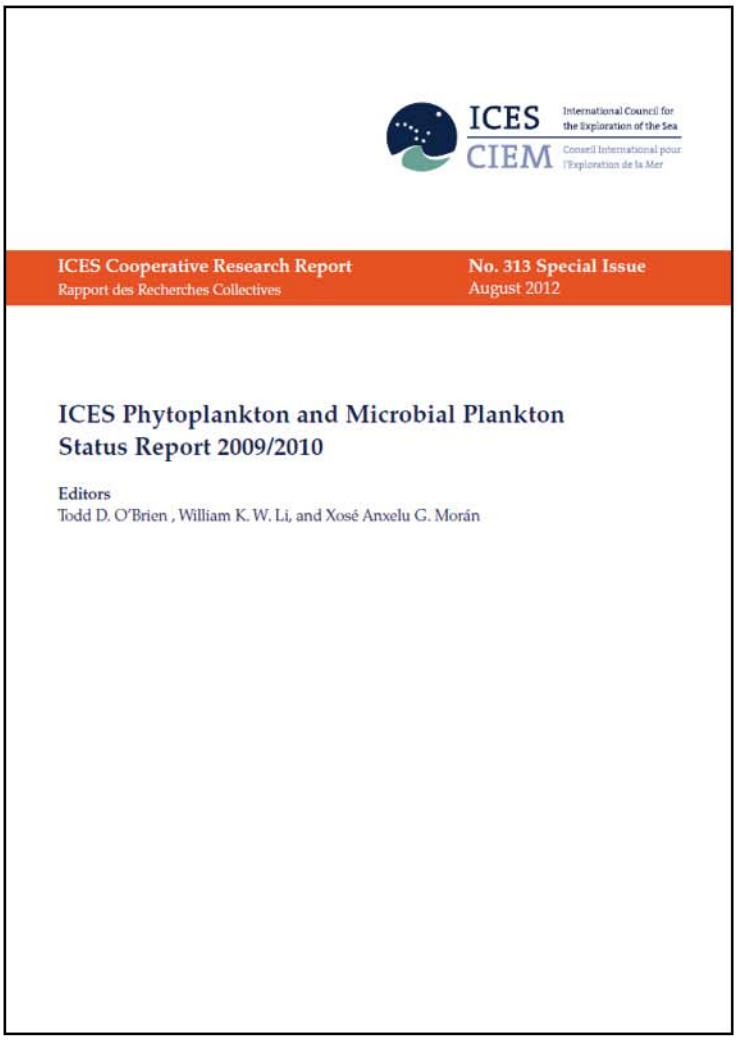

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O'Brien, T. D., Li, W. K. W., and Morán, X. A. G. (Eds). 2012.
ICES Phytoplankton and Microbial Plankton Status Report 2009/2010.
ICES Cooperative Research Report No. 313. 196 pp.

The time-series analyses and figures used in this report were created using COPEPODITE:
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3.3 Bedford Basin (Site 3)

William K. W. Li

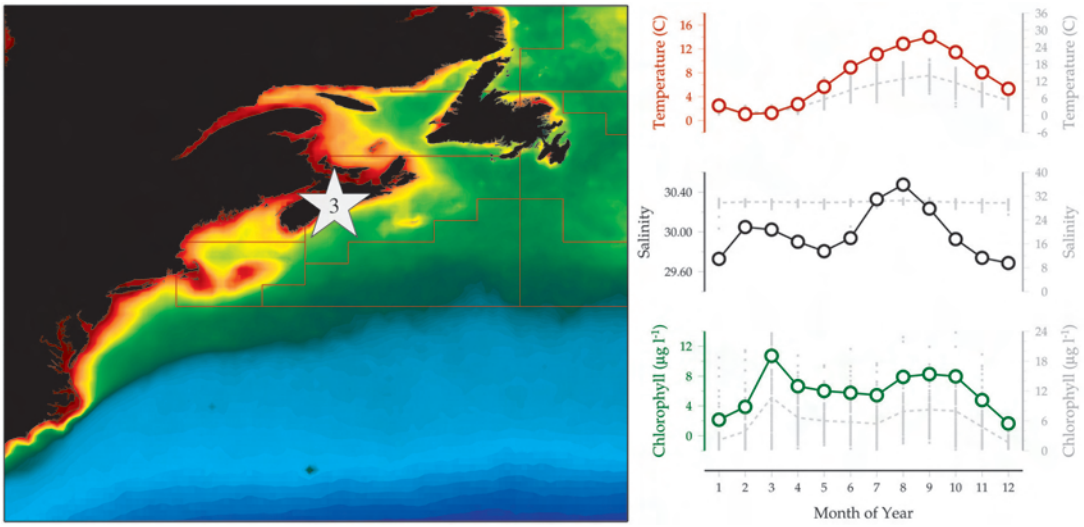

Figure 3.3.1
Location of the Bedford Basin plankton monitoring area (Site 3), plotted on a map of average chlorophyll concentration, and its corresponding environmental summary plot (see Section 2.2.1).

Bedford Basin is a small embayment forming the inner portion of Halifax Harbour, encircled by the largest urban population centre in eastern Canada. Bedford Basin is an estuary with a maximum depth of 71 m and a connection to the adjoining harbour through a narrow and shallow sill. The Basin receives freshwater from the Sackville River at an annual average inflow of 5 m^3 s^{-1}. Additional run-off enters the Basin from a large watershed. The mean circulation is a two-layer structure where lower density surface water (salinity 29–31) flows outwards to the open Atlantic, and deeper saline water (salinity 31–32) flows into the Basin over the sill. The mean tidal range is 1.5 m, the ratio of tidal to freshwater volume is 109:1, and the flushing time is 261 h.

