IMOS Integrated Marine Observing System

Australian National Mooring Network Facility Project Plan

Call for Proposals under the IMOS (EIF) Five Year Strategy: Enhancement or extension of IMOS – July 2009 to June 2013

Proposals should be submitted by 30 October 2009 to:

Tim Moltmann, IMOS Director, University of Tasmania
email: tim.moltmann@imos.org.au

Overview:

Proposed Infrastructure Investment:	A nation system of moored sensors and associated water samples
IMOS Facility:	Australian National Mooring Network (ANMN)
Operating Institution:	CSIRO Marine and Atmospheric Research (CMAR)
Facility Leader (for this Proposal):	Tim Lynch , CMAR, 03 6232 5239, tim.lynch@csiro.au
Other(s) key people involved:	John Middleton (SARDI), Vittorio Brando (CSIRO), Ming Feng (CSIRO), Moninya Roughan (SIMS and UNSW), Rob McCauley (Curtin University), Craig Steinberg (AIMS), Anthony Richardson (CSIRO and UQ), Bronte Tilbrook (CSIRO), Peter Thompson (CSIRO), Leanne Larmand (Macquarie University)
Collaborating Institutions:	South Australian Research and Development Institute (SARDI), Commonwealth Science and Industry Research Organisation (CSIRO), Sydney Institute of Marine Science (SIMS), Curtin University, Australian Institute of Marine Science (AIMS), University of Queensland (UQ), University of Technology Sydney (UTS), Macquarie University, Australian Antarctic Division (AAD), NSW-Department of Climate Change and Water (DECCW),Oceanographic Field Services (OFS), Manly Hydraulics Laboratory (MHL), Sydney Water Corporation (SWC), National Marine Science Centre (NMSC), Flinders University, University of Adelaide. Australian National University (ANU), Queens University, (Ontario, Canada)

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Nature of Investment

For ease of understanding this proposal is divided into chapters. The first chapter provides an overview of the facility structure, summaries of the implementation plans, higher level risks and a consolidated budget. Each additional chapter provides details on individual sub-facilities.

The Australian National Mooring Network ANMN is an established facility of the Integrated Marine Observing System (IMOS) which received funding of $14,793,000 from NCRIS and a further $1,800,000 and a proportion of $1,700,000 as part of the Education Investment Fund (EIF) 2009-10 allocations. The facilities infrastructure is composed of nationally distributed systems of coastal and continental shelf moored sensors and associated biogeochemical (BGC) water sampling. The multiple datasets collected measure physical, chemical and biological parameters of coastal waters.

The ANMN is the largest and most scientifically diverse of the IMOS facilities. The recurring theme of the facility is monitoring the behaviour and attributes of all of Australia's continental shelf boundary currents. The facility achieves this by combining elements of physical and chemical oceanography with marine biology across most states and one territory of Australia.

Structure of the ANMN

The foundation structure of the ANMN was for 7 sub-facilities which have individual contracts with IMOS. The original sub-facilities and their host organisations in brackets were:

- National Reference Stations - Coordination & Analysis (CMAR)
- Western Australia (CMAR)
- Passive Acoustic Observatories (Curtin University of Technology)
- Queensland and Northern Australia (Australian Institute of Marine Science - AIMS)
- New South Wales (Sydney Institute of Marine Science - SIMS)
- South Australia (South Australian Research and Development Institute - SARDI)
- Satellite Ocean Colour – Calibration & Verification (CSIRO).

During this planning process, a variety of changes have been suggested for the ANMN structure. On the enhancement side there is a proposal for two additional sub-facility, the National Coastal Time Series, which would be hosted by SIMS and a Carbon and acidification sub-facility hosted by CMAR. Two other mooring enhancements for Tasmania and South East Queensland have also been proposed which will be initially hosted by the NRS - Coordination & Analysis sub-facility. Finally the Satellite Ocean Colour – Calibration & Verification sub-facility has been proposed to be moved to the Satellite Remote Sensing facility. The proposed new structure of the ANMN, their host organisations and leaders are provided in Figure 1, new sub-facilities or functional units are in red.

Relationship with other Facilities

The ANMN has a strong existing relationship with another IMOS mooring and oceanographic sensor facility the Southern Ocean Time Series (SOTS) facility.

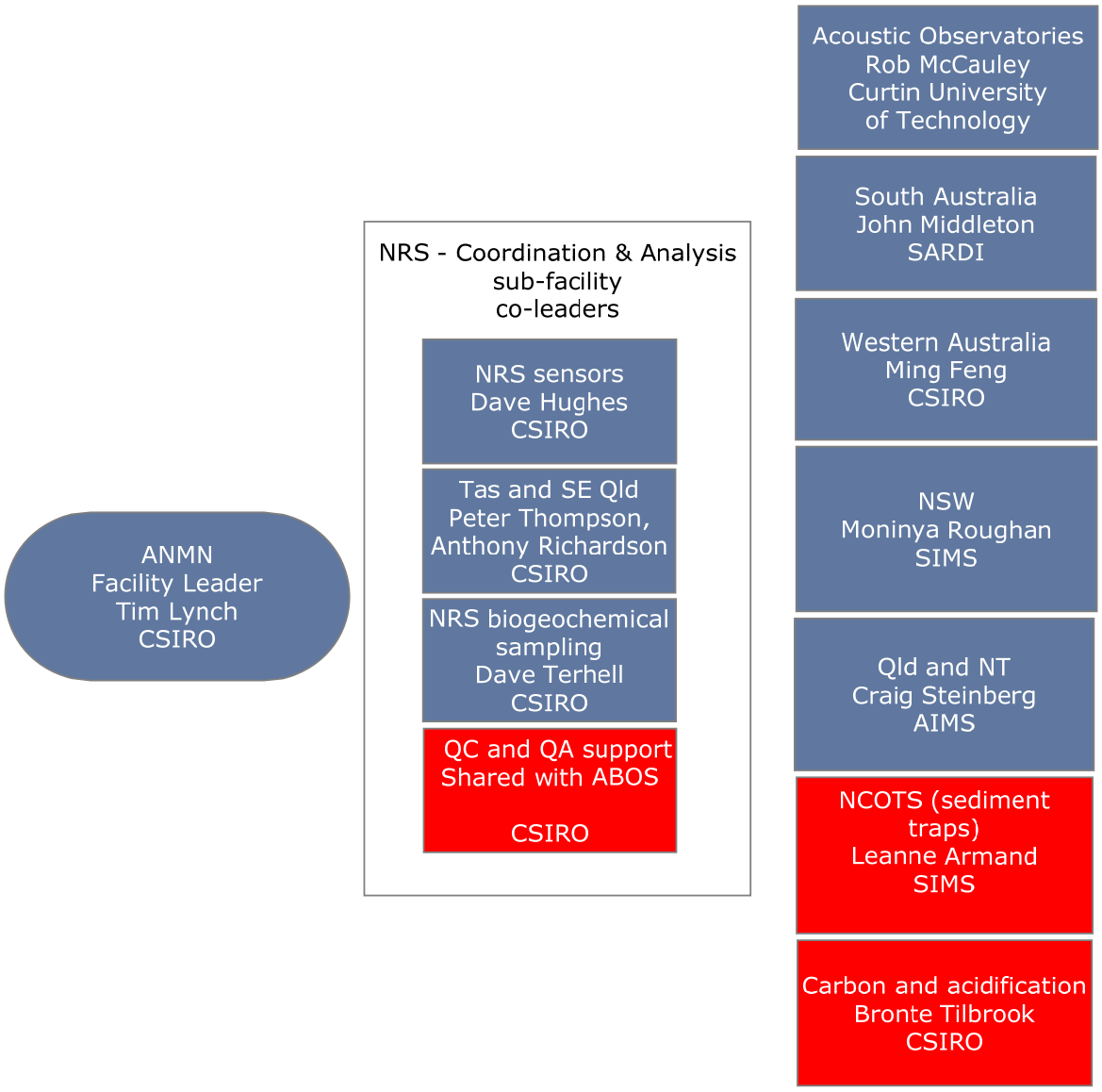

Figure 1. Structure of the ANMN

This deepwater facility is proposed to be enhanced to become the Australian Bluewater Observing Sites (ABOS) facility. To strengthen this relationship there is a cost sharing proposal for a Quality Control and Quality Assurance experimental scientists and a project officer to be shared between these facilities. These two officers would maintain data quality for upload to eMII and assist in the management of logistics for these widely distributed moored arrays.

A proposal is underdevelopment by John Church and Neil White for the Satellite Remote Sensing (SRS) facility to deploy four moorings along satellite paths to calibrate sea level elevation and other parameters with remote sensed data. All of this work would be undertaken by the CMAR Ocean Sensor deployment team which is also responsible for the mooring aspects of the NRS co-ordination and analysis and Western Australian sub-facility's of the ANMN. Although the Satellite Ocean Colour – Calibration & Verification sub-facility is being proposed to be moved to the SRS facility an enhancement proposal is to be submitted for bio-optical observations to be carried out at NRS moorings by measuring CDOM fluorescence and scattering at BLUE & GREEN bands, complementing the Chlorophyll measurements currently acquired at each NRS mooring. This will provided a nationally consistent validation data for the 4 primary Ocean Colour Products of Chlorophyll, coloured dissolved organic matter and vertical attenuation of light.

Implementation Strategy:

The first two years of the ANMN have been a start up and capacity building process. This has included establishment of instrumented monitoring sites in WA, SA, TAS, NSW, QLD and NT as well as the development and implementation of a standard system of BGC water sampling. While having achieved considerable progress the ANMN is set to expand in the future with the remainder of NCRIS funds, already committed EIF funding and the EIF extension. This includes completion of approved mooring deployments such as the Ningaloo (NIN), Port Hacking (PH) and North Stradbroke Island (NSI) NRS, purchase of ADCPs for all NRS sites and also deployment of moorings that measure pCO_2 at the Maria Island and Yongala NRS. Further approved expansions include a new array of moorings across the north of Australia which will contribute to the North Australia Observing System (NAOS).

Extension funds will include bridging finance between NCRIS and EIF for the 2010/11 financial year to continue already committed EIF funded projects, such as operation of the NSI NRS and purchase of additional ADCPs to allow servicing hot-swaps for continual measurements and calibration and funds to build moorings that will hold the telemetering ADCP. Extension funding from 2011/12 onwards will maintain the existing infrastructure. In addition to new sub-facilities, the existing sub-facilities are also all seeking enhancement of their original investment and brief summaries of each sub-facilities implementation plan are provided below.

National Reference Stations co-ordination and analysis

The National Reference Stations (NRS) co-ordination and analysis sub-facility provides facility management support, analysis of biogeochemical (BGC) samples, and research and development for $pC0_2$ moorings, satellite telemetry, sensors and mooring systems. The sub-facility also services the Maria Island and North Stradbroke Island NRS. Servicing and budget responsibility for all other NRS are with regional sub-facilities (eg Rottnest NRS is serviced by the Western Australian sub-facility). The NRS forms the backbone of the ANMN, providing context to other studies with a time series of datasets to monitor climate change both through oceanographic and biological processes. Essentially the NRS are areas where both water samples are taken and where multiple moorings with various instruments are located in close proximity to each other (Figure 2).

The sub-facility also acts as a holding company for new proposals, such as the NSI NRS and pCO2 moorings, that may develop over time into their own sub-facilities. The NRS co-ordination and analysis sub-facility has acted as a holding point for already approved aspects of EIF funding, such as the NSI NRS and pCO2 moorings at Maria Island and Yongala. This sub-facility has also been used during the planning process to host enhancement bids for three new pCO2 moorings and two shelf arrays in Tasmania and Queensland. This growth of an already complex sub-facility makes reporting and budget responsibility difficult. Hence following a decision by the IMOS board on funding these enhancements, consideration would need to be given towards developing sub-facilities with individual budgets and identified leaders for pCO2, Tasmania and South East Queensland.

EXTENSION – NRS co-ordination and analysis

The NRS co-ordination and analysis sub-facility has a national role to fulfil in the system and the IMOS extension will allow the following activities to continue:

1) Host the Facility management
2) Servicing and builds for the Maria Island and NSI sub-surface and telemetry NRS moorings
3) Maintain telemetry at Maria Island and NSI NRS
4) Analysis of Biogeochemical samples from all sites
5) Development of pCO_2 moorings for deployment at Maria and Yongala NRS
6) A light manufacturing run of telemetry systems for 7 NRS sites (excludes Darwin and Yongala where telemetry is being developed by AIMS)
7) Development of ADCP telemetry and other sensors

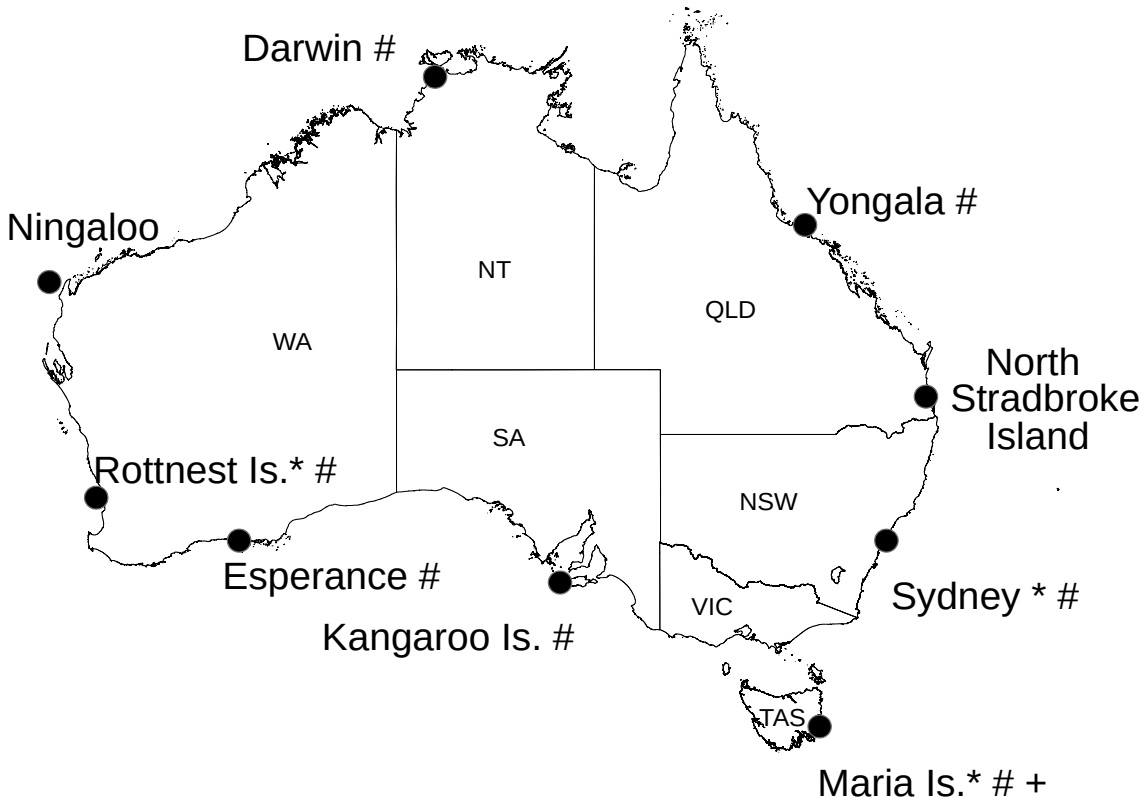

Figure 2. NRS location status 2009, * indicate historical site, # indicates sub-surface mooring infrastructure deployed, + surface telemetry gear deployed

ENHANCEMENT– NRS co-ordination and analysis

Proposed enhancement to the NRS analysis and co-ordination sub-facility include both additional funds to enhance established capabilities, funds required to support proposed enhancements to other areas of IMOS and completely new proposals. The new proposals, if funded, could be developed into sub-facilities.

The enhancements to established capabilities include:

1) An increase in the management and scientific oversight for the facility. This would entail the employment of a project officer to assist in the delivery of infrastructure and a coastal oceanographer - experimental scientist to undertake quality control and assurance of data streams. Both roles would be cost shared with the ABOS facility.
2) A contingency fund to self-insure for gear loss and to account for cost overruns.
3) Operational funds to establish workshops to service IMOS infrastructure at Hobart, Floreat and Cleveland.

The enhancement that is dependent on support of enhancements to other areas of IMOS is:

1) Increased funding for analysis of BGC samples from the Western Australian sub-facility, the NSW sub-facility and the Lucinda Jetty Coastal Observatory.

Enhancements for completely new proposals are:

1) Four new shelf moorings around Tasmania
2) Two shelf moorings as a cross shelf transect offshore from the NSI NRS
3) A pool of 25 bio-optical instruments (WETLabs ECO triplet B with internal Battery, data-logger and eco-wipers) for deployment and hot-swapping at NRS sites.

Carbon and acidification

Originally part of the NRS co-ordination and analysis sub-facility the Carbon and acidification sub-facility will install mooring at NRS on the Australia shelves and on the GBR to form a network for determining changes in ocean CO_2 uptake and acidification in our region. The acidification of surface waters is driven by ocean CO_2 uptake and carbonate chemistry and one of the most significant threats to the health and sustainability of Australia's marine ecosystems in the next few decades, with environmental and economic consequences for Australia. Evidence is already emerging of declines in calcification of tropical and polar marine species, but a lack of data on the changes in carbonate chemistry is making any link to acidification tenuous. The network of moorings, combined with some underway observations in the SOOP program will provide key observations to address this problem.

Each mooring site will be equipped with surface CO_2 systems, using proven and robust technology. Thee sensors will determine surface pCO_2, dissolved oxygen, temperature and salinity. During implementation up-take of servicing responsibilities by regional sub-facilities will be negotiated.

EXTENSION - Carbon and acidification

1) Service the pCO_2 moorings once established, at the Maria Island and Yongala NRS

ENHANCEMENT - Carbon and acidification

1) Deploy and service three new pCO_2 moorings at Port Hacking, Kangaroo Island and Rottnest NRS.

Western Australian

The Western Australian sub-facility manages infrastructure for two NRS (Rottnest and Esperance) and two shelf mooring arrays (Two Rocks and Perth Canyons). These arrays provide data to monitor the variability in the Leeuwin and continental shelf currents both in-terms of along-shore and cross-shore structures as well as how other oceanographic processes, such as upwelling within the Perth Canyon, interact with this boundary current.

A third NRS, Ningaloo, is yet to be deployed and it is proposed that the mooring infrastructure servicing is transferred to the Queensland and Northern Australian sub-facility for management, while the BGC sampling is sub-contracted to the University of Western Australia.

EXTENSION – Western Australia

The extension to the Western Australian sub-facility will include continued operations:

1) Servicing of two NRS sites, at Esperance and Rottnest.
2) Servicing of a shelf mooring arrays of five moorings deployed as a cross shelf transect just north of Perth off Two Rocks.
3) Deployment and servicing of an array of three moorings, which have been designed and built around the Perth Canyon.

ENHANCEMENT – Western Australia

The enhancement of the Western Australian sub-facility involves increased BGC sampling at two NRS (Ningaloo and Esperance). This increase impacts on the NRS analysis and co-ordination sub-facility, and subsequently necessitates additional resources for sample analysis.

1) To enhance the physical sampling rates at the two NRS stations, Esperance and Ningaloo, from 4 times a year to 12 times a year from July-2010 to June 2013.
2) To enhance the capability to hot-swap ADCPs.
3) Introduce telemetry at the NRS sites.
4) A further proposal is to provide enhancement funds for 1 FTE to assist in additional Hydrochemistry, deck work, data handling and sub-facility management.

Queensland and Northern Australia

The Queensland and Northern Australia sub-facility consists of two NRS sites at Yongala and Darwin and four pairs of array moorings located north to south along the Great Barrier Reef (GBR). For the array moorings, each of the 4 pairs has an outer mooring on the continental slope in water greater than 200m and an on-shelf mooring sitting in shallower water around 30-70m deep. Like other ANMN moorings, the array deploys a range of instrumentation including ADCPs and WQMs. Three of the four shelf moorings will also have surface buoys to measure meteorological and radiation observations in real-time. The sub facility's objective is to observe the cross-shelf exchange of water between the Coral Sea and the GBR. Water moving along and onto the GBR will be measured by monitoring the southward flowing EAC and the northward Hiri western boundary current. The moorings located in the southern GBR monitor the strength of currents related to upwelling events detectable on the Capricorn-Bunker Shelf, which supply deep, nutrient-rich water to the reef.

EXTENSION – Queensland and Northern Australia

The extension to the Queensland and Northern Australia sub-facility will include continued operations of the GBR moorings, established in 2007 and the roll out and servicing of the Northern Australian Observing System (NAOS) moorings from 2010.

1) Servicing of two NRS sites, at Darwin and Yongala and developing real time telemetry
2) Servicing of shelf mooring arrays consisting of 4 pairs of outer shelf and slope moorings along the GBR
3) Provision, deployment and servicing of the moorings component of the Northern Australian Observing System comprising:
    a. Arafura and Wessels Mooring pair
    b. Shelf component of the Indonesian Throughflow (ITF) transect (three moorings) in tandem with the BAOS operated deep water components
    c. ITF BAOS instrumentation: 3 ADCPs and 3 PIES

d. Kimberley mooring transect (four)
e. Pilbara mooring transect (three)

4) Service the Ningaloo NRS mooring (transferred from WA CSIRO)

ENHANCEMENT – Queensland and Northern Australia

1) A sea level array in the Torres Strait to determine Arafura and Coral sea exchanges in partnership with Torres Strait Regional Authority

Acoustic Observatories

The Acoustic Observatories sub-facility has deployed arrays of acoustic listening stations that passively record sounds from the ocean. The acoustic loggers have been developed by the Centre for Marine Science and Technology (CMST) over the last 20 years and the stations provide baseline data on ambient oceanic noise, detection of fish and mammal vocalizations linked to ocean productivity, monitoring of multiple species of whales and detection of underwater events. Examples of information available on physical sea noise sources includes: seasonal and climate driven inter-annual changes in rainfall over large ocean areas; calculating the size and propagation speed of seafloor ruptures due to earthquakes; deriving long term trends in seismic activity in subsea fault zones; or monitoring Antarctic ice calving.

Arrays are located in the Perth Canyon in Western Australia, Portland in South Australia and offshore from Sydney, NSW. These sites have been chosen due to their biological interests; for example, the Perth Canyon is a focal feeding area for pygmy blue whales, *Balaenoptera musculus brevicauda*, and the station has now been in operation since 2000. Thus by the end of the proposed sampling period, mid 2013, ten whale seasons, over 14 years, will be available. This particular array is also closely matched to the moorings being deployed in the canyon by the Western Australian sub-facility. This will allow for correlations between the acoustic data on biological processes with oceanographic data.

EXTENSION – Acoustic Observatories

The extension of the sub-facility would allow for the continuation of servicing of the existing passive acoustic moorings. Each acoustic observatory comprises four moorings with sea noise loggers in underwater housings, hydrophones, ORE CART releases and associated mooring gear. The three arrays that are part of the EIF extension are:

1) Perth Canyon acoustic array (WA)
2) Portland acoustic array (SA)
3) Acoustic array (NSW)

ENHANCE – Acoustic Observatories

Three individually budgeted enhancements have been proposed by the Acoustic Observatories sub-facility, these are:

1) Southern Ocean - Provide and deploy two passive acoustic moorings each with single receivers in the southern ocean and along the Antarctic shelf from summer 2010-2011 into summer 2013.

2) Northern Australia - Provide and deploy one passive acoustic observatory for the proposed northern Australian mooring line from mid 2010 to mid 2013.
3) Queensland – provide and deploy one sea noise logger mooring east of Stradbroke Island.

New South Wales

The New South Wales sub-facility is establishing a national reference transect of moorings and measurements off Sydney, which includes all parameters measured by other NRS. Like the NRS sites at Maria and Rottnest Islands, data has been collected for over 70 years at Port Hacking in the south of Sydney. The NRS transect consists of three moorings in 65, 100 and 140m of water and four water sampling stations in 25, 50, 100 and 125m of water in an area downstream from where the EAC typically separates from the coast, and is hence often influenced by EAC eddies. Data collection will support research on the marine ecosystems associated with these eddies and, as the sub-facility is located in the most densely populated area of Australia, issues such as water quality, waste disposal, shipping hazards, harmful algal blooms and recreation are also of particular research interest. The sub-facility has also deployed two moorings across the shelf at Coffs Harbour, upstream of the EAC separation point, and a single mooring at Jervis Bay, south of Sydney. There are also plans to deploy a single mooring in southern NSW waters. The arrays will enhance the ANMN coverage along the coast of south-eastern Australia to provide long term monitoring of the continental shelf oceanography both upstream and downstream of the EAC separation point.

EXTENSION – NSW

The extension relates to the deployment and maintenance of shelf moorings and BGC sampling across the continental shelf offshore from NSW.

1) Continuation of Coffs Harbour moorings CHO70 and CH100.
2) Continuation of the Sydney moorings SYD100 and SYD140.
3) Deployment and continuation of the Sydney NRS moorings PH100.
4) Continuation of the Jervis Bay mooring JB070.
5) Deployment and continuation of the Eden mooring ED100.
6) Continuation of BGC sampling at four sites off Port Hacking.
7) Continuation of in-kind data mooring data (waverider and ORS065) being delivered to IMOS portal.

ENHANCEMENT – NSW

The NSW enhancement bid relates to purchase of hot-swap equipment, introduction of real time telemetry to moored sensor platforms as well as additional moorings and BGC samples.

1) Implementation of real time telemetry at Sydney NRS.
2) Implementation of real time telemetry at CH and JB sites.
3) Augmentation of NRS with a hot swap ADCP for velocity measurements.
4) Augmentation of NRS with bio-optical sensors (Eco-triplet, FRRF).
5) Deployment and maintenance of a single new mooring at Stockton Bight.
6) Augmentation of CH moorings with additional sensors (2x WQMs).
7) Implementation of BGC sampling at Coffs Harbour CH100.

South Australia

The Southern Australian sub-facility is deploying six moorings to monitor the large seasonal coastal upwelling of water that occurs along the continental shelf during summer. This includes a NRS site at Kangaroo Island, located at a convergence point of isobaths to monitor upwelling/outflow events as well as long-term variations in the strength of the coastal current. The array also includes a slope mooring at the 600m isobath to measure the Flinders Current. The Flinders Current is in part driven by the Tasman Outflow, a remnant of the EAC, and also forms a link to the west where it becomes the Leeuwin Undercurrent. Three shelf moorings are located in the path of both upwelling and down elling to measure the alongshore currents and exchange, and the planktonic systems as they evolve towards the St. Vincent and Spencer Gulfs and Eyre Peninsula. An outer shelf mooring examines outflows of saline rich water from coastal gulfs during

Austral winter as well as enhanced upwelling from the du Couedic Canyon. A substantial water sampling program is also undertaken to measure temperature, salinity, nutrients, phytoplankton, viruses and bacteria. The purpose of the sampling and mooring programs is to understand and monitor the boundary/shelf currents and ecosystems of the region.

EXTENSION – SA

The extension relates to the deployment and maintenance of shelf moorings along the coast of NSW.

1) Maintain and service the Kangaroo Island NRS - KAI
2) Maintain and service six slope and shelf moorings: SAM5CB, SAM2CP, SAM8SG, SAM3MS, SAM7DS and SAM4CY
3) Undertake eight 6-day field surveys per annum to measure environmental variables at five biological stations: B01, B02, B03, B05 and KAI

ENHANCEMENT– SA

The SA enhancement bid requests additional instrumented moorings as well as biological sensors to equip existing moorings equipment. There is also a request for an additional 5 FTE to run the program.

1) An additional moorings, SAM3MS, with ADCP, CTD and temperature loggers located on the 200 m isobath off Kangaroo Island to provide additional information on the temporal variability of the Flinders Current and associated thermocline.
2) An additional mooring located off the Bonney Coast to provide vertical information that is to be supplemented by the HF RADAR system that is to be deployed by ACORN by June 2010.
3) An additional 1.0FTE is requested with priority to employ Shaun Byrnes. Shaun is currently funded through a $100K one-off grant from the IMOS office to assist with moorings and gliders as recommended by the mid-term external review.
4) 3 Fast Repetition Rate Fluorometers (FRRFs) and 3 Autonomous Plankton Recorders (APRs) to be placed onto existing KI-Eyre Peninsula region the moorings to determine primary/secondary productivity and carbon cycling.
5) An additional 1.0FTE to service three new FRRF and APR data streams.
6) An additional 2.0FTE is requested for the production of the biological data streams as well as to assist in the production of the molecular data streams from the DNA facilities at Flinders and Adelaide Universities.
7) An additional 1.0 FTE will be needed to assist with the administration, capital acquisition, contracts and reporting.

NCOTS

The National Coastal Time Series (NCOTS) sub-facility is a new proposal to instigate a time-series collection of particulate material relevant to monitoring the biological and geochemical variations of boundary currents. NCOTS seeks to add instrumentation within the vicinity of current NRS and other ANMN shelf mooring array locations. This sub-facility enhancement is for annually serviced sediment traps (Technicaps) and associated instrumentation such as Ecopuk sensors, ARGOS beacons, acoustic releases and thermistors.

NCOTS will represent an addition to the current IMOS study of coastal ecosystems notably from the base of the food chain and with respect to chemical and physical systems. This will provide currently missing data between the physical observations provided by coastal currents and water properties facilities (i.e. ANMN) and largely distribution based coastal ecosystem facilities (i.e. AATAMS, AUV, AusCPR).

ENHANCEMENT – NCOTS

The proposed NCOTS enhancement is for two new IMOS funded moorings in NSW and SA and additional equipment for a proposed CMAR mooring in Western Australia. To operate the sub-facility 1.5 FTE are requested.

1) Additional NSW-IMOS sediment trap mooring – PH 400.
2) Enhancement to the SAIMOS sediment trap mooring – SAM7DS.
3) Enhancement to a proposed CMAR sediment trap mooring in Western Australia – located near the existing WAIMOS Two Rocks 200.
4) 1 FTE Technical officer.
5) 0.5 FTE electronics technician.

Access, pricing regimes

How will access be provided

An ANMN and IMOS principle is free access to data. All ANMN data will flow through the IMOS portal managed by eMii. Data from all asset groups will be provided both for telemetry and download of delayed data in a timely and reasonable manner.

How will data be managed

Data management will be the joint responsibility of eMii, and the sub-facilities. For many aspects of the data streams identical software (matlab toolbox and deployment database) run in parallel to provide a continual backup of the processing, data delivery and QC of telemeter data. Delayed mode QC, in which the data are subjected to a thorough check, can only be done every 3-6 months after a mooring is serviced. This will be handled by individual sub-facilities and the data delivered to eMii, ensuring that all of our mooring data is of the highest quality. Additional resources are being sought to ensure that QC and QA are of a high international standard.

Dependencies on external / other facilities (national and international)

Funding is complex with NCRIS, the initial EIF funds and the next round of EIF funds being split between extension and enhancement budgets. In particular bridging finance for the 2010/11 financial year for the initial EIF funds will be sort under the extension funding model as special extension funding. Individual sub-facility plans also have a variety of external dependencies with the numerous collaborating organisations.

Collaborative structures for allocation of priorities

The design of ANMN is the result of a national, collaborative process via the sub-facility leaders of the network and input from regional nodes. National coordinating meetings for the facility are held twice a year between representatives of CSIRO, AIMS, SARDI, Curtain University and SIMS to ensure that national priorities, such as effective coverage to feed into models, are met. This project is also overseen by the IMOS office.

Governance

Performance indicators

Performance indicators for the existing infrastructure are provided in the IMOS ANMN facility report 2008-9. Additional performance indicators are provided in individual sub-facility plans.

Describe key risks and risk management strategies

The following key risk and mitigation strategies are for facility wide issues. More detailed risk management is provided in chapter form for the various sub-facilities and in the initial EIF project proposal. Issues raised in the 2008 IMOS Review were addressed in the IMOS ANMN facility report 2008-9.

Risk 1 – Project management of sub-facilities

Delivery of infrastructure and management of projects require considerable FTE. During the first two years of NCRIS funding there was a mismatch between expectations and delivery. This resulted in several milestones being missed for the WA, NA & QLD and NSW sub-facilities. The risk is that sub-facilities will over-commit and under-deliver on milestones.

There are no position descriptions of either facility of sub-facility leadership roles. As IMOS is designed to be on-going this lack of explicitness increases the risk of project failure following staff turn-over particularly at a facility leadership level.

Mitigation strategy 1a – Project management of sub-facilities
The management overhead of sub-facility leaders should be made explicit. Operators of individual sub-facilities will budget to provide either in-kind or costed support of 0.2-0.3 FTE to account for expected sub-facility management work load.

Mitigation strategy 1b – Project management of sub-facilities
An FTE analysis model was developed for the WA sub-facility. This outlines FTE requirements for mooring preparation, deployment, recovery and servicing. This model will be made available to test expectations against proposals.

Mitigation strategy 1c– Project management of sub-facilities
The ANMN facility leader will develop position descriptions for a sub-facility with the operators and sub-facility leaders, for endorsement by the IMOS office. This will help develop an understanding of what the required commitment by operators and sub-facility leaders are to an ongoing program and also allow for more seamless staff turn-over.

Risk 2 - Conflicts of interest

There are two conflicts of interests that impact the ANMN Facility.

a) Some individuals are both node and facility or sub-facility leaders, which limits the availability of individuals to contribute to planning or reporting.
b) The ANMN Facility leader's organisational job as CMAR mooring manager has already resulted in prioritisation conflicts between the ANMN and other facilities such as SOTS which rely on the same resources.

Mitigation strategy 2a - Conflicts of interest
The ANMN will request from operators that facility and sub-facility leaders are not also node leaders.

Mitigation strategy 2b - Conflicts of interest
The CMAR mooring team will develop two units one for deep water work and the other for coastal work. Co-ordination of the units will be assisted by the NRS co-ordination and analysis project officer who will be jointly funded by ANMN and the deepwater mooring sub-facility.

Risk 3– Operational vs. research infrastructure

There is a risk that telemetry streaming will produce the perception that the facility is an operational rather than research infrastructure. Operational infrastructure guarantees continuous service provision, which demands significantly more resources.

Mitigation strategy 3 – Operational vs. Research infrastructure
The ANMN will ask eMii to produce a disclaimer that all telemeter data streams are research infrastructure with explanations of the limitations of this funding model.

Risk 4 – Loss of gear and cost over-runs

Attrition of gear is ongoing and there is no formal mechanism to report gear loss through the facility. This risk increases at identified sites, which have a higher incident of fishing or boating interactions. During the first two years of NCRIS funding a $700,000 contingency fund was depreciated completely due to lost gear and cost over-runs.

Mitigation strategy 4a – Loss of gear and cost over-runs
A contingency fund will be requested as part of EIF enhancement, to self insure from 2010-2013 and as part of the EIF extension.

Mitigation strategy 4b – Loss of gear and cost over-runs
Risky sites will be identified and will not be self insured under the contingency fund.

Mitigation strategy 4c – Loss of gear and cost over-runs
All gear lost or samples over $40,000 will require a report detailing the type, date and location to the Facility.

Other risks

A final risk, of gear depreciation was identified. As IMOS is designed to be ongoing there is a known gear depreciation issue with life spans of deep water gear being 10 years and coastal gear being less at 5 years. IMOS policy is that it won't fund depreciation, which is for the Operators to manage. IMOS will however fund capital cost, to rollover the asset base on an appropriate life cycle. This risk, however, requires additional consideration outside the scope of this facility proposal

Summary Budget

Individual NCRIS/EIF, Extension and Enhancement budgets are provided for each sub-facility in chapter form with details for capital, salaries and operating. A combined budget for the entire facility extension and enhancement follows.

Description of proposed new infrastructure for Nodes is provided in each sub-facility chapter.

