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

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

Gabriela Hannach
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Kimberle Stark
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 µm

Endpoints:
- Abundance (Particles mL\(^{-1}\))
- Biovolume (mm\(^3\) L\(^{-1}\))

Biovolume to C biomass conversion

\[ y = 127.67 \times x^{0.4496} \]

Poster #92!
Central Basin combined surface temperatures

Surface (<2 m) temperature (°C)

- 2014
- Start high temperature anomaly
- Start FlowCAM phytoplankton monitoring
Central Basin combined surface temperatures

Surface (<2 m) temperature (°C)

- 2014
- 2015
Central Basin combined surface temperatures

Surface (<2 m) temperature (°C)

- 2014
- 2015
- 2016
Central Basin combined surface temperatures

Surface (<2 m) temperature (°C)

- 2014
- 2015
- 2016
- 2017

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
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

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
• Spatial pattern in total biomass
• Central Basin annual totals are similar year to year
All Diatom Taxa

Mean Annual Biovolume (mm³ L⁻¹)

2014 data May-Dec, all others Jan-Dec
All Dinoflagellate Taxa

Mean Annual Biovolume (mm³ L⁻¹)

2014 data May-Dec, all others Jan-Dec
Other misc. microplankton

Mean Annual Biovolume (mm³ L⁻¹)

- Ebria
- Phaeocystis
- Dictyocha
- Heterosigma
- Mesodinium
- Misc ciliates
- Misc zoo

2014 data May-Dec, all others Jan-Dec
Some “new” common taxa in 2017
Previously very uncommon or absent from our records

**DIATOMS**
- Guinardia striata
- Thalassionema sp.
- Bacteriastrium delicatulum

**DINOFLAGELLATES**
- Ceratium lineatum
- Prorocentrum micans
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...