



Western Washington University  
**Western CEDAR**

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Salish Sea Ecosystem Conference

2018 Salish Sea Ecosystem Conference  
(Seattle, Wash.)

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Apr 6th, 9:15 AM - 9:30 AM

## Long-term monitoring in Central Puget Sound: Are local climate anomalies impacting phytoplankton populations?

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Hannach, Gabriela; Swanson, Lyndsey M.; and Stark, Kimberle, "Long-term monitoring in Central Puget Sound: Are local climate anomalies impacting phytoplankton populations?" (2018). *Salish Sea Ecosystem Conference*. 467.

<https://cedar.wvu.edu/ssec/2018ssec/allsessions/467>

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# Long-term monitoring in Central Puget Sound: Are local climate anomalies impacting phytoplankton populations?

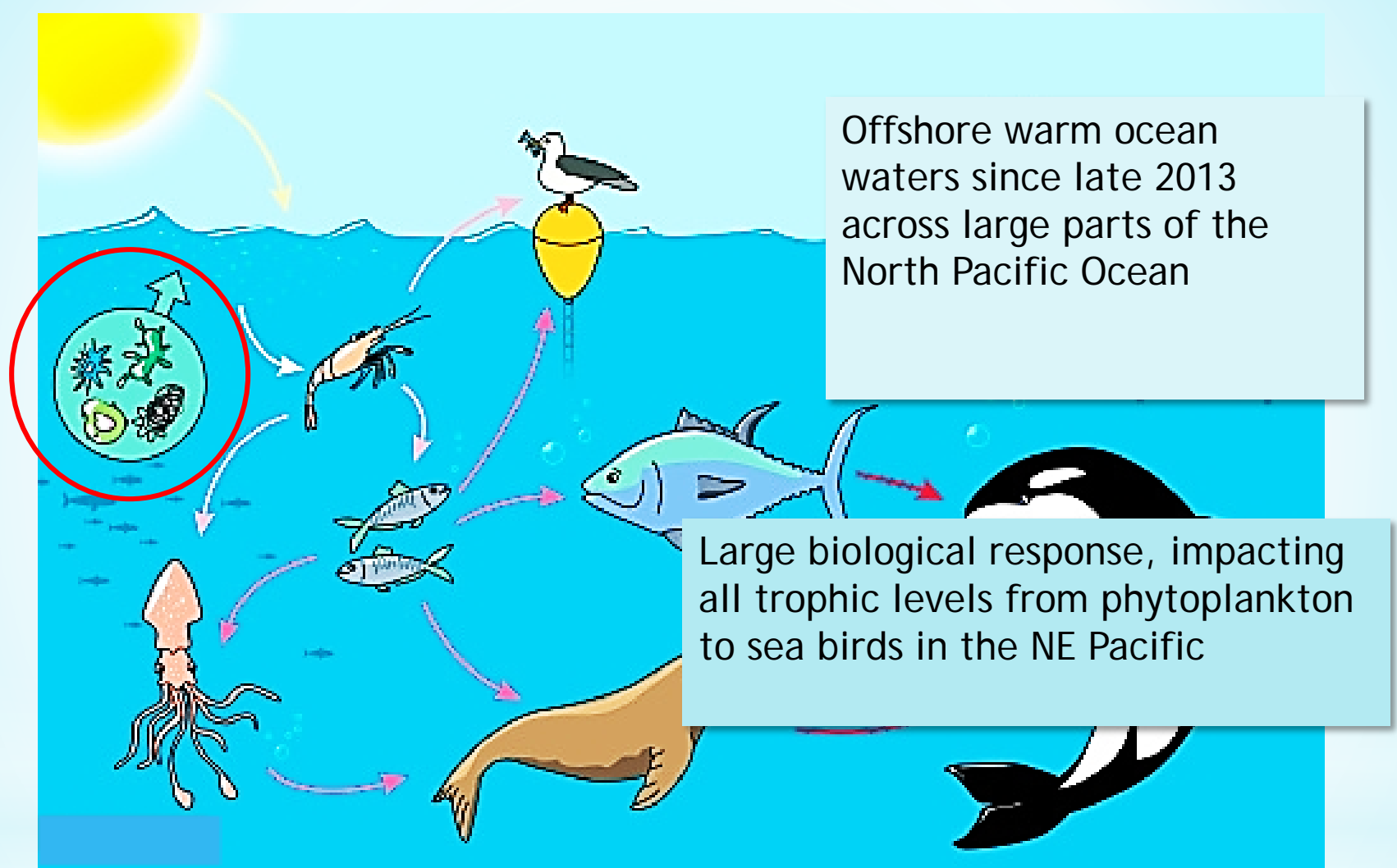
Gabriela Hannach  
Lyndsey Swanson  
Kimberle Stark



**King County**

Environmental Lab

Water and Land Resources Division



✓ What do we know about the biological effects of these recent climate events inside Puget Sound?

# 10 Sampling Stations in the Central Basin

22 times per year

Phytoplankton (surface) - some zoo

Chlorophyll *a*

Nutrients

Physical parameters (CTD)





# Phytoplankton Analysis

- Microscopy (since 2008)  
qualitative
- FlowCAM (since May 2014)

Particle size range:

2 flow cell sizes/magnifications

Total range is 10-300  $\mu\text{m}$

Endpoints:

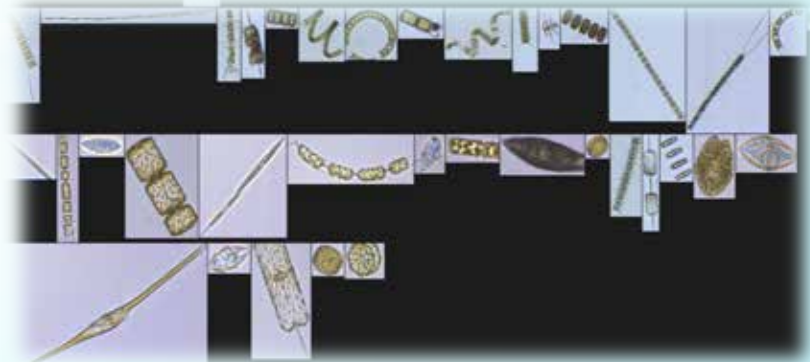
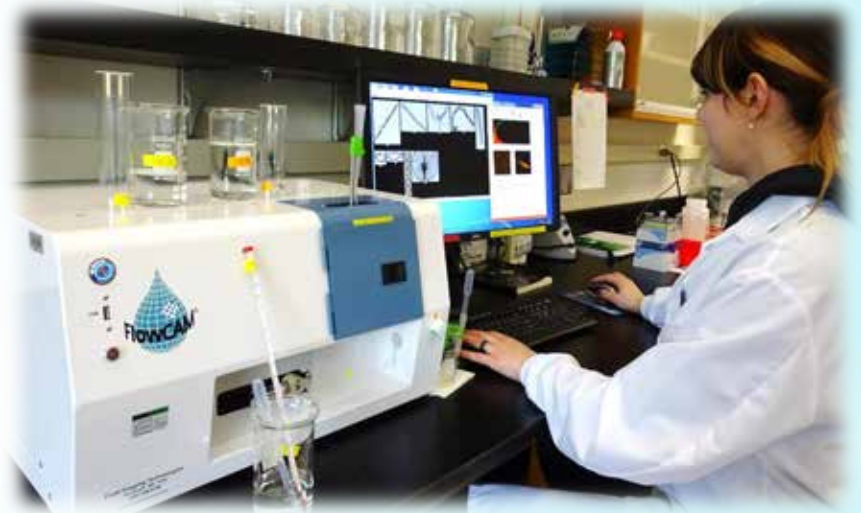
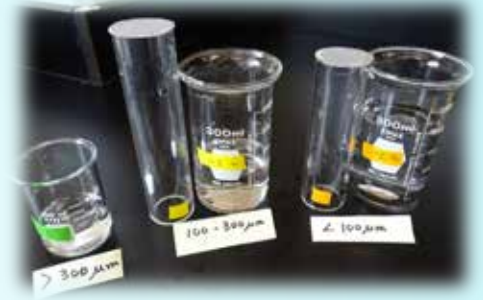
Abundance (Particles  $\text{mL}^{-1}$ )

