Seasonal cycle of phytoplankton community composition off Newport, Oregon, in 2009

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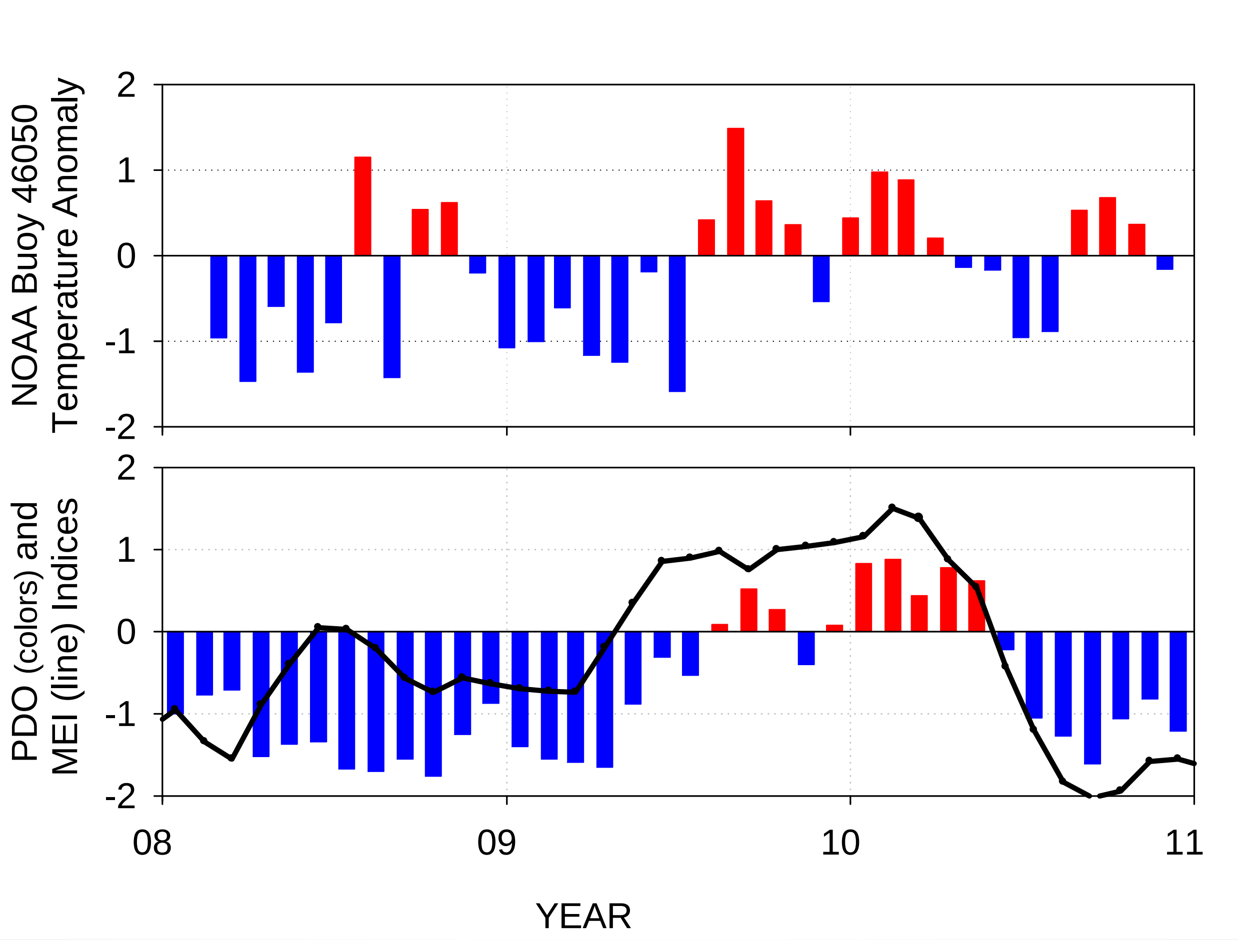
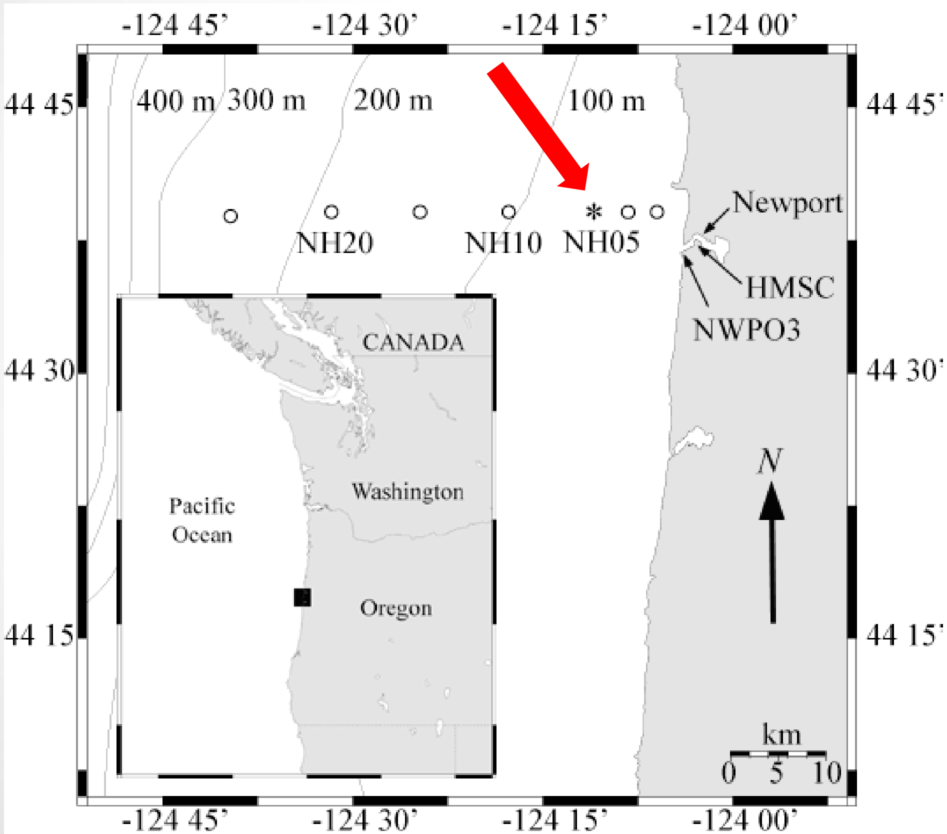
Why did we do the study?

