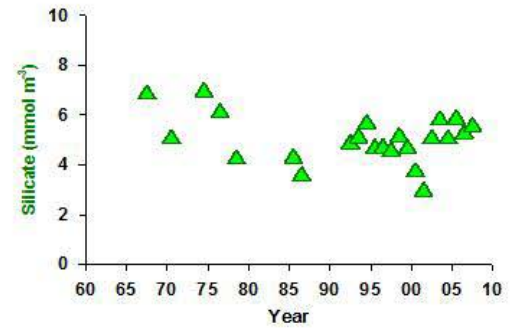
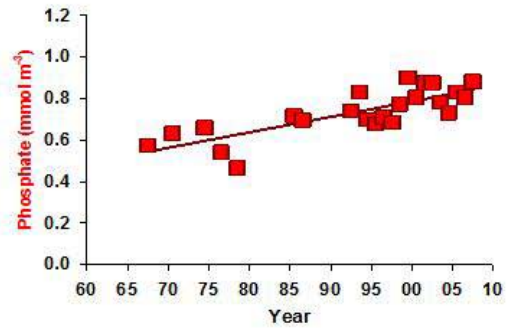
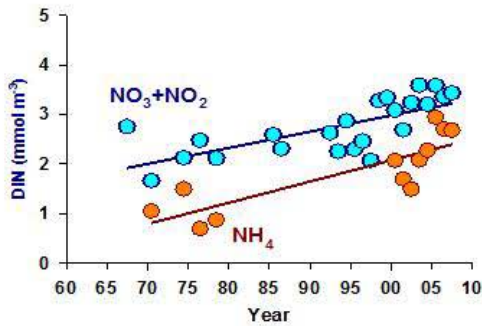
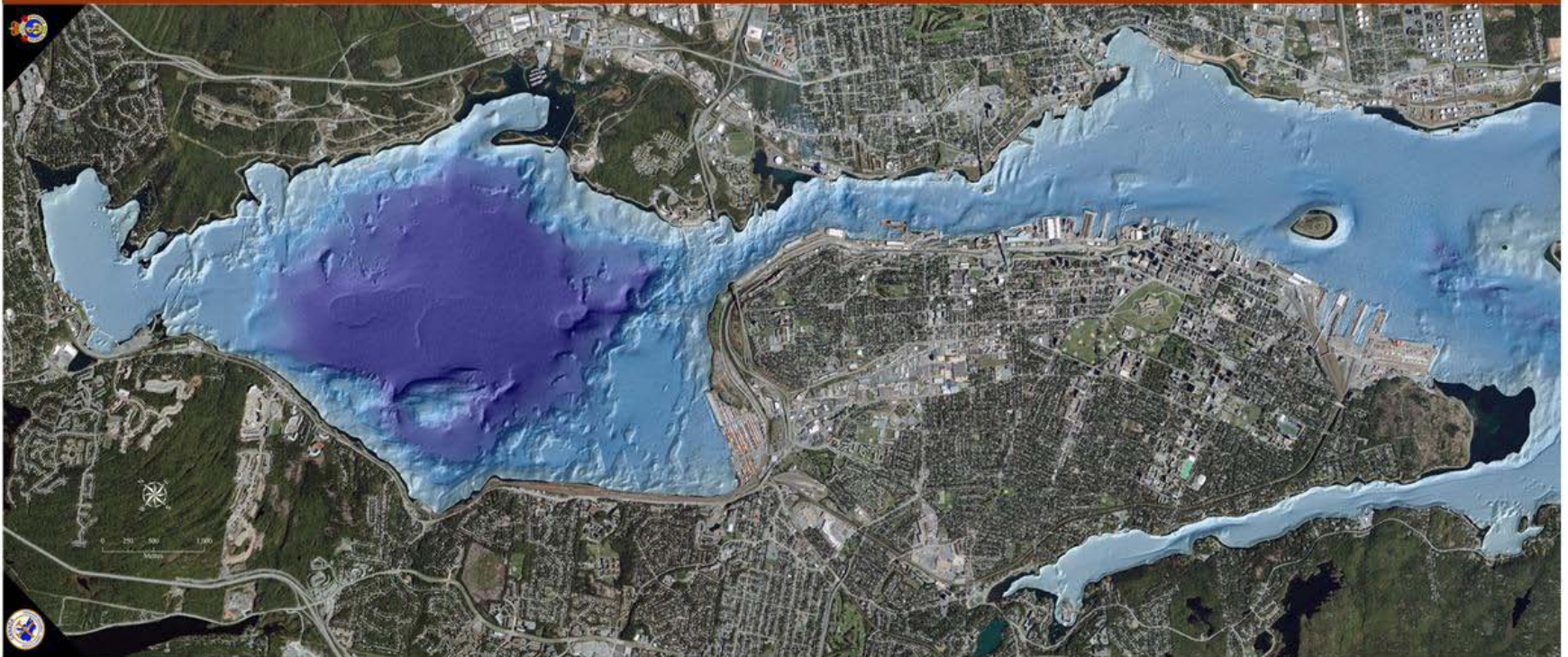


**Propagation of an atmospheric climate signal to
phytoplankton in a small marine basin**

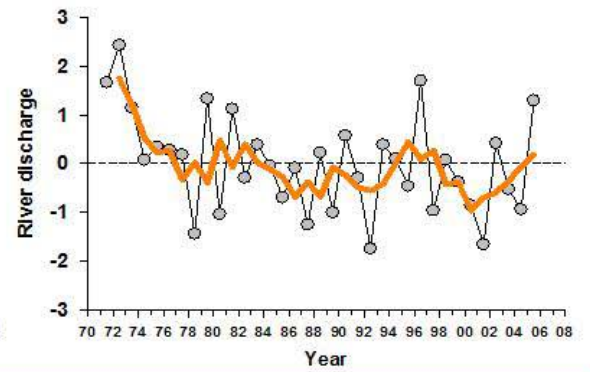
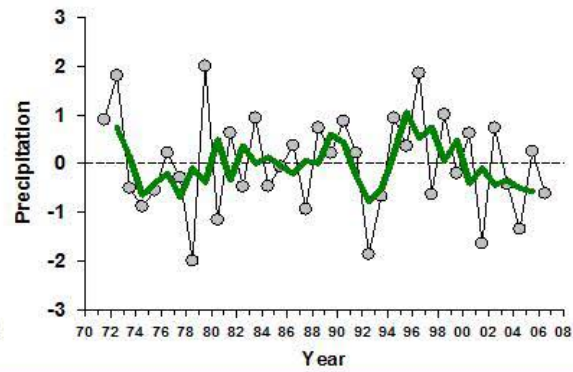
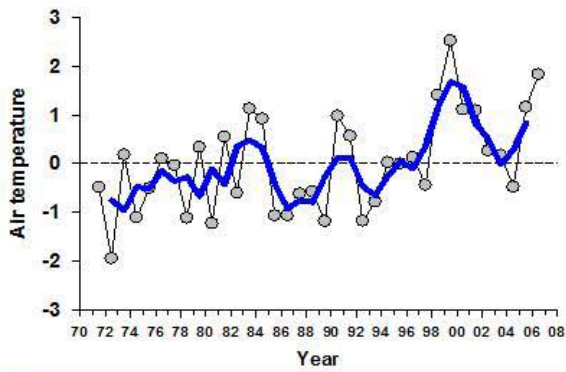
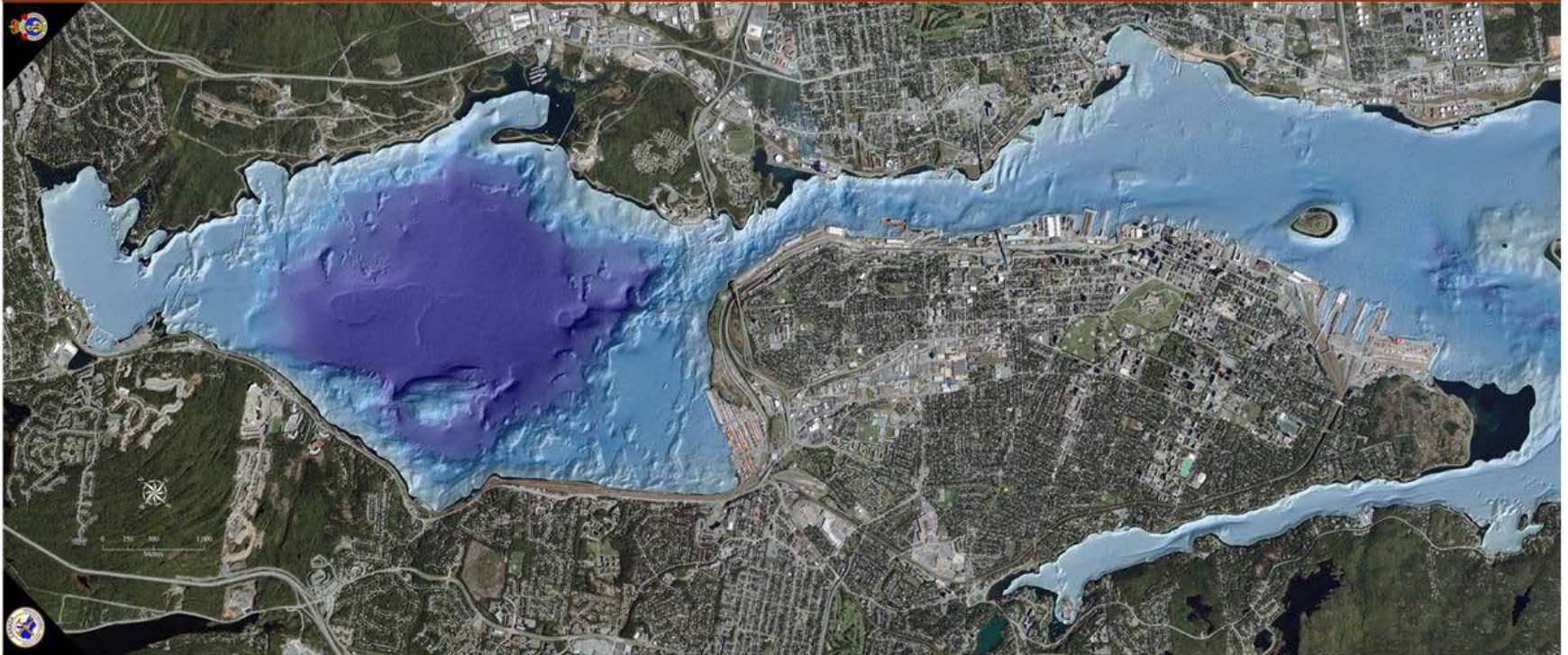
**William Li
Bedford Institute of Oceanography
Canada**

Bedford Basin, Halifax Harbour



Over a period of 40 years, annual average concentrations of N and P have increased, but Si has not.

