

# The Role of Zooplankton Grazing on Noxious Cyanobacteria Blooms in Vancouver Lake, WA



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## **Problem:**

**Noxious, summertime cyanobacteria blooms that force closure of the lake to swimming/water contact**



**Vancouver Lake August 2008**

## **Our key questions:**

- **What environmental factors influence the formation, persistence, and decline of cyanobacteria blooms?**
- **What is the impact of small (<0.2 mm) and large (0.2-2.0 mm) planktonic grazers on cyanobacteria blooms?**



# A Pathway to Noxious Cyanobacteria Blooms

Elser (1999)

Freshwater Biology

42: 537-543

Is nutrient loading high?

yes

no

Is loading N:P low?

no

yes

Are hydrodynamic and light conditions

“correct”?

yes

no

Does food web structure inhibit *Daphnia*

dominance?

yes

no

**NOXIOUS CYANOBACTERIA BLOOM**

**The food web  
as the final  
turn...**

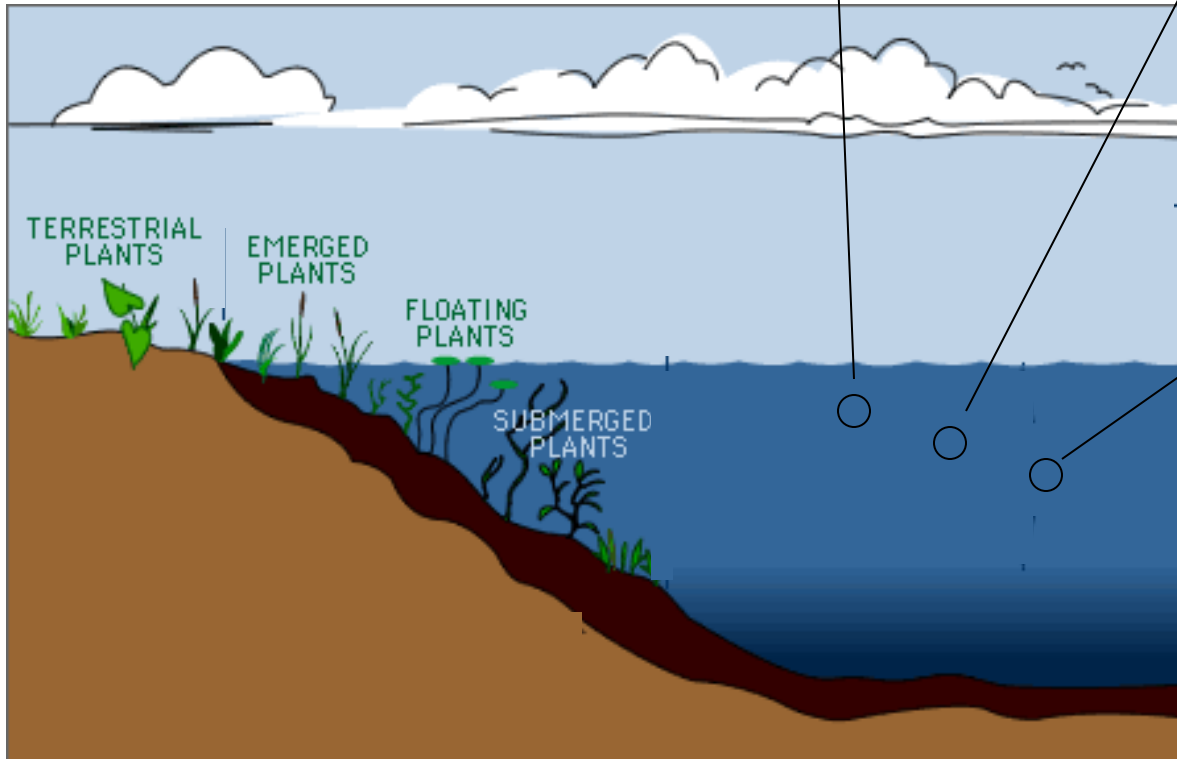
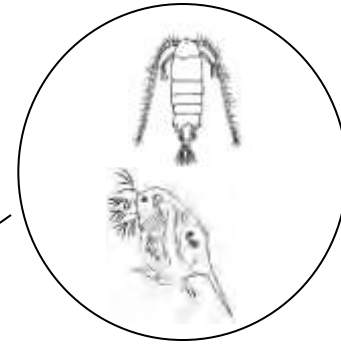
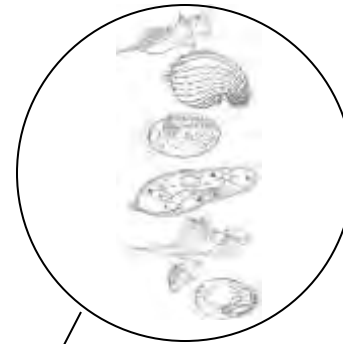
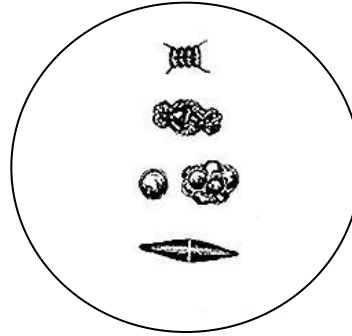
# Plankton groups in lakes:

