Environmental Drivers of Zooplankton Diversity at Loch Ewe, Scotland

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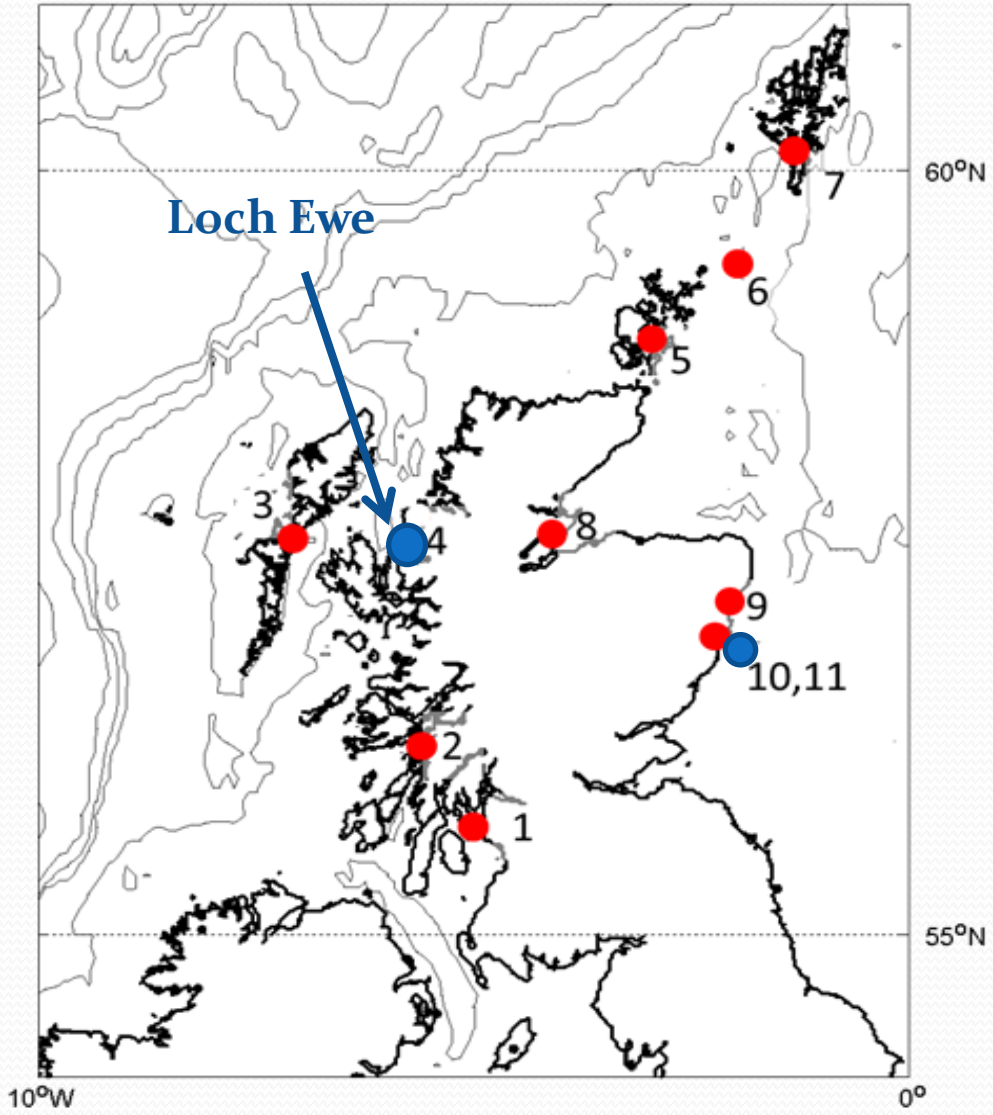
Scottish coastal observatory

- Established 1999
- 11 sites, 2 zooplankton stations

- Loch Ewe monitoring began in 2002
- One of the largest sea lochs by volume
- Represents western Scotland for UK monitoring under MSFD



Loch Ewe sampling

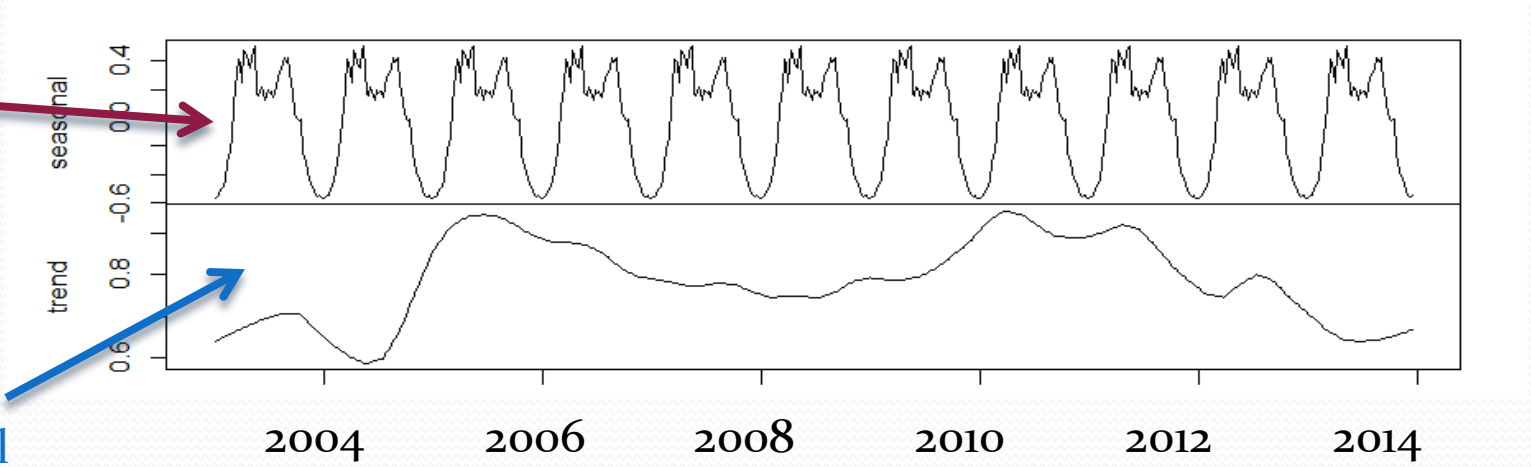
- High resolution – weekly
- Nutrients, salinity and temperature
- Phytoplankton and chlorophyll – 0-10m
- Mesozooplankton (200µm mesh) – 40cm bongo net, 30m