- Funded by a harmful algal bloom project MOCHA (Monitoring Oregon's Coastal Harmful Algae). Project interested in Pseudo-nitzschia. When does it bloom? Do blooms of P-n relate to other phytoplankton blooms?
- Interested in relationships between blooms and upwelling.
- Basic study of phytoplankton ecology.
- We also measured copepod egg production during the same cruises – needed to know how to interpret copepod egg production using phytoplankton species composition and biomass data.
- **This talk mostly about the seasonal cycle of phytoplankton community structure**
- **By chance, the study took place during the onset of a weak El Niño event in August 2009**

Monthly SST anomalies at the NOAA Buoy off Newport (upper panel) and monthly values of the Pacific Decadal Oscillation (PDO: colored bars) and Multivariate ENSO Index (MEI: black line)



NH05: (5 miles, 62m depth, 44.6°N) located at the very center of the most active upwelling zone; temperature is the lowest and nutrients are the highest.

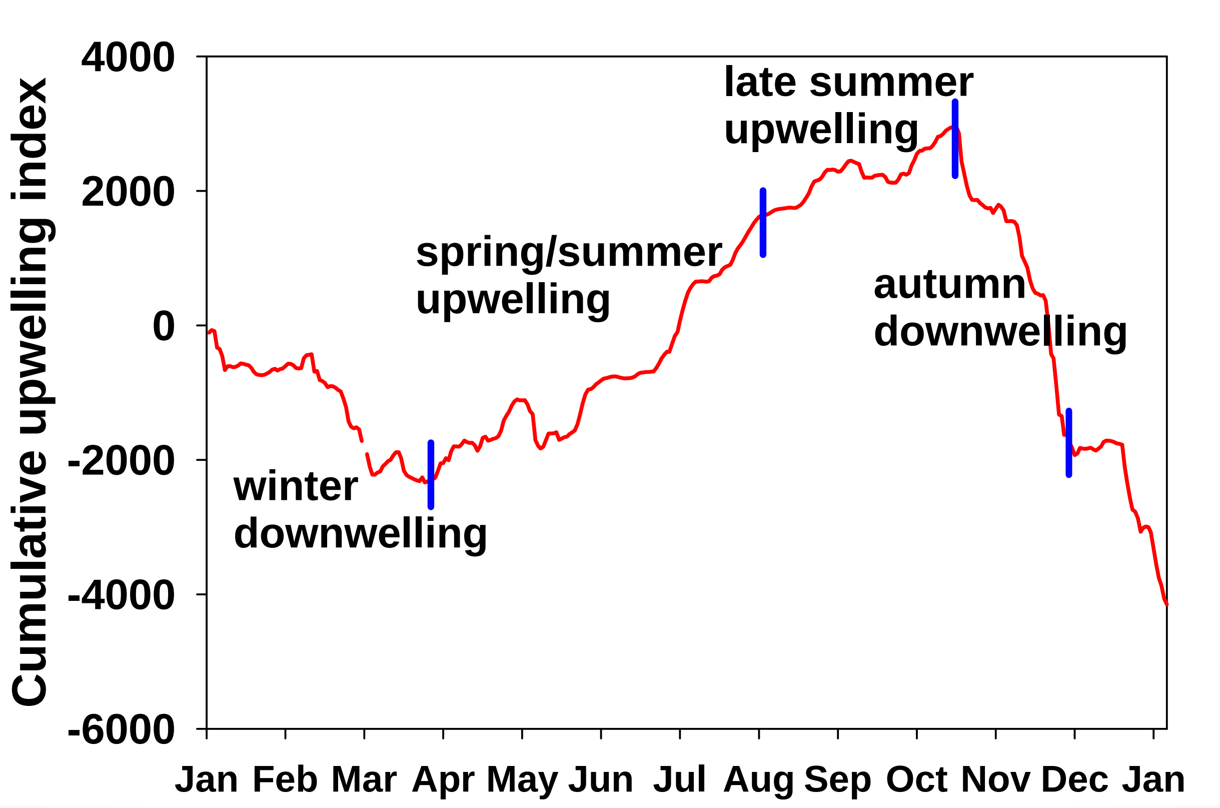


Study area

Methods

- Went to sea every two weeks in 2009
- Preserved surface water in Lugols
- Inverted microscope counts
- Identification using Rita Horner's book