Phytoplankton

Algae & Cyanobacteria

Protozoans

Zooplankton



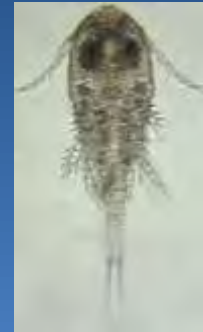
# Potential trophic interactions in Vancouver Lake



rotifers

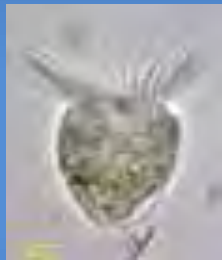


cladocerans



copepods

Zooplankton  
(large)



ciliates



dinoflagellates

Protozoans  
(small)



diatoms



chlorophytes



Algae and cyanobacteria

Nutrients:  $\text{NO}_3$ ,  $\text{NO}_2$ ,  $\text{NH}_4$ ,  $\text{PO}_4$ ,  $\text{SiO}_4$

Note: these data and the interpretation of these data are not to be reproduced or used without consent of the investigators

# Vancouver Lake Sampling Locations



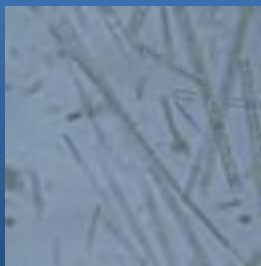
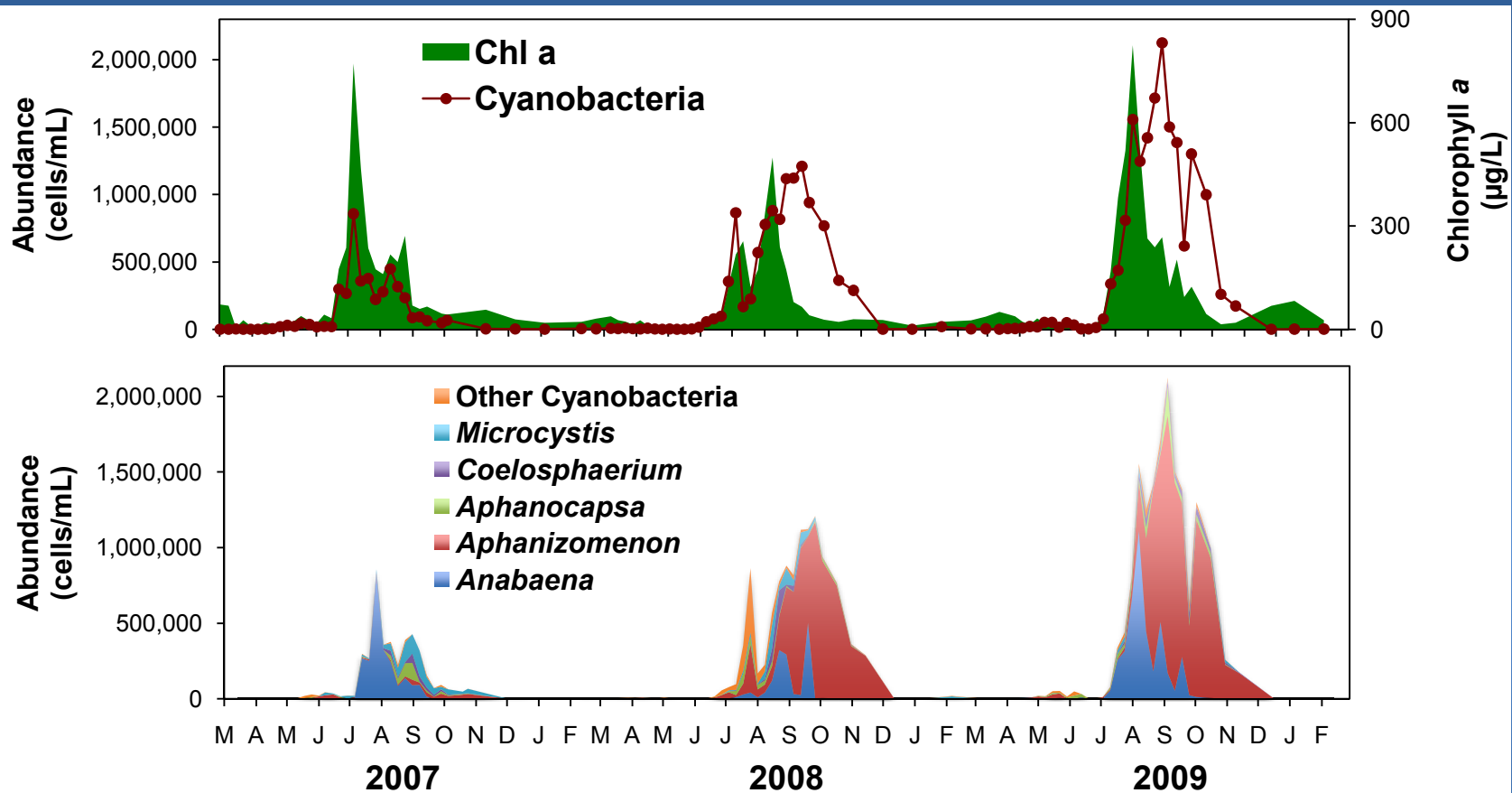
## Station 1 (Sailing Club Dock)