Biovolume ( $\text{mm}^3 \text{ L}^{-1}$ )

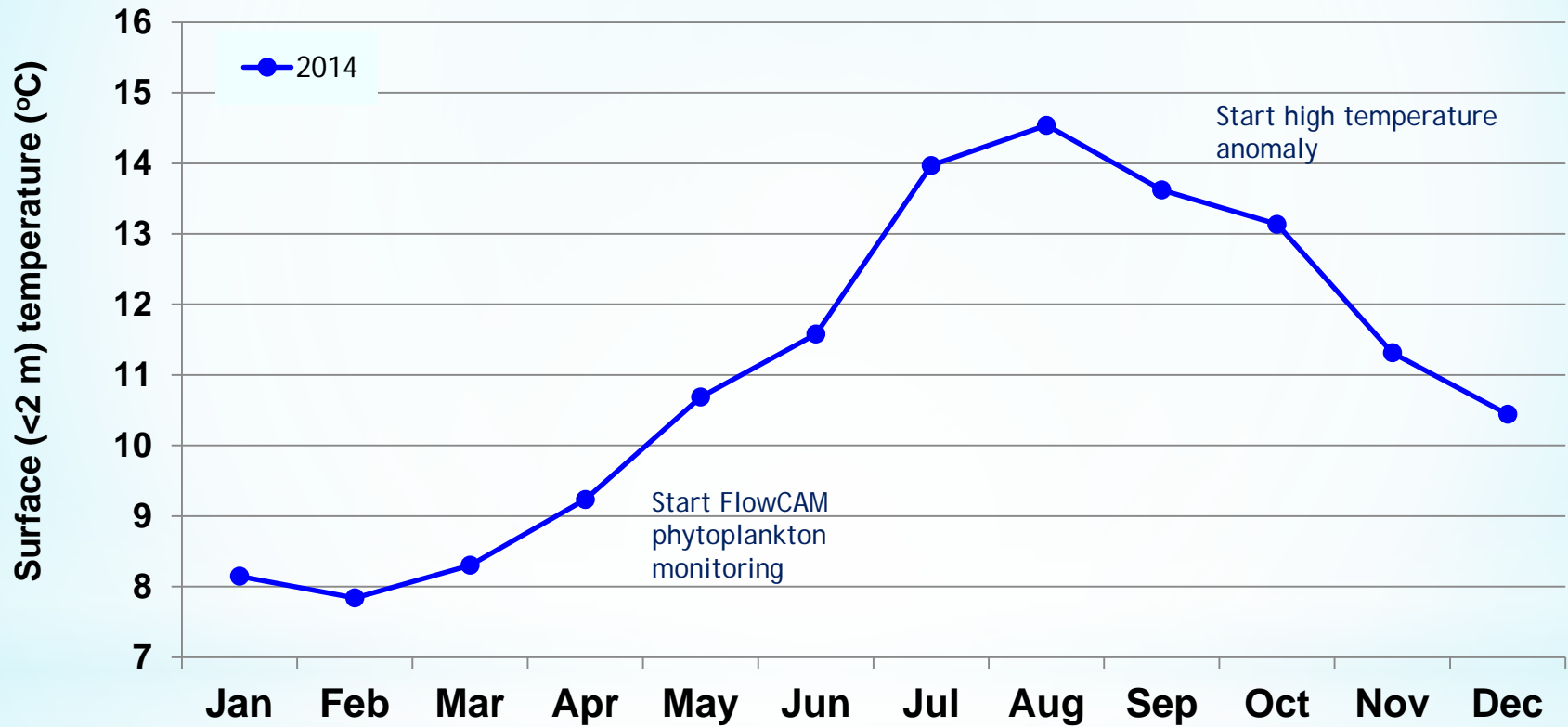
Biovolume to C biomass conversion

$$y = 127.67 x^{0.4496}$$

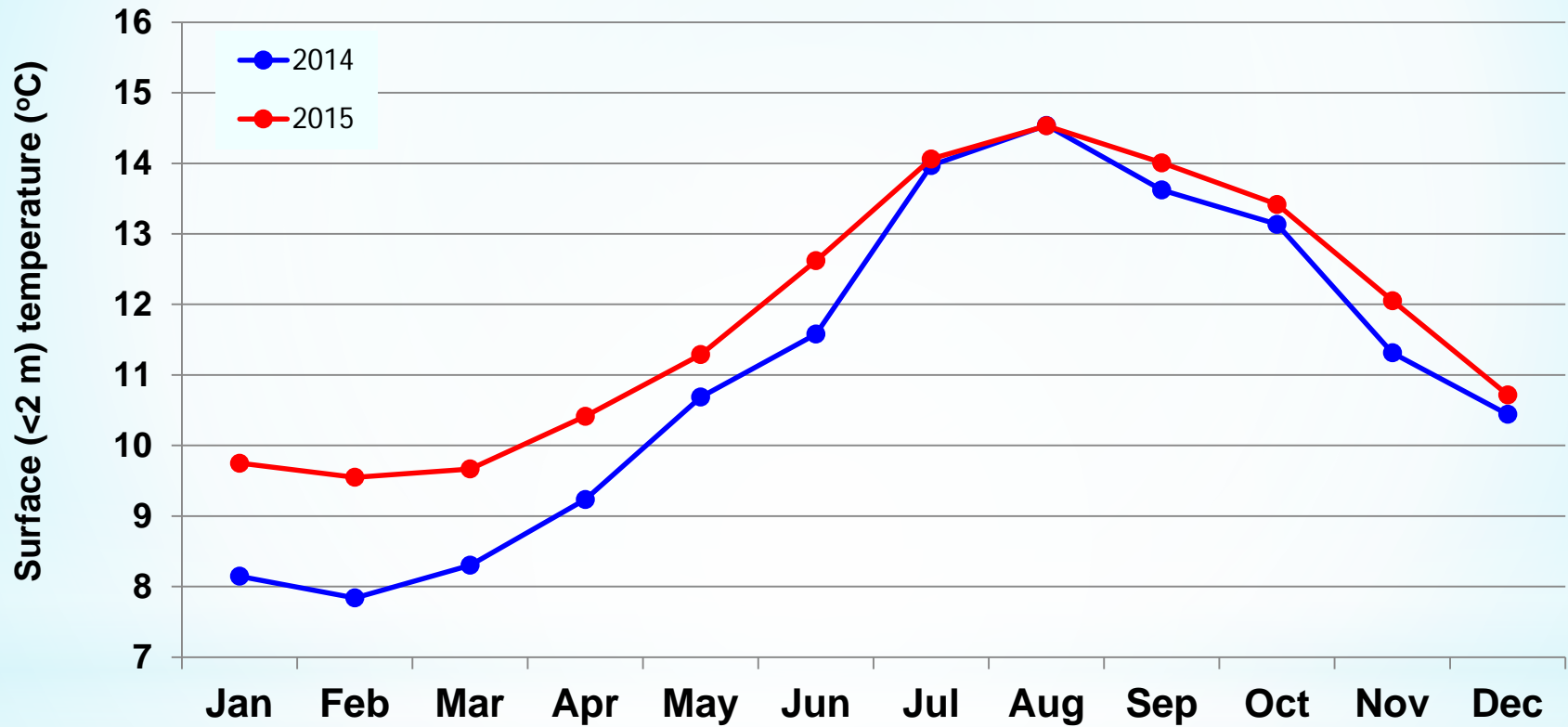
Poster #92!