The Compass Buoy station (44°41'37"N 63°38'25"W) in Bedford Basin may be considered the inshore terminus of the Halifax Line of the Atlantic Zone Monitoring Programme (AZMP) conducted by Fisheries and Oceans Canada. Since 1992, weekly measurements have been made of selected properties by CTD profiling and Niskin sampling to characterize the physical, chemical, biological, and optical environments of the water column (Li and Dickie, 2001). Phytoplankton are characterized by chlorophyll *a* concentration measured by *in vitro* fluorescence, by cell abundance in size classes measured by flow cytometry, and by accessory pigment concentration measured by high-performance liquid chromatography. Bacterial abundance is measured by flow cytometry after cells have been stained with SYBR Green I, a nucleic acid-binding fluorochrome. In this report, the values for samples collected at 1, 5, and 10 m are averaged to represent the state of surface waters in the Basin.

Seasonal and interannual trends (Figure 3.3.2)

Seasonal vertical stratification of the water column is determined primarily by temperature, but multiyear change in the seasonally adjusted annual average stratification is related to salinity, which is correlated *inter alia* with local precipitation and river discharge. At the multiyear time-scale, stratification anomalies explain significant amounts of variability in the anomalies of total phytoplankton biomass (chlorophyll *a*), especially that contributed by diatoms (fucoxanthin), but not the biomass of picophytoplankton (*Synechococcus* and picoeukaryotic algae). Instead, the multiyear response of these small phytoplankton appears directly related to variations in temperature (Li and Harrison, 2008).

On a four-decade time-scale (1970s–2000s), sea surface temperature, nitrate, ammonium, phosphate, chlorophyll *a*, and particulate organic matter have all increased (Figure 3.3.2; Li *et al.*, 2010). On a shorter two-decade time-scale, over which flow cytometry measurements are available, the picophytoplankton have also increased.

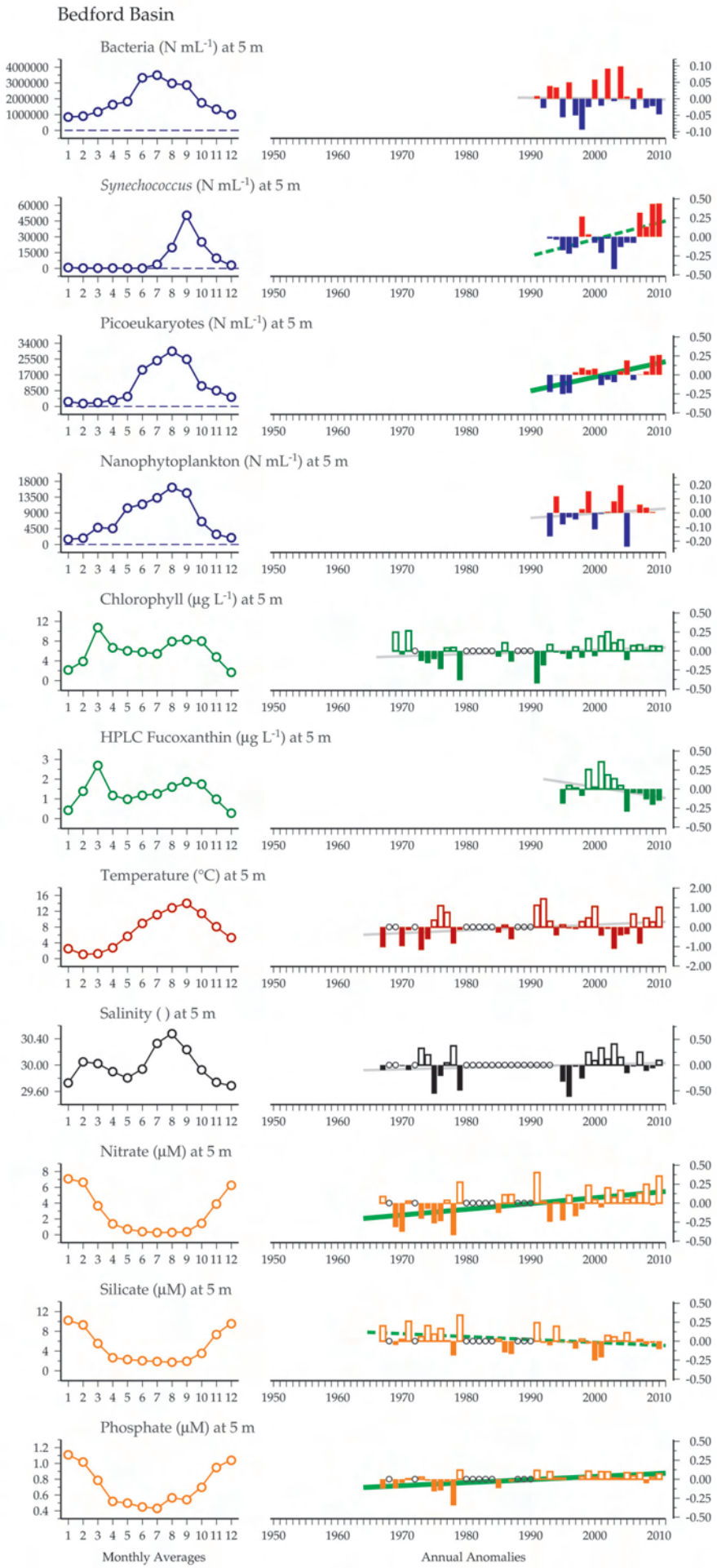

Figure 3.3.2
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Bedford Basin plankton monitoring site. Additional variables from this site are available online at http://wgpme.net/time-series.