Sampled *monthly or weekly* 2007-2010

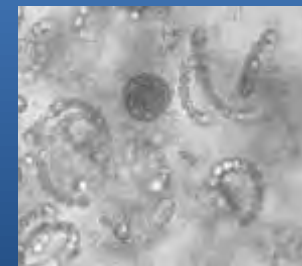
## Stations 1 – 8

Sampled *quarterly* from RV *Sea-Coug*  
2007-2008

# Cyanobacteria Abundance and Composition March 2007 – February 2010



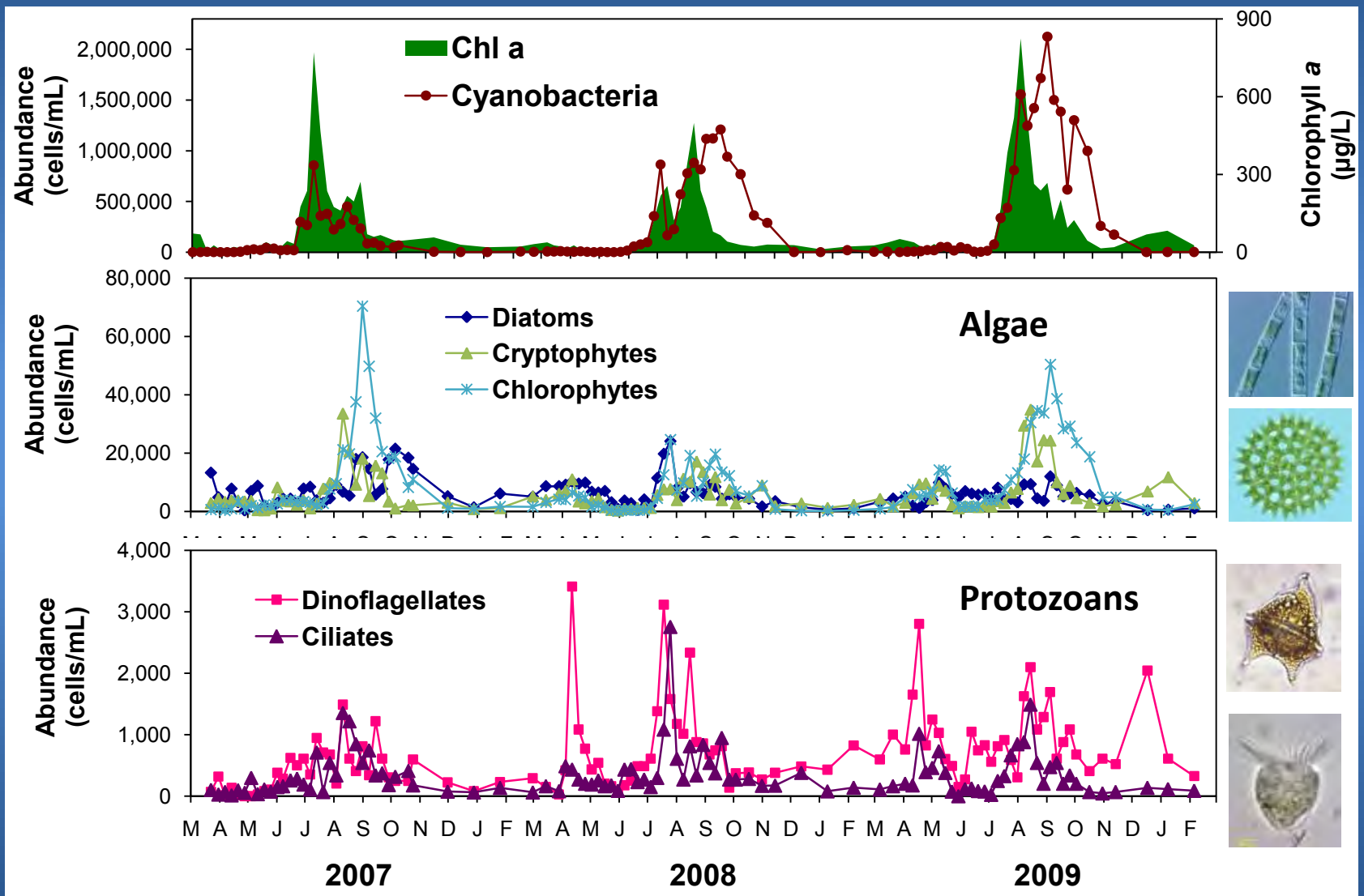
*Aphanizomenon*



*Anabaena*