Seasonal and interannual trends

Seasonal trend

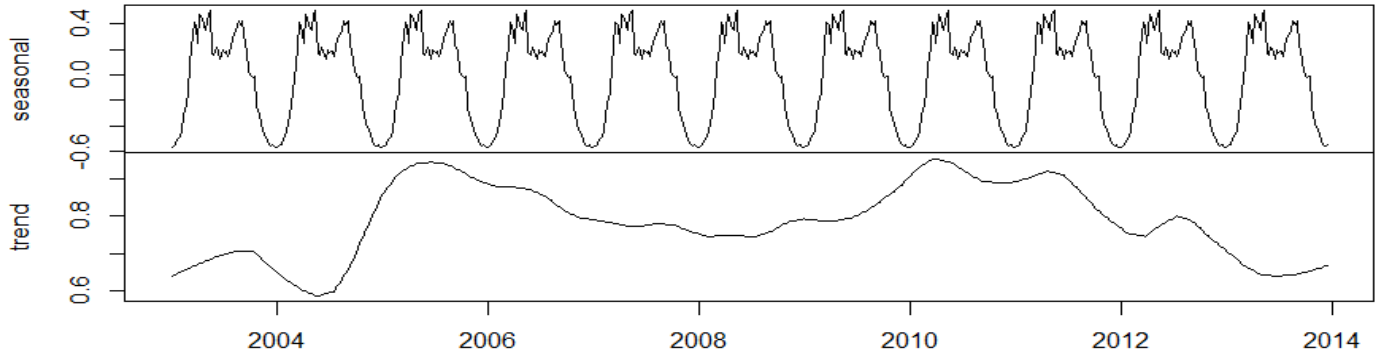
Chlorophyll

Interannual trend

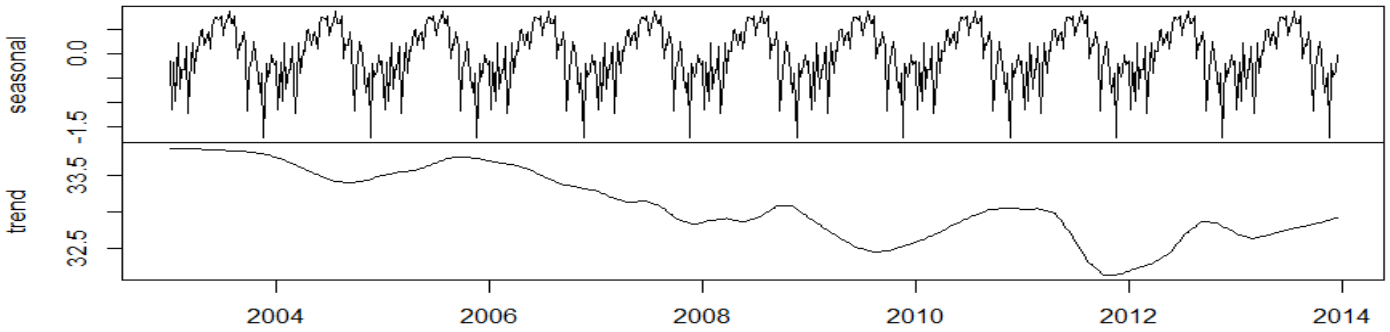


Seasonal and interannual trends

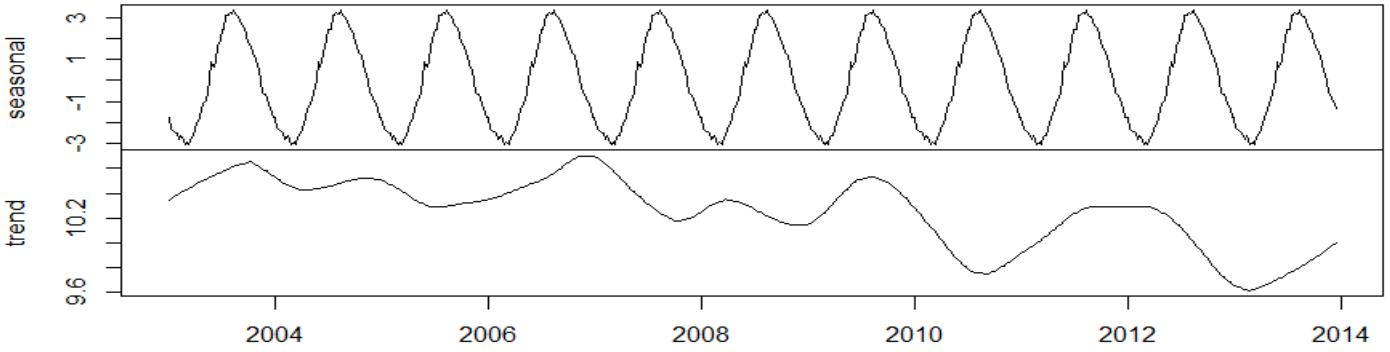
Chlorophyll



Salinity

