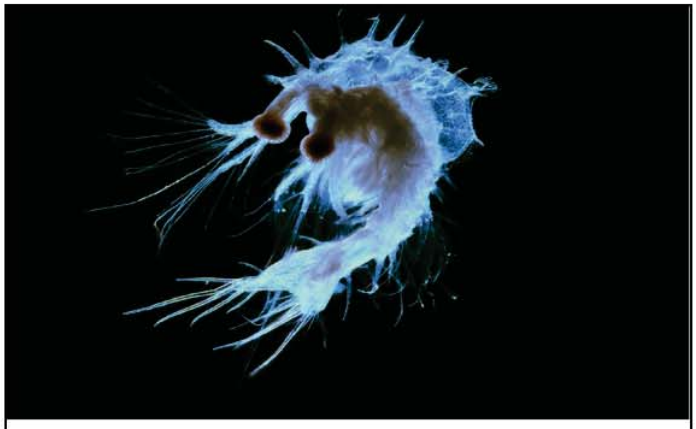

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Above :
Mud shrimp *Solenocera membranacea* larva, caught in the western Bay of Biscay. - Juan Bueno, Instituto Español de Oceanografía (IEO)

Cover image:
Assorted copepods and a decapod, caught in the Mallorca Channel. - María Luz Fernández de Puelles, Instituto Español de Oceanografía (IEO)

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

Antonina dos Santos and A. Miguel P. Santos

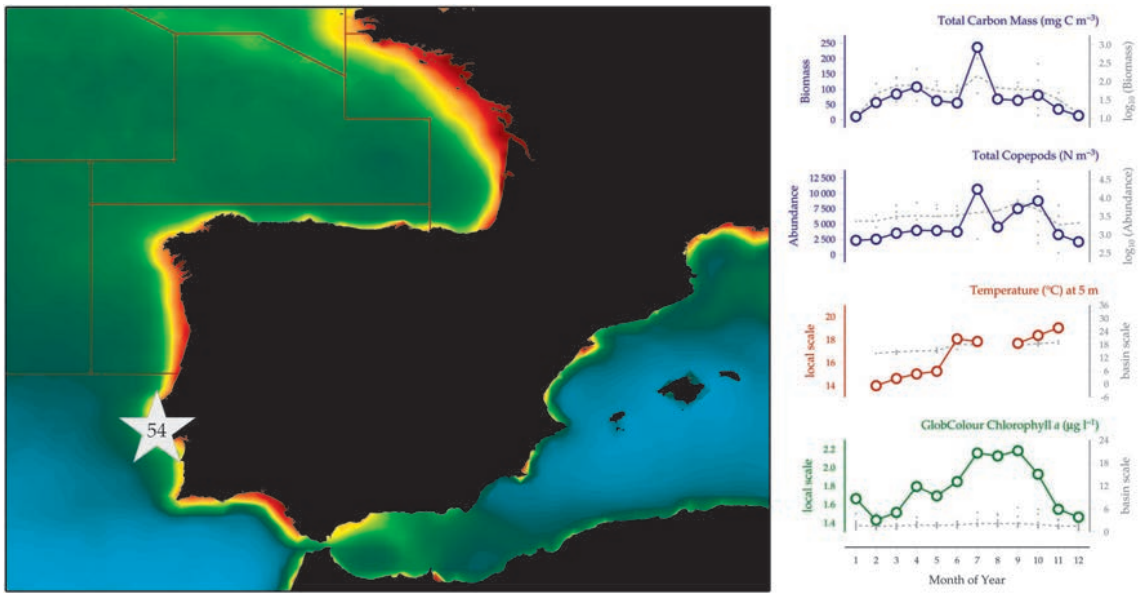

Figure 8.6.1
Location of the Cascais Bay monitoring area (Site 54) plotted on a map of average chlorophyll concentration, and its corresponding seasonal summary plot (see Section 2.2.1).

The Cascais monitoring site is a station of the time-series CASCAIS-WATCH, the oceanographic observation programme of the Oceanography and Plankton Group of the Instituto Português do Mar e da Atmosfera (IPMA), former Instituto Nacional de Recursos Biológicos. The station is located off Cascais Bay, outside the Tagus River estuary at 38°40'N 09°26.2'W and approximately 4 km offshore from Cascais, a town 40 km west of Lisbon, in a water depth of around 38 m. The hydrography of the bay is influenced by coastal morphology, the bottom topography (submarine canyons of Lisbon and Setúbal), and the discharge of freshwater from the Tagus River (Ribeiro and Amorim, 2008).