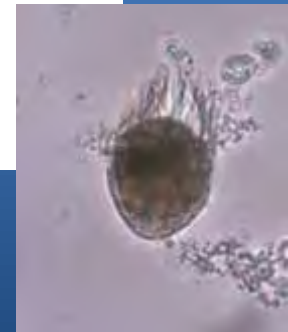
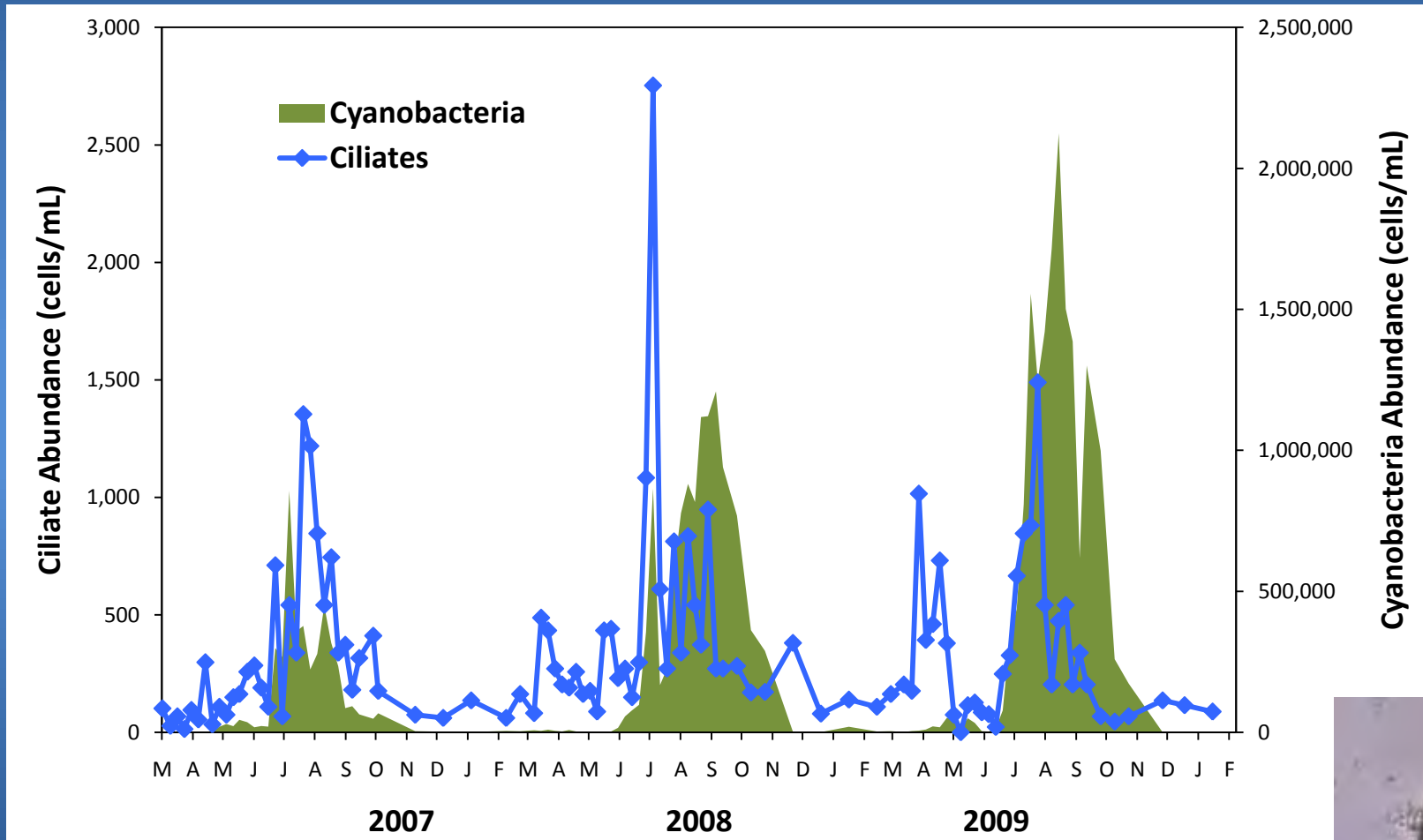
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# Phytoplankton-Protozoan Abundance March 2007 – February 2010



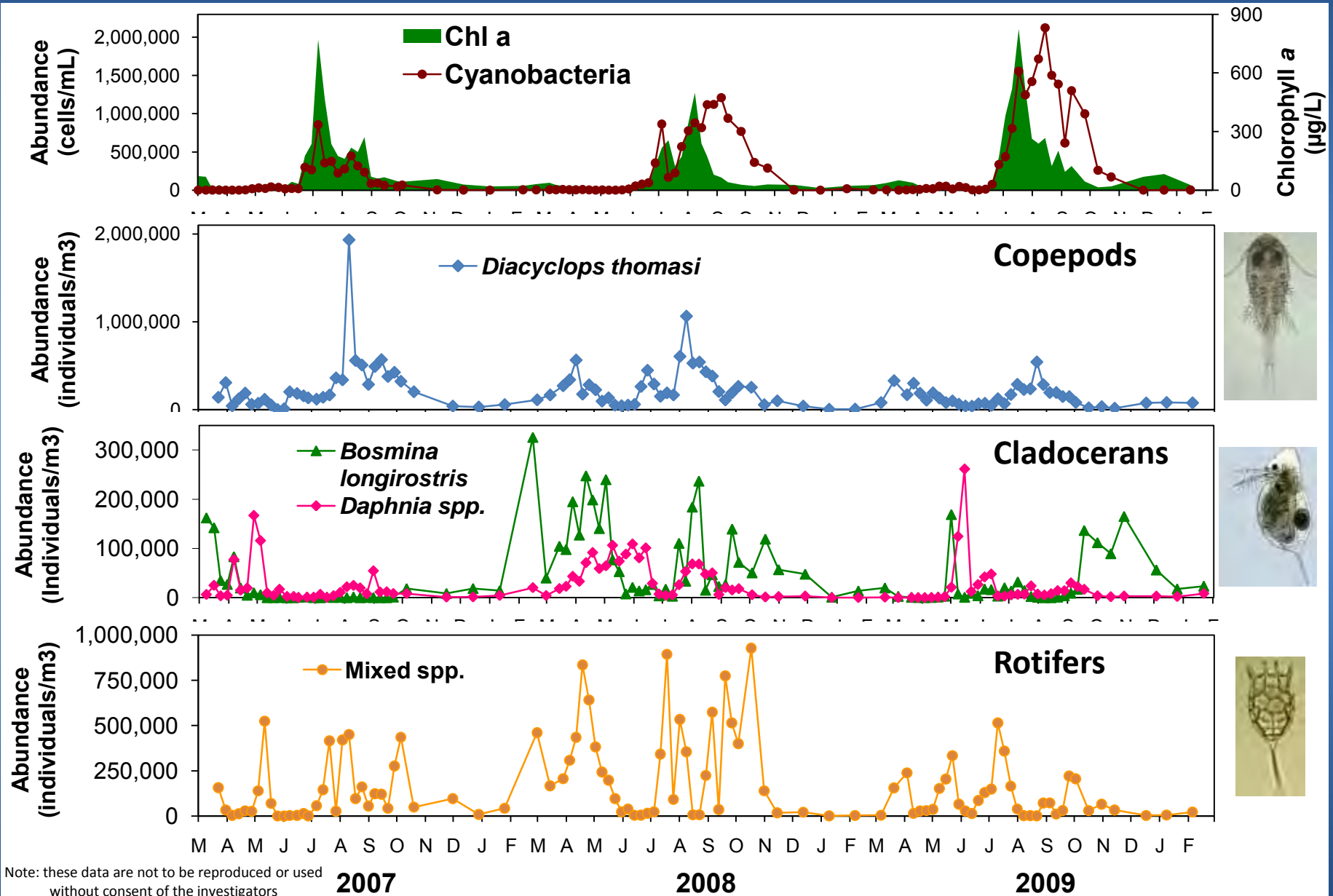
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# Cyanobacteria vs. Ciliate Abundance