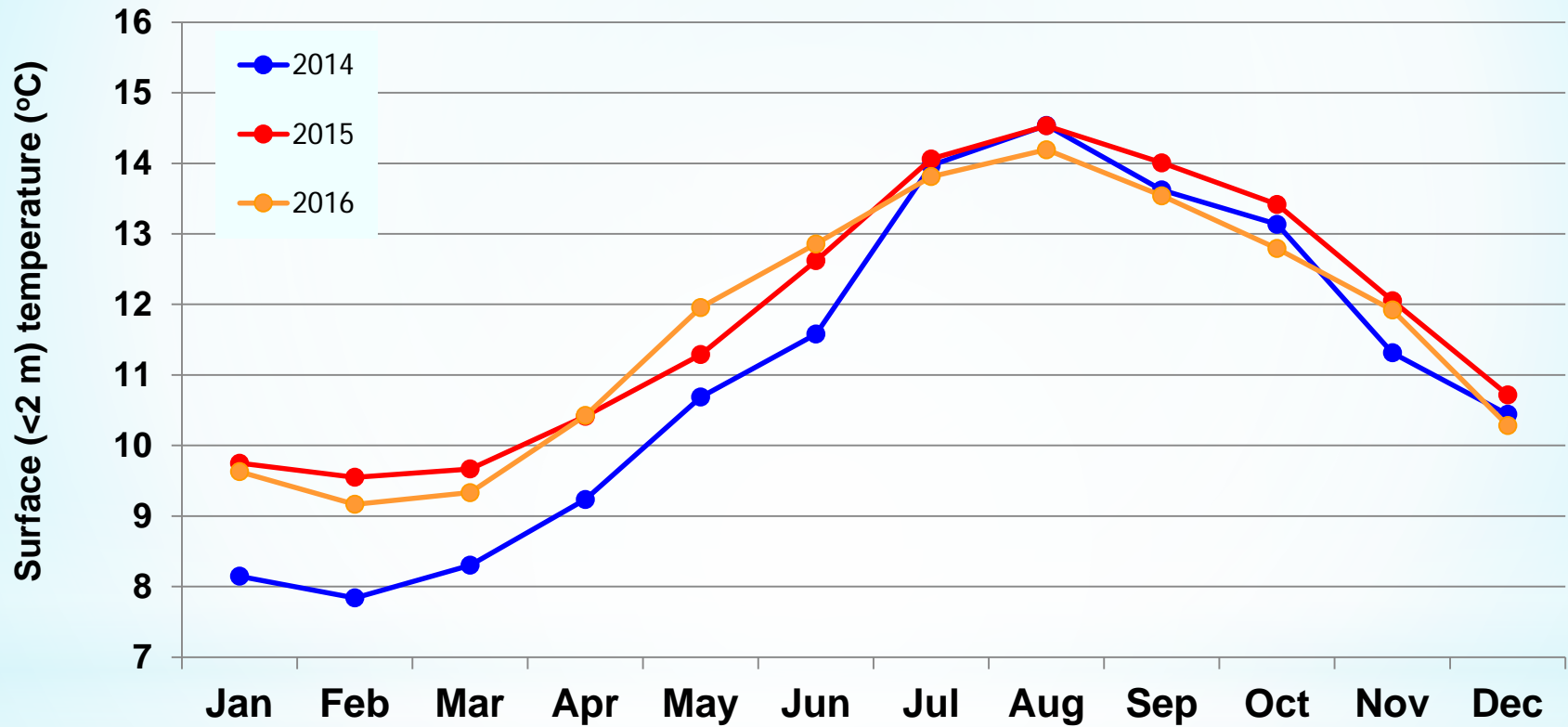
# Central Basin combined surface temperatures



