

**Call for Proposals under the IMOS EIF Five Year Strategy:
Enhancement / extension of IMOS – July 2010 to June 2013**

**Extend and enhance the AusCPR
(Australian Continuous Plankton Recorder sub facility)**

Sub Facility Project Plan for 2010-2013

Last Update: 30 October 2009

Proposed Infrastructure Investment:	Extend and enhance the Australian Continuous Plankton Recorder survey
IMOS Facility:	Ships of Opportunity
Operating Institution:	CSIRO Marine and Atmospheric Research
Sub Facility Leader (for this Proposal):	Dr Anthony J Richardson, CSIRO Marine and Atmospheric Research and University of Queensland, 07 38267183, anthony.richardson@csiro.au Dr Graham Hosie, DEWHA, Australian Antarctic Division, SCAR SO-CPR Survey, Australian Antarctic Division, 03 6232 3364, graham.hosie@aad.gov.au
Other(s) key people involved:	Dr Peter Thompson, CSIRO Marine and Atmospheric Research, Hobart Rudy Kloser, CSIRO Marine and Atmospheric Research, Hobart Ed Butler, CSIRO Marine and Atmospheric Research, Hobart Gustaaf Hallegraeff, University of Tasmania Dave McKinnon, Australian Institute of Marine Science (QMOS) Anya Waite, University of Western Australia (WAIMOS) Laurent Seuront, Flinders University and SARDI (SAIMOS) Iain Suthers, University of NSW (NSW-IMOS)
Co-investing / Collaborating Institutions:	CSIRO Marine and Atmospheric Research, Australian Antarctic Division

Overview:

This proposal is to extend and enhance the Australian Continuous Plankton Recorder survey (AusCPR). Under the extend option, which is maintaining the East Australian Current route from Brisbane to Melbourne and the Southern Ocean route from Hobart to Antarctica, the EIF cost is \$865K from 2010 to 2013.

Under the enhanced option, the AusCPR would grow to service all nodes and proposed nodes in IMOS and provide a more national coverage of datastreams on plankton communities:

- The Northern Tasman Sea (Brisbane to Wellington; Bluewater node)
- The Great Barrier Reef (from Cairns to Gladstone; Q-IMOS)
- Southern Australia (from Melbourne to Adelaide; SAIMOS)
- Western Australia (The Kimberley from Wyndham to Broome, and the Leeuwin Current from Carnarvon to Fremantle; WAIMOS)
- Tasmanian east coast (Melbourne to Hobart; TasIMOS)
- The Southern Tasman Sea (Annual route only; Devonport to Nelson; TasIMOS)

The cost to EIF for the enhanced option is \$1.04M, giving a total EIF cost of \$1.9M for the extended and enhanced options (2010-2013).

The AusCPR survey deploys CPRs behind ships of opportunity (SOOPs) to collect plankton samples for subsequent identification in the laboratory. Data products are abundances and species composition of phytoplankton and zooplankton communities, as well as simultaneous auxiliary data (temperature, salinity, fluorescence). The CPR is mature technology, in use in the North Atlantic since 1931, and AusCPR has been successfully operating tows in Australian waters since June 2009. AusCPR is part of a growing international alliance of CPR surveys globally: in the Northeast Atlantic, the Northwest Atlantic, the Southern Ocean, and the North Pacific. Long-term data from these surveys have provided the basis for our best understanding of the impact of climate change on plankton communities and their dependent fisheries over broad space scales (e.g. the IPCC Fourth Assessment Report heavily cited publications emanating from CPR data, including 11 *Science* and *Nature* publications over the past decade).

Data from AusCPR will be used in a diverse range of applied research including, but not limited to, mapping marine biodiversity, understanding climate variability, documenting climate change impacts, validating ecosystem models and remote sensing products, providing indices of ecosystem health, fisheries management, understanding trophic linkages, measuring marine plastic pollution, and monitoring impacts of ephemeral events such as dust storms or oil spills.

A major aim of this proposal is to contribute to an integrated view of marine pelagic ecosystems. It is thus proposed that there is a priority focus region where the nutrients, plankton and mid trophic levels are sampled together to measure ecosystem response to climate. The Tasman Sea, a hotspot for climate change, is an ideal location. We suggest that this route would not only have a CPR, but also have a compact flow analyser onboard for nitrate and phosphate concentrations (*IMOS proposal by Ed Butler and Lesley Clementson CSIRO, and Ian McKelvie Monash University*) and bio-acoustic measurements to estimate critical mid-trophic organism (e.g., small fish, crustaceans, and squids) distribution and abundance (*Rudy Kloser, CSIRO; see IMOS Bio-acoustic ship of opportunity sub-facility proposal*). Further, In addition, all *Aurora Australis* Southern Ocean CPR data will be contributed freely to IMOS, representing a substantial co-investment from the AAD. An integrated transect would greatly enhance our understanding of the dynamics of marine ecosystems in response to climate variability and climate change, will be unique globally, and will provide valuable inputs to ecosystem-based fisheries management, marine planning and monitoring impacts of climate change, and be invaluable for understanding trophic linkages.