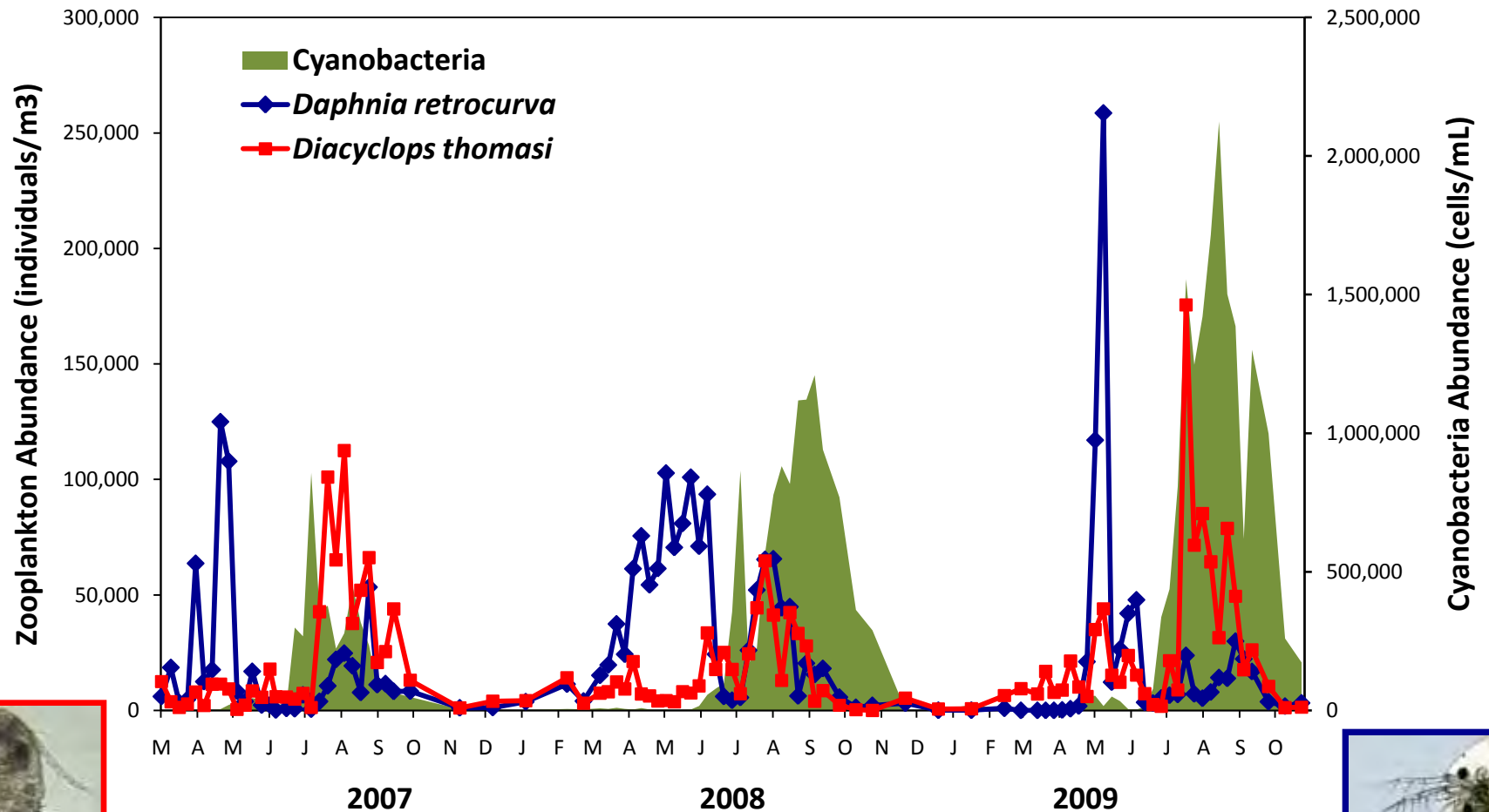


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# Zooplankton Abundance March 2007 – February 2010



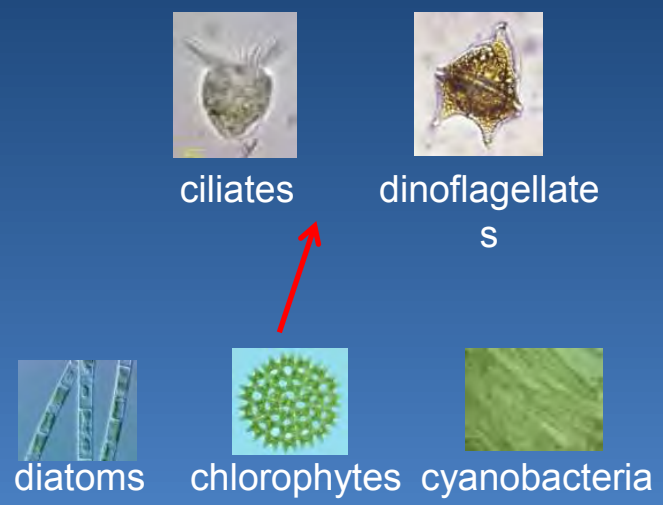
# Cyanobacteria vs. Copepod-Cladoceran Abundance