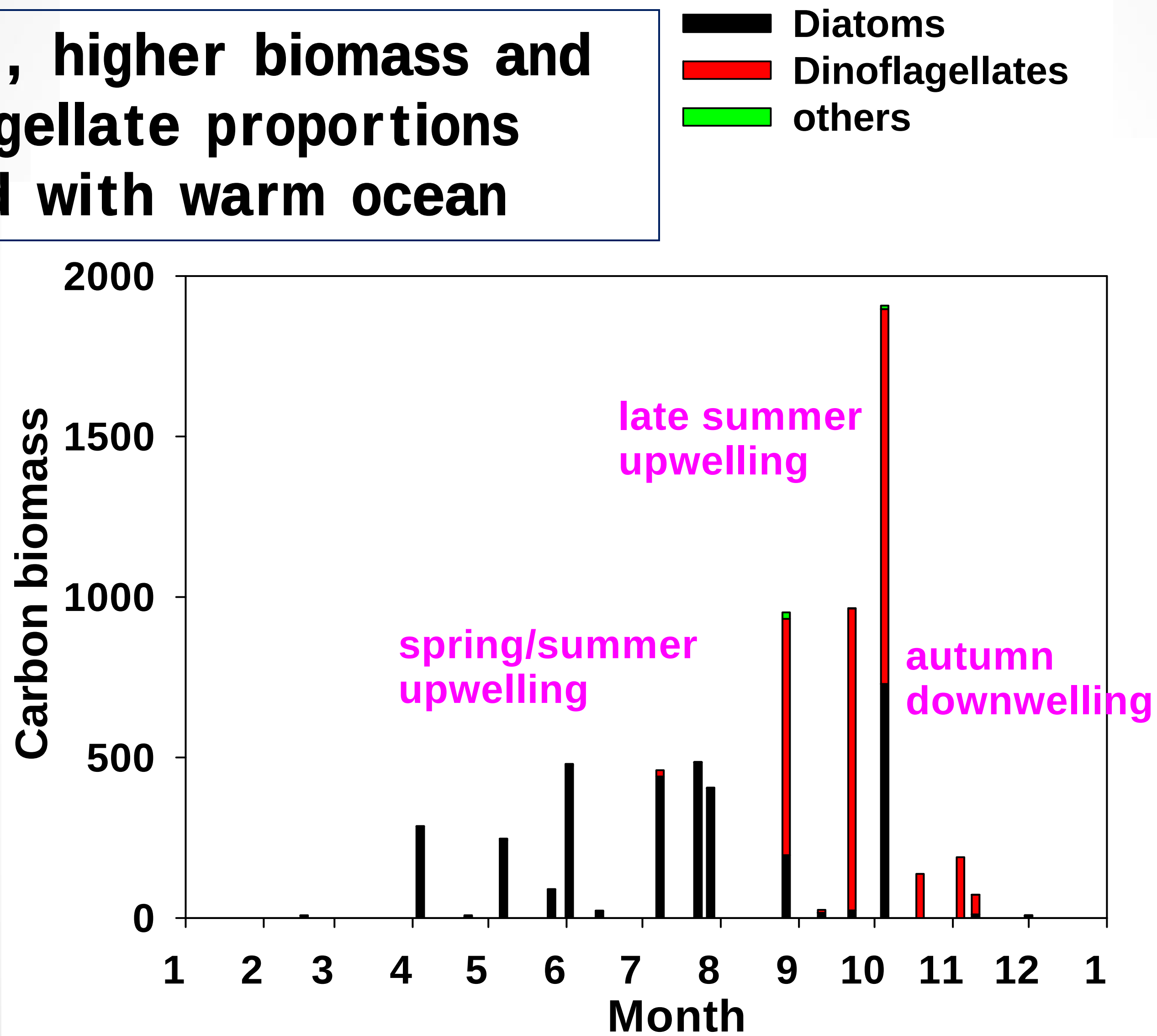
Seasonal upwelling/downwelling cycles in 2009