Nature of Investment:

This proposed investment comprises two components, with budgets presented separately:

- A. **Extend:** Extend from mid-2010 into mid-2013 the existing IMOS AusCPR survey along the east coast of Australia (Brisbane to Melbourne) and in the Southern Ocean (Hobart to Antarctica);
- B. **Enhance:** Enhance the existing AusCPR survey in Australian waters and regional seas to include quarterly routes in:
 - a. The Northern Tasman Sea (Brisbane to Wellington; Bluewater node)
 - b. The Great Barrier Reef (from Cairns to Gladstone; Q-IMOS)
 - c. Southern Australia (from Melbourne to Adelaide; SAIMOS)
 - d. Western Australia (The Kimberley from Wyndham to Broome, and the Leeuwin Current from Carnarvon to Fremantle; WAIMOS)
 - e. Tasmania east coast (Melbourne to Hobart; TasIMOS)
 - f. The Southern Tasman Sea (Annual route only; Devonport to Nelson; TasIMOS)

The AusCPR survey deploys Continuous Plankton Recorders (CPRs) behind ships of opportunity (SOOPs) and on research/supply vessels in the Southern Ocean in collaboration with the SCAR SO-CPR Survey to collect plankton samples for subsequent identification in the laboratory. The device can carry instrumentation (e.g., CTD-F, multispectral fluorescence) onboard. Data products from AusCPR are abundances and species composition of phytoplankton and zooplankton communities, as well as the physical data (temperature, salinity, fluorescence) simultaneously.

Implementation Strategy:

Objectives

The objectives of AusCPR are to collect, count and archive plankton samples from Australian waters and regional seas, and to make these available to the community. Information on phytoplankton and zooplankton species composition and abundance is of immense value.

Unlike habitats on land that are dominated by massive immobile vegetation, the bulk of the ocean environment is far from the sea floor and replete with microscopic drifting primary producers. These are the phytoplankton, and they are grazed by microscopic animals known as zooplankton. Each day, phytoplankton perform nearly half of the photosynthesis on Earth, fixing more than 100 million tons of carbon in the form of CO₂ and producing half of the oxygen we breathe. Phytoplankton photosynthesis directly and indirectly supports almost all marine life. Phytoplankton are a major food source for fish larvae, some small surface-dwelling fish such as sardine, and shoreline filter-feeders such as mussels. However, the major energy pathway to higher trophic levels is through zooplankton, the major grazers in the oceans. One zooplankton group, the copepods, is so numerous that they are the most abundant multicellular animals on Earth, outnumbering even insects by three orders of magnitude. Zooplankton support the teeming multitudes of the oceans higher up the food web: fish, seabirds, penguins, marine mammals and turtles. Further, carcasses and faecal pellets of zooplankton and uneaten phytoplankton slowly yet consistently rains down on the cold dark sea floor, keeping alive the benthic (bottom-dwelling) communities of sponges, anemones, crabs and fish.

Currently, research into plankton in Australian waters is limited; the only ongoing zooplankton time series are as part of IMOS, and there are few phytoplankton time series. Data from AusCPR will be used in a diverse range of applied research including, but not limited to:

1. *Marine biodiversity and biogeography.* Plankton data will be used to describe the species present, their abundance, and seasonal cycles in Australian waters. This knowledge is currently lacking for almost all of Australia. Ocean colour data from satellite are useful for estimating phytoplankton biomass, but can not measure species composition of phytoplankton, or the abundance or species composition of zooplankton. Australia has international obligations to preserve its biodiversity and the minimum responsibility is an inventory of the species present, which is currently lacking in Australia for plankton.
2. *Climate variability.* Plankton population dynamics is intimately linked to its physical and chemical environment. An understanding of the link between ocean physics and plankton dynamics can provide a window into how climate change may influence plankton communities in the future.
3. *Long-term baselines and climate change.* The AusCPR survey will provide a baseline against which we can assess global changes such as climate change, eutrophication, pollution, exotic species introductions, and overfishing. In particular, these data will underpin future State of the Environment Reporting.
4. *Biogeochemical/ecosystem model development.* Data on phytoplankton and zooplankton are needed to initialise and validate nutrient, phytoplankton and zooplankton (NPZ) models and other ecosystem models (e.g., Atlantis, Ecopath, In Vitro). These models are used to understand ocean productivity, and to link it to higher trophic levels). Such data, especially on zooplankton, is unavailable in Australia.
5. *Remote sensing.* Species-level data for phytoplankton aid validation of remote-sensing products and development of algorithms for identification of functional phytoplankton types from space, which is necessary for improved primary production estimates.
6. *Ecosystem health and harmful algal blooms (HABs).* Species-level data on HABs will provide the information essential to understanding the timing and environmental variables that trigger the occurrence of HABs in Australian waters, and pose such a threat to mariculture.
7. *Fisheries oceanography.* Phytoplankton and zooplankton are food sources for almost all species of fish larvae and many small adult fish, so plankton data can be used to understand fluctuations in abundances for many commercially-exploited and recreational fish species.
8. *Molecular biology.* Molecular analyses performed will indicate whether key species are genetically similar in different regions and whether different genes are expressed in different parts of a species range.
9. *Stable isotope analysis.* Plankton samples can be used to generate time series for stable isotope analysis (e.g., C and N), which gives an indication of the feeding pathways in pelagic foodwebs, and how these might change with time. Such analyses identify the primary food of zooplankton (whether diatoms or flagellates, which could change with global warming) and the feeding pathways to higher predators such as tuna.
10. *Plastics.* Millions of tonnes of plastics are accumulating in the marine environment, and many break down through abrasion into microplastics and fibres. The CPR retains many of these, which can be examined microscopically and using Fourier Transform Infra-red spectroscopy. This large-scale view of pollution in our oceans would be extremely useful for State of the Environment Reporting and as an index of ecosystem health (as many of these plastics are toxic to animals, both large and small).
11. *Monitoring ephemeral events.* Long-term datasets are particularly useful for placing short-term periodic massive events in context. For example, the recent dust storm off the East Coast of Australia fertilised the ocean with hundreds of thousands of tonnes of iron, a limiting nutrient for phytoplankton. The CPR has sampled the resulting massive phytoplankton off the East Coast and will provide information on the distribution of biomass and species involved.
12. *Understanding mitigation options.* Fertilising the oceans with iron and other nutrients is being investigated to mitigate climate change by leading to plankton blooms that then sediment out to

the deep ocean, removing carbon from the system. A key group being examined is salps, which have heavy faecal pellets that rapidly sink out from the upper layers of the ocean. Australian seas have massive swarms of salps and the CPR is providing an improved understanding of their distribution and the ocean conditions that trigger massive blooms.