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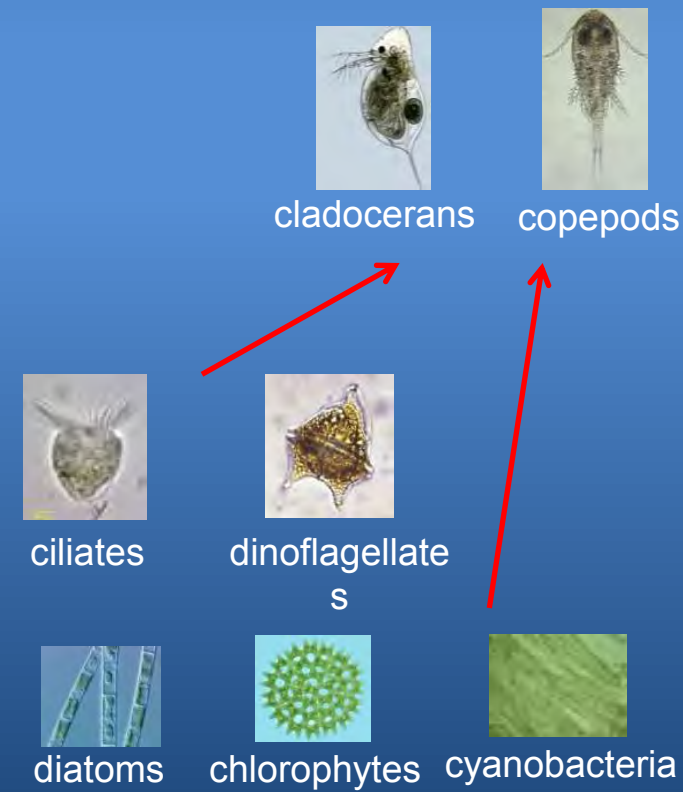
# Grazing impact of protozoan plankton (“small” grazers):

- Dilution experiments every two weeks from May-October in 2008 and 2009
- Measured feeding rates of protozoans on chlorophyll-containing cells (algae and cyanobacteria)



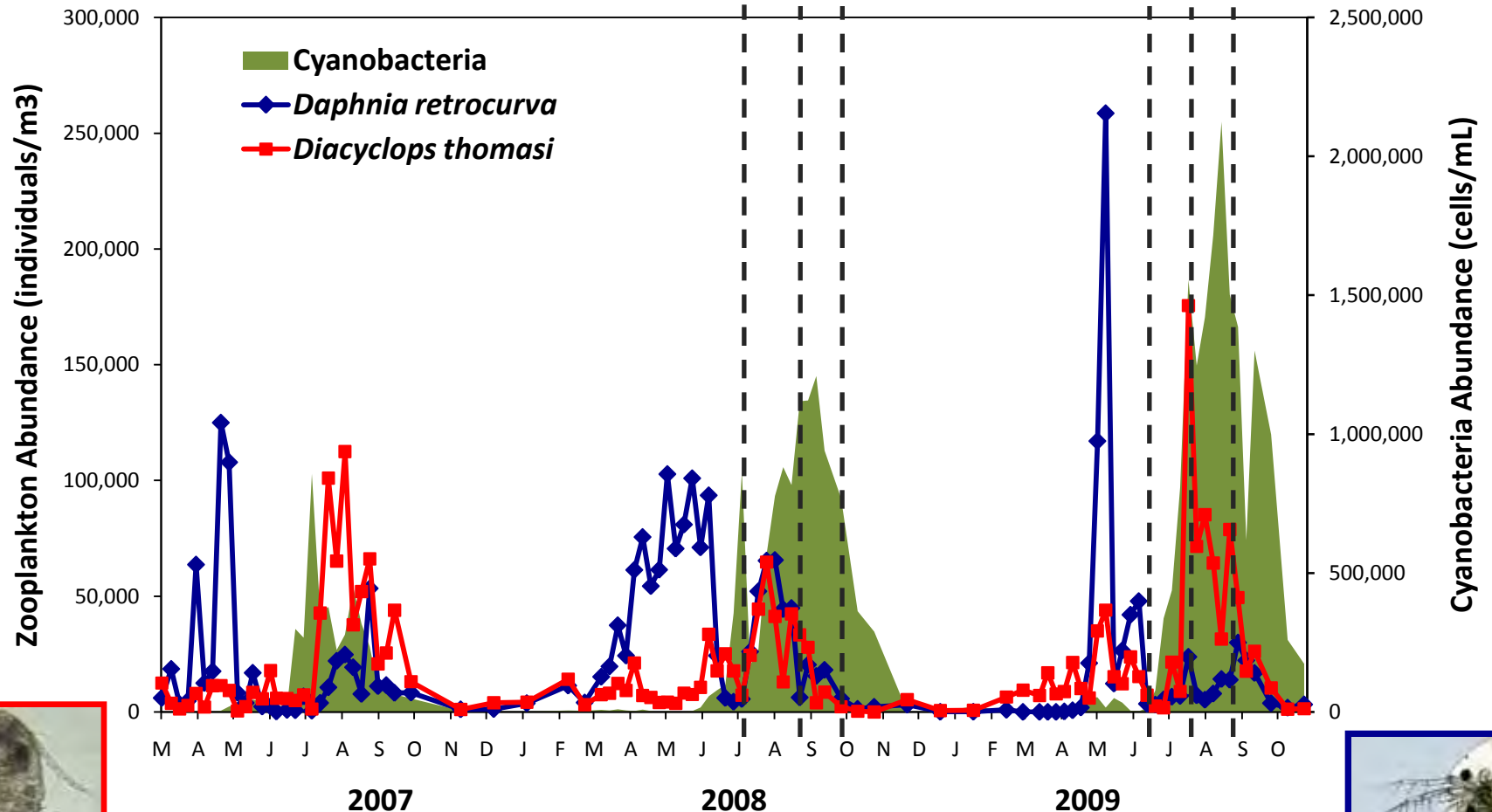
# Grazing impact of crustacean zooplankton (“large” grazers):