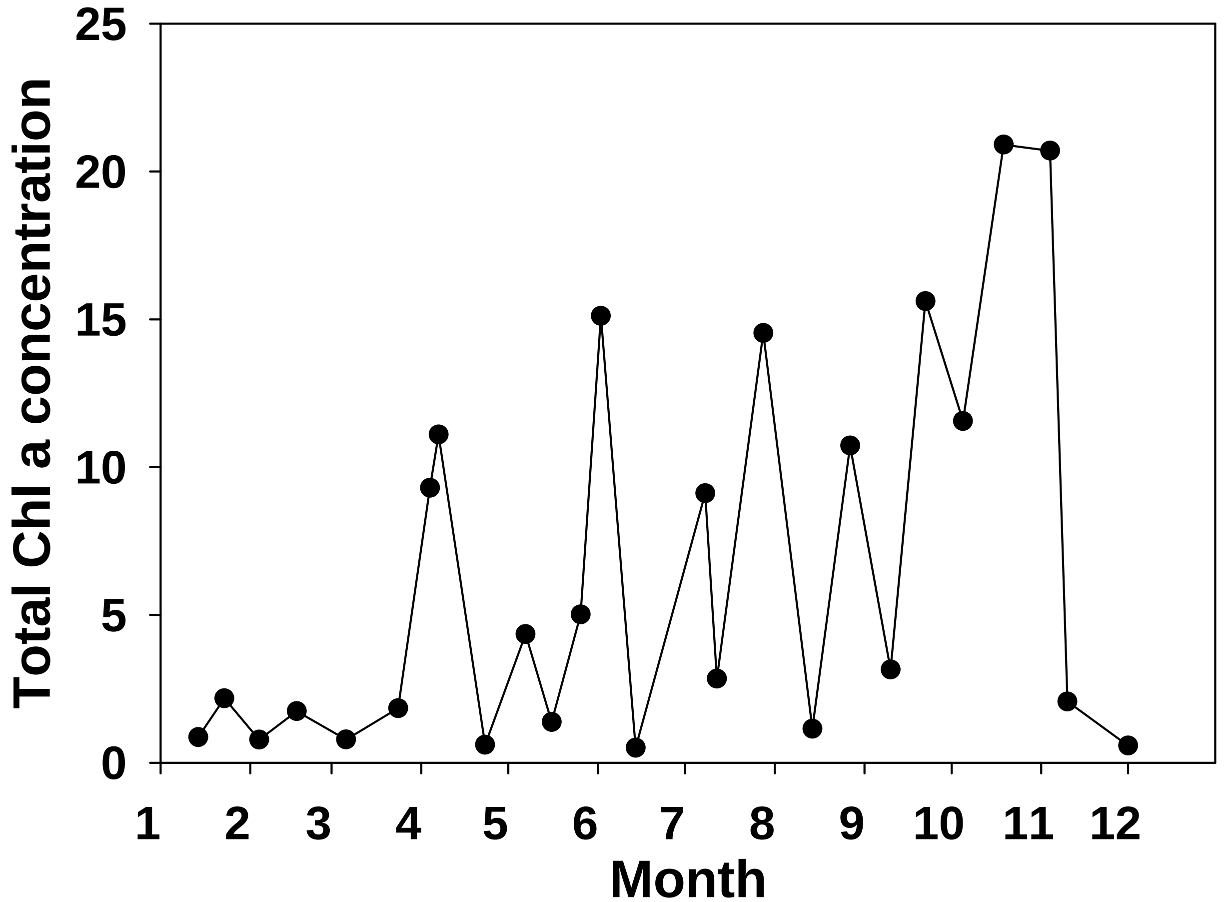
Upwelling season started around on **Mar. 23** and ended on **Oct. 12**

Seasonal cycle of main group biomass ($\mu g\ C\ L^{-1}$) in phytoplankton community

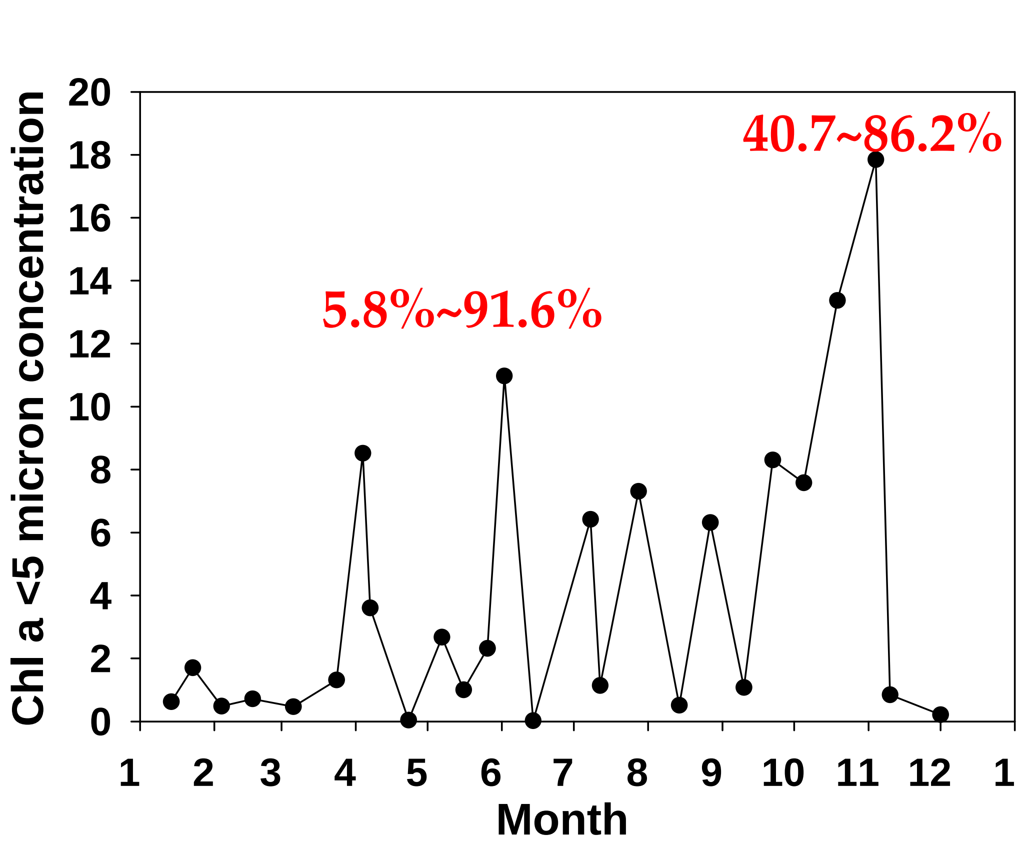
Overall, higher biomass and dinoflagellate proportions started with warm ocean



