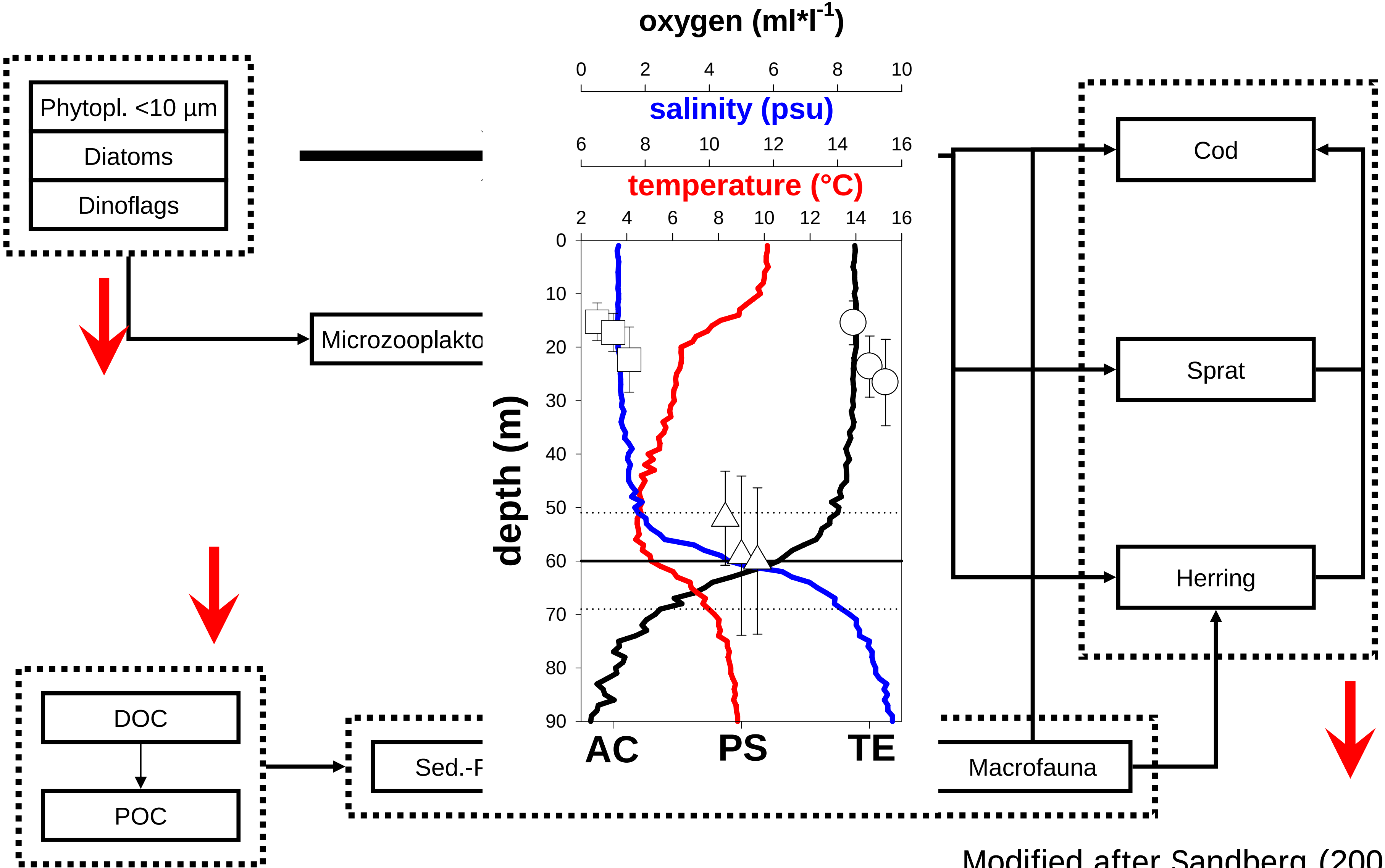
Zooplankton regimes



Food-web models

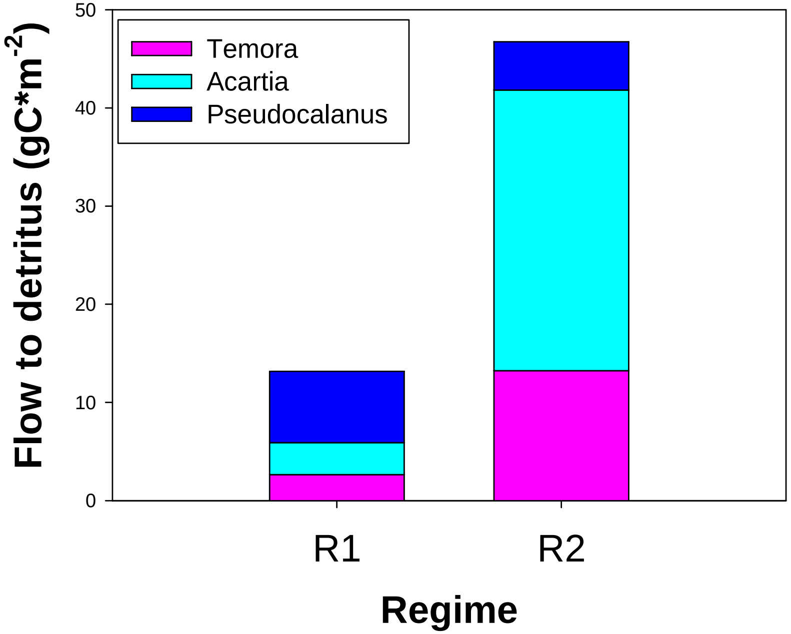
- ECOPATH (without ECOSIM)
- 2 „snapshots“ for the 2 regimes (1974-1987 & 1994-2004)
- 12 living componts, 3 * detritus