Bedford Basin, Halifax Harbour



Over a period of 40 years, there have been climatic variations.

Coastal ecosystems are subject to multiple stresses

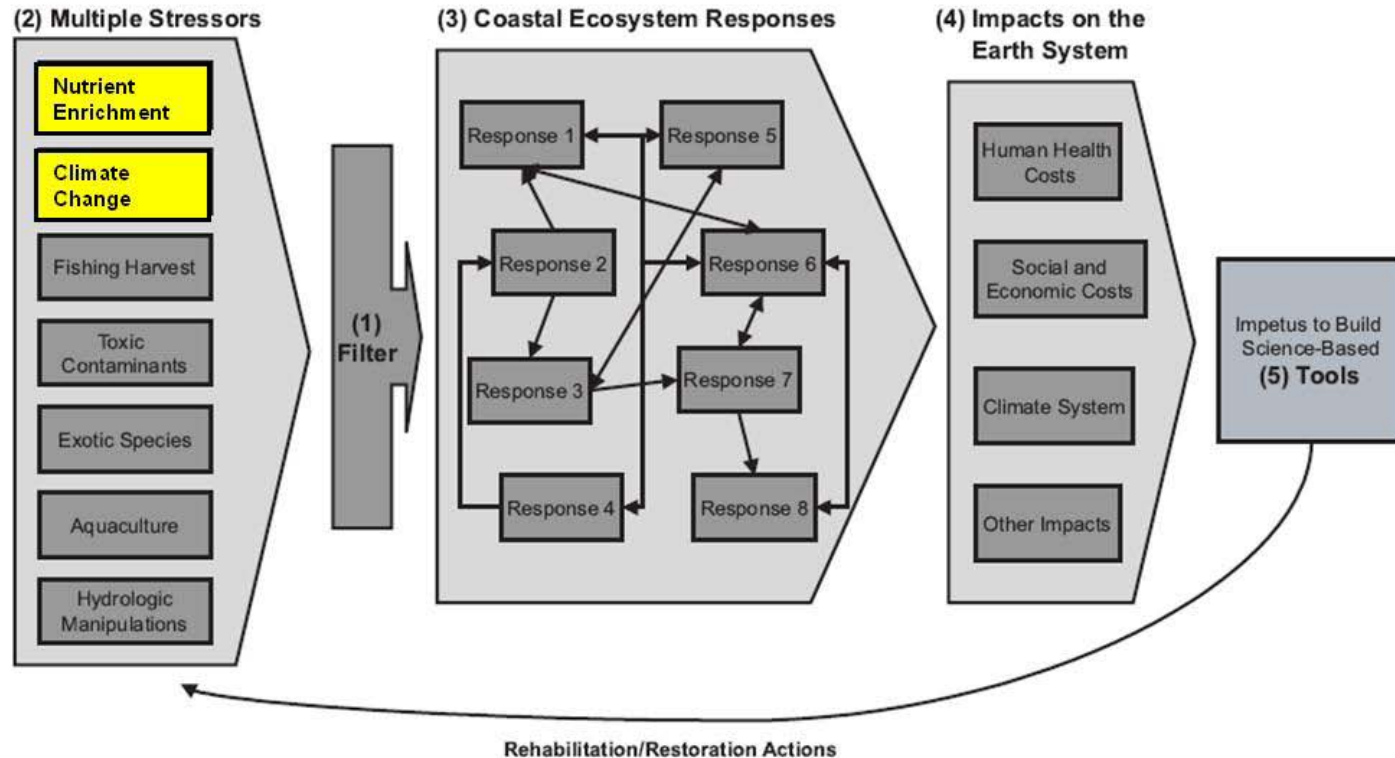
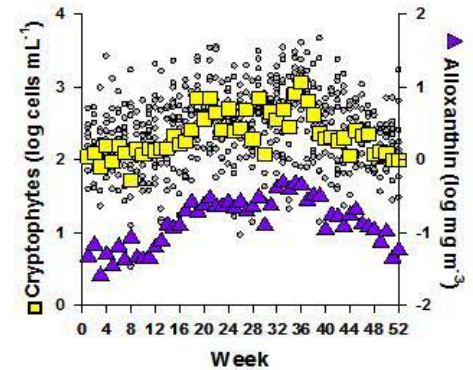
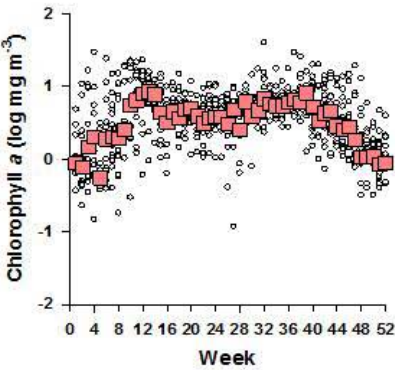
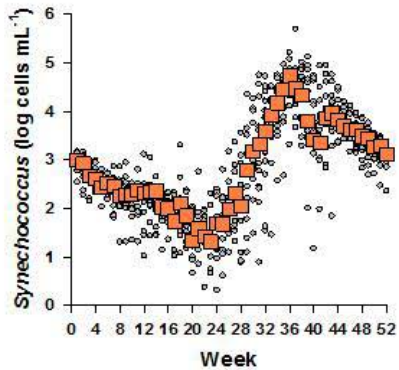
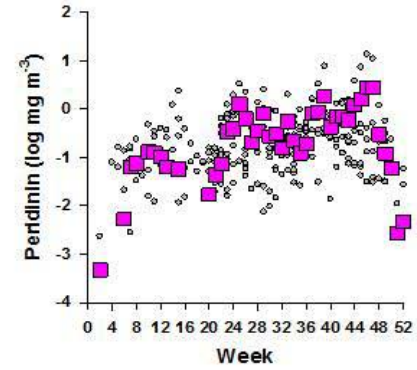
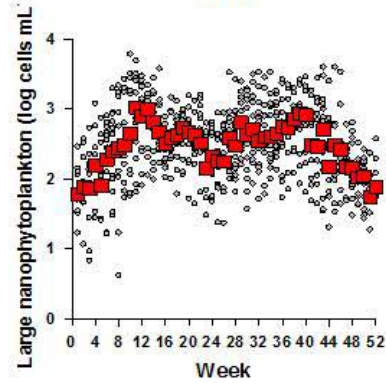
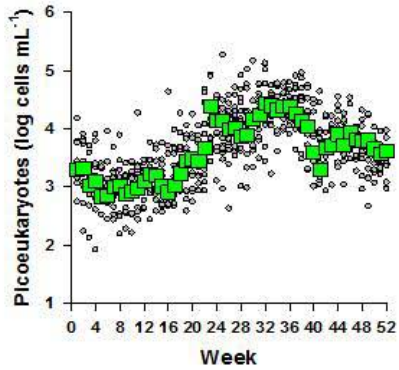
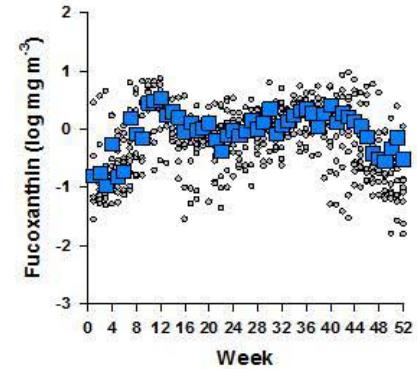
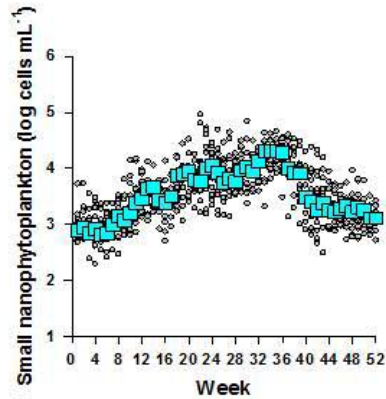
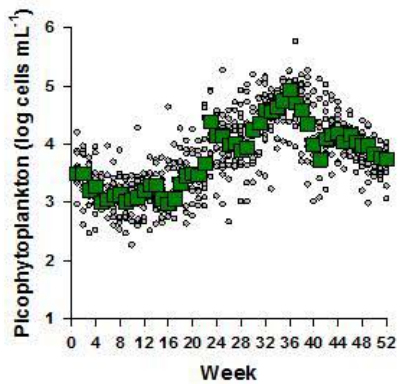
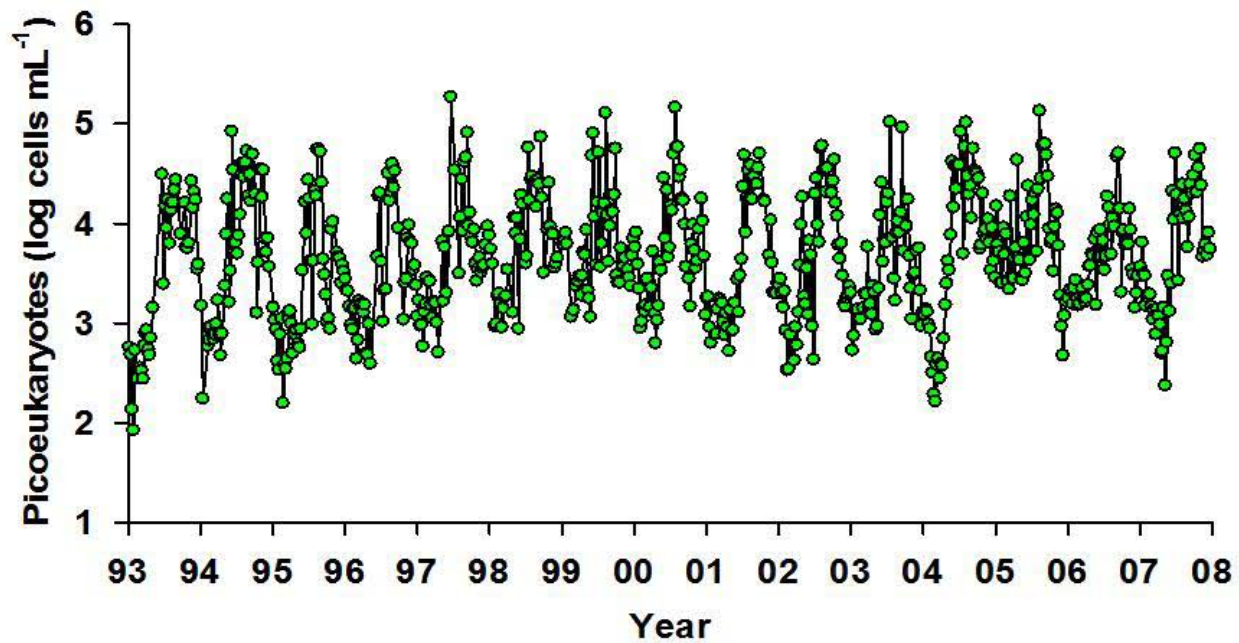