List of major activities – including major party(s) involved, duration, start, finish

A *Extend*

- 1) Continue deploying CPR on the East Australian Current route from Brisbane to Melbourne and on the Hobart to Antarctica route.
- 2) Analyse CPR samples for phytoplankton and zooplankton abundance and species composition.
- 3) Provide data to eMII on abundance estimates for each phytoplankton and zooplankton species in numbers per m³, and on auxiliary variables (temperature, salinity and fluorescence).

The original IMOS plan identified a single repeated CPR route across the Southern Ocean between Hobart and the French Antarctic station Dumont d’Urville using *l’Astrolabe*. Without substantial and expensive modifications to the vessel, towing of CPRs is not possible. Instead all the *Aurora Australis* CPR tows will be contributed to IMOS. The eMII facility has already received the *Aurora Australis* CPR data from 1991 to 2008. AusCPR/IMOS as partners in the SCAR Southern Ocean CPR Survey will gain access to the whole circum-Antarctic CPR dataset providing further connectivity to global data.

B *Enhance*

The two existing routes along the EAC and in the Southern Ocean will be maintained and six new routes added (Fig. 1). Note that based on consultation with stakeholders, however, we will change the EAC route from monthly to quarterly sampling (after 1 year of monthly sampling). This is because it will free-up staff to work on samples from other routes in the enhanced phase, and it is logistically challenging to maintain a monthly sampling programme with more routes. A seasonal survey enables a greater buy-in from stakeholders and a greater diversity of science.

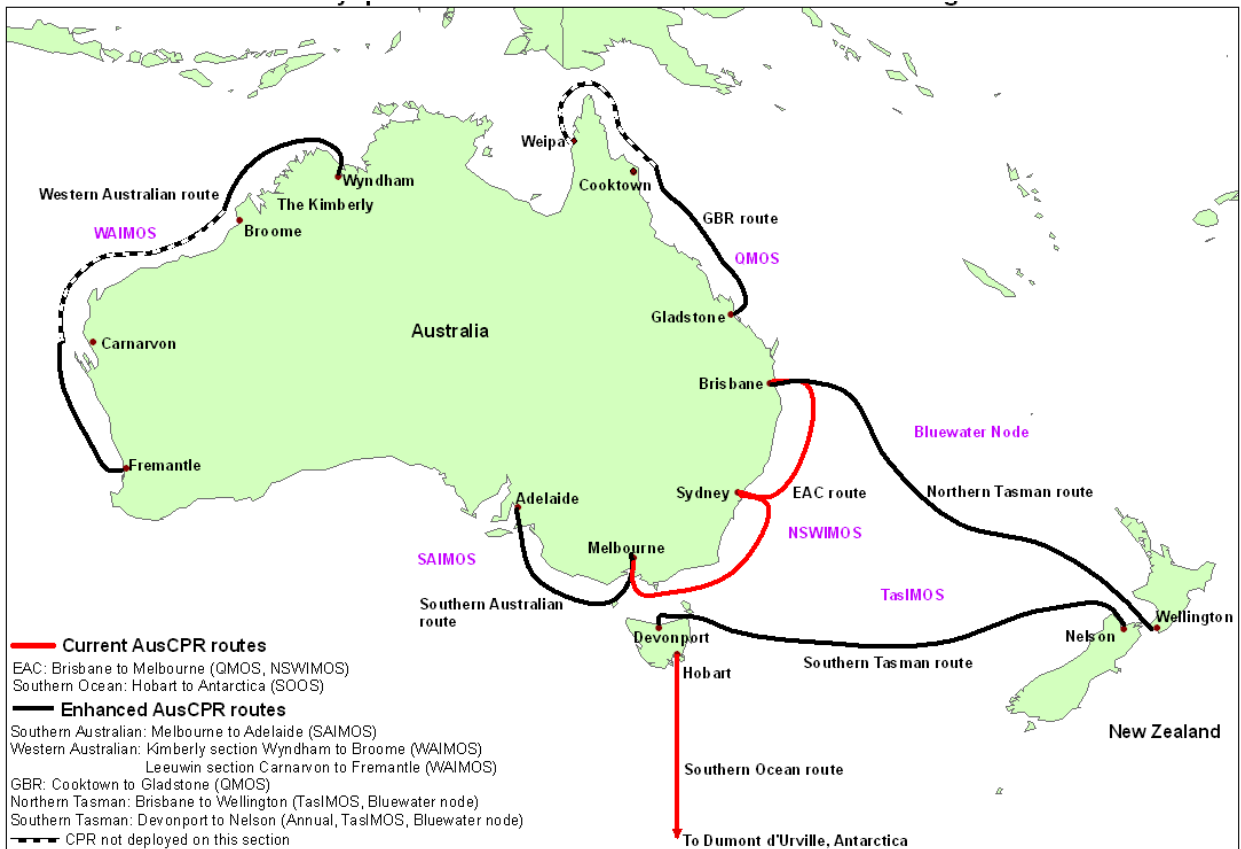


Fig. 1. Map of current AusCPR routes (in red) and enhanced AusCPR routes (in black)

