The North Pacific Continuous Plankton Recorder Survey

by Sonia D. Batten

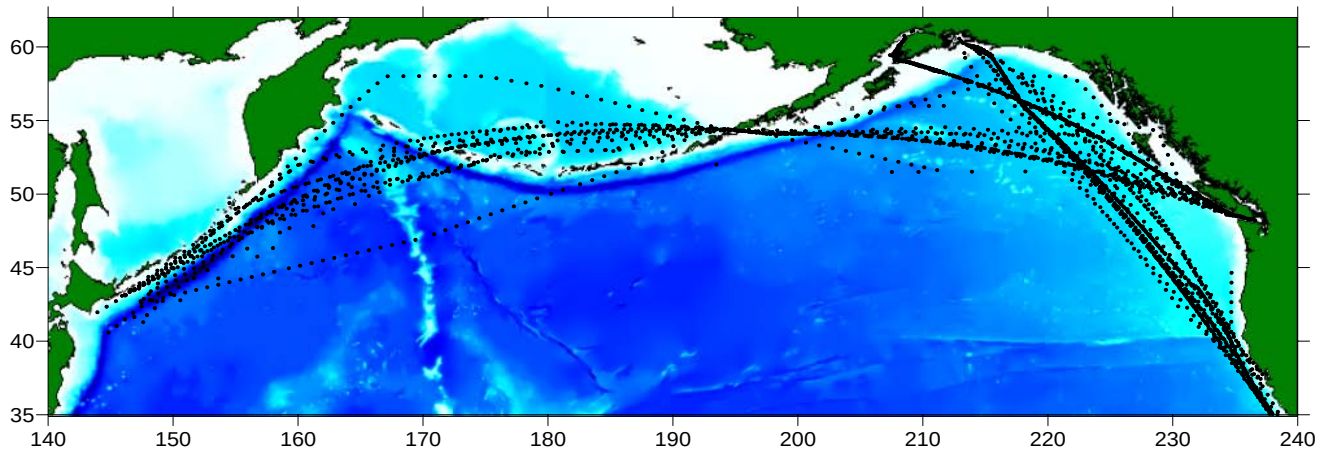

Fig. 1 Location of all processed CPR samples for 2000–2007. Data have recently been made available through the PICES website for selected areas (http://pices.int/projects/tcprsotnp/default.aspx) and all data are freely available by contacting Sonia Batten (soba@sahfos.ac.uk).

Some results from the North Pacific CPR survey

The Continuous Plankton Recorder (CPR) survey of the North Pacific is a PICES project now in its ninth year and facing an uncertain future. CPRs have been towed behind commercial ships along two (north–south and east–west) transects for a total of ~ nine times per year. Samples are collected with a filtering mesh and are then microscopically processed for plankton abundance in the laboratory. The survey, so far, has accumulated 3,648 processed samples (with approximately three times as many archived without processing), each representing 18 km of the transect (**Fig. 1**) and containing an abundance of data on over 290 phytoplankton and zooplankton taxa. A CTD with a fluorometer has been attached to the CPR sampling at the east–west transect in more recent years to provide supplementary environmental data.

Although still relatively short, the time series of CPR data covers a period when the dominant climate signal in the North Pacific, the Pacific Decadal Oscillation (PDO), switched with unusual frequency between warm/positive states (pre-1999 and 2003–2006) and cool/negative states (1999–2002 and 2007 to present). Responses to this variability are evident in the northeast Pacific (which has the greatest sampling resolution since both transects overlap there), and some examples are described here.

The dominant contributors to the spring mesozooplankton biomass are the copepods *Neocalanus plumchrus* and *N. flemingeri*. The timing of their peak abundance varies from year to year (Mackas *et al*., 1998; Mackas *et al*., 2007). Although the exact mechanism is not yet known, environmental forcing through water temperature, stratification effects and/or differential survival of the young copepodites produced during the late winter is likely to play a role. The CPR data show (**Fig. 2**) that at the start of the times series (2000–2001), when the PDO was negative and the northeast Pacific was somewhat cool, the peak in biomass was later in the year and the period of abundance was relatively long. In the warmer, PDO-positive years 2003–2005, the peak was earlier in the year and more focused, with a narrower period of abundance. The switch to cooler, PDO-negative conditions that took place in late 2006 has apparently caused the timing to shift back again to somewhat later in 2007, but it is not yet as late as in the earlier part of the time series. Only additional sampling will show whether several successive cool years are needed to shift the timing back further. It is expected that timing of peak prey abundance has an impact on higher trophic levels that depend on *Neocalanus* as a spring food resource, so determining the extent of its variability under rapidly alternating modes of the PDO will be important.