IMOS Integrated Marine Observing System

ANMN Facility budget - NCRIS and EIF extension

Extension of existing NCRIS Facility (*Note 1*)

NCRIS/EIF Funding (*Note 2*)		2009/10 (NCRIS/EIF)	2010/11 (NCRIS/EIF)	2011/12 (EIF)	2012/13 (EIF)	Total (NCRIS+EIF)
Capital						
NRS		914,477	30,000	378,560	393,702	1,716,739
NRS - Special			240,666.00			240,666
pCO2			70,000			70,000
WA		207,868	449,956	369,463	384,241	1,411,528
QLD		2,111,596	577,450	0	0	2,689,046
AO		0	276,225	0	0	276,225
NSW		50,000				50,000
SA		359,781	71,174	108,000	108,000	646,955
						0
Salaries	see detailed plans					0
NRS		626,200	537,061	754,386	792,106	2,709,753
NRS - Special			181,402.00			181,402
pCO2			168,861	177,304	186,169	532,334
WA		209,845	269,917	369,768	388,256	1,237,786
QLD		122,553	313,736	869,951	898,400	2,204,640
AO		0	0	111,038	114,369	225,407
NSW		149,756	163,926	203,183	211,089	727,953
SA		289,880	206,848	212,013	219,189	927,930
						0
Operating						0
NRS		222,961	153,022	588,906	612,462	1,577,351
NRS - Special			265,576.00			265,576
pCO2			85,000	88,400	91,936	265,336
WA		135,000	214,192	251,778	261,850	862,820
QLD		542,850	1,298,908	3,022,505	3,110,180	7,974,443
AO		83,717	0	111,038	114,369	309,124
NSW		482,200	576,200	652,124	661,586	2,372,110
SA		179,825	170,796	229,834	260,978	841,433
	NCRIS/EIF Funding Total	**6,688,509**	**6,320,916**	**8,498,251**	**8,808,882**	**30,316,557**

Cash Co-investment (*Note 3*)		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Total**
NRS		579,963	497,406	698,685	733,619	2,509,673
NRS - Special			168,008.00			168,008
pCO2 - CSIRO	Staff time - high		156,393	164,213	172,423	493,029
WA - CSIRO	In-kind for salaries for operators (provisional)	194,351	249,987	342,465	359,589	1,146,392
WA -CSIRO	In-kind for salaries for managements (confirmed)	100,000	100,000	100,000	100,000	400,000
AO - Cutin Univerity	Staff time - high	156,000	156,000	156,000	156,000	624,000
SA - SARDI	Cash, Provisional	2,500	2,500	2,500	2,500	10,000
SA - Flinders University	Cash, Provisional	2,500	2,500	2,500	2,500	10,000
NSW - UNSW	Salary Contribution Roughan 0.25 FTE - Confirmed	32,000	33,000			65,000
NSW - SIMS	Salary Contribution Scognamiglio 0.175 FTE - confirmed	15750	14000	17500	17500	64,750
	Cash Co-investment Total	**1,083,064**	**1,379,794**	**1,483,863**	**1,544,131**	**5,490,852**

In-kind Co-investment (*Note 3*)		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Total**
pCO2 - CSIRO	Co2 and O2 calibration and set up - high		20,000	20,000	20,000	60,000
Cutin Univerity	use of vehicles/facilitys - confirmed		35,000	35,000	35,000	105,000
SARDI	Ship-Time (20-days), Provisional	60,000	60,000	100,000	120,000	340,000
SARDI	Salary, John Middleton (0.5, 0.4, 0.3, 0.3FTE)	81,900	65,907	50,915	52,443	251,165
SARDI	Salary, Paul van Ruth (0.2 FTE)	20,409				20,409
Flinders	Salary, Louise Renfrey (1.0 FTE),Provisional	87,000	89,610	92,298	95,067	363,975
Flinders	Salary, Shaun Byrnes (0.25 FTE) Provisional	4,875				4,875
Flinders	Salary, Laurent Seuront (0.05 FTE), Provisional	8,400	8,652	8,912	9,179	35,143
Flinders	Operating, (Leterme&Seuront lab costs)	10,260	10,260	10,260	10,260	41,040
SARDI	Capital, Provisional	17,000	17,000	17,000	17,000	68,000
SARDI	Operating, Provisional	26,400	26,400	26,400	26,400	105,600
All	Salary Overheads 30%	60,775	49,251	45,638	47,007	202,670

	nominal					
SIMS	Boat usage 1 per month ($1500 per day) -Confirmed	18,000	18,000	18,000	18,000	72,000
Sydney Water Corp (SWC)	Ocean Reference Station Data -Confirmed	250,000	250,000	250,000	250,000	1,000,000
NSW DECCW	NRS Sampling - Highly Likely	12,000	12,000	12,000	12,000	48,000
NSW DECCW	Waverider Buoy Data - Highly Likely	700,000	700,000	700,000	700,000	2,800,000
NSW DECCW	Coastal Data - Provisional	460,000	460,000	460,000	460,000	1,840,000
AIMS	NAOS Vessel	300,000	750,000	927,000	954,810	2,931,810
AIMS	NAOS Salary overheads	122,553	313,736	390,050	401,752	1,228,091
AIMS	Q-IMOS Salary overheads			343,588	355,564	699,152
AIMS	Yongala NRS			51,379	53,178	104,557
AIMS	Darwin NRS			84,934	87,906	172,840
	In-kind Co-investment Total	**2,239,572**	**2,885,816**	**3,643,373**	**3,725,566**	**12,494,327**
	TOTAL Resources	**10,011,146**	**10,586,526**	**13,625,487**	**14,078,578**	**48,301,737**

ANMN Facility budget - EIF enhancement

Enhancement to Facility / New Facility (*Note 1*)

NCRIS/EIF Funding (*Note 2*)	**2010/11** (EIF)	**2011/12** (EIF)	**2012/13** (EIF)	**Total** (EIF)
Capital				
NRS	1,369,630	356,180	204,090	1,929,900
pCO2 - NRS	880,000			880,000
WA	798,267	316,000		1,114,267
QLD	150,000	152,000	153,000	455,000
AO - Sth Ocean	170,357			170,357
AO - Nth A	106,260			106,260
AO - Brisbane	25,565			25,565
NSW	360,421	680,351	216,471	1,257,244
SA	535,401	9,200	9,200	553,801
NCOTS	539,840	54,113	51,038	644,991

Salaries	see detailed plans				
NRS		663,417	696,288	731,502	2,091,207
pCO2 - NRS		213,513	270,074	276,077	759,664
WA		101,125	106,181	111,490	318,796
QLD					0
AO- Sth Ocean		151,433	52,419	52,419	256,271
AO - Nth A		93,537	21,652	21,652	136,841
AO - Brisbane		19,574	12,294	12,294	44,162
NSW					0
SA		452,713	485,701	516,551	1,454,965
NCOTS		166,280	118,426	86,941	371,647
					0
Operating					0
NRS		228,700	240,948	252,046	721,694
pCO2 - NRS		135,000	140,400	146,016	421,416
WA		267,200	277,888	289,004	834,092
QLD					0
AO - Sth Ocean		6,831	6,831	6,831	20,493
AO - Nth A		15,550	31,100	31,100	77,750
AO - Brisbane		15,714	31,428	31,428	78,570
NSW		22,200	275,000	282,200	579,400
SA		216,360	219,160	220,729	656,249
NCOTS		25,000	25,000	25,000	75,000
	EIF Funding Total	**7,729,888**	**4,578,634**	**3,727,079**	**16,035,602**

Cash Co-investment (*Note 3*)		**2010/11**	**2011/12**	**2012/13**	**Total**
NRS - CSIRO	NRS, TAS and SEQ - Overheads & facilities - likely	497,736	522,622	548,753	1,569,111
NRS CSIRO	Bio-optics labour overheads, highly likely	114,000	120,000	126,000	360,000
pCO2 CSIRO - NRS	salaries (confirmed)	197,750	140,400	146,016	484,166
WA CSIRO	salaries (provisional)	93,658	98,341	103,258	295,257
AO - Sth_AAD	salaries (provisional)	28,194	28,736	29,295	86,225
AO -Sth -AAD	salaries (provisional)	66,667	68,667	70,727	206,061
AO - Sth -Curtin Uni	salaries (provisional)	13,000	13,000	13,000	39,000
AO - Nth - Curtin Uni	salaries (provisional)	39,000	39,000	39,000	117,000
AO - Bris - Curtin Uni	salaries (provisional)	16,800	16,800	16,800	50,400
NSW - SIMS	Coastal oceanography equipment 40% -Confirmed	220,000			220,000
NSW - SIMS	Oceanography Lab and		40,000		40,000

	Workshop				
NCOTS- SIMS	(17.5% salary, confirmed)	24,000			24,000
NCOTS- SIMS	(17.5% salary, provisional)		30000	30000	60,000
NCOTS- SIMS	(Facility, confirmed)	29750			29,750
NCOTS- SIMS	(Facility, provisional)		17500	17500	35,000
	Cash Co-investment Total	**1,340,555**	**1,135,066**	**1,140,349**	**3,615,970**

In-kind Co-investment (*Note 3*)		**2010/11**	**2011/12**	**2012/13**	**Total**
NRS	CMAR equipment - Tas shelf moorings	132,390	37,826	18,913	189,129
pCO2 CSIRO - NRS	Calibration of PCO2 and O2	20,000	20,000	20,000	60,000
AO - Sth O - Curtin Uni	vehicles and infrastrucure	35,000	35,000	35,000	105,000
AO - Nth - Curtin Uni	vehicles and infrastrucure	16,000	16,000	16,000	48,000
AO - Bris - Curtin Uni	vehicles and infrastrucure	5,500	5,800	6,000	17,300
SA-SARDI	Salary, Paul VanRuth (0.2 FTE), Provisional	21,635	22,644	23,313	67,592
SA-SARDI	Salary, Mark Doubell (0.1 FTE)	10,817	11,322	11,656	33,795
SA-SARDI	Salary, Laura Richardson (0.15 FTE)	11,700	12,051		23,751
SA-Flinders	Salary, Luciano Beheregaray (0.1FTE)	18,750	18,750	18,750	56,250
SA-Flinders	Salary, Post-Doctoral fellow(0.5FTE)	32,000	33,000	34,000	99,000
SA-Flinders	Operating (Use of Aanderaa Data Buoy)	20,000	20,000	20,000	60,000
SA-Flinders	Operating (FUSA molecular facility)	53,000	53,000	53,000	159,000
SA-UoA	Salary, Alan Cooper (ACAD)	34,800	34,800	34,800	104,400
SA-UoA	Operating, (Ancient DNA Lab)	47,200	47,200	47,200	141,600
SA-ANU	Salary, Michael Ellwood (0.01 FTE)	1,192	1,192		2,384
SA-Queens University	Salary, Kurt Kyser +Noel James (0.01 FTE)	1,561	1,561		3,122
SA-Queens University	Operating (isotope Facility)	19,800	19,800		39,600
SA-All	Salary Overheads 30% nominal	39,737	40,596	36,756	117,088
NCOTS - NSW - UTS	Doblin/Ralph 0.05 FTE x 1.3 - confirmed	10,000	10,000	10,000	30,000
NSW - NSW - UTS	Doblin/Ralph 0.05 FTE x 1.3 - confirmed	10,000	10,000	10,000	30,000
NSW - UNSW - ADFA	H.Wang 0.2 FTE x1.3 - confirmed	26,000	26,000	26,000	78,000

NSW - UNSW - ADFA	C Symons 0.2 FTE x1.3 - confirmed	21,000	21,000	21,000	63,000
NSW - UNSW - ADFA	R Lawson 0.05 FTE x1.3 - confirmed	5,000	5,000	5,000	15,000
NSW - UNSW - ADFA	RDI ADCP	40,000			40,000
NCOTS - Macquarie University	(LA salary 0.2FTE 1.3 mult. confirmed)	27,300	27,300	27,300	81,900
NCOTS - Macquarie University	(FlowCam analyses, confirmed)	10,000	10,000	10,000	30,000
NCOTS - Macquarie University	(PhD student scholarship, confirmed)	32,800	32,800	32,800	98,400
NCOTS - SIMS	(Sediment trap for hot swapping NSW, highly likely)	27,000			27,000
NCOTS - CMAR	(Sediment trap at Two Rocks, confirmed)	27,000			27,000
NCOTS - SAIMOS	(mooring wire/term.)	1,600			1,600
NCOTS - UNSW	(MR salary 0.05 FTE 1.3mult. highly likely)	7,000	7,000	7,000	21,000
NCOTS - UTS	(MD salary 0.05 FTE highly likely)	7,000	7,000	7,000	21,000
NCOTS - CMAR	(PT salary 0.05 FTE 1.3mult. potential)	10,000	10,000	10,000	30,000
TSRA	Torres Strait Sea Level Array, Provisional, Medium	1,000,000			1,000,000
AIMS	Salary overheads	50,000	52,000	53,000	155,000
(enter Organisation)	(insert description, including likelihood)				
	In-kind Co-investment Total	**1,832,782**	**648,642**	**594,488**	**3,075,911**
	TOTAL Resources	**10,903,225**	**6,362,342**	**5,461,916**	**22,727,483**

IMOS Integrated Marine Observing System

Sub-facility proposals

National Reference Stations co-ordination and analysis

Call for Proposals under the IMOS (EIF) Five Year Strategy: Enhancement or extension of IMOS – July 2009 to June 2013

Facility Project Plan template

Proposals should be submitted by 30 October 2009 to:
Tim Moltmann, IMOS Director, University of Tasmania
email: tim.moltmann@imos.org.au

Background:

Overview:

Proposed Infrastructure Investment:	Facility management, R&D, MAI and NSI NRS, BGC processing, pCO2 moorings, TAS and SEQ shelf moorings and bio-optics
IMOS Sub-facility:	National Reference Stations - Coordination & Analysis
Operating Institution:	CSIRO Marine and Atmospheric Research
Facility Leader (for this Proposal):	David Hughes, David Terhell
Other(s) key people involved:	Tim Lynch, G. Critchley; P. Bonham, John Middleton (SARDI), Vittorio Brando (CSIRO), Ming Feng (CSIRO), Moninya Roughan (SIMS and UNSW), Rob McCauley (Curtin University), Craig Steinberg (AIMS), Anthony Richardson (CSIRO and UQ), Bronte Tilbrook (CSIRO), Peter Thompson (CSIRO), Leanne Larmand (Macquarie University), Vittorio E. Brando
Collaborating Institutions:	South Australian Research and Development Institute (SARDI), Commonwealth Science and Industry Research Organisation (CSIRO), Sydney Institute of Marine Science (SIMS), Curtain University, Australian Institute of Marine Science (AIMS), University of Queensland (UQ), NSW-Department of Climate Change and Water (DECCW), DERM, Dekker, Daniel, CLW Canberra, Clementson, CMAR Hobart, Lynch, Fearns, CUT, Perth

Nature of Investment:

The National Reference Stations - Coordination & Analysis sub-facility has multiple roles within the ANMN:

1) It hosts the Facility leader and the contingency budget for self insurance of capital and unbudgeted cost over-runs

2) It has a strong research and development and with the Maria Island National Reference Station which the facility services and has been used as a test bed for the national system. Systems being developed include pCO_2 moorings, satellite telemetry, sensors and mooring systems.

3) The sub-facility undertakes analysis of most of the biogeochemical samples from the nine National Reference Sites (NRS) at the CMAR Hobart, Cleveland and Floreat laboratories.

4) The sub-facility also services the Maria Island and North Stradbroke Island (NSI) NRS. Servicing and budget responsibility for all other NRS are with regional sub-facilities (eg Rottnest NRS is serviced by the Western Australian sub-facility).

The sub-facility also acts as a holding company for new proposals, such as the NSI NRS and pCO_2 moorings, that may develop over time into their own sub-facilities. This sub-facility has also been used during the planning process to host enhancement bids for two shelf arrays in Tasmania and Queensland.

While the sub-facility services the Maria Island and North Stradbroke Island NRS, servicing and budget responsibility for moorings and BGC sampling for all other NRS are with regional sub-facilities (eg Rottnest NRS is serviced by the Western Australian sub-facility).

The nine stations which the NRS sub-facility services for BGC sample processing and R&D, build on three existing sites where monthly water quality data have been collected since the 1940s (See Fig. 2 in the ANMN facility plan). The three established stations, off Sydney, Rottnest Island and Maria Island, provide the only long-term data sets of physical (temperature, salinity) and chemical (nitrate, nitrite, phosphate and silicate) properties of the water column around Australia. Prior to IMOS, the stations had no permanent moorings, simply being waypoints where water samples were taken. The inclusion of moored instrumentation and monthly biological sampling for phytoplankton, zooplankton and other data streams at each NRS is a significant upgrade to the three historical sites. The addition of six new sites now provides a sparse but nationally cohesive monitoring network. Investment in moored instrumentation will allow fine temporal observations of short-term physics and chemistry and provide the context to interpret the monthly biological (plankton) sampling.

As it is most efficient if data sets are examined in concert each NRS is a multidisciplinary, long-term, monitoring sites, where data are collected for oceanographic, meteorological, hydro-chemical and biological phenomena. In situ and monthly physical sampling will allow wide-scale validation of sea surface temperature and phytoplankton biomass to provide a national set of calibration sites for remotely sensed chlorophyll and permit more intense process studies, located near the NRS, to be viewed in a broader (time and space) context. Expanded types, intensities and improved accuracy of the data collected will result in an increased understanding of changes in coastal water properties and how it interacts with marine biological productivity and diversity. Ultimately, the NRS will provide a baseline to assess the impact of natural and anthropogenic changes to the marine environment at a synoptic scale, to help policy makers ensure the sustainability of Australian coastal ecosystems and related fisheries

Implementation Strategy:

Summary

While the initial EIF funds are included in the NRS co-ordination and analysis budget for extension and enhancement their implementation are considered in the separate already submitted plan.

The Maria Island NRS is the most heavily instrumented NSR sites. It will be the first site to have all four moorings types:

1) Sub-surface Wetlabs water quality meters (WQM) moorings
2) Surface, wave height, SST, weather station and telemetry float
3) Sub-surface ADCP mooring
4) pCO2 mooring

The implementation of the Maria Island NRS begun with deployment of sub-surface moorings, which host the WQMs. The second step has been development of the telemetery systems. The third and fourth step, approved as part of the EIF 2009-10 allocation, will occur in the in 2010.

The Maria site also has a strong record for the extended IMOS monthly water sampling program and will continue to process samples for the nine existing sites and, as required, from enhancement proposals.

The NSI NRS will be a fully-configured real-time system located slightly south of the present NRS site into 67 m of water where it will sit next to a wave rider buoy operated by DERM. This feature is well known to fisherman and should minimise the likelihood of trawl damage. Investment in the moored instrumentation will allow fine temporal investigation of short-term physics and nutrients and provide the context to interpret the monthly biological (plankton) sampling.

The mooring will include Wetlabs instrument packages at two depths with sensors for salinity (conductivity), temperature, dissolved oxygen, chlorophyll and turbidity. In addition, it will have a sensor for photosynthetic available radiation (PAR) and an Acoustic Doppler Current Profiler (ADCPs) for currents. Data from the NRS will be linked to a proposed enhancement of a pair of shelf moorings (200 m and 400 m) along a transect off Brisbane. This array will provide data on the strength and variability of the East Australia Current (EAC) where it is strongest and most coherent off Southeast Queensland.

One further proposal is to Enhance bio-optical observations at the NRS moorings to ensure national consistent Ocean Colour Calibration and Validation from late 2010 to mid 2013

- **Objectives**

The NRS thus has three main objectives:

1) Monitor Boundary Currents – The NRS will provide a sparse but consistent dataset observing conditions across Australia boundary currents into which local studies can be placed with increase confidence and remote sensing calibrated.

2) Observe marine biodiversity –Phytoplankton and zooplankton data will be used to describe the species present, their abundance, and seasonal cycles.

3) Interpret climate variability as a window on ecological change – Plankton population dynamics is intimately linked to its physical and chemical environment. An understanding of this link between ocean physics and plankton dynamics, particularly how populations

change seasonally, can provide a window into how climate change may influence coastal ecology.

The geographical spread of these sites and their locations allow the NRS to be an intrinsic part of the backbone of IMOS. *Insitu* moored sensors and monthly biogeochemical sampling allows by the expansion of the data types, intensities and improved accuracy of the data collected will result in an increased understanding of changes in coastal water properties and how it interacts with marine biological productivity and diversity. Ultimately, the NRS will provide a baseline to assess the impact of natural and anthropogenic changes to the marine environment at a synoptic scale.

Additionally, these NRS sites can be utilised for the incorporation of additional instrumentation or sampling to enhance the whole-of-system approach which is already substantially met.

The inclusion of observations of marine biodiversity by the inclusion of detailed phytoplankton and zooplankton data will be used to describe the species composition, abundance, and the seasonal cycles in these. The interpretation of seasonal climate variability can be utilised as a window on ecological change and any long term shifts or changes will provide a strong basis for interpretation of how this may allow us to forecast change in plankton biodiversity and dynamics – due to the intimate linkages between these populations and the physical and chemical environment; and thus into how climate change may influence coastal ecology in the Australian region.

BGS - analysis

The geographical spread of the NRS sites for biogeochemical sampling regime, by their very nature, brings together a host of participating organisations nationwide – from CSIRO through many other Federal, State and University bodies. The sampling strategy was developed in a very collaborative manner – refer to: http://imos.org.au/facility_manuals.html - IMOS NRS NATIONAL REFERENCE STATIONS BIOGEOCHEMICAL OPERATIONS - A PRACTICAL HANDBOOK

Although our budget submission is for extension and enhancement of the IMOS-NRS sites of [MAI] and [NSI] it also includes the full costing for the analytical components of all sites for full, comprehensive and comparative analyses. It also accounts for bearing the anticipated increase in requests for new and/or enhanced sample throughput for the equal treatment of samples from all sites as we have factored in the analytical and data handling cost estimates that we have been informed of via the Node NRS (plus) requests.

Currently, research into phytoplankton and zooplankton in Australian waters is limited; the only ongoing zooplankton time series time series are as part of IMOS, and there are few phytoplankton time series. The phytoplankton and zooplankton components of the IMOS National Reference Stations has helped rectify this situation.

Data from the plankton observing system within IMOS will be a springboard to a diverse range of applied research including:

1) Marine Biodiversity – 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 zooplankton, or abundance of zooplankton. Australia has international obligations to preserve its biodiversity and the minimum responsibility is an inventory of the species present.

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) Biogeochemical/Ecosystem Model Development. Data on phytoplankton and zooplankton are needed to initialise and validate nutrient, phytoplankton and zooplankton (NPZ) models. These models are used to understand ocean productivity. Such data, especially on zooplankton, is unavailable in Australia.

4) Remote sensing. Species-level phytoplankton data aid validation of remote-sensing products, and development of algorithms for identification of functional types and estimation of primary production.

5) 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.

6) Fisheries Oceanography. Phytoplankton and zooplankton are food sources for almost all species of fish larvae, so the present data will be useful for many commercially-exploited and recreational fish species.

7) 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. Biochemical data on RNA:DNA ratios will provide estimates of zooplankton growth rates.

8) Long-term baselines – The intention is to continue sampling plankton at the National Reference Stations into the future to 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.

Southeast Queensland

As the EAC is most intense and coherent off SEQ it is thus a key location to monitor EAC dynamics. SEQ is the location of the “head” of the EAC, and because of its strength here, the dynamics of EAC flows in this area are important to the understanding overall EAC variability. Presently, there is considerable interest from commercial companies to generate renewable power using huge ocean turbines driven by the strong and consistent EAC flow off Brisbane. Because many eddies in the EAC, important to fisheries productivity and weather both in SEQ and NSW, are initiated in SEQ, a better understanding of the eddy dynamics in SEQ is a key area for parameterising physical models such as BlueLink.

As the EAC plays a dominant role in transferring Pacific Ocean heat into a region of active cyclone genesis, a better understanding of the EAC should enable more accurate predictions of cyclone activity. Further, warm core gyres of the EAC have the potential to intensify low pressure weather systems off the coast, with destructive consequences. To the west of the EAC, coastal counter currents, largely wind-driven, frequently prevail, with important consequences for processes such as sand transport. These are especially strong when south-easterly winds combine with swells that also produce northward flowing coastal currents. There are therefore a series of interactions with features of the EAC which will impact strongly on the southeast Queensland region.

For the above reasons an array of 3 moorings across the shelf from the coastal NRS (67m) to the shelf break (200m and 400m) will provide an opportunity to monitor the EAC flows and cross shelf interactions.

- **Major Activities and major parties involved**

For both extension and enhancement the major parties for management and mooring R&D include all of the ANMN sub-facility operators and leadership teams. These include South Australian Research and Development Institute (SARDI), Commonwealth Science and Industry Research Organisation (CSIRO), Sydney Institute of Marine Science (SIMS), Curtain University, Australian Institute of Marine Science (AIMS), University of Queensland (UQ), NSW-Department of Climate Change and Water (DECCW). The major parties involved in the biogeochemical data being produced from these sites are CMAR (for some sampling, all of the analyses, metadata production and data archival), AIMS, SARDI, Flinders University, University of NSW, NSW DECCW.

Two other IMOS facilities, Satellite Remote Sensing (SRS) and the proposed Australian Bluewater Observing Sites (ABOS) will potentially have a major involvement with the NRS co-ordination and analysis sub-facility if there enhancement bids are successful.

EXTENSION – NRS co-ordination and analysis

The NRS co-ordination and analysis sub-facility has a national role to fulfil in the system and the IMOS extension will allow the following activities to continue:

1) Host the Facility management
2) Servicing and builds for the Maria Island and NSI sub-surface and telemetry NRS moorings
3) Maintain telemetry at Maria Island and NSI NRS
4) Continuation of the existing biogeochemical operations, relating to the current National Reference Stations – from sample collection, through analyses to data warehousing.
5) Development of pCO_2 moorings for deployment at Maria and Yongala NRS
6) A light manufacturing run of telemetry systems for 7 NRS sites (excludes Darwin and Yongala where telemetry is being developed by AIMS)
7) Development of ADCP telemetry and other sensors

The position for the fulltime electronics technician to service the NSI NRS to be based at CSIRO Marine and Atmospheric Research is currently being advertised. That person will play a major role in the establishment and maintenance of the NRS mooring. We have budgeted for a ship of sufficient size (e.g., PNG Pride based in Gladstone) to deploy and service the mooring.

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ENHANCEMENT– NRS co-ordination and analysis

This growth of an already complex sub-facility makes reporting and budget responsibility difficult. There are also strong concerns over quality control and assurance and scientific direction for the sub-facility. Unlike other sub-facility's the NRS co-ordination and analysis sub-facility does not have access to a coastal oceanographer PI.

Proposed enhancement to the NRS analysis and co-ordination sub-facility include both additional funds to enhance established capabilities, funds required to support proposed enhancements to other areas of IMOS and completely new proposals. The new proposals, if funded, could be developed into sub-facilities.

The enhancements to established capabilities include:

1) An increase in the management and scientific oversight for the facility. This would entail the employment of a project officer to assist in the deliver of infrastructure and a coastal oceanographer - experimental scientist to undertake quality control and assurance of data streams. Both roles would be cost shared with the ABOS facility
2) A contingency fund to self insure for gear loss and to account for cost overruns.

3) Operational funds to establish workshops to service IMOS infrastructure at Hobart, Floreat and Cleveland.

The enhancement that is dependent on support of enhancements to other areas of IMOS is:

To account for the extra analyses and provision of biogeochemical data from enhancement bids from the Western Australian sub-facility, the NSW sub-facility, the Lucinda Jetty Coastal Observatory and NAOS increased funding for analysis of BGC samples is sort.

Enhancements for completely new proposals are:

1) Four new shelf moorings around Tasmania The Tasmanian Moorings: from the NRS at Maria Island east across the shelf and slope (200m, 500m , 1000m) that transect the shelf + one additional mooring (100m) south of Storm Bay (Fig. 1-5 and Table 1).
2) Two shelf moorings as a cross shelf transect offshore from the NSI NRS (Fig. 6)
3) Provide bio-optical observations from Australian waters from a pool of 25 bio-optical instruments (WETLabs ECO triplet B with internal Battery, data-logger and eco-wipers).

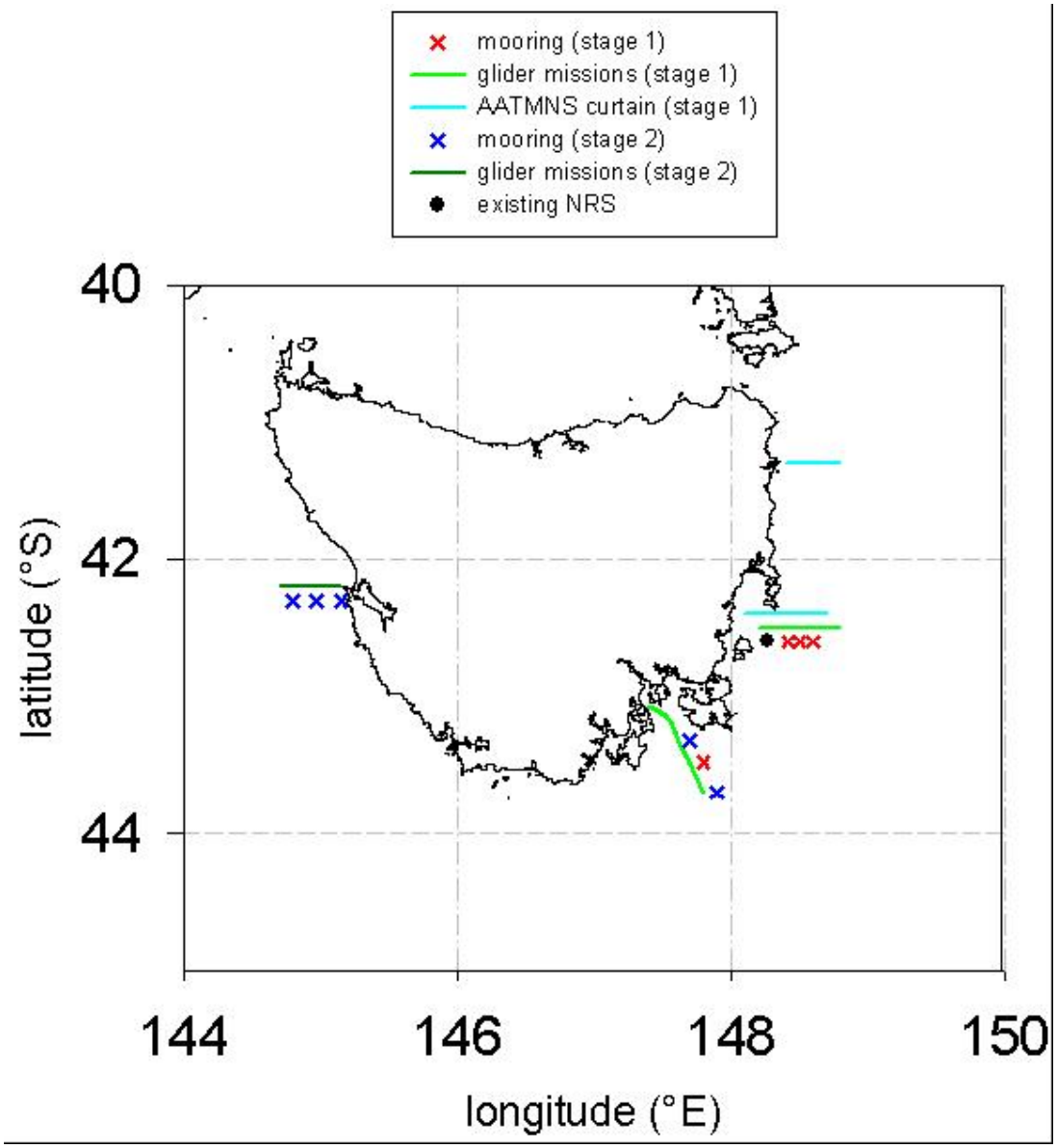


Figure 1. The existing National Reference Station (NRS) proposed mooring deployments, AATMS curtains and glider missions in stage 1 (2011 to 2013) and proposed for stage 2 (> 2013

Table 1. Estimated capital costs for Tasmania moorings.

200m mooring east coast			From facility	CMAR contribution
Item	*quant*	*$*		
IMOS sub surface float	1	$1,850.00	$1,850.00	
Seabird SBE39/clamsp/cable	8	$1,350.00	$10,800.00	
Wetlabs WQM	1	$37,906.00		$37,906.00
PAR sensor for above	1	$7,470.00		$7,470.00
ADCP	1	$36,000.00	$36,000.00	
other components to build: shackles, line, swivels, cable, anchor	1	$2,500.00	$2,500.00	
CART release	2	$8,500.00		$17,000.00
Sub-Total			$51,150.00	$62,376.00

500m mooring east coast			From facility	CMAR contribution
Item	*quant*	*$*		
IMOS sub surface float	1	$1,850.00	$1,850.00	
ADCP	1	$36,000.00	$36,000.00	
other components to build: shackles, line, swivels, cable, anchor	1	$3,000.00	$3,000.00	
CART release	2	$8,500.00	$17,000.00	
Sub-Total			$57,850.00	

1000m mooring east coast			From facility	CMAR contribution
Item	*quant*	*$*		
IMOS sub surface float	1	$1,850.00	$1,850.00	
Seabird SBE39/clamsp/cable	8	$1,350.00	$10,800.00	
Seabird SBE37/clamsp/cable	8	$2,000.00	$16,000.00	
Wetlabs WQM	1	$37,906.00		$37,906.00
PAR sensor for above	1	$7,470.00		$7,470.00
ADCP	1	$36,000.00	$36,000.00	
other components to build: shackles, line, swivels, cable, anchor	1	$3,500.00	$3,500.00	
CART release	2	$8,500.00	$17,000.00	
Sub-Total			$85,150.00	$45,376.00

100m mooring south coast	From facility	CMAR contribution

Item	*quant*	*$*		
IMOS sub surface float	1	$1,850.00	$1,850.00	
Seabird SBE39/clamsp/cable	4	$1,350.00	$5,400.00	
Wetlabs WQM	1	$37,906.00		$37,906.00
PAR sensor for above	1	$7,470.00		$7,470.00
ADCP	1			$36,000.00
other components to build: shackles, line, swivels, cable, anchor	1	$2,500.00	$2,500.00	
CART release	2	$8,500.00	$17,000.00	
Sub-Total			$26,750.00	$81,376.00

Figure 2. Schematic of proposed 200m mooring on east coast.

