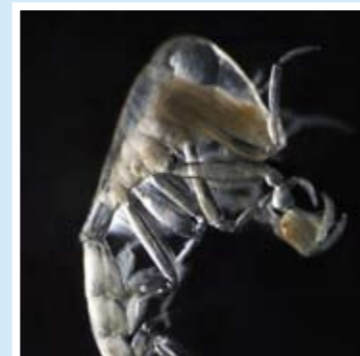
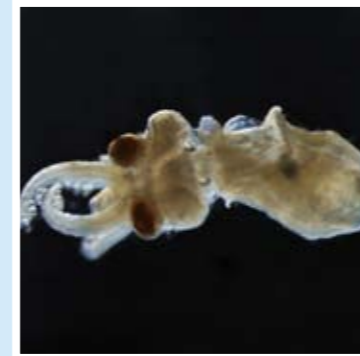


Right (top to bottom): Zooplankton from Australian waters; harpacticoid copepod, octopus larva, actinotrocha larva of a phoronid worm, amphipod.



www.imos.org.au

Project Highlights - SO route

The RSV *Aurora Australis* is Australia's Antarctic research supply vessel conducting both marine research and also resupplying Australia's Antarctic stations annually between spring and autumn. Under the direction of SO-CPR, the CPR is deployed from the *Aurora Australis* during research and resupply voyages, monitoring the health of the Southern Ocean by assessing individual plankton species and community response to changes in the environment. The primary focus of SO-CPR has been on studying krill and zooplankton patterns. Collaboration with AusCPR has provided additional support to count phytoplankton on routes south of Australia greatly enhancing the Southern Ocean dataset. The inclusion of phytoplankton data increases the sensitivity of detecting change in the region. It also helps explain the zooplankton and krill distribution patterns, as well as determine hot spots and cold spots of productivity. This can include potential foraging zones for fish, birds and marine mammals.

Future Expansion

Additional funding secured in the 2009 Federal Budget will allow the survey to extend out to mid-2013. This will allow for significant enhancements that will provide better coverage and monitoring of Australian plankton communities, as well as contributing to increasing our understanding of regional seas. A number of future routes are planned, and these include the Great Barrier Reef (to identify the response

of calcifying plankton to ocean acidification); Southern Australia (across Australia's largest upwelling system, the Bonney); the Tasman Sea (investigating relationships with fisheries productivity across the Tasman and along the east Coast of Tasmania); and Western Australia (to monitor the impacts of increased development and potential pollution on plankton communities).

AusCPR Data

The data is freely available through the IMOS Ocean Portal (<http://imos.aodn.org.au/webportal/>) according to the IMOS data policy and is providing researchers and policy makers with environmental and climatic indicators on harmful algal blooms, eutrophication, pollution, climate change and fisheries. AusCPR data are also particularly useful as supporting information for more localised plankton studies.

The AusCPR survey will ensure that we monitor the long-term health of our oceans by listening to its biological heartbeat - the changes in the plankton.

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Learn more about the AusCPR survey by visiting www.imos.org.au/auscpr.html

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Australian Government
Department of Innovation
Industry, Science and Research

Australian Continuous Plankton Recorder (AusCPR) Survey

The Australian Continuous Plankton Recorder (AusCPR) survey measures plankton communities as a guide to the health of Australia's oceans. It is part of the Ships of Opportunity Facility in Australia's Integrated Marine Observing System and is jointly operated by CSIRO Marine and Atmospheric Research (CMAR) and the Australian Antarctic Division (AAD).

The AusCPR survey aims to:

- Map plankton biodiversity & distribution
- Develop the first long-term plankton baseline for Australian waters
- Document plankton changes in response to climate change
- Provide indices for fisheries management
- Detect harmful algal blooms
- Validate satellite remote sensing
- Initialise and test ecosystem models

Drifting Barometers of Change

The ocean teems with microscopic drifting primary producers. These are phytoplankton, and they are grazed by microscopic animals known as zooplankton.

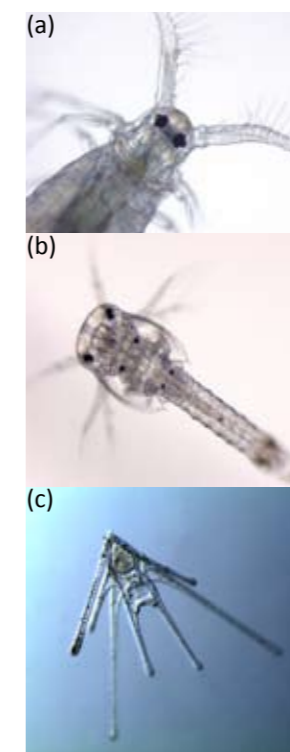
Through photosynthesis, phytoplankton produce half of the world oxygen by plants and support most marine life. Zooplankton include krill, copepods and young stages of crabs, lobsters, squid and most fish. They provide food for a multitude of creatures including fish, penguins, whales and turtles.

