

# Phytoplankton data in the Lena delta: What do they tell us and what is lacking?

A. Kraberg

Time Series Co-ordinator

Alfred Wegener Institute Helmholtz Centre for Polar and  
Marine Research

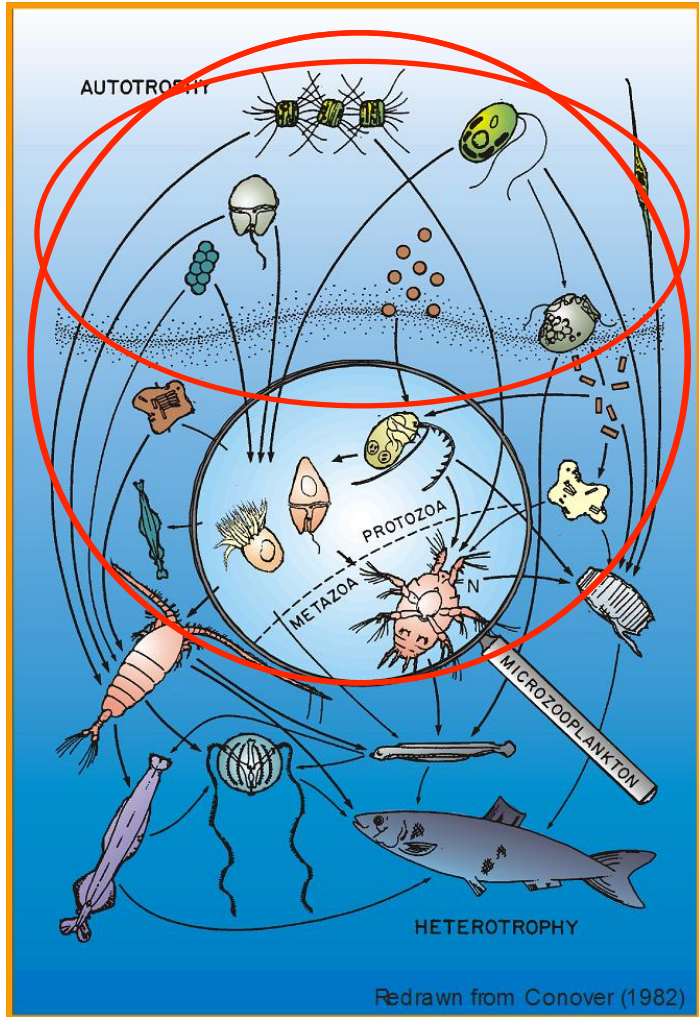
## Lena studies in the AWI context

---

- Lena activities are part of the AWI research programme PACES 2
  - Topic 1: Changes and regional feedbacks in Arctic and Antarctic
  - Topic 2: Fragile Coasts and Shelf Seas
    - Work package 1: Long-term patterns
    - Work package 2: Investigations of foodweb interactions
- Study topics so far mainly related to geology, paleobiology, permafrost dynamics
- But: no detailed study of the biological interactions or diversity

**Why is this important?**

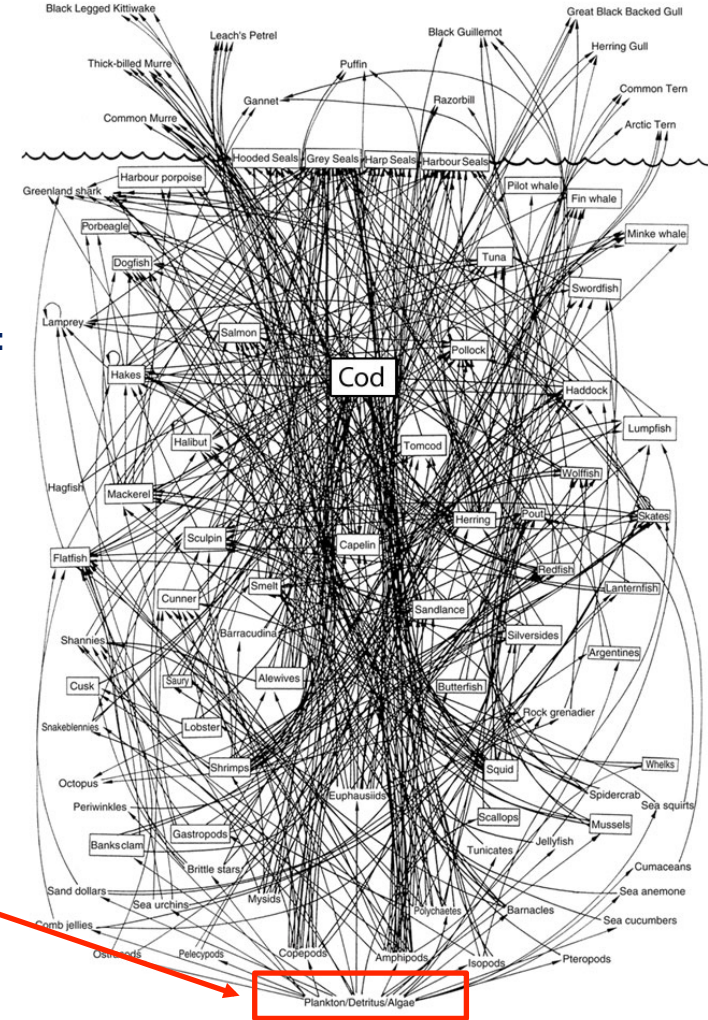
# Foodwebs and communities



**Light:  
Turbidity**

**Limited motility:  
Currents  
Vertical mixing**

**Dissolved  
Nutrients:  
Run-off  
Vertical mixing**



Need to identify/quantify the interactions for model parameterization

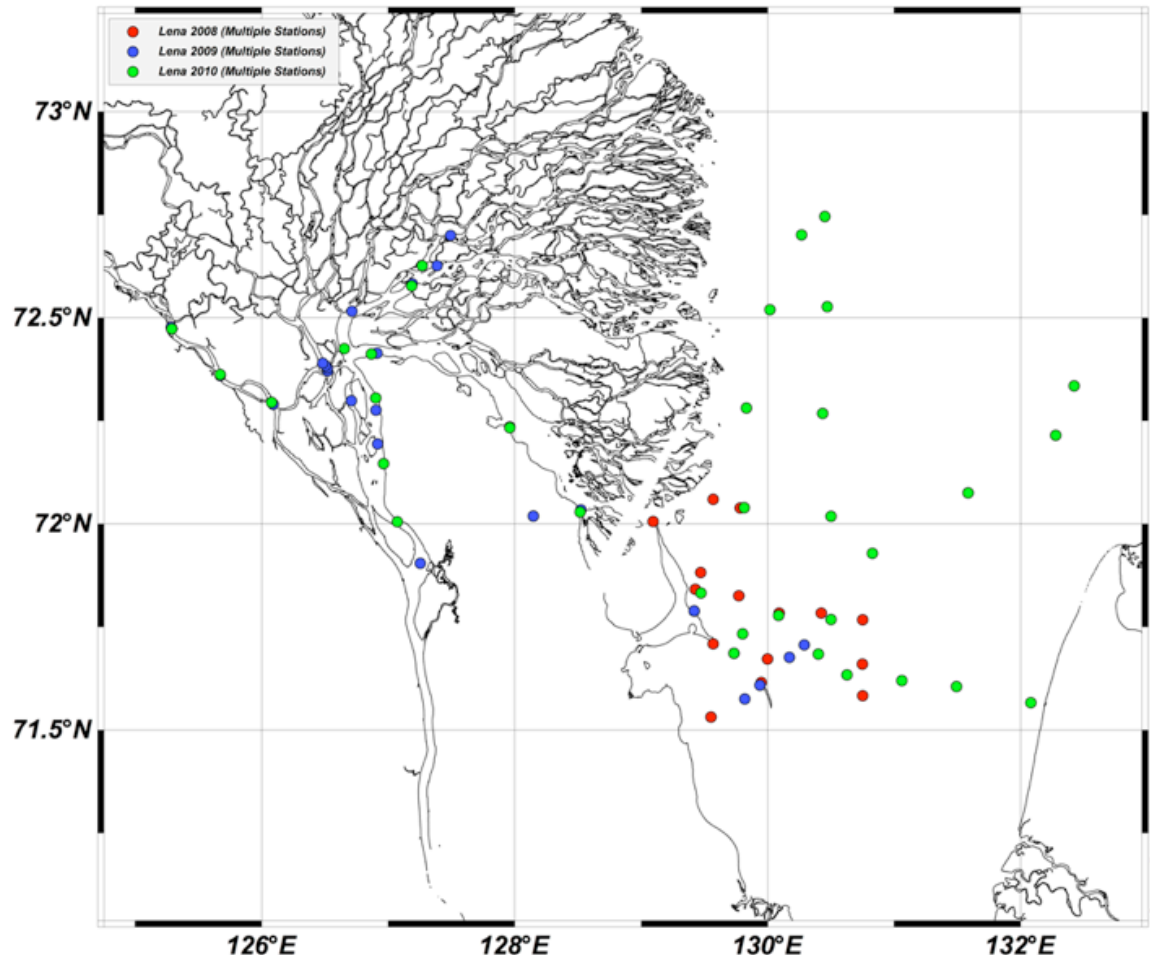
1. How many species are there at the base of the foodweb?
2. How do they interact?
3. How much turnover/variability is there?
4. How are characteristics of species and biological communities related to physico-chemical conditions
5. Why do we need to know?
  - Rising air and water temperatures
  - Thawing permafrost/changing river runoff patterns
    - Changing water chemistry
    - Changing turbidity patterns
    - → **VERY DIFFERENT CONDITIONS FOR PHYTO- AND ZOOPLAKTON**