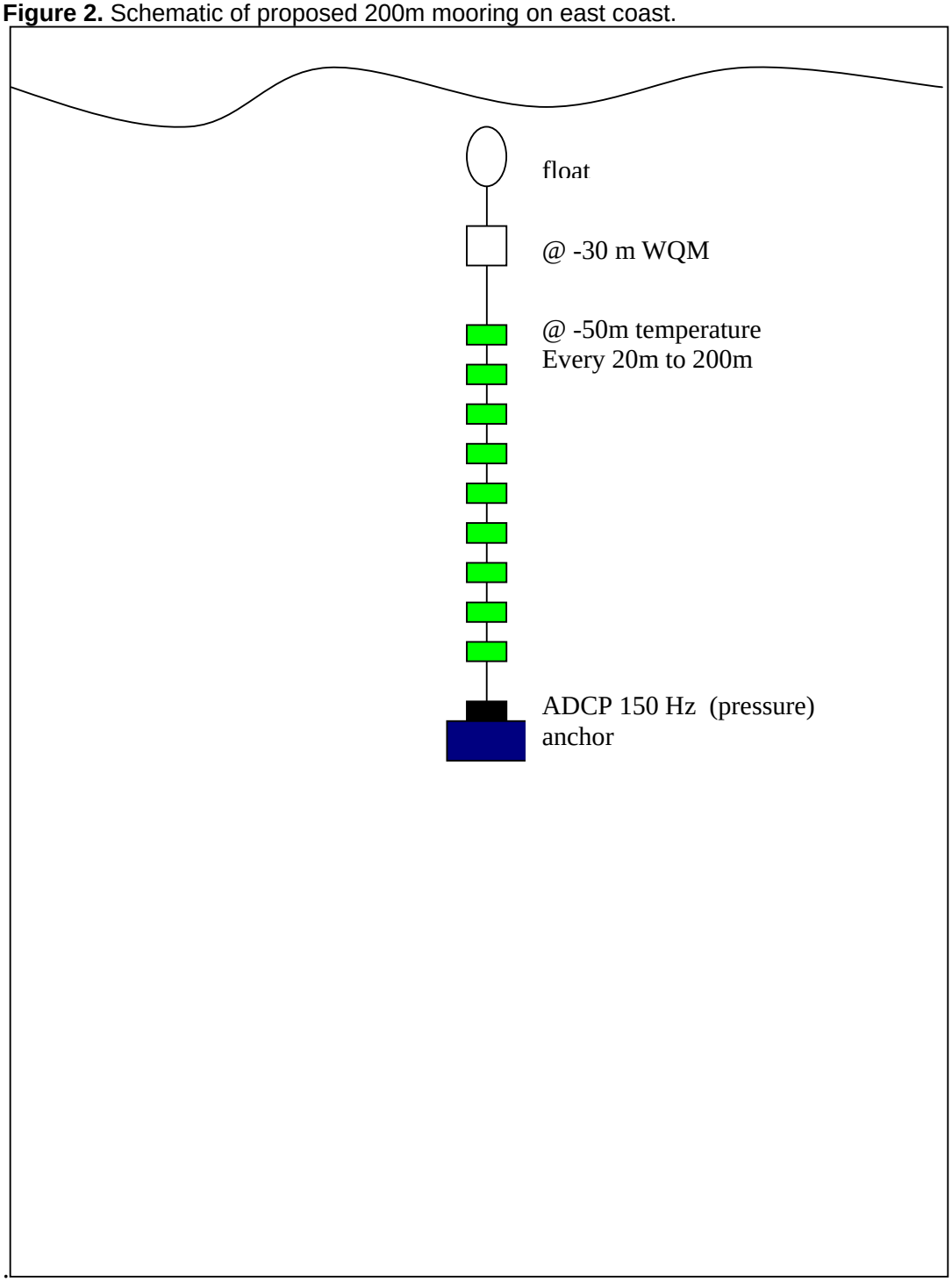


Figure 3. Schematic of proposed 500m mooring on east coast.

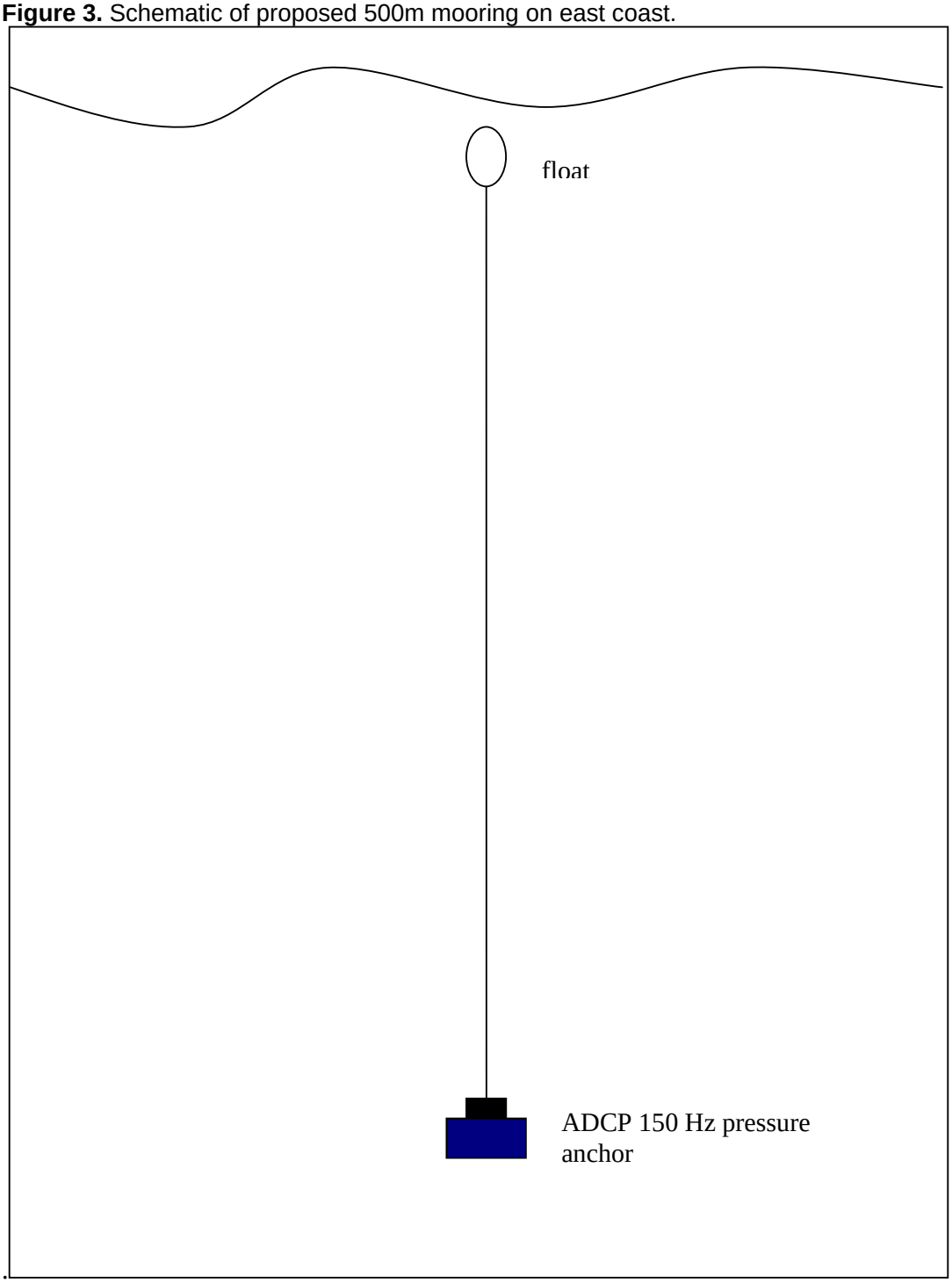


Figure 4. Schematic of proposed 1000m mooring on east coast.

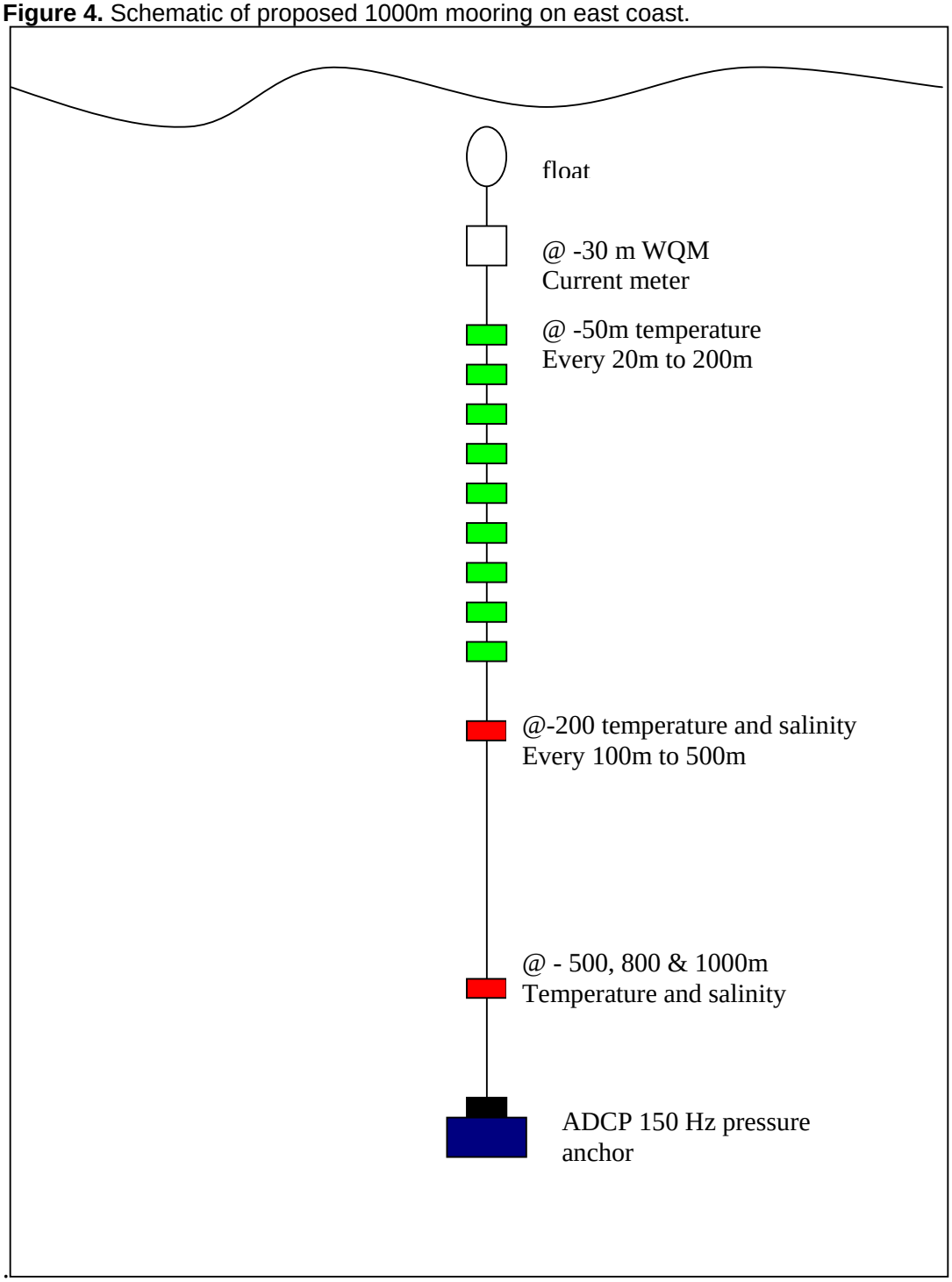
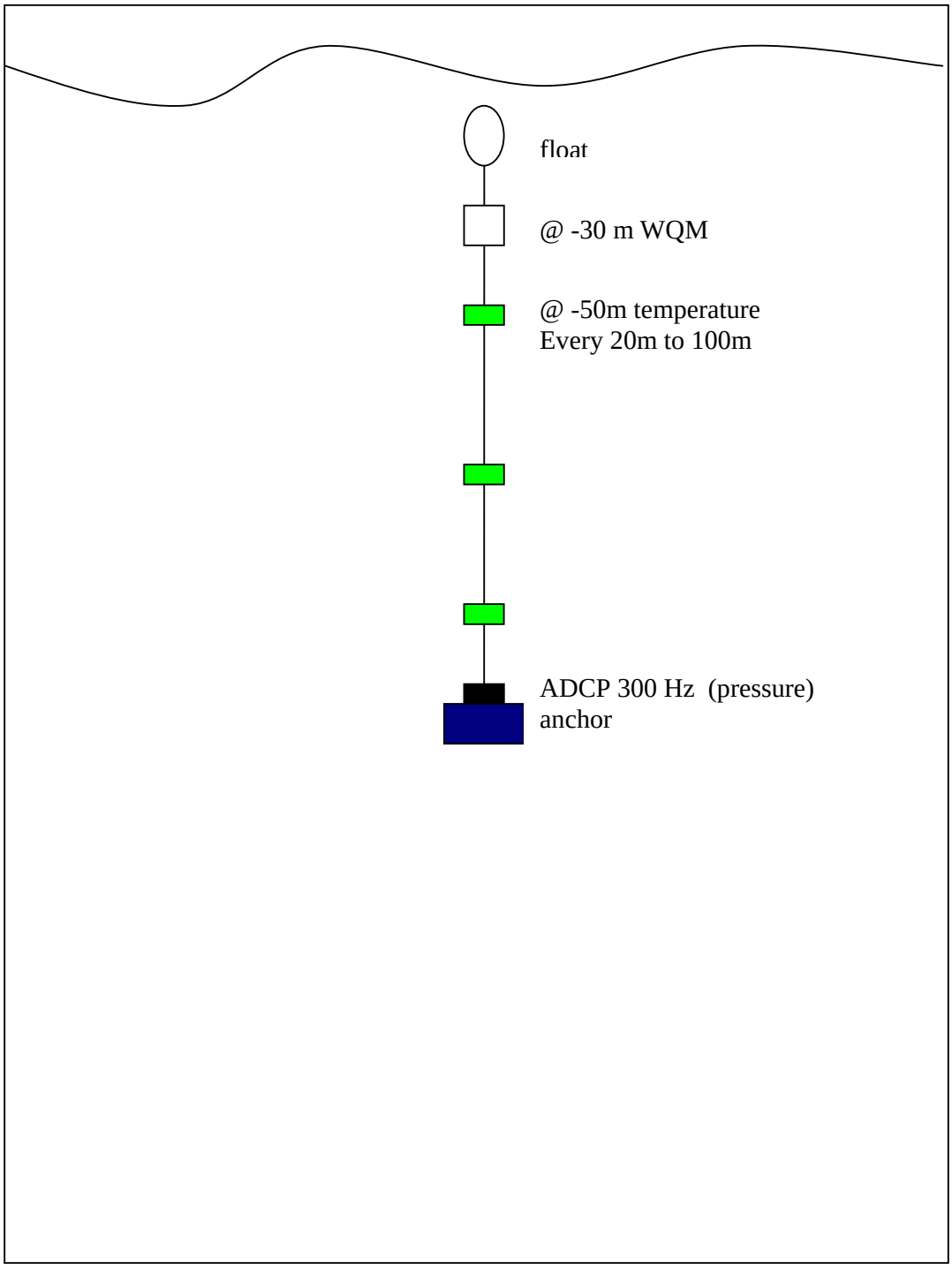


Figure 5. Schematic of proposed 100m mooring on south coast.



Stradbroke Island NRS and SEQ enhanced moorings
The mooring will be purchased and built by CSIRO MAR and will be deployed by June 2010. The 2 deeper moorings will be initially deployed ASAP in the first half of 2010/11.

To be serviced by CSIRO Cleveland staff every 6 months. The monthly sampling is performed by an IMOS funded technician and CSIRO Cleveland staff. These two delayed mode moorings will provide a cross-shelf transect from the NRS reference station. The configuration of the 200 m and 400 m mooring is shown in Figure 6.

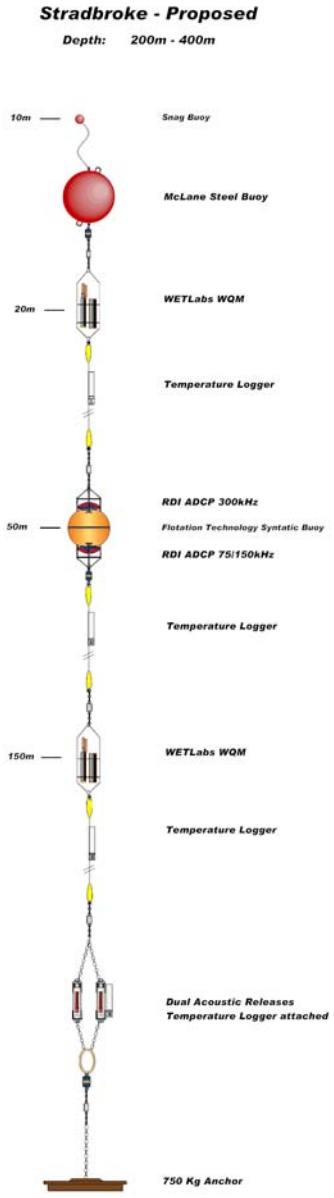


Figure 6. Schematic of moorings to be located at 200 m and 400 m depth off North Stradbroke Island in SEQ.

The total request for EIF funds is $685,000 in capital (Table 2) for 2 additional SEQ moorings with $300,000 for operating them

Table 2 Summary of capital to be purchased for the Stradbroke Island Moorings Enhancement

Capital Items purchase	AUS$ USD$ exchange rate 0.8				
	make & model	cost per item US$	cost per item	Num.	total $A
Stradbroke Moorings 200m + 400m			**$ 273,284.38**	1	**$ 585,475.01**
Water Quality Monitor	Wetlabs WQM	36,000	$ 45,000.00	6	$ 270,000.00
Temperature loggers 5	SBE39T	1,225	$ 1,531.25	15	$ 22,968.75
Current Profiler	TRDI ADCP 300khz	26,000	$ 32,500.00	0	$ 65,0000
Current Profiler	TRDI Quartermaster 150khz	47,000	$ 58,750.00	1	$ 58,750.00
Current Profiler	TRDI Longranger 75khz	55,000	$ 68,750.00	1	$ 68,750.00
Acoustic Release	Benthos ACR 866	10,600	$ 13,250.00	4	$ 53,000.00
Flotation	Flotation Tech 45"	17,000	$ 21,250.00	4	$ 85,000.00
Sensors	Par Conductivity	15,000	$ 18,750.00	0	$ 37,500
Buoy Locators	Novatec RDF+Strobe		$ 3,600.00	2	$ 7,200.00
Mooring components			$ 9,903.13	2	$ 19,806.26
Misc					$ 2,000.00
Stradbroke Total					**$ 685,475.01**

Bio-optics at NRS

Augment the bio-optical observations currently performed at the National Reference Stations moorings by measuring CDOM fluorescence and scattering at BLUE & GREEN bands, complementing the Chlorophyll fluorescence and RED scattering measurement acquired with the WQMs at each NRS mooring,

A pool of 25 bio-optical instruments (WETLabs ECO triplet B with internal Battery, data-logger and eco-wipers), will be acquired to ensure hot-swaps at each NRS mooring (one in the water, one ready to deploy for each mooring, and few spares in sub-facility labs for quick replacements). The instruments would be deployed as stand-alone to avoid delays due to R&D for real-time telemetry with acoustic or inductive modems. The total capital cost is $660,000 with the total EIF bid salaries and operating placed at $1,087,000 (Table 3).

Measurements on samples collected on NRS of spectral absorption apportioned to Phytoplankton, Coloured Dissolve organic matter and non-algal particulate matter will provide calibration of the instrumental data (the budget for this activity includes a resource of 0.1 FTE per year for laboratory analysis).

This activity would be wholly responsible of the data stream: each NRS operator would receive calibrated instruments, deploy them and send them back to the subfacility where, data would be downloaded, QA/QC-ed, and then uploaded to EMII, the instruments would be calibrated and then sent back for deployment (with a resource of 1 FTE per year for instrument maintenance).The pool of 25 instruments would cost ~625k (-each WETLabs ECO triplet B with internal Battery and eco-wipers cost 20 K US : ~ 25K at the IMOS office suggest exchange rate of 0.80) the purchase will be phased out in the three years.

The operating budget for this activity includes for every year 3 k$ per consumable and freight for lab analysis, 2k$ for instruments freight to/from moorings and 5k$ for attendance of national meetings

Key Staff:

- Vittorio Brando – Sub Facility leader
- Paul Daniel, Rebecca Edwards, CLW

- Lesley Clementson, Natasha Waller, CMAR
- Merv Lynch, Peter Fearns CUT

Table 3 Summary of budget for the bio- optical enhancement to the NRS.

		2010/11	2011/12	2012/13	Total
EIF Funding (*Note 2*)		(EIF)	(EIF)	(EIF)	(EIF)
Capital	Pool of 25 WETLabs Eco-triplets	150,000	300,000	175,000	625,000
Capital	setup of calibration facility	10,000			10,000
Capital	instrument mounting for moorings	6,000	12,000	7,000	25,000
Salaries	1 FTE: instrument maintenance (based on and estimate that each instrument needs 8-10 days of technical staff per year at a central facility for cleaning, calibration, data download, QA/QC and upload to eMII)	114,545	120,000	126,364	360,909
Salaries	0.1 FTE: analtical laboratory time for absorptions by particulate and diossolved matter	11,455	12,000	12,636	36,091
Operating	analitycal costs and sample freight	3,000	3,000	3,000	
Operating	instruments freight to/from moorings	2,000	5,500	7,500	15,000
Operating	attend meetings	5,000	5,000	5,000	15,000
	EIF Funding Total	**302,000**	**457,500**	**336,500**	**1,087,000**
Cash Co-investment (*Note 3*)		**2010/11**	**2011/12**	**2012/13**	**Total**
	Cash Co-investment Total	**0**	**0**	**0**	**0**
In-kind Co-investment (*Note 3*)		**2010/11**	**2011/12**	**2012/13**	**Total**
CSIRO/CUT	labour overheads, highly likely	114,000	120,000	126,000	360,000
	In-kind Co-investment Total	**114,000**	**120,000**	**126,000**	**360,000**
	TOTAL Resources	**416,000**	**577,500**	**462,500**	**1,447,000**

Access, pricing regimes:
Access and pricing:

- How will access be provided

Access is free and unrestricted through the IMOS portal. Data from all groups will be provided both from telemetry and download of delayed data.

- How will data be managed

Data management will be the joint responsibility of eMII and CMAR with mooring data being passed through the matlab toolbox and deployment database to provide a continual backup of the processing, data delivery and QC of telemeter data. Delayed mode QC, in which the data subjected to a thorough check, can only be done every 3-6 months after a mooring is serviced. The enhancement proposal for a QC and QA officer will reduce the identified risk of poor quality data from the facility being up-loaded to eMII. Flow of data from BGC samples to eMII is managed by Gary Critchely from CMAR.

- Dependencies on external / other facilities (national and international)

This funding is an adjunct to existing NCRIS IMOS funding and as such, has a share of the co-investment in place there.

- Collaborative structures for allocation of priorities

The design of ANMN is the result of a national, collaborative process via the sub-facility leaders of the network and input from regional nodes. National coordinating meetings for the facility are held twice a year between CSIRO, AIMS, SARDI, Curtain University and the SIMS to ensure that national priorities, such as effective coverage to feed into models, are met. This project is also overseen by the IMOS office.

Governance

- **Performance indicators**

See the ANMN EIF initial 1.6M proposal for details on the MAI and NSI NRS.

TAS and SEQ – shelf moorings

1. 2 moorings built and deployed by end of 2011
2. Remaining 2 moorings built and deployed by end of 2012
3. Moorings serviced and data retrieved

BGS – analysis

The quality of biogeochemical sampling required must be impeccable, hence the running of an annual sampling workshop at the CMAR Hobart Campus where expert samplers in their particular fields of specialisation exhaustively train participants in both the proper sampling techniques and the special post-collection preparation of the samples for storage and transport to the analysts; the outcome of which is that sampling teams at all sites are competent, confident, (and importantly) consistent. The uniform collection and preparation of samples is essential in ensuring quality samples which are comparable across all sites and provide analysts with quality samples to ensure best practice data production. All NRS operators, from all States and Territories send members from their sampling team each year for training and "community maintenance". We recognise that no data is better than bad data.

Bio-optics at NRS

- Successful rollout of bio-optical instruments on all the NRS moorings,"
  - First set of instruments ordered by mid/late 2010 and deployed by early/mid 2011.
  - Other sets to follow same schedule doe following years.
- Timely delivery of QC-ed data to eMII for distribution
- Uptake of bio-optical data by the community, this will be ensured through collaboration with ANFOG and SRS/Ocean Colour and the Bio-optical working group

- **Providing Research Infrastructure** (Value of new infrastructure by facility)

Meeting Researcher Needs

MAI NRS

Data has been delivered for water temperature, salinity, dissolved oxygen, turbidity and chlorophyll from two sites at Maria in delayed mode since April 2008. Telemetered data and weather station data have been uploaded to the website since April 2009.

TAS - Shelf

For ANMN the data streams include temperature, salinity, fluorescence, DO, PAR, ADCP output. The quantity of data will be substantial. The service schedule for the moorings should make it possible for most to have relatively small temporal gaps in the data record. Additional infrastructure could reduce this to zero by allowing 'hotswapping' but this has not been priced into the existing bid. It is envisioned the additional instrumentation could be made available from CMAR to facilitate the maintenance of the data stream but this is still under negotiation.

NSI and SEQ - shelf

The Healthy Waterways Partnership (HWP) in SEQ monitors and improves coastal water quality and habitat condition through evidence based and adaptive management approaches. The HWP has also developed hydrodynamic models and has recently commissioned a new generation 3-D hydrodynamic and biogeochemical model of SEQ between Fraser Island and the NSW border.

The combined empirical and modelling approach used by the HWP provides an excellent complement to IMOS observations in SEQ as well as parallels with the modelling and observation efforts in the GBR. HWP modelling which is designed to operate in a data assimilating near-real-time mode will be a major user of data flows from IMOS both in the initial calibration phases, but also in an ongoing operational context. In this way IMOS observations will be assured of maximum uptake and impact in the region, with numerous benefits to the accuracy of the model for scenario generation and management strategy evaluation. Q-IMOS data will provide key boundary conditions for the new generation hydrodynamic model for Moreton Bay and adjacent coasts. Coastal and Environmental Engineering Q-IMOS members expect significant benefits from this linkage and these data will enable much greater confidence in future modelling of different climate scenario and the impact of bio-chemical fluxes in SEQ waterways. Note that Version 3 of the RWQM being developed is now 3-D and needs profile measurements of temperature, salinity and light, as well as , and offshore currents and their variability. Further, the boundary conditions for the model extend north to Noosa and south (including the Broadwater) and offshore to the EAC. The RWQM is nested within BlueLink. HWP is not looking to use Q-IMOS data to replace the Ecosystem Health Monitoring Program but the synergies between the programs, with the EHMP providing the estuarine and Bay measurements and Q-IMOS providing the shelf and slope measurements will be a powerful addition that will greatly improve our understanding and hydrodynamics models for SEQ.

There are also a number of PhD students in SEQ that will use data from the NRS and moorings. These include students looking at plankton dynamics in SEQ and the feeding and movements of large marine megafauna (e.g., manta rays). These data streams will feed into other programs using data from Q-IMOS.

BGS

As at August 11, 2009, the following biophysical samples had been undertaken for the NRS:

- MAI – 4 full sampling trips have been carried out.

- KAI – 9 sampling trips have been undertaken with the sensible approach of introducing sampling types depending on the delivery of sampling gear. Sampling types have included Carbon, nutrients, salinity, Phytoplankton and HPLC pigments, although there has been some unexplained delays in the delivery of some sample types – to date.

- ESP – 2 full sampling trips have been carried out, which is quite good given the remote nature of this station and an executive decision was made to only sample it four times per annum.

- ROT – Sampled only for 3 months (in 2008) using the old "CMAR Coastal Station parameters only" – (not those described in the IMOS NRS Biogeochemical Operations Manual). The samples and data are at Floreat.

- YON – has still not been sampled at this stage

- MOR – Have done 5 sampling trips to Stradbroke Island (started Sep 2008) for zooplankton and secchi only. Have collected zooplankton and secchi disk to date. Delays in having a winch fitted has meant some more (but limited) sampling – but not the full suite

The North Stradbroke Island National Reference Station has been sampled monthly for plankton abundance since Oct 2008, with the full suite of nutrient, phytoplankton and zooplankton samples collected since August 2009.

- PHB – The first sampling trip was conducted mid – February, 2009 and continued monthly since then.

- DAR – has still not been sampled at this stage

List of data streams that are available for use in research - including a description of each data stream, the volume of data that is available and how it can be accessed

Please outline the continuity of one key time series of data to be assessed against an appropriate benchmark (please define) for this facility.

NRS

WQM data from the Maria Island reference station mooring now extends for 18 months and telemetry from March 2009.

Ongoing and new research projects and PhD students using IMOS data

The large scale umbrella project INFORMD, a joint venture between CSIRO and UTas already has 2 PhD students and expects to gain more. It represents ~ $4 million worth of research investment that will use the new IMOS data for the hydrodynamic and biogeochemical modelling of regional Tasmania.

Quality of research infrastructure

The proposed moorings are similar to those used overseas in a range of national observing programs. They are virtually identical to those used in other IMOS mooring facilities around Australia. Generally the IMOS moorings are limited by power in terms of what instruments can be supported and limited in data collection in real time by the acoustic modem links and satellite communication costs. Internationally other mooring programs on the shelf have used cabled systems that allow huge amounts of real time data and much more energy intensive instrumentation to be used. Unfortunately these systems cost substantially more than type IMOS has chosen to invest in

List of publications using IMOS data

Lynch, T.P., Mclaughlan D., Hughes, D., Cherry D., Critchly, G., Allen S., Pender L., Thompson, P., Richardson, A.J., Coman, F., Steinberg C., Terhell D., Roughan, M., Seuront, L., Mclean, C., Brinkman, G. and G. Meyers (2008) A National Reference Station infrastructure for Australia – using telemetry and central processing to report multi-disciplinary data streams for monitoring marine ecosystem response to climate change. Oceans 2008 MTS IEE Oceans,

Petrusivics, P., J. Bye, J. Luick, (2009) Coupling between density fronts and chlorophyll levels at the entrance of Spencer Gulf, South Australia. In prep.

Details of participation in other conferences, symposia or workshops in relation to this facility (include title, location, date and your role)

Conference proceedings

Coman, Frank, Claire Davies*, Jocelyn Delacruz, David McLeod, Tim Pritchard, Anita Slotwinski, Anthony J. Richardson Seasonal, inter-annual, and potential decadal changes in the zooplankton community off Port Hacking, NSW

Lynch, T., S. Allen, C. Steinberg, M. Roughan, J. Middleton, M. Feng, R. McCauley, K. Klaka, V. Brando, M. McGowan and G. Meyers (2010) The Australian National Mooring Network.OceanObs09. Venice, Italy, 21-25 September 2009. Poster and extended abstract.

Other meetings

Meeting ANMN facility and TAS and bluewater nodes 13th October

IMOS and CMAR meeting CSIRO IMOS Proposals 23rd October

A facility meeting was held at Melbourne Airport on the 12th of June and was well attended by both members and observers from CMAR and DEWHR.

The 2009 Annual IMOS NRS Biogeochemical Sampling Workshop to be conducted in Hobart in November 2009

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

Risk 1 – Project management of Facility

Current management of the ANMN facility is part of this sub-facility and is funded at 0.5 full time equivalents (FTE). With a 16-20 million dollar budget, multiple funding streams and partners across most states this management task is onerous. This will have an impact on the quality of reporting, governance, oversight and accounts.

Mitigation strategy 1– Project management of Facility

The ANMN will request as enhancement a Project Officer to assist in project management of ANMN infrastructure, reporting, contracts and accounts.

Risk 2 – Project management of the sub-facility

The NRS sub-facility is complex and spatially varied. The risk is that the sub-facility leader will not be across all of the aspects of the facility.

Mitigation strategy 2a – Project management of the sub-facility

The sub-facility management it divided into co-leaders for BGC and sensors.

Mitigation strategy 2b – Project management of the sub-facility

As projects mature or expand they become there own sub-facilities with budget responsibility.

Risk 3 - QC and QA

The ANMN is cumulatively increasing the amount of data being up-loaded to eMii. While this data is being placed through rudimentary automatic Quality Control (QC), Quality Assurance (QA) is more *ad hoc*, primarily due to the decentralised nature of the facility and a lack of dedicated staff to assess the data. The risk to the facility is that a damning critique of aspects of the data will be undertaken by an outside organisation that has free and open access to the data.

Mitigation strategy 3a – QC and QA

An enhancement bid will be made to employ an experimental scientist to undertake detailed QC and QA analysis of identified ANMN data streams.

Mitigation strategy 3b – QC and QA

An Honours student program will be developed with Professor Anya Waite from the University of Western Australia to analyses both BGC samples and associated sensor data from NRS.

Budget

The Budget is divided into EIF special, which is the funding required to continue initial EIF spend, NCRIS/EIF and EIF enhance.

Staffing

Special extension is for 2 FTE – Cleveland and Hobart electronics technicians

NCRIS/EIF – is for 6.36 FTE in 09/10 which includes Tim Lynch (0.5), Dave Hughes (0.5), Phil de Boer (0.5), Cleaveland (0.5) and Hobart electronic techs (0.5), Gary Critchely (1) with the remainder as various BGC analysis.

The enhancement includes 0.5 FTE for SEQ shelf moorings, 1.6 FTE for Tas shelf moorings, 0.5 for the ANMN/ABOS project officer, 0.5 for the ANMN/ABOS QC and QA officer and 2.45 FTE for increased BGC sample processing, and 1.1 FTE for the bio-optics.

