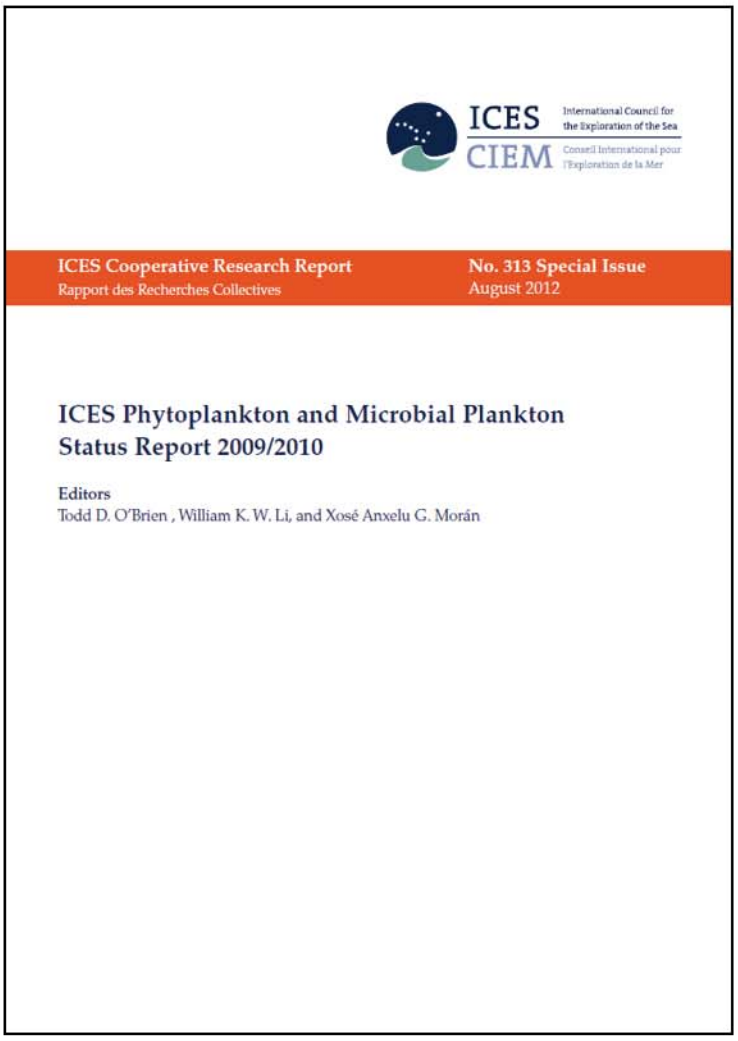

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O'Brien, T. D., Li, W. K. W., and Morán, X. A. G. (Eds). 2012.
ICES Phytoplankton and Microbial Plankton Status Report 2009/2010.
ICES Cooperative Research Report No. 313. 196 pp.

The time-series analyses and figures used in this report were created using COPEPODITE:
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8.6 Guadiana estuary (Site 54)