# Central Basin combined surface temperatures

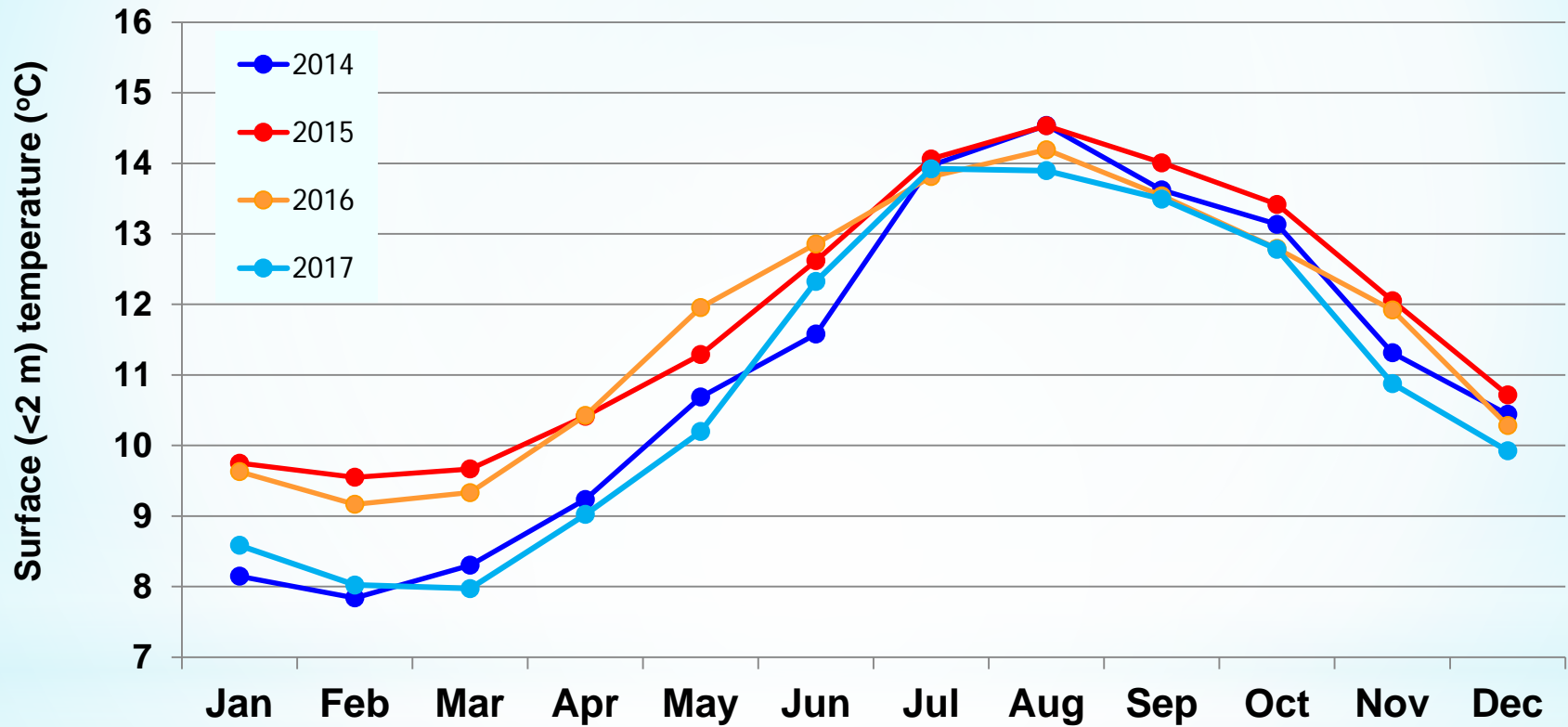


# Central Basin combined surface temperatures





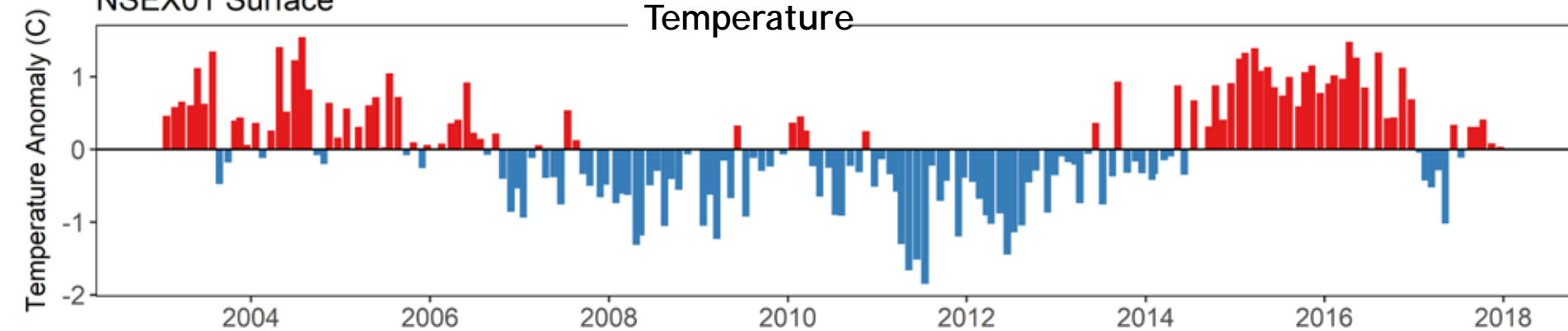
# Central Basin combined surface temperatures



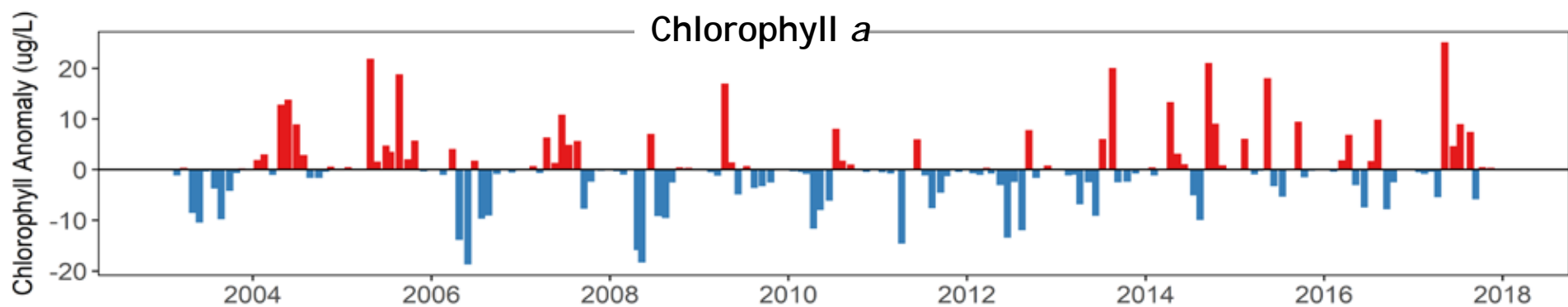
# Anomalies 2003-2017 - East Passage

NSEX01 Surface

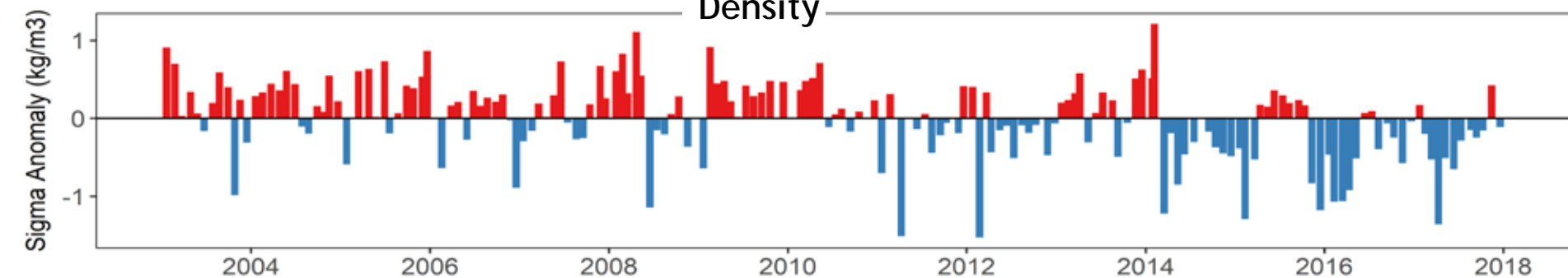
Temperature



Chlorophyll *a*



Density

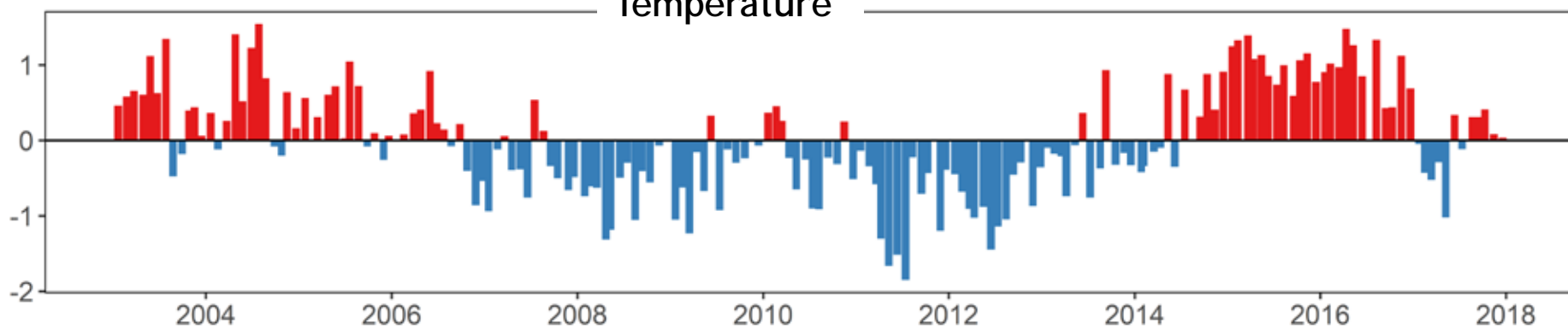


# Anomalies 2003-2017 - East Passage

NSEX01 Surface

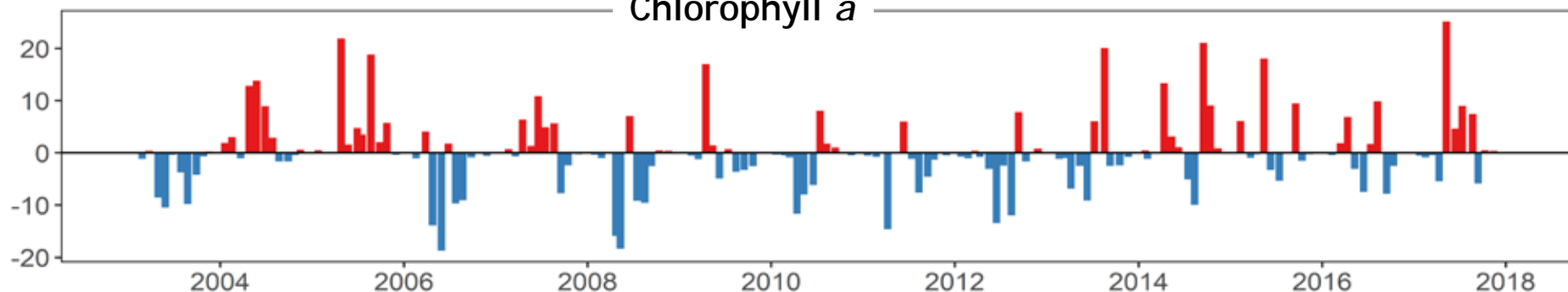
Temperature

Temperature Anomaly (C)