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

Extention of existing NCRIS Facility (*Note 1*)
EIF Extension - Special

		2009/10	2010/11	2011/12	2012/13	Total
NCRIS/EIF Funding (*Note 2*)			(NCRIS/EIF)			(NCRIS+EIF)
Capital	hotswap ADCP x 1 -MAI		85,333.00			85,333
Capital	hotswap ADCP x 1 -NSI		85,333.00			85,333
Capital	Lab fitout [new staff] HBT		30,000.00			30,000
Capital	Lab fitout [new staff] QLD		20,000.00			20,000
Capital	Lab fitout [new staff] WA		20,000.00			20,000
Salaries	Total FTEs each year 2.0		181,402.00			181,402
Operating	Stradbroke		180,326.00			180,326
Operating	Stradbroke [Training]		45,250.00			45,250
Operating	ANMN - mtg- travel		40,000.00			40,000
	NCRIS/EIF Funding Total	**0**	**687,644.00**	**0**	**0**	**687,644**

Cash Co-investment (*Note 3*)		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Total**
CSIRO	Overheads & Facilities		168,008.00			168,008
(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**	**168,008.00**	**0**	**0**	**168,008**

In-kind 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
	In-kind Co-investment Total	**0**	**0.00**	**0**	**0**	**0**
	TOTAL Resources	**0**	**855,652.00**	**0**	**0**	**855,652**

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

Extension of existing NCRIS Facility (*Note 1*)

NCRIS-EIF Extension

NCRIS/EIF Funding (*Note 2*)		**2009/10** (NCRIS/EIF)	**2010/11** (NCRIS/EIF)	**2011/12** (EIF)	**2012/13** (EIF)	**Total** (NCRIS+EIF)
Capital	ANMN Contingency fund- self insurance			378,560	393,702	772,262
Capital	Sensors-MAI-NRS R&D/ NCRIS		30,000			30,000
Capital	Sensors-MAI-NRS ADCPs - initial EIF contract	50,000				50,000
Capital	Sensors NSI NRS - initial EIF contract	377,477				377,477
Capital	PCO2 Moorings -initial EIF contract	487,000				487,000
Salaries	Total FTEs 7.06			754,386	792,106	1,546,492
Salaries	Total FTEs 6.36	626,200				626,200
Salaries	Total FTEs 5.06		537,061			537,061
Operating	BGC - Operating	30,843	95,000	116,480	121,139	363,462
Operating	BGC - Travel			4,680	4,867	9,547
Operating	Sensors MAI - Operating	27,895	58,022	170,747	177,577	434,241
Operating	Sensors MAI - Travel			62,400	64,896	127,296
Operating	Sensors-R&D for ADCP telemetry	19,000				19,000
Operating	NSI -Operating -initial EIF contract	10,000		187,539	195,040	392,579
Operating	NSI - Travel and recruitment - initial EIF contract	31,390		47,060	48,943	127,393

Operating	PCO2 Moorings - initial EIF contract -operating	63,833				63,833
Operating	PCO2 Moorings - initial EIF contract - travel	20,000				20,000
Operating	ANMN Travel	20,000				20,000
	NCRIS/EIF Funding Total	**1,763,638**	**720,083**	**1,721,852**	**1,798,270**	**6,003,843**

Cash Co-investment (*Note 3*)		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Total**
CSIRO	Overheads & facilities	579,963	497,406	698,685	733,619	1,432,304
(enter Organisation)	(insert description, including likelihood)					0
	Cash Co-investment Total	**579,963**	**497,406**	**698,685**	**733,619**	**1,432,304**

In-kind 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
	In-kind Co-investment Total		**0**	**0**	**0**	**0**
	TOTAL Resources	**2,343,601**	**1,217,489**	**2,420,537**	**2,531,889**	**7,436,147**

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

Enhancement to Facility / New Facility (*Note 1*)

NCRIS/EIF Funding (*Note 2*)		**2010/11** (EIF)	**2011/12** (EIF)	**2012/13** (EIF)	**Total** (EIF)
Capital	SE-QLD Shelf Moorings	685,000			685,000
Capital	TAS - Shelf Moorings	154,630	44,180	22,090	220,900
Capital	ANMN Contingency Fund - self insurance	364,000			364,000

Capital	Bio-optics Pool of 25 WETLabs Eco-triplets	150,000	300,000	175,000	625,000
Capital	Bio-optiocs setup of calibration facility	10,000			10,000
Capital	bio-optics instrument mounting for moorings	6,000	12,000	7,000	25,000
Salaries	Bio-optics1 FTE: instrument maintenance (based on and estimate that each instrument needs 8-10 days of technical staff per year at a central facility for cleaning, calibration, data download, QA/QC and upload to eMII)	114,545	120,000	126,364	360,909
Salaries	bio-optics 0.1 FTE: analtical laboratory time for absorptions by particulate and diossolved matter	11,455	12,000	12,636	36,091
Salaries	NRS/TAS/SEQ - Total FTEs each year 5.2	537,417	564,288	592,502	1,694,207
Operating	BGC- Enhancements	18,700	19,448	20,226	58,374
Operating	SE-QLD Shelf Moorings	80,000	83,200	86,528	249,728
Operating	SE-QLD Shelf Moorings [Travel]	20,000	20,800	21,632	62,432
Operating	TAS - Shelf Moorings	100,000	104,000	108,160	312,160
Operating	Bio-optics analitycal costs and sample freight	3,000	3,000	3,000	9,000
Operating	Bio-optics instruments freight to/from moorings	2,000	5,500	7,500	15,000
Operating	Bio-optics attend meetings	5,000	5,000	5,000	15,000
	NCRIS/EIF Funding Total	**2,261,747**	**1,293,416**	**1,187,638**	**4,742,801**

Cash Co-investment (*Note 3*)		**2010/11**	**2011/12**	**2012/13**	**Total**
NRS - CSIRO	NRS, TAS and SEQ - Overheads & facilities	497,736	522,622	548,753	1,569,111
NRS CSIRO	Bio-optics labour overheads, highly likely	114,000	120,000	126,000	360,000
	Cash Co-investment Total	**611,736**	**642,622**	**674,753**	**1,929,111**

In-kind Co-investment (*Note 3*)		**2010/11**	**2011/12**	**2012/13**	**Total**
NRS	CMAR equipment - Tas shelf moorings	132,390	37,826	18,913	189,129
	In-kind Co-investment Total	**132,390**	**37,826**	**18,913**	**189,129**
	TOTAL Resources	**3,005,873**	**1,973,864**	**1,881,304**	**6,861,041**

TABLE: Observations required by the Nodes in relation to this Facility

Facility	Observations required by the Node			
	NCRIS Funded (already allocated to Jun11) (see Appendix 1 of the Guidelines)	EIF first $8M funded (already allocated to Jun10)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
Bluewater & Climate				BCG analysis for Lucinda jetty coastal observatory Bio-optics
WAIMOS	BCG analysis for two NRS sites		BCG analysis for three NRS sites	Increased BGC analysis at two NRS sites
GBROOS	BCG analysis for two NRS sites	pCO2 mooring at NRS Yongala NSI NRS	BCG analysis for two NRS sites NSI NRS	SEQ shelf moorings
NSW-IMOS	BCG analysis for one NRS site		BCG analysis for one NRS site	BCG analysis for additional CH site
SAIMOS	BCG analysis for one NRS site		BCG analysis for one NRS site	
Tas IMOS	BCG analysis for one NRS site (MAI)	pCO2 mooring at NRS Maria Island	BCG analysis for one NRS site (MAI)	New mooring array for Tasmania node

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

Extend and enhance the Australian Mooring Network facility, Carbon and acidification subfacility

Sub Facility Project Plan for 2010-2013

Overview:

Proposed Infrastructure Investment:	Australian ocean carbon and acidification mooring network
IMOS Facility:	Australian Mooring Network
Operating Institution:	CSIRO Marine and Atmospheric Research, Tasmania
Sub Facility Leader (for this Proposal):	Dr Bronte Tilbrook, CSIRO Marine and Atmospheric Research, PO box 1538, Hobart, TAS 7001; mob: 0407688832; bronte.tilbrook@csiro.au
Other(s) key people involved:	Dr Tim Lynch, *CMAR, TAS*; Mr Craig Steinberg, *AIMS, QLD*; Dr Scott Bainbridge, *AIMS, QLD*, Dr John Middleton, *SARDI, SA*; Dr Martina Doblin, *UTS, NSW*; Dr Ming Feng, *CMAR, WA*
Co-investing / Collaborating Institutions:	CSIRO Marine and Atmospheric Research; Australian Institute of Marine Research; South Australian Research and Development Institute; University of Technology, Sydney

Nature of Investment:

This proposed investment comprises three components with budgets presented separately:

A. ***Extend*** - Extend from mid-2010 into mid 2013 existing IMOS CO_2/acidification moorings installed in FY09/10 located at National Reference Sites: 1) Maria Island: 2) Yongala;
B. ***Enhance: National Reference Sites*** - Provide and deploy CO_2/acidification moorings at national reference sites at Kangaroo Island, Port Hacking, and Rottnest Island from late 2010 until mid 2013

Moorings will be installed at National Reference Sites on the Australia shelves and on the GBR to form a network for determining changes in ocean CO_2 uptake and acidification in our region. The acidification of surface waters is driven by ocean CO_2 uptake and carbonate chemistry and one of the most significant threat to the health and sustainability of Australia's marine ecosystems in the next few decades, with environmental and economic consequences for Australia. Evidence is already emerging of declines in calcification of tropical and polar marine species, but a lack of data on the changes in carbonate chemistry is making any link to acidification tenuous. The network of

moorings, combined with some underway observations in the SOOP program will key observations to address this problem.

Each mooring site will be equipped with surface CO_2 systems, using proven and robust technology. Thee sensors will determine surface pCO_2, dissolved oxygen, temperature and salinity. The hydrochemistry sampling at the National Reference Sites will also provide total alkalinity data, allowing for a complete determination of the carbonate system and pH. For the extend option, pH sensors on the moorings will also provide data. The pH sensors are not considered robust enough to justify costs associated deployment on all moorings without further development and testing on the first two moorings. The pCO_2 sensors and alkalinity data from monthly samples will provide enough in formation to characterise pH and carbonate chemistry.

Data products will be delivered in near real time (daily), and as a delayed mode product (within 3-6 months) when final calibrations have been applied and more extensive data checking completed. The national reference sites at Darwin, Ningaloo and Esperance are difficult to implement at this time due high tides and currents (Darwin) or logistical problems (Ningaloo and Esperance), and can be targeted in future.

The sites proposed here will characterise changes down the east coast of Australia and the influence of the East Australian Current on CO_2 uptake and acidification. The Rottnest site will capture the changes in the SW Australian shelf. The Kangaroo Island site is a key location for monitoring the upwelling off South Australia. Deeper waters upwelled on the SA shelf are expected to have higher CO_2 and this could accelerate the exposure of the ecosystems in the region to acidification earlier than other locations.

Implementation Strategy:

Summary

A ***Extend*** – Maintain existing CO_2/acidification moorings until mid 2013. The two sites at Maria Island and Yongala are being established in 2010. The Maria Island mooring will initially be recovered and redeployed every 3 months, with an aim to extend the turnaround to 6 months if biofouling is not a problem. The Yongala sensors are attached to a large buoy that should be deployed by mid-2010 as a part of the existing IMOS network. The sensors will be swapped out each 6 months, with the mooring remaining on site and cleaned.

B ***Enhance: National Reference Sites*** – Moorings will be constructed and deployed at three sites (Kangaroo Island, Pt Hacking, and Rottnest Island). The moorings will be built at CSIRO, Hobart, and sensors prepared and tested for deployment. The moorings with sensors and spares required for turnarounds will be shipped from Hobart to the SA, WA and NSW facilities with the first deployments anticipated in late 2010/early 2011. The turnarounds will be handled at the same time as the existing reference site moorings are serviced leading to cost savings. The mooring groups from SA, NSW and WA will eventually take responsibility for recovery/redeployment using standard and well documented procedures. The CO_2 systems will be returned to Hobart for servicing. The moorings will be recovered each year and replaced with a new mooring. The old mooring will be returned to shore for more thorough maintenance and be made ready to recycle back to the site the following year.

The sensors on the moorings will be maintained and calibrated by the sub-facility at a central lab at CSIRO, Hobart. Data management and QC will also be handled by the central facility to ensure consistency and rapid delivery of data through the IMOS system.

Objectives

The proposal aims to deliver the first integrated network of ocean CO_2 and acidification measurements around Australian shelves, using new and well tested mooring and sensor technology. The acidification of ocean waters is driven by CO_2 uptake and is considered one the most imminent threats to the health and sustainability of marine ecosystems. Australia contains some of the most extensive carbonate based ecosystems on earth that are considered at risk, including tropical reefs. Data generated from the moorings will complement and enhance observational programs at mooring sites and the SOOP underway biogeochemistry programs. Benefits include:

- deliver a network of intercalibrated sites that determine the rate and variability in the acidification of shelf waters around Australia, a prerequisite for understanding the exposure and resilience of Australia's marine ecosystems to acidification,
- provide data to test biogeochemical models and predict the influence of climate drivers (stratification, warming, ENSO, SAM) and biological feedbacks on the future uptake and acidification of Australia's seas,
- make a strong Australian contribution to coordinated international programs on CO_2 uptake and acidification in the oceans. The observational programs now being developed in EU, USA and Asian countries parallel the network proposed here and will be coordinated through IOC (UNESCO) and IGBP programs including the Global Carbon Project, SOLAS and IMBER. Community white papers on the core needs and the design of a global observational program for CO_2 uptake and acidification have already been developed and include the shelf mooring sites in this proposal.

The subfacility will utilise expertise already developed for the National Mooring Reference Sites to construct, deploy and service the moorings. The CO_2 group at CSIRO, Hobart, who will manage the sub-facility, have experience in the maintenance, calibration and management of data from the moored sensors through collaboration with NOAA, who developed the technology. Collaboration across the sub-facility and the existing mooring groups will provide a cost-effective way to merge the expertise in sensors and moorings to develop the national.

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

A. ***Extend***

1) CSIRO, mid 2010: complete installation and testing of CO_2 sensors on the Yongala buoy, pending the deployment of the buoy through AIMS;
2) CSIRO, mid 2010 to 2013: service Maria Island moorings and CO_2 systems at 3 month intervals, and turn around CO_2 sensor system on Yongala mooring each 6 months during AIMS servicing of Yongala mooring. Based on experience with deployments near reefs, it appears the Yongala sensor will only need a 6 month servicing;
3) CSIRO, mid 2010 to 2013: prepare, calibrate and maintain sensors. The CO_2 sensors are made by Battelle and provide high quality and high reliability data streams, provided they are well maintained and calibrated. CSIRO staff are trained in maintaining these systems;

4) CSIRO, mid 2010 to 2013: Maintain data stream and deliver near real-time and delayed-mode QC data products for sensors on the Maria Island and Yongala moorings;
5) AIMS, mid 2010 to 2013: AIMS to deploy and service the Yongala mooring site. CSIRO will send a technician to help with CO_2 system sensor swap outs on the first two turnarounds, with AIMS then to take responsibility for retrieving and redeploying the sensors.

B. ***Enhance National Mooring Reference Sites***

1) CSIRO, mid 2010- early 2011: order equipment, construct and deploy moorings at four reference sites (Pt Hacking, Kangaroo Island, and Rottnest Island). The existing IMOS NRS moorings do not have space for the CO_2 systems and separate moorings need to be deployed near to the NRS buoys. The CO_2/acidification mooring buoys were designed by NOAA to accommodate the sensors and these buoys have been proven to deliver high quality CO_2 data and survive harsh shelf and open ocean conditions for deployments of up to 14 months.
2) CSIRO, mid 2010 to 2013: Prepare, maintain and calibrate sensors. CSIRO staff are trained in the procedures needed to maintain the systems in working order. The subfacility will handle this in Hobart and will freight sensors to the sites prior to deployment. Spare buoys and mooring hardware is needed for the deployments to avoid large data gaps. For the first deployment and servicing, subfacility staff from Hobart will participate to train the mooring site staff for future turnarounds;
3) CSIRO, mid 2010 to 2013: Maintain data stream and deliver near real-time and delayed-mode QC data products. Data files will be transmitted each day via an iridium system and will be available through IMOS. CSIRO staff are already skilled in the data;
4) National Reference Site mooring groups at SARDI, UWA/CSIRO, and SMI early 2011 to 2013: The deployments/recoveries will be made during the planned schedule of NRS mooring turnarounds. The target is for a three month deployment/turnaround schedule in the first year and that may be extended to 6 months or longer if biofouling is not a problem. Sensor data are transmitted every day and the sensor performance can be checked for drift and offsets through analysis of gas standards and air samples. For servicing, the moorings will be pulled from the water, inspected, cleaned, and components replaced, where necessary. Every 6-12 months the sensors will be returned to the subfacility for maintenance and calibration, with the mooring replaced every 12 months and returned to land for maintenance. The suitability of a boat that can handle the heavy anchors at the Pt Hacking site is still being determined;

List of major equipment to be purchased

Major equipment (**A Extend; B Enhance Reference Sites**) is listed in Table . These items are all commercially available and do not require development work. The mooring design is well tested in the field with communications established and requires no electronics development. The design and daily communication also allows rapid identification and swap out of modules for the CO_2 sensors during sampling visits to the sites. Some fittings for the moorings do need to be manufactured in a mechanical workshop, but this is straightforward.

The requirement for frequent servicing out of Hobart, Perth, Adelaide and Sydney, means there is limited scope for pooling of equipment. A spare sensor package needs to be taken to each mooring turnaround for swap-outs and as insurance that sensor damage or problems that could occur during recovery or deployment will not cause large gaps in the data. For normal servicing the moorings are recovered, cleaned, any damaged or suspect items of hardware replaced, and redeployed. Once per year the mooring is returned to shore for maintenance and later deployment. With a 3-6 month

retrieval schedule, it is not feasible to retrieve the sensors or hardware from one mooring and ship in a container to another city for deployment. There is scope to add other surface sensors to the mooring (e.g. weather station, fluorometer, turbidity), and this can be explored for future work.

Component A: Extend

Replacement components are requested for a pH, conductivity and temperature, and an acoustic release.

Component B: Enhance National Mooring Reference Sites.

Each of the three reference sites requires two sensor packages each (one on the mooring and one for replacement/backup).

Access, pricing regimes:

- **How will data access be provided?**
  Data are delivered daily from each sensor via iridium using mature and tested technology. These data will be available through the IMOS data centre. A delayed mode QC product will also be delivered with final calibrations applied within 3-6 months.

- **How will data and products be managed?**
  CSIRO have a group already working on the collection, QC and delivery of CO_2 and related data. The mooring data will be received at CSIRO and QC procedures applied to check the daily data transmissions. These data will be displayed and made available through IMOS along with the delayed mode QC products.

- **What are the dependencies on external / other facilities (national and international)?**
  The sensors packages are managed by CSIRO.

  For the **Extend** component, the instrumentation of the Yongala site will depend on AIMS for access the mooring and after the first deployment, for installation and retrieval of the sensors on the mooring. The Maria Island mooring will be handled by CSIRO.

  The ***Enhance National Reference Sites*** component depends on the NSW, WA, and SA mooring groups for recoveries, logistics support, and servicing of mooring hardware. The initial mooring build will be carried out by CSIRO, along with servicing and maintenance of the instrumentation, and management of the data obtained for IMOS.

  Collaborative structures for allocation of priorities
  The CO_2 subfacility at CSIRO will be responsible for managing and maintaining sensors on the moorings. The subfacility will work with SAIMOS, WAIMOS and NSW IMOS to deploy and recover sensors from the National Reference Sites. AIMS will collaborate with the subfacility and be responsible for the mooring infrastructure and servicing schedule at Yongala. The groups in the various states will decide the deployment and recovery schedules and CSIRO will collaborate with these groups to make sensors available for the deployments.

Table 1: List of equipment to be purchased for he three components:

Equipment	Requirement	Source	Date to be purchased /developed

	Extend		
Acoustic releases	Replacement parts	ORE, USA	mid 2011
CO_2 system spares	Replacement parts	Battelle, USA	mid 2011
pH sensor	Replacement parts	Sunburst, USA	mid 2011
Mooring hardware	Replacement mooring hardware	CSIRO Hobart	As required
	Enhance National Reference Sites		
6 x CO_2 sensors	For moorings and turnarounds	Battelle, USA	Order mid 2010
6 x SBE16plus	For moorings and turnarounds	Seabird, USA	Order mid 2010
6 x optodes	For moorings and turnarounds	AAD, Norway	Order mid 2010
6 x Mooring Buoys	For moorings and turnarounds	USA	Order mid 2010
Mooring hardware	Replacement mooring hardware	CSIRO Hobart	As required
acoustic releases	For moorings and turnarounds	ORE, USA	Order mid 2010

Governance

Performance indicators

- Sensors and mooring components ordered by late 2010 and mooring construction complete in mid 2011.
- All funded moorings deployed and operating by late 2011
- Real time data available publically within 1 month of first mooring deployment for each site with daily updates of data.
- Moored CO_2 sensor data utilised in developing CO_2 flux maps and acidification maps for the Australian region, and incorporated in international databases

Describe key risks and risk management strategies

Key risks are defined in Table 1.

Table 1: Key risks and mitigation strategies.

Risk	Risk mitigation
	Common risks
Mooring loss	10% of equipment pool allocated to losses and maintenance The mooring is designed to withstand high seas and winds. A similar type of mooring has been deployed in the Nth Pacific, and around the shelves of the USA. This design is unlikely to break loose unless there is a mooring hardware failure. In that case, the buoy does send GPS position every three hours and it may be possible to retrieve it. We are working with NOAA engineers in the USA, who have a great deal of experience with the buoys to minimise the risk of hardware failures.
System failure	10% of equipment pool allocated to losses and maintenance The mooring equipment and sensors have been selected because of their proven reliability in the field. The systems will be tested thoroughly before deployment and this should minimise any failures. The sub-facility has experience in troubleshooting issues with this type of sensor and checking their performance.

	The daily data transfer will also allow the system's field performance to be monitored. If necessary, replacement CO_2 sensors can be swapped in while the system is still in the water. This is not possible for the salinity and temperature sensors needed on the buoy, but these are proven to be robust for long field deployments. If the salinity or temperature sensors do fail there will be some nearby data from the other National Reference Site mooring that will allow some data collection, but at a reduced quality.
Loss of key staff	The staff are not expected to leave the sub-facility or mooring groups. If key staff leave Hobart there is enough expertise to continue. The mooring turnarounds will be carried out in five states ensuring their is expertise available if some staff leave the moorings teams.
Loss of gear due to fishing and vandalism	Most of the moorings are located at National Reference sites and incidents of vandalism or fishing trawling appear to be low. The CO_2/acidification mooring has a cover to stop vandals interfering with the sensors or boats tying up to it. Vandalism has not been an issue to date.

Budgets are presented separately for the three components below. High capital costs are needed for the equipment. Provided the sensors are maintained the lifetime is expected to be 5-8 years, with some replacement of sensor components.

Extension of existing facility

EIF Funds

- Funds are sought to replace some mooring components, including a pH and oxygen sensor, an acoustic release, and mooring hardware ($70K).
- Operating costs include 3 monthly field trip to Maria Island site with 1 days time budgeted for ships crew and boat hire at each turnaround ($5K/day) (see Table 2). The twice per year Yongala mooring turnaround adds 2 days of ship time at $10K/day. A servicing time of six months may eventually be possible at Maria Island, but that still needs to be established depending on the amount of biofouling.
- Operating funds also include costs associated with servicing the moorings (mooring lines, batteries, anchors and anodes etc), travel and shipping of sensors.

Co-investments – source and nature

- The primary co-investment is CSIRO staff time in project and data management and sensor maintenance and calibration.

Staffing details

- Staff required include: a 0.5FTE data manager /QC person that also handles the project management, and a 0.5FTE person to maintain, and calibrate the sensors. A mooring technician at 0.5FTE is also required to maintain the moorings.

Enhance National Reference Sites

EIF Funds

- Funds are requested to build 6 moorings with sensors in Hobart for three sites at Kangaroo Island, Rottnest and Port Hacking.
- Operating costs at each site include an estimate of 3 monthly turnarounds of one day each ($5K/day) with time (4 days per person) allowed for science and boat crew to prepare and participate.
- Support for a full time mooring engineer in FY10/11 at CSIRO to construct the 6 moorings. After the moorings are built and deployed, $50K/yr funds will be transferred to the three national reference site groups (Pt Hacking, Kangaroo Is. and Rottnest) to fund a mooring technician for maintenance of the mooring hardware.
- Operating funds include costs associated with servicing the moorings (boat hire at $5K/day, mooring lines, batteries, anchors and anodes etc), travel and shipping of sensors. After the first mooring is deployed at each site in FY10/11, operating funds of $35K/yr will be transferred to each of the three national reference site groups to support the mooring servicing and mooring hardware replacements (anchors, lines, bungie) and $10K/yr for each deployed sensor ($30K/yr) to the subfacility to maintain the sensors.

Co-investments – source and nature

- The primary co-investment is CSIRO staff time in project and data management and sensor maintenance and calibration. These positions are co-investments with CSIRO contributing 45% of salaries.

Staffing details

- The staffing requirements for the CO_2 subfacility are a full time mooring technician at CSIRO needed in FY10/11 to build the 6 moorings, a 0.5FTE for management and QC and 0.5FTE, and a 0.5FTE for maintaining and calibrating the sensors. After the initial moorings are deployed, $50K/yr will be transferred to each of the three reference sites to support a technician for mooring maintenance.

Budget for Extend CO2/acidification moorings mid 2010 to mid 2013

			2010/11	2011/12	2012/13	Future (a)	Total
EIF Funding		Maria and Yongala moorings					
	Capital	pH sensor, SBE16 plus, acoustic release, iridium rudi	70,000	0	0	Not applicable	70,000
	Salaries	maintain project, sensors and data delivery, turnaroun	168,861	177,304	186,169		532,334
	Operating	boat time, mooring hardware and expendables, anchor	85,000	88,400	91,936		265,336
		EIF Funding Total	**323,861**	**265,704**	**278,105**		**867,670**
Cash Co-investment (b)							
	CSIRO	Staff time	156,393	164,213	172,423		493,029
	AIMS	Staff and ship time					
		Cash Co-investment Total	**156,393**	**164,213**	**172,423**	**0**	**493,029**
In-Kind Co-investment (b)							
	CSIRO	CO2 and O2 calibration setups	20,000	20,000	20,000		60,000
		Cash Co-investment Total	**20,000**	**20,000**	**20,000**	**0**	**60,000**
		TOTAL Resources	**500,254**	**449,917**	**470,528**	**0**	**1,420,699**
	NOTES:						
(a)	If any amounts included in Future column for Cash or In-Kind Co-investment, please provide detail of the time-frame of these resources:						
	NOTE: salaries need AIMS estimate for Yongala includes boat $20K/yr and about $10K/yr for shipping, new anchors						
	NOTE: need to determine if people ship time for maria island (extra 0.22FTE) goes here or in NMRS budget. Also where does moorig tech budget go.						
	NOTE: The opreating is $43K fo Maria Island (includes $20K/yr for boat). Remainder for Yongala with $20k for ship and no mooring requirement.						

Budget for Enhance National Reference Sites 2010-2013

		2010/11	2011/12	2012/13	Future (a)	Total
EIF Funding						
Capital	6 CO2 sensors, and mooring hardware, 3 sites	880,000	0	0	Not applicable	880,000
Salaries	Build & maintain mooring and sensors	213,513	270,074	276,077		759,664
Operating	freight, consumables, project travel,boat time	135,000	140,400	146,016		421,416
	EIF Funding Total	**1,228,513**	**410,474**	**422,093**		**2,061,080**
Cash Co-investment (b)						
CSIRO	Staff time, confirmed	197,750	140,400	146,016		484,166
	Cash Co-investment Total	**197,750**	**140,400**	**146,016**	**0**	**484,166**
In-Kind Co-investment (b)						
CSIRO	Carbon and oxygen calibration facility, confirmed	20,000	20,000	20,000		
	Cash Co-investment Total	**20,000**	**20,000**	**20,000**	**0**	**0**
	TOTAL Resources	**1,446,263**	**570,874**	**588,109**	**0**	**2,545,246**

NOTES:

(a) If any amounts included in Future column for Cash or In-Kind Co-investment, please provide detail of the time-frame of these resources:

(b) For amounts included in Cash and In-Kind Co-investments, please include the likelihood of these resources being made available (eg confirmed, provisional, possible)

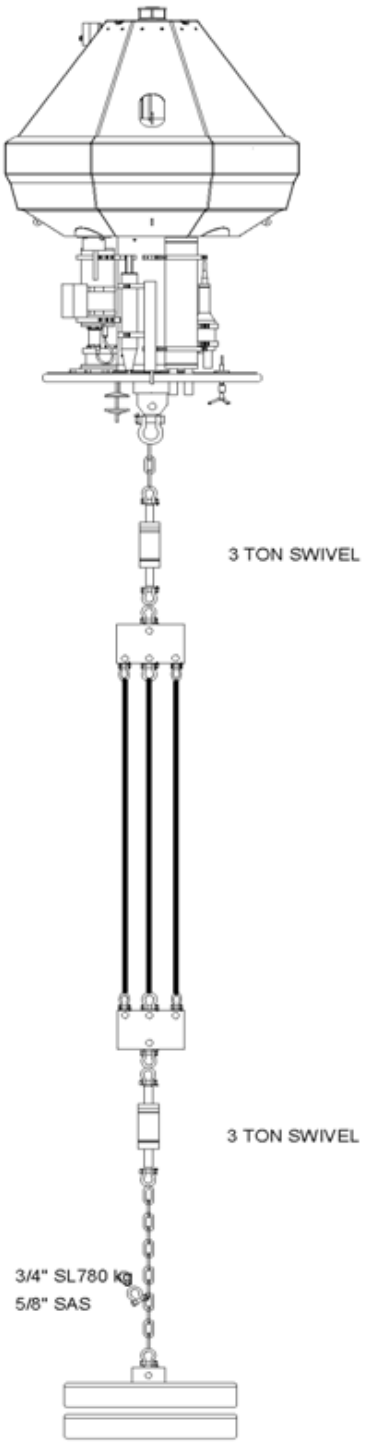


Figure 1. CO_2-acidification mooring with three piece bungy tether. The top of the mooring is covered to reduce vandalism and damage to the CO_2 sensors during recovery.

Western Australian

Overview:

Proposed Infrastructure Investment:	WA IMOS NRS and shelf mooring operation plan
IMOS Facility:	ANMN - Australian National Mooring Network. Sub-facility: ANMN WA Sub-facility
Operating Institution:	CSIRO Marine and Atmospheric Research
Facility Leader (for this Proposal):	**Facility ANMN:** Dr T.P. Lynch Ocean Sensor Deployment Team Leader CSIRO Marine & Atmospheric Research Castray Esplanade HOBART, TAS 7000 GPO Box 1538 HOBART TAS 7001. Ph: (03) 6232 5239 Fax: (03) 6232 5000 Mob: 0416 089 749 tim.lynch@csiro.au WA Sub-facility leader Dr. Ming Feng Research Scientist CSIRO Marine & Atmospheric Research Underwood Avenue Floreat WA 6014 Australia Phone +61 8 9333 6512 Fax +61 8 9333 6555 Ming.feng@csiro.au
Other(s) key people involved:	Ian Darby, electronic technician, CMAR Prof. Chari Pattiaratchi, UWA Prof. Anya Waite, UWA
Collaborating Institutions:	University of Western Australia

Please attach:

- Letter from senior person in Operating Institution, confirming that the proposed infrastructure can be developed and operated within that institution
- Resume of Facility Leader
- Letters received from Collaborating Institutions, detailing their support to the Proposal, and indicative level of co-investment

Nature of Investment:

The proposal comprises two components:

Extend Australian National Mooring Network (ANMN) facility's observing programs at the Western Australia National Reference Stations (NRS), Rottnest, Esperance, and Ningaloo, and at the shelf mooring arrays off Two Rocks and the Perth Canyon to June 2013; and Implement the NRS stations with ADCP (acoustic Doppler current profiler) and realtime telemetry as approved by the NCRIS/EIF funds.

Enhance the physical sampling rates at the Esperance and Ningaloo NRS stations and enhance the capability of instrument hot swaps at the NRS stations.

Implementation Strategy:

- Summary

1. To extend NRS and shelf mooring observation to June 2013

Currently two of the three NCRIS funded WA NRS stations have been implemented by the ANMN WA IMOS Sub-facility and the Ningaloo NRS station will be established in early 2010. The proposed EIF funds will extend all the three NRS observations to June 2013, with the additional ADCP and surface telemetry moorings at each of the NRS stations.

Five shelf moorings along the section off Two Rocks have been deployed by the Sub-facility and the three Perth Canyon moorings are scheduled to be deployed in late 2009. The proposed EIF funds will extend the shelf mooring observations from mid-2011 to June 2013.

2. To enhance the NRS measurements

Under the NCRIS funds, the Esperance and Ningaloo NRS stations were designed to have physical sampling rates of 4 times a year, as they are the two relatively remote sites, compared to other NRS stations. The proposed EIF funds will enhance the sampling rates of these two stations from 4 times a year to 12 times a year between July 2010 and June 2013, to meet the research demand of the WA community.

The proposed EIF funds will also be used to purchase extra ADCP and WQM hardware and spare mooring parts to enable hot-swapping of the NRS moorings which need three-monthly servicing. The proposed EIF funds will also help WA Sub-facility to enhance its data managements.

The Sub-facility will also support the plan to enhance the Rottnest NRS station with CO2/acidification mooring in late 2010/early 2011. The CO2 mooring budget sits in the ANMN central facility.

- Objectives

The Leeuwin current has an impact on most of the marine based industries off the coasts of Western Australia. The southward transport of water via the Leeuwin Current transports tropical and subtropical species which are mixed with temperate species to form diverse and unique biological communities. The region is home to the western rock lobster fishery, which is Australia's largest single species fishery with catches ranging between 8,000 and 15,000 and valued at more than $250 million. The Leeuwin Current also acts as a conduit to the migration of the southern bluefish tuna which is a very profitable aquaculture industry in Port Lincoln, South Australia. The Australian Defence Forces conduct a range of military training, research and preparatory operations in the Region. Training occurs within Commonwealth waters at the Western Australia

Exercise Area (WAXA) situated off the Perth canyon. Shipping is a vital industry for southern Australian economies and many ships transit through the region to and from the eastern seaboard of Australia, and the main port in the region is Fremantle. Thus, there is a need to better understand the dynamics of the Leeuwin Current, Leeuwin Undercurrent, and the Capes Current in the region through long term monitoring. High quality and high resolution time series of ocean current as well as upper ocean current, temperature, salinity, and biogeochemical variables will be crucial to monitor the variability and changes in the boundary current system and to address the above applications.

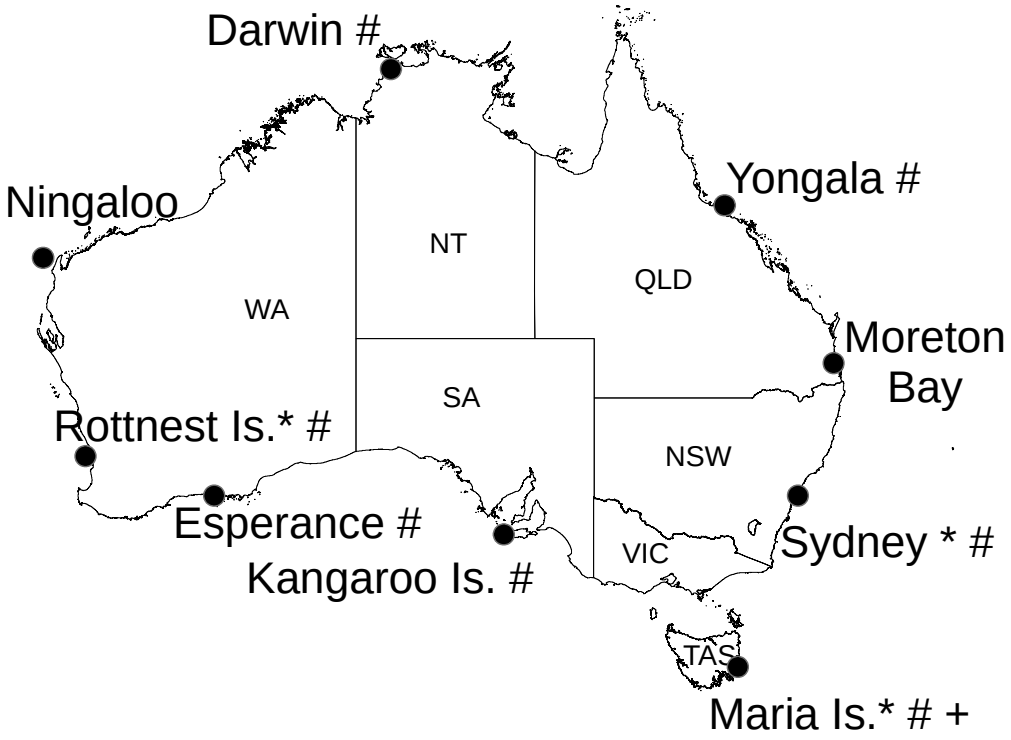


Figure 1: NCRIS funded NRS stations around Australia.

The ANMN WA IMOS Sub-facility plans to maintain the three NRS stations off the Western Australia coast, Rottnest, Esperance, and Ningaloo, and enhance the NRS observation with additional ADCP ocean current measurements and real time telemetry (Figure 1). The three NRS stations will be the focus areas of current and future multi-disciplinary, multi-institutional marine research in WA, which track the influence of the Leeuwin Current from tropical, to subtropical and temperate marine environments. To extend the NRS observations in WA has been regarded as the highest priority observing program in the WA IMOS science plan.

The Rottnest NRS mooring data have revealed rich information on short term variability on upper ocean thermal and chlorophyll structures on the shelf off the west coast of WA (Figure 2).

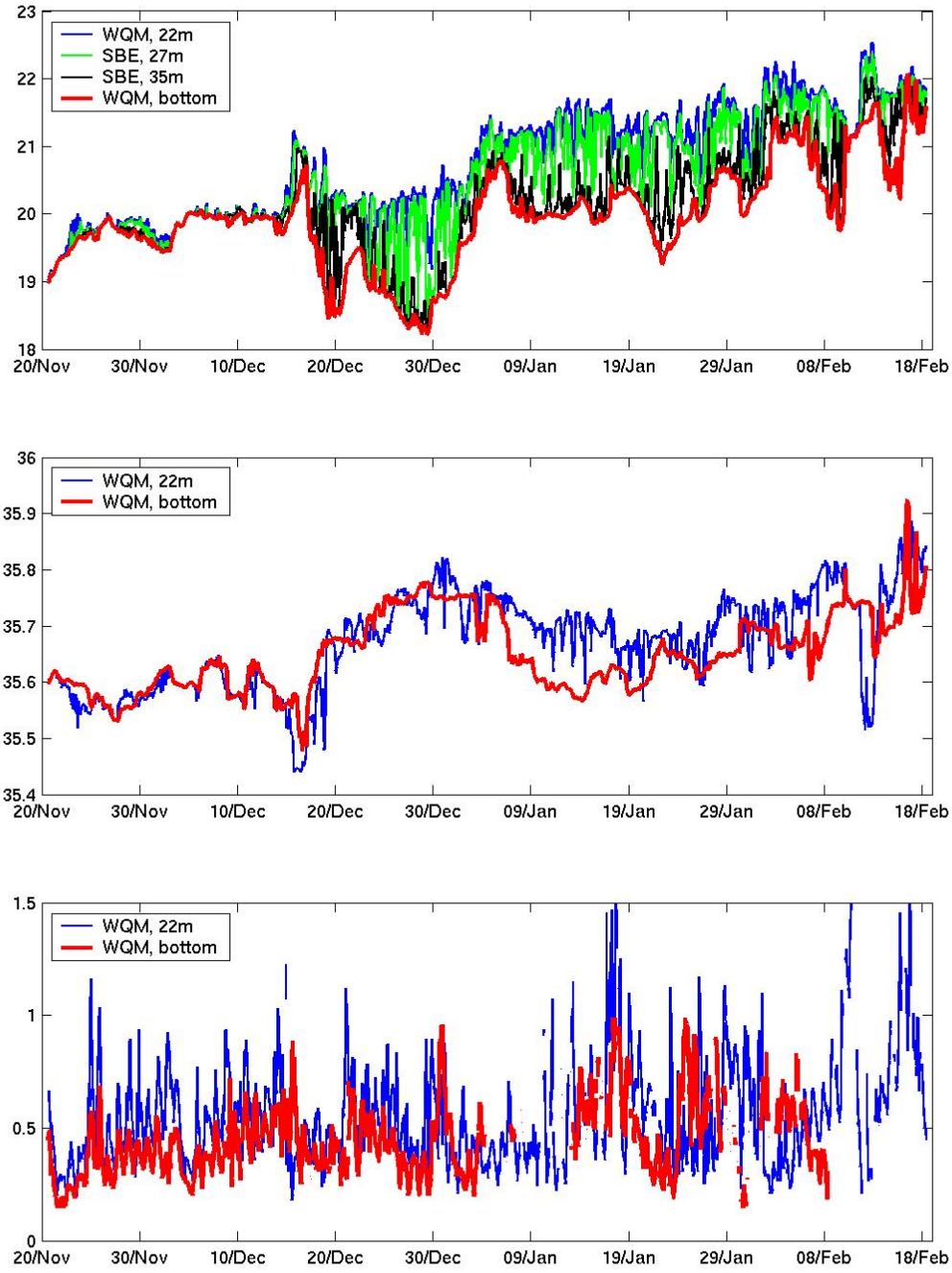


Figure 2: Temperature, salinity and chlorophyll concentration measurements at the Rottnest NRS mooring during November 2008 and February 2009.

