Plankton

What is the issue?

Increased regional sea temperatures in the North-East Atlantic have triggered a major re-organisation of zooplankton species composition and biodiversity. Future warming will lead to further changes in the regional distribution of primary and secondary production and, as the base of the marine food web, lead to impacts at higher trophic levels.

What has happened and how confident?

Beaugrand *et al.,* (2002) and Edwards *et al.,* (2008) highlight observed changes in zooplankton distribution and abundance, specifically biogeographical shifts of calanoid copepod communities in recent decades, with the warm-water species shifting northwards and the cold-water species retreating northwards.

The changes that have taken place in these northern European waters are sufficiently abrupt and persistent to be termed as 'regime shifts' (Beaugrand, 2004) with a northward shift in the distribution of many plankton and fish species by over 10 degrees of latitude (or over 1000 km) being observed over the past fifty years (Figure 3.2.1). This has been particularly associated with the shelf edge current running north along the European continental margin (Beaugrand *et al.,* 2002; Brander *et al.,* 2003; Genner *et al.,* 2004).

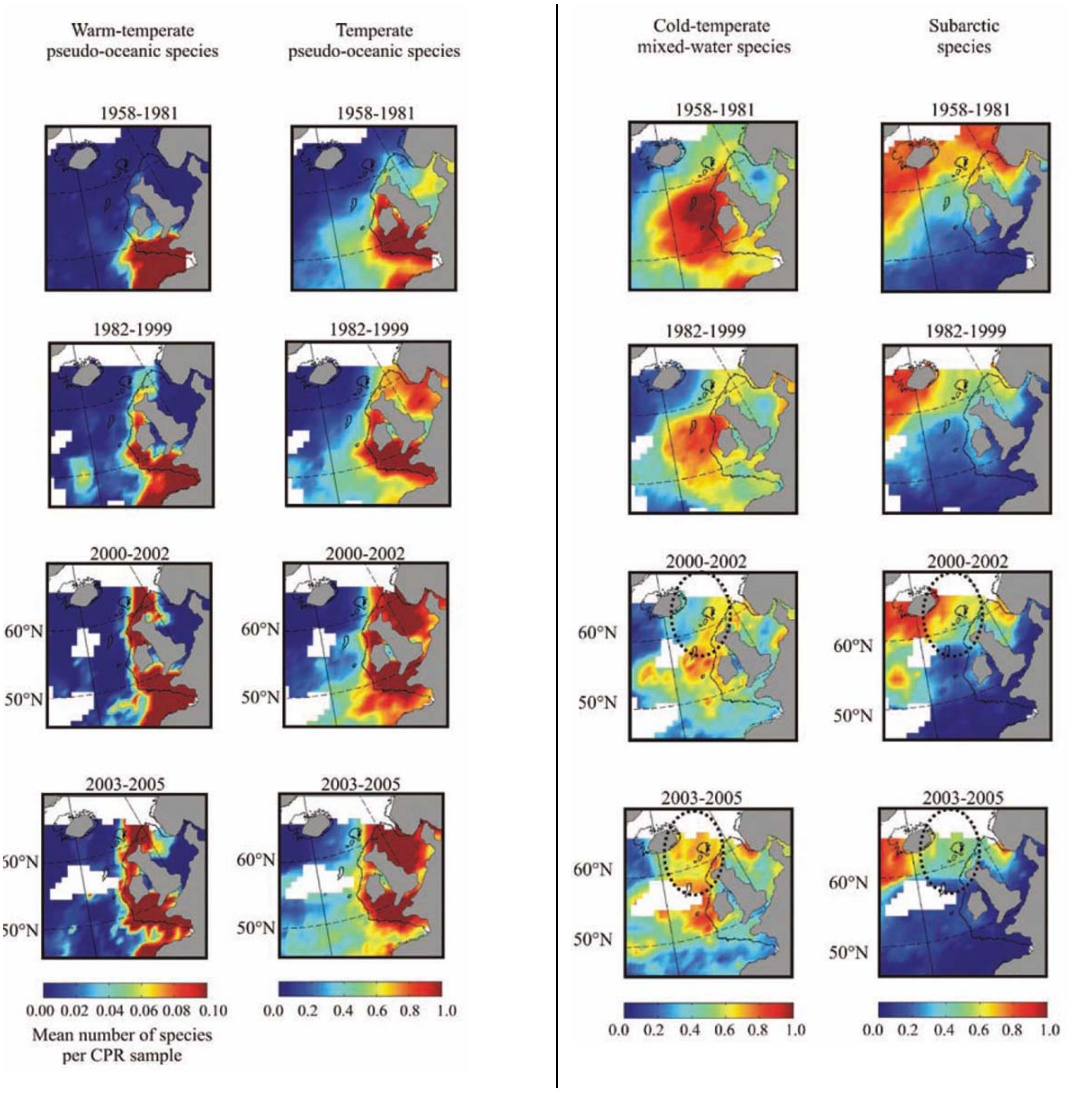

***Figure 3.2.1.** Maps showing biogeographical shifts of calanoid copepod communities in recent decades, with the warm-water species shifting northwards and the cold-water species likewise retracting north, by over 10° of latitude (Edwards et al., 2008a).*

In the North Sea, the regime shift is well demonstrated by the ratio of the cold-temperate *Calanus finmarchicus* to the warm-temperate *Calanus helgolandicus* (see Figure 3.2.2). The dominance of *C. helgolandicus* over the last decade is clear and it should be noted that the overall abundance of *Calanus* in the North Sea has considerably declined with important implications for other trophic levels.

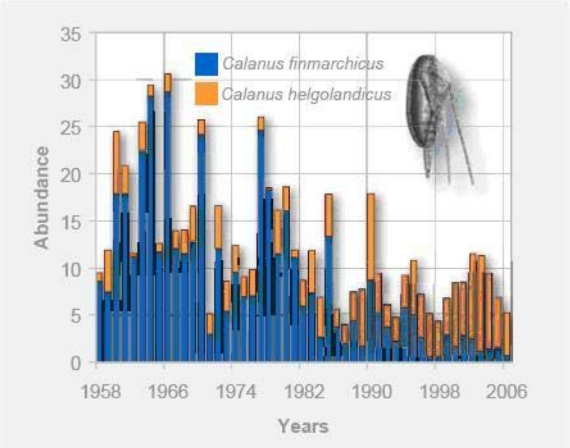

Figure 3.2.2 *A simple percentage ratio between a warm-water species (Calanus helgolandicus) and a cold-water species (Calanus finmarchicus) annually from 1958–2006 and total annual Calanus abundance. Note: while the warm species is replacing the cold water species, the actual total Calanus abundance is decreasing (Edwards et al., 2008a)*