Zooplankton samples are collected from 30 m to the surface (oblique hauls) on a monthly basis with a WP2 net (50 cm diameter, 200 µm mesh). Samples are divided into two with a Folsom plankton splitter: one half is preserved in 4% borax-buffered formalin in seawater and later examined for identification and counting of mesozooplankton. The other half is lyophilized and weighed for biomass determination. During the first four years of sampling (2005–2008), neuston samples were also taken with a rectangular net with a mouth opening of 0.2 × 1.0 m and 200 µm mesh size, towed horizontally at the surface for 3 min. The samples were preserved and stored for later analysis. During the first year of sampling, *Calanus helgolandicus* egg production was determined whenever possible. After the first year of sampling and having concluded that *Acartia* spp. was the most abundant copepod present in the samples, egg production measurements were started for this taxon and stopped for *C. helgolandicus*. Besides zooplankton monitoring, temperature, salinity, and chlorophyll *a* are measured with a CTD fluorometer.

The Cascais site is thought to be under the influence of the Eastern North Atlantic Upwelling System in spring and summer. This seasonal upwelling is responsible for the high phytoplankton production that promotes stable zooplankton abundance through the year (Santos *et al.*, 2007). *In situ* temperatures at Cascais demonstrate a two-tier seasonal pattern, usually < 16°C during winter and spring, and ≥18°C in June–November. This pattern is attributed to the station being located in an upwelling shadow (Moita *et al.*, 2003), where winds favourable to upwelling can promote local water stratification and stability.

Seasonal and interannual trends (Figure 8.6.2)

The seasonal cycle of zooplankton biomass is characterized by a bimodal pattern, as observed at sites 52 and 53 to the north, with peak biomass in April and August. Copepod abundance remains high throughout the season, with highest abundance from August through November. The observed bimodal pattern is caused by seasonal upwelling in the area. Copepods at Cascais Bay are mainly represented by the genera *Acartia, Paracalanus, Oncaea*, and *Oithona*. Other species (*Temora stylifera, T. longicornis,* and *Centropages* spp.) are also important, but occur later in the season, which explains the high copepod abundance late in the year. The short length of this time-series limits its interannual analysis. Total copepod abundance and *in situ* temperature interannual anomalies oscillate together and result in a significant negative correlation ($r^2 = 0.7848$). Total copepod abundance has been decreasing in the last two years of sampling, mainly caused by a reduction in the three most abundant genera: *Acartia*, *Paracalanus*, and *Oithona*. The trends in these species are positively correlated. Following the decrease in abundance of copepods, bivalve veligers have become more abundant in the area, being the most abundant taxa in 2009, representing 26.2% of total zooplankton in that year. Veliger abundance follows the increasing abundance of the invasive species *Ruditapes philippinarum* in the Tagus estuary since its establishment 10 years ago. This clam now supports a local fishery (Garaulet, 2011). The decrease in copepod abundance at this site (54) follows the trends shown at site 53 Vigo (north of Cascais site) where the copepods *A. clausi* and *Calanoides carinatus* have been decreasing. However, additional data are necessary to better understand this shift in species abundance at the Cascais site and the relationship with the temperature increase over the past 30 years (Figure 8.6.3). Also, identification of the bivalve veligers to lower taxonomic levels is necessary in order to understand the importance of introduced species in the area.

The long-term temperature record for this region (Figure 8.6.3) demonstrates that SSTs are currently at the high end of those seen in the past 100 years.