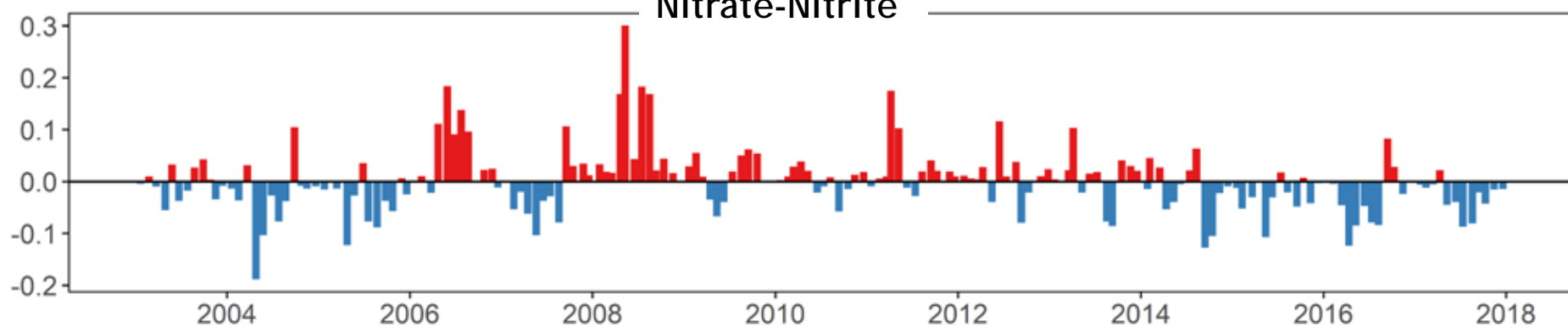
Chlorophyll *a* Anomaly (ug/L)

Chlorophyll *a*



Nitrate + Nitrite Anomaly (mg/L)

Nitrate-Nitrite



# What could be some effects of these climate anomalies on phytoplankton?

- Biovolume (C biomass)

  - Seasonality pattern

  - Total biovolume

- Taxonomic composition

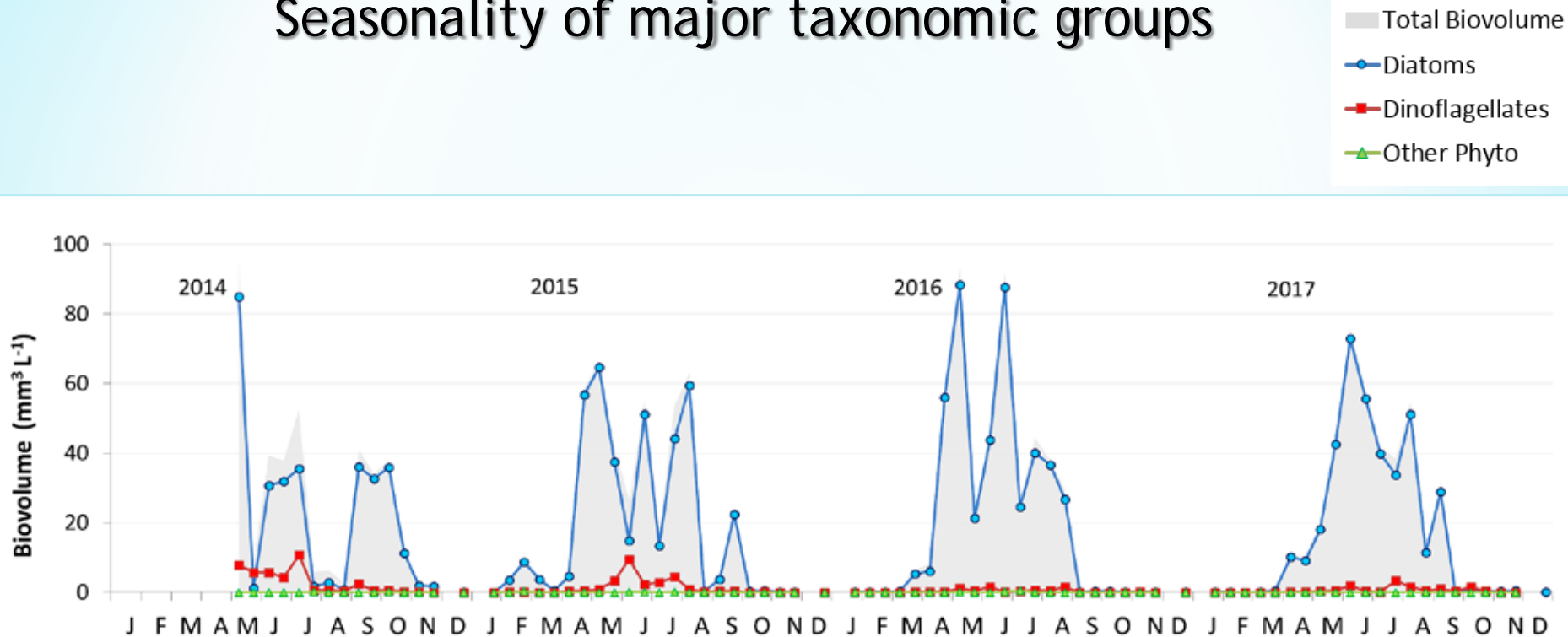
  - Seasonal succession

  - Relative abundances

  - Cell size

**Drivers:**      Physiology (e.g. temperature tolerance limits)  
                     Ecological interactions (e.g. grazing rates)