Our schedule is (see Table 1):

- 1) June 2010: Buy 4 new CPRs from the North Atlantic CPR survey (SAHFOS).
- 2) June 2010: Buy 4 RBR-XR420 CTD-Fs, one for each CPR.
- 3) June 2010: Buy 4 Chelsea Trilux sensors measuring phytoplankton pigments (chlorophyll-a, phycoerythrin, phycocyanin).
- 3) July 2010: The rollout of the new routes will begin with the Melbourne to Adelaide route because the existing ship we use for the EAC route from Brisbane to Melbourne (the ANL Windarra) continues on from Melbourne to Adelaide. This will not require a new CPR or CTD-F. The ship then continues to Singapore, returning to Brisbane within the month. The CPR will be picked up at the Port of Brisbane by AusCPR staff and serviced, for deployment in 2 months time (quarterly) on the Brisbane to Melbourne to Adelaide route. If any help is required with the CPR in Adelaide, then SAIMOS staff have offered to help.
- 4) July 2010: We will deploy a CPR from Devonport (Tasmania) to Nelson (New Zealand South Island). This will be an only annual route and is aboard a fishing vessel that Rudy Kloser (CSIRO Marine and Atmospheric Research, Hobart) has been conducting annual hydroacoustic surveys for mesopelagic fish since 2005 (see *IMOS Bio-acoustic ship of opportunity sub-facility proposal*). This will provide us with the unique ability to collect data simultaneously on the plankton and fish communities across the Tasman Sea. AusCPR currently has a staff member in Hobart who will ensure that the CPR is ready to go and the ship's crew is trained in deployment and retrieval.
- 5) October 2010: We begin the quarterly GBR route from Cairns to Gladstone. The ship identified is a Rio Tinto Bauxite carrier travelling weekly from Weipa to Gladstone. Bronte Tilbrook (CSIRO Marine and Atmospheric Research, Hobart) has a proposal in with the GBR Foundation to instrument this ship with in situ sensors for pCO₂. This will provide

unique information on the pH of GBR waters and will be invaluable for interpreting the effect of ocean acidification on plankton with calcium carbonate shells that we collect in the CPR (e.g., coccolithophores, forams, pteropods, mussel larvae, echinoderm larvae).

- 6) January 2011: We begin towing the Western Australian route: the Kimberley section from Wyndham to Broome, and the Leeuwin section from Carnarvon to Fremantle. This route will provide the large-scale plankton context in the west, and we will be able to match-up our sampling with the more detailed sampling at the reference stations off the Kimberley and Rottnest Island. Supply ships regularly ply this coast. Logistically, CSIRO Floreat will help with servicing the CPR and sending the samples to CSIRO Cleveland.
- 7) March 2011: we begin towing the Northern Tasman Sea route from Brisbane to Wellington quarterly. It is also proposed that this quarterly route will have bio-acoustic measurements to estimate critical mid-trophic organism distribution and abundance (Rudy Kloser, CSIRO Marine and Atmospheric Research, Hobart; see *IMOS Bio-acoustic ship of opportunity sub-facility proposal*). Integrating datasets of the abundance and species composition of phytoplankton and zooplankton with abundance estimates of the larger-bodied micronekton communities (~2 to 20 cm length) including small fish, crustaceans, squids and gelatinous will be unique globally, will provide valuable inputs to ecosystem-based fisheries management, marine planning and monitoring impacts of climate change, and be invaluable for understanding trophic linkages. NIWA has also expressed interest in supporting this route. This is an easy route for us to support from Brisbane, and NIWA has said that they can support the route from the Wellington end if needed.
- 8) May 2011: we begin towing the Tasmanian east coast route from Melbourne to Hobart quarterly. This will provide the large-scale plankton view to complement the Maria Island NRS.

Table 1: Proposed deployment schedule for new AusCPR routes.

Date	Task
Jul 2010	Begin Southern Australia route from Melbourne to Adelaide (quarterly) Begin Southern Tasman route from Devonport to Nelson (annual) Switch East Australian Current route from Brisbane to Melbourne from monthly to quarterly
Oct 2010	Begin GBR route from Cairns to Gladstone (quarterly)
Jan 2011	Begin Western Australian route from Wyndham to Fremantle (quarterly)
Mar 2011	Begin towing Northern Tasman Sea route from Brisbane to Wellington (quarterly)
May 2011	Begin towing Tasmanian east coast route from Melbourne to Hobart (quarterly)

List of major equipment to be purchased/developed

Extend: No major equipment is needed to extend the AusCPR survey to mid-2013. In terms of minor equipment Filtering silks are needed for each CPR deployment (see Table 3). Wire will also need to be purchased and replaced on the Brisbane to Melbourne route every 6 months.

Enhanced: A total of 4 CPRs will be purchased from the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) who run the North Atlantic CPR survey. This includes the 4 new routes to be undertaken. A schematic of a CPR is shown in Fig. 2. Note that the Melbourne to Adelaide route does not require a CPR as this is an extension of the current Brisbane to Melbourne route aboard the same ship. CPRs have been in operation there since the 1930s in the North Atlantic, and SAHFOS deploys 20 CPRs each month.