- Modified (simplified) from earlier work (Harvey et al. 2003, Sandberg 2007)
- Unit: Carbon
- „Spring-model“ → most climate (hydrographic) impact

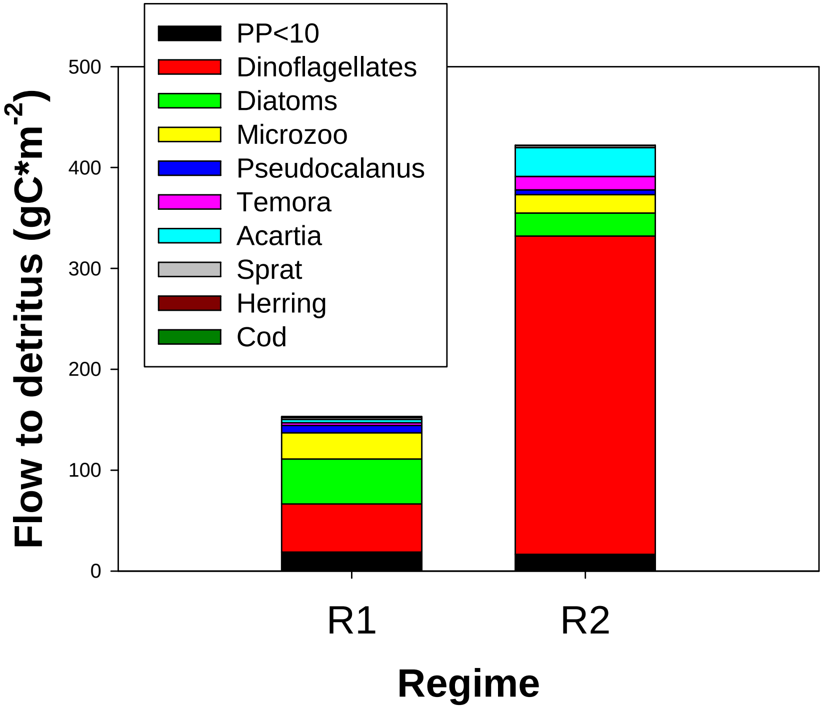
Flow to Detritus ?