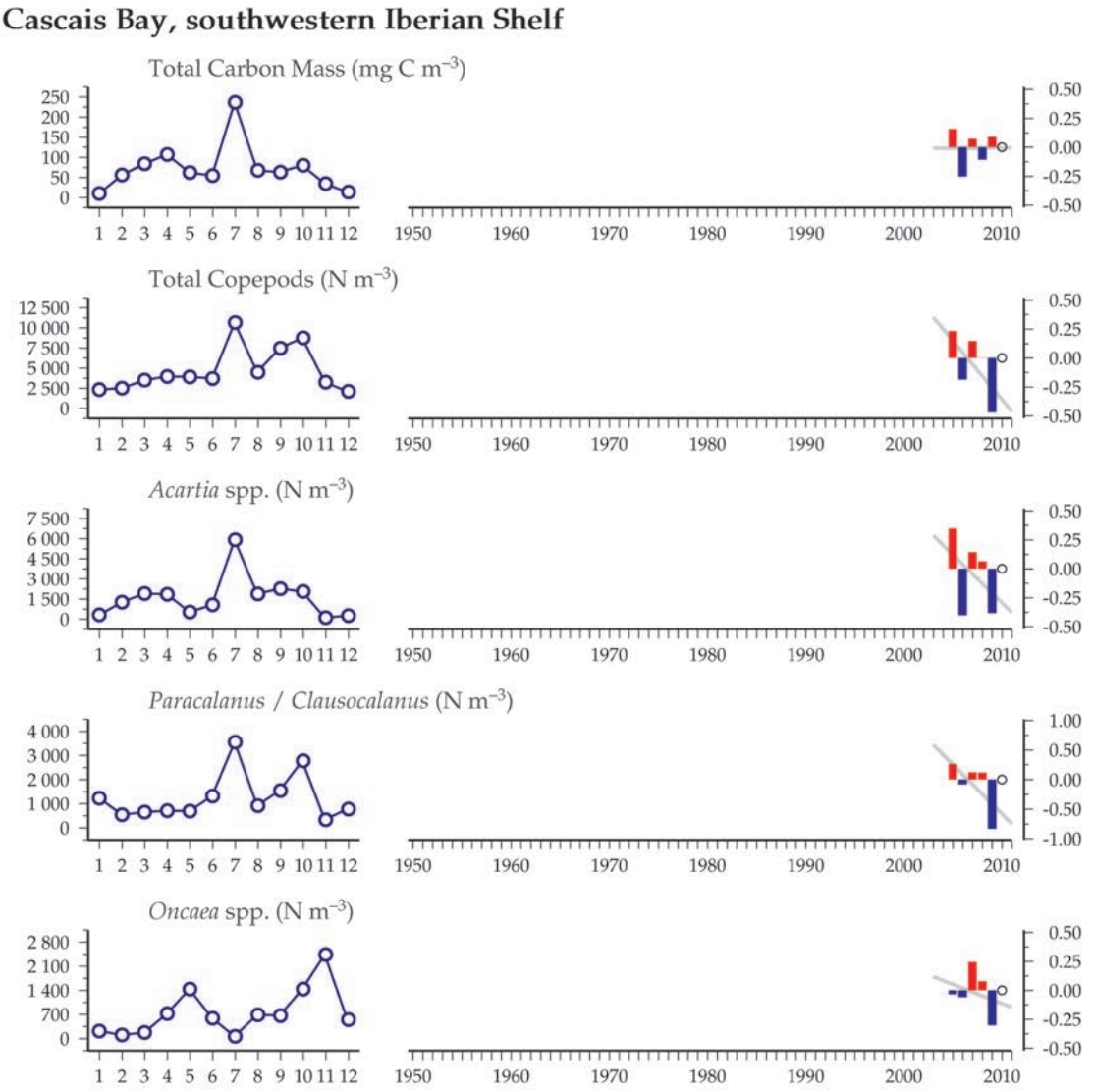

Figure 8.6.2
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Cascais Bay monitoring area.

Additional variables are available online at: http://WGZE.net/time-series.

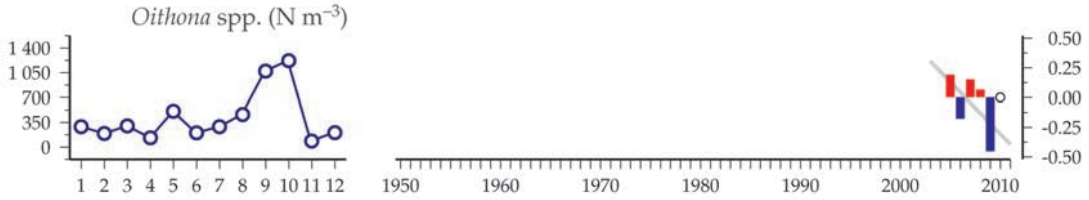

Figure 8.6.2
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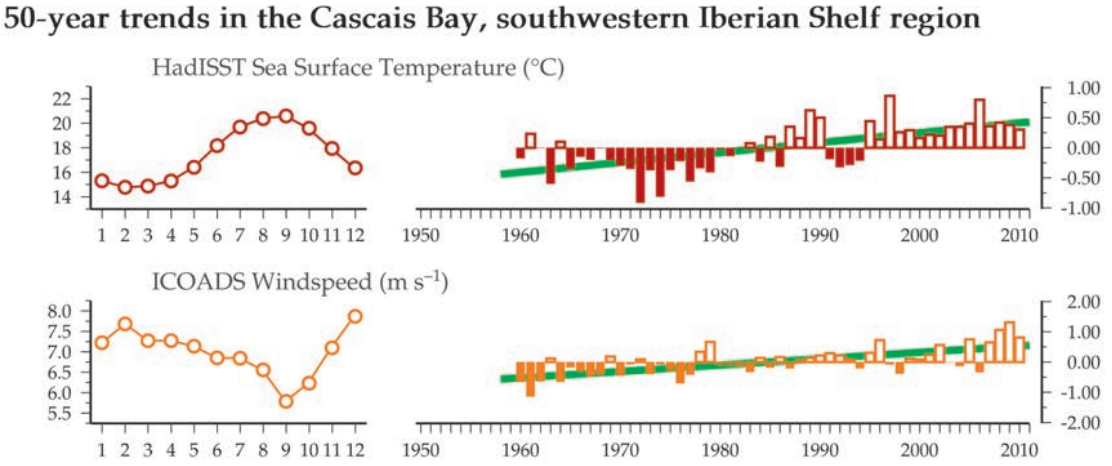

Figure 8.6.3
Regional overview plot (see Section 2.2.3) showing long-term sea surface temperatures and windspeeds in the general region surrounding the Cascais Bay monitoring area.