Fig. 24. One view of the next (Phase III) conceptual model of coastal eutrophication, organized around 5 basic questions concerning: (1) the system attributes that act as a filter to modulate the responses to nutrient enrichment; (2) nutrient enrichment as 1 of many interacting stressors; (3) the complex linkages between responses to multiple stressors; (4) impacts of change in coastal ecosystems on the Earth system, including aspects that influence sustainability of the human population; and (5) the application of a deeper and broader scientific understanding of coastal eutrophication to produce a set of tools for building rational management strategies and action plans for ecosystem rehabilitation/restoration

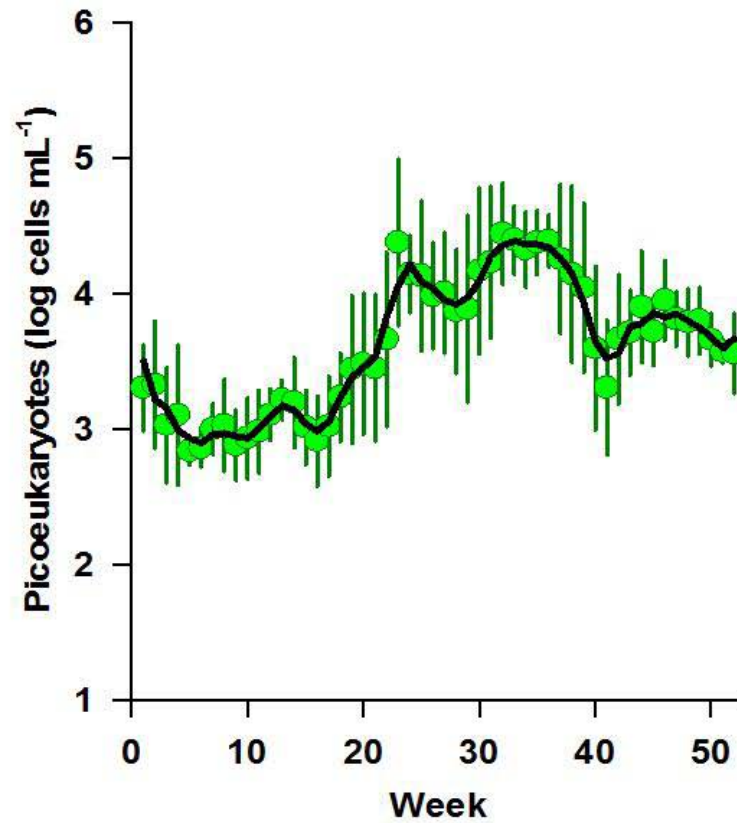
Seasonal variation is very strong, and differs amongst phytoplankton groups



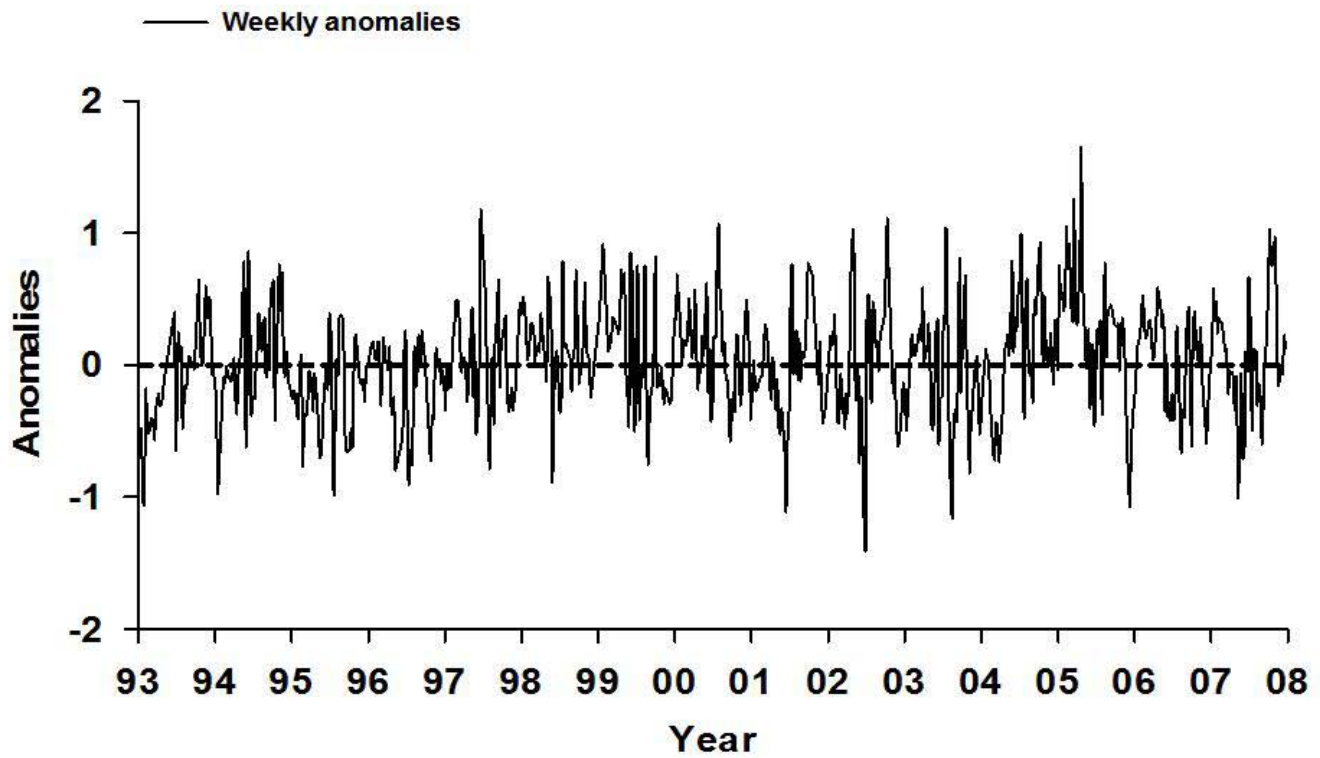
Weekly measurements (15 years)