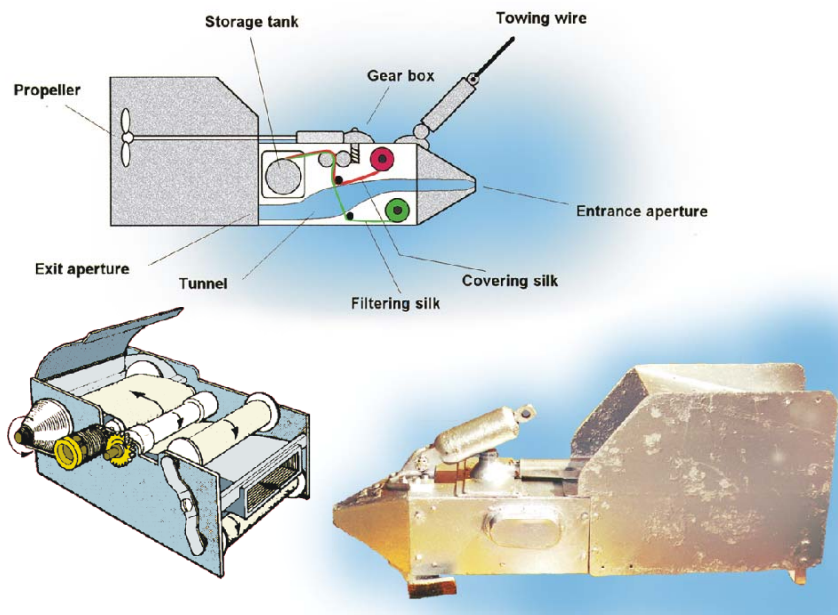


Figure 2. Schematic of the Continuous Plankton Recorder.

We will also purchase 4 x XR-420 CTD-Fs for each CPR from RBR Limited (Figure 3), together with the Ecopuck. The XR-420 is a small, autonomous 24-bit logger with 1Hz. conductivity, temperature and depth are measured using RBR sensors calibrated to NIST traceable standards.



Figure 3. The RBR Limited XR-420 CTD-Fs and ecopuck.

All CPRs and CTD-Fs are off-the-shelf devices.

Table3. List of equipment to be built or purchased.

Equipment	Requirement	Source	Date to be purchased/developed
Extend			
Wire x 8	To attach the CPR to ship	Local engineering firm	Month before towing
Silk meshes	Capturing plankton	SAHFOS	Ongoing
Enhanced			
4 x CPRs and cassettes	For collecting plankton samples	SAHFOS	June 2010
4 x XR-420 CTD-Fs	Measure temperature, salinity, depth and fluorescence	RBR Limited	June 2010
4 x Chelsea Trilux sensors	Measures phytoplankton pigments (chlorophyll-a, phycoerythrin, phycocyanin)	Chelsea Instruments	June 2010

Silk meshes	Capturing plankton	SAHFOS	Ongoing
Tow points	For towing CPR	Local engineering firm	Month before towing
Wire	To attach the CPR to ship	Local engineering firm	Month before towing
Laboratory equipment	Counting of samples	Crown Scientific	Ongoing

Access, pricing regimes:

- **How will data access be provided?**

The 4 data streams (Phytoplankton Colour Index; phytoplankton species counts; zooplankton species counts; associated temperature, salinity and fluorescence) will be made accessible through eMII, together with appropriate metadata. Data will be provided to eMII either within 1 month (Phytoplankton Colour Index and CTD-F) or within 3 months (phytoplankton and zooplankton counts). Further, we will archive all samples and make them available to the scientific community for other research projects.

- **How will data and products be managed?**

CSIRO and AAD have been running the AusCPR Survey for the past 2 years, and the AAD has been running the SCAR Southern Ocean CPR Survey for 19 years. CSIRO and AAD have well developed protocols and manuals, and are currently supplying data regularly to eMII. Data from around the Australian mainland are stored in a database at CSIRO (Cleveland) and then exported to eMII; data in the Southern Ocean are maintained in a database at the Australian Antarctic Data Centre (AADDC), as well as by the SCAR Marine Biodiversity Information Network (SCAR-MarBIN), and then exported to eMII.

- **What are the dependencies on external / other facilities (national and international)?**

The *Extend* option in this proposal is jointly driven by CSIRO and AAD. The project is dependent upon a continued strong working relationship with ANL (see attached letter of support). Delivery is also dependent upon the regular supply silk meshes from the Sir Alister Hardy Foundation for Ocean Science (SAHFOS). Silks are sourced from SAHFOS to maintain international standards. AusCPR is in regular contact with SAHFOS and has a solid working relationship with SAHFOS, as one of the sub-facility leaders worked there for 3 years and the other sub-facility leader is a governor of SAHFOS and member on its Council. The SO-CPR Survey is a cohesive, robust collaboration of 14 Antarctic nations under the SCAR banner, coordinated by the AAD and supported by the SCAR Expert Group on CPR Research to help develop the Survey. AusCPR/IMOS as an important partners in SO-CPR providing further international linkages.

The *Enhanced* option is driven solely by CSIRO. The project is dependent upon developing strong working relationships with several shipping companies. We have already developed a strong relationship with ANL and envisage no difficulties in developing more relationships. We will also be relying upon support from the nodes in which the routes are happening, and the AusCPR routes and this is contained within the particular node plans for WAIMOS, SAIMOS, NSW-IMOS, QMOS and the Bluewater node.

- **Collaborative structures for allocation of priorities**

CSIRO Marine and Atmospheric Research will be responsible for the *Extend* and *Enhance* options in Australian mainland and the Australian Antarctic Division will be responsible for the Southern Ocean component.