# Seasonality of major taxonomic groups



Biovolume means of 6 offshore stations

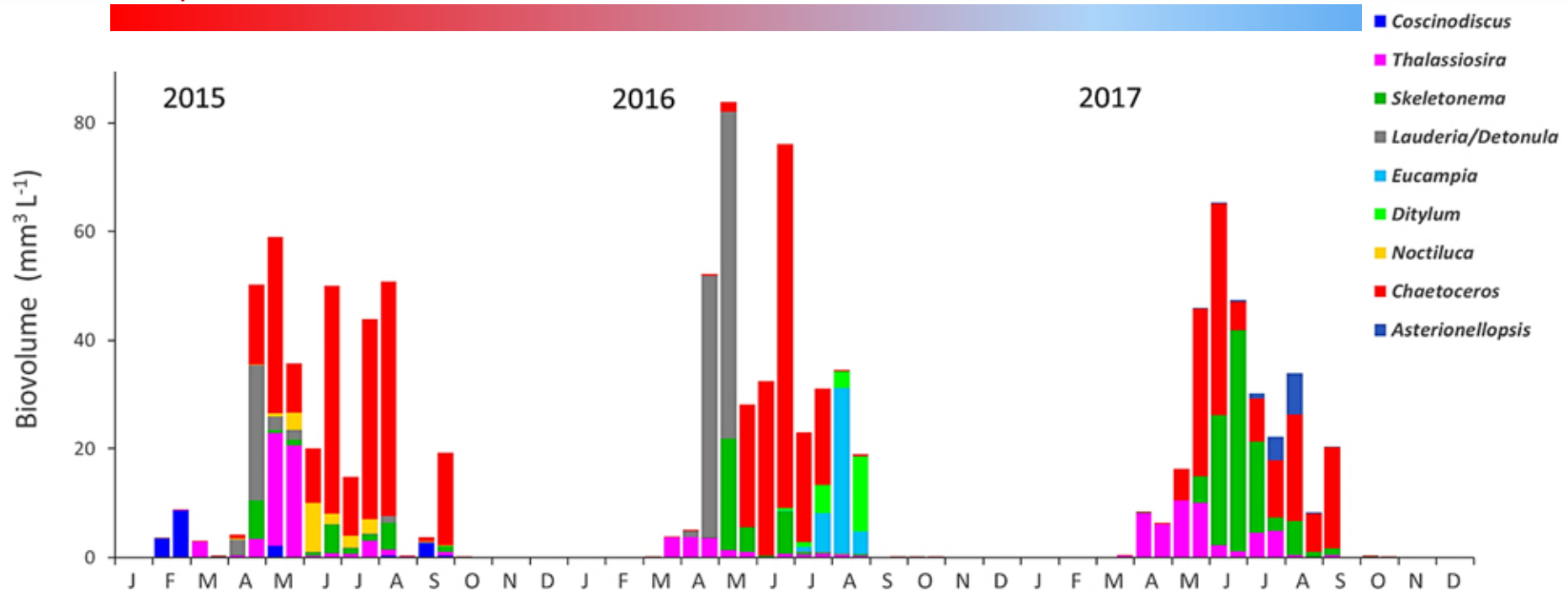
- Year to year variations in seasonal pattern
- Diatoms always dominate - typical of estuarine areas

Biomass conversion:  $100 \text{ mm}^3 \text{L}^{-1} \sim 1000 \mu\text{g C L}^{-1}$