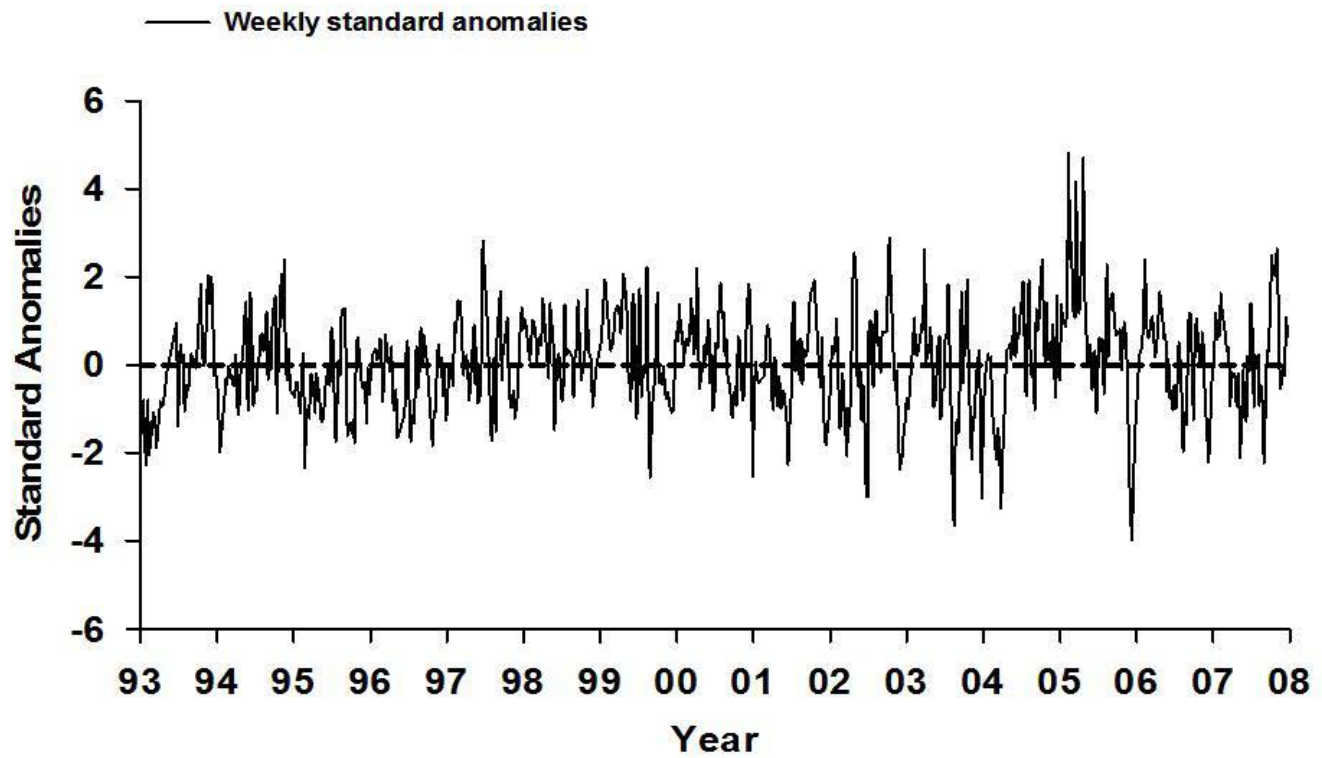
Normals (climatology) : weekly averages and standard deviations



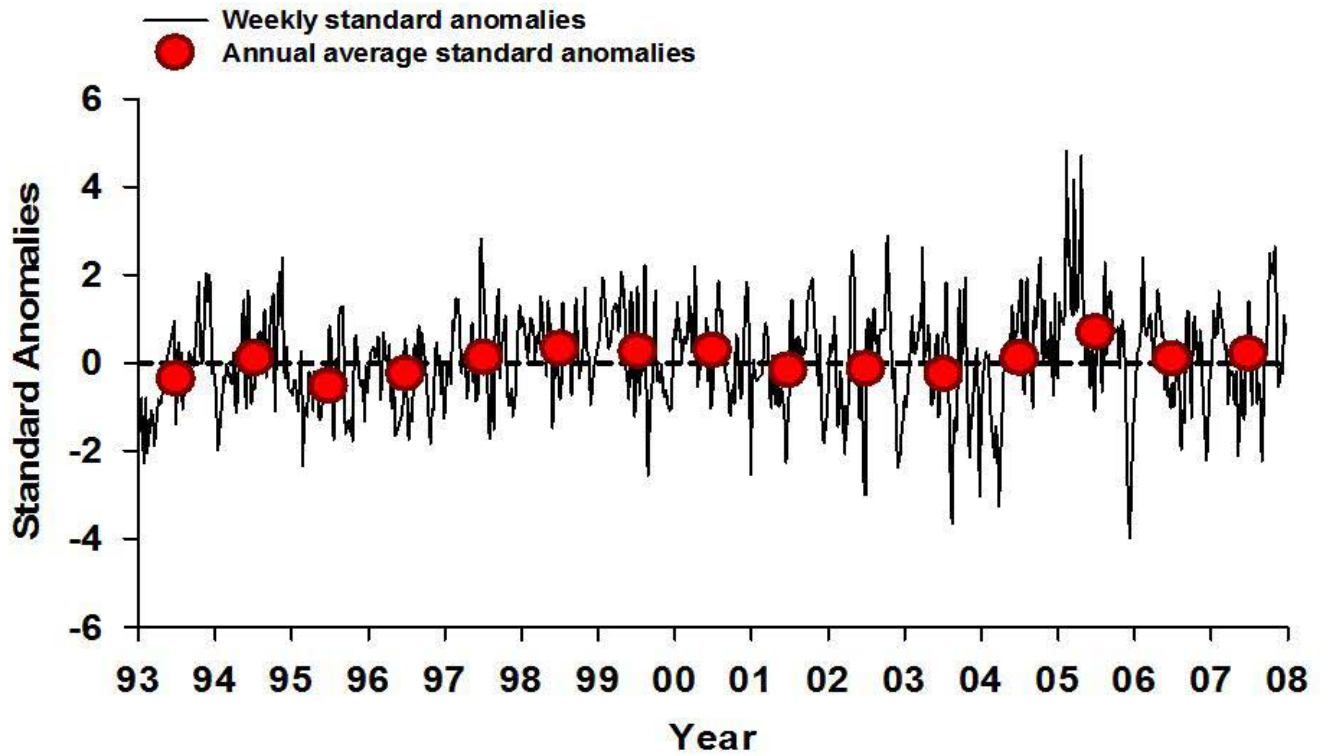
Weekly anomalies: departures of observations from norms



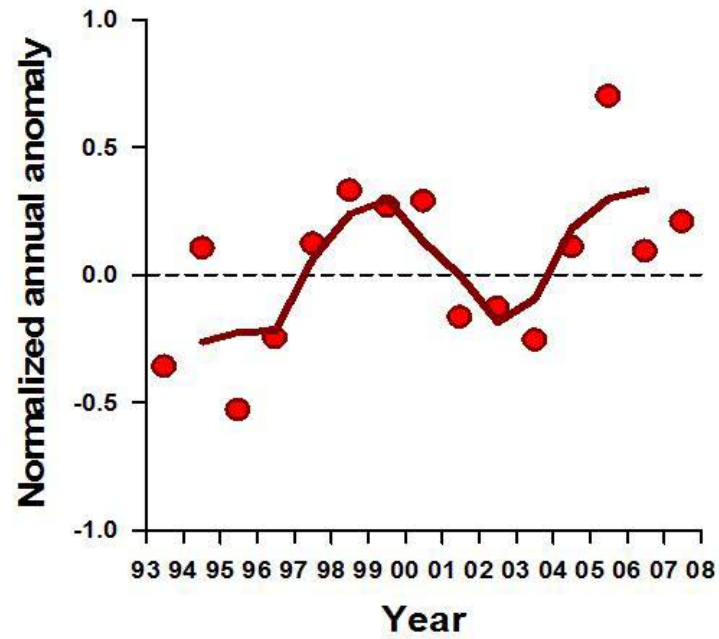
Weekly standard anomalies: standardised departures of observations from norms



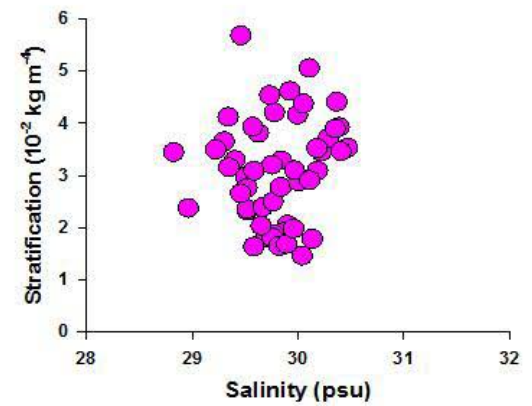
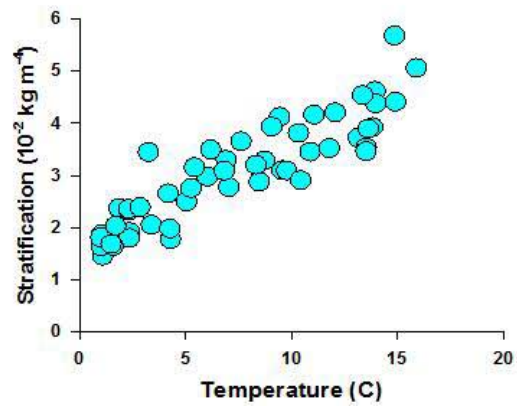
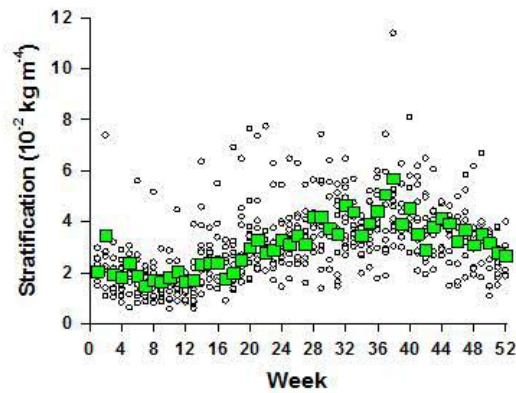
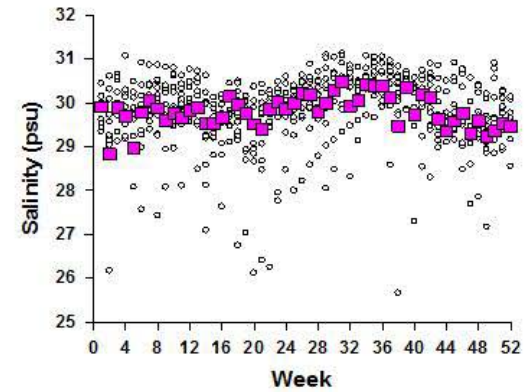
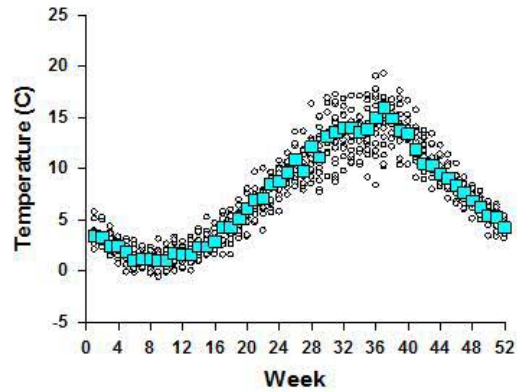
Weekly standard anomalies: standardised departures of observations from norms