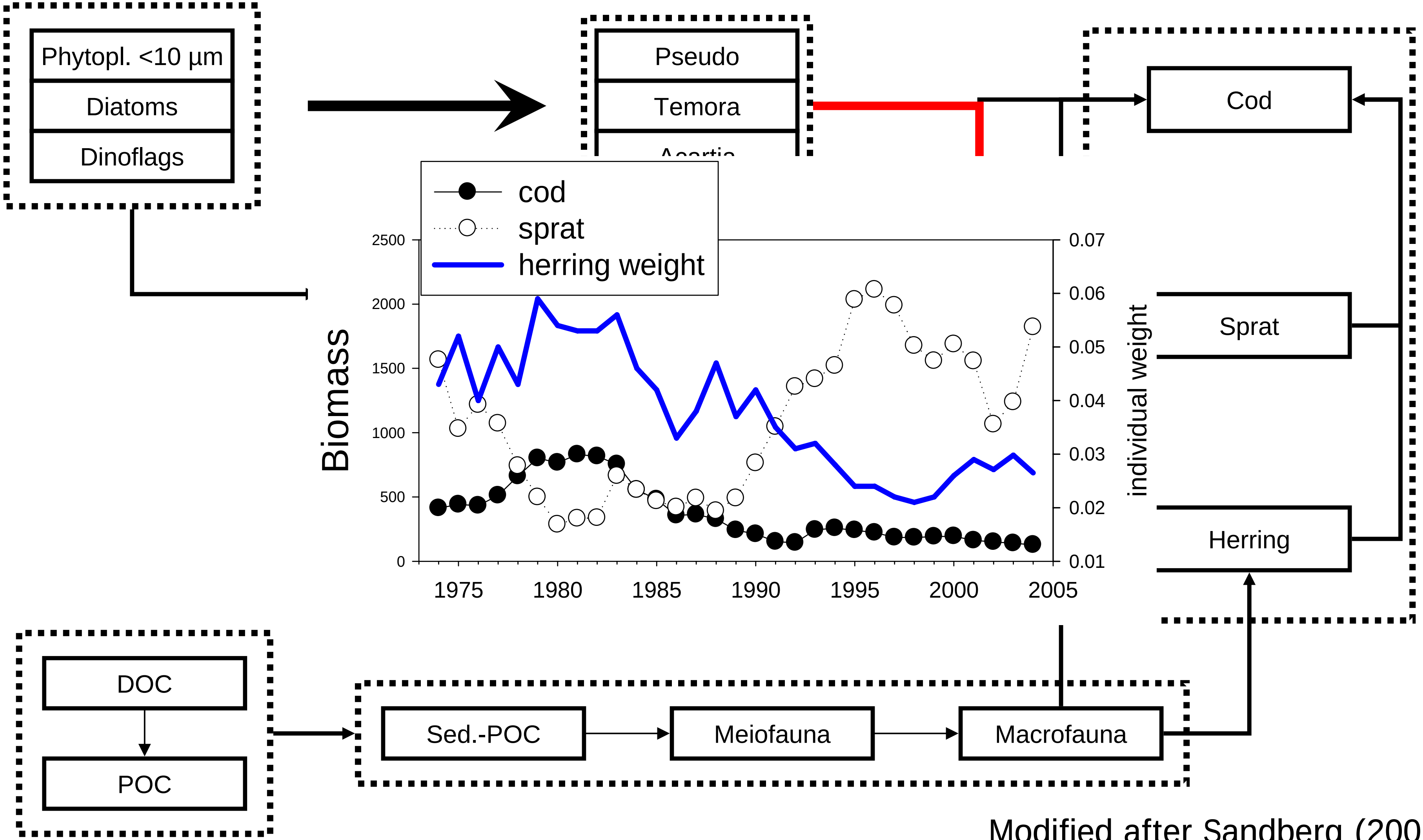
Modified after Sandberg (2007)

Flow to Detritus





Flows Copepods to Pelagics ?