Seasonal cycle of total Chl a and <5µm fraction concentrations (µg L^{-1}) in 2009



Seasonal cycle of total Chl a and <5μm fraction concentrations (μg L^{-1}) in 2009

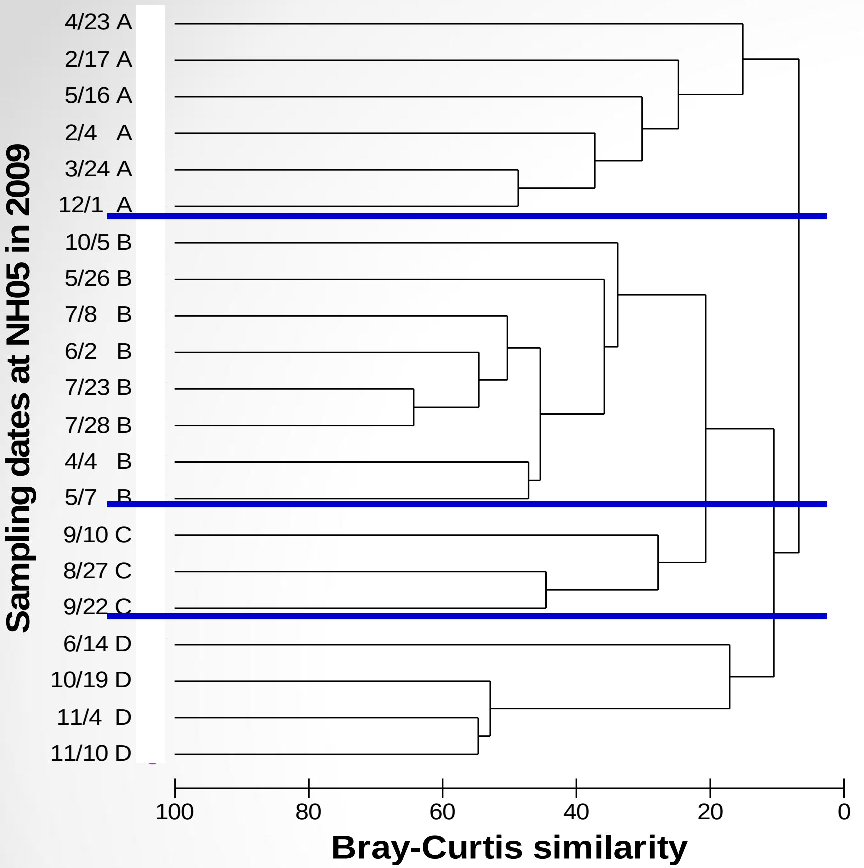


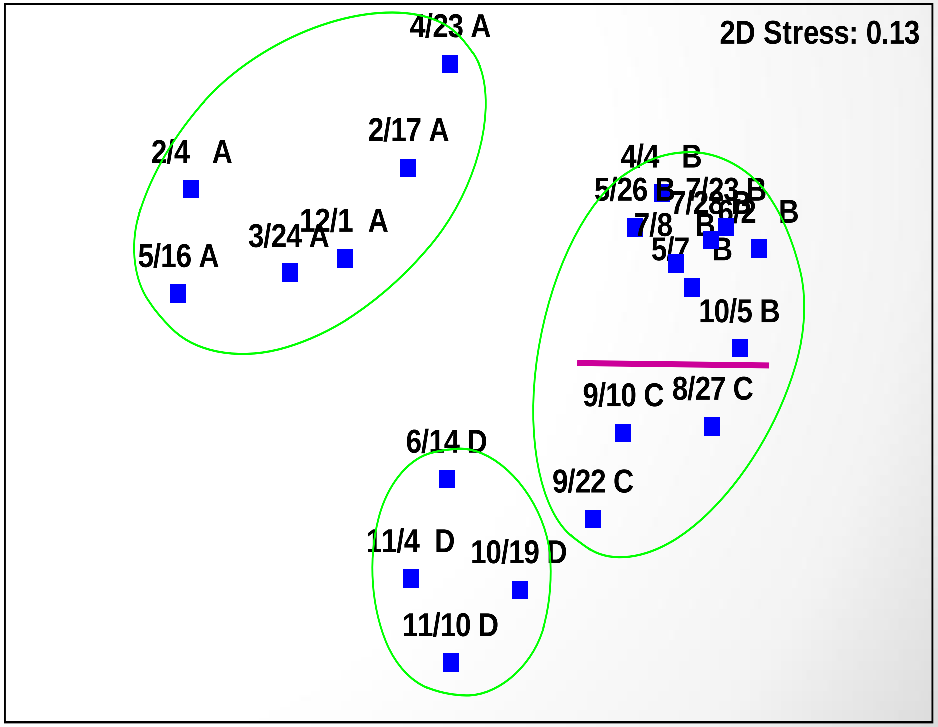
All the observed higher total Chl a concentrations (9~21 μg L^{-1}) had Chl a <5μm contributions of 50~91.6% in total.