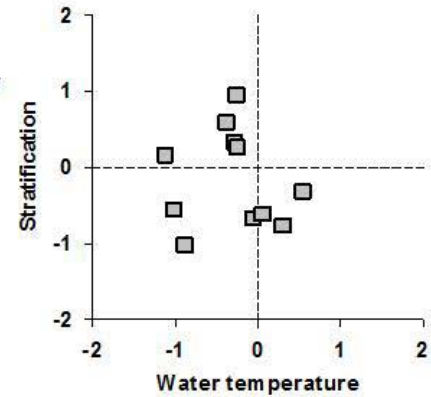
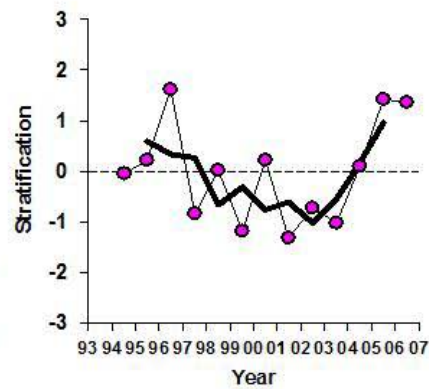
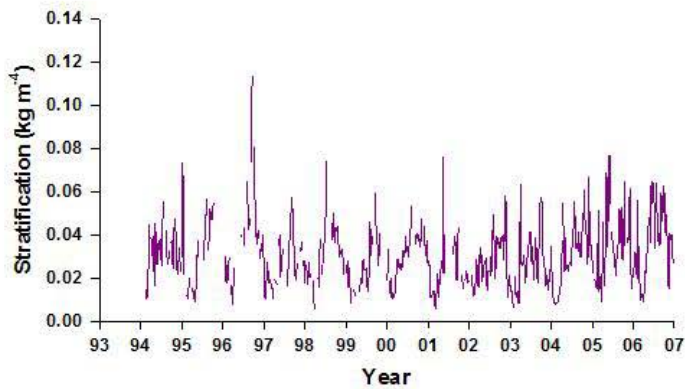
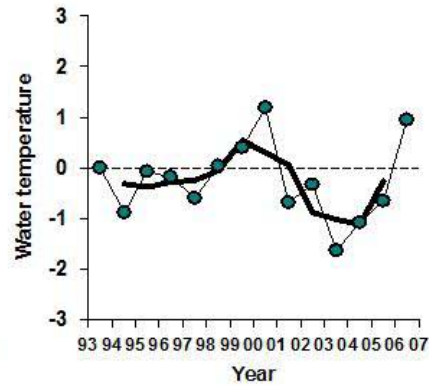
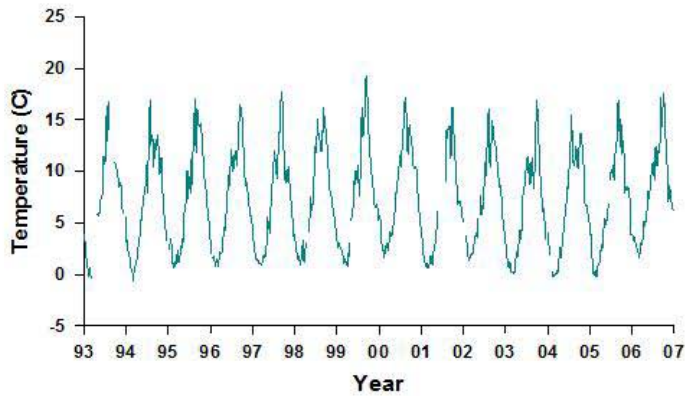
Normalized annual anomalies: annual anomalies in standard deviate units



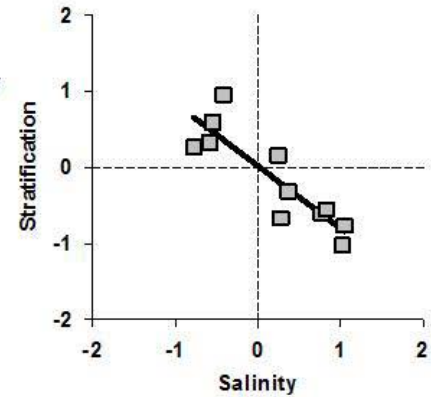
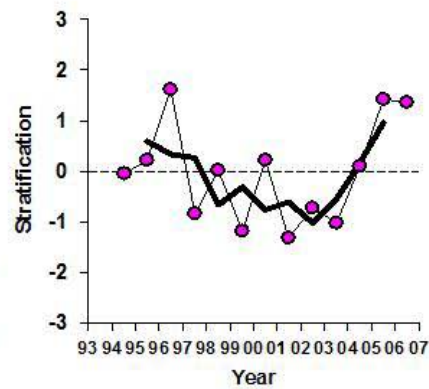
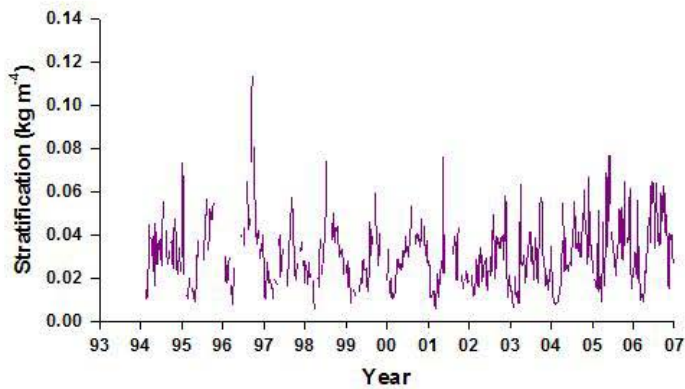
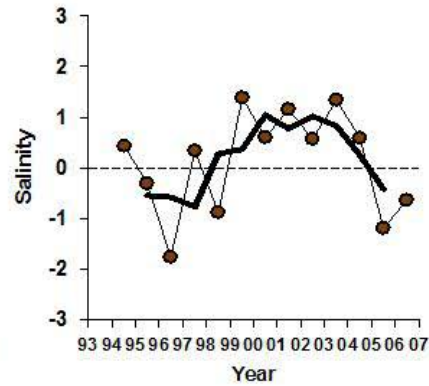
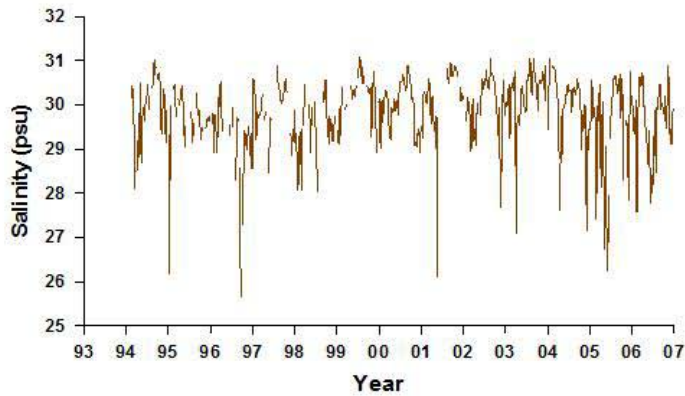
On an intra-annual basis, stratification is determined by temperature