Governance

- **Performance indicators**

Key performance indicators for the AusCPR program will be:

- Placement and delivery of orders for CPRs and CTD-Fs
- Successful negotiation of routes with shipping companies
- Successful deployment of CPRs on routes
- Analysis of CPR samples
- Provision of data to eMII

1) List of the data streams that are available for use in research, grouped by facility
AusCPR produces 4 data streams. The phytoplankton biomass (the Phytoplankton Colour Index), phytoplankton species composition and abundance, zooplankton species composition and abundance, and CTD-F data streams (temperature, salinity, fluorescence).

In addition, all *Aurora Australis* Southern Ocean CPR data will be contributed freely to IMOS, representing a substantial co-investment from the AAD and a tangible benefit to the Australian IMOS community.

2) Meeting Researcher Needs

We have identified a PhD student to work on AusCPR samples (Julian Uribe, University of Queensland) who will start in 2010. We have had extensive discussions with key people in the Australian and overseas scientific community in terms of research concerning our key objectives. CSIRO Marine and Atmospheric Research is particularly interested in phytoplankton and zooplankton data for model validation, and potentially in the future for model assimilation. CSIRO Land and Water are interested in the potential for validation of ocean colour products using phytoplankton data from the CPR. UNSW, USyd, UTS are all interested in collaborating on a study investigating the impact of the recent large-scale dust event on primary and secondary productivity off the East Coast of Australia.

3) Quality of Research Infrastructure

We are using exactly the same CPRs and CTD-Fs that are deployed routinely and successfully in the North Atlantic survey. These are compatible with the CPRs and underway data collected in the Southern Ocean. This allows qualitative comparisons against data from other CPR programs throughout the world.

4) Fostering Collaborative Development of Infrastructure

A major aim of this proposal is to contribute to an integrated view of marine pelagic ecosystems, including the physical, chemical and biological environment. Each CPR will have a CTD-F onboard measuring temperature, salinity, and chlorophyll.

It is proposed that the Tasman Sea route from Brisbane to Wellington will have a compact flow analyser for phosphorus and nitrogen species detection (*IMOS proposal by Ed Butler and Lesley Clementson CSIRO Marine and Atmospheric Research, and Ian McKelvie Monash University*) and bio-acoustic measurements to estimate critical mid-trophic organism distribution and abundance (Rudy Kloser, CSIRO Marine and Atmospheric Research, Hobart; see *IMOS Bio-acoustic ship of opportunity sub-facility proposal*). Integrating regular data from phytoplankton and zooplankton species composition with the available nutrient regime and the mid trophic level organisms will be a unique contribution globally and will greatly advance our understanding of the dynamics of lower trophic levels and limitations on productivity.

Finally, we are collaborating closely with other CPR programs internationally collecting similar data streams. Any improvements developed by any partner program are shared amongst the entire CPR community. For example, we have been deploying a pitch and roll sensor on our CPRs, and the North Atlantic and Southern Ocean CPR surveys are now deploying these as well. The SO-CPR Survey developed a software program to combine CPR and underway environmental data which is now widely used. We have also designed an alternative analysis stage for phytoplankton analysis and this is being investigated by the North Atlantic survey.

5) Fostering Interdisciplinary and World-class Research

Work is in progress for the first papers from the AusCPR data. Considerable high impact science (a Nature and Science paper each year for the last decade) has been produced by the North Atlantic CPR survey and its focus on the impact of global change (climate change, eutrophication, over-fishing, pollution, species introductions).

- **Describe key risks and risk management strategies**

Key risks are defined in Table 4.

Table 4. Key risks and mitigation strategies.

Risk	Risk mitigation
CPR loss	CPRs have been deployed in the North Atlantic survey since 1931. Over 4000 deployments have been completed, and only a single unit has been lost during deployment when the tow vessel failed to retrieve the recorder before entering port. As a precaution to loss, CPR towing points on vessels are tested and certified after installation (to 2 tonnes safe working load). We also inspect the towing points on the CPR unit itself after each deployment, and replace when necessary. We replace the towing wire after every 6 tows. CPR loss is considered unlikely.
CPR damage	The CPR is built to withstand the rigours of deployment behind large vessels travelling at >20 knots. However, minor damage is common, usually in the form of damage to the sacrificial fender, which is easily replaced. We inspect the CPR after each deployment and replace any worn components. AusCPR now has considerable experience in maintaining and servicing CPRs. The crew retrieve the CPR under rough sea conditions (Beaufort Scale 7), minimising the chance of damage and loss. CPR damage is commonplace, but we have taken all necessary precautions to minimise this problem.
CTD-F	They are housed within the box-tail of the CPR, which has a level of protection. The crew has also been trained in the safe and gentle deployment and retrieval of CPRs. The CTD-F that we are using has been used extensively for a decade in the North Atlantic CPR survey with minimal problems.
Crew safety	We use methods that reduce to as small as possible the safety risks to ships' crew. We emphasise that safety is our key concern and ask them not to deploy the device if they have safety concerns (e.g., rough weather, fishing vessels nearby). We have provided a manual for deploying and retrieving the CPR, which emphasises these precautions.
Laboratory safety	Formalin, which is a carcinogen, is used as a fixative in our plankton samples. We have used best practice to reduce risks posed by formalin. We cut the silks in a fume cupboard, conduct phytoplankton counts within a microscope fume hood, and count zooplankton in water without fixative. All samples once counted are preserved in a safer chemical and removed from the laboratory as soon as possible. We also check that formalin readings within the lab are below recommended levels using a formaldemeter.
Loss of key staff	AusCPR is dependent on key staff (Anthony Richardson and Graham Hosie; the IMOS AusCPR PIs). Anthony Richardson has just received an ongoing appointment between UQ and CSIRO and has been with the organisation for more than 4 years. Graham Hosie has been with the AAD for 26 years. Frank Coman, the principal technician, has been with CSIRO for 20 years and is unlikely to leave. Claire Davies, Anita Slotwinski and David McLeod have been trained during the first phase of IMOS, which built on their previous plankton identification and sampling skills. The extensive opportunities for training, both nationally and internationally, have not only meant that plankton identification skills of the AusCPR team are extremely high but have kept the team extremely interested. We have manuals in place detailing procedures for CPR repair, database entry and plankton identification. All team members have expressed their interest in helping to build the Survey. Staff loss is thus not considered a serious risk.