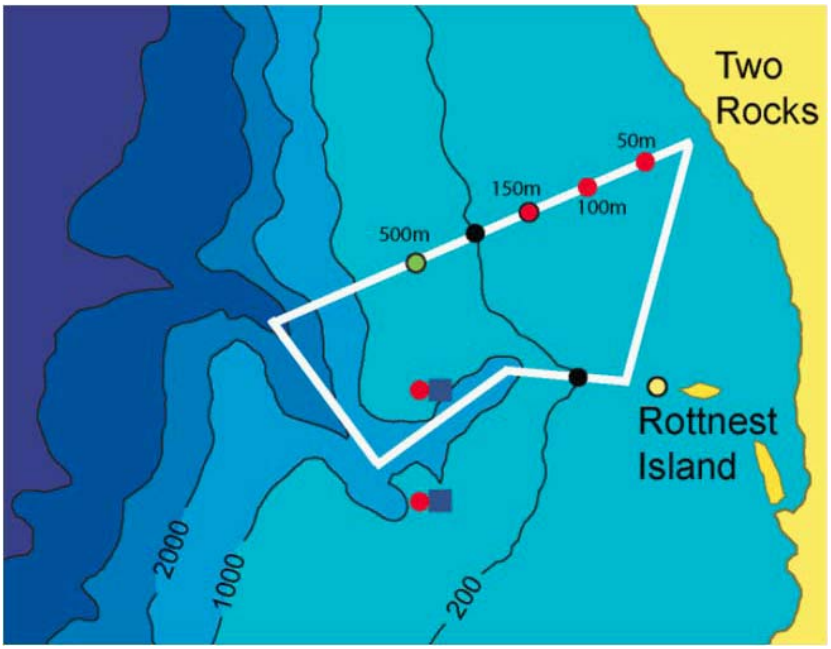


Figure 3: NCRIS funded shelf mooring arrays off Two Rocks and in Perth Canyon. The red dots denote the thermistor moorings, black dots denote thermistor/BGC/ADCP moorings, and the green dot denote thermistor/ADCP mooring. The co-located Rottnest NRS (yellow dot) and AATAMS moorings (squares) are also shown.

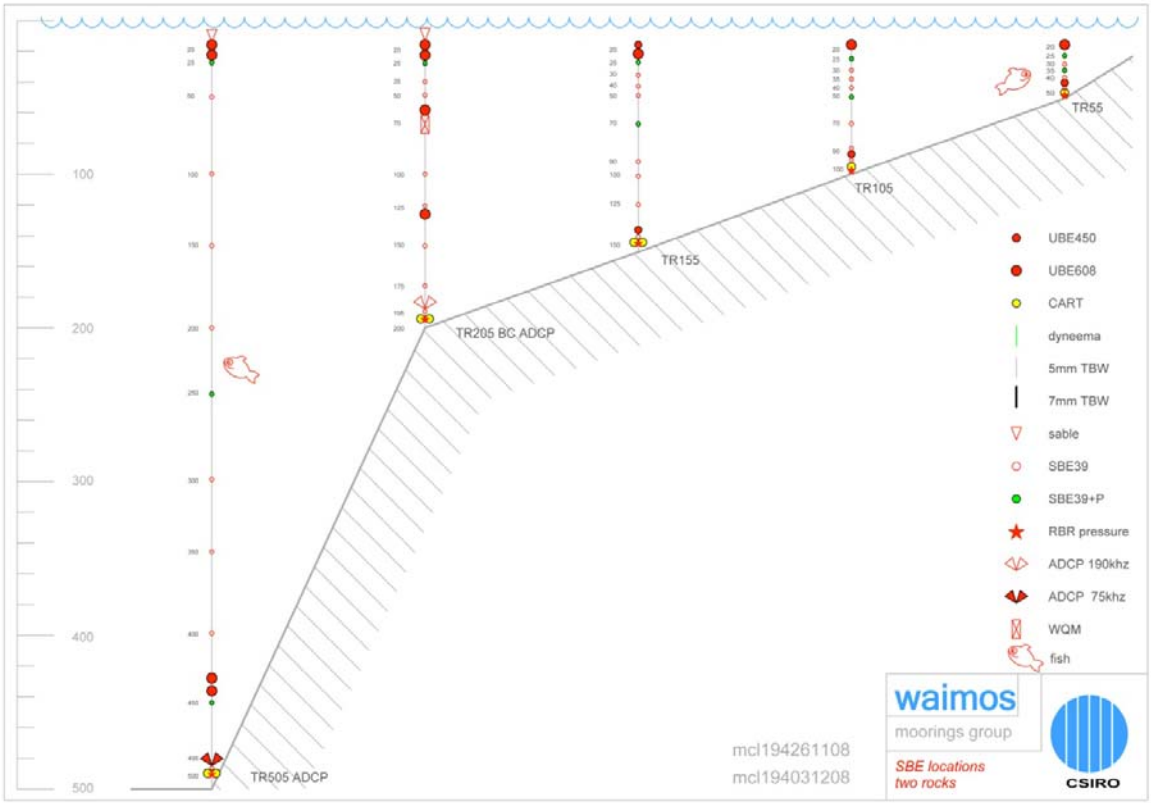


Figure 4a: Mooring design of the Two Rocks mooring array.

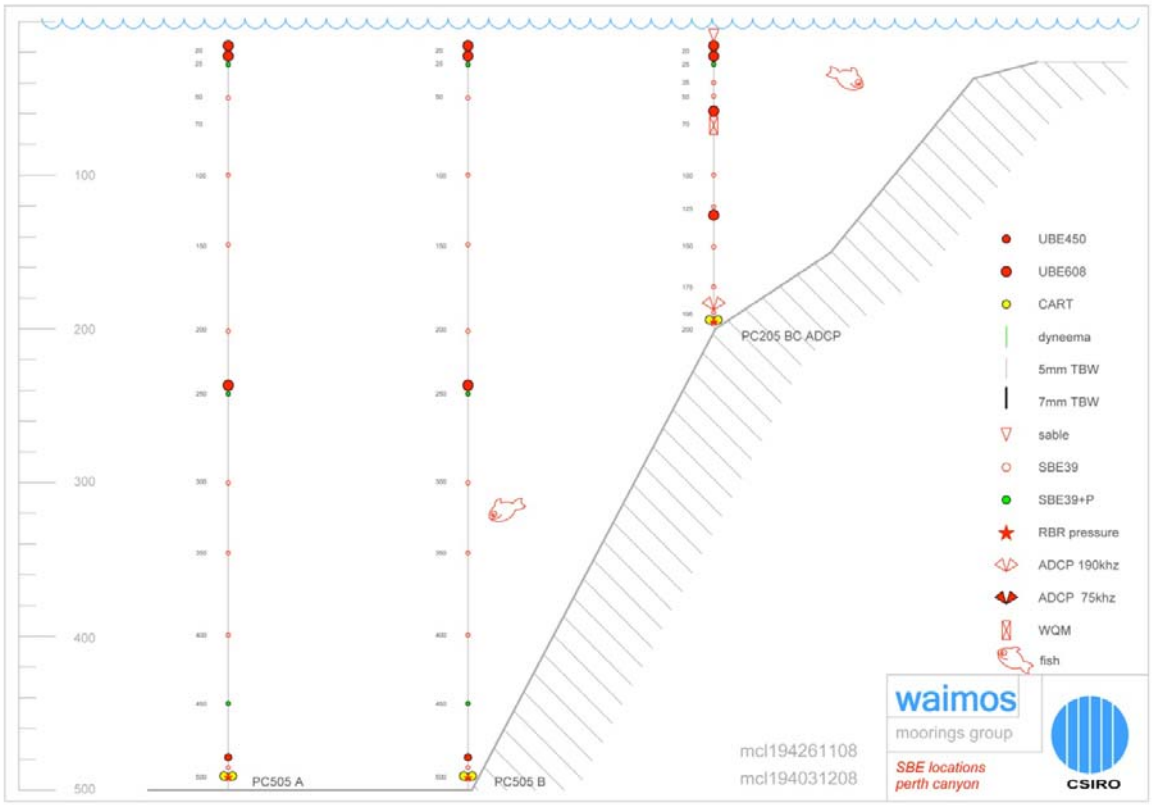


Figure 4b: Mooring design of the Perth Canyon mooring array.

The shelf mooring array off Two Rocks will provide the first systematic long term monitoring of the Leeuwin Current and the Leeuwin Undercurrent off the west coast of Australia (Figures 3 and 4). In combination with the mooring array in the Perth Canyon, the shelf mooring array will also be the first whole-of-system approach to understand the cross-shelf process driven by the Leeuwin Current/Undercurrent and mesoscale eddies, and their impacts on nutrient and carbon transport and ocean production in the Leeuwin Current and on the shelf off the coasts of Western Australia. To extend the shelf mooring arrays is also listed as the highest priority in the WA IMOS science plan.

The NRS stations and shelf moorings off the west coast will also be a national backbone for observing the Leeuwin Current, the longest ocean boundary current, and its impacts on marine ecosystem. CSIRO will continue to build research and technical capability in WA and the nation in multi-disciplinary, cross-institutional research and observations, though investment in ANMN WA IMOS Sub-facility.

With additional EIF funds, the facility also proposes to enhance the physical sampling rates at the Esperance and Ningaloo stations from 4 times a year to 12 times a year to better resolve the intraseasonal, annual and interannual variations in the biophysical properties on the shelf and in the boundary current. The EIF funds will also be used to enhance the capability of hot-swapping moorings that need frequent services, in order to reduce the operation cost. The EIF funds will also help the WA Sub-facility to enhance its data management capability.

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

Extend

Two mechanical engineers based in Floreat lab will be recruited by January 2010.

ADCP moorings and surface telemetry mooring for the three NRS stations will be built by the ANMN central facility and delivered by mid-2010.

Hot swap ADCPs on shelf moorings will be purchased by June 2010.

Rottnest NRS:
WQM and thermistor mooring will be serviced every three months, in February, May, August, and November;
Physical sampled will be carried out on monthly bases;
ADCP mooring and surface telemetry mooring will be deployed by August 2010 and then will be serviced at three month intervals;

Esperance NRS:
WQM and thermistor mooring will be serviced every three months, in March, June, September, and December;
Physical sampled will be carried out at the three month intervals;
ADCP mooring and surface telemetry mooring will be deployed by September 2010 and then will be serviced at three-month intervals;

Ningaloo NRS:
WQM and thermistor mooring will set up in February 2010, and then be serviced every three months, in February, May, August, and November;
Physical sampled will be carried out at the three month intervals;
ADCP mooring and surface telemetry mooring will be deployed by November 2010 and then will be serviced at three-month intervals;

Two Rocks mooring array:
The ADCP and thermistor moorings will be serviced at 6-month intervals, in June and December;
The WQM and thermistor mooring will be serviced at 3-month intervals;

Perth Canyon mooring array:
The mooring array will be set up in November 2009 and then serviced at 6-month interval;
The WQM and thermistor mooring will be serviced at 3-month intervals;

Enhance

June 2010 – June 2013: Enhance sampling rates at Esperance and Ningaloo NRS stations from 4 times a year to 12 times a year;

Hot swap ADCPs for NRS will be purchased by June 2010.

- List of major equipment to be purchased / developed

See attached planning table.

Access, pricing regimes:

- How will data access be provided?

  At the recovery of the moorings, data will be downloaded and electronically deposited into the central archive of the ANMN facility in Hobart, where the data will be processed based

on the instrument calibrations and quality controlled and delivered to IMOS EMII IVEC facility in Perth. The WA Sub-facility will provide delayed data quality assurance.

All water samples for biogeochemical analysis will be delivered to the central facility according to instructions and quality controlled data will be delivered to IMOS EMII IVEC facility in Perth.

- How will data and products be managed?

  ANMN central facility through CSIRO data centre will maintain the meta data for each deployment/sample and keep an backed up archive of all raw data.

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

  The Sub-facility depends on the ANMN central facility for technical support, data processing and data archive.

- Collaborative structures for allocation of priorities

  The Sub-facility has close relationship with the ANMN central facility through CSIRO internal collaboration. To implement the WA IMOS NRS and shelf mooring arrays is the priority of CSIRO observation program and the top priority in the WA IMOS science plan.

  The Sub-facility has established close collaboration with UWA operators.

Governance

- Performance indicators

To maintain the mooring and physical sampling instruments at the high standard;

To deliver quality controlled data stream from shelf moorings and NRS stations on time and on schedule;

To minimise instrument losses;

- Describe key risks and risk management strategies

Partial or complete loss of mooring hardware

This is managed by i) a careful program of platform development and testing, ii) working closely with engineers from the CMAR Hobart lab on mooring designs, iii) planning for loss by funding replacements.

Loss of key staff

Most of CMAR technical staff in Floreat lab is brought into the IMOS work on term basis, so that we need to liaise with other CMAR labs to ensure the mutual support.

- For existing Facilities, respond to any issues raised in the 2008 IMOS Review

Budget: Please complete the spreadsheet provided, and detail here any further information you have available on the background to the Budget:

See attached budget form for details.

The primary co-investment is CSIRO staff time in project and data management and sensor maintenance and calibration. These positions are co-investments with CSIRO contributing 45% of salaries.

CSIRO will also support the ANMN Facility leader Sub-facility leader's engagement in managing the Sub-facility.

- Staffing details

CSIRO
Tim Lynch – ANMN facility leader
Ming Feng – ANMN WA IMOS Sub-facility leader

Ian Darby – electronic technician	1 FTE
Peter Hughes – hydro chemist	0.1 FTE
Ryan Crossing – physical sampling / Deck hand	0.75 FTE in NCRIS/EIF Extend and 0.25 in EIF Enhancement
TBN – senior mechanical technician	1 FTE
TBN – mechanical technician	1 FTE

- Description of proposed new infrastructure for Nodes – please complete the Table on the next page, referring to Attachment 1 to the Guidelines for further information

IMOS Integrated Marine Observing System

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

Extension of existing NCRIS Facility ANMN WA IMOS

NCRIS/EIF Funding (*Note 2*)		**2009/10** (NCRIS/EIF)	**2010/11** (NCRIS/EIF)	**2011/12** (EIF)	**2012/13** (EIF)	**Total** (NCRIS+EIF)
Capital	ADCP, Surface mooring, and regular servicing	207,868	449,956	369,463	384,241	1,411,528
Salaries	Mechanical and electronic technicians	209,845	269,917	369,768	388,256	1,237,786
Operating	Vessel charter and travels	135,000	214,192	251,778	261,850	862,820
	NCRIS/EIF Funding Total	**552,713**	**934,065**	**991,009**	**1,034,347**	**3,512,134**

Cash Co-investment (*Note 3*)		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Total**
CSIRO	In-kind for salaries for operators (provisional)	194,351	249,987	342,465	359,589	1,146,392
CSIRO	In-kind for salaries for managements (confirmed)	100,000	100,000	100,000	100,000	400,000
(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**
(enter Organisation)	(insert description, including likelihood)					0
(enter Organisation)	(insert description, including likelihood)					0
	In-kind Co-investment Total	**294,351**	**349,987**	**442,465**	**459,589**	**1,546,392**
	TOTAL Resources	**847,064**	**1,284,052**	**1,433,474**	**1,493,936**	**5,058,526**

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

Enhancement to Facility ANMN WA IMOS

		2010/11	2011/12	2012/13	Total
NCRIS/EIF Funding (*Note 2*)		(EIF)	(EIF)	(EIF)	(EIF)
Capital	Mooring replacement and hotswaps	798,267	316,000		1,114,267
Salaries	technican and data management	101,125	106,181	111,490	318,796
Operating	including subcontract to UWA	267,200	277,888	289,004	834,092
	NCRIS/EIF Funding Total	**1,166,592**	**700,069**	**400,494**	**2,267,155**
Cash Co-investment (*Note 3*)		**2010/11**	**2011/12**	**2012/13**	**Total**
WA CSIRO	salaries (provisional)	93,658	98,341	103,258	295,257
(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**
(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	**93,658**	**98,341**	**103,258**	**295,257**
	TOTAL Resources	**1,260,250**	**798,410**	**503,752**	**2,562,412**

TABLE: Observations required by the Nodes in relation to this sub-facility

Facility	Observations required by the Node			
	NCRIS Funded (already allocated to Jun11)	EIF first $8M funded (already allocated to Jun10)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
	(see Appendix 1 of the Guidelines)			
Bluewater & Climate				
WAIMOS	ANMN NRS Rottnest x 12 times/year Esperance x 4 times/year Ningaloo x 4 times/year ANMN Shelf mooring arrays: Two Rocks x 5 Perth Canyon x 3	NRS ADCP x 3	NRS Rottnest Esperance Ningaloo Shelf mooring arrays: Two Rocks x 5 Perth Canyon x 3	NRS Esperance x 12 times/year Ningaloo x 12 times/year Hot swap ADCPs, WQMs Shelf mooring arrays Hot swap ADCPs, WQMs Enhanced data management
GBROOS				
NSW-IMOS				
SAIMOS				
Other <enter name>				

IMOS Integrated Marine Observing System

Queensland and Northern Australia

Call for Proposals under the IMOS (EIF) Five Year Strategy: Enhancement or extension of IMOS – July 2009 to June 2013

Queensland and Northern Australia Sub-Facility Project Plan

30th October 2009

Overview:

Proposed Infrastructure Investment:	Shelf and Slope Moorings and quality assured data streams
IMOS Facility:	Queensland and Northern Australia sub-facility
Operating Institution:	Australian Institute of Marine Science
Facility Leader (for this Proposal):	Craig Steinberg, AIMS, 07 4753 4345, c.steinberg@aims.gov.au
Other(s) key people involved:	Mr Scott Bainbridge & Dr Peter Doherty, AIMS Dr Anthony Richardson CSIRO & UQ Dr Russ Babcock, Dr Tim Lynch & Dr Bronte Tilbrook CSIRO Dr Richard Brinkman, Dr David Parry and Mr David Williams, AIMS Prof Karen Edyvane, Julia Fortune NRETA Mr. David Hanslow, Torres Strait Regional Authority Dr Chari Pattiaratchi UWA Dr Ming Feng & Dr Tim Lynch CSIRO
Collaborating Institutions:	CSIRO, UQ, NRETA, TSRA, UWA

List of attachments:

- Letter from senior person in Operating Institution, confirming that the proposed infrastructure can be developed and operated within that institution
- Resume of Facility Leader
- Letters received from Collaborating Institutions, detailing their support to the Proposal, and indicative level of co-investment

1. Nature of Investment:

The existing Queensland and Northern Australia sub-facility consists of two NRS sites at Yongala and Darwin and four pairs of array moorings located north to south along the Great Barrier Reef (GBR). For the array moorings, each of the 4 pairs has an outer mooring on the continental slope in water greater than 200m and an on-shelf mooring sitting in shallower water around 30-70m deep. Like other ANMN moorings, the array deploys a range of instrumentation including Acoustic Doppler Current Profilers (ADCPs) and Water Quality Monitors (WQMs). Three of the four shelf moorings will also have surface buoys to measure meteorological and radiation observations in real-time. The sub facility's objective is to observe the cross-shelf exchange of water between the Coral Sea and the GBR. Water moving along and onto the GBR will be measured by monitoring the southward flowing East Australian Current (EAC) and the northward Hiri western boundary currents. The moorings located in the southern GBR monitor the strength of currents related to upwelling events detectable on the Capricorn-Bunker Shelf, which supply deep, nutrient-rich water to the reef that is linked to a recirculation of the main EAC flow.

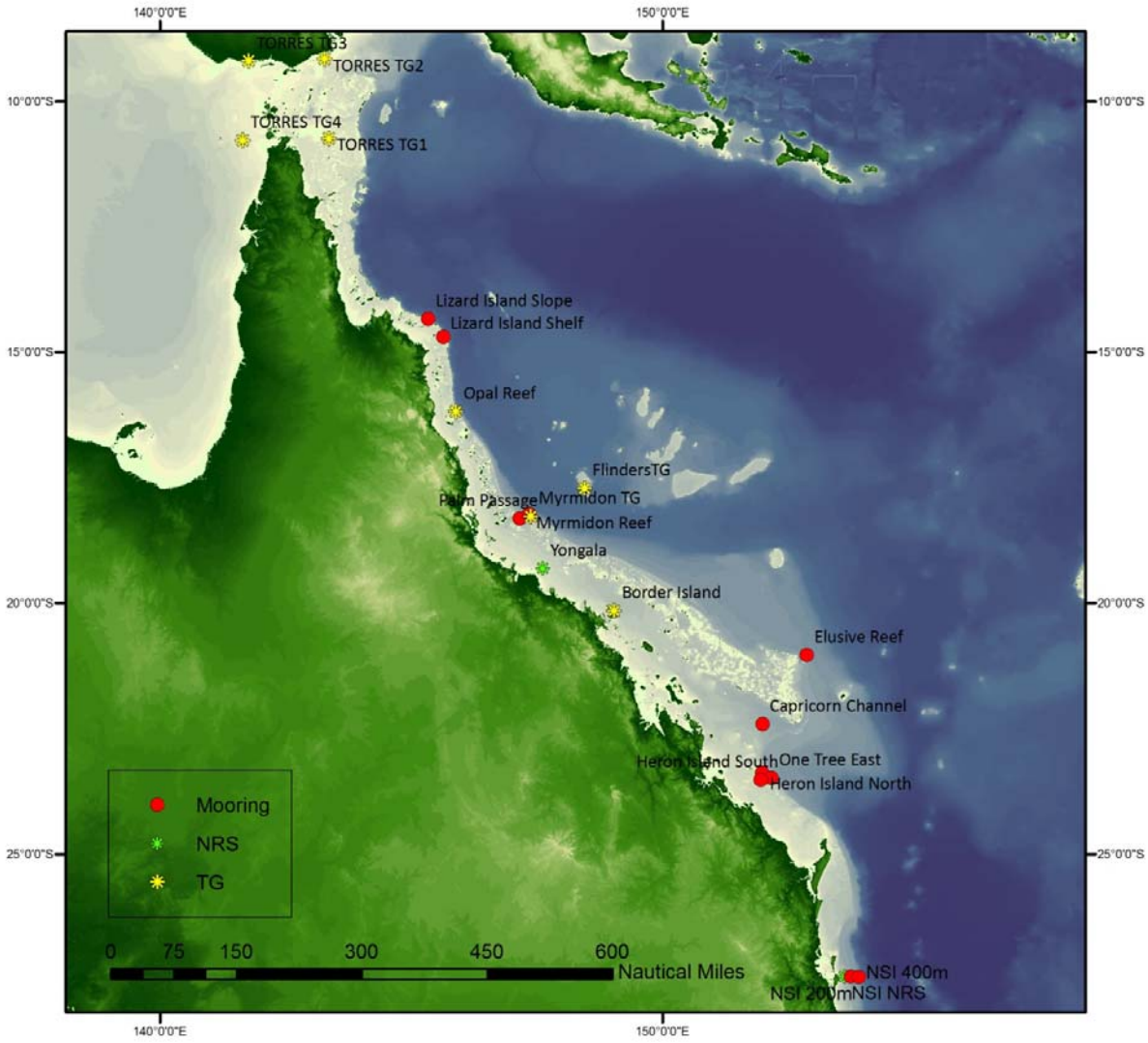


Figure 1 Proposed mooring array for Q-IMOS.

EXTENSION – Queensland and Northern Australia

The extension to the Queensland and Northern Australia sub-facility will include continued operations of the GBR moorings, established in 2007 and the roll out and servicing of the Northern Australian Observing System (NAOS) moorings from 2010.

1) Servicing of two NRS sites, at Darwin and Yongala and developing real time telemetry
2) Servicing of shelf mooring arrays consisting of 4 pairs of outer shelf and slope moorings along the GBR
3) Provision, deployment and servicing of the moorings component of the Northern Australian Observing System comprising:
    a. Arafura and Wessels Mooring pair
    b. Shelf component of the Indonesian Throughflow (ITF) transect (three moorings) in tandem with the BAOS operated deep water components
    c. ITF BAOS instrumentation: 3 ADCPs and 3 PIES
    d. Kimberley mooring transect (four)
    e. Pilbara mooring transect (three)
4) Service the Ningaloo NRS mooring (transferred from WA CSIRO)

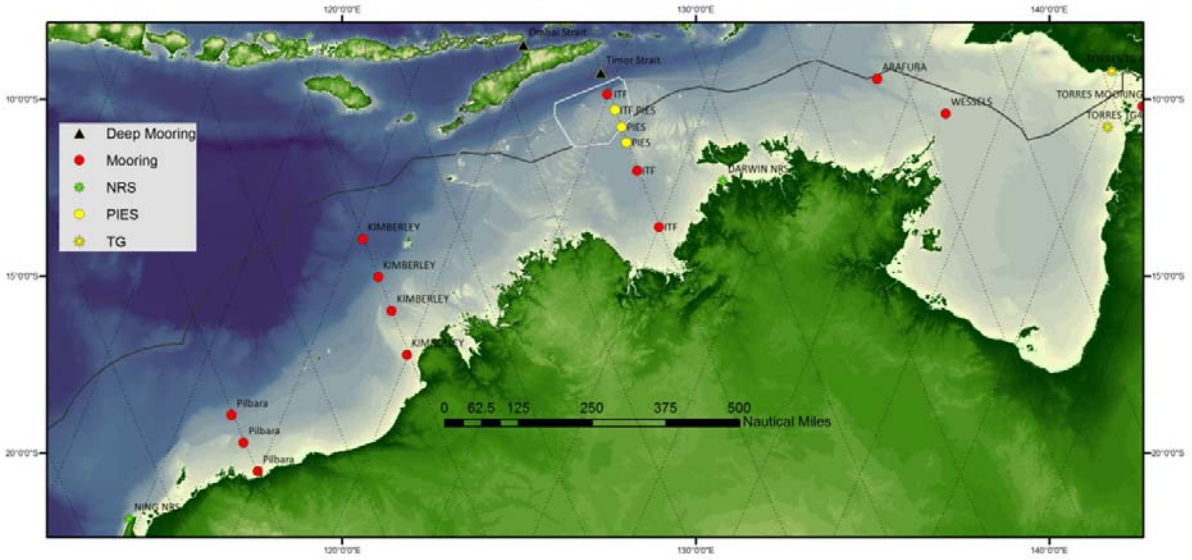


Figure 2 Proposed mooring array for NAOS with JASON-2 Altimeter tracks overlain

ENHANCEMENT – Queensland and Northern Australia

2) A sea level array in the Torres Strait to determine Arafura and Coral sea exchanges in partnership with Torres Strait Regional Authority

2 Implementation strategy:

Summary

The aim is to strengthen the existing backbone of measurements rolled out in 2007 for the GBR Ocean Observing and to expand from the GBR core to other regions where there are no sustained

measurements. This includes the neglected continental shelf region off the Torres Strait. The plan reflects the clear direction that any enhancement should be directed to Northern Australian regions.

Serious consideration was given to extending the GBROOS array to the far northern array and a deep water Coral Sea mooring as per the IMOS-1 proposal however due to budgetary constraints these will not be a part of this proposal.

The EIF has allocated funding to a Northern Australian Observing System (NAOS) in recognition of the large gap in observation in this region. Discussions have occurred between the Bluewater and Climate, Queensland, Western and Northern Australian nodes to determine the most appropriate mooring array design. If we are to keep to the requested timeline AIMS staff will need to be re-tasked from other duties and a recruitment drive will need to occur as soon as possible. What is presented here is a preliminary plan only as there is a definite need to improve and discuss more widely the locations and appropriateness of the observing design.

We believe the proposed NAOS configuration represents a sustainable balance between observational capability and affordability, and provides a backbone observing infrastructure with ongoing operational costs that are realistic and sustainable into the future.

The common observational strategy is to collect baseline data on the water quality and productivity of northern tropical seas and monitor the variability of ocean currents over long time scales. The emphasis remains on monitoring boundary current flows and cross shelf exchanges. The data will be used to help inform or validate regional modelling efforts.

The following information is extracted from the Q-IMOS and WAIMOS node plans where more detailed scientific justification is made for IMOS.

Objectives:

2.1 Q-IMOS

Great Barrier Reef (GBROOS array)

The westerly flows through the Coral Sea towards Queensland set up sea-level gradients at the shelf break that drive geostrophic currents over the outer continental shelf containing the majority of the 3,000 discrete coral reefs comprising the GBR. Consequently, dynamic flows in the Coral Sea have a direct influence on the transport of materials, including spawn, among elements of the reef matrix.

Advection by water currents on the shelf affects all organisms with dispersive propagules although actual dispersal outcomes are determined by many factors including larval duration and behaviour. The only way to deal with such complexity is to build a reliable and highly spatially resolved model of 3-D flows on the continental shelf that can be forced by observations from the open ocean boundary. The GBR shelf-slope mooring pairs straddling the shelf-break at four latitudes between 14^{o}S and 24^{o}S are intended to feed a data-assimilating model (under construction by AIMS and CSIRO) that will be the engine of understanding and prediction for many problems including connectivity.

During El-Niño, the SEC is displaced to the south as the Western Pacific Warm Pool moves towards the central Pacific. This reduces flow in the Hiri Current with potential impact on the replenishment of rock lobster stocks in FNQ and Torres Strait. In this phase of the Southern

Oscillation, the East Australian Current is strengthened with many consequences for downstream ecosystems. The long-term outlook under climate change for boundary currents adjacent to the GBR is unknown but major changes will have profound consequences for the replenishment and dynamics of most populations.

Torres Strait Tide Gauge Array

The Torres Strait and Gulf of Carpentaria remain a neglected region in terms of infrastructure and development, in all forms, not just ocean observing. The region however is economically significant and supports important commercial fisheries and is a major thoroughfare for shipping. The Straits provide a third alternative pathway for Pacific Ocean waters to exchange with the Indian Ocean. Whilst this is a very shallow region (~15m), large sea level gradients in excess of 6m can occur due to the phasing of the tides on either side of the Straits, and the generally higher sea levels in the Coral Sea

The observational strategy in this particular application for IMOS is beyond sea level monitoring, per se, but to use the tide gauge array as a way to indirectly determine integrated current flow from the surface slopes and then derive the volume fluxes through the Torres Strait. It is necessary to take this approach instead of a simple current meter array given the complex and variable topography. In tandem, regular deployments of surface drifters will help determine Coral Sea and Gulf of Carpentaria/Arafura Sea exchanges.

2.1 NAOS

The Northern and Western Australian shelves are one of the most remote and harsh environments in the world. It is a significant growth area for industry however there are very few long term observations of the region's ocean climate. NAOS will attempt to fill the vast northwest gap for Australia's ocean observing system.

Arafura/Wessels

The Southern Arafura Sea and Gulf or Carpentaria have been previously identified as a priority area in the *Review of Marine Research in Tropical Australia*. While the region has received a degree of research effort, the oceanography of the region is still poorly described. The Gulf of Carpentaria and Arafura Sea provide a pathway, via the Torres Strait, for water from the Coral Sea to pass through to the northeastern Indian Ocean. The region is generally shallow, and bounded by mudflats, sea grass and mangrove ecosystems, which together with large volumes of fresh water from many rivers draining the western escarpment of the Great Dividing Range and Arnhem Land, provide an environment that is highly productive and supports large commercial fisheries. Like the Kimberley, the region experiences a tropical monsoonal climate with a wet season lasting from November to March and a dry from April to October. Coupled to this the monsoonal cycle is a strongly seasonal wind regime with north westerly winds during the wet season and south-east trade winds during the dry season.

The strong seasonality of the winds dominate the circulation in the Gulf. During the northwest monsoon a clockwise circulation prevails during December to April, however this reverses and becomes an anti-cyclonic gyre during the southeast trade winds season April to November (Forbes and Church, 1983). Tregoning (2008) found that there is a seasonal fluctuation in sea level of over 40 cm in the Gulf due to the seasonal winds setting up water levels during the monsoon and the subsequent relaxes with the SE trades. Implications of this may be quite significant as the movement of water westward through the Arafura Sea may influence the onset of the Holloway Current and by extension the Leeuwin Current that affects the western seaboard of the continent.

The Arafura and Wessel mooring pair will therefore be able to monitor the seasonal movement of waters and perhaps provide a predictor of the onset of the Holloway Currents on the NW shelf, and by extension perhaps the Leeuwin Current as well.

Indonesian Through flow transect

The ITF is generated by the wind field over the Pacific Ocean, primarily the Trade Winds, which pile up water on the western side of the ocean creating a pressure gradient from the Pacific toward the Indian Ocean. It is a system of currents flowing through the passages between the Indonesian Archipelago, Timor Leste and northwest Australia. The largest single component of ITF flows in the narrow passage between Darwin and Timor Leste. While its net mass (volume) transport is moderate, the current transports a significant amount of heat.

The ITF controls the strength of the Leeuwin Current and in particular its inter-annual variability. Most current maps show the ITF to flow through Indonesian passages and then flow along the Timor Trench to join the South Equatorial Current. However the ITF can also have a major influence on the slope and shelf regions of northern Australia.

By extending the BAOS deep water moorings with a cross-shelf transect of moorings into Joseph Bonaparte Gulf, the volume flux of waters between Timor and Australia will be able to be estimated. The transect is co-located on a JASON-2 altimeter track to look at cross shelf sea levels in a macro-tidal shelf region. The shelf transect will also provide a good opportunity to monitor the strength and variability of the Holloway Current and other shelf processes.

Kimberley Transect

A Marine Nation identifies the Kimberley Coast as one of the Australian ocean and coastal regions containing “iconic treasures … with stunning biodiversity, much of which is endemic to the region, and still largely unknown.” The Kimberley region is generally considered to be a source region of the Leeuwin Current and is a region of energetic tides (largest tides in the world adjacent to an open coastline) and associated nonlinear internal waves (Holloway, 1995), weak wind forcing in the absence of tropical cyclones (Church and Craig, 1998), low surface wave energy (neglecting those generated by tropical cyclones) and strong wintertime evaporative fluxes (Holloway, 1995).

Pilbara Transect

The Pilbara is located in the heart of offshore oil and gas industry and export of iron ore resulting in major shipping activity. The mooring transect here provides an opportunity to observe the developing Leeuwin current between the Kimberley transect and the Ningaloo NRS to the south.