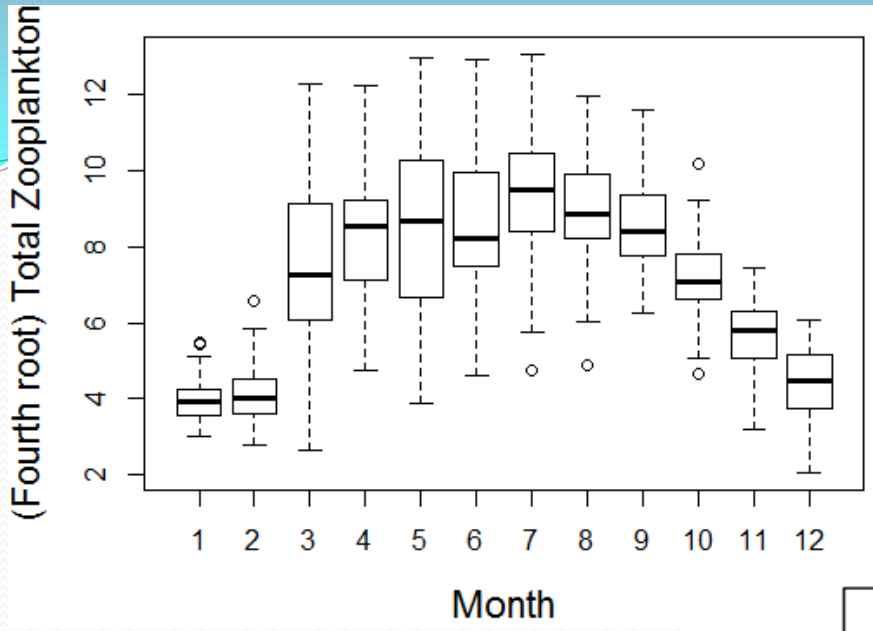


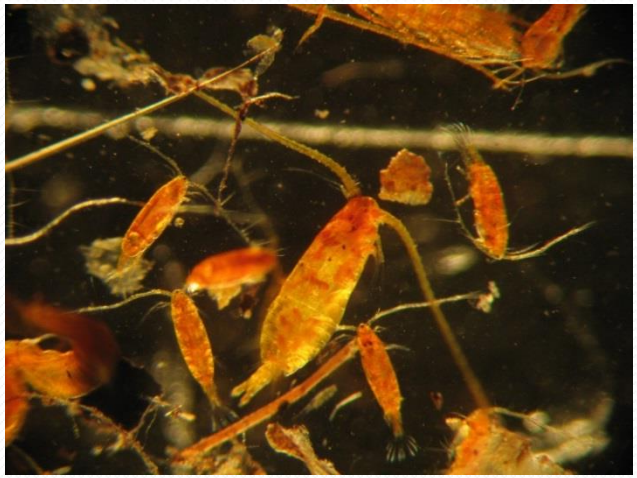
SST

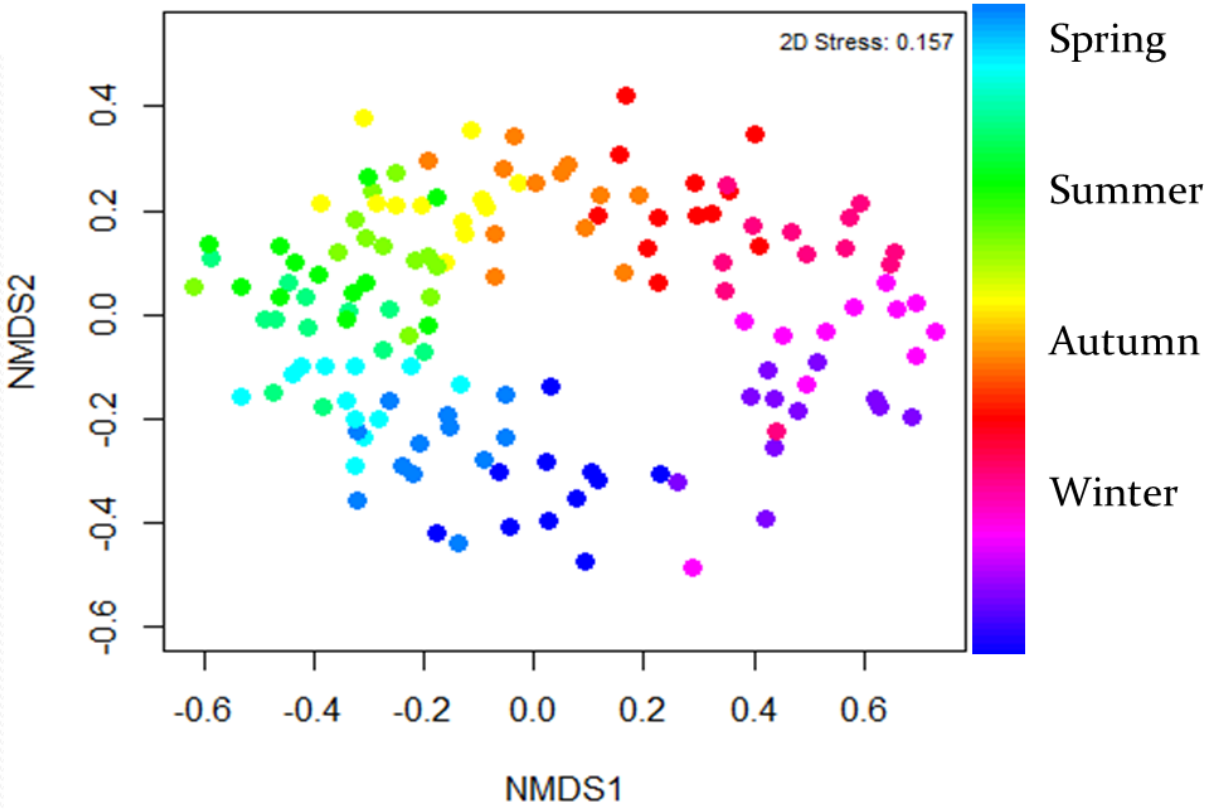


Zooplankton

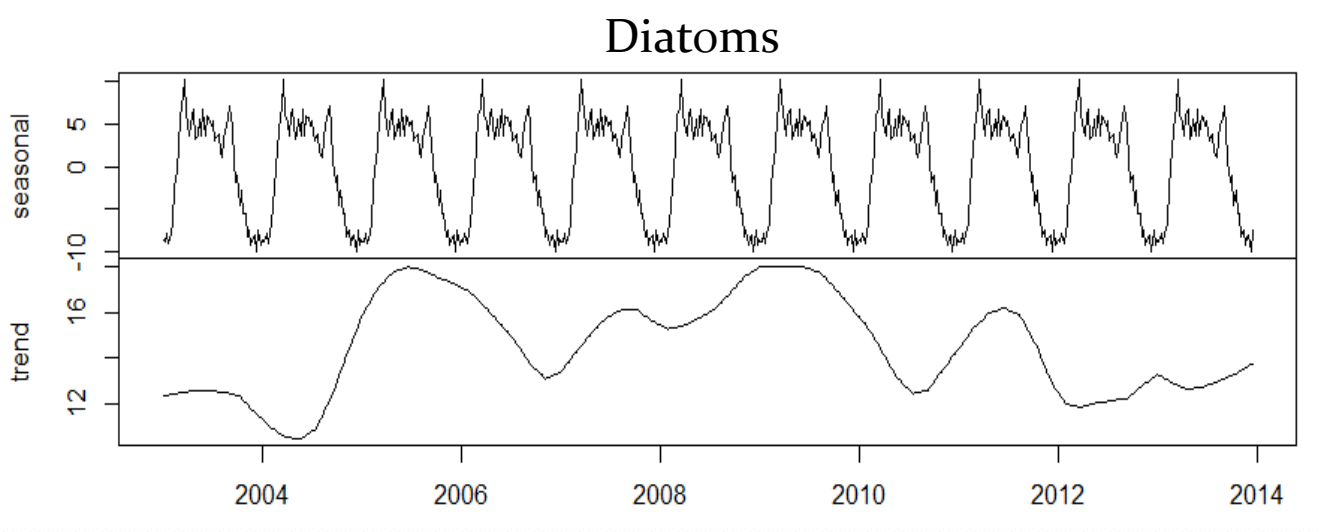
- Complicated dataset
- 138150 observations
- 225 taxonomic categories