We could see the progression of diatoms → dinoflagellates →smaller flagellates assemblages from the alternation of upwelling season and downwelling season.

Also, the progression of diatoms →smaller flagellates during the course of event-scale upwelling/downwelling cycles.

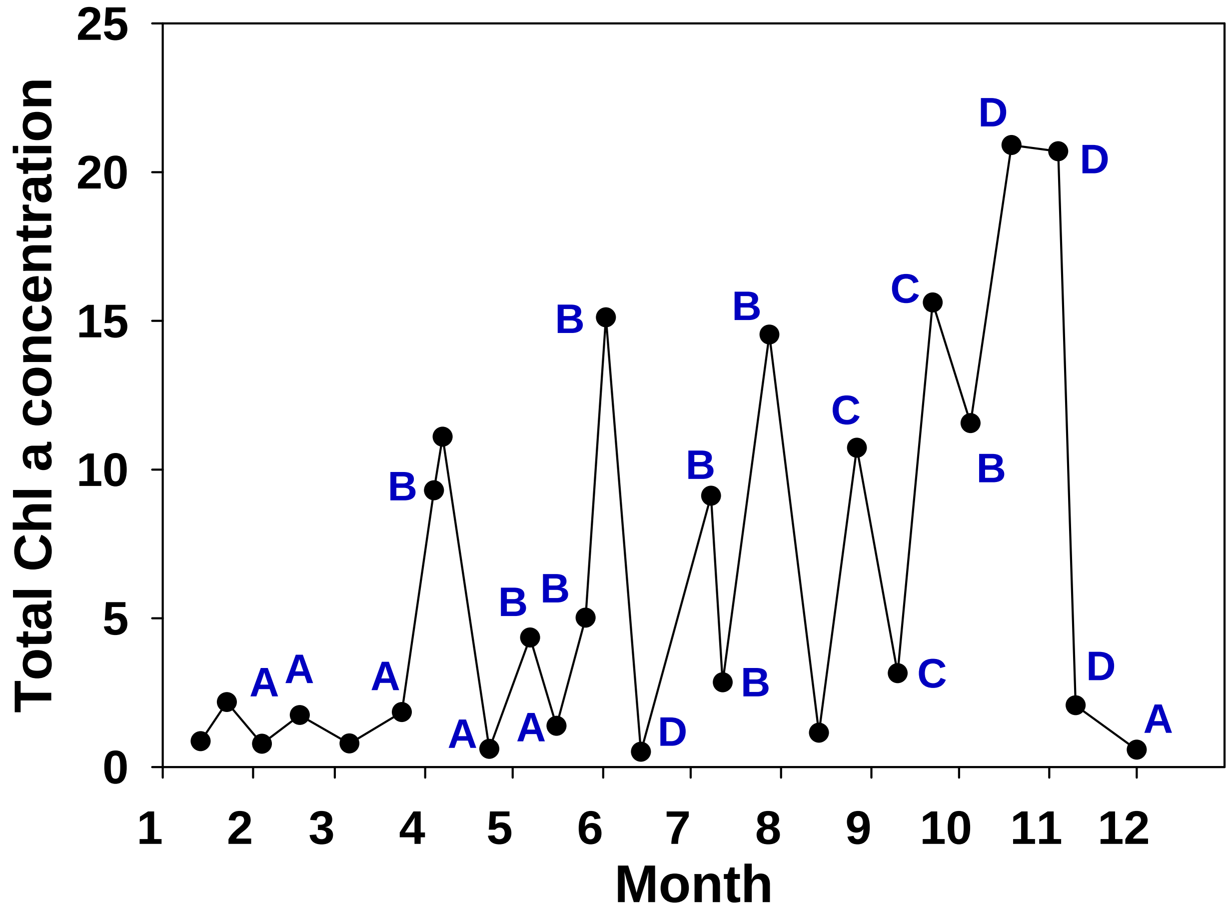
Phytoplankton community structure analysis based on cruise by cruise sampling throughout year of 2009





Four clusters:

- **A: cold winter**
- **B: strong cold upwelling**
- **C: late upwelling season**
- **D: warm autumn**



Phytoplankton chlorophyll biomass of the four clusters

Cold winter cluster A: low Chl a: <2.2 μg L^{-1}

Strong cold upwelling cluster B: high Chl a: 4.4 ~14.5 μg L^{-1}

Late upwelling season cluster C: high Chl a: 10.3, 3.7, 15.6 μg L^{-1}

Warm autumn cluster D: high Chl a: 20.9, 20.7, 2.1, 0.50 μg L^{-1}

Cluster A (cold winter)
Coscinodiscaceae
silicoflagellates
Protoperidinium spp.
Gonyaulax spp.