# Sampling the Lena Delta

Contributes 20 % of total annual river discharge into the Arctic Ocean

An area of rapidly melting permafrost → effects on turbidity, salinity, nutrients



**2008: Coastal river and lake sites**

**2009: mainly riverine sites/  
4 coastal sites (mainly  
surface samples)**

**2010: 4 coastal transects  
4 riverine transects  
Samples from: surface, chl  
maximum and bottom**

# Sampling stations 2013

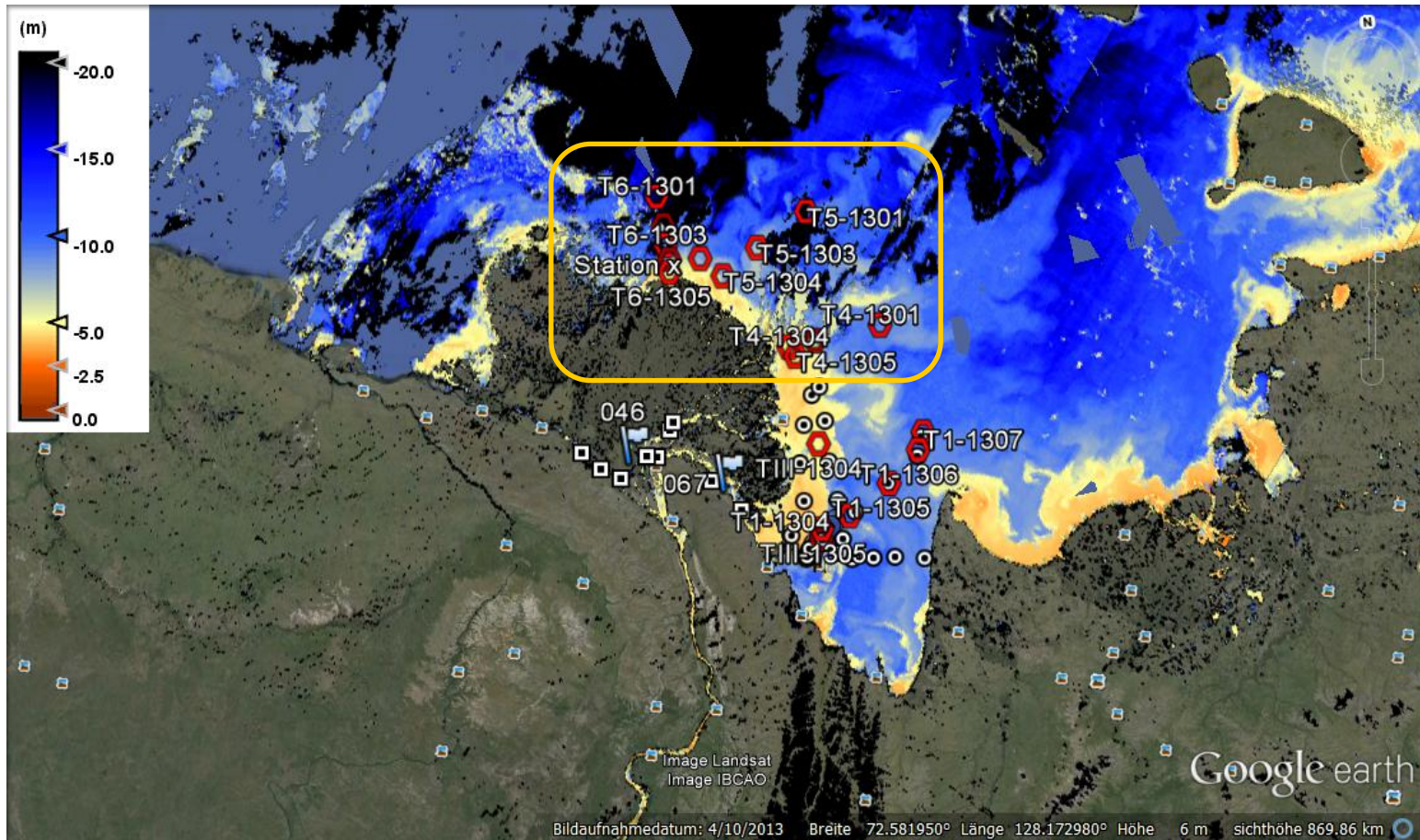


Image: Heim et al. 2013

**2013: Repeat of T1 from 2010 + additional coastal transects**

## Additional data: Phytoplankton and Zooplankton

---

### Taxonomic studies

Cremer, H.: The **diatom flora** of the laptev sea (arctic ocean), Bibliotheca Diatomologica, 40, 1–168, 1998.

Cremer, H.: Distribution of **diatom** surface sediment assemblages in the laptev sea (arctic ocean), Mar. Micropaleontol., 38, 39–67, 1999.

Okolodkov, Y. B. and Dodge, J. D.: Biodiversity and biogeography of planktonic **dinoflagellates** in the arctic ocean, J. Exp. Mar. Biol. Ecol., 202, 19–27, 1996.

Kosobokowa et al 1998 Composition and distribution of zooplankton in the Laptev Sea and adjacent Nansen Basin during summer, 1993, Polar Biology

### Seasonality/Biogeography

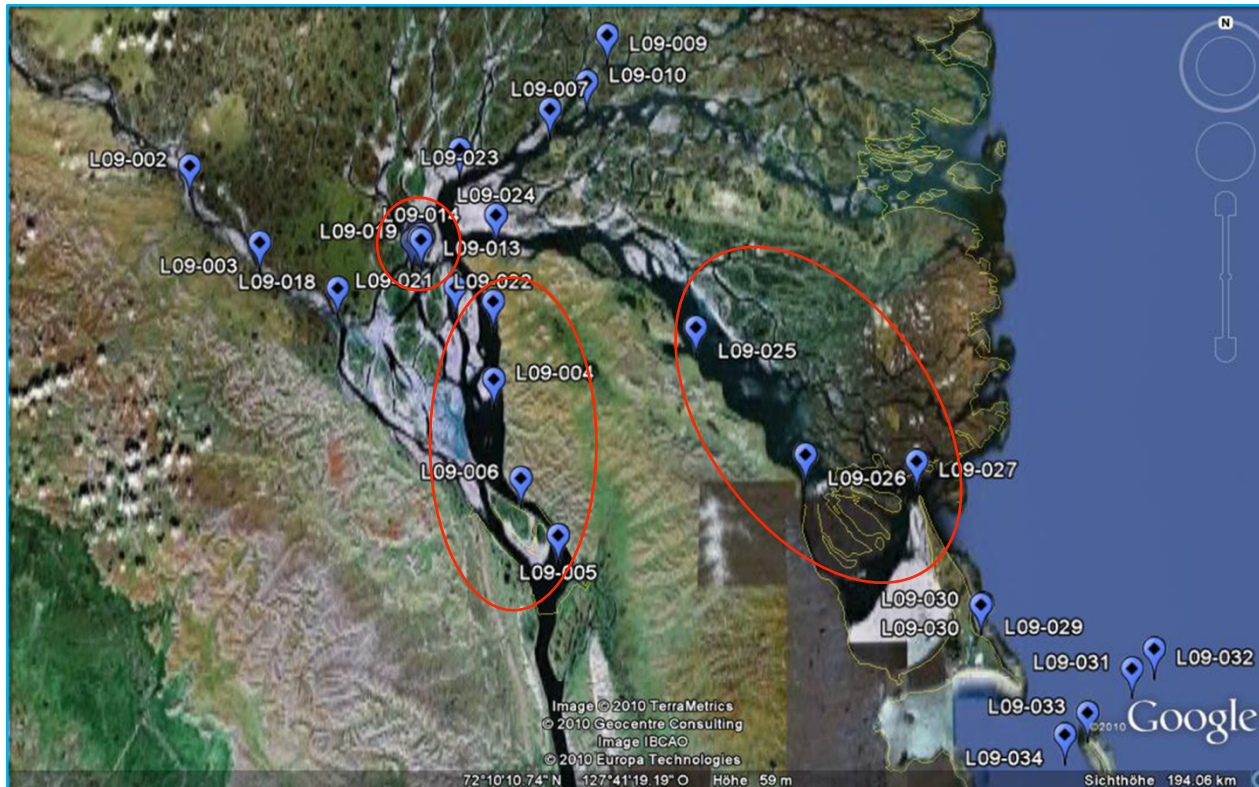
Tuschling, K.: **Phytoplankton** ecology in the arctic laptev sea – a comparison of three seasons, Berichte zur Polar-und Meeresforschung/Reports on Polar and Marine Research, 347, 1–144, 2000.