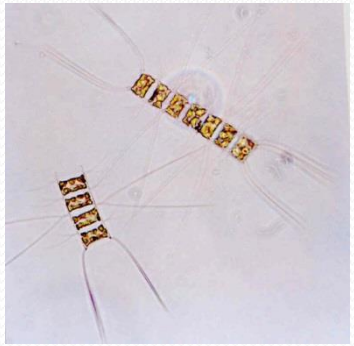


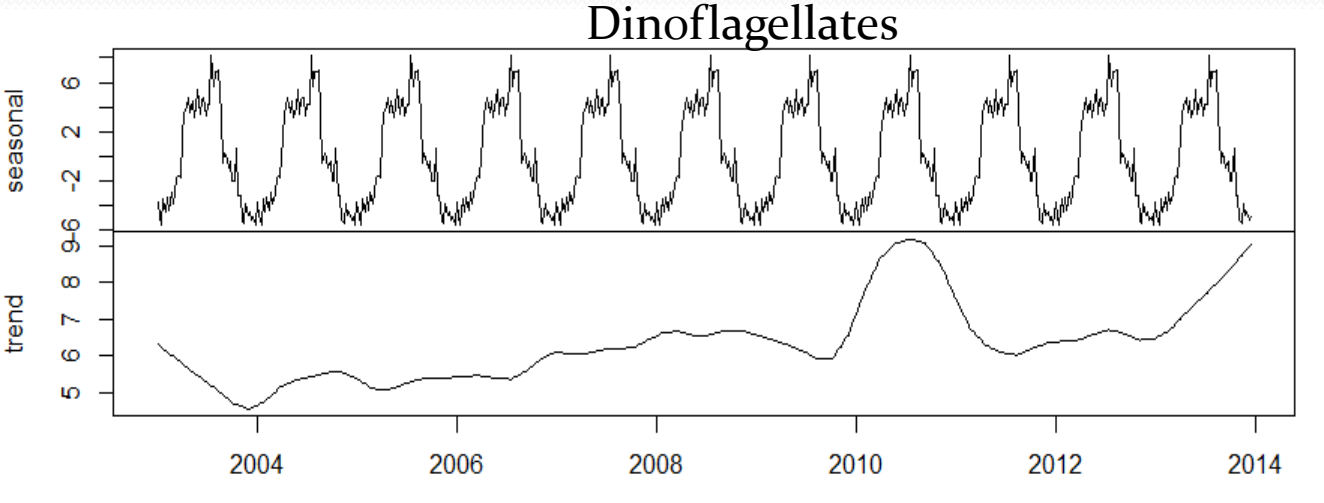




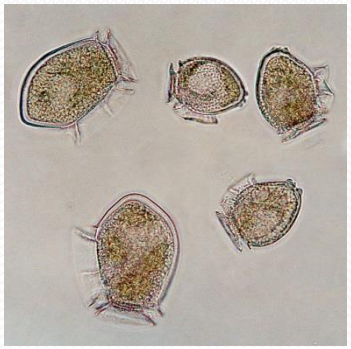
Diatoms and Dinoflagellates



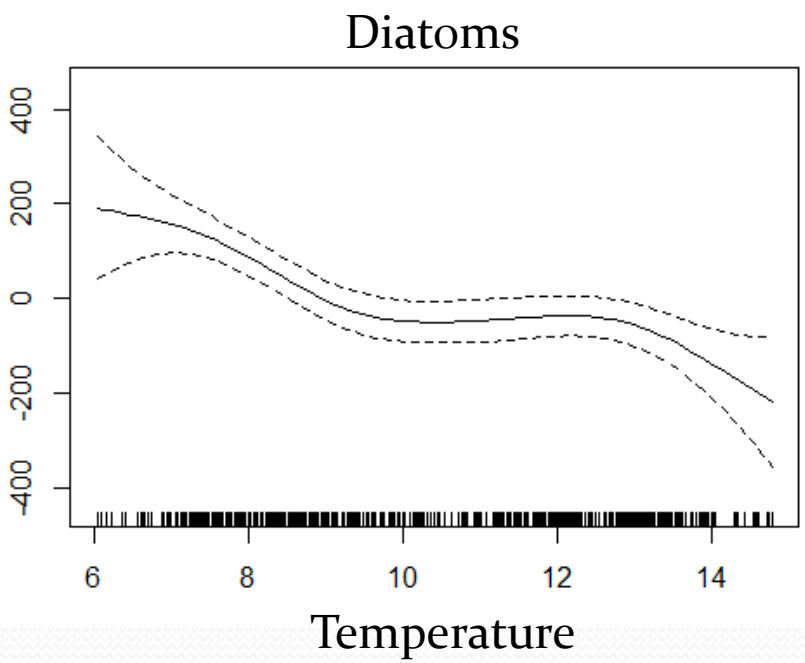


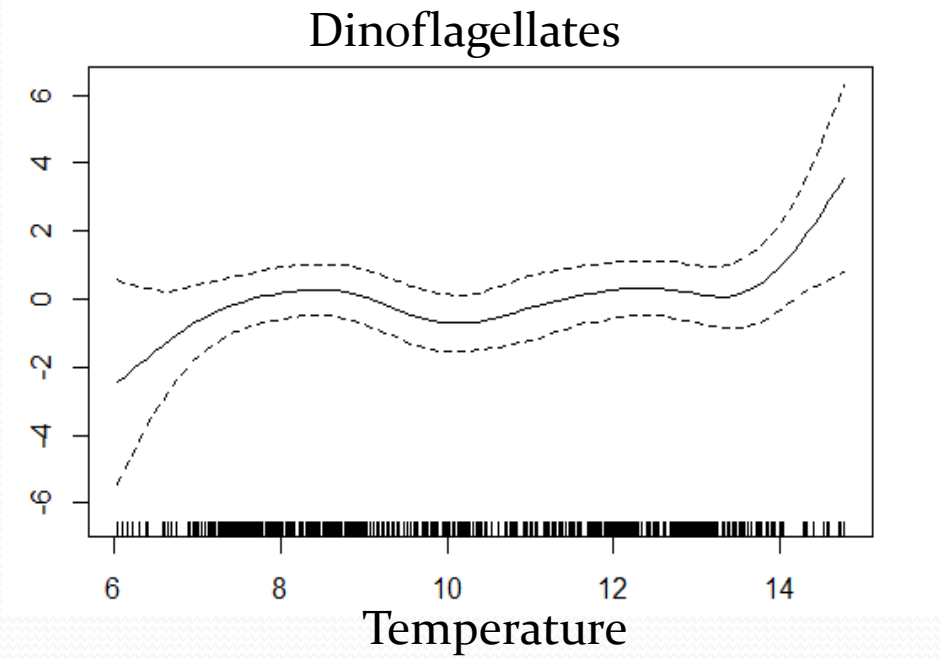


Increase in relative abundance of Dinoflagellates?



Diatoms and Dinoflagellates





- Temperature and Silicate significant ($p<0.001$)
- 44.3% variation explained

- Non-significant relationship with Temperature
- Nitrate important ($p<0.001$)
- 41.9% variation explained

So…..

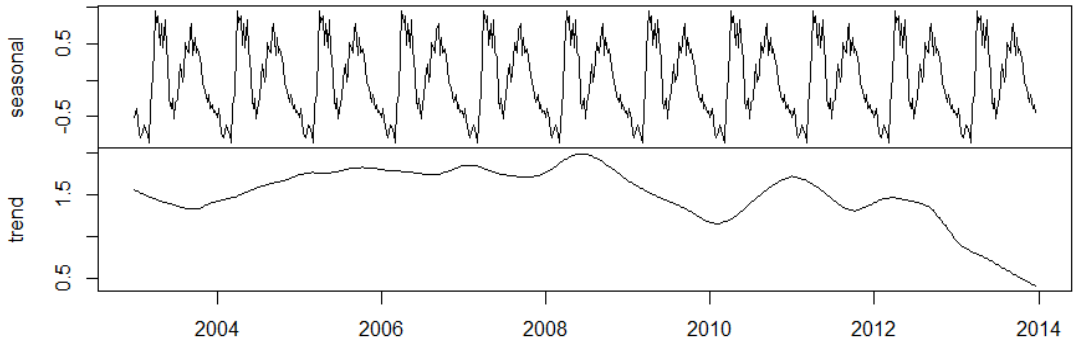
- Will these changes in temperature and the phytoplankton community affect zooplankton community composition?