On an interannual basis, stratification is not determined by temperature



On an interannual basis, stratification is determined by salinity



Intra-annual versus interannual control

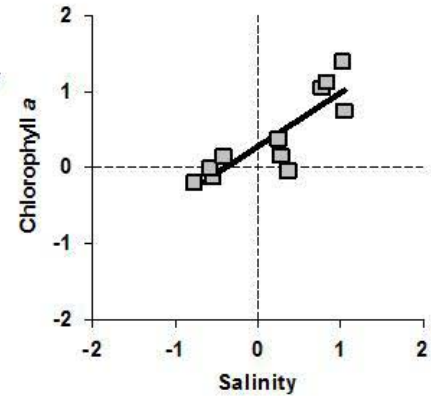
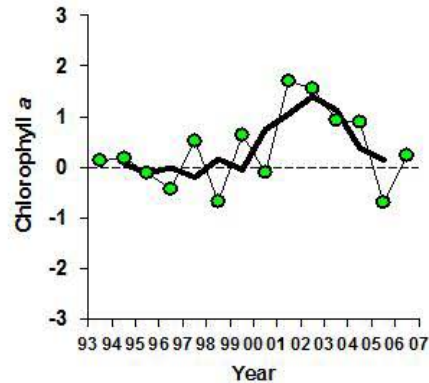
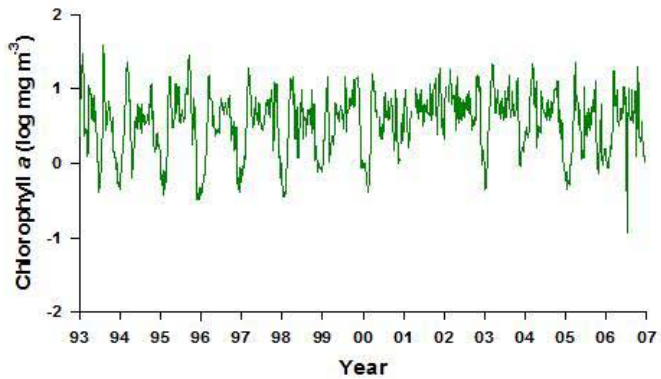
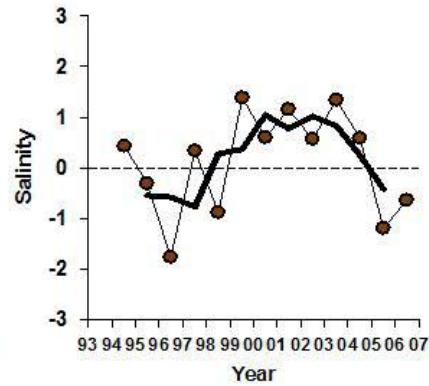
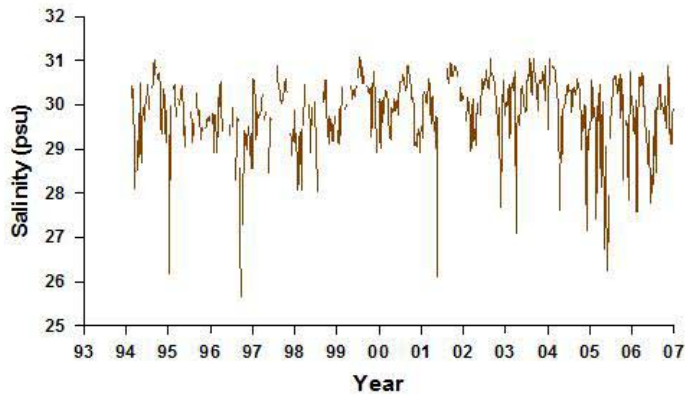
Temperature has a strong seasonal cycle, but yearly averages are not very different.

On the other hand, salinity has a weak seasonal cycle, but yearly averages are substantially different.

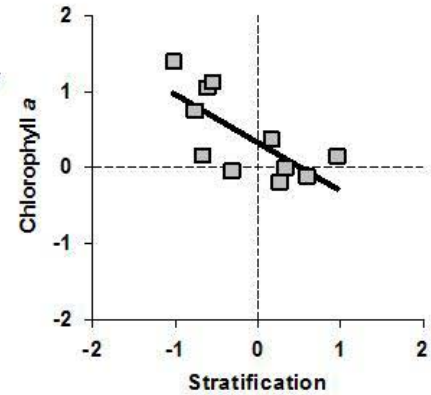
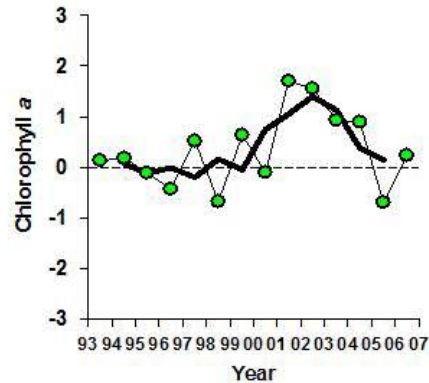
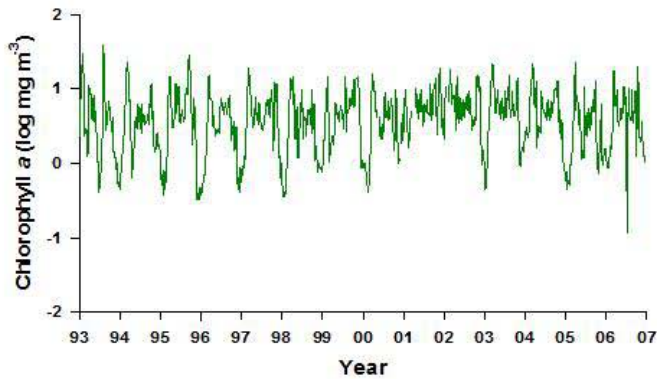
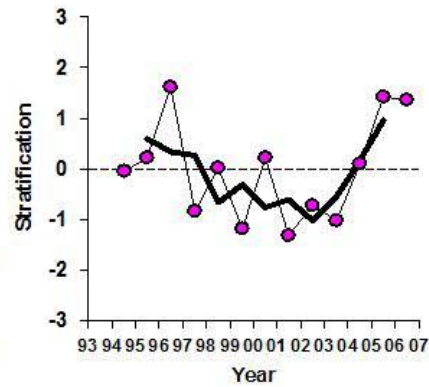
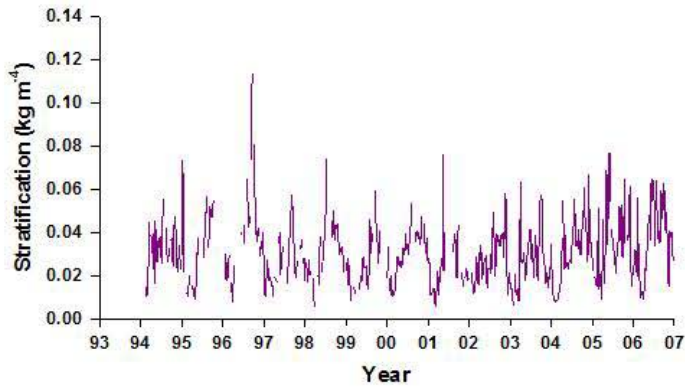
Thus, at the interannual scale, changes in stratification are related to changes in salinity.

The dominant factor controlling a process (either physical or biological) may not be the same at intra-annual and interannual time scales.

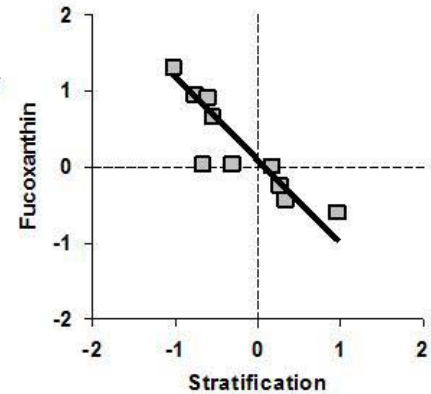
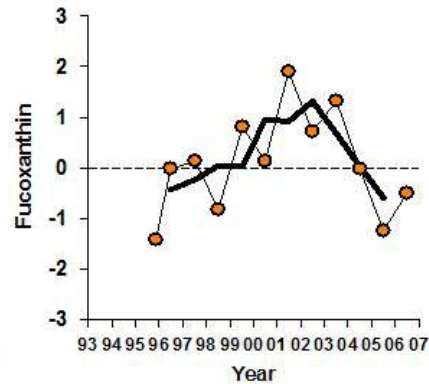
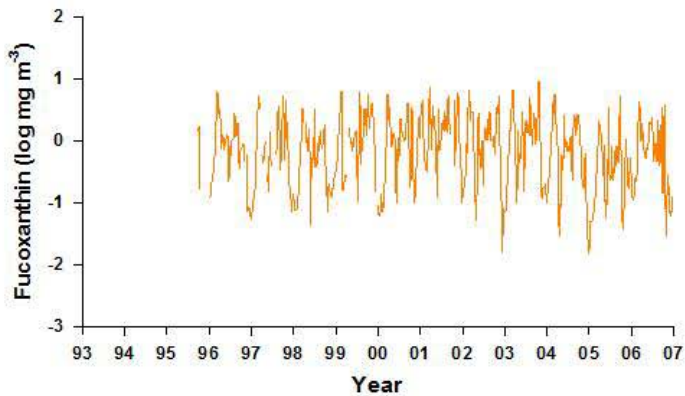
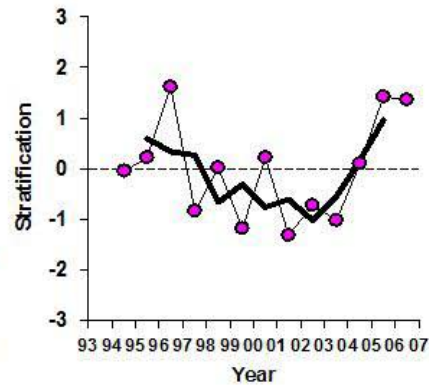
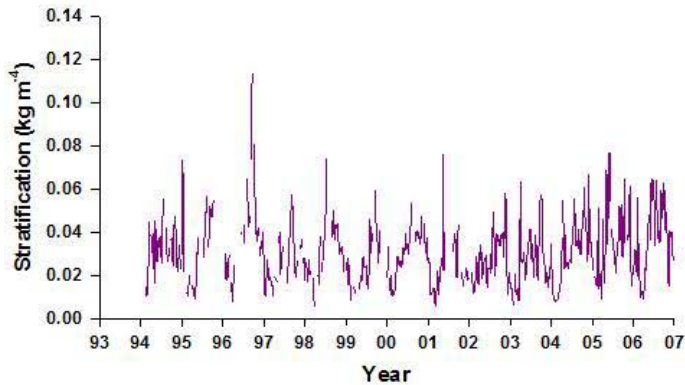
On an interannual basis, chlorophyll a is correlated with salinity