Ana B. Barbosa, Rita B. Domingues, and Helena M. Galvão

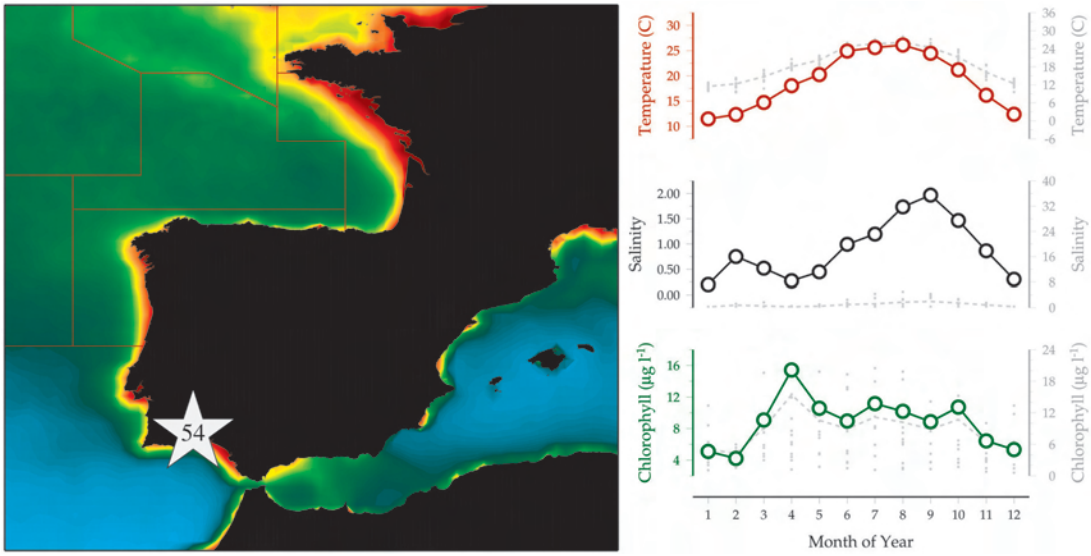

Figure 8.6.1
Location of the Guadiana estuary plankton monitoring area (Site 54), plotted on a map of average chlorophyll concentration, and its corresponding environmental summary plot (see Section 2.2.1).

The Guadiana estuary (GE) is located in southwestern Iberia and is a 22 km^2 mesotidal ecosystem (average depth: 6.5 m), ranging from partially stratified to well-mixed. GE is located in a Mediterranean climate area, classified as highly sensitive to climate change, and is currently considered one of the best preserved and most vulnerable estuaries of the Iberian Peninsula. The Guadiana River watershed is the fourth largest river basin in the Iberian Peninsula and demonstrates a torrential hydrographic regime, with concentrated rainy periods and a prolonged dry season, usually from May to September. Managing water availability under such demanding conditions led to the construction of hundreds of dams, almost 90 of which have a volume capacity over 1 hm^3. Recent construction of the large Alqueva dam, built in the upper estuary in 1999 and completed in 2002, further increased freshwater flow regulation up to 81% (see Barbosa *et al.*, 2010, and references therein).

Phytoplankton monitoring in GE began in 1996 and was motivated by an anticipated increase in cyanobacterial blooms caused by the construction of the Alqueva dam. Physical–chemical variables (e.g. temperature, salinity, intensity of photosynthetic available radiation, light extinction coefficient, dissolved oxygen, concentration of dissolved inorganic macronutrients, particulate suspended matter) and phytoplankton abundance, composition, and biomass were routinely monitored at different stations in the upper, middle, and lower estuary in the framework of projects funded by the Portuguese Foundation of Science and Technology (FCT) and the European Union. Abundance of heterotrophic bacterioplankton and phytoplankton and bacterial production were less frequently determined. Water quality and phytoplankton are also regularly monitored by the Portuguese Water Institute (INAG). Since 2008, water quality and hydrodynamics have been measured by an autonomous instrumented platform positioned at the estuary entrance (Garel *et al.*, 2009).

Data displayed in this site are average monthly values (1996–2010) collected at station "Alcoutim" (37°28'N 7°28'W; Datum WGS84) at subsurface levels (ca. 0.5 m). The station is located ca. 38 km from the Guadiana river mouth within the upper Guadiana estuarine region and has a mean depth of 9 m. Details on sampling and analytical methods are given in Barbosa *et al.* (2010). Samples were usually collected from the Alcoutim pier using a sampling bottle, and sampling frequency was usually monthly during autumn–winter and biweekly during the spring–summer productive period. Physical–chemical variables were analysed using standard methods. Chlorophyll *a* concentration, used as a proxy for phytoplankton biomass, was analysed using a spectrophotometric method, after GF/F sample filtration and acetone extraction. Abundance of picoplankton (< 2 µm) and nanophytoplankton (2–20 µm) was estimated using epifluorescence microscopy, after gluteraldehyde preservation and proflavin staining. Abundance of microphytoplankton (>20 µm) was analysed using

inverted microscopy, after Lugol preservation (see Barbosa *et al.*, 2010 for details).

Seasonal and interannual trends (Figure 8.6.2)

Phytoplankton seasonal patterns, studied before, during, and after the construction of the Alqueva dam, revealed bimodal to unimodal annual cycles, with chlorophyll *a* maxima usually occurring between March and October. Seasonal patterns show an alternation between a persistent light limitation and episodic nutrient limitation (Rocha *et al.*, 2002; Domingues *et al.*, 2005, 2011a,b,c, 2012; Barbosa *et al.*, 2010). Phytoplankton succession, with spring diatom blooms and summer–early fall cyanobacterial blooms, is driven by changes in nutrients, water temperature, and turbulence, clearly demonstrating the role of river flow and climate variability.