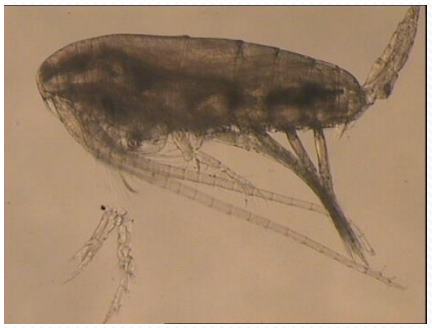
- Focus on commercially and ecologically important taxa: *Calanus helgolandicus* and *finmarchicus*, *Pseudocalanus* spp., *Acartia clausi*, decapod larvae, fish larvae, and gelatinous zooplankton.

- Run GAMs to investigate potential environmental drivers

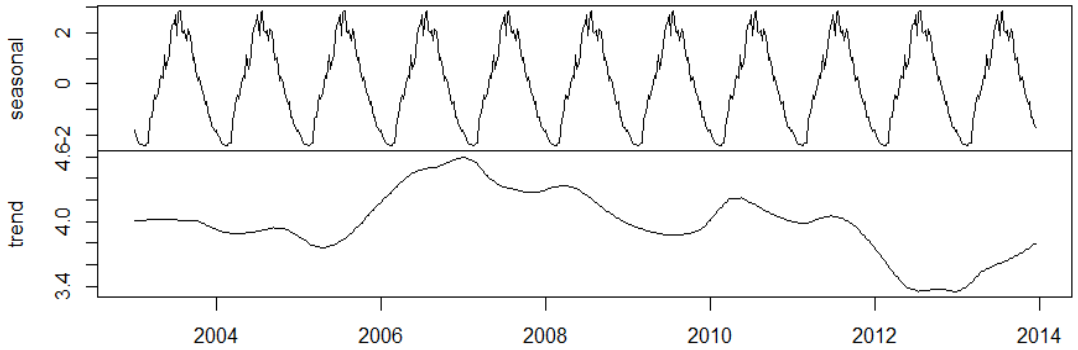
Taxa showing biomass decline

Calanus helgolandicus

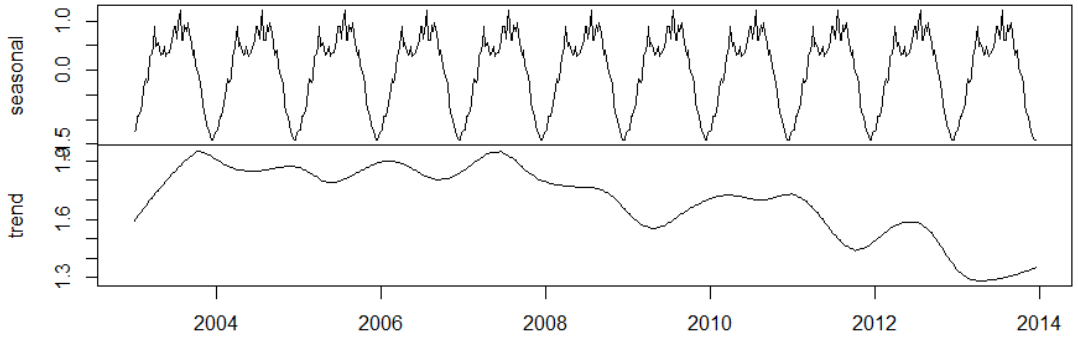


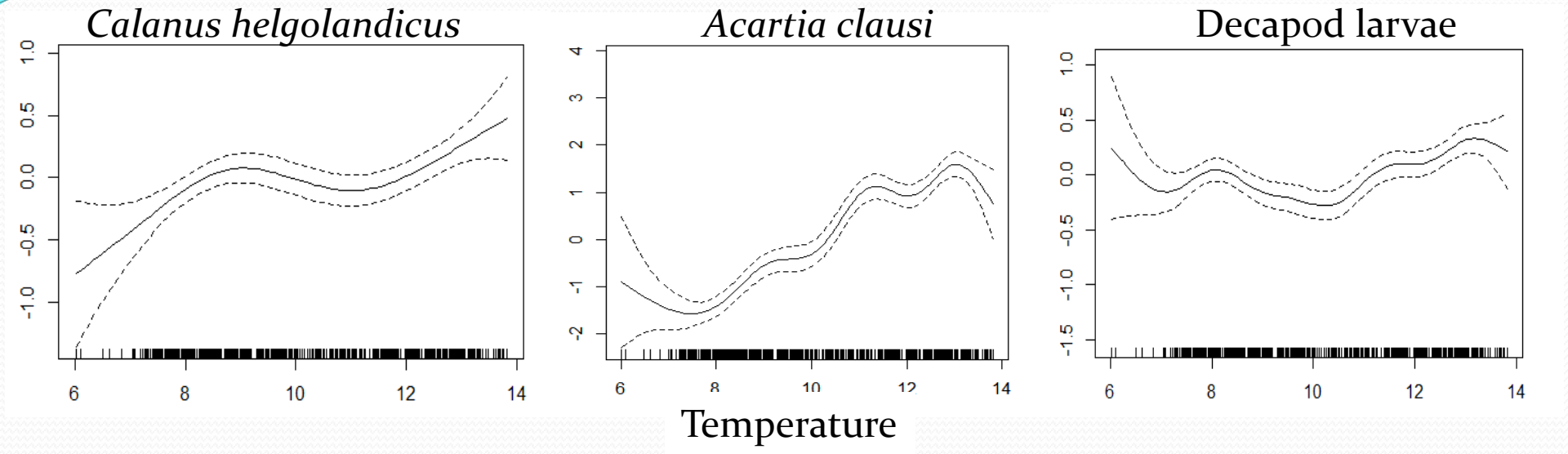


Acartia clausi

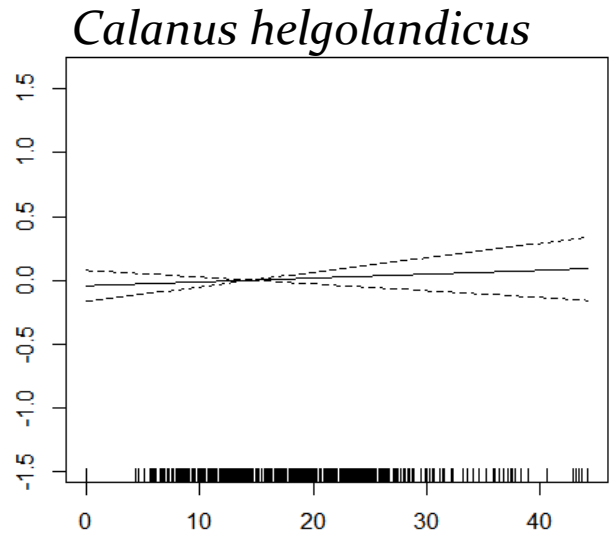


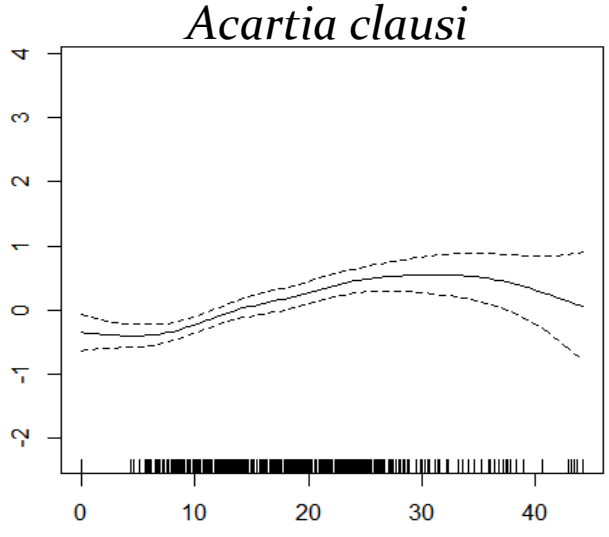
Decapod larvae

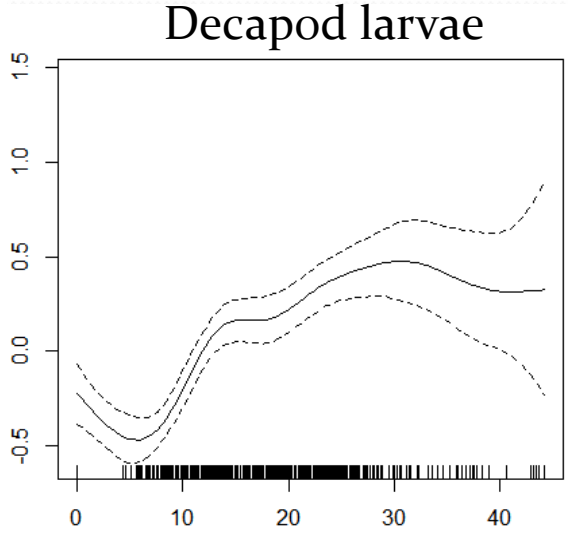




- Salinity and NAO index non-significant
- All significant ($p<0.001$) positive relationships with temperature



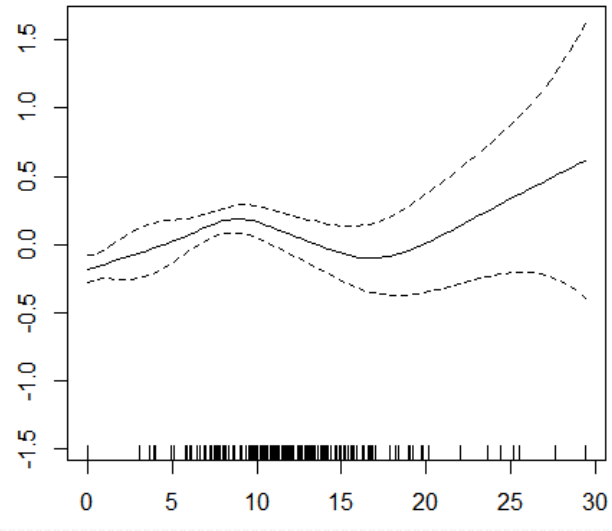