# Seasonality of 6 top taxa for each year

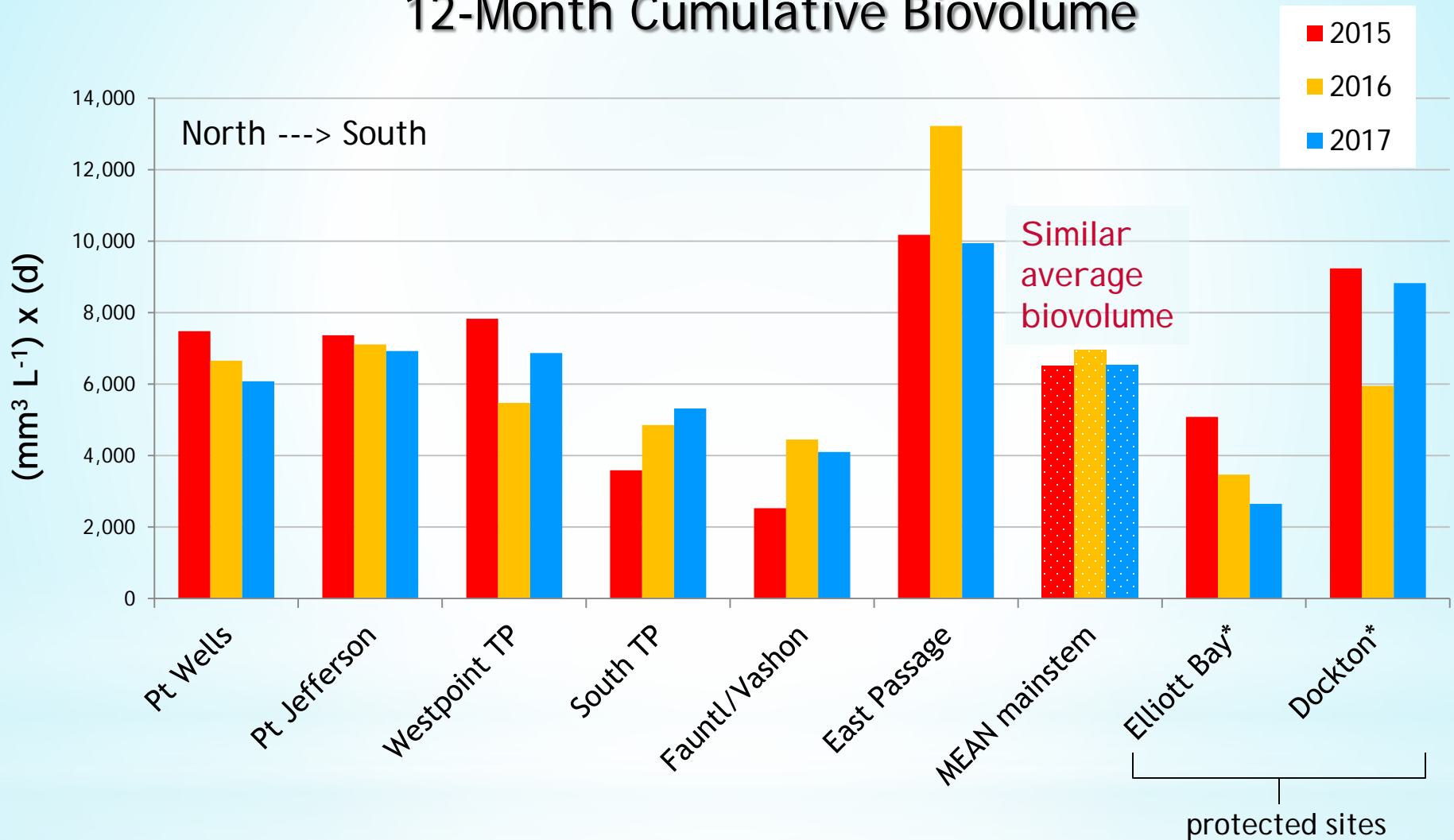
## Temperature



Biovolume means of 8 offshore stations

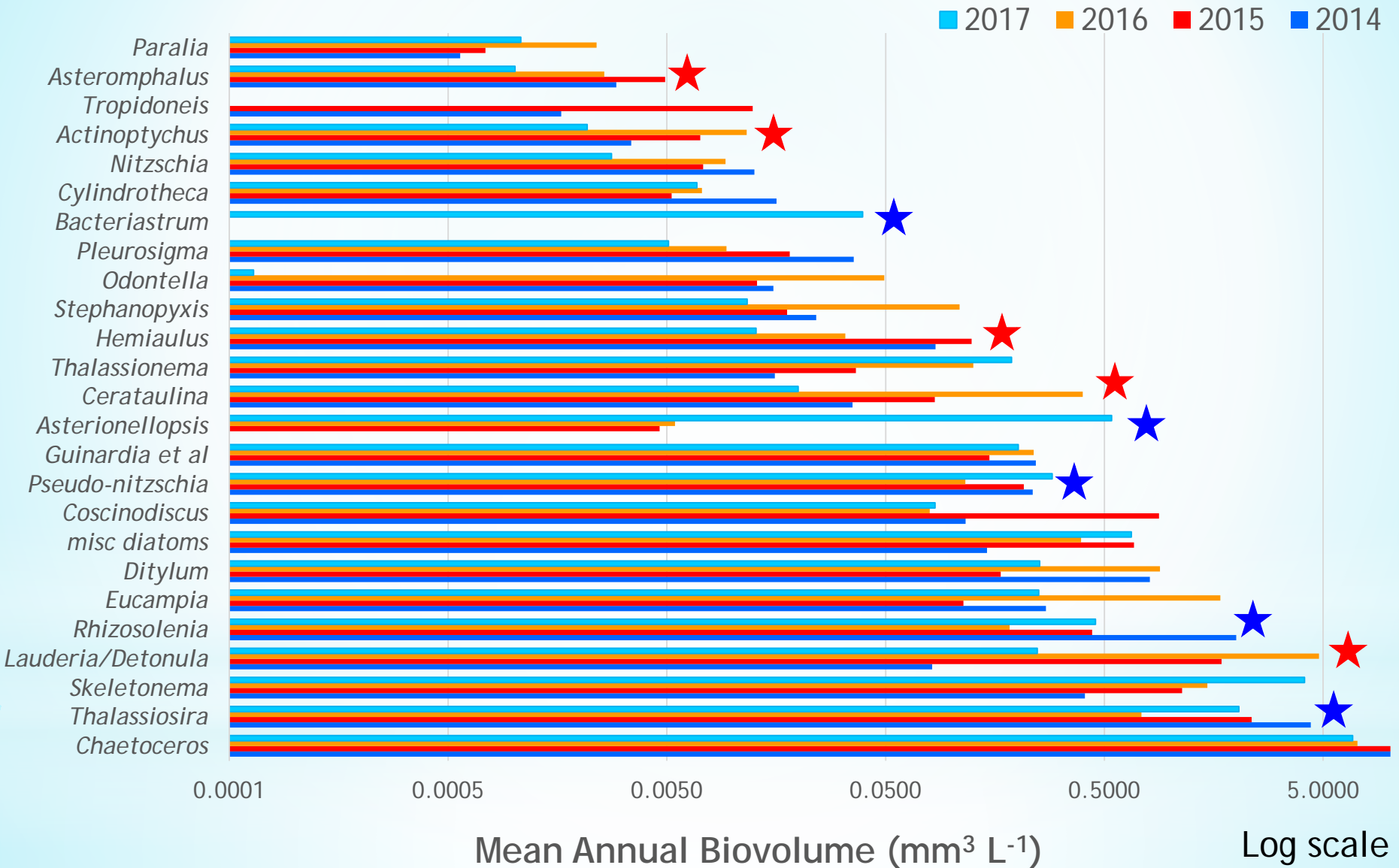
- Characteristic seasonal succession (mostly chain-forming diatoms)
- Year to year variations are the norm
- Some taxa are abundant every year, others unpredictable

# 12-Month Cumulative Biovolume



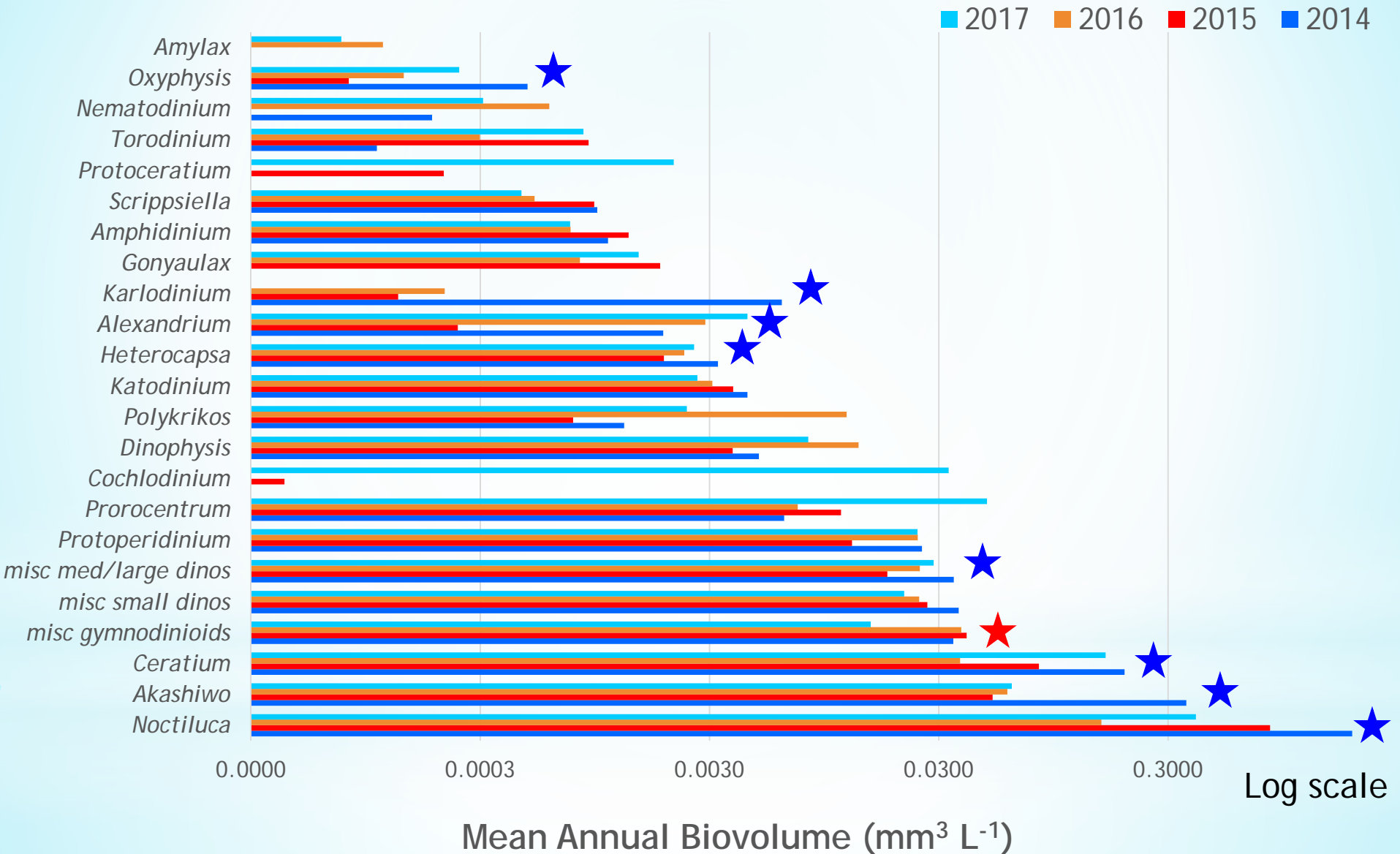
- Spatial pattern in total biomass
- Central Basin annual totals are similar year to year