Transdrift cruises e.g. Zooplankton and ocean colour

**A few individual studies, but no co-ordinated assessments and no long-term measurements**

**→NO BASELINE DATA FOR ASSESSING CHANGES**



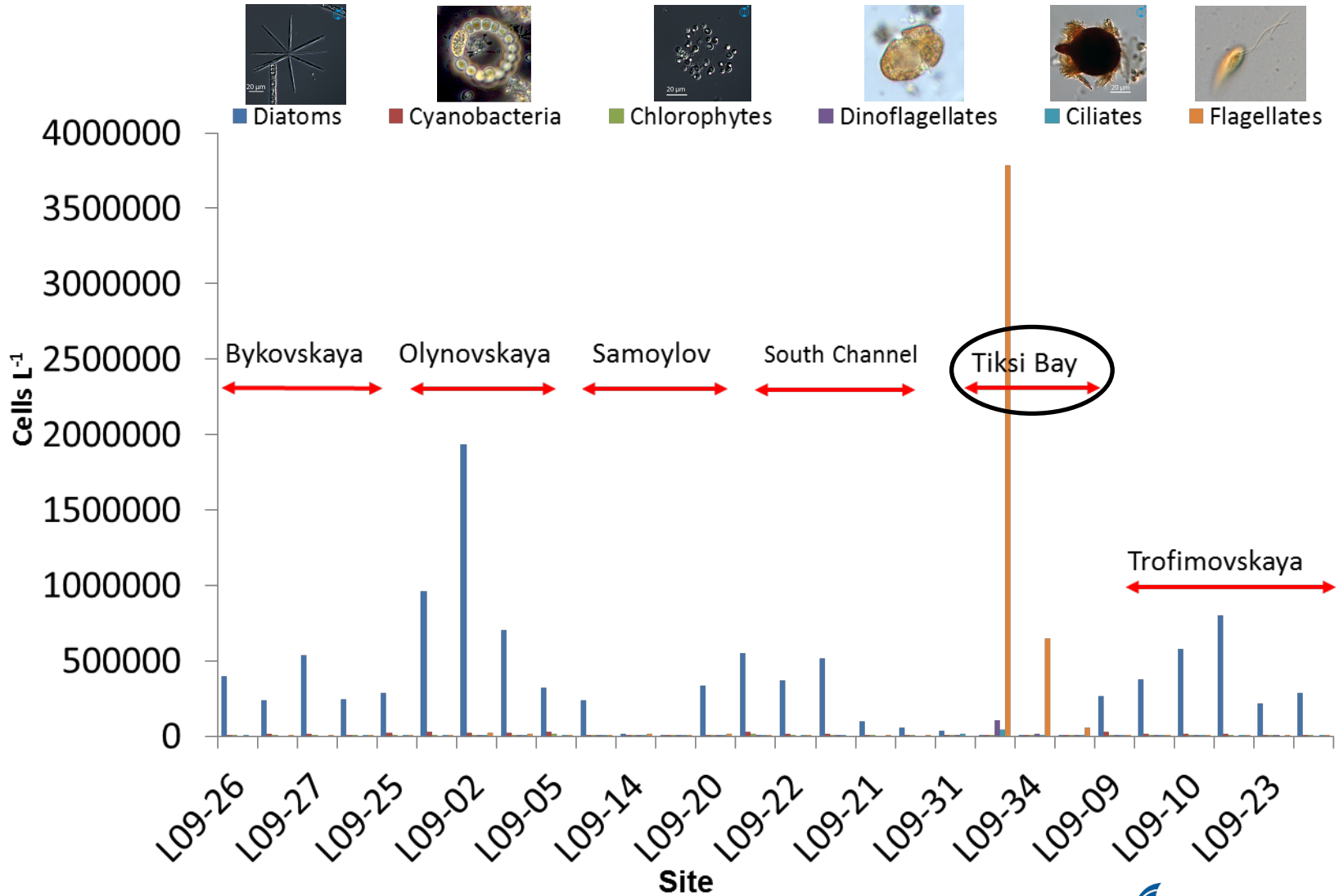


## Measured parameters

- Temperature
- Salinity
- Inorganic nutrients
- Total chlorophyll
- Phytoplankton abundance
  - (surface samples plus some subsurface samples)

Phytoplankton samples counted with inverted microscope (Uthermöhl method)

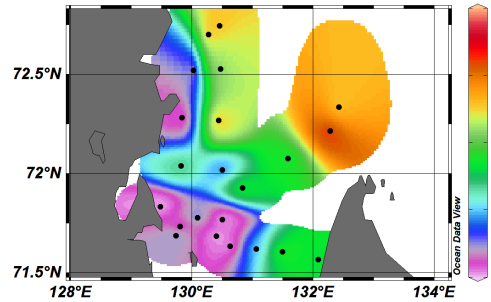
# Community composition 2009



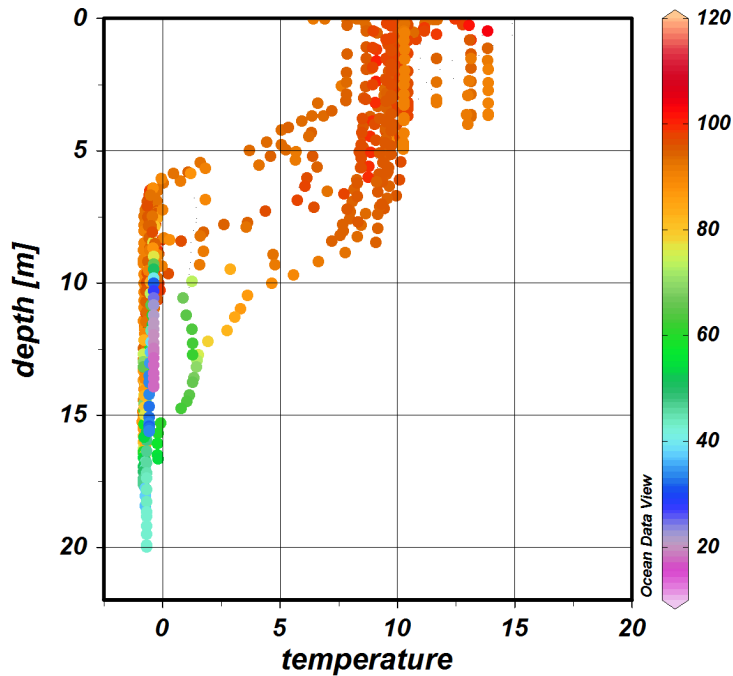


# Surface salinity and Oxygen profiles 2010

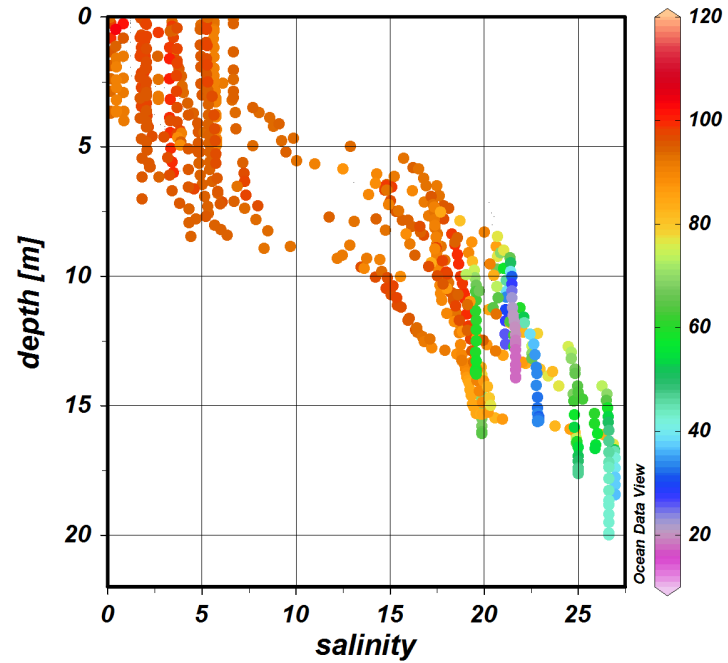
SALNTY [PSS-78] @ DEPTH [M]=first



oxygen [‰]