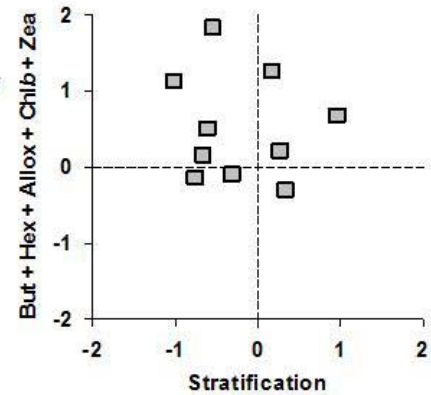
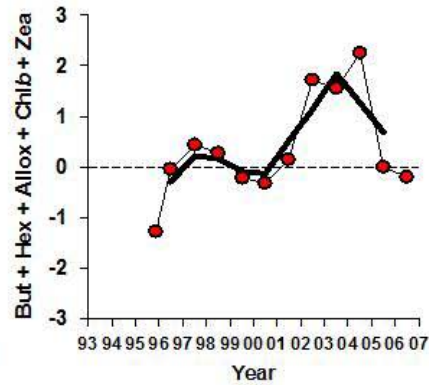
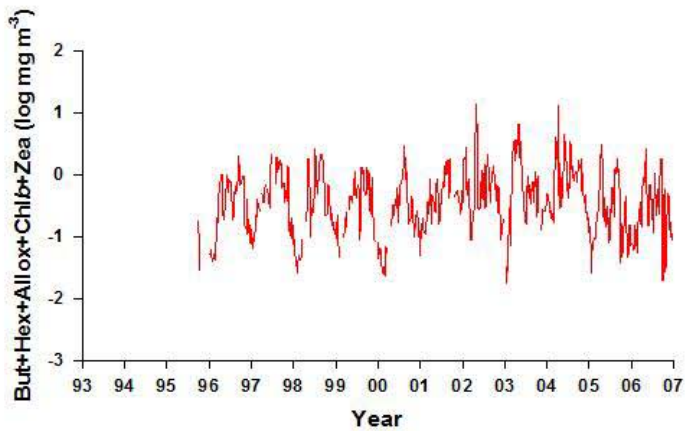
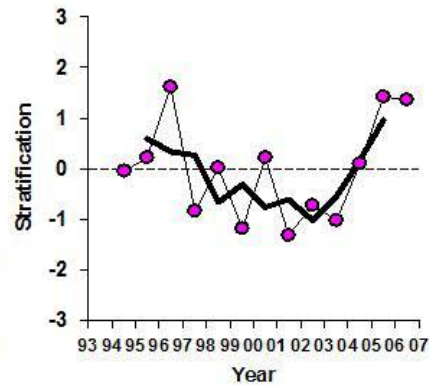
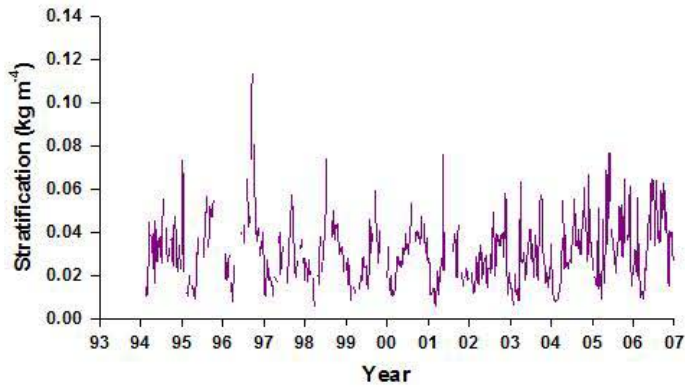
On an interannual basis, weak stratification favours high chlorophyll a



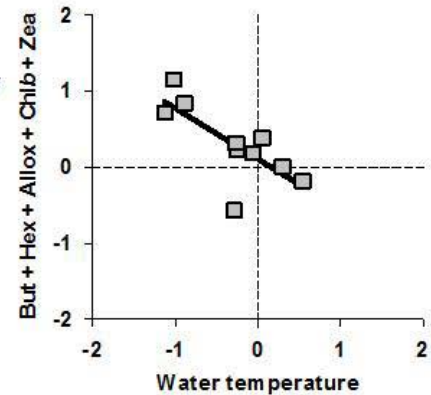
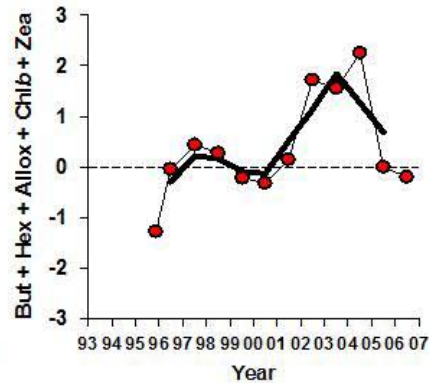
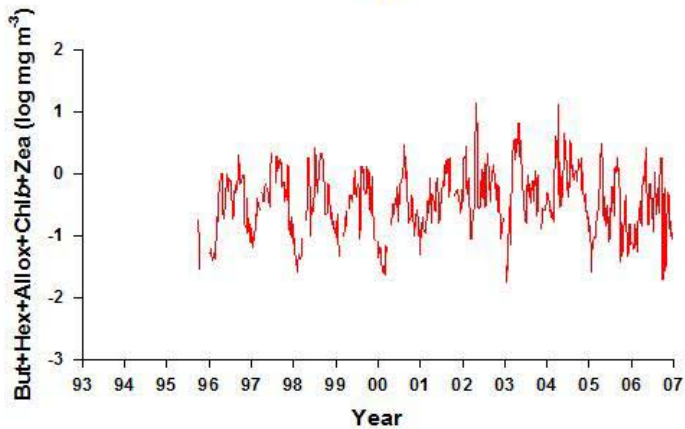
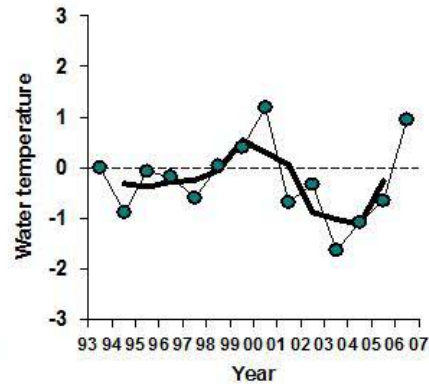
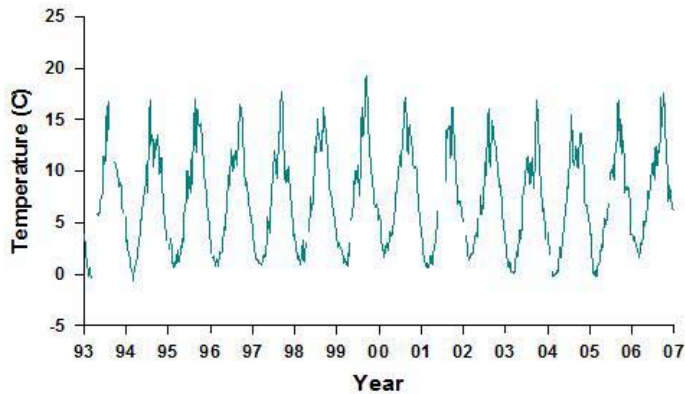
On an interannual basis, weak stratification favours diatoms



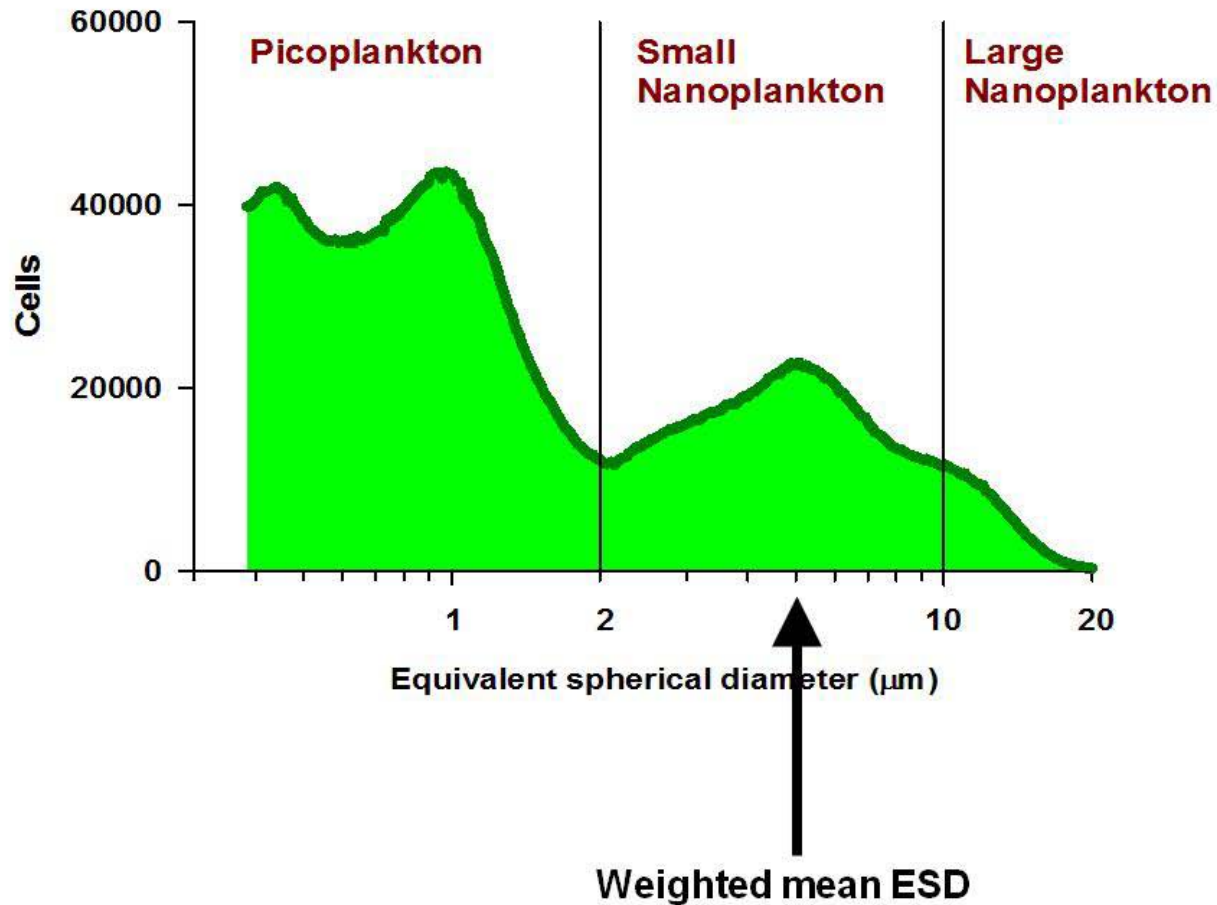
On an interannual basis, small phytoplankton are not correlated with stratification