# All Diatom Taxa



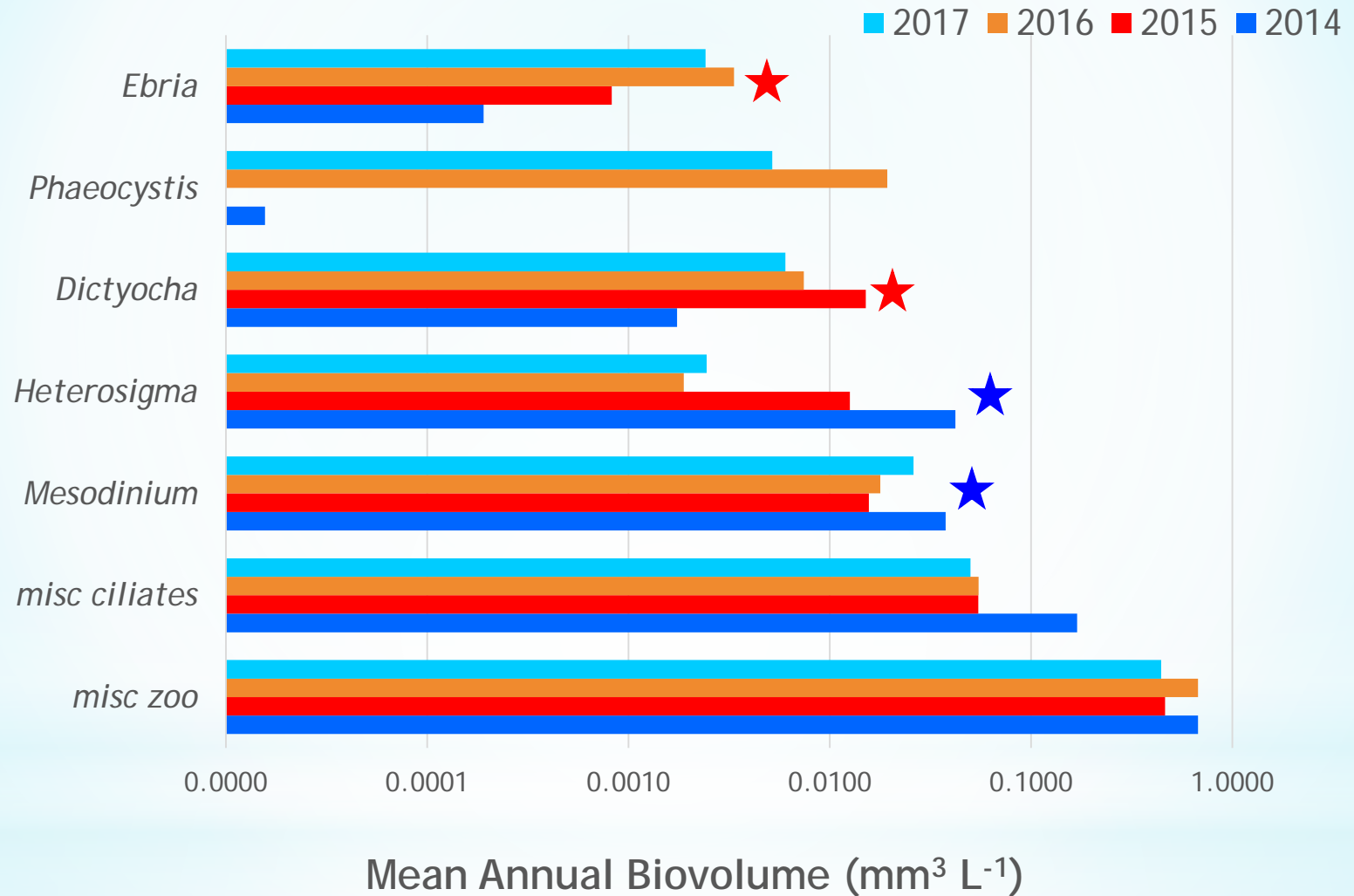
2014 data May-Dec, all others Jan-Dec

# All Dinoflagellate Taxa



2014 data May-Dec, all others Jan-Dec

# Other misc. microplankton



2014 data May-Dec, all others Jan-Dec



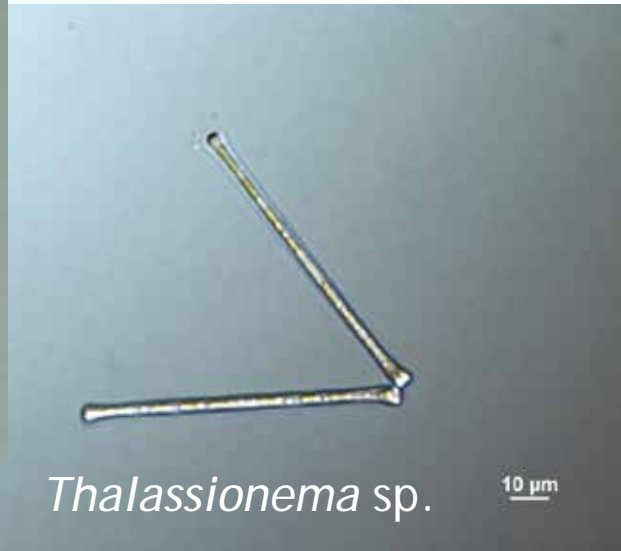
# Some “new” common taxa in 2017

Previously very uncommon or absent from our records

## DIATOMS



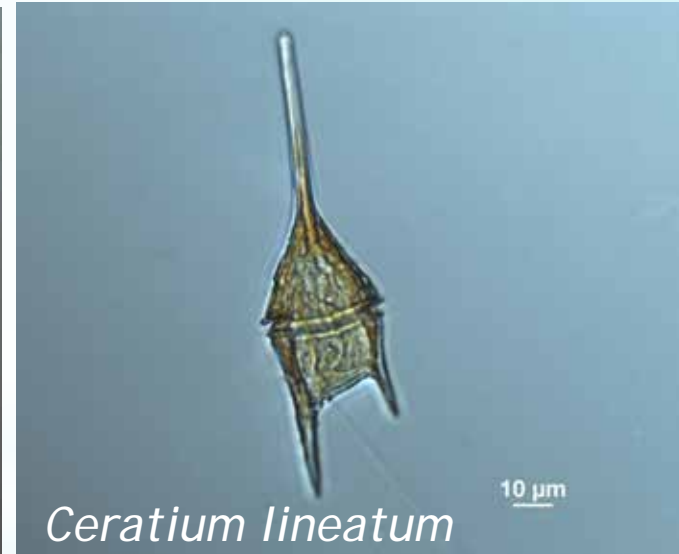
*Bacteriastrum delicatulum*



*Thalassionema* sp.

10  $\mu$ m

## DINOFLAGELLATES



*Ceratium lineatum*

10  $\mu$ m



*Guinardia striata*

25  $\mu$ m



*Prorocentrum micans*

10  $\mu$ m

# Conclusions

## ✓ Environmental anomalies

- Increased temperature: late 2014-2016
- Lower surface density -> increased stratification: 2015-2017
- Lower nutrients: late 2014-2017

## ✓ Biovolume (C biomass)

- Chlorophyll anomalies suggest small increase in phytoplankton growth 2014-2017 relative to previous 6 years
- But... total annual biovolume remained the same 2015-2017
- Biovolume seasonality 2014-2017, inter-annual differences but no clear pattern

## ✓ Taxonomic composition


- Changes in taxonomic composition likely
- Diatom taxa increased/decreased, but many dinoflagellates decreased during the two warmer years
- No increase of harmful species

Inherent system variability - difficult to detect biological changes in short time period

Many thanks to the Environmental Lab  
Field Unit for year round sample collection

Rain or shine...

Wind or calm...



100  $\mu\text{m}$

This is a fluorescence micrograph of a filamentous cyanobacterium. The organism is a long, thin chain of cells that has been stained with a fluorescent dye, likely DAPI, which highlights the cell walls and internal structures. The filament is highly curved and coiled, forming a complex, tangled shape. The background is dark, making the brightly stained cells stand out. In the bottom left corner, there is a white scale bar with the text '100  $\mu\text{m}$ ' next to it.