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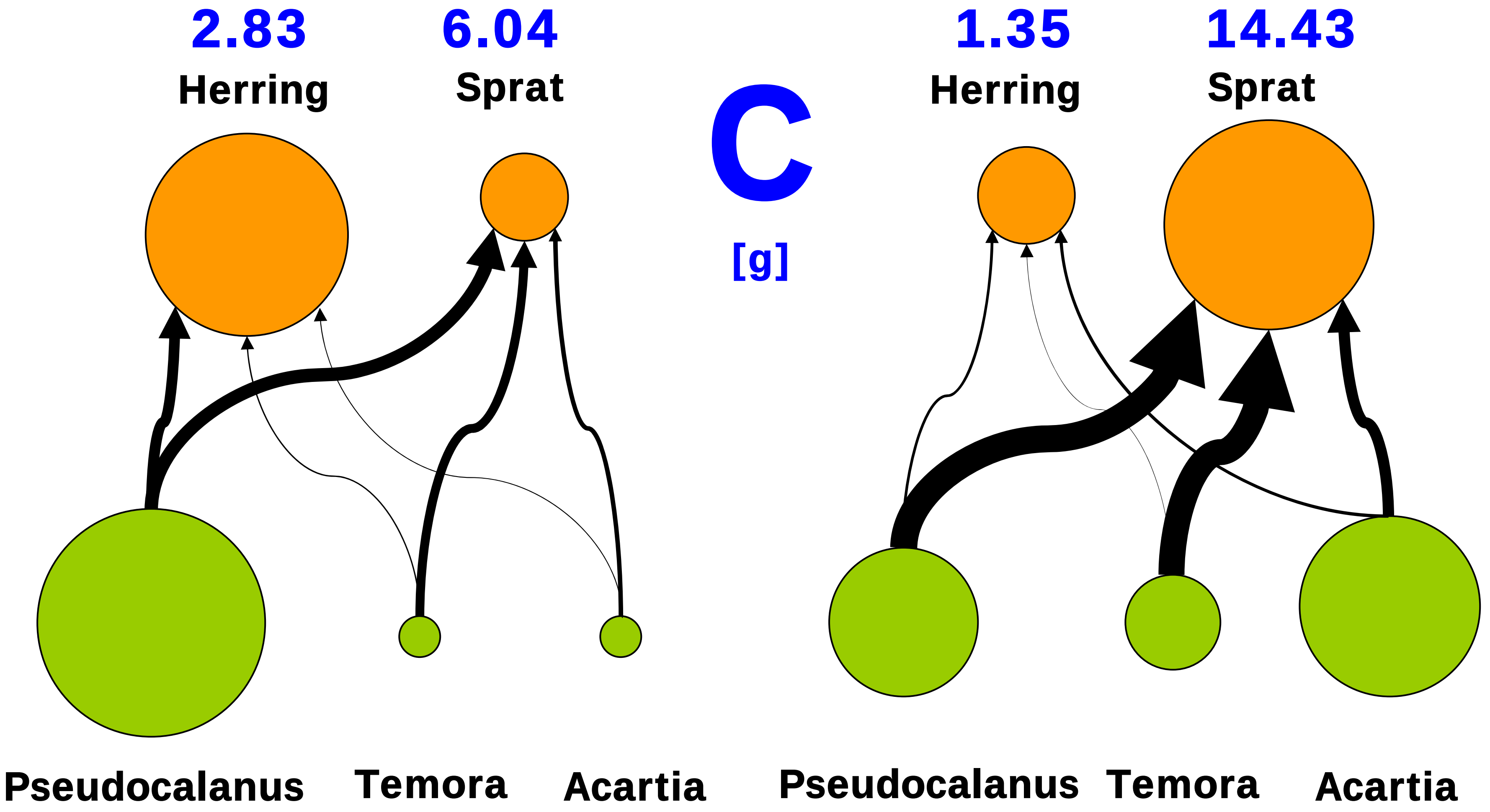
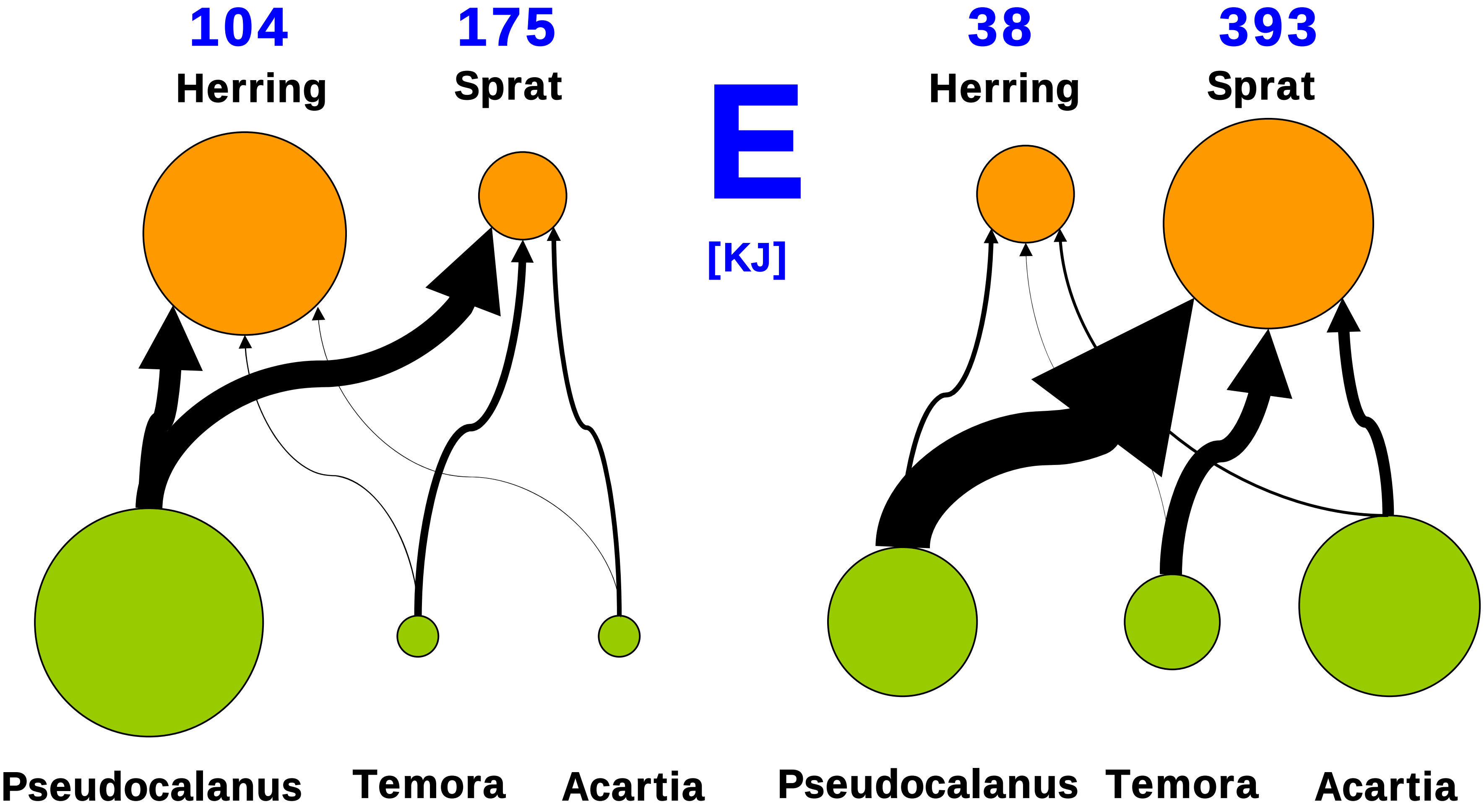


Flows Copepods to Pelagics



104 **175**

Herring **Sprat**

E

[KJ]

38 **393**

Herring **Sprat**

Pseudocalanus **Temora** **Acartia** **Pseudocalanus** **Temora** **Acartia**

Summary

- Zooplankton is affected by climate-related changes in hydrography (direct & indirect effects)
- Zooplankton is a major part of the restructuring of the Baltic ecosystem
- Potential export of Zooplankton-C out of the pelagic zone has increased in the new regime; however is relatively unimportant compared to phytoplankton changes
- Zooplankton energy flow to pelagic fish has changed in new regime causing a decrease in herring growth
- Changes in ecosystem structure significantly change carbon and energy fluxes

Thanks

- Co-Authors
- „ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea“
- ICES/PICES … for a nice symposium !