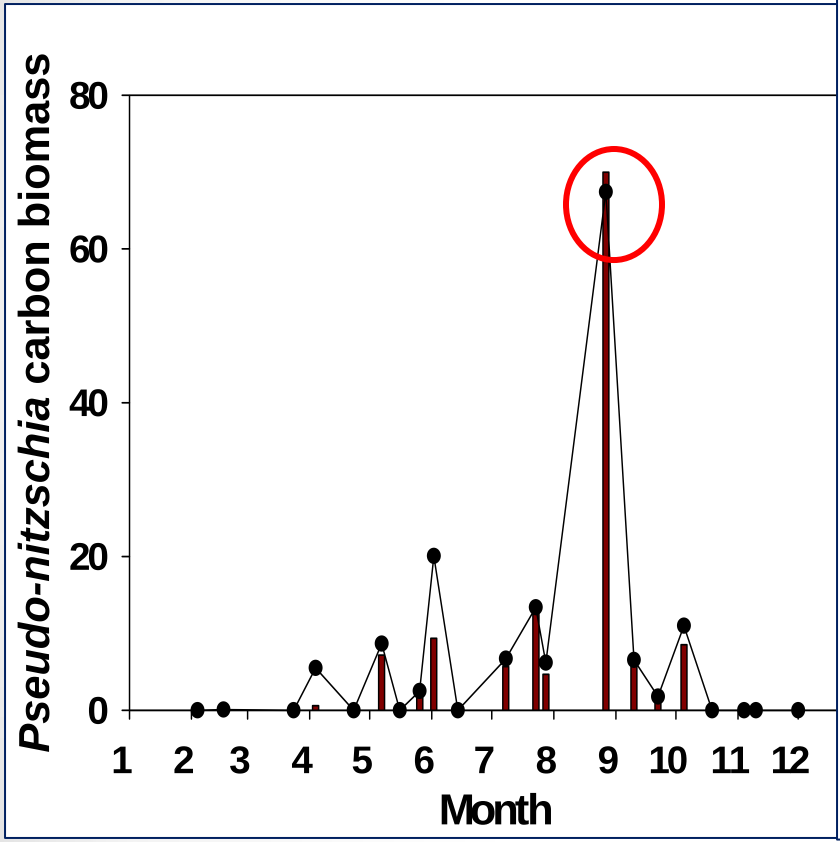
Species contributed most to the similarities for each cluster

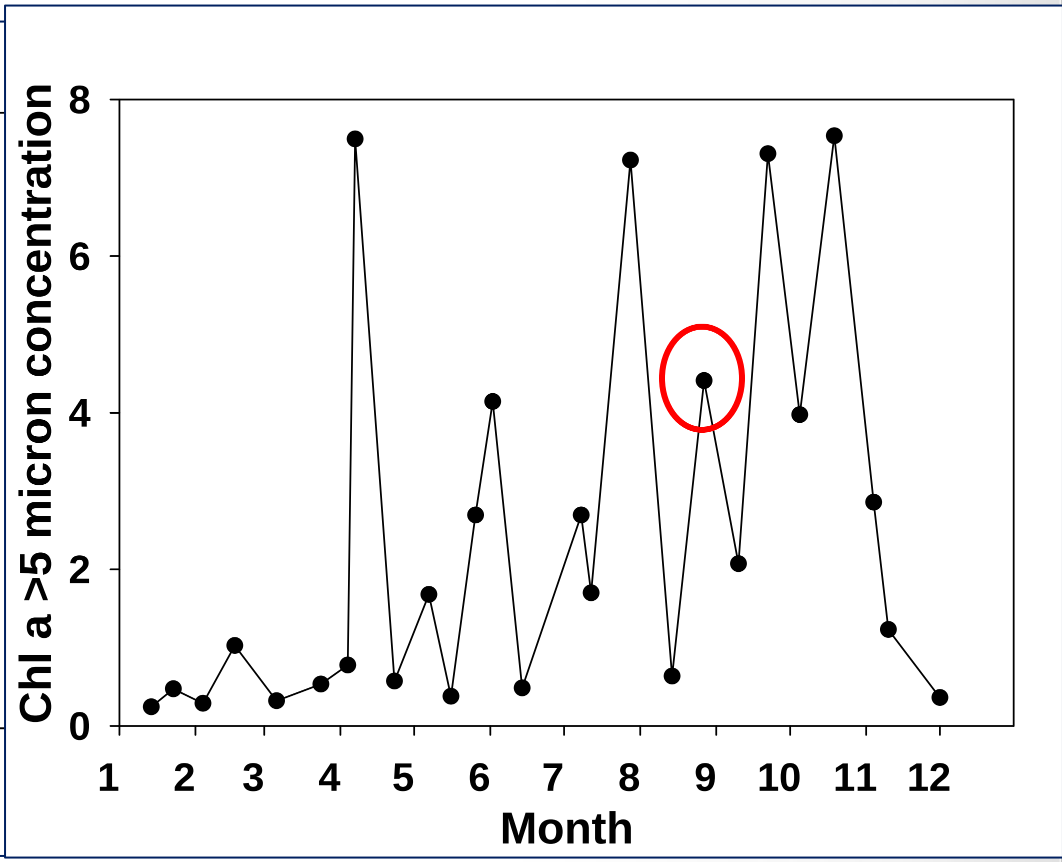
Cluster B (strong cold upwelling)
Chaetoceros debilis
Thalassiosira nordenskioeldii
Asterionellopsis glacialis
Thalassiosira rotula
Thalassiosira pacifica/aestivalis
Pseudo-nitzschia australis complex
Eucampia zodiacus