Plankton are short-lived and respond rapidly to changes in ocean conditions. This makes them valuable sentinels of

environmental change such as global warming. Measurements of plankton diversity and distribution over time provide a baseline for detecting impacts of climate change at the base of the marine food web.

The Continuous Plankton Recorder (CPR)

The most cost-effective way to monitor phytoplankton and zooplankton over vast areas of ocean is to use the CPR. Today's version of the CPR is a modified form of a device first used by pioneering



Left: Zooplankton from east coast Australian waters (a) a copepod (most abundant multicellular animal in the world); (b) krill larvae (young stage); (c) echinoderm larvae (turns into a seastar) (images: Anita Slotwinski CSIRO); the CPR being deployed (above) and will be towed 100 m behind the vessel at about 10 m below the surface of the water (image: Stevie Davenport, AAD)

Routes

Australia is unique in being bounded by warm-water poleward-flowing boundary currents off both east (the East Australian Current, EAC) and west (Leeuwin Current) coasts. Although this results in generally low plankton and fisheries productivity, diversity is high and has affinities with the diverse tropical taxa of the tropical Indian and Pacific Oceans. AusCPR is currently observing the plankton monthly along two routes using Continuous Plankton Recorders.

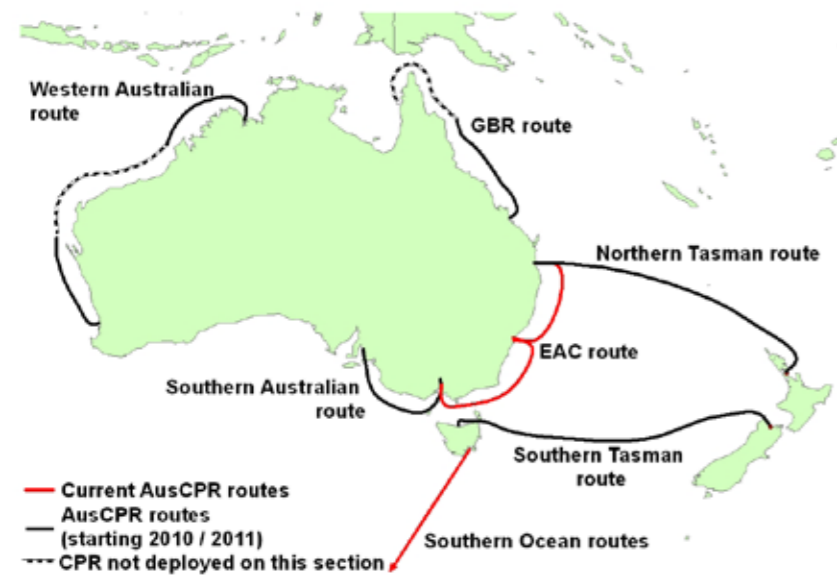
The EAC route extends from Brisbane (Queensland, latitude 27°S) to Melbourne (Victoria, latitude 37°S) down the east coast of Australia and follows the southward-flowing warm-water East Australia Current. This region is forecast to warm more than anywhere else in the Southern Hemisphere this century. This CSIRO-run route is towed by a commercial Australian National Line (ANL) vessel whose generous support is critical to the operation.

The other set of routes are conducted between Australia and Antarctica in collaboration with the Scientific Committee on Antarctic Research

(SCAR) Southern Ocean CPR (SO-CPR) survey led by the Australian Antarctic Division (Department of the Environment, Water, Heritage and the Arts) since 1991. Tows are conducted on voyages of the RSV *Aurora Australis*. The Australian tows combine with tows from 14 other countries within SO-CPR consortium producing a near circum-Antarctic survey. This provides access to plankton data beyond Australia helping to understand observed changes in a wider regional and global context.

Background

Australia has few zooplankton time series. Globally there are zooplankton times series spanning more than 15 years in no fewer than 30 countries, including many relatively small and developing nations. The longest ongoing times series in Australia is 2 years. Given its diversity of marine habitats and the economic and social importance of fishing, Australia is clearly impoverished in long-term zooplankton datasets. The AusCPR project will help redress this situation by providing estimates of plankton abundance monthly along the east coast of Australia and complemented by the tows between Australia and Antarctica.



Current and proposed AusCPR routes



Sir Alister Hardy deploying one of the first CPR instruments.