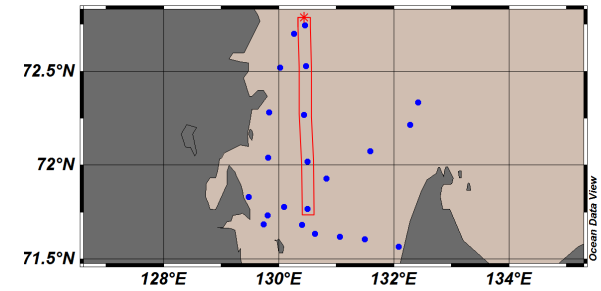
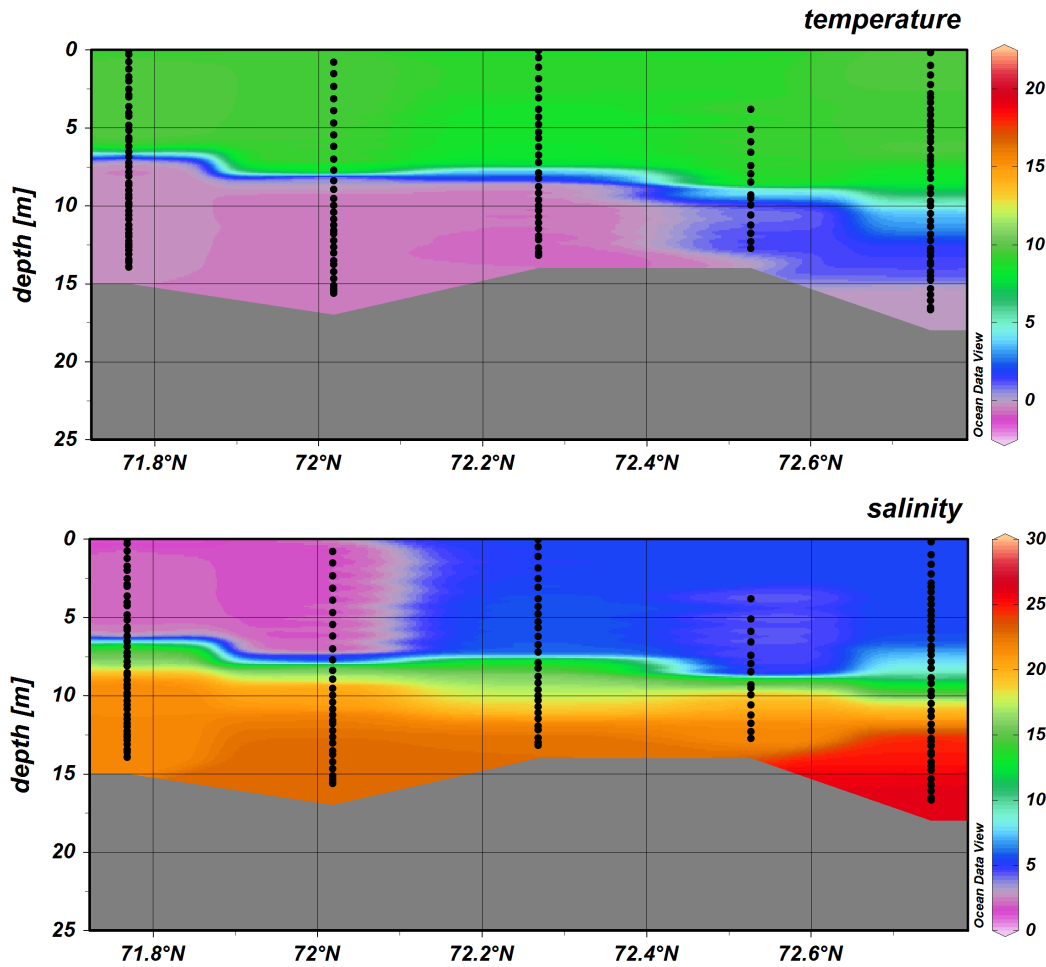


oxygen [%]



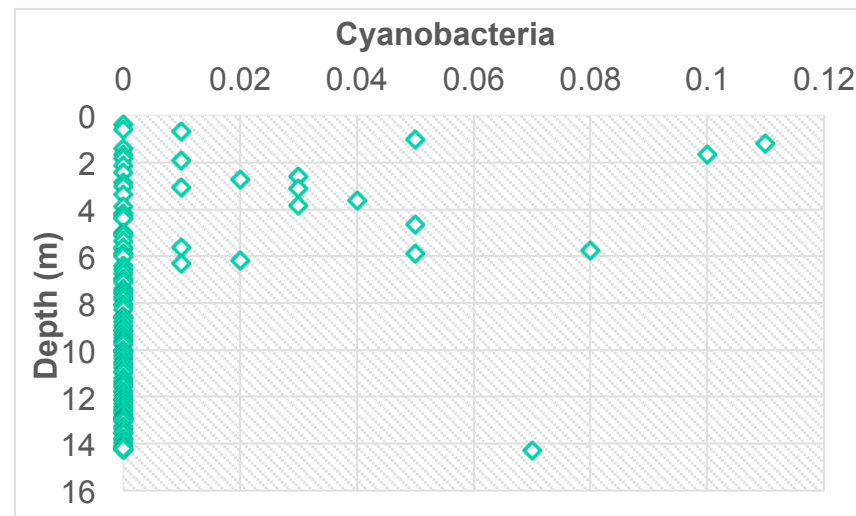
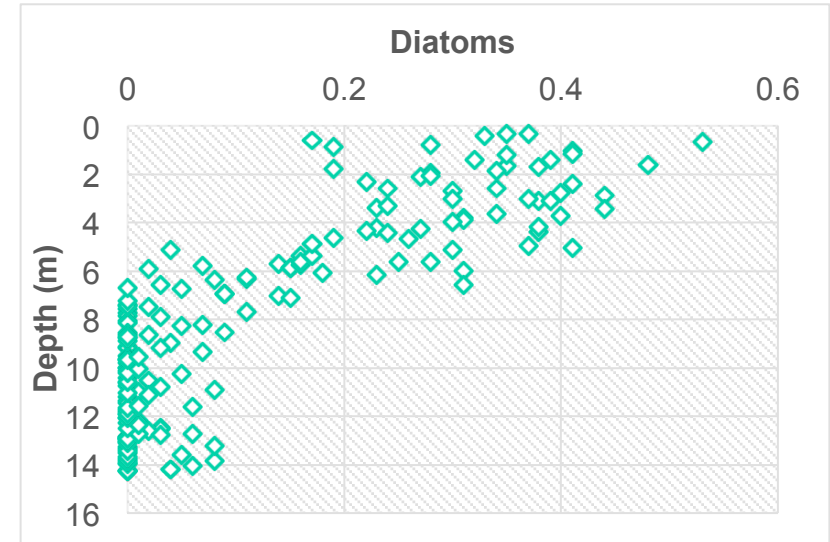
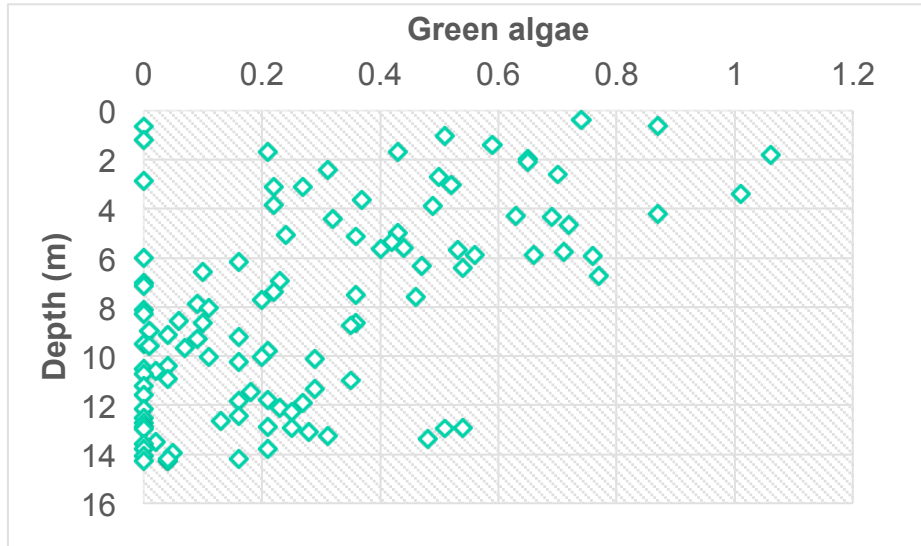
Water clearly stratified, watermasses below Halo/thermocline oxygen poor