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

The GBROOS moorings are regularly serviced every 6 months and this routine program will be extended through to June 2013 by AIMS. Cruises are split between the Southern and Northern arrays and are currently on track to be serviced in 6 month cycles from April and June.

The majority of NAOS is planned to be deployed prior to June 2010 from the RV Solander by AIMS staff. The ITF transect purchase and deployment will be delayed to be in concert with the deep water moorings operated by BAOS.

Yongala NRS

Serviced by a charter vessel every 6 months during the regular GBROOS array servicing.
A small AIMS vessel (Apollo) is used for the monthly sampling by AIMS staff.

Darwin NRS
Monthly biogeochemical sampling performed by Darwin based AIMS and NRETA staff. Six monthly servicing performed with either the RV Solander or with the assistance of a Pilot vessel through the collaboration with Darwin Port Authority.

Ningaloo NRS
Mooring servicing to be done by AIMS NAOS staff every 6 months. The monthly biogeochemical sampling will be done through UWA and the WAIMOS node.

2.5 List of major equipment to be purchased

A list of the major equipment to be purchased, timing and funding sources are shown in tables 1 and 2 below. Capital approved in IMOS-1 is not included here.

Q-IMOS receives $100K fro ADCP upgrades to Darwin and Yongala NRS

NAOS purchases have been broken down into transect lines: Arafura/Wessels, ITF, Kimberley and the Pilbara. These moorings are delayed mode to keep costs down in order to maximise the coverage of the vast Northern Australian shelf waters.

The Ningaloo NRS also receives $50K for another ADCP.

Table 1 Summary of extension capital equipment to be purchased including the timing

	2009/10 (NCRIS/EIF)	2010/11 (NCRIS/EIF)	2011/12 (EIF)	2012/13 (EIF)	Total (NCRIS+EIF)
QMOS					
GBROOS moorings		0	0	0	0
Yongala NRS	50,000	0	0	0	50,000
Darwin NRS	50,000	0	0	0	50,000
NAOS					
Arafura/Wessels moorings	392,519				392,519
Indonesian Through Flow - ADCPs 75 KHz 3 @58,700	176,100	0	0	0	176,100
Indonesian Through Flow - PIES 3@27,548	82,644	0	0	0	82,644
ITF shelf moorings		527,450	0	0	527,450
Kimberley moorings	832,883		0	0	832,883
Pilbara moorings	527,450		0	0	527,450
Ningaloo NRS	50,000				50,000

3. Access and pricing:

- How will access be provided

An ANMN and IMOS principle is free access to data. All ANMN data will flow through the IMOS portal managed by eMII. Data from all asset groups will be provided both for telemetry and download of delayed data in a timely and reasonable manner.

- How will data be managed

Data management will be the joint responsibility of eMii, and the sub-facilities. For many aspects of the data streams identical software (matlab toolbox and deployment database) run in parallel to provide a continual backup of the processing, data delivery and QC of telemeter data. Delayed mode QC, in which the data subjected to a thorough check, can only be done every 3-6 months after a mooring is serviced. This will be handled by individual sub-facilities and the data delivered to eMii, ensuring that all of our mooring data is of the highest quality. Additional resources are being sought through the main facility to ensure that QC and QA are of a high standard.

- Dependencies on external / other facilities (national and international)

Funding is complex with NCRIS, the initial EIF funds and the next round of EIF funds being split between extension and enhancement budgets. In particular bridging finance for the 2010/11 financial year for the initial EIF funds will be sought under the extension funding model as special extension funding. Individual sub-facility plans also have a variety of external dependencies with the numerous collaborating organisations.

- Collaborative structures for allocation of priorities

The design of ANMN is the result of a national, collaborative process via the sub-facility leaders of the network and input from regional nodes. National coordinating meetings for the facility are held twice a year between CSIRO, AIMS, SARDI, Curtain University and the SIMS to ensure that national priorities, such as effective coverage to feed into models, are met. This project is also overseen by the IMOS office.

Q-IMOS and NAOS will also work in collaboration with the appropriate local research collaborators and stakeholders. These include UWA, JCU, NRETA, CDU, CSIRO, TSRA, QLD state government, GBRMPA, Darwin Port Authority, DEWHA and AMSA.

4. Governance

- Performance indicators

These are the production of timely data steams outlined above.

- Describe key risks and risk management strategies

Please refer to the main ANMN plan. Some specific issues are detailed below.

Risk - loss of vessel capability through break-down of AIMS' *RV Solander and Charter Vessel*. Management: Various charters can provide a similar level of service. We have built a portable laboratory for placement on suitable vessels.

Risk – mooring design and sampling. Management: to ensure improved quality of data streams mooring design and sampling strategies are being continuously assessed. In some cases this may mean a re-design or even perhaps relocation.

Risk – loss of moorings due to equipment failure/bad weather. Management: to minimise loss, most moorings have two releases or a ground line and sub-anchor and surface float. In addition, all ADCP float packs will have satellite locators for recovery. AIMS insures all gear deployed in the field. NAOS in particular is moving to remote and poorly understood regions where large currents and harsh environments exist.

5. Budget:

- EIF Funds

The budget is summarised in accordance with Q-IMOS and NAOS structures.
A 3% annual CPI increase is assumed as is an 0.80 US$ exchange rate.

5.1 Extension of existing Facility

Q-IMOS
Summary: The totals are $339,000 for the capital and $217,000 for capital. Total = $1,139,013

Capital: The extension of GBROOS has no new capital request for the extension.

Salaries: Have increased to reflect actual operating costs of a team of about approximately 4.O EFT positions that are required to maintain the increasingly complex mooring array. Total = $700,000 over 2 years.

Operating:
Vessel: We shall continue to charter a commercial vessel on the GBR.
Total = $600,000 per annum. Another $461,000 is needed to service, maintain, calibrate and pay for operating expenses.

Darwin and Yongala NRS
Summary: The Yongala and Darwin salary and operating costs have been costed at $400,000 and $558,000 each for the 2 year extension. Total = $1,059,000 includes the capital for ADCPs.

Budgets have been adjusted upwards to reflect actual operating costs which were under costed in IMOS-1.

Capital: The extension of the NRS has $100,000 for ADCPS for the two stations.

Salaries: Yongala costs $51,379 per annum and Darwin $84,934. Darwin will require a contractor to assist with the biogeochemical sampling and has higher overall costs.

Operating: The Yongala and Darwin operating costs have been costed at $296,000 and $386,000 each for the 2 year extension period.

NAOS
Summary: The totals are $339,000 for the capital and $217,000 for capital. Total = $1,139,013

Capital: The full array will cost $2.330M consisting of Arafura/Wistari ($392,519), ITF shelf ($537,450), Kimberley ($832,883) and the Pilbara transect ($527,450). The deep ITF moorings operated bi BAOS have requested 2 ADCPs and 3 PIES costing a total of $258,744.

Salaries: A field going and data processing team of 4.O EFT positions are required to maintain the NAOS mooring array in its current form and this will ramp up as the full array is deployed over 2 years. Total salaries = $1.228M over 4 years.

Operating:
Vessel: The RV Solander will be tasked for 90 days each year to service the array extending from Ningaloo Reef to the Wessels off Arnhem land. It is charged at $10,000 per day bringing the total cost to $900,000 per annum. The total operating costs for the period 2010 to mid 2013 will cost $4.684M

Ningaloo NRS

Summary: The Ningaloo mooring will be serviced by the NAOS group every 6 months as part of the NAOS servicing run. Biogeochemical sampling costs have not been included in this budget as that will be operated by UWA. Total = $281,700 includes the capital for ADCP upgrade.

Capital: The extension of the NRS has $50,000 for an ADCP.

Salaries: These will ramp up from 2010 after a handover of the mooring from CSIRO. The first dull year of operating is expected to be 2010/11 and is budgeted to be $16,831.

Operating: The Ningaloo mooring operating costs have been costed at $48,000 in 2010/11 costing a total of $171,500 for the period 2010-mid 2013.

5.2 Enhancement: 2010/2011 – 2012/2013

Torres Strait sea level array

The TSRA have the necessary capital to build 4 to 5 real time seal level gauges. Q-IMOS requests operating funds starting in 2010 for a tide gauge network in the Torres Strait but recognises that IMOS does not have an appropriate Facility to receive such funds. It is estimated to cost $150,000 per annum for salary and operational funds.

5.3 Co-investments – source and nature

AIMS will co-invest salary overheads ($699,000 for Q-IMOS 2011/12-2012/13 and $1.228M for NAOS from 2010 to 2013). RV Solander ship time of $10,000 per day for NAOS related mooring work will also be co-invested, totalling $2.9M from 2010 to 2013.

Darwin Port Authority has provided assistance with the NRS buoy by providing basic mooring infrastructure and on occasion a Pilot vessel to assist with deployments. The actual cost is difficult to ascertain however it is a substantial contribution.

Torres Straits Regional Authority has the capital funds $1,000,000 for a network of gauges to monitor sea-levels but lacks the means for servicing and sustaining such a network. Q-IMOS seeks these operating costs assuming that IMOS and the TSRA can reach agreement about mutually beneficial co-investment.

5.4 Staffing details

Craig Steinberg, Mooring sub-facility leader, 50% Q-IMOS & NAOS
Scott Bainbridge, GBROOS Project Leader, 5% Q-IMOS
Ms Felicity McAllister, Experimental Scientist, 50% Q-IMOS
Dr Paul Rigby, Experimental Scientist, 100% Q-IMOS
Mr John Luetchford, Senior Oceanographic Technican, 85% Q-IMOS
Chris Bartlett and Neil Roberts Oceanographic Technician 100% Q-IMOS

Mr Peter Speare, Senior Experimental Scientist, 20% Yongala NRS
Ms Michelle Skuza, Senior Experimental Scientist, 20% Yongala NRS

Dr David Parry, ATRF lead scientist –NAOS (AIMS in-kind)
Dr David K Williams, Senior Experimental Scientist, 20% Darwin NRS
Julia Fortune, Biogeochemical Sampling, 20% Darwin NRS

Frank Coman, CSIRO Oceanographic Technician, 100% North Stradbroke Island NRS

A team of ~4.0 EFT Experimental Scientists and Oceanographic Technicians to be appointed for the NAOS work. The balance will be taken up by administration and management of the program.

5.5 **Description of proposed new infrastructure for Nodes** – see also Table 5 below
The following tables summarise the capital purchase of items for each of the component parts of this sub-facility.

Table 4 NAOS Capital Purchase Summary

Capital Items purchase	AUS$ USD$ exchange rate 0.8				
	make & model	cost per item US$	cost per item	Num.	total $A
Timor Array - ITF					
Timor A					
Current Profiler	TRDI Longranger 75khz	55,000	$ 68,750.00	1	$ 68,750.00
Timor A total					**$ 68,750.00**
Timor B					
Current Profiler	TRDI Longranger 75khz	55,000	$ 68,750.00	1	$ 68,750.00
Timor B total					**$ 68,750.00**
Ombai					
Current Profiler	TRDI Longranger 75khz	55,000	$ 68,750.00	1	$ 68,750.00
Ombai total					**$ 68,750.00**
PIES mooring	PIES	27,548	$ 27,548.00	3	**$ 82,644.00**
Shelf Mooring 20-100m			**$ 128,750.00**	3	**$ 386,250.00**
Flotation	Flotation Tech 45"	17,000	$ 21,250.00	3	$ 63,750.00
Current Profiler	RDI Workhorse BB 300Khz	26,000	$ 32,500.00	3	$ 97,500.00
Temperature loggers 10	SBE39T +1PT	1,225	$ 15,312.50	3	$ 45,937.50
Shallow water recovery	AIMS		$ 1,000.00	3	$ 3,000.00
Acoustic Releasex2	Benthos ACR 866	10,600	$ 26,500.00	3	$ 79,500.00
33% spares			$ 32,187.50	3	$ 96,562.50
Shelf Mooring 20-100m +WQM			**$ 202,083.33**	4	**$ 808,333.33**
Flotation	Flotation Tech 45"	17,000	$ 21,250.00	4	$ 85,000.00
Water Quality Monitor + PAR	Wetlabs WQM + PAR	44,000	$ 55,000.00	4	$ 220,000.00
Current Profiler	RDI Workhorse BB 300Khz	26,000	$ 32,500.00	4	$ 130,000.00
Temperature loggers 10	SBE39T +1PT	1,225	$ 15,312.50	4	$ 61,250.00
Shallow water recovery	AIMS		$ 1,000.00	4	$ 4,000.00
Acoustic Releasex2	Benthos ACR 866	10,600	$ 26,500.00	4	$ 106,000.00
33% spares			$ 50,520.83	4	$ 202,083.33
Slope Mooring 200-400m			**$ 175,750.00**	4	**$ 703,000.00**
Flotation	Flotation Tech 45"	17,000	$ 21,250.00	4	$ 85,000.00
Temperature loggers x10	SBE39T +1PT	1,225	$ 15,312.50	4	$ 61,250.00
Current Profiler	TRDI Longranger 75khz	55,000	$ 68,750.00	4	$ 275,000.00
Acoustic Releasex2	Benthos ACR 866	10,600	$ 26,500.00	4	$ 106,000.00
33% spares			$ 43,937.50	4	$ 175,750.00
Kimberley Deep			**$ 284,133.33**		**$ 284,133.33**
Current Profiler	TRDI Quartermaster 150khz	47,000	$ 58,750.00	1	$ 58,750.00
Current Profiler	TRDI Longranger	55,000	$ 68,750.00	1	$ 68,750.00

	75khz				
Nortec					$ -
Flotation	Flotation Tech 45"	17,000	$ 21,250.00	1	$ 21,250.00
Flotation	Flotation Tech 40"	15,000	$ 18,750.00	1	$ 18,750.00
Temperature and Conductvity	SBE37		$ 10,500.00	1	$ 10,500.00
Acoustic Release		10,600	$ 26,500.00	1	$ 26,500.00
Buoy Locators	Novatec RDF+Strobe		$ 3,600.00	1	$ 3,600.00
Mooring components			$ 5,000.00	1	$ 5,000.00
33% Spares			$ 71,033.33	1	$ 71,033.33
Totals	NAOS + Timor +Ombai				**$ 2,470,610.67**
	NAOS				**$ 2,181,716.67**

Queensland and Northern Australia - Extension

Extension of existing GBROOS Moorings and NAOS

NCRIS/EIF Funding (*Note 2*)		2009/10 (NCRIS/EIF)	2010/11 (NCRIS/EIF)	2011/12 (EIF)	2012/13 (EIF)	Total (NCRIS+EIF)
Capital	**QMOS**					
	GBROOS moorings		0	0	0	0
	Yongala NRS	50,000	0	0	0	50,000
	Darwin NRS	50,000	0	0	0	50,000
	NAOS					
	Arafura/Wessels moorings	392,519				392,519
	Indonesian Through Flow - ADCPs 75 KHz 3 @58,700	176,100	0	0	0	176,100
	Indonesian Through Flow - PIES 3@27,548	82,644	0	0	0	82,644
	ITF shelf moorings		527,450	0	0	527,450
	Kimberley moorings	832,883		0	0	832,883
	Pilbara moorings	527,450		0	0	527,450
	Ningaloo NRS	50,000				50,000
Salaries	**QMOS**					0
	GBROOS moorings			343,588	355,564	699,152
	Yongala NRS			51,379	53,178	104,557
	Darwin NRS			84,934	87,906	172,840
	NAOS					0
	Arafura/Wessels moorings	20,426	42,077	43,339	44,639	150,480
	ITF deep moorings					0
	ITF shelf moorings		61,277	130,017	133,917	325,210
	Kimberley moorings	49,021	100,984	104,013	107,134	361,152
	Pilbara moorings	44,936	92,569	95,346	98,206	331,056
	Ningaloo NRS	8,170	16,831	17,336	17,856	60,192
Operating	**QMOS**					
	GBROOS moorings			1,061,719	1,093,571	2,155,290
	Yongala NRS			145,760	150,133	295,893
	Darwin NRS			190,104	195,807	385,911
	North Stradbroke Island NRS	153,000	100,000	100,000	100,000	453,000

	NAOS					
	Arafura/Wessels moorings	71,750	180,596	186,013	191,594	629,953
	ITF deep moorings					
	ITF shelf moorings		188,150	483,841	498,356	1,170,347
	Kimberley moorings	153,230	435,563	448,630	462,089	1,499,511
	Pilbara moorings	141,590	346,643	357,042	367,754	1,213,029
	Ningaloo NRS	23,280	47,957	49,396	50,877	171,510
						0
	NCRIS/EIF Funding Total	**2,826,999**	**2,140,094**	**3,892,456**	**4,008,580**	**12,868,130**

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**
AIMS	NAOS Vessel	300,000	750,000	927,000	954,810	2,931,810
	Q-IMOS Vessel					0
AIMS	NAOS Salary overheads	122,553	313,736	390,050	401,752	1,228,091
AIMS	Q-IMOS Salary overheads			343,588	355,564	699,152
AIMS	Yongala NRS			51,379	53,178	104,557
AIMS	Darwin NRS			84,934	87,906	172,840
CSIRO	Timor Deep					0
	In-kind Co-investment Total	**422,553**	**1,063,736**	**1,796,951**	**1,853,210**	**5,136,450**
	TOTAL Resources	**3,249,552**	**3,203,831**	**5,689,407**	**5,861,790**	**18,004,580**

Queensland and Northern Australia - Enhancement

Enhancement to Facility / New Facility (*Note 1*)

NCRIS/EIF Funding (*Note 2*)		**2010/11** (EIF)	**2011/12** (EIF)	**2012/13** (EIF)	**Total** (EIF)
	Far Northern GBR Moorings				0
	Coral Sea Mooring				0
	Torres Strait Sea Level Array	0	0	0	0
	Far Northern GBR Moorings				0
	Coral Sea Mooring				0
	Torres Strait Sea Level Array	50,000	52,000	53,000	155,000
					0
	Far Northern GBR Moorings				0
	Coral Sea Mooring				0
	Torres Strait Sea Level Array	100,000	100,000	100,000	300,000
	NCRIS/EIF Funding Total	**50,000**	**52,000**	**53,000**	**155,000**

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**
TSRA	Torres Strait Sea Level Array, Provisional, Medium	1,000,000			1,000,000
AIMS	Salary overheads	50,000	52,000	53,000	155,000
(enter Organisation)	(insert description, including likelihood)				0

In-kind Co-investment Total	**1,050,000**	**52,000**	**53,000**	**1,155,000**
TOTAL Resources	**1,100,000**	**104,000**	**106,000**	**1,310,000**

Table 5 Observations required by the Nodes in relation to this facility

Facility	**Observations required by the Node**			
	NCRIS Funded (already allocated to Jun11)	EIF first $8M funded (already allocated to Jun10)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
	(see Appendix 1 of the Guidelines)			
Bluewater & Climate				
WAIMOS				
GBROOS/Q-IMOS	4 GBR Shelf and Slope Mooring pairs NRS Yongala + Darwin	ADCP for NRS	4 GBR Shelf and Slope Mooring pairs 2 NRS Yongala + Darwin + pCO2	Torres Strait sea level array
NSW-IMOS				
SAIMOS				
NAOS	NRS Darwin	4 Mooring transects: Arafura/Wessels, Timor, Kimberley, Pilbara ADCP for Ningaloo NRS	NRS Darwin	4 Mooring transects: Arafura/Wessels, Timor, Kimberley, Pilbara

Acoustic Observatories

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

Extend and enhance the Australian Mooring Network sub facility, passive acoustic observatories

Sub Facility Project Plan for 2010-2013

Prepared on 29 October 2009

CMST reference - 877

Overview:

Proposed Infrastructure Investment:	Extend and enhance passive acoustic observatories
IMOS Facility:	Australian Mooring Network
Operating Institution:	Curtin University, Western Australia
Sub Facility Leader (for this Proposal):	A. Prof. Robert McCauley, Centre for Marine Science and Technology (CMST) Curtin University, 0428 101 046, r.mccauley@cmst.curtin.edu.au
Other(s) key people involved:	A. Prof. Alexander Gavrilov CMST Curtin Uni., Dr. Jason Gedamke Australian Antarctic Division
Co-investing / Collaborating Institutions:	Curtin University, Australian Antarctic Division

Nature of Investment:
This proposed investment comprises four components with budgets presented separately. The data products are ocean noise samples with some pre-processed data of whale presence and summary information provided.

The four components are:

C. ***Extend & Enhance*** - Extend from mid-2011 into mid 2013 existing IMOS passive acoustic observatories (funded under the NCRIS scheme) located: 1) in the Perth Canyon: 2) south of Portland; and 3) off the NSW coast. Enhance the operations of these (and reduce maintenance costs) by building five spare sets of mooring hardware to enable hot swapping of moorings and with one set of gear as a spare.

D. ***Enhance: Southern Ocean*** - Provide and deploy two passive acoustic moorings each with single receivers in the southern ocean and along the Antarctic shelf from summer 2010-2011 into summer 2013;

E. ***Enhance: Northern Australia*** - Provide and deploy one passive acoustic observatory for the proposed northern Australian mooring line from mid 2010 to mid 2013.

F. ***Enhance: Queensland*** – provide and deploy one sea noise logger mooring east of Stradbroke Island from mid 2010 to mid 2013.

A passive acoustic observatory comprises four moorings with independent receivers set in a grid over several km so as to enable source tracking. The ***Extend & Enhance*** and ***Enhance: Northern Australia*** components utilise tracking grids. The proposed southern ocean moorings all comprise single, widely spaced receivers without source tracking capability. Only a single noise logger is proposed for the mooring for ***Enhance: Queensland***, again with no tracking capability. The ***Extend & Enhance*** component includes hardware to enable hot swapping for the ***Enhance: Northern Australia*** and ***Enhance: Queensland*** components.

Implementation Strategy:

Summary

A ***Extend & Enhance*** – Maintain existing passive acoustic moorings until 2013. The three sites of the Perth Canyon, Portland and NSW are currently being serviced at a ten month turnaround cycle. Five spare sets of sea noise loggers and acoustic releases will be budgeted for (enhance part), otherwise all costs relate to servicing moorings and providing data. Currently moorings are recovered, returned to port, serviced and re-deployed on a separate trip. Extra hardware and spare mooring parts will be prepared to enable hot-swapping of moorings, reducing vessel days and staff field time. Equipment budgeted here will service other passive acoustic observatories if these are supported.

B ***Enhance: Southern Ocean*** – The CMST of Curtin University will build and supply to the Australian Antarctic Division (AAD) two sea noise loggers and moorings suitable for 3000 m depth deployments. The AAD will provide staff and ship time to deploy and recover the two moorings during summer supply runs to Australian Antarctic bases. We will aim for the first deployment in the summer of 2010-2011, with this dependant on funding available mid 2010 since vessels leave Australian late each year. Two spare moorings will be prepared to enable hot swapping (ie. a total of four moorings are budgeted). The AAD will service mooring parts, the CMST will service the sea noise logger hardware. Scope exists for sharing within IMOS the deepwater acoustic releases required for the moorings. The AAD and CMST have been collaborating in deploying sea noise logger moorings around the Southern Ocean over four years.

C ***Enhance: Northern Australia -*** The CMST of Curtin University will build four sea noise loggers and moorings suitable for deployment in northern Australia, with the first deployment scheduled for late 2010. Synergy with the ***Extend*** proposal (A) exists such that only one set of gear needs to be built and hot-swapping of moorings can be carried out with gear built or purchased under the ***Extend*** option. The CMST has extensive experience in setting sea noise loggers in northern Australia.

D ***Enhance: Queensland*** – The CMST will build one sea noise logger and its mooring, deploy this east of Stradbroke Island as advised by the QMOS node (GBROOS) and maintain it at a ten month cycle until mid 2013.

Objectives

The proposal objectives are to provide and archive ocean noise samples from Australian waters, with concurrent meta data, calibrations and file format descriptions. Sources of ocean noise vary, broadly comprising biological, physical and man-made sources. Different users may analyse the samples for different objectives, for information on biological phenomena such as whale passage, on physical events such as ice calving, wind noise or rainfall patterns, or on levels of man-made ocean noise and changes in this over time. The raw ocean noise data is complex and does not come as a string of whale counts, fish presence or immediate indexes of say ocean rainfall trends (which

are derived from rainfall noise). But, while the data uptake and analysis may not be immediate and requires considerable processing, having the archived sea noise data will enable future researchers access to high quality historic data sets for analysis of a wide range of phenomena over hopefully decadal time scales. It is difficult to envisage any other single sensor which can provide information on such wide ranging phenomena.

As an example of what can be done with ocean noise samples, all great whales vocalise profusely with species specific signal types. By monitoring whale vocalisations one can capture a high resolution time-series of whale passage for multiple species and so monitor whale populations. This can be done in time and space by using the passive acoustic observatory local tracking capability or widely spaced receivers (continent scale for the current IMOS passive acoustic observatories). As an example in October 2009 on recovery of the currently deployed IMOS passive acoustic observatory in the Perth Canyon, data on visitation of the Canyon by pygmy blue whales over a ten year span will become available. Examples of information available on physical sea noise sources includes: seasonal and climate driven inter-annual changes in rainfall over large ocean areas; calculating the size and propagation speed of seafloor ruptures due to earthquakes; deriving long term trends in seismic activity in subsea fault zones; or monitoring Antarctic ice calving.

Immediate data uptake will have objectives of: monitoring blue whale stocks (true and pygmy blue whale) around Australia and in the southern ocean; monitor whale passage along the east Australian coast (several species); and obtain short range ice cracking signals from the Antarctic shelf edge for use in a program monitoring Antarctic ice disintegration via underwater noise.

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

A ***Extend* & *Enhance*** –

1) CMST, second half 2010 - Build five sea noise loggers, prepare spare mooring hardware, purchase five spare acoustic releases (ORE CART's) to enable hot swapping of moorings and as spares;

2) CMST, mid 2010 to mid 2013, service moorings on a ten month cycle - The currently planned schedule is listed in Table 2 using dates from mid 2010 onwards only. The budget figures for the Extend option listed at the document end include all mooring servicing costs. The IMOS loggers are a new generation of CMST-DSTO sea noise loggers for which we have yet to fully establish the battery life. Considerable effort has gone into making the electronics low power, with the IMOS housings having more batteries and larger disk drives than our previous versions. We currently get 10 month deployments from our sea noise loggers, this is what the IMOS servicing schedule given in Table 2 has been set at, noting that we while we have increased battery and disk capacity, we have increased the sampling duty cycle in the IMOS deployments. Once we have recovered several data sets it may be that we can increase the IMOS passive acoustic mooring service interval to 12 months, with 10 months the minimum estimate of servicing.

Table 2: Currently planned mooring service schedule for existing IMOS passive acoustic arrays based on a ten month service interval. Abbreviations are: TA = turnaround; R= recover; D=deploy.

Perth Canyon		Portland		NSW	
Date	type	Date	type	Date	type
06-Jul-2010	TA	18-Sep-2010	TA	07-Jul-2010	TA
13-Mar-2011	TA	26-May-2011	TA	14-Mar-2011	TA
06-Nov-2011	TA	31-Jan-2012	TA	19-Nov-2011	TA
03-Jul-2012	TA	07-Oct-2012	TA	26-Jul-2012	TA
28-Feb-2013	TA	14-Jun-2013	R	02-Apr-2013	R
Jun-2013	R				

3) CMST, ongoing, prepare, maintain and service noise logger electronics and mooring hardware – Each set of electronics and its associated hydrophone needs to be serviced on recovery. Full servicing from recovery to deployment comprises: end caps cleaned; hydrophone, connector and cable checked for damage; data downloaded; clock drift read from GPS transmitted signal; system gain calibration; data quality checked; hard disks re-formatted; on board battery changed; system clock re-set; and unit re-programmed. Some of this servicing can only be done in the workshop by the CMST engineer, some can be carried out in the field.
4) CMST, ongoing, Prepare data and meta-data for supply to IMOS, provide baseline analysis (simple metrics which can be retrieved easily from the sea noise data with no or minimal checking).

B ***Enhance: Southern Ocean*** –

1) CMST, late 2010 - Build two sea noise loggers and moorings to be deployed in the second half of 2010 for deployment by an Antarctic supply vessel departing Hobart in late 2010. These moorings will be in the traditional oceanographic style, using a short riser with the sea noise logger mounted in the riser string.
2) Australian Antarctic Division staff deploy and service moorings annually during base supply runs.
3) CMST, early to mid 2011 – Build two spare noise loggers and moorings to replace in-situ gear over summer of 2011-2012.
3) CMST, ongoing - service noise logger electronics annually and deals with data supply for IMOS (as for 3 and 4 in Extend option).

C ***Enhance: Northern Australia –***

1) CMST, late 2010, build four sea noise loggers and moorings for deployment late 2010 or early 2011.
2) CMST / IMOS staff, late 2010 into 2013, deploy and recover sea noise moorings at schedule set by IMOS Australian Mooring Network. At the time of writing this document the location of the proposed northern Australian moorings was not specified. For budgeting it is assumed that the northern Australian passive acoustic observatory will be deployed in 150-350 m water depth and vessel costs will either be in-kind or budgeted elsewhere. For budgeting a mooring service schedule was required to enable staff commitment calculations thus a deployment date of 01-Nov-2010 was specified and a ten month turnaround used. This gives the mooring service schedule in Table 3, although this is totally dependant on the in-kind vessel logistics.

Table 3: Proposed deployment schedule for the northern Australian passive acoustic observatory.

Date	Task
01-Nov-2010	Deploy
09-Jul-2011	Recover and deploy
15-Mar-2012	Recover and deploy
20-Nov-2012	Recover and deploy
30-Jun-2013	recover

3) CMST, ongoing, services noise logger electronics annually and deals with data supply for IMOS (as for 3 and 4 in ***Extend*** option).

D. ***Enhance: Queensland*** –

1) CMST, mid 2010 - Build one sea noise loggers and mooring to be deployed in the second half of 2010 east of Stradbroke Island.
2) CMST maintain mooring on a ten month cycle with the servicing schedule as for Table 4.
3) CMST, ongoing - service noise logger electronics annually and deals with data supply for IMOS (as for 3 and 4 in Extend option).

Table 4: Servicing schedule for Stradbroke Island noise logger.

Brisbane	
Date	type
01-Sep-2010	Deploy
09-May-2011	Recover and deploy
14-Jan-2012	Recover and deploy
20-Sep-2012	Recover and deploy
28-May-2013	Recover

List of major equipment to be purchased / developed

Major equipment to be purchased or built is listed in Table . All sea noise logger electronics have been designed by the CMST at Curtin specifically for collecting sea noise, with an emphasis on low-power and low self-noise (electronic). The current IMOS noise logger electronics comprise a unit which fits into a 100 mm ID housing, is 150 mm in length and uses a 160 GB hard disk drive. A battery string of 52 D sized alkaline batteries is used in the housings set around Australia. The ***Enhance: Southern Ocean*** housings will have increased battery packs to compensate for lower temperatures and so worse battery performance.

All moorings will have temperature loggers attached. On the tracking grids temperature loggers will form a spatial array at two depths. This data will be fed to the EMII IMOS portal for dissemination.

The ***Extend & Extend***, ***Enhance: Northern Australia*** and ***Enhance Queensland*** components will share a single pool of four sea noise loggers and mooring components for hot-swapping of moorings plus have one spare sets of gear to cover any instrument failures. These are budgeted in the ***Extend & Extend*** option. The ***Enhance: Southern Ocean*** component will require a complete set of replacement hardware and moorings to enable hot-swapping. It is considered that the risk of mistakes being made by attempting to carry out at-sea re-furbishment of the acoustic release, sea

noise logger, recovery light and VHF transmitter, far outweighs the cost of simply having a full set of replacement equipment. Re-furbishing the noise loggers at sea gives almost no quality control on the data, which is a reasonable risk as components (particularly the hydrophone, its underwater connector and cable) can be damaged easily during deployment and recovery. While having a full set of four replacement moorings doubles the hardware cost, it will greatly reduce inherent risk of equipment loss or failure and allow continual data to be collected (rather than every second year of data if only one set of gear were available and this serviced ashore).

Aside from the sea noise loggers all mooring gear comprises off the shelf components. For moorings less than 500 m depth, single ORE CART acoustic releases are used with deep sea fishing buoys as flotation. A schematic of a coastal passive acoustic mooring is shown on **Figure 1** in appendix 1. For the proposed ***Enhance: Southern Ocean*** moorings, a conventional oceanographic style mooring is proposed using a Benthos 865-A deep sea acoustic release, steel floatation and a light and VHF transmitter on each mooring (to assist recovery at the surface in the Southern Ocean).

Table 5: List of equipment to be built or purchased. UVS = Underwater Video Systems

Equipment	Requirement	Source	Date to be purchased /developed
	Extend & Extend		
5 x ORE CART's	hot-swapping &two spares	US	Order mid 2010
5 x sea noise loggers	For hot-swapping moorings and two spares	Curtin	Order components mid 2010, build four by end 2010, two (spare) by mid 2011
Battery packs	New pack each noise logger & acoustic release, each deployment	Siomar, WA	Order in batches, long lead times
Mooring gear	Replacement mooring hardware	WA local, Tasmania (deep sea floats)	As required
	Enhance Southern Ocean		
2 x sea noise loggers	For first deployment	Curtin	Order components mid 2010, build by Oct 2010
2 x 3000 m rated housings	For first deployment	Ocean Industries, WA	Order components mid 2010, build by Oct 2010
2 x sets battery packs	For first deployment, noise loggers, acoustic releases, lights, VHF transmitters	Siomar, WA	Order mid 2010
2 x Benthos 865-A acoustic release & deck unit	For first deployment	Benthos, US	Order mid 2010 for delivery Oct 2010
2 x mooring hardware floats, lights, VHF transmitters & direction finders	For first deployment	UVS	Order mid 2010 for delivery Oct 2010
2 x housings and logger electronics	For hot swapping in subsequent years	Curtin / Ocean Industries	Build by mid 2011 for vessel departure late 2011
2 x Benthos 865-A acoustic release	For hot swapping in subsequent years	Benthos, US	For delivery in mid 2011
2 x spare mooring floats, lights, VHF transmitters	For hot swapping	UVS	For delivery in mid 2011
Batteries	Noise loggers, acoustic releases, VHF transmitter, light,	Siomar, WA	as required

	Enhance Northern Australia		
4 x ORE CARTS	Required for one observatory	US	Order mid 2010
4 x sea noise loggers	Required for one observatory	Curtin	Order components mid 2010, build by end 2010
Battery packs	As required	Siomar, WA	Order in batches, long lead times
Mooring gear	Floats lines etc, build four sets with spares	WA local, Tasmania (deep sea floats)	As required
	Enhance Queensland		
1 x sea noise logger	Deployment late 2010	Curtin	Mid 2010
1 x ORE CART	Deployment late 2010	ORE, US	Order mid 2010
Mooring sundry	Deployment late 2010	Local WA	Mid 2010

Access, pricing regimes:

- **How will data access be provided?**
  At the recovery of a set of sea noise loggers, raw data will be supplied to the IVEC facility in Perth for archiving. The raw data is the most valuable product as it allows potential users to analyse the data for whatever sources they wish. Data routinely supplied will be: raw data files (the sea noise samples) with a file mixed text header and footer with 16 bit unsigned binary data, in two folders per noise logger (one folder for each sampling regime); calibration files (system gain with frequency, ASCII file, [frequency gain(dB)]); a time file listing the noise logger specified UTC date and time for each noise logger file; and a meta-data file listing deployment details, file naming, formatting conventions, and description of data quality. In addition for one of the four noise loggers in a deployment grid we will provide processed data of 1/3 octaves averaged over each sample, over the centre frequencies 5 Hz to the upper bandwidth of the recording system. A single acoustic observatory of four loggers should retrieve around 640 GB of data (four HDD at 160 GB each). In addition to raw data we will provide access to Matlab routines for reading and managing raw data files, via a web library. A small amount of time has been allocated to allow us to provide some processed data. Processed data will comprise: summary images of full data sets (five day stacked spectrograms); for the southern ocean data, ASCII files listing blue whale presence, as [YY MM DD HH MM SS Source]; 1/3 octave averaged data as ASCII files; and where a local tracking capability exists some source tracking data (as output by an algorithm run across the data sets which identifies coherent signals on all loggers then tracks these in space). As we become more familiar with the sources present and a library of search algorithms is developed the source presence files may be extended to other species.