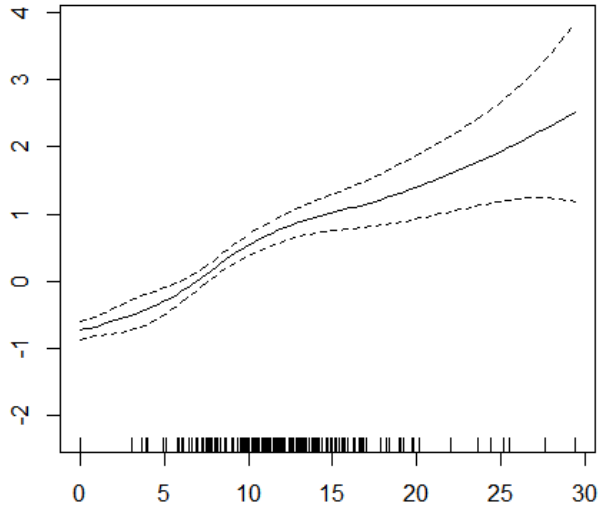
Diatoms

- Salinity and NAO index non-significant
- All significant ($p<0.001$) positive relationships with temperature
- *Calanus helgolandicus* non-significant relationship with Diatoms

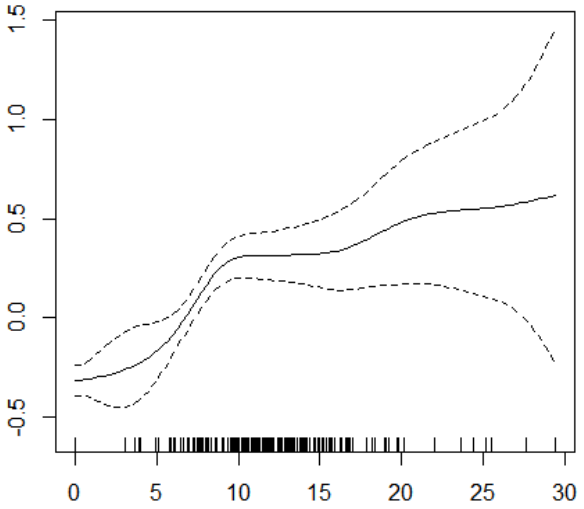
Calanus helgolandicus



Acartia clausi



Decapod larvae

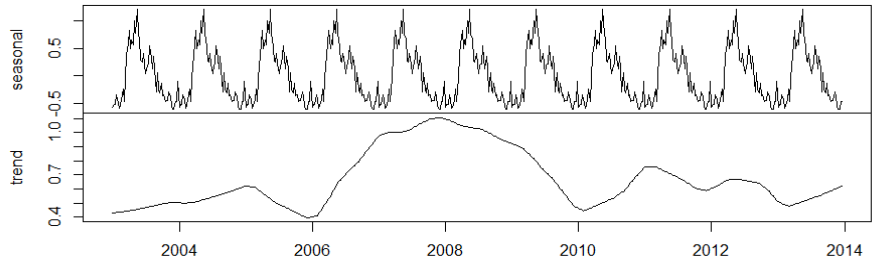


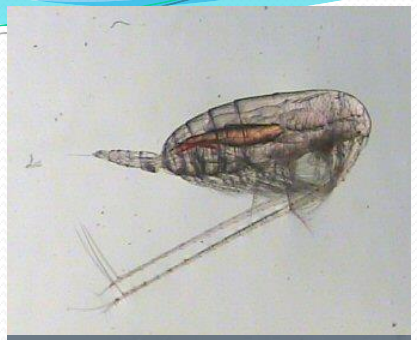
Dinoflagellates

- Salinity and NAO index non-significant
- All significant ($p<0.001$) positive relationships with temperature
- *Calanus helgolandicus* non-significant relationship with Diatoms
- All highly significant ($p<0.001$) positive non-linear relationships with Dinoflagellates
- 18.9%, 66% and 54.2% variation explained respectively by temperature and the phytoplankton community