In addition to sampling during the period 2000–2007, a pilot transect from California to Alaska was also sampled in the summer of 1997. This was at the start of a strong El Niño event, and the CPR data provide a useful comparison with the warm conditions associated with a positive PDO that occurred in 2003–2005. The abundance of subtropical copepods commonly found off the Californian coast, but which extend further north into the subarctic Pacific (*Mesocalanus tenuicornis*, *Clausocalanus* spp. and *Corycaeus* spp.), was calculated for each sample on the north–south transect, and their northward extension in July–August was recorded (as 75% of the cumulative abundance from 48°N to the Alaskan shelf). **Figure 3** shows the latitude reached by subtropical copepods each summer, together with the spring temperature at Amphitrite Point lighthouse on the west coast of Vancouver Island (mean of February–May monthly mean sea surface temperature, SST).

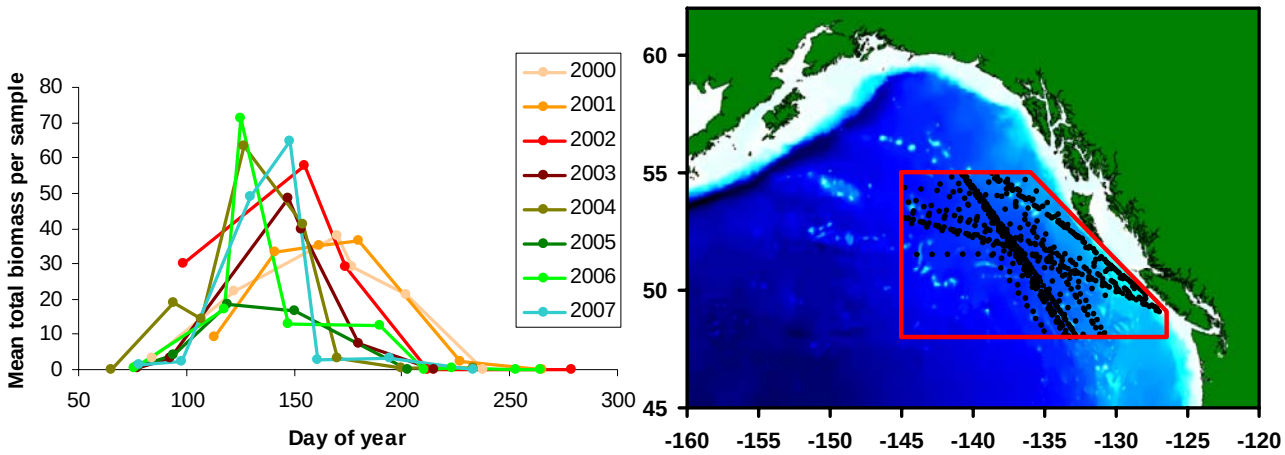

Fig. 2 *The mean biomass of* Neocalanus plumchrus *and* N. flemingeri *copepodites (stages 2–5) on each sampling of the region shown on the side map.*

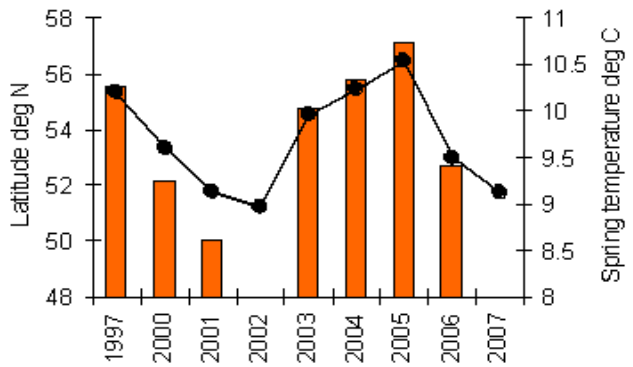

Fig. 3 *Latitude where 75% of the cumulative abundance of subtropical copepods was reached (bars) and mean spring sea surface temperature at Amphitrite Point, Vancouver Island (line).*

During the two coldest years (2002 and 2007) no subtropical copepods occurred north of 48°N in July and August, and for the remaining years the correlation between latitude and spring temperature was 0.99 ($p<0.01$), showing a very strong influence of spring temperature on copepod distribution.