Budget:

Budgets are presented separately for the *Enhance* and *Extend* options below. Note that there is currently \$950K remaining in the AusCPR budget (Oct 15 2009). The ask for new EIF money for extension is thus: \$1.815M - \$950K = \$865K. The ask for new EIF money for enhancement is \$1.041M.

Extend

EIF Funds

- No funds are sought for capital expenditure to extend the AusCPR survey.
- Operating expenses include money for silks that are loaded within the CPR to capture plankton, QC and training to maintain the data quality, regular replacement of wire to minimise risk of loss of the CPR and maintain safety, maintenance of laboratory and provision of chemicals, and transport of samples to the laboratory.
- **Co-investments – source and nature**

The source of co-investment is through in-kind support for salaries from CSIRO and AAD. This equates to \$2M. The East Australian Current route is towed by a commercial ship of opportunity for a small gratuity (\$200; see Letter of Support in Appendix B) and the Hobart to Antarctica routes are towed free of charge by the RSV *Aurora Australis*. The second major form of co-investment is by CSIRO in terms of project management, project support, provision of laboratory space, provision of equipment (e.g., microscopes), as detailed in the budget. In particular, the 0.25 FTE provided by the CSIRO PI. Similarly, the AAD also provides project support, management, laboratory space and access to equipment for the Southern Ocean routes, and the AAD PI providing 0.8 FTE administering the SO-CPR Survey and AusCPR, plus 0.8 of the AAD Senior Plankton Analyst who is responsible for analysis of *Aurora Australis* samples and operations. This equates to about \$184,000 co-investment in salaries.
- **Staffing details**

A total of 3.75 FTE is required currently to run the AusCPR survey, with 2.75 FTE in Cleveland and 1 FTE in Hobart. To keep the Team highly motivated and to increase the capability of the AusCPR Team, all staff perform most functions: scoping new routes; liaising with ships; preparing CPRs for deployment; servicing CPRs; analysing samples for phytoplankton and zooplankton abundance and species composition; archiving samples; maintaining quality control; entering data into the database and exporting it to eMII; and maintaining our web presence (www.imos.org.au/auscpr.html).

Enhance

EIF Funds

There is an exciting opportunity to enhance the spatial coverage of the AusCPR survey considerably for a relatively modest cost because the Team are now expert in taxonomic identification and process samples more quickly, we have the protocols in place, we have experience negotiating with ships, and we have experience in setting up and servicing CPRs. Funds are requested to start 6 new routes to be towed quarterly

1. The Northern Tasman Sea (Brisbane to Wellington; Bluewater node)
2. The Great Barrier Reef (from Cairns to Gladstone; Q-IMOS)
3. Southern Australia (from Melbourne to Adelaide; SAIMOS)
4. Western Australia (The Kimberley from Wyndham to Broome, and the Leeuwin Current from Carnarvon to Fremantle; WAIMOS)
5. Tasmanian east coast (Melbourne to Hobart; TasIMOS)

6. The Southern Tasman Sea (Annual route only; Devonport to Nelson; TasIMOS)

Specifically funds are requested for 4 new CPRs. Note that a new CPR is not needed for the Southern route from Melbourne to Adelaide because it is the same ship that tows from Brisbane to Melbourne. We will also purchase 4 x RBR X-40 CTD-Fs to measure concomitant temperature, salinity, and fluorescence. The CTD-F will be located in the boxtail at the rear of the CPR. One of the reasons that we will be able to operate 5 new routes with only a modest cost increase is because we will tow the current East Australian Current route quarterly rather than monthly from June 2010 under the Enhance option.

- **Co-investments – source and nature**

The source of co-investment is through in-kind support for salaries from CSIRO and AAD. This equates to \$434K.

- **Staffing details**

An extra 1.5 FTE is required to accomplish the enhanced routes (taking into account the reduced frequency of the East Australian Current route).

Extended

Facility budget proforma for IMOS EIF Call for Proposals 2010-2013

Extension of existing NCRIS Facility (Note 1)

		2009/10	2010/11	2011/12	2012/13	Total
		(NCRIS/EIF)	(NCRIS/EIF)	(EIF)	(EIF)	(NCRIS+EIF)
NCRIS/EIF Funding (Note 2)						
Capital	2 new CPR and cassettes (including 1 spare)	130,000				130,000
Capital	1 RBR X-420 (CTD-F)	30,000				30,000
Capital	1 Chelsea trilux sensor	15,000				15,000
Salaries	3.75 FTE yr1; (CSOF 3 and 5 + 5% p.a.)	316,662	332,495	349,120	366,576	1,364,852
Operating	Silk mesh	20,000	20,000	20,000	20,000	80,000
Operating	QC and training - see Note A	15,000	15,000	15,000	15,000	60,000
Operating	Sample transport + gratuity see Note A	15,000	15,000	15,000	15,000	60,000
Operating	Lab (chemicals, formalin disposal, jars, microscope servicing, reference collection)- see Note A	17,000	17,000	17,000	17,000	68,000
Operating	Wire + davits	2,000	2,000	2,000	2,000	8,000
NCRIS/EIF Funding Total		560,662	401,495	418,120	435,576	1,815,852
Cash Co-investment (Note 3)		2009/10	2010/11	2011/12	2012/13	Total
(enter Organisation)	(insert description, including likelihood)					0
(enter Organisation)	(insert description, including likelihood)					0
(enter Organisation)	(insert description, including likelihood)					0
(enter Organisation)	(insert description, including likelihood)					0
Cash Co-investment Total		0	0	0	0	0
In-kind Co-investment (Note 3)		2009/10	2010/11	2011/12	2012/13	Total
Salaries	3.75 FTE yr1; (CSOF 3 and 5 + 5% p.a.)- confirmed	293,280	307,944	323,342	339,509	1,264,075
Salaries	Australian Antarctic Division	184,000	184,000	184,000	184,000	736,000
In-kind Co-investment Total		477,280	491,944	507,342	523,509	2,000,075
TOTAL Resources		1,037,942	893,439	925,462	959,085	3,815,927