History of the Continuous Plankton Recorder

On the Discovery expedition of the Antarctic in 1926, Sir Alister Hardy collected continuous records of phyto and zooplankton abundance that dramatically showed the patchiness of plankton in the Southern Ocean. He called the new sampling device the “Continuous Plankton Recorder” and it remains in use and virtually unchanged to this day. This robust and durable device is towed near the ocean surface over extended transects (100s-1000s km), collecting plankton on a filtering silk.

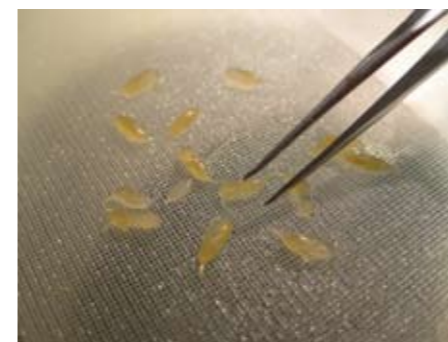
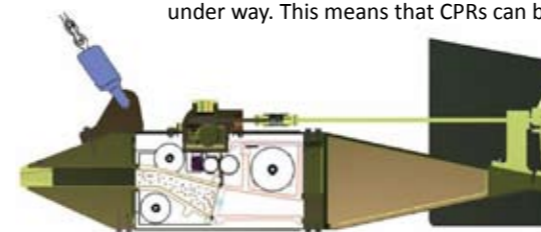
The AusCPR survey builds on the success of the ‘mother’ CPR survey run by the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) based in Plymouth, and also on the success of the SO-CPR Survey led by Australia.



The SAHFOS marine monitoring program has been collecting data in the North Atlantic and North Sea on the ecology and biogeography of plankton since 1931, and is one of the longest biological marine time series in the world. The unique marine biological dataset has provided a wide range of ecological indicators. These have been used by scientists and policy makers to address marine environmental management issues such as harmful algal blooms, pollution, eutrophication, climate change and fisheries. SAHFOS has successfully collected and archived over 220,000 plankton samples on a monthly basis since 1946 in the North Sea and North Atlantic Ocean through this practical and cost-effective technology. Similarly, the SO-CPR Survey has collected over 30,000 samples. Data are being used for research, conservation and management purposes, such as the bioregionalisation of Southern Ocean.

Ships of Opportunity

The advantage of the CPR is that it is robust and can be easily deployed and retrieved in minutes while the vessel is under way. This means that CPRs can be



The ANL container ship the ‘Windarra’ (left), the CPR (top) (Image: AAD), Zooplankton analysis (bottom) (Image: David McLeod, AAD).

deployed from a range of vessels including ‘ships of opportunity’: commercial vessels on their normal trading routes operating at their conventional speeds and gathering scientific measurements along regular routes.

Most large-scale surveys are part of fish stock surveys (because of cost constraints) and are thus usually conducted annually over relatively restricted areas, whereas sampling programmes that operate frequently (weekly– monthly) are usually point samples taken close to the coast where they are subject to local coastal processes.

The frequent sampling over large spatial scales of ships of opportunity programs, and the ability of the ships’ crew to deploy CPRs themselves, means that this sampling platform is extremely cost effective. Crews enjoy volunteering, and the support of ocean monitoring enhances the environmental profile of a shipping company.

Project Highlights - EAC route

The AusCPR survey has been towing a CPR down the east coast of Australia monthly since June 2009 and the AusCPR team based at the Cleveland plankton laboratory in Queensland are now undertaking laboratory analyses for each sample, gathering a range of phytoplankton and zooplankton data. A Phytoplankton Colour Index (PCI) (an estimate of phytoplankton biomass) has been determined for each route, and, to date, 100 phyto- and 50 zooplankton species have been identified from the Brisbane to Melbourne route. With an ongoing dataset, the survey is now well placed to investigate effects of future events in context of historical



The phytoplankton colour index for July 2009

data. For example, the AusCPR survey was able to monitor the impact of the large-scale dust storm in September 2009 investigating the effects of the increased iron input to the ocean on phytoplankton productivity. We are also able to examine effects of the increasing and decreasing strength of the EAC through the seasons, as well as the impact of smaller-scale oceanic features such as eddies, which are present down the east coast of Australia. A number of key zooplankton species have so far been detected, including euphausiids (known as krill and are important food for fish), salps and larvaceans (important in carbon cycling), pteropods (indicators of ocean acidification), chaetognaths and jellyfish (strongly influence fish recruitment through predation). The survey has also been monitoring harmful algal species (HABs) and noxious species such as species of *Dinophysis* and *Lyngbya*, which have the potential to effect human health.