Over the past 30 years, rising sea temperatures have been accompanied by a rise in the NAO index. This has led to significant changes in plankton production, biodiversity and species distribution with impacts on fisheries production and other higher predators (e.g. seabirds) (Reid and Edwards, 2001; Edwards *et al.*, 2002; Beaugrand *et al.,* 2003; Richardson and Schoeman, 2004; Southward *et al.*, 2004; Alheit *et al.*, 2005; Heath, 2005).

The seasonal timing of plankton production has also altered in response to recent climate changes with some species occurring between four to six weeks earlier than 20 years ago. This has effects upon their availability to predators, including fish (MCCIP, 2008). As responses to climate warming have varied between different functional groups and trophic levels, there has been a mismatch in predator-prey relationship (Hoepffner, 2006).

What might happen?

With increasing temperature in the future there is an expectation that there will be a demonstrable shift/expansion of distribution northward related to species' biological associations and ecological characteristics (ICES, 2008a). In the northern seas of Europe, and the Arctic, the open ocean plankton production is predicted to significantly increase in the large areas that will become ice-free in summer as the result of higher temperatures (ACIA, 2005). Such changes in productivity will affect the biodiversity and carrying capacity of these natural systems, as well as the potential for the use of the sea by society (Hoepffner, 2006).

Future warming is likely to alter the geographical distribution of primary and secondary pelagic production, affecting ecosystem services such as oxygen production, carbon sequestration and biogeochemical cycling. These changes may place additional stress on already depleted fish stocks as well as have consequences for mammal and seabird populations (Edwards *et al.,* 2008b).

Are there any OSPAR regional differences?

As described above, changes across all European seas have been observed associated with the 'regime shift' in species composition, abundance and timing over the past 50 years.

➥ *Go to the full QSR assessment report on impacts of climate change (publication number 463/2009)*

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