- **How will data and products be managed?**
  The CMST has been collecting sea noise samples for over 20 years. Internally we have a system for naming, archiving raw data (backing up) and accessing meta data for each deployment and advanced, in-house processing capability. Within CMST the IMOS deployments will fall within this proven system.

- **What are the dependencies on external / other facilities (national and international)?**
  The ***Extend*** option presented in this proposal is driven entirely by Curtin University and has no external or other facility input.

The ***Enhance Southern Ocean*** component depends on the Australian Antarctic Division for gear deployments and recoveries, some logistics and servicing of moorings. The AAD are offering a huge in-kind support component in access to Antarctic base-supply vessels and a staff member to participate in cruises for gear turn-arounds. Initial mooring and hardware development will be carried out by CMST of Curtin, along with annual servicing of electronics and dealing with data recovered for IMOS archiving purposes.

The ***Enhance Northern Australia*** component depends on supply of vessels for deployment and recovery of moorings only. It is anticipated that vessel time will be factored into the northern Australian mooring servicing via the Australian Mooring Network and that a CMST staff member can participate in these trips to recover and deploy the passive acoustic observatory. All other development, logistical and support costs are covered within this proposal. The CMST has extensive experience operating in northern Australia and has logistical support at various towns and a network of vessels which can be utilised.

The ***Enhance Queensland*** component depends on in-kind vessel support supplied by QMOS. For this reason the mooring will be deployed not far from proposed QMOS oceanographic moorings east of Stradbroke Island. Some in-kind support from either CSIRO (Cleveland) or UQ will be supplied for logistical purposes (storing gear). The CMST will provide and maintain all mooring hardware.

- **Collaborative structures for allocation of priorities**
  The CMST of Curtin University will be responsible for the ***Extend***, ***Enhance Northern Australia***, and ***Enhance Queensland*** options. The CMST and the Australian Antarctic Division will be jointly responsible for the ***Enhance Southern Ocean*** component.

Governance

- **Performance indicators**

The performance of the Passive Acoustics sub facility is assessed using criteria supplied by IMOS under the heading *Providing Research Infrastructure*. This performance rating is given as:

1 Value of new infrastructure by facility / node

The value of infrastructure to be provided by the facility is listed in the budget tables presented below for each component. The component totals broken down by facility and node are listed in Table 6. The value of capital equipment for each component is listed in Table 7 to Table 9.

Table 6: List of IMOS EIF support requested and in-kind support broken down by facility and node (all costs ex GST).

Grouping	IMOS EIF support	In Kind	Totals
Extend & enhance	633,931	573,000	1,206,931
Enhance Southern Ocean	447,121	459,284	906,405
Enhance Northern Australia	320,851	165,000	485,851
Enhance Brisbane	149,296	65,400	214,696
Bluewater & Climate (Southern Ocean)	447,121	459,284	906,405

WAIMOS extend & enhance	211,311	159,835	371146
WAIMOS enhance northern Australia	320,851	165,000	485,851
WAIMOS total	538,818	324,835	863,653
SAIMOS	211,310	213,952	425,262
NSW IMOS	211,310	199,213	410,523
QMOS	149,296	65,400	214,692
Totals	1,551199	1,262,684	2813883

Table 7: Items and value (ex GST and freight) of capital equipment for *Extend* option. Note labour costs for assembling and testing noise loggers are not included here.

Item	Cost
Extend& Enhance	
5 x sea noise logger electronics.	40,250
5 x Underwater housings	14,375
5 x Hydrophones	17,825
5 x underwater connectors and cable terminations	6,900
5 x ORE CART acoustic releases	50,600
5 x sets mooring gear	2,875
Temperature loggers	9,000
Total	141,825

Table 8: Items and value (ex GST) of capital equipment for *Enhance Southern Ocean* option. Note labour costs for assembling and testing noise loggers are not included here.

Item	Cost
Enhance Southern Ocean	
4 x logger electronics	28,000
4 x housings	12,000
4 x hydrophones	12,400
4 x underwater connectors &cable terminations	4,800
Buoys	15,192
4 x Lights	7,464
4 x Radio transmitters	7,880
Benthos 865-A acoustic releases	57,776
VHF direction finder	2,475
Benthos deck unit	15,370
sundry	2,000
Freight & customs	5,000
Total	170,357

Table 9: Items and value (ex GST and freight) of capital equipment for *Enhance Northern Australia* option. Note labour costs for assembling and testing noise loggers are not included here.

Item	Cost
Enhance Northern Australia	
4 x logger electronics	32,200
4 x housings	11,500
4 x hydrophones	14,260
4 x underwater connectors &cable terminations	5,520
4 x ORE CART acoustic releases	40,480
Line etc	2,300
Total	106,260

Table 10: Items and value (ex GST and freight) of capital equipment for *Enhance Queensland* option. Note labour costs for assembling and testing noise loggers are not included here.

Item	Cost
Enhance Northern Australia	
1x logger electronics	8,050
1 x housings	2,875
1 x hydrophone	3,565
1 x underwater connectors &cable terminations	1,380
1 x ORE CART acoustic releases	10,120
Line etc	575

Total	25,565

2 Data streams that are available for use in research, grouped by facility

o *Including a description of each data stream and the volume of data that is available*

Data streams immediately available will include raw sea noise data in digital form. The same data streams will be available for all systems. Raw data files consist of a file header and footer which contain details of the sampling regime used and the on-board clock time of the first and last bytes collected. The raw data is located between the header and footer lines in unsigned 16 bit integer format using the PC, IEEE byte format and so is immediately available for analysis on PC platforms. Each noise logger has a 160 GB hard disk (nominal capacity) with actual data storage of approximately 140-150 GB (this depends on the way the files are written to disk). Thus an acoustic observatory deployment, with all noise loggers filling their hard disk will return in the vicinity of 560-600 GB of data. All deployments will have coupled meta data of gear locations, water depths, hardware specifications and calibration (system frequency response and clock drift) details.

If the EIF funding is approved we will add in some processing of data. At the minimum this will consist of:

- For one of the four receivers in a passive acoustic observatory, plots of time-frequency-intensity in five day batches of the full recording period. These plots allow for quick identification of major noise sources in the recording sets
- System time offset calculations. For tracking purposes the relative clock drifts of all receivers need to be known (relative to one receiver). This is achieved by: 1) synchronising each independent logger clock to GPS transmitted time before a deployment and reading the drift afterwards combined with: 2) each logger once a day sampling pings from a modified acoustic release at a known location. The arrival time of the ping, coupled with the receiver and pinger geometry and assuming a sound speed, can be used to get relative clock drifts. The relative clock drifts of each system receiver will be supplied in an ASCII text file.
- For locations with local tracking data, processing data to identify coherent signals on all loggers and tracking these. A standard format of source file identification, estimated source range and bearing, with uncertainties, and date-time stamp will be provided.
- Some source identification, provided as [date time source-type] for pygmy and true blue whales. As the program proceeds we may expand this to other sources, particularly in the southern ocean data sets.

o *The continuity of one key time series of data from each facility will be assessed against an appropriate benchmark for that facility*

The longest time series of data will be from the Perth Canyon station. McCauley, the sub facility Leader has five non-IMOS funded pygmy blue whale seasons (January to April) from the Perth Canyon over 2000-2007, plus two current IMOS seasons (2008 pygmy blue whale season data in-hand and 2009 data in-water). Thus in late 2009, with the retrieval of the current passive acoustic observatory in the Perth Canyon, seven pygmy blue whale seasons over a ten year span will become available. By the end of the proposed sampling period, mid 2013, then ten seasons over 14 years will be available.

3 Meeting Researcher Needs

· *Number of ongoing and new research projects and PhD students using IMOS data*

Currently there are proposals submitted by the CMST of Curtin University for two PhD students and one Post Doc to work on IMOS and other sea noise data for whale abundance trends and ice calving information. The whale abundance proposals have been supported by the Western

Australian Department of Environment and Conservation. Defence (Dr. Doug Cato) is preparing a proposal within the Defence Science and Technology Organisation for one Post Doc and two PhD students on Defence related issues from IMOS sea noise data, and in collaboration with US researchers has one funding proposal lodged with the US Governments ONR funding scheme to utilise IMOS sea noise data. Dr. Mike Noad of University of Queensland has PhD students whom will uptake IMOS data immediately it becomes available and whom will be taking on other students to work on different aspects of IMOS sea noise in relation to east coast data streams and whale trends. The AAD is mandated to study southern ocean whale stocks and will uptake all southern ocean data for whale presence. In particular the AAD will expand its program to monitor Antarctic blue whale stocks using the IMOS receivers.

We have yet to advertise the IMOS passive acoustic data internationally, but expect there will be considerable interest when the full observatory data sets become available (from late 2009 onwards).

4 Quality of Research Infrastructure

· *Benchmark against other similar overseas infrastructure.*

Comparative, publicly available international data sets to compare the IMOS passive acoustic observatories against include:

- Data from below an ice station offered over the internet by the Alfred Wegener Institute for polar research
- The network of CTBTO (Nuclear Comprehensive Test Ban Treaty Organisation) hydro-acoustic stations. This system is designed to detect clandestine underwater nuclear explosions.

For the data offered by the Alfred Wegener Institute the internet access of acoustic data is not feasible for large sample sizes (too much data to easily transmit), the data is un-calibrated, has no tracking capability and is from an under-ice receiver only. The CTBTO data is high quality, has a tracking capability, but is difficult and slow to access (years delay) and is band limited from 1-100 Hz (this is deliberately done to reduce its applicability for Defence purposes).

o *Qualitative comparisons against other similar international non-IMOS facilities, if they exist*

There are efforts underway in various countries to collect sea noise data by individuals but most of these are in-house, not publicly available and we do not know how systematic the observations are. The applicants know of at least one station where systematic sea noise data collection is proposed (Canadian west coast) but this is a new facility and we know little of its output.

5 Fostering Collaborative Development of Infrastructure

· *Participation in international programs collecting similar data streams*

Currently there are no international programs for the collection and analysis of sea noise apart from the CTBTO. The CTBTO data is analysed in real time, specifically for detecting underwater explosions. The use of sea noise for biological studies is increasing thus it is probable that there will eventually be such international programs, especially as the technique is well suited for studying animals with large migratory habits. The IMOS data streams will be a benchmark for this.

6 Fostering Interdisciplinary and World-class Research

· *List of publications using IMOS data*

Data is only just beginning to be recovered from the IMOS passive acoustic observatories thus it is early to judge the system on publication output.

- **Describe key risks and risk management strategies**
  Key risks are defined in Table 1.

Table 11: Key risks and mitigation strategies.

Risk	Risk mitigation
	Common risks
Mooring loss	Moorings set down to 500 m depth use a long ground line, typically at least twice the water depth, laid on the seabed in bights (see Figure 1). This line makes an easy grapple target. To date the CMST has lost only three of 128 moorings set in this configuration, with two of these losses due to moorings set beyond the design depth (the ground line then tangles so the mooring buoys do not surface, in both these cases grappling could not be carried out due to ship constraints). Thus provided the moorings set in the *Extend*, *Enhance Northern Australia* and *Enhance Brisbane* components are designed and set correctly (ground line fully laid out) then they have a low risk of failure and a relatively easy option for recovery. The moorings set in the *Enhance Southern Ocean* proposal are to be located near the seabed at considerable depths (500-3000 m) and so will not be capable of being grappled as the water is too deep and ship time too expensive. Thus we will use proven deep water acoustic releases, at this stage only one per mooring, have rigid acoustic release servicing protocols, and fit the moorings with gear which increases the chance of finding it when it surfaces (lights and VHF transmitter).
System failure	We do get failures of various components and so compromised data quality (9% with partial data failure, 4% with total data failure of the 125 deployments recovered to date). By far the most common failure we experience is due to damage incurred to the hydrophone cable or underwater connector compromising the signal fed to the system electronics. This damage can occur during deployment, from faulty underwater connectors, or due to shark bites on the cables. The new generation IMOS housings have several features built in which are designed to minimise these source of failure including high quality underwater connectors. While we had a few instances of system electronic failures when the sea noise loggers were first designed (ie. the 4% above) we have not had any failures in the system electronics for several years now. Thus the CMST has considerable experience at analysing potential sources of system failure and is always working to reduce this risk. A further mitigation factor is the fact that a passive acoustic observatory as set on the Australian continental shelf involves four independent receivers. Thus if one system does fail for some reason there are three other systems available with only a limited loss of the tracking capability incurred (dead zones in range estimation introduced).
Loss of key staff	The CMST is dependant on key staff (McCauley the IMOS PI, Thomas the CMST engineer, and Perry the technician). But, these staff have been at the CMST for 8-13 years each and due to the specialised nature of the underwater acoustics work are unlikely to leave in the immediate term. The work is gradually becoming more streamlined with failure points well understood and extensive documentation on all facets of gear and deployments available and continually upgraded. Thus staff loss is not considered a serious risk.
Loss of gear due to trawling	We have liaised with commercial fishing operations in the selection of sites for deployment of gear in Australian waters. The Portland and Perth Canyon sites are free of trawling operations, We are currently searching for a site along the NSW coast free of trawling.

Budget:

Budgets are presented separately for the components below. The ***Enhance Northern Australia*** and ***Enhance Queensland*** components depend on the ***Extend & Enhance*** component for hot swapping hardware. All costs in the budget tables below are ex GST.

The ***Extend & Enhance*** budget is presented as one table, with the ***extend*** component budgeted over 2011/2012 and 2012/2013 only (the 2009/2010 and 2010/2011 operating costs and staff time for servicing gear are covered under committed NCRIS funds) with the ***enhance*** component listed in the capital section for 2010/2011 only. The ***enhance*** budget includes the five sets of spare field hardware to enable hot swapping and keep one set of gear as a spare to cover failures. The remaining current funding for the three passive acoustic observatories in the Perth Canyon, Portland

and NSW is $211,117 for financial year 2009/2010 and $148,825 for financial year 2010/2011, all of which is operating costs and salary time to maintain data streams.

Extend & Enhance budget

- **EIF Funds**
- Funds are sought to build five sea noise loggers and purchase five ORE CART acoustic release units (the enhance part). Four noise loggers are to be used for hot-swap moorings – an acoustic observatory comprises four moorings. One set of gear is to be held as spare to cover gear failures etc. The cost of building five new sea noise loggers with their acoustic releases is significantly less than if no spare components were available and we increased the staff field time and doubled the vessel charter days for the ***Extend*** component only. A passive acoustic observatory of four moorings is too complicated to be serviced at sea and if this is done greatly increases the risk of mooring loss or data failure. If the ***Enhance Northern Australia*** passive acoustic observatory and the ***Enhance Queensland*** components are funded then the spare noise loggers budgeted here will be used to hot swap moorings. The same flexibility is not available for the ***Enhance Southern Ocean*** equipment as the acoustic release units and housings differ plus recovered gear will not be available until the vessel returns to Australia and the gear is freighted to Perth (approximately 2-5 months from the vessel leaving Hobart).

- Operating costs include field trips (see Table 2 for field trips). Over the extend budgeting period (mid 2011 to mid 2013) four trips are to be made into the Perth Canyon, three to Portland and three to NSW. Each field trip entails: one days vessel charter ($4000 pd ex GST budgeted); field labour (two staff); freight; travel and air fares (except Perth Canyon); dump weights (175 kg per mooring); batteries (acoustic release and sea noise logger); and sundry mooring spares. Field trips are costed at $7,800 (ex GST) per trip into the Perth Canyon (no travel, one staff) and approximately $20,100 (ex GST) interstate (travel and two staff). Operating costs include all costs associated with servicing moorings.

- **Co-investments – source and nature**
  The primary co-investment is Curtin staff time in project management, project support and in-kind support as detailed in the budget.

- **Staffing details**
  Staff required include: the CMST engineer to build new sea noise loggers plus maintain and calibrate recovered noise loggers; technical expertise to build, prepare and de-mobilise moorings plus organise logistics; staff time to deal with incoming data, archiving and some initial processing; and project management.

Enhance Southern Ocean

- **EIF Funds**
  Funds are requested to build four sea noise loggers and associated moorings and to keep two in the water continuously from the summer of 2010-2011 into the summer of 2012-2013. The moorings will all be designed to be 3000 m depth rated and will use in-line housings. This type of mooring can produce noise artefacts in the recordings due to cable strum and turbulent flow over the hydrophones from upstream protuberances, thus great care will be needed in designing the hydrophone encasement. All moorings will use Benthos deep sea acoustic releases and be fitted with a light which activates at the surface on recovery plus a VHF radio transmitter.

The vessel will only be on site for a limited time at each location, thus hot swapping moorings is a necessity. A complete set of new moorings will be shipped on each voyage and recovered moorings serviced ashore.

- **Co-investments – source and nature**
  Vessel time for a ship to deploy and recover the moorings is the largest co-investment. The vessel time used in the budget spreadsheet only includes the time on-station at each site and does not include steaming time to and from Australia. Other co-investment includes Curtin and AAD staff time in project management, project support and in-kind support as detailed in the budget.

- **Staffing details**
  Curtin staff required include: the CMST engineer to build new sea noise loggers plus maintain and calibrate recovered noise loggers; technical expertise to build, prepare and de-mobilise moorings plus organise logistics; staff time to deal with incoming data archiving and some initial processing; logistical and financial support; and project management .

  Australian Antarctic Division staff include: a senior scientist to co-ordinate the AAD activities and deal with data streams; ship borne staff to be responsible for mooring deployment and recovery; and technical staff to deal with mooring servicing.

Enhance Northern Australia

- **EIF Funds**
  Funds are sought to build four sea noise loggers, purchase four ORE CART acoustic releases and build four moorings. Equipment for hot swapping moorings and spares are covered in the ***Extend*** budget.

  Operating costs include five field trips. At this stage exact details of field deployments are not known thus a first deployment date of 01-Nov-2010 has been assumed and a ten month turnaround into mid 2013 used for servicing. Vessel time for field deployments has been considered as an in-kind contribution through the Australian Mooring Network (ie. not included here). For field work we have budgeted for one staff to be in the field for 10 days per field trip with the mobilisation and disembarkation port being Broome. Operating costs include all costs associated with servicing moorings except vessel time.

- **Co-investments – source and nature**
  The primary co-investment is Curtin staff time in project management, project support and in-kind support as detailed in the budget.

- **Staffing details**
  Staff required include: the CMST engineer to build new sea noise loggers plus maintain and calibrate recovered noise loggers; technical expertise to build, prepare and de-mobilise moorings plus organise logistics; and staff time to deal with incoming data archiving and some initial processing; logistical and financial support; and project management .

Enhance Queensland

- **EIF Funds**
  Funds are sought to build one sea noise loggers, purchase one ORE CART acoustic releases and build one moorings. Equipment for hot swapping moorings and spares are covered in the ***Extend*** budget.

Operating costs include five field trips. At this stage exact details of field deployments are not known thus a first deployment date of 01-Sep-2010 has been assumed and a ten month turnaround into mid 2013 used for servicing. Vessel time for field deployments has been considered as an in-kind contribution from QMOS. For field work we have budgeted for one staff to be in the field for 4 days per field trip with the mobilisation and disembarkation port being Brisbane. Operating costs include all costs associated with servicing moorings except vessel time.

- **Co-investments – source and nature**
  The primary co-investment is Curtin staff time in project management, project support and in-kind support as detailed in the budget.

- **Staffing details**
  Staff required include: the CMST engineer to build the new sea noise logger plus maintain and calibrate recovered noise loggers'; technical expertise to build, prepare and de-mobilise moorings plus organise logistics; and staff time to deal with incoming data archiving and some initial processing; logistical and financial support; and project management .
  .

Budget for Extend & Enhance Pasive Acoustic Observatories mid 2011 to mid 2013

		2010/11	2011/12	2012/13	Future (a)	Total
EIF Funding						
Capital	5 spare sea noise loggers & 5 x ORE CARTS	276,225	0	0	Not applicable	276,225
Salaries	Maintain noise loggers, prepare gear, data	0	111,038	114,369		225,407
Operating	field trips Perth Canyon,Portland & NSW	0	35,526	96,773		132,299
	EIF Funding Total	**276,225**	**146,564**	**211,142**		**633,931**
Cash Co-investment (b)						
Curtin University)	Staff time	156,000	156,000	156,000		468,000
	Cash Co-investment Total	**156,000**	**156,000**	**156,000**	**0**	**468,000**
In-Kind Co-investment (b)						
Curtin University	use vehicles confirmed	1,750	1,750	1,750		5,250
Curtin University	Curtin infrastructure access confirmed	15,750	15,750	15,750		47,250
Curtin University	Fremantle research facility access confirmed	17,500	17,500	17,500		52,500
						0
	Cash Co-investment Total	**35,000**	**35,000**	**35,000**	**0**	**105,000**
	TOTAL Resources	**467,225**	**337,564**	**402,142**	**0**	**1,206,931**

NOTES:

(a) If any amounts included in Future column for Cash or In-Kind Co-investment, please provide detail of the time-frame of these resources:

Budget for Enhance Southern Ocean passive acoustics 2010-2013

			2010/11	2011/12	2012/13	Future (a)	Total
EIF Funding							
	Capital	4 noise loggers, acoustic rel. & mooring parts	170,357	0	0	Not applicable	170,357
	Salaries	Build & maintain noise loggers, prepare gear, data	151,433	52,419	52,419		256,271
	Operating	freight, mooring consumables, project travel	6,831	6,831	6,831		20,493
		EIF Funding Total	**328,621**	**59,250**	**59,250**		**447,121**
Cash Co-investment (b)							
	Australian Antarctic Division	Staff time	28,194	28,736	29,295		86,225
	Australian Antarctic Division	Ship time	66,667	68,667	70,727		206,061
	Curtin University)	Staff time	13,000	13,000	13,000		39,000
		Cash Co-investment Total	**107,861**	**110,403**	**113,022**	**0**	**331,286**
In-Kind Co-investment (b)							
	Curtin University	use vehicles confirmed	750	750	750		2,250
	Curtin University	Curtin infrastructure access confirmed	6,750	6,750	6,750		20,250
	Curtin University	Fremantle research facility access confirmed	7,500	7,500	7,500		22,500
	Australian Antarctic Division	Use research infrastructure & logistics	25,000	28,000	30,000		83,000
		Cash Co-investment Total	**40,000**	**43,000**	**45,000**	**0**	**128,000**
		TOTAL Resources	**476,482**	**212,653**	**217,272**	**0**	**906,407**

NOTES:

(a) If any amounts included in Future column for Cash or In-Kind Co-investment, please provide detail of the time-frame of these resources:

(b) For amounts included in Cash and In-Kind Co-investments, please include the likelihood of these resources being made available (eg confirmed, provisional, possible)

Budget for Enhance Northern Australia passive acoustics 2010-2013

		2010/11	2011/12	2012/13	Future (a)	Total
EIF Funding						
Capital	4 sea noise loggers, CARTS & moorings	106,260	0	0	Not applicable	106,260
Salaries	Build & maintain noise loggers, prepare gear, data	93,537	21,652	21,652		136,841
Operating	5 field trips Broome	15,550	31,100	31,100		77,750
	EIF Funding Total	**215,347**	**52,752**	**52,752**		**320,851**
Cash Co-investment (b)						
Curtin University)	Staff time	39,000	39,000	39,000		117,000
	Cash Co-investment Total	**39,000**	**39,000**	**39,000**	**0**	**117,000**
In-Kind Co-investment (b)						
Curtin University	use vehicles confirmed	750	750	750		2,250
Curtin University	Curtin infrastructure access confirmed	6,750	6,750	6,750		20,250
Curtin University	Fremantle research facility access confirmed	7,500	7,500	7,500		22,500
Curtin University	use various hardware and computer facilities	1,000	1,000	1,000		3,000
	Cash Co-investment Total	**16,000**	**16,000**	**16,000**	**0**	**48,000**
	TOTAL Resources	**270,347**	**107,752**	**107,752**	**0**	**485,851**

NOTES:

(a) If any amounts included in Future column for Cash or In-Kind Co-investment, please provide detail of the time-frame of these resources:

(b) For amounts included in Cash and In-Kind Co-investments, please include the likelihood of these resources being made available (eg confirmed, provisional, possible)

Budget for Enhance Brisbane passive acoustics 2010-2013

		2010/11	2011/12	2012/13	Future (a)	Total
EIF Funding						
Capital	1 sea noise loggers, CART & mooring	26,565	0	0	Not applicable	26,565
Salaries	Build & maintain noise loggers, prepare gear, data	19,574	12,294	12,294		44,162
Operating	5 field trips Brisbane	15,714	31,428	31,428		78,570
	EIF Funding Total	**61,853**	**43,722**	**43,722**		**149,297**
Cash Co-investment (b)						
Curtin University)	Staff time	16,800	16,800	16,800		50,400
	Cash Co-investment Total	**16,800**	**16,800**	**16,800**	**0**	**50,400**
In-Kind Co-investment (b)						
Curtin University	resreacrh infrastructure confirmed	5,500	5,800	6,000		17,300
	Cash Co-investment Total	**5,500**	**5,800**	**6,000**	**0**	**17,300**
	TOTAL Resources	**84,153**	**66,322**	**66,522**	**0**	**216,997**

NOTES:

(a) If any amounts included in Future column for Cash or In-Kind Co-investment, please provide detail of the time-frame of these resources:

(b) For amounts included in Cash and In-Kind Co-investments, please include the likelihood of these resources being made available (eg confirmed, provisional, possible)

Appendix 1

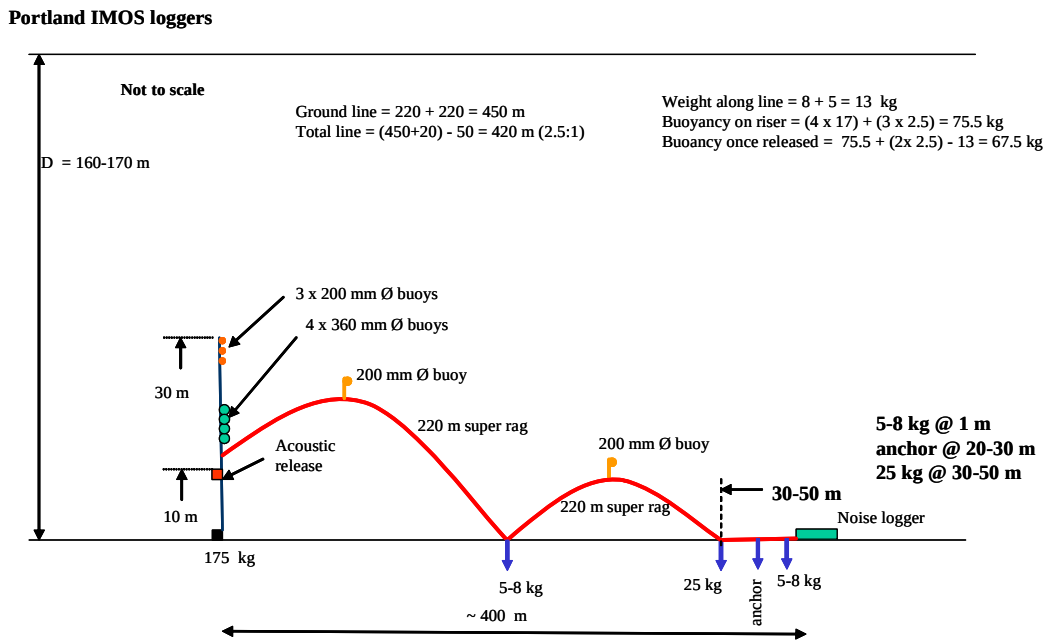


Figure 1: Schematic of passive acoustic mooring for deployment down to 500 m depth (the ground line length is increased for deeper depths). The design is optimised for: reducing mooring induced noise artefacts at the hydrophone; coupling the hydrophone to the seabed; and for deployment off any Australian commercial fishing vessel

New South Wales

Call for Proposals under the IMOS (EIF) Five Year Strategy: Enhancement or extension of IMOS – July 2009 to June 2013

NSW-IMOS ANMN Sub-Facility Project Plan

30 October 2009

Proposed Infrastructure Investment:	Extension and Enhancement of the NSW-IMOS moorings and biogeochemical sampling
IMOS Facility:	NSW-IMOS Sub-facility of ANMN
Operating Institution:	SIMS
Sub-Facility Leader (for this Proposal):	Moninya Roughan mroughan@unsw.edu.au 02 9385 7067 Sydney Institute of Marine Science & Coastal and Regional Oceanography Lab, School of Maths and Stats UNSW, Sydney NSW 2052
Other(s) key people involved:	Iain Suthers (UNSW/SIMS) Brad Morris (UNSW), Martina Doblin (UTS), Tim Pritchard (NSW-DECCW) Hua Wang (UNSW@ADFA) ANMN/CMAR
Collaborating Institutions:	NSW-DECCW - Tim Pritchard Oceanographic Field Services (OFS) – Clive Holden Manly Hydraulics Laboratory (MHL) – Ed Couriel Sydney Water Corporation (SWC) – Peter Tate National Marine Science Centre (NMSC) – Alistair McIlgorm

Please attach:

- Letter from senior person in Operating Institution, confirming that the proposed infrastructure can be developed and operated within that institution
- SIMS

Please find attached letters of support from collaborating Institutions, detailing their support to the Proposal, and indicative level of co-investment

- Sydney Water Corporation
- National Marine Science Centre
- UTS
- NSW DECCW

Nature of Investment:

Deployment and maintenance of shelf moorings along the coast of NSW as per the figure below.

Extension of IMOS 2011-2013

- Continuation of existing Moorings at Coffs Harbour, Sydney, Jervis Bay, Eden
- Continuation of hydrographic sampling off Port Hacking
- Continuation of in-kind data (waverider and ORS) being delivered to IMOS portal
- Augmentation of NRS with velocity measurements (ADCP)

Enhancement 2009-2013

- Implementation of real time telemetry at Sydney NRS
- Augmentation of NRS with bio-optical sensors (Eco-triplet, FRRF)
- Deployment and maintenance of a single new mooring at Stockton Bight
- Augmentation of CH moorings with additional sensors (2x WQMs)
- Implementation of hydrographic sampling at Coffs Harbour CH100
- Implementation of real time telemetry at CH and JB sites.

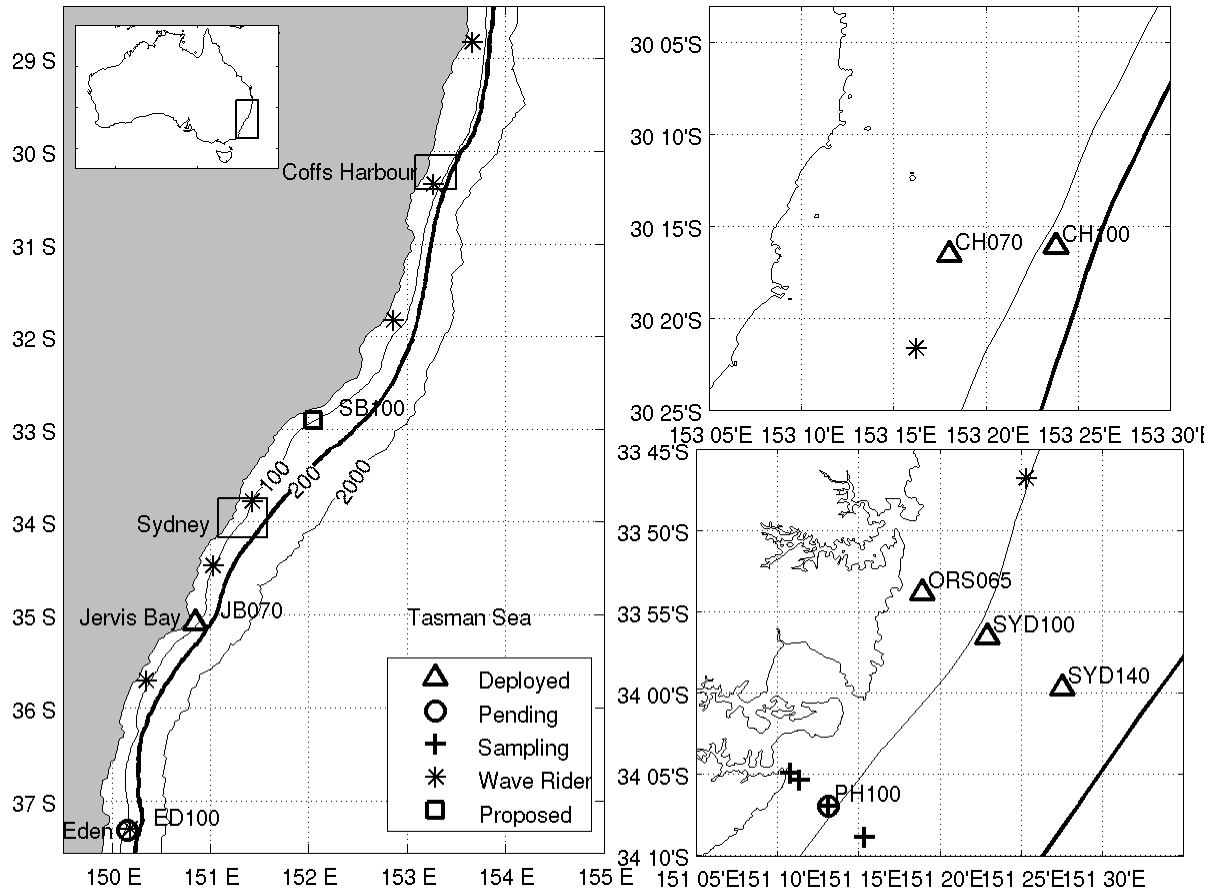


Figure 2 Map showing locations of NSW -IMOS moorings, including moorings already deployed, the Eden mooring to be deployed this financial year and the location of the new mooring proposed for Stockton Bight. Also shown are the locations of the hydrographic sampling sites. New hydrographic sampling sites are proposed for CH100. The wave rider buoys and the ocean reference station are also shown. The data from these moorings are provided to NSW-IMOS as a significant in-kind contribution to IMOS (Roughan et al, submitted).

Implementation Strategy:

- Summary

  The goal of the NSW-IMOS moorings sub-facility is to collect data in support of the oceanographic needs of NSW-IMOS. This includes measurements of temperature, salinity, velocity, and biogeochemical and bio-optical properties in the East Australian Current.

  Extension

  We aim to continue the sampling that we have implemented in the first phase of IMOS. This includes the maintenance and delivery of data from 8 oceanographic moorings along the coast of NSW, as well as hydrographic sampling at 4 stations along a transect off Port Hacking (Figure 1). The extension of this program in its current format will require approximately $900k per annum. This is the majority of the proposed budget.

  Enhancement

  A select number of enhancements have been chosen to add value to the existing data streams. The most important feature being the development of real time telemetry at three key locations. Real time telemetry will facilitate our involvement in improving model output (by its inclusion in ocean forecasts and re-analysis products), as well as making the data immediately available to the science community and the general public. It will also allow rapid response to events (e.g East Coast Lows, floods and algal blooms) and for us to respond quickly when instruments fail, thus avoiding large data gaps.

  We propose to deploy one new mooring in Stockton Bight, a biologically important region. Model predictions validated by ship-based observations indicate consistent nutrient enrichment, high chl-a and elevated zooplankton biomass in this area, that is sometimes advected away from the coast, potentially subsidising other parts of the NSW coastal foodweb. Additionally we aim to include bio-optical sensors on our national reference station, in conjunction with pCO2 and sediment trap moorings (see pCO2 (Tilbrook) and NCOTS (Armand) proposals). The proposed PAR, Ecotriplet and FRRF sensors will provide data describing *in situ* light fields, the type and quantity of dissolved and particulate constituents of water (that absorb and scatter light), as well as the photosynthetic rates of primary producers, allowing a mechanistic understanding of lower trophic level responses to physical forcing. These data will serve to create realistic subsurface light fields for modeling key biogeochemical processes like photosynthesis, provide valuable in-situ ground truth data for developing satellite remote sensing algorithms for ocean production and other parameters and will significantly enhance our whole of system approach, integrating biology with physics. These enhancements have been budgeted at approximately $680k of capital in 2011/2012. Operational costs will only increase marginally with the enhancements of the system.