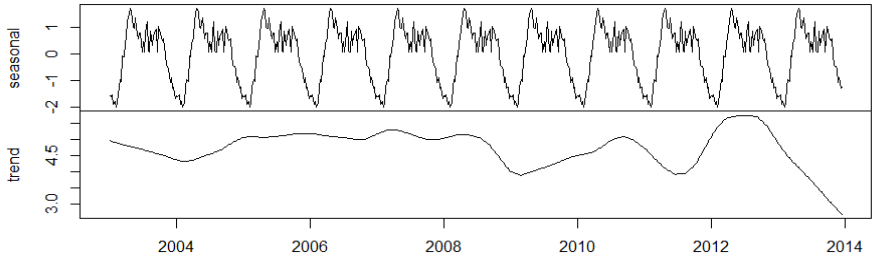
Other taxa

Calanus finmarchicus

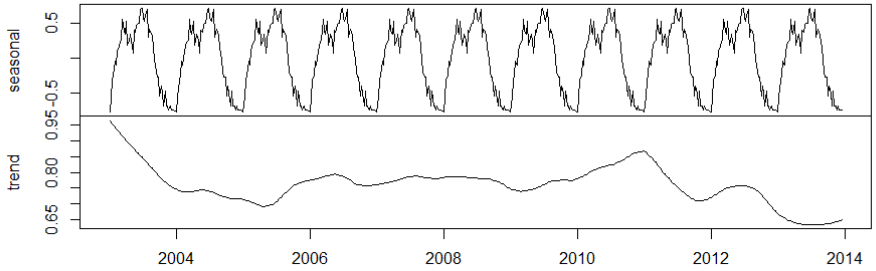




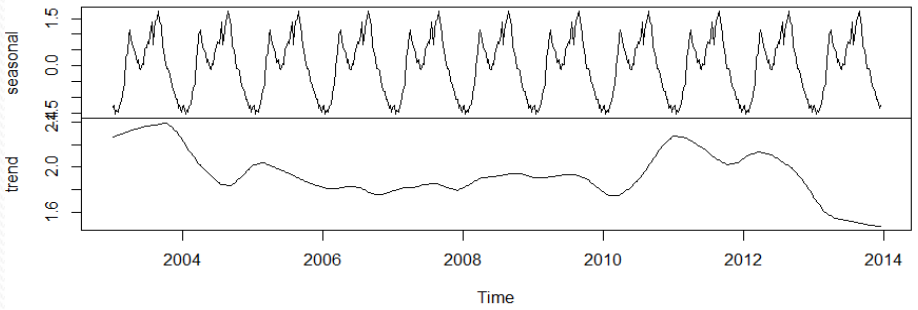
Pseudocalanus Spp.