Enhanced

Facility budget proforma for IMOS EIF Call for Proposals 2010-2013

Enhancement to Facility / New Facility (Note 1)

		2010/11	2011/12	2012/13	Total
		(EIF)	(EIF)	(EIF)	(EIF)
NCRIS/EIF Funding (Note 2)					
Capital	4 CPRs	260,000			260,000
Capital	4 RBR X-420 (CTD-F)	120,000			120,000
Capital	4 Chelsea trilux sensor	60,000			60,000
Salaries	1.5 FTE (CSOF 4 + 5% p.a.)	148,739	156,176	163,985	468,900
Operating	Silk mesh	6,500	6,500	6,500	19,500
Operating	QC and training	0	0	0	0
Operating	Sample transport + gratuity	25,000	25,000	25,000	75,000
Operating	Lab (chemicals, formalin disposal, jars, microscope servicing, reference collection)	2,000	2,000	2,000	6,000
Operating	Wire and davits	20,000	7,000	5,000	32,000
NCRIS/EIF Funding Total		642,239	196,676	202,485	1,041,400
Cash Co-investment (Note 3)		2010/11	2011/12	2012/13	Total
(enter Organisation)	(insert description, including likelihood)				0
(enter Organisation)	(insert description, including likelihood)				0
(enter Organisation)	(insert description, including likelihood)				0
(enter Organisation)	(insert description, including likelihood)				0
Cash Co-investment Total		0	0	0	0
In-kind Co-investment (Note 3)		2010/11	2011/12	2012/13	Total
Salaries- overheads	1.5 FTE (CSOF 4 + 5% p.a.)	137,757	144,645	151,877	434,279
(enter Organisation)	(insert description, including likelihood)				0
(enter Organisation)	(insert description, including likelihood)				0
(enter Organisation)	(insert description, including likelihood)				0
(enter Organisation)	(insert description, including likelihood)				0
(enter Organisation)	(insert description, including likelihood)				0
In-kind Co-investment Total		137,757	144,645	151,877	434,279
TOTAL Resources		779,996	341,321	354,362	1,475,679

Marine and Atmospheric Research
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30 October 2009

Mr Tim Moltmann
Director Integrated Marine Observing System (IMOS)
University of Tasmania
Private Bag 110
Hobart, TAS, 7001

Dear Tim

CSIRO Support for request to IMOS for Infrastructure/funding

I write in support of the following submissions to IMOS:

Node Leadership

It is confirmed that CSIRO will support the leadership and governance of the following nodes:

- Bluewater and Climate
- TASIMOS

Facility Leadership

Further, we also confirm that the proposed infrastructure of the following facilities, and sub facilities where we are not the facility operator, can be developed and operated within CSIRO:

- Argo
- Ships of Opportunity
- Australian Bluewater Observing Sites
- Australian National Mooring Network
- Satellite Remote Sensing

Please note that timing has not allowed a comprehensive assessment of the impact on facility submissions of the facility demands either explicitly or implicitly articulated in the node plans. It has also not been possible to consider CSIRO's full co-investment commitment. We will need to reserve the right to more fully review and indicate our support of these post submission of the node and facility responses. We will take your advice as to where in the IMOS planning process it is most convenient for us to do that, given the apparently high likelihood of iterations after today's deadline.

Yours sincerely



Ms Toni Moate
Deputy Chief Business
CSIRO Marine and Atmospheric Research

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Appendix B. Letter of Support from ANL Shipping Company.



ANL. It's Australian for Shipping.

Re: AusCPR Project

The Integrated Marine Observing System (IMOS)

26 October 2009

To whom it may concern

ANL Container Line is the shipping company that specialises in moving clients product between Australia and just about anywhere in the world. Our parent company the CMA CGM Group is the third largest container shipping line in the world and operates on more than 100 shipping routes with over 370 vessels.

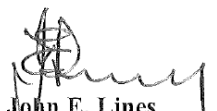
ANL Container Line has been a strong supporter of the AusCPR project since CSIRO researchers first explained this project in detail to us.

In April 2009, the ANL Windarra had the first continuous plankton recorder installed on its stern. Through the efforts of this vessel's Captains and crew this unit has been successfully deployed as and when instructed to do so by the CSIRO researchers. ANL has been happy to contribute to and be involved with this important research project which is providing data on the impact of climate change on the marine ecosystem.

We have found the CSIRO researchers to be professional in their dealings with ANL.

ANL will continue to collaborate on this project for as long as there is of mutual benefit, without any negative impacts, for both ANL and the AusCPR project.

Yours faithfully,


John E. Lines
Managing Director
ANL Container Line

CMA CGM group

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