- Incubation experiments before, during and following late summer blooms in 2008 and 2009
- Measured feeding rates and diet preferences of copepods on all available planktonic prey (algae, cyanobacteria, protozoans)



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# Cyanobacteria vs. Copepod-Cladoceran Abundance

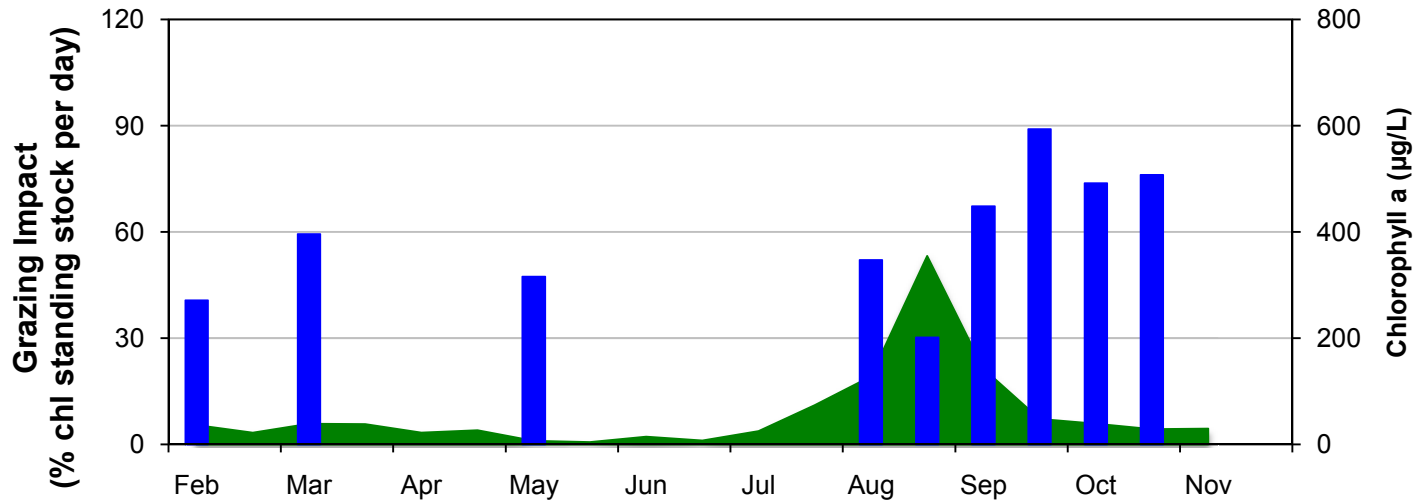


----- Dates of incubation experiments

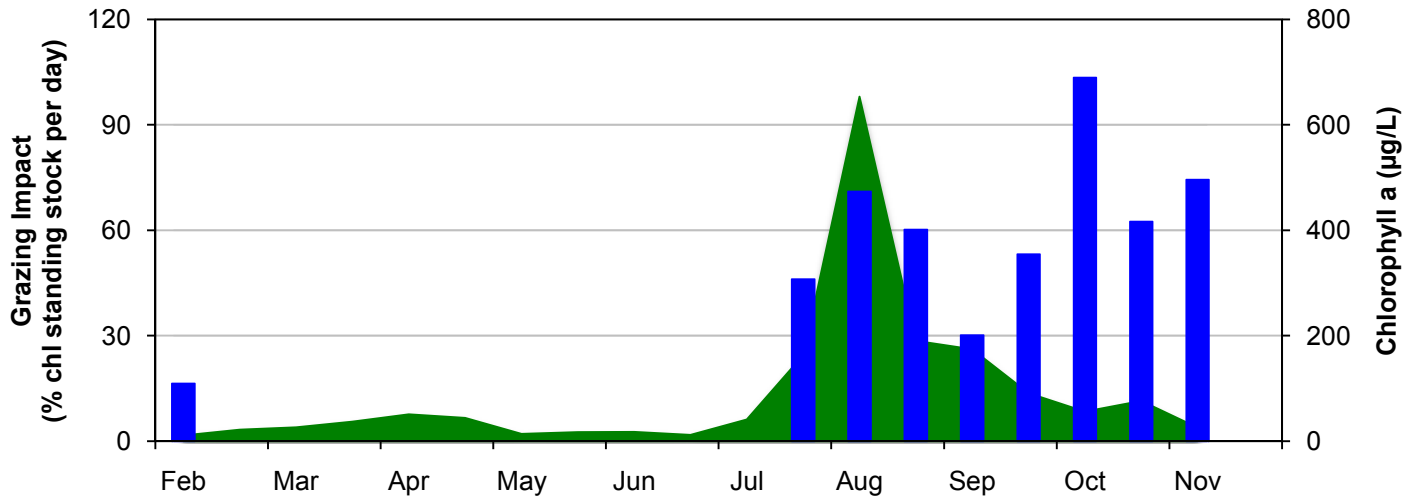
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# Protozoan Grazing Impact 2008 – 2009