# Temperature and salinity profiles Transect 4, 2010

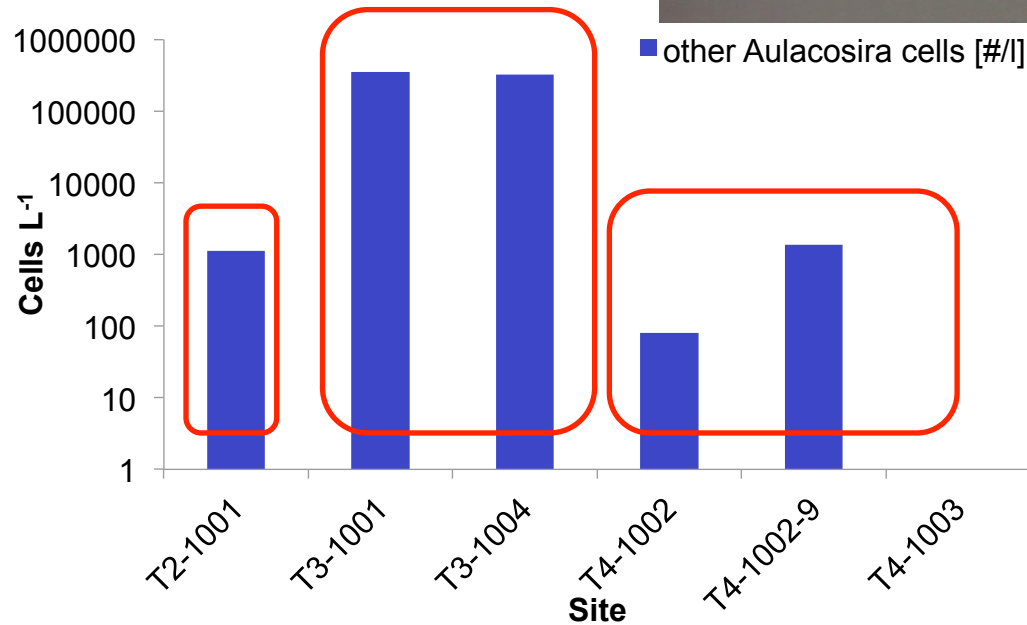
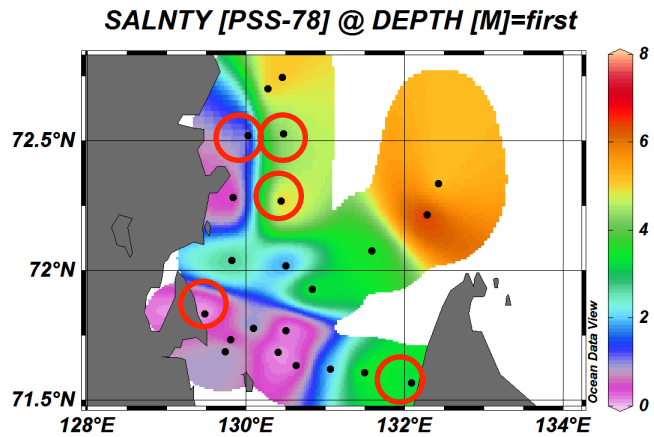


Profiles based on CTD profiles

# Site T4-1005: Chlorophyll ( $\mu\text{g/l}$ ) depth profiles 2010

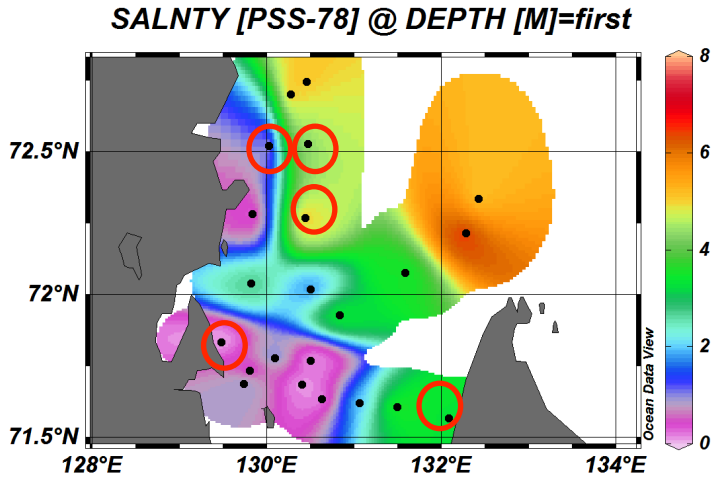


# Phytoplankton community 2010: Diatoms

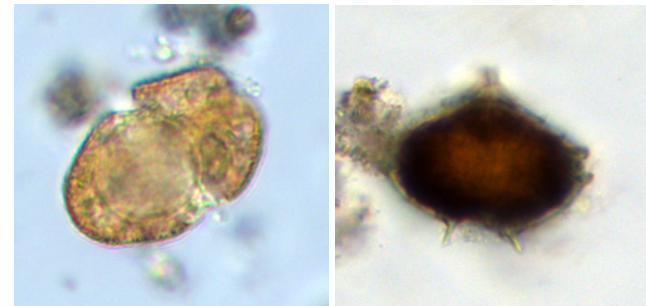


Differences in abundance of the most common diatom in the Lena Delta (diatoms=autotroph, i.e. requiring light for growth)

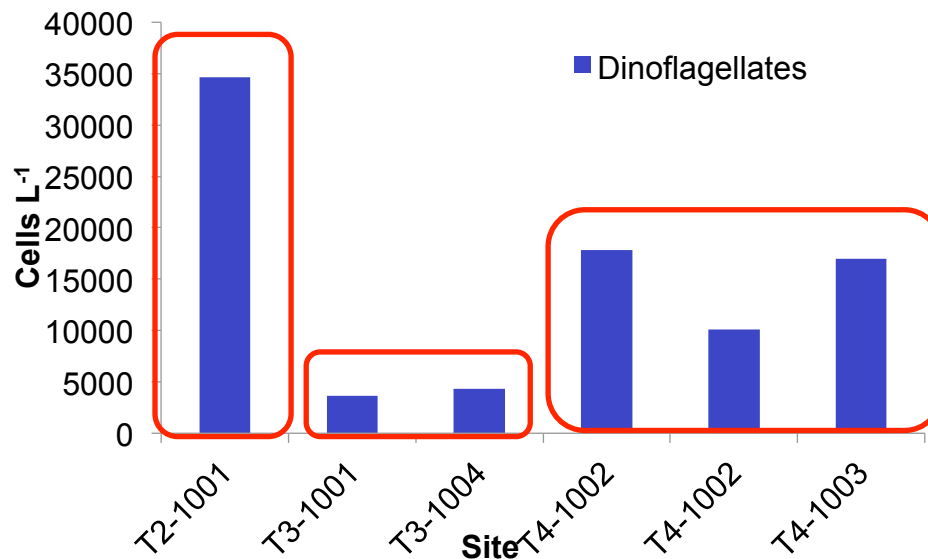
# Phytoplankton community 2010: Dinoflagellates