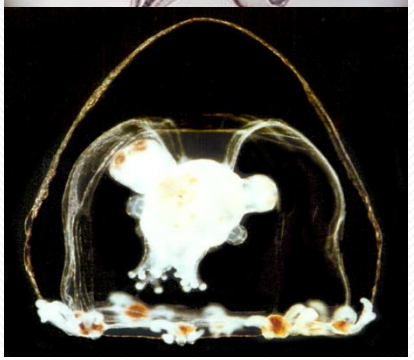


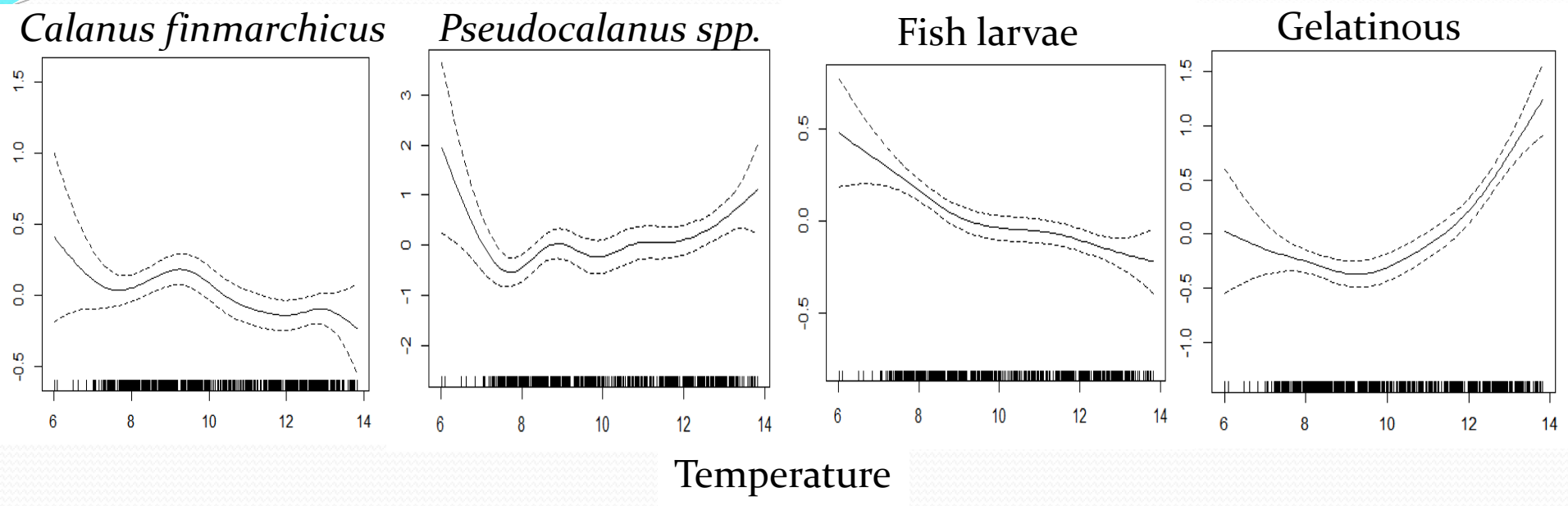
Fish larvae



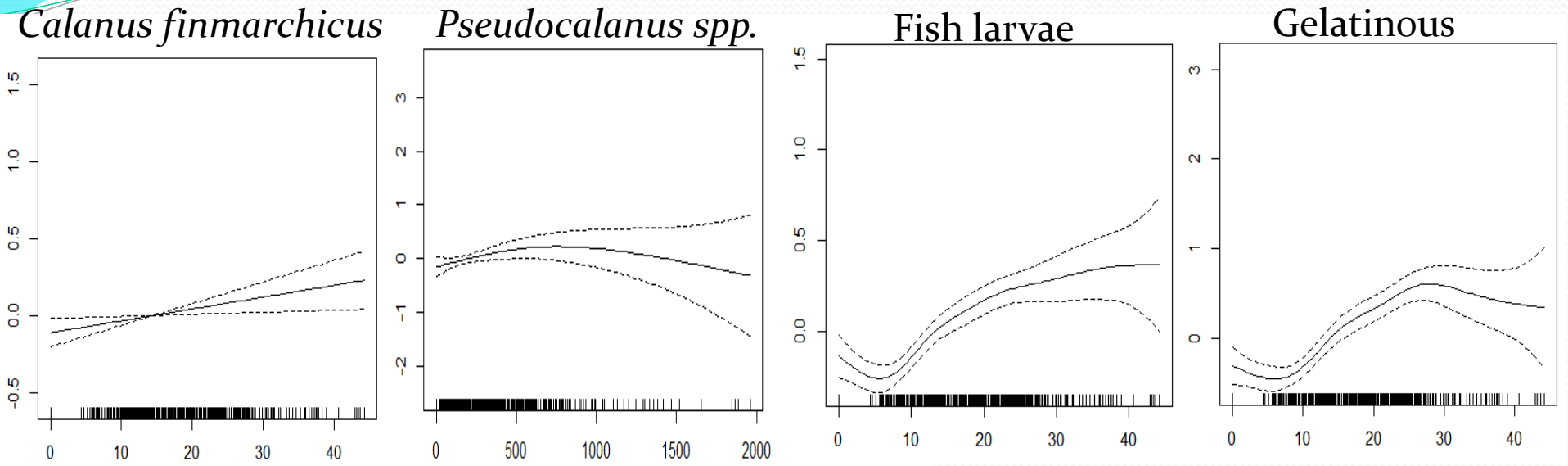
Gelatinous zooplankton





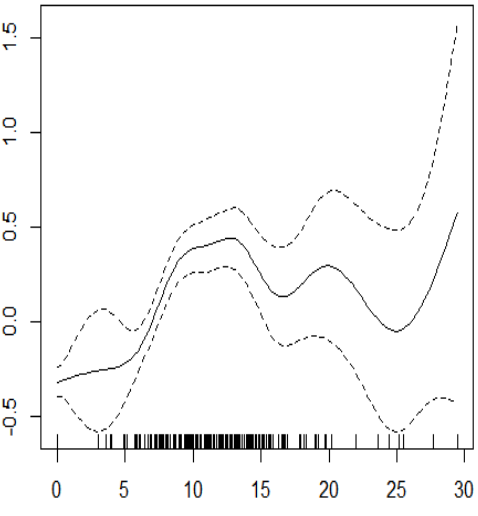


- Salinity and NAO index non-significant
- All significant ($p<0.001$) relationships with temperature

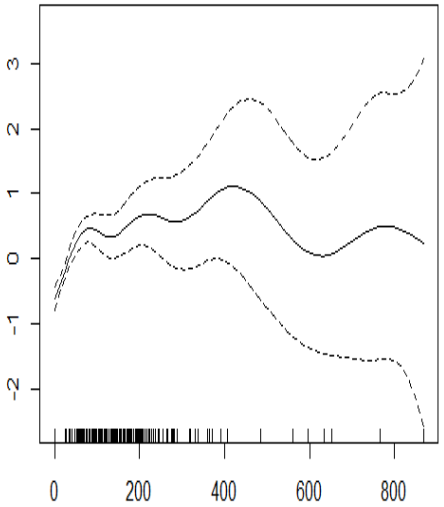


- Salinity and NAO index non-significant
- All significant ($p<0.001$) relationships with temperature
- *Pseudocalanus* non-significant relationship with Diatoms

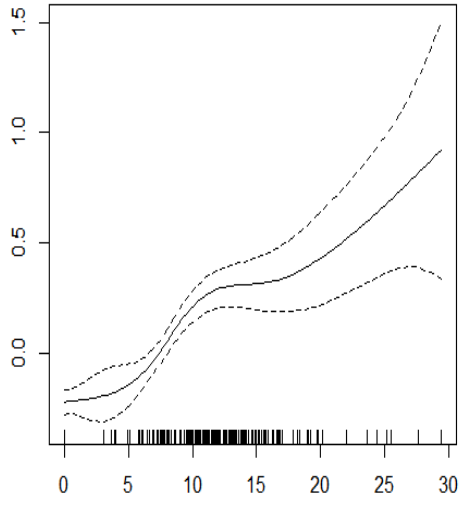
Calanus finmarchicus



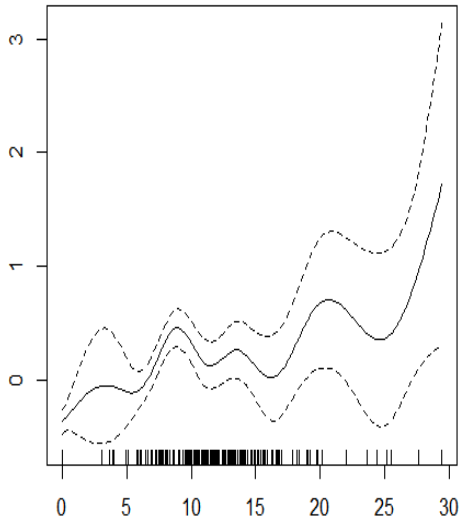
Pseudocalanus spp.



Fish larvae



Gelatinous



Dinoflagellates

- Salinity and NAO index non-significant
- All significant ($p<0.001$) relationships with temperature
- *Pseudocalanus* non-significant relationship with Diatoms
- All highly significant ($p<0.001$) non-linear relationships with Dinoflagellates
- 24.3%, 18.8%, 41.4% and 51.9% variation explained respectively by temperature and the phytoplankton community

Conclusions

Will these changes in temperature and the phytoplankton community affect zooplankton community composition?

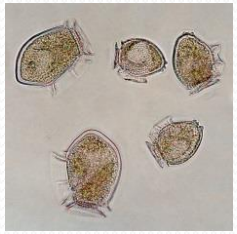
Conclusions

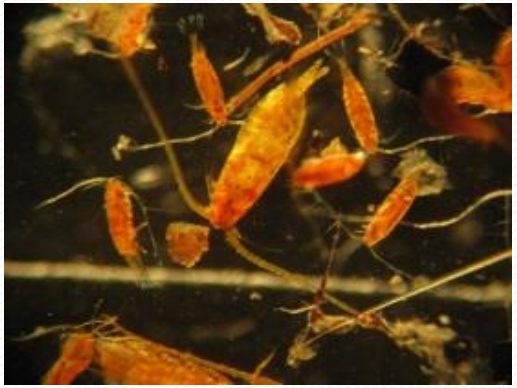
Taxa	Temp	Diatoms	Dinos	Variation Explained (%)
C. helgolandicus	+		(+)	18.9
C. finmarchicus	-	+		24.3
Pseudocalanus spp.	(+)			18.8
Acartia clausi	+	(+)	+	66
Fish larvae	-	+	+	41.4
Decapod larvae	(+)	+	+	54.2
Gelatinous	+	+		51.9

- Temperature and the phytoplankton community most important drivers to explain seasonal variation
- The strength of the relationships vary between taxa
- Need species level taxonomic analysis for copepods
- Relatively short time series

Future work

- Refit models to include lags and explore more detrending options
- Boundary detection techniques
- Phytoplankton species
- Comparison with Stonehaven site
- Comparison with other locations around the West coast and Shetland to establish how representative Loch Ewe is





Acknowledgements

Jane Grant, John Fraser and all analysts involved in the Loch Ewe time series, Supervisors, Sari Giering

Common Trends

- Dynamic factor analysis on seasonally de-trended data