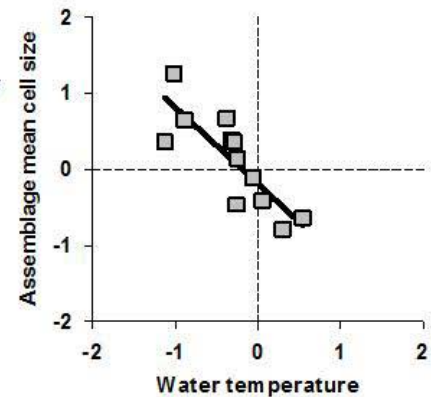
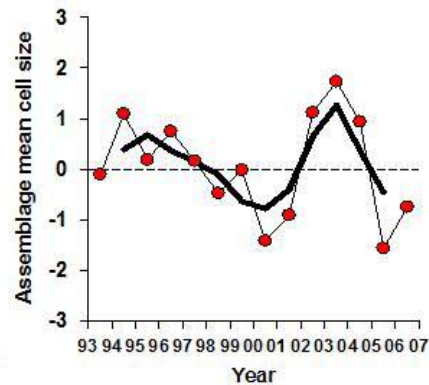
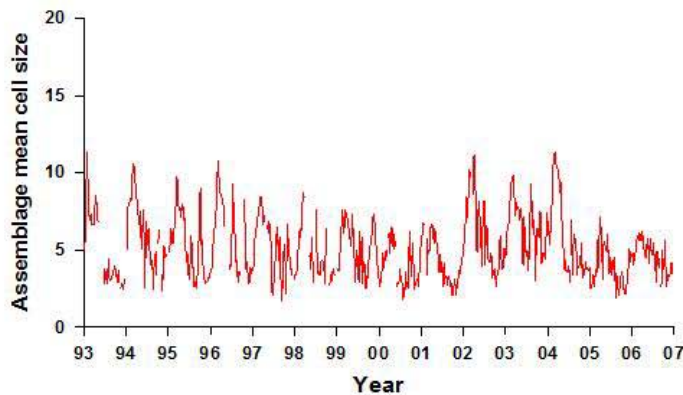
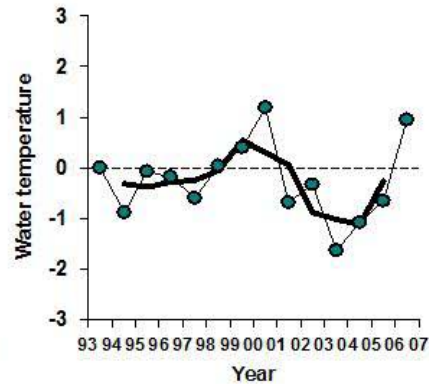
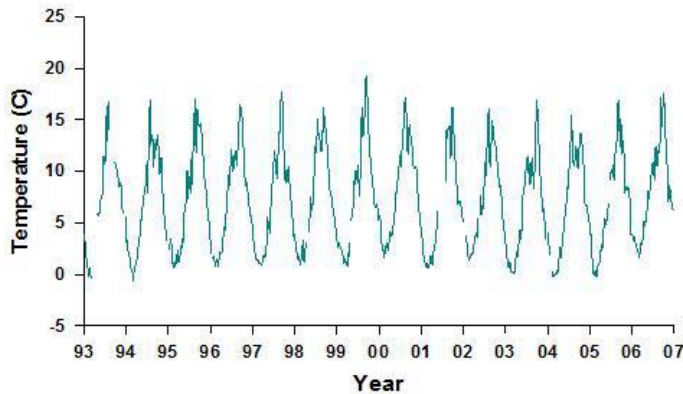
On an interannual basis, small phytoplankton are anti-correlated with temperature



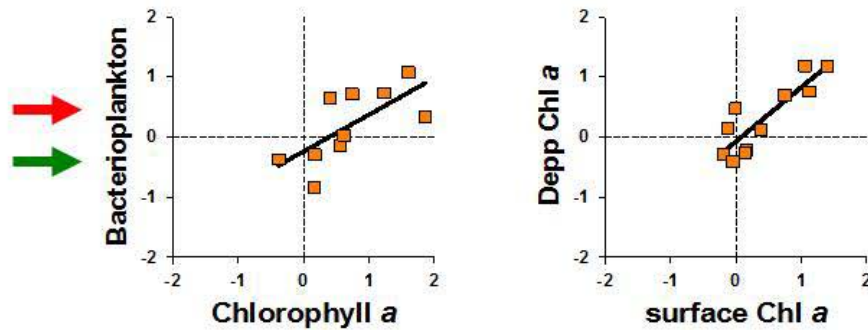
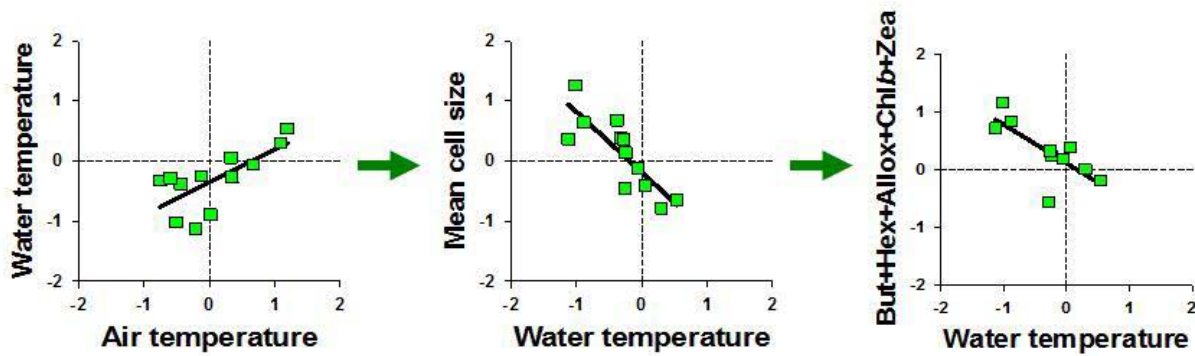
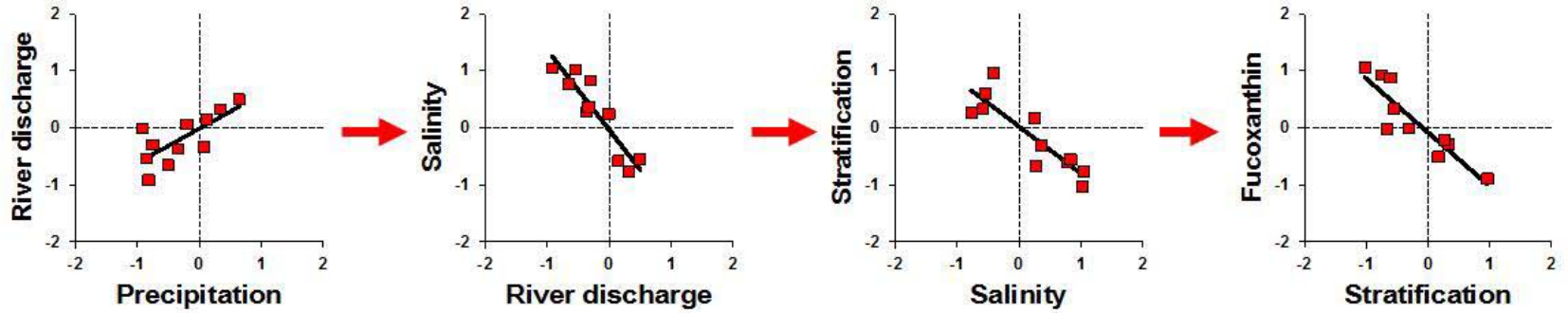
The community of small phytoplankton can be characterized by a weighted size index



On an interannual basis, mean cell size (community assembly) is related to temperature



SUMMARY: Climate effect in Bedford Basin



Conclusion

The consequences of climate change for the structure and function of (marine) ecosystems are of considerable current interest.

(One) approach is simply to measure the phenomenology of variations in both climate and ecosystem components, for the purpose of detecting shared patterns.

Departures from long-term mean conditions can be defined; further, the response of the biota to climatic anomalies can be described in terms of direction, magnitude and frequency.

To the degree that (plankton) can serve as a proxy for the state of the rest of the system, we have achieved some real insight into how climate affects oceanic ecosystems.

McGowan JA 1990. *Trends in Ecology and Evolution* 5:293-299.