## Dinoflagellates



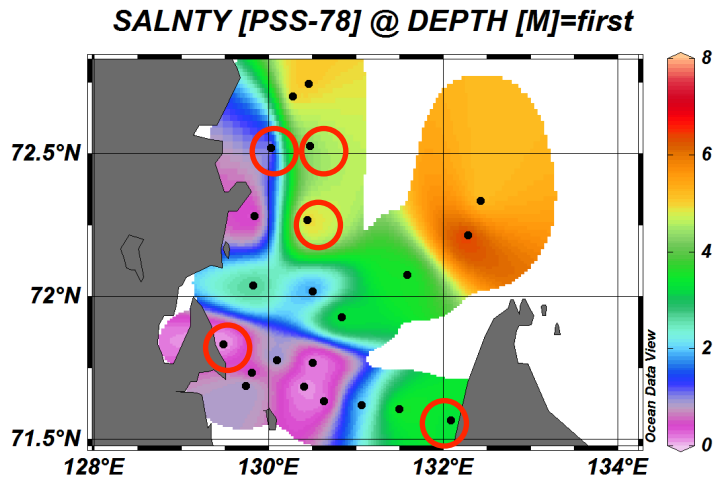
→ heterotrophic and mixotrophic



Dinoflagellate distribution at selected stations in the Lena Delta



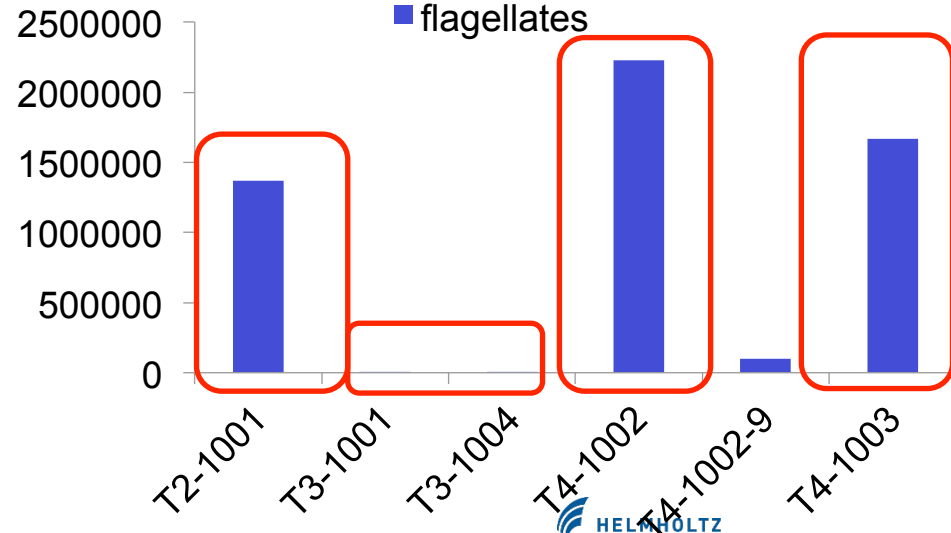
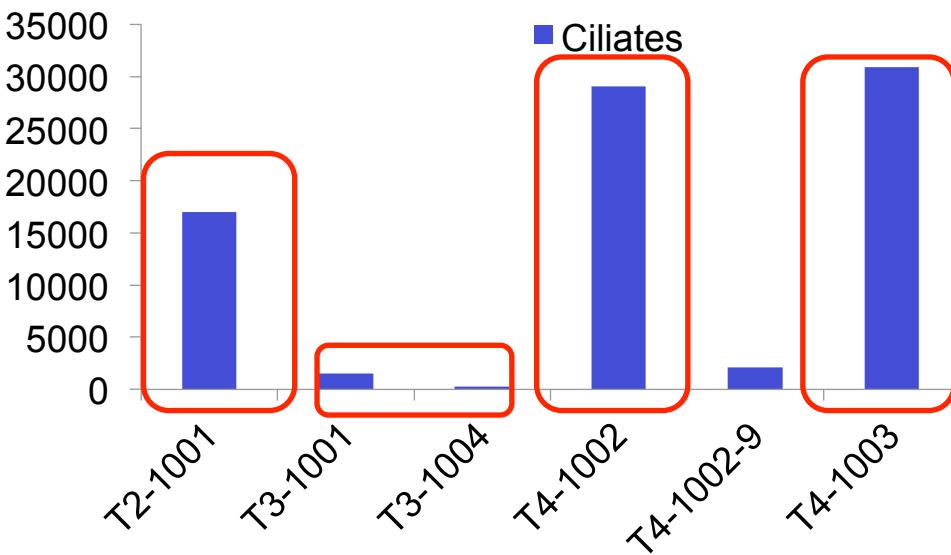
# ,Phyto'plankton community 2010: Ciliates/flagellates



Ciliate

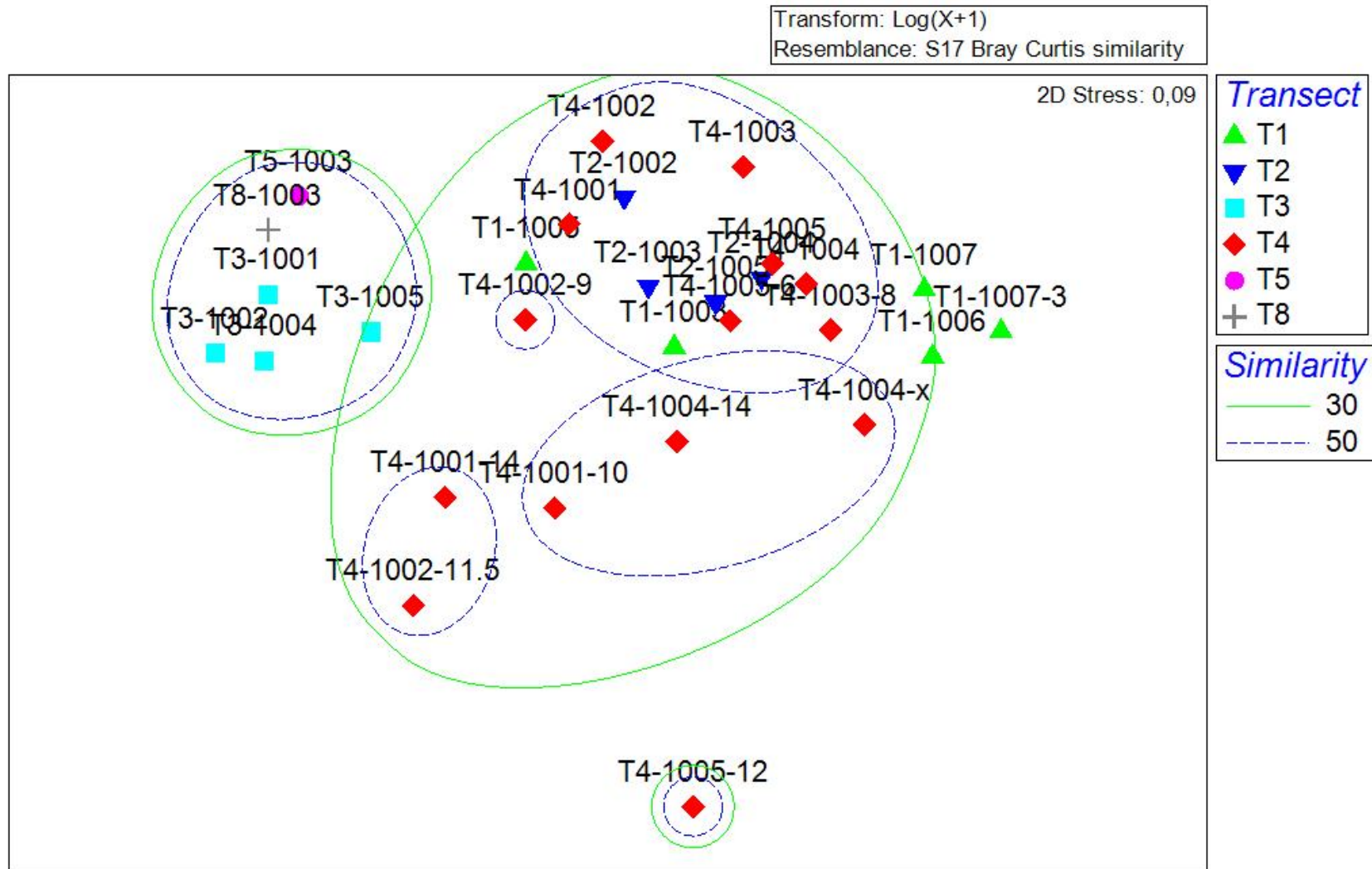


Flagellate



Predator-prey relationship

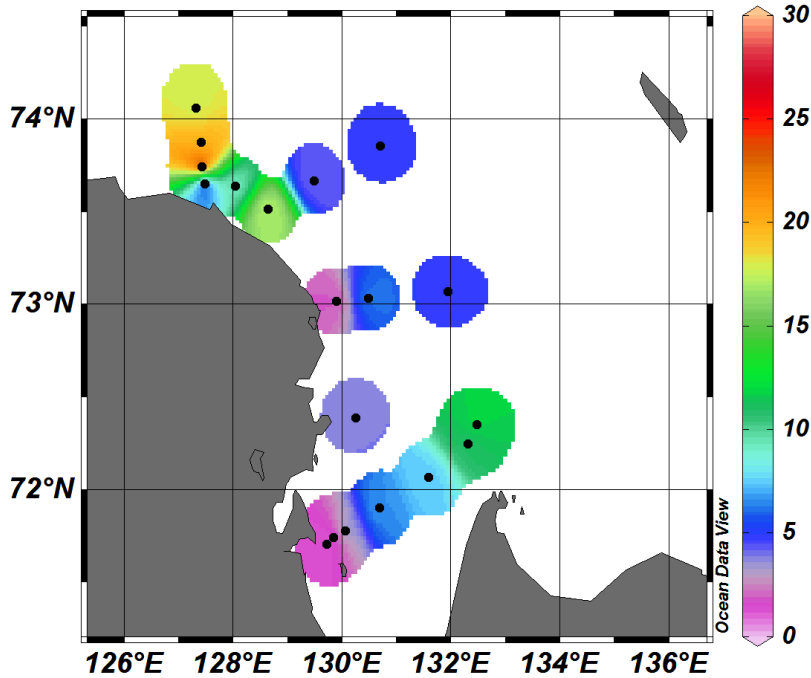
# Relationships between sites: Multidimensional scaling analysis