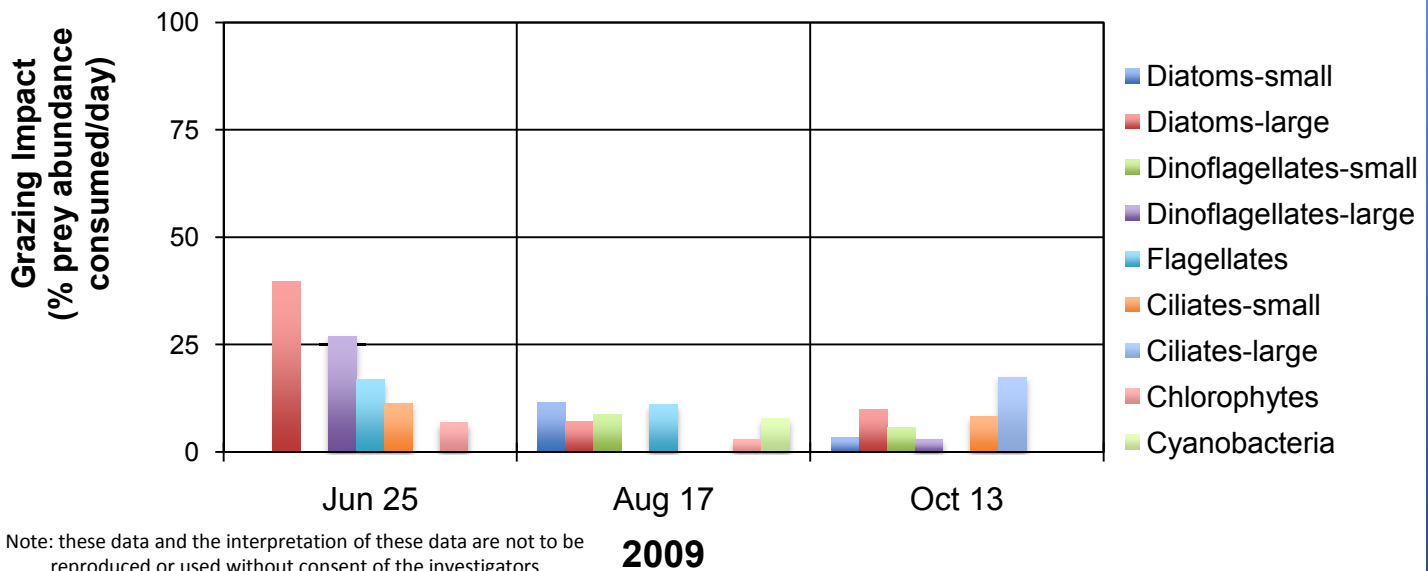
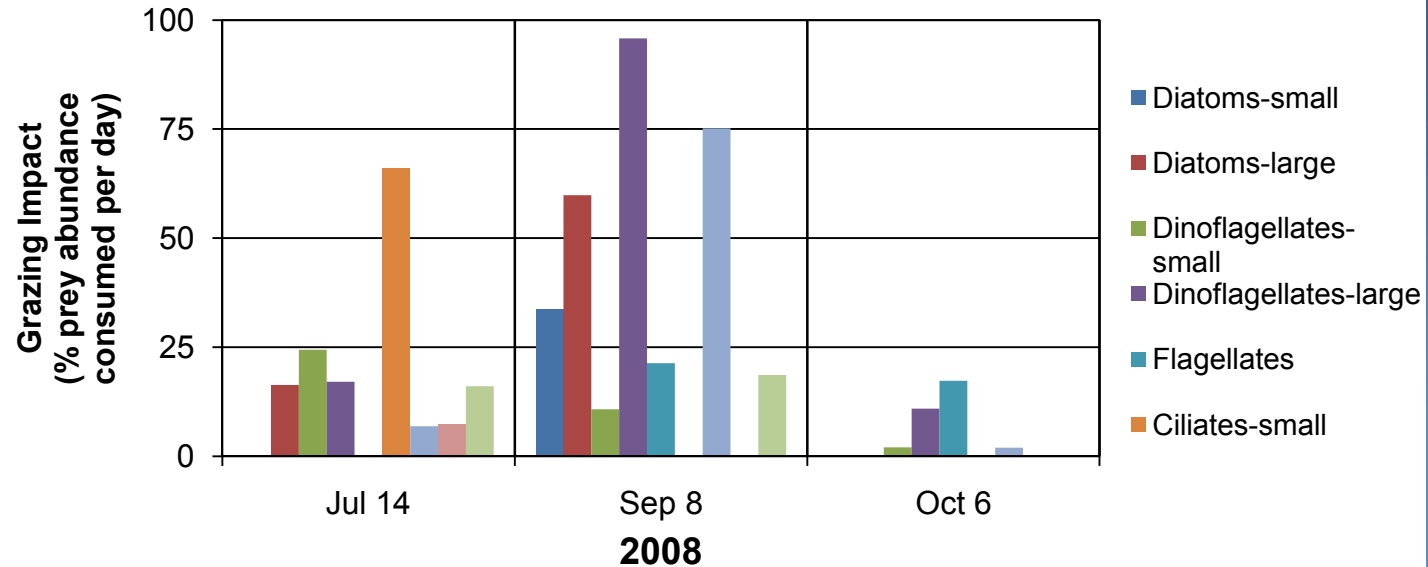
2008



2009

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# Copepod Grazing Impact 2008 – 2009



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# Summary (2007-2009)

- Very little spatial variability of phytoplankton, protozoans or zooplankton
- Cyanobacteria had extended summer blooms with extremely high abundance in 2007, 2008 and 2009
- Protozoan grazers (e.g. ciliates and dinoflagellates) may be influencing cyanobacteria blooms
- Both microzooplankton and mesozooplankton have high grazing impact on algae and cyanobacteria
- Likely modulating timing and magnitude of cyanobacteria blooms

# Recommended Future Studies

- Cyanobacteria

- continued collection for taxonomic identification
- molecular genetic techniques for assessing toxin production and gene expression
- higher frequency (daily) sampling with moored instruments

- Food web studies

- role of higher trophic levels, e.g. fish and macroinvertebrates
- biomanipulation as possible control of cyanobacteria blooms tested using experimental manipulation (e.g. enclosures or limnocorrals) and computer modeling