Species contributed most to the similarities for each cluster

Cluster C (late upwelling season)
Prorocentrum gracile
Pseudo-nitzschia australis complex
Chaetoceros debilis
Thalassiosira pacifica/aestivalis
Protoperidinium spp.
Cluster D (warm autumn)
Akashiwo sanguinea
Ceratium lineatum
Alexandrium catenella

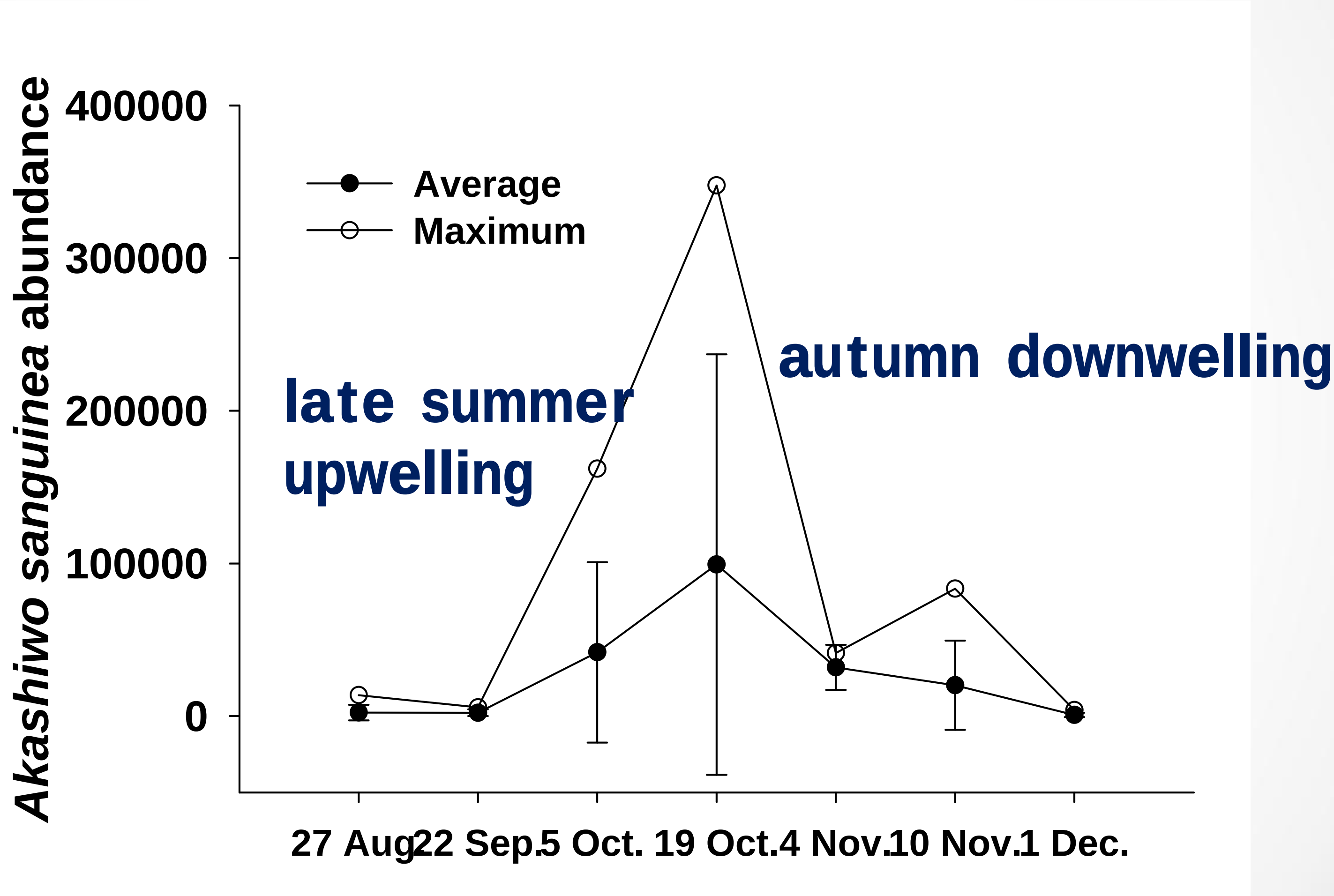
Pseudo-nitzschia abundance (line) and biomass ($\mu g\ C\ L^{-1}$) (bar) versus time





Upwelling, mixing, nutrients, lights, species succession, biological factors......

Akashiwo sanguinea unusual bloom during autumn (October to November) of 2009



(Du et al., 2011)

Conclusion

- **Strong seasonal cycle with modest blooms (based on chl-a) in February, larger blooms in April-August. Very large bloom in October/November due to *Akashiwo sanguinea*.**

- **Phytoplankton community structure changes related to upwelling intensity and seasonality. It progressed in the order of mixture taxa→diatom type→mixture taxa→ dinoflagellate type.**

- **No clear relationship with El Niño other than water got unusually warm in August and September; we do not know if the El Niño contributed to the dinoflagellate blooms in August/September (*Prorocentrum gracile*) and October/November (*Akashiwo sanguinea*).**

- ***Pseudo-nitzschia* high density (above 10^5 cells L^{-1}) occurred during upwelling season and related to upwelling events.**

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