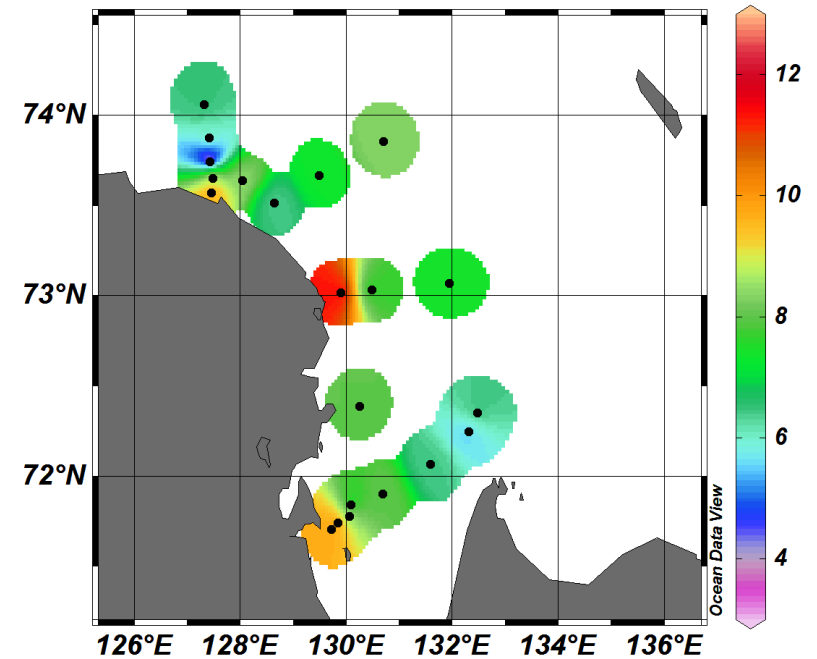
Analysis combines all sites sampled in 2010

# The situation in 2013: Surface sample

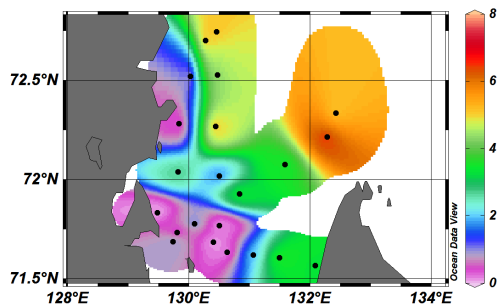
**SALNTY [PSS-78] @ DEPTH [M]=first**



**TEMPERATURE [°C] @ DEPTH [M]=first**



**SALNTY [PSS-78] @ DEPTH [M]=first**



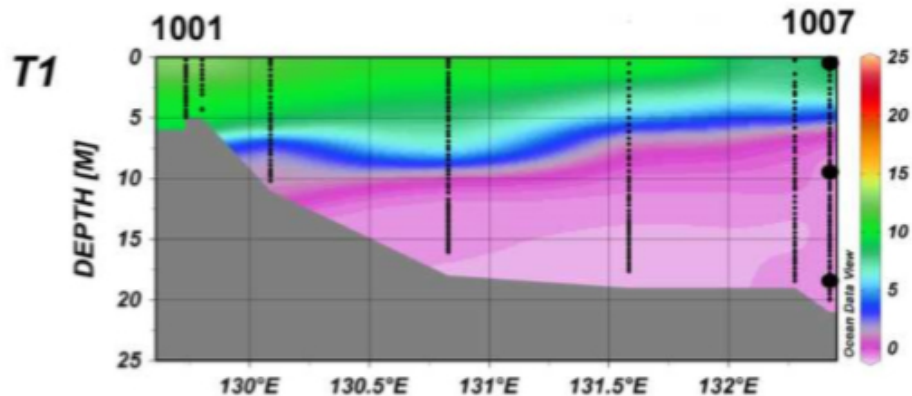
Greater freshwater influence in 2010?

Reminder: 2010

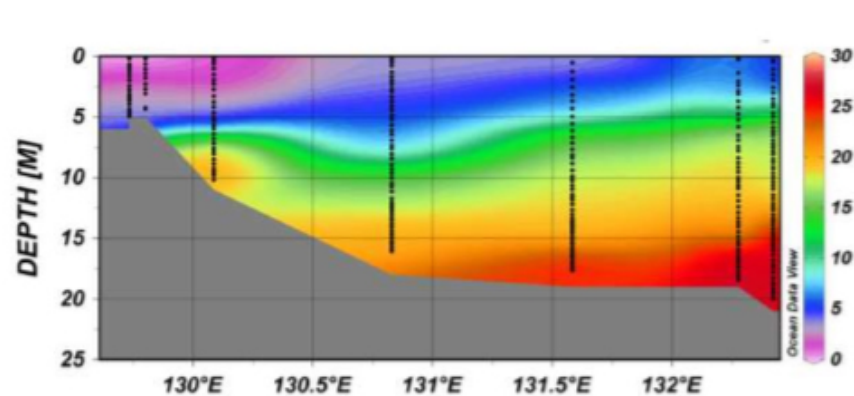
# Salinity/temperature in 2010 and 2013

2010

Temperature (°C)

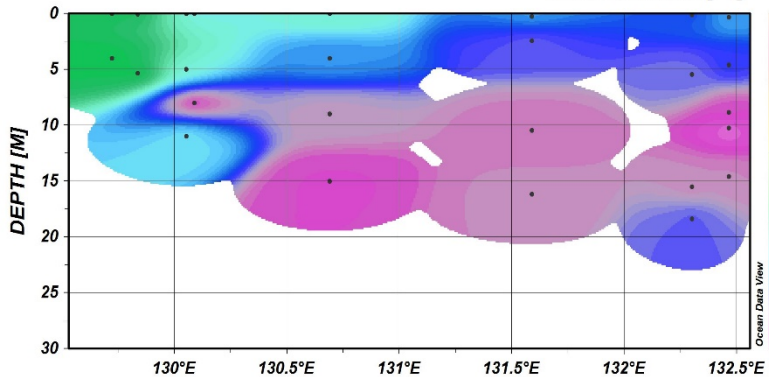


Salinity

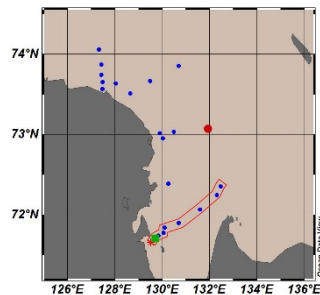
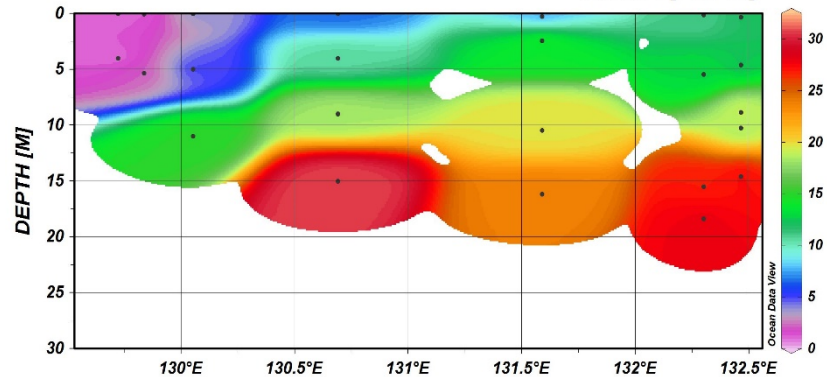


