

The Continuous Plankton Recorder (CPR) survey

GEOSS consists of existing and future Earth observations. The CPR survey is an existing operational survey that was in place well before GEO or GEOSS were conceptualised, but with respect to the North Atlantic has followed a parallel vision for more than 75 years. More recently a North Pacific survey and a number of sister CPR surveys have been established, including the Southern Ocean CPR survey operated by Australia and Japan and the USA NMFS CPR survey. Other pilot or new surveys are in development.

A key element of the success of the CPR is the low cost to obtain large amounts of information from remote ocean areas by using merchant ships to tow the sampling machine; second, the methodology of collection and analysis has changed little in over 75 years and third a wide global use is made of the data by researchers, modellers, private and NGO companies and government agencies. The data is used to address a wide range of issues e.g. fisheries, biodiversity, Harmful Algal Blooms, strategic environmental assessments, contaminant/eutrophication impacts and indicators of change.

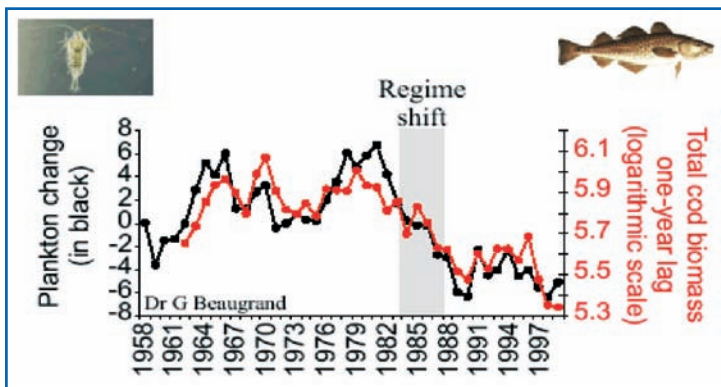
As part of the Initial Observing Programme of GOOS the Survey automatically comes under the umbrella of GEO and is a model example of a proven operational observation programme with many outputs, that address six of the GEOSS Societal Benefit Areas (Health, Energy, Water and especially Climate, Ecosystems and Biodiversity). The survey is fully compliant with GEO and GOOS data protocols and operates an open data policy <http://www.sahfos.ac.uk/datapolicy.htm>.

An acclaimed web-based outreach programme has helped promote the work and research results from the survey to a wide international audience and can be integrated into the developing GEO outreach plans.

Changing ocean ecosystems

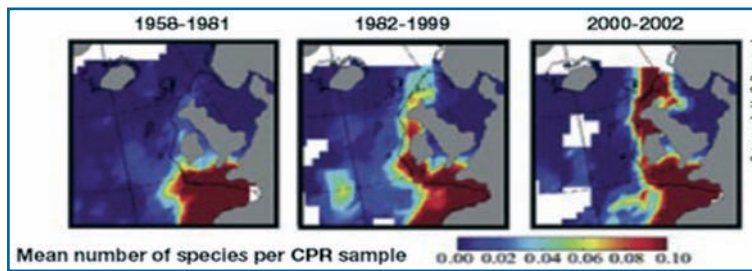
Description

Large changes have been observed in the plankton of the North Atlantic, at times with step-wise changes in abundance. Chlorophyll has increased by 60%; changes that have impacted all trophic levels (plants to fish and birds) in regional marine ecosystems. The tonnage of fish within a given ecosystem is dependent on the abundance and composition of plankton, and recruitment of new stock to the fisheries is governed by the timing/matching of occurrence of fish larvae with suitable planktonic food. A large decrease in total zooplankton and especially the dominant copepod *Calanus finmarchicus* has had a major impact on cod stocks in the North Sea (Figure 1). Declining returns of salmon to home waters have also been shown to be closely correlated with the changing composition of plankton in the North Atlantic from the mid 1980s and many other changes in fish abundance occurred at about the same time.



North Sea plankton food index (black) and cod biomass (red), 1958-1999. Note that changes in food supply had an effect on cod biomass with a one- to two-year lag. See Beaugrand et al. 2003, *Nature*.

Superimposed on the above changes has been a major northward shift in warm water plankton communities in the eastern North Atlantic by 10° latitude (1000 km) between 1958 and 1999 (Figure 2) a trend that has occurred to the present day with subtropical plankton species occurring at levels 6 standard deviations above the long-term mean in 2005.



Biogeographical changes to the west of Europe of warm temperate plankton assemblages spanning five decades. Warm water plankton are moving north and cold water plankton are moving out of the North Sea. Based on Beaugrand et al. 2002 Science.

In terms of climate such large changes in the plankton are likely to affect the extent to which the oceans take up CO₂ from the atmosphere. Understanding the mechanisms and effects of these changes is important.

Added Value

To fully address the societal benefit needs of GEO the few sister CPR surveys need to be expanded to all ocean basins so that the impact of biological changes in the oceans on humankind and vice versa can be properly assessed on a global scale. New funding mechanisms need to be put in place to ensure long-term sustained support of the CPR and its sister surveys within a GEOSS framework and GEO could assist with helping to put in place such a mechanism as well as supporting necessary expansion.

Relevance to GEO

This work contributes directly to the GEO tasks: Health HE-07-02, Energy EN-07-02, Climate CL-06-05, Water WA-07-01, Ecosystems EC-06-02, EC-06-07 and Biodiversity BI-06-02, BI-07-01 and Outreach as well as providing parallel observations of relevance to GEO tasks covering distributional and time series studies in the terrestrial sphere.

The multidecadal CPR time series gives a high socio-economic return at low cost by providing a 'barometer' against which the scale and impact of current and future global change can be assessed at temporal and spatial scales in the oceans that would otherwise be impossible. Results from the survey are used by a number of governments to support policy under the headings fisheries, biodiversity and environmental assessment and quality as well as the production of indicators. The data is also used for the validation of remote sensed data and ecological and climate change modelling. Work from the survey has provided input to the IPCC AR4 Climate Change report, OSPAR, ICES, EEA and national environment authorities. The data is being extensively applied by the Hadley Centre and Norwegian/Faroes modelling groups as input and for validation of advanced climate models and by conservation agencies in the development of their marine programmes. The survey forms an integral part of the Canadian Atlantic Zone Monitoring Program (AZMP) and the UK National Marine Monitoring Programme. The Southern Ocean CPR survey contributes information to CCAMLR, the Marine Biodiversity Information NetWork (SCAR-MarBIN) and is an endorsed SCAR project.

Participants

In the last decade supported by UK, Canada, Iceland, Faeroe Islands, Finland, Denmark, Netherlands, France, Ireland, Portugal, Spain, USA, EU, EEA, IOC, Gulf of Guinea LME, BCLME and in the case of the Southern Ocean CPR survey, Australia, Japan, Germany and New Zealand, UK and SCAR.

Current Status and Next Steps

The CPR survey was temporarily closed down in 1989 and is now operated by a charity, the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), with funding contributions from 12 countries plus the European Union and the Intergovernmental Oceanographic Commission (IOC) over the last decade. Maintaining consortium funding of the survey has been a major problem and new mechanisms need to be put in place to ensure operational survival of the survey and its sister surveys into the future. If the CPR survey had been closed the world would probably not be aware of the scale and speed of the biological changes that are taking place in the North Atlantic. There is virtually no information available to determine if similar changes have occurred elsewhere in the oceans, which cover ~71% of the surface of the Earth. Poor global coverage of biological measurements is a major gap in current ocean observation systems that has high relevance to assessing the rate and scale of global change.