Zooplankton respond to climate effects not only by changes in their absolute abundance (*e.g.*, McGowan *et al*. 1998) but by changes in community composition and diversity (*e.g.*, Peterson and Schwing, 2003; Mackas *et al*. 2004; Hooff and Peterson, 2006). Subtropical copepods make up only a small proportion of the subarctic community, so we undertook an analysis of the entire summer zooplankton community for the region shown in **Figure 2**. Data were restricted to July and August again, to allow the inclusion of the 1997 data, and the mean abundance of each of the 68 taxa that were found transformed (log(x + 1)). Bray-Curtis similarities were calculated for pairs of years and the resulting matrix subjected to hierarchical clustering and Multi-Dimensional Scaling (MDS) analyses (**Fig. 4**).

These results show a clear separation of community composition between cold and warm years, with the transition years of 2003 and 2006 occurring in the centre of the MDS plot. The years of 1997 and 2007 both plot as distinctly different years, showing a greater difference than for any other pairs of years. Analysis is ongoing to determine which species are making the largest

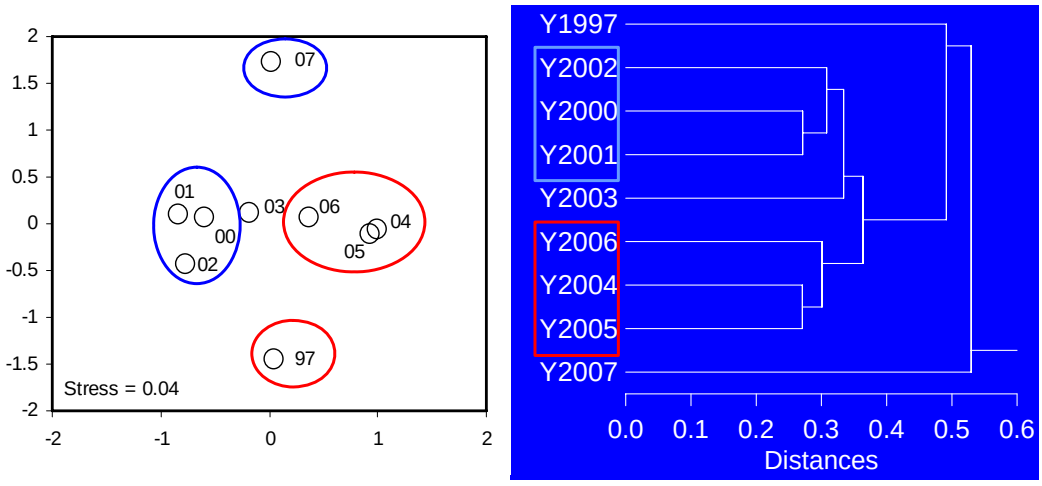

Fig. 4 *Multi-Dimensional Scaling (MDS) analysis (left) and cluster analysis (right) of between year community composition similarities. Clusters of warm and cold years are indicated by coloured shapes.*

contribution to these patterns. Different taxa are likely to have differing nutritional content, so this result suggests that not only the timing and abundance changes discussed earlier, but also community composition changes as a response to climate variability, will affect higher trophic levels by changing the availability of their prey.

The future

The survey has been funded in the past by the North Pacific Research Board and the Exxon Valdez Oil Spill Trustee Council. However, funding for 2008 is much reduced and only about one third of the normal sampling is planned. Although samples west of the Bering Sea will be collected in the spring and summer of 2008 so that summer sampling of the western Pacific is carried out for the ninth consecutive year, there is no funding to process them, and they will be archived for now in the hope that future funds can be found. Funding beyond 2008 is, as yet, non-existent.

PICES has invited several organizations to participate in a consortium to share the funding and secure the North Pacific CPR survey into the future. Other participants, particularly from the western Pacific, are welcome to join the consortium and help ensure that this valuable dataset continues to accumulate. Further details on the sampling, available data and bibliography can be seen on the PICES website at http://pices.int/projects/tcprsotnp/default.aspx. For information on joining the consortium please contact the PICES Executive Secretary, Dr. Alexander Bychkov (bychkov@pices.int).

Acknowledgements

The survey would not be possible without the generous involvement of the ships and their operating companies. Thanks are given to the officers, crew and land-based staff of Seaboard International's *Skaubryn* and Horizon's *Horizon Kodiak*. Thanks are also due to the North Pacific Research Board and the Exxon Valdez Oil Spill Trustee Council for their financial support.

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PICES Ecosystem Status Report Wins Design Award

On May 26, 2008, the Society of Graphic Designers of Canada, Vancouver Island Chapter, presented a Merit Award for the design of the PICES Special Publication "*Marine Ecosystems of the North Pacific*". In total, 350 entries created over the last five years were judged by the panel and 35 awards were presented. The PICES entry was for the category "Books – Complete Design". The book design was the result of close collaboration between the designers at Anonymous Art and the staff of the PICES Secretariat.