2013

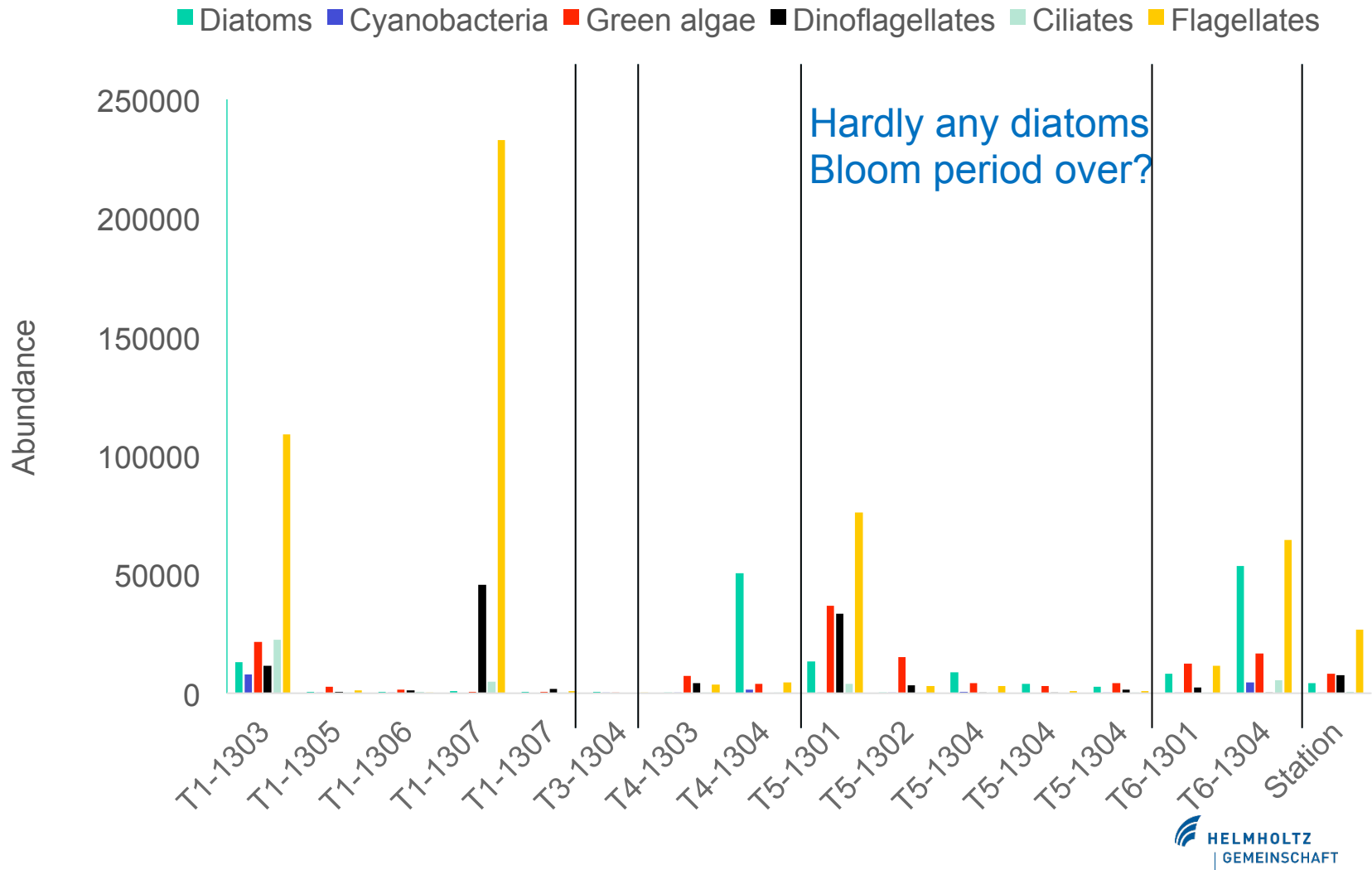
TEMPERATURE [°C]



SALNTY [PSS-78]

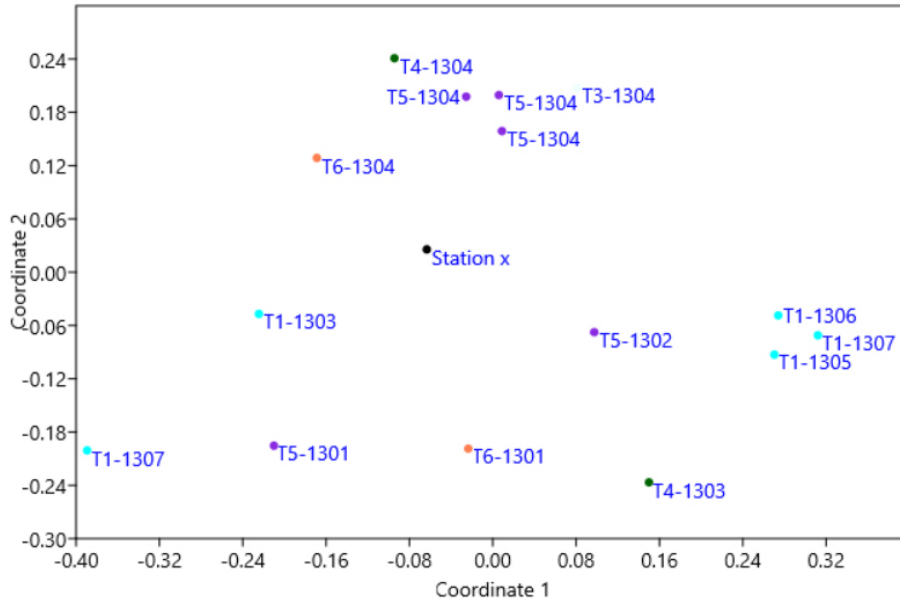


# Distribution of major plankton groups in 2013





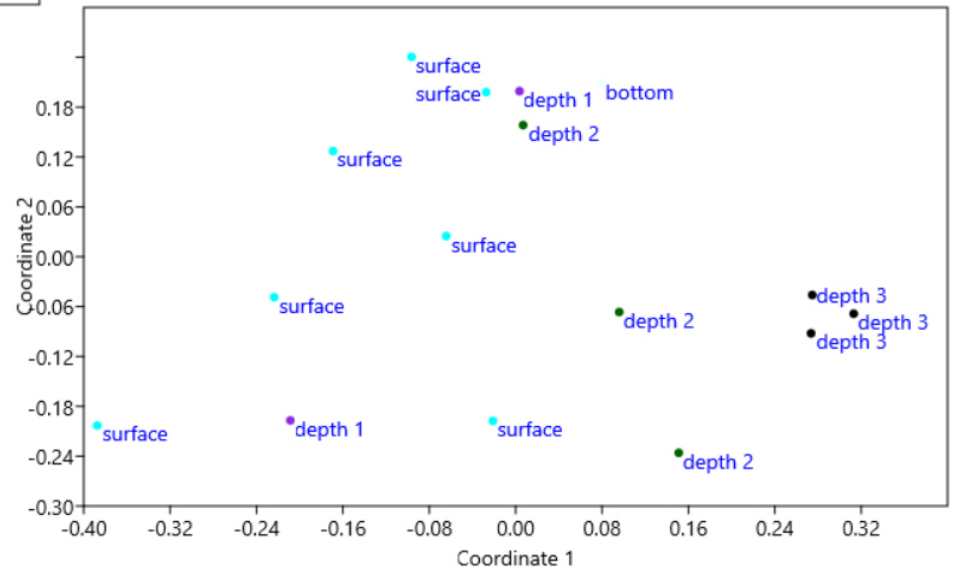
# MDS analysis for 2013 (preliminary)



Labels= transects

Not all data analyzed yet!!

Labels= depth



## Summary

---

- Water masses can be very strongly stratified (strength and extent vary interannually)
- Lower strata low in oxygen and light in 2010 → hinders diatom production but not bacterial communities
- Phytoplankton clearly partitioned in different hydrographic regimes
  - Diatom dominated (autotrophic) community in low salinity/warm waters directly influenced by the river plume
  - Dinoflagellate dominated community in higher salinity waters
- 2013: Generally lower abundance, very few diatoms, community more uniform (at least near the surface)

## Further research needs

---






- Resolution of the vertical structuring of the water column for development of biological communities
- Vertical transport mechanisms and changes in vertical structure as the result of melting permafrost (need data on annual extent of vertical stratification)
- Spatial dynamics: Long-term changes in interaction between saline and riverine watermasses (horizontal transport of water masses)
- Quantification of ecological community processes
- Prediction of changes in turbidity, DOC concentrations on foodweb structure and functioning etc.
- Need to link different different research groups working on physical oceanography, hydrography, phyto- and zooplankton

What data are lacking: **Everything**

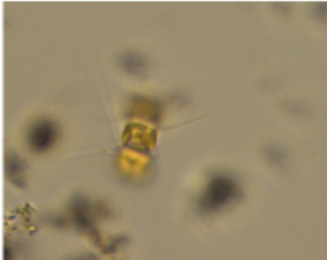
- Comprehensive **catalogue of species/taxa** in the Lena proper and Delta region with data summaries of environmental conditions they are found in. This needs to be **publicly available**

## Preliminary catalogue of Lena phyto- and zooplankton species

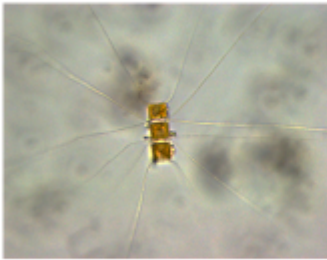
A basis for the species counts of Lugol fixed samples from the Lena river and Delta

<b>Content</b>	
Introduction Biogeographical notes Species Descriptions	
Diatoms	Dinoflagellates
	
Green Algae	Cyanobacteria
	
Zooplankton	
	

## Chaetoceros cf wighamii




**Images**



**Description**  
Chains straight, delicate. Apertures lanceolate, with poles of adjacent cells touching. Orientation of intercalary setae variable, from perpendicular to parallel to the chain axis. Terminal setae of similar thickness to the intercalary setae, running almost parallel to the chain axis  
Resting spores: Primary valve rounded with fine spines, secondary valve cone shaped in the centre

**Biogeography**



Consistent/standardized information!!!!!!!!!!!!!!





## What data are lacking: **Everything ctd**

---

- Regular measurements in the same area and transect: **(long-term observatory)**
  - Measurements need to capture the full salinity and temperature gradient from the fresh Lena to the open Arctic Ocean waters
- **‚Rates‘ data**: There are no laboratory studies on growth rates and other traits. We cannot judge whether the ecosystem is under pressure from anthropogenic climate change.
- Regular combined observations of biological communities and the underlying hydrography and physico-chemical parameters

Thank you for your attention!!