Diatom, green algae, cyanobacteria, and total phytoplankton abundance displayed significant interannual declining trends over the period 1996–2010. Light intensity in the mixed layer is a prevalent driver of phytoplankton interannual variability. Yet, increased water retention by the Alqueva dam led to interannual decreases not only in turbidity but also in nutrient inputs, promoting a shift from persistent light limitation towards a more nutrient-limited mode (see Barbosa *et al.*, 2010; Domingues *et al.*, 2012).

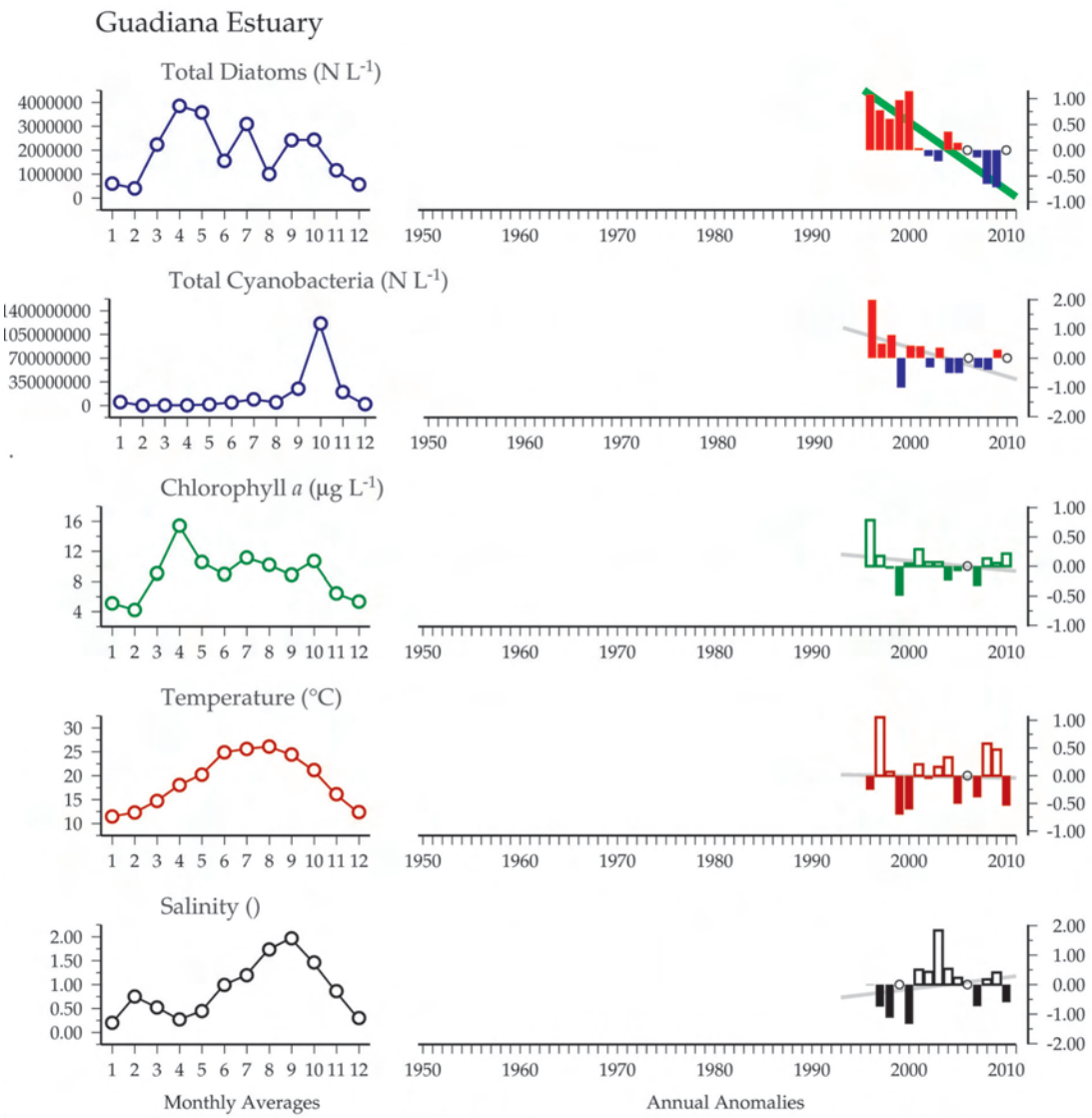

Figure 8.6.2
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Guadiana estuary plankton monitoring site. Additional variables from this site are available online at http://wgpme.net/time-series.