  NB: the addition of bio-optical sensors on the NRS could ultimately become the responsibility of the SRS facility, however its rationale and scientific value is included here for completeness. Additionally, independent proposals are being prepared for CO2 and sediment trap moorings that could sit under this sub-facility.

- Objectives
  - Providing a national backbone for observing boundary currents

The mooring program described here gives a comprehensive view of the East Australian Current and its interactions with the continental shelf upstream and downstream of its separation from the coast. We intend to augment the CH mooring site which will add to the national backbone for observing the East Australian Current. We will do this incrementally, by commencing hydrographic sampling, augmenting the instrumentation and finally obtaining the data in real time. The new mooring in Stockton Bight fills an observational gap in a biologically important region which is heavily influenced by the EAC and its eddy field. The entire array compliments the proposed Bluewater array across the shelf at 28^{o}S (at the NSW/QLD border) and the mooring pairs located along the Qld coast.

- Continuing to build institutional strengths into national capability

We are involving a number of institutions with key expertise, data, infrastructure and other in-kind support in our program (OFS, MHL, DECCW, NMSC, UNSW, ADFA and SIMS). By having 3 different organisations involved in maintaining the mooring array (OFS, MHL, ADFA) we are spreading the risk and building capacity as each of the teams builds their expertise. DECCW and UNSW are involved in the hydrographic sampling components again building capacity in the area. The enhancements in the area of bio-optics brings in other members of the community with additional expertise in that area. NB the cash and in-kind support provided by each of these institutions is reflected in the Tables 5 and 6.

- Exploring the potential for whole-of-system approaches

This proposed extension and enhancement to the mooring array provides three important factors necessary for a whole-of-system approach: 1) incorporating sensors that provide mechanistic information to explain biological responses to physical forcing; 2) integration of observations made by different platforms across multiple spatial and temporal scales; and 3) use of the combined observations in a modelling/spatial framework such as Bluelink. The enhancements to the moorings by including WQMs at CH and bio-optical sensors will allow a greater understanding of the biological response to physical processes. Our mooring program is strongly complementary to the NSW-IMOS plans to access the ANFOG, AATAMS, AUV and MMO facilities; hence we are looking at a whole of system approach—from physics through to the biology using different platforms. Importantly, the design of the mooring array along has optimised data spacing along the NSW shelf that integrates with QMOS and the BWC node to investigate the East Australian Current in its entirety.

- Driving down the cost per observation

By integrating with the ANMN and building on existing expertise and sampling programs we are driving down the cost per observation. For example the data from one of our Sydney moorings (ORS065) is provided at no cost to us as an in-kind contribution from SWC/OFS. Similarly the Waverider data is provided by NSW-DECCW free of charge. Telemetry may save costs of data gaps, and allow rescue of compromised sensors before they are damaged beyond repair. As outlined in the budget, the bio-optical sensors will not require significant additional resources as the NRS will be maintained and serviced as part of the extension, which means the cost per individual observation from the moorings will decline.

- Outline how facility implements node plan

The proposed mooring array goes a long way towards understanding the questions posed by the goals of NSW-IMOS. The mooring program contributes directly to the physical understanding of the EAC and its eddy field as well as the biological response through the bio-

geochemical sampling at the NRS. Each of the infrastructure activities listed below will provide observations that are directly linked to answering the questions that NSW- IMOS wishes to address. We are investigating the boundary current along the shelf of NSW and its interaction with the shelf environment and the biological response. The observing system has always been designed with these goals in mind, and a holistic approach to understanding the EAC. We are limiting new deployments to 1 new mooring. This indicates that the original design of the observing system was well thought out. The next priorities are obtaining the data in real time and augmenting the existing moorings to obtain bio-optical data.

Goals of NSW-IMOS related to this sub-facility:

1. **To investigate the EAC, its separation and resultant eddy field along the coast of SE Australia**.
    i. To determine seasonal and spatial variability in the separation of the EAC from central NSW;
    ii. To determine the frequency, form and function (horizontal and vertical) of EAC eddies;
    iii. To understand air sea interactions, particularly to determine the ontogeny of East Coast Lows and severe winter storms in relation to warm core eddies.

2. **To quantify key continental shelf processes along the coast of SE Australia**
    i. Quantify the impact of key processes such as onshore encroachment of the EAC, slope water intrusions, upwelling, downwelling and internal waves;
    ii. Quantify the seasonal and decadal variation in the EAC and its southward extension;
    iii. Examine the coastal wind and wave climate in driving nearshore currents and the northward sediment transport.

3. **Determine the biological response to oceanographic processes and climatic effects.**
    i. Quantify the daily to decadal variation of planktonic communities in relation to oceanographic and climate-driven changes in physical and chemical ocean properties;
    ii. Quantify the biogeochemical cycling of carbon (pCO2, sediment trap to examine particle and nutrient fluxes, microbial and phytoplankton composition);
    iii. Determine the transport and dispersal of passive particles (e.g. larvae, eggs, spores) and the degree of along coast connectivity and trophic linkages.
    iv. Relationship of the EAC, its eddies and oceanographic conditions on fisheries, and movements by fish and sharks;

List of major activities – including major parties involved and operating funds

Table 12: List of major activities – including major parties involved and operating funds

YEAR	Extension/ Enhancement	Locations	Activity	EIF Funds-operating	Specified Personnel
2009/2010	Extension	NRS– SYD	Deploy ADCP on NRS	-	Roughan/Lynch
	Extension	All	Maintain existing data streams	-	MHL/OFS/SIMS/ADFA/DECCW/
Subtotal					
2010/2011	Enhancement	NRS-SYD	Develop real time telemetry system*	$22,200	Roughan/Morris/OFS
	Enhancement	NRS-SYD	Enhance NRS with bio-optical sensors	-	Doblin/OFS/Suthers
	Extension	All	Maintain existing data streams	-	MHL/OFS/SIMS/ADFA/DECCW/
Subtotal				**$22,200**	
2011/2012	Enhancement	Stockton Bight	Deploy 1 new mooring in Stockton Bight	$158,400	Suthers/SIMS
	Enhancement	Coffs Harbour	Develop real time telemetry system	$33,000	Roughan/MHL/CMAR/Morris
	Enhancement	Coffs Harbour	Augment existing CH070 Mooring with WQMs	-	Roughan/MHL/SIMS
	Enhancement	Sydney	Commence Biogeochemical sampling- SYD100	$50,000	SIMS/DECCW
	Enhancement	Coffs Harbour	Commence Biogeochemical sampling	$50,000	NMSC/ DECCW
	Enhancement	Jervis Bay	Develop real time telemetry system	$33,000	Wang/ADFA/CMAR
	Extension	All	Maintain existing data streams	$855,530	MHL/OFS/SIMS/ADFA/DECCW/
Subtotal				**$1,180,180**	
2012/2013	Extension	All	Maintain all data streams	$1,205,000	MHL/OFS/SIMS/ADFA/DECCW/
Subtotal				**$1,205,000**	
Total Operating				**$2,407,380**	

- * Real time telemetry was not possible under the existing NCRIS budget due to financial and logistical limitations. It will be implemented as highest priority under EIF funding.
- The funding listed here does not include capital purchases as they are listed in the table below.
- Maintenance of existing data streams includes salaries.

NSW-IMOS List of major equipment to be purchased / developed

Table 13: NSW-IMOS List of major equipment to be purchased / developed

Year	Locations	Enhancement	EIF Funds Capital	Specified Personnel
2009/2010	NRS -SYD	ADCP and Acoustic Modem for NRS	$50,000	Roughan/SIMS/OFS
Total09/10			**$50,000**	
2010/2011	NRS-SYD	ADCP and Acoustic Modem and releases (3) for NRS (incl hotswap)	$65,400	Roughan/SIMS/OFS
	NRS-SYD	Infrastructure for real time Telemetry (float, modems, telemetry, thermistors, incl hotswap)	$155,600	CMAR /OFS/Roughan
	NRS-SYD	Bio-Optical Sensors for NRS	$139,400	Doblin/Roughan/OFS
Total10/11			**$360,400**	
2011/2012	Stockton Bight	Instrumentation for New Mooring (ADCPx4, WQMx2, Releasesx4, thermistors, + spares, and hardware	$225,500	Roughan/Morris/SIMS
	Coffs Harbour	Purchase of WQMS for 1 mooring (incl hotswap)	$75,000	Roughan/SIMS/MHL
	Coffs Harbour	Infrastructure for real time Telemetry	$127,500	Roughan/CMAR/SIMS/MHL
	Jervis Bay	Infrastructure for real time Telemetry	$118,000	Roughan/ADFA/CMAR/Wang
	All	Purchase of spare/replacement instrumentation to maintain existing data streams	$135,000	Roughan/SIMS/Morris
Total11/12			**$681,000**	
2012/2013	All	Purchase of spare/replacement instrumentation to maintain existing data streams	$247,400	Roughan/SIMS/Morris
Total 12/13			**$216,500**	
EIF Capital Total			**$1,308,000**	

Note an exchange rate of 0.8 USD/AUD has been used to calculate capital costs. See spreadsheet in Table 8 and 9 for specific break down of costs. A depreciation cost of 10% has **NOT** been included in these capital calculations.

EIF NRS enhancement implementation strategy

Table 14: EIF NRS enhancement implementation strategy

New Infrastructure	Operator	Site	Milestones 15/06/2010	Milestones 15/12/2010	Milestones 15/06/2011	Milestones 15/12/2011	Milestones 15/06/2012	Milestones 15/12/2012	Milestones 15/06/2013
Velocity Measurements (ADCP) on NRS	SIMS & OFS	Sydney/Port Hacking	ADCP placed onto NRS moorings – data logging	Replacement ADCP and CART releases ordered to facilitate Hot Swap	Data available through emii	Continuing	Continuing	Continuing	Continuing
Real time Telemetry NRS	SIMS & OFS	Sydney/ Port Hacking	Infrastructure ordered	Surface float deployed at NRS	Data logging in real time	Data transfer to web (public) and eMII	Continuing	Continuing	Continuing
Bio-optical sensors for NRS	SIMS & OFS	Sydney/ Port Hacking	Infrastructure ordered	Bio-optical sensors deployed at NRS	Data available eMI	Continuing	Continuing	Continuing	Continuing
Mooring in Stockton Bight	SIMS	Stockton Bight	-	-	Infrastructure ordered	Mooring deployed	Data available eMI	Continuing	Continuing
Augmentation of CH mooring 2x WQMs	SIMS/ MHL	Coffs Harbour	-	-	Infrastructure ordered	Instruments added to mooring	Data available eMI	Continuing	Continuing
Biogeochemical Sampling SYD100	SIMS/DE CCW	Sydney	-	-	Infrastructure ordered	Monthly sampling commenced	Samples transferred for processing	Data available eMII	Continuing
Biogeochemical Sampling Coffs Harbour	SIMS/NM SC	Coffs Harbour	-	-	Infrastructure ordered	Monthly sampling commenced	Samples transferred for processing	Data available eMII	Continuing
Real time Telemetry Coffs Harbour	SIMS MHL CMAR	Coffs Harbour	-	-	Infrastructure ordered	Surface float deployed	Data logging in real time	Data transfer to web (public) and eMII	Continuing
Real time Telemetry Jervis Bay	SIMS ADFA CMAR	Jervis Bay	-	-		Infrastructure ordered	Surface float deployed	Data logging in real time	Data transfer to web (public) and eMII

Access, pricing regimes:

- **How will data access be provided?**
  Access to QA/QCed data from the NSW-IMOS mooring array will be provided free and unrestricted in IMOS compliant netCDF format via the IMOS Ocean Portal and eMII. This will be a continuation of the current arrangements through which over twelve months of mooring data is already available.

- **How will data and products be managed?**
  Data will be retrieved on a periodic (monthly or bimonthly basis) from mooring instrumentation by the mooring operators, Oceanographic Field Services (OFS) and Manly Hydraulics Laboratory (MHL) and supplied to SIMS/UNSW. Data is QA/QCed by experienced staff using IMOS netCDF toolbox which then outputs IMOS compliant netCDF data files. These are then transferred directly to the Data Fabric for discovery via the IMOS Ocean Portal. These methods and protocols for the throughput of data from sensor to web have been developed over the past twelve months and are now in place.

  The biophysical data collected monthly at the NSW National Reference Transect off Port Hacking will continue to be delivered under the current protocols. Likewise the proposed collection of hydrographic data at Coffs Harbour would be managed using these protocols.

  In-kind data from the NSW Waverider network (DECCW) and the ORS (Sydney Water Corporation) will continue to be supplied to SIMS/UNSW and delivered in compliant netCDF format to the IMOS Ocean Portal.

  When the real-time telemetry at three of the moorings (Sydney NRS, Coffs Harbour and Jervis Bay) is implemented the periodic data retrieval by operators at these sites will be undertaken on a longer time cycle. Regular maintenance of instrumentation will still be required. The real-time data stream will be delivered directly to the web either via the IMOS Ocean Portal or a local website, with non real-time data delivered under the current arrangements.

- **What are the dependencies on external / other facilities (national and international)?**
  The retrieval of the data from and maintenance of deployed mooring instrumentation is dependent on the operators OFS and MHL and UNSW@ADFA. These contractors presently have contracts through to the end of 2011 which are valuated annually based on performance. In-kind data is supplied by collaborating institutes NSW-DECCW and Sydney Water Corporation. There is also a dependence on eMII and ARCS to deliver the data via the IMOS Ocean Portal.

- **Collaborative structures for allocation of priorities**
  The design and implementation of the NSW-IMOS mooring sub-facility and its contribution to the ANMN is the result of a national collaborative process via the other sub-facility leaders and input from the NSW-IMOS regional node. The NSW IMOS mooring sub-facility has a steering committee and a moorings operation team, comprising representatives from each of the stakeholders. Both groups hold regular regional meetings, as well as participating in ANMN national coordinating meetings to ensure that both regional and national priorities are met.

Governance

- **Performance indicators**
  One of the key performance indicators of IMOS is the availability and discoverability of IMOS data. In April 2009 we employed a technician whose primary focus has been the implementation and development of methods for data delivery from the NSW-IMOS moorings to the IMOS Ocean Portal. This has included liaising with eMII and working closely with CSIRO programmers to ensure that the means to process the various mooring

data have been developed as part of the IMOS netCDF toolbox. Raw temperature and velocity data collected from the NSW-IMOS moorings up to the end August 2009 are available on the portal. We have also obtained 2 years of historical data from one of our partners SWC. This has been transferred to eMII and will be released when compliance issues have been addressed. With the recent implementation and roll-out of the IMOS toolbox version 1.5 the means now exist to convert the mooring data to IMOS compliant netCDF and make it available via the portal, which will occur by the end of 2009. We are one of the few nodes to have taken this step and have made all our data readily available.

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

Table 15: Risk Management Strategies

Risk	Management Strategy
Mooring Loss	Use of experienced sub-contractors. Design of mooring to minimise loss Careful choice of moorings locations. Liaison with local fishermen etc. Regular servicing.
Equipment Failure	Regular maintenance, calibration and pre-deployment testing of all mooring instrumentation. Hot swapping. Regular servicing.
Depreciation of assets	We have **NOT** included a depreciation rate for the assets. By the end of the extension some of the instruments will be seven years old and reaching retirement stage. It has been suggested that is a whole of IMOS issue and should not be addressed at the sub facility level.

Issues raised in the 2008 IMOS Review

Real Time Data

Real time delivery of data was identified as a priority area for improvement in the mid-term review. We are working towards getting three of the key data streams in real time. Real time telemetry will facilitate our involvement in improving model output (by its inclusion in ocean forecasts and re-analysis products), as well as making the data immediately available to the science community and the general public. It will also allow rapid response to events (ECLs and floods) and for us to respond quickly when instruments fail, thus avoiding large data gaps. Additionally velocity measurements will be added to the national reference station site in 2009/2010. Additional budgetary requests have been made for the NRS real time system (in 2010/2011) as this was not costed appropriately initially at a national level.

Location of NRS - PH100 or SYD100

There is still an issue surrounding the security of the Port Hacking Site. It is desirable to have the hydrographic sampling co-located with the NRS mooring. PH100 is a known trawl ground. We have chosen a safer site in the vicinity and have implemented a phased approach to installing the mooring. Initially we deployed a dummy mooring (March2009) which survived 6 months. We are now in the process of deploying a thermistor string and a separate surface float mooring. If the thermistor string survives 3 months we will add a fluorometer to the mooring. The desire is to collect concurrent measurements of temperature and fluorescence at the PH100 site and the SYD100 site to compare the biological signal in these two regions. If the signals are comparable then the mooring site will be moved to SYD 100 and the hydrographic sampling will be spatially separated from the mooring. If the signals are significantly different we will endeavour to maintain a mooring at the PH100 site for as long as instrument loss is low (i.e at a comparable level as other sites. We note that loss is inevitable at any site). The real time telemetry system will be installed at the safe SYD100 site which is located within a telecommunication cable trawl exclusion zone.

Budget:

Proposed activities and capital purchases are listed in Table 1 and 2 above with budget details provided in the following pages.

Capital Expenses: Capital expenses under NCRIS and the EIF extension remain relatively low as the majority of capital has now been purchased. Expenses are limited to the replacement of assets. Under the enhancement, capital expenses are as follows, 2009/2010 $50,000 for an ADCP at the NRS. 2010/2011, additional instrumentation needed to deploy the ADCP (incl. Hotswap). We have also included capital costs of converting the NRS to real time telemetry which was identified as a priority under the mid-term review for a total of $220k.

The largest capital costs are included in 2011/2012 as an enhancement of the observational system. The extension of this program in its current format will require approximately $900k per annum. This is the majority of the proposed budget. A select number of additional enhancements have been chosen. The most important feature of the enhancements is the development of real time telemetry at two additional locations. This will facilitate our involvement in improving model output (by its inclusion in ocean forecasts and re-analysis products), as well as making the data immediately available to the science community and the general public. It will also allow rapid response to events and for us to respond quickly when instruments fail, this avoiding large data gaps. We propose to deploy one new mooring in Stockton Bight, a biologically important region. Additionally we aim to include bio-optical sensors on our national reference station. These measures will enhance our whole of system approach. These enhancements have been budgeted at approximately $680k of capital in 2011/2012. We have also included the addition of bio-optical sensors on the NRS at a cost of $139k in 2010/11. Operational costs will only increase marginally with the enhancements of the system, hence driving down the cost per observation. Capital costs in 2012/2013 are confined to spare instrumentation needed for hotswap to maintain continuity of the data streams ($216k).

Salaries: Presently the NSW-IMOS moorings team employs a staff of 1.5 FTE. It is anticipated that this will rise to 1.75FTE under the extended program (2011-2013). The moorings are deployed by three different operators in keeping with the IMOS goal of developing capacity nationally. This also allows us to keep staffing levels low. Presently the staff are Roughan (moorings management and co-ordination) and Morris (data delivery and field support). We expect to maintain the same staff in the same roles, with a 0.25FTE increase for Roughan. Salary expenses include 30% overhead and an annual salary indexation of 6%.

Operating: Maintaining the data streams is a large component of the budget. Understandably the maximum operating costs under NCRIS funding are in the last two years where all instrumentation has been deployed. Prior to this the deployment was phased which had the result of keeping costs down. This means that operating costs increase with the proposed enhancements in 2011/2012, however remain stable in 2012/2013 (approx $900k per annum). Operating costs include the monthly or bi-monthly servicing of the moorings, and all the associated costs such as replacement of consumables, boat hire, fuel etc. It also includes the preliminary QA/QC of the data. The operation of the moorings is under subcontract to three different organisations and the contracts are fixed for the life of the present NCRIS funding (to June 2011). This means that significant increases in costs are unlikely. The operators wear the risk of rising fuel or consumable costs not IMOS. This allows for accurate budget planning in the case where contracts have been signed (presently 7 of the 8 moorings and the hydrographic sampling at Port Hacking) to June 2011.

Data transmission for the real time telemetry system. These costs are based on the experience at Maria Island where iridium communications are necessary. These costs may diminish if next G communications are feasible.

Calibration of Sensors: The ANMN require that all sensors are calibrated annually and to facilitate this they have established a calibration facility based at CMAR in Hobart. Costs include freight to send the sensors to Hobart for annual calibration. This is significantly less than previous costs involved with returning large instruments to manufacturers for calibration in the USA. In case of our 150 thermistors, it is still more cost effective to ship them to the UK for calibration ($75 per sensor) than to have them calibrated at the CMAR facility ($150 per sensor).

Other Expenses: This includes allowances for the purchase of IT infrastructure in the first year of EIF funding which was not included in previous NCRIS funding budgets. There is also an allowance for travel for the ANMN staff to attend national meetings and workshops (such as the annual BGC workshop and bi-annual moorings meetings).

Co-investments – source and nature

We are fortunate that the co-investment instigated in the first round of IMOS will continue into the extension. Our industry partners DECCW and SWC have indicated that they will continue to provide data to NSW IMOS (which is accessible via the eMII portal) as an in kind contribution to IMOS (see attached letters of support). This is a significant contribution. Furthermore DECCW provide significant support for the biogeochemical sampling along the Port Hacking line. SIMS, the operator of NSW-IMOS moorings sub-facility is co-investing in a number of ways, namely: cash towards salaries for staff, the purchase of coastal oceanography equipment, vessel usage at 2 days per month, as well as the provision of a new oceanography laboratory and workshop as land based support. These co-investments have been included under the 'extension' component of the budget.

Staffing details

Presently the NSW-IMOS moorings team employs a staff of 1.5 FTE. It is anticipated that this will rise to 1.75FTE under the extended program (2011-2013). The moorings are deployed by various operators in keeping with the IMOS goal of developing capacity nationally. This also allows us to keep staffing levels low. Presently the staff are Roughan (moorings management and co-ordination) and Morris (data delivery and field support). We expect to maintain the same staff in the same roles.

Description of proposed new infrastructure for Nodes –

Observations required by the Nodes in relation to this Facility

As this proposal refers to a sub-facility of the ANMN, each of the observations outlined here are required by the NSW-IMOS node. In addition, the data we collect will support observations in the Bluewater and Climate node (offshore of NSW) and in the Tasmanian node (downstream of NSW). The observations provided by the QMOS node will also support our understanding of the East Australian Current as we lie downstream of their study site. The proposed new infrastructure is as follows (as per the major activities listed in Table 1, and the map in Figure 1):

- Maintenance of existing data streams. The initial instrumentation plan was well thought out with input from multiple stakeholders and it is considered important to maintain the existing data streams to enable the questions posed above to be answered.
- Addition of ADCPs (velocity measurements) on the national reference station. This is as per the recommendation of the mid-term review and in keeping with the ANMN national plan.
- Development of real time telemetry at 3 locations along the NSW coastline. This will allow the data to be available in real time, significantly increasing its value, both to scientists (allowing for rapid response to events), the general public, and to modelers who will be able to incorporate the data into their prediction models. It will also reduce the chance of large data gaps as instrument failure will be identified immediately.
- Deployment of one new mooring in Stockton Bight (Figure 1). This region is a biologically important region as it is the receiving grounds for upwelled waters driven by the separation

of the EAC. The deployment of a mooring in Stockton Bight equipped with WQMs will enable us to investigate the impact of the EAC on the NSW shelf and the biological response. This is in keeping with all the aims of NSW IMOS. This region was not instrumented initially due to funding constraints.

- Enhancement of the national reference station with bio-optical sensors. This will enable the investigation of the biological response to changes in the physical environment—specifically the quantity and quality of light—and its impact on photosynthetic rates at the base of the marine foodweb. By providing mechanistic information to link biology with physics, a 'whole of system' approach will start to be realised.
- Augmentation of the Coffs Harbour (CH100) mooring with WQMs to measure timeseries of fluorescence, light and salinity as well as temperature. This will again provide a more holistic view of the shelf waters in a very biologically significant region.
- Commencement of biogeochemical sampling at Coffs Harbour. This will again provide an investigation of the biological response to the physical environment. Thus enhancing the 'whole of system' view.

References

Roughan, M., Suthers, I., Morris, B.D., Baird, M.E. Pritchard. T., submitted, a. NSW-IMOS, An Integrated Marine Observing System for Southeastern Australia: The East Australian Current and its interaction with coastal environments. Submitted to Deep Sea Research, 22nd Oct 2009.

Table 16 Facility Budget for IMOS EIF Extension

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 Funding (*Note 2*)		(NCRIS/EIF)	(NCRIS/EIF)	(EIF)	(EIF)	(NCRIS+EIF)
Capital	Mooring Instrumentation	50,000	0	0	0	50,000
Salaries	1.75 FTE Moorings Team	149,756	163,926	203,183	211,089	727,953
Operating	Maintentance of Data Streams	482,200	576,200	652,124	661,586	2,372,110
	NCRIS/EIF Funding Total	**681,956**	**740,126**	**855,307**	**872,675**	**3,150,063**
Cash Co-investment (*Note 3*)		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Total**
UNSW	Salary Contribution Roughan 0.25 FTE - Confirmed	32,000	33,000			65,000
SIMS	Salary Contribution Scognamiglio 0.175 FTE -confirmed	15750	14000	17500	17500	64,750
	Cash Co-investment Total	**47,750**	**47,000**	**17,500**	**17,500**	**129,750**
In-kind Co-investment (*Note 3*)		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Total**
SIMS	Boat usage 1 per month ($1500 per day) -Confirmed	18,000	18,000	18,000	18,000	72,000
Sydney Water Corp (SWC)	Ocean Reference Station Data - Confirmed	250,000	250,000	250,000	250,000	1,000,000
NSW DECCW	NRS Sampling - Highly Likely	12,000	12,000	12,000	12,000	48,000
NSW DECCW	Waverider Buoy Data - Highly Likely	710,000	710,000	710,000	710,000	2,840,000
	In-kind Co-investment Total	**990,000**	**990,000**	**990,000**	**990,000**	**3,960,000**
	TOTAL Resources	**1,719,706**	**1,777,126**	**1,862,807**	**1,880,175**	**7,239,813**

Table 17: Facility budget for IMOS EIF Enhancement

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**
NCRIS/EIF Funding (*Note 2*)		(EIF)	(EIF)	(EIF)	(EIF)
Capital	Mooring Instrumentation	360,421	680,351	216,471	1,257,244
Salaries	1.75 FTE Moorings Team	0	0	0	0
Operating	Maintentance of Data Streams	22,200	275,000	282,200	579,400
	NCRIS/EIF Funding Total	**382,621**	**955,351**	**498,671**	**1,836,644**
Cash Co-investment (*Note 3*)		**2010/11**	**2011/12**	**2012/13**	**Total**
SIMS	Confirmed	220,000			220,000
SIMS	Oceanography Lab and Workshop		40,000		40,000
	Cash Co-investment Total	**220,000**	**40,000**	**0**	**260,000**
In-kind Co-investment (*Note 3*)		**2010/11**	**2011/12**	**2012/13**	**Total**
UTS	Doblin/Ralph 0.05 FTE x 1.3 - confirmed	10,000	10,000	10,000	30,000
UNSW-ADFA	H.Wang 0.2 FTE x1.3 - confirmed	26,000	26,000	26,000	78,000
UNSW-ADFA	C Symons 0.2 FTE x1.3 - confirmed	21,000	21,000	21,000	63,000
UNSW-ADFA	R Lawson 0.05 FTE x1.3 - confirmed	5,000	5,000	5,000	15,000
UNSW-ADFA	RDI ADCP	40,000			
	In-kind Co-investment Total	**102,000**	**62,000**	**62,000**	**186,000**
	TOTAL Resources	**704,621**	**1,057,351**	**560,671**	**2,282,644**

NB: For ease of budgeting the majority of the co-investment has been included in the extension (previous table).

Table 18 Appendix 1: NSW IMOS Moorings Budget 2009-2013

		NSW IMOS Moorings Sub Facility Operating Budget 2009-2013							EIF Total
	2009/2010		2010/2011		2011/2012		2012/2013		
Salaries	Base	Oncosts	Base	Oncosts	Base	Oncosts	Base	Oncosts	
Roughan ((	$46,714	$60,728	$50,976	$66,269	$78,649	$102,244	$80,840	$105,091	
Morris (1.0	$68,483	$89,028	$75,120	$97,656	$77,645	$100,939	$81,536	$105,997	
NCRIS Subtotal		$149,756		$163,926					$313,682
EIF Salaries Total						$203,183		$211,089	$414,271
Operating	Per Mon.	Per Ann.	Per Mon.	Per Ann.	Per Mon.	Per Ann.	Per Mon.	Per Ann.	
MHL (CH07(	$12,125	$145,500	$12,125	$145,500	$13,338	$160,050	$13,944	$167,325	
OFS (SYD10	$16,645	$199,740	$16,645	$199,740	$18,310	$219,714	$19,142	$229,701	
MHL(ED070	$0	$50,000	$12,000	$144,000	$13,200	$158,400	$13,800	$165,600	
DECC-BGC		$22,000		$22,000		$25,000		$25,000	
ADFA	$0	$6,000	$0	$6,000	$0	$15,000	$0	$15,000	
NCRIS Exter	$28,770	$423,240	$40,770	$517,240					
EIF Oper. Exten Sub Total					$44,847	$578,164	$46,886	$602,626	
SB100	$0	$0	$0	$0	$13,200	$158,400	$13,800	$165,600	
Hydrograph	$0	$0	$0	$0	$0	$50,000	$0	$50,000	
EIF Oper. Er	$0	$0	$0	$0	$13,200	$208,400	$13,800	$215,600	
Data Transmission									
Modem				$15,000		$45,000		$45,000	
Tracker				$200		$600		$600	
Expansion Estimate				$7,000		$21,000		$21,000	
EIF Subtotal				$22,200		$66,600		$66,600	$155,400
Other									
Travel/Incidentals		$15,000		$15,000		$15,000		$15,000	
IT Infrastructure						$15,000			
NCRIS Subtotal		$15,000		$15,000					
EIF Subtotal						$30,000		$15,000	$45,000
Calibration									
Sensors		$34,800		$34,800		$34,800		$34,800	
Freight		$9,160		$9,160		$9,160		$9,160	
NCRIS Subtotal		$43,960		$43,960					
EIF Subtotal						$43,960		$43,960	$87,920
NCRIS Operating Total		$482,200		$576,200					
EIF Extension OperatingSubTotal				$0		$652,124		$661,586	
EIF Enhancement Operating SubTotal				$22,200		$275,000		$282,200	
EIF Operating Total				$22,200		$927,124		$943,786	$1,893,110
Capital -EIF									
EIF Extension				$221,021				$216,471	
EIF Extension Capital SubTo		$50,000		$221,021		$0		$216,471	$487,493
EIF Enhancement		$50,000		$139,400		$680,351		$0	
EIF Enhancement Capital SubTotal				$139,400		$680,351		$0	$819,751
EIF Capital Total		$50,000		$360,421		$680,351		$216,471	$1,307,244
EIF Total Costs		$50,000		$382,621		$1,810,658		$1,371,346	$3,614,625
NCRIS Total Costs		$631,956		$740,126					$1,372,082
EIF Extension	100%		100%	$382,621	51%	$921,907	68%	$939,275	$2,243,802
EIF Enhancem	0%	$50,000	0%		49%	$888,751	32%	$432,071	$1,370,823
EIF Total Costs		$50,000		$382,621		$1,810,658		$1,371,346	$3,614,625
Grand Total		$681,956		$1,122,747		$1,810,658		$1,371,346	$4,986,707
NB Capital Costs are based on a USD/ AUD exchange rate of 0.8.									

Table 19 Appendix 2 Capital Purchases for NSW IMOS 2009-2013

				NSW IMOS Capital Purchases													
	Exchange I	$0.70	$0.80									Replacement	Total requ	Current	To purcha	AUD 0.7	AUD 0.8
Capital 2009																	
ADCP 300Khz + EBC															1	50000	50000
Sub Total 2009																**$50,000**	**$50,000**
Capital 2010																	
Extension 2010																	
Units + ancillaries																	
	USD Price	AUD Price	**CH070**	**CH100**	**SB100**	**SYD100**	**SYD140**	**PH100**	**JB070**	**ED100**		Replacement	Total requ	Current	To purcha	AUD 0.7	AUD 0.8
ADCP 300Khz + EBC	$27,000	$38,571						1					1		1	$38,571	$33,750
Cart Acoustic Release	$6,275	$8,964						2				1	3		3	$26,893	$23,531
WQM	$29,660	$42,371											0		0	$0	$0
Aquatech 520T	$820	$1,171											0		0	$0	$0
Aquatech 520PT	$1,320	$1,886											0		0	$0	$0
SBE39	$950	$1,357						20					20		20	$27,143	$23,750
SBE39b	$1,857	$2,653						8					8		8	$21,223	$18,570
Acoustic modems (2)	$5,660	$8,086						2					2		2	$16,171	$14,150
Seabird clamp	$102	$146						28					28		28	$4,080	$3,570
Quick release (2)	$680	$971						2					2		2	$1,943	$1,700
Benthos ATM891 Deck Box	$12,000	$17,143						1					1		1	$17,143	$15,000
Surface float for Telemetry		$73,000						1					1		1	$73,000	$73,000
Telemetry Can (2)		$7,000						2					2		2	$14,000	$14,000
Stockton Bight Hardware		$25,000													0	$0	$0
Subtotal Extension 2010			$ -	$ -	$ -	$ -	$ -	$ 231,202.86	$ -	$ -		$ 8,964.29				**$240,167**	**$221,021**
Enhancement 2010																	
Fastracka Fluorometer		$37,700						2					2		2	$75,400	$75,400
Wetlabs Eco Triplet	$20,000	$28,571						2					2		2	$57,143	$50,000
PAR Sensors for WQMs		$7,000						2					2		2	$14,000	$14,000
Sub Total Enhancement 2010								$ 146,543								**$146,543**	**$139,400**
Total 2010																**$386,710**	**$360,421**

IMOS Integrated Marine Observing System

Table 20 Continuation of previous table

	Exchange Rat	$0.70	$0.80													
Capital 2011	USD Price	AUD Price														
Units + ancillaries												Total requ	Current	To purcha	AUD	0.8 USD
			CH070	**CH100**	**SB100**	**SYD100**	**SYD140**	**PH100**	**JB070**	**ED100**	Replacement					
ADCP 300Khz + EBC	$27,000	$38,571			2						1	3		3	$115,714	$101,250
Cart Acoustic Release	$6,275	$8,964			4						3	7		7	$62,750	$54,906
WQM	$29,660	$42,371	2		2						1	5		5	$211,857	$185,375
Aquatech 520T	$820	$1,171			14						20	34		34	$39,829	$34,850
Aquatech 520PT	$1,320	$1,886			8						8	16		16	$30,171	$26,400
SBE39	$950	$1,357										0		0	$0	$0
SBE39b	$1,857	$2,653	4									4		4	$10,611	$9,285
Acoustic modems (2)	$5,660	$8,086	2						2		1	5		5	$40,429	$35,375
Seabird clamp	$102	$146	4									4		4	$583	$510
Quick release (2)	$680	$971	2						2			4		4	$3,886	$3,400
Benthos ATM891 Deck Box	$12,000	$17,143	1						1			2		2	$34,286	$30,000
Surface float for Telemetry		$73,000	1						1			2		2	$146,000	$146,000
Telemetry Can (2)		$7,000	2						2			4		4	$28,000	$28,000
Stockton Bight Hardware		$25,000			1							1		1	$25,000	$25,000
Sub Total 2011			$ 218,194.29	$ -	$ 254,228.57	$ -	$ -	$ -	$ 122,257.14	$ -	$ 154,435.71				**$749,116**	**$680,351**
Capital 2012	USD Price															
Units + ancillaries												Total requ	Current	To purcha	AUD	
			CH070	**CH100**	**SB100**	**SYD100**	**SYD140**	**PH100**	**JB070**	**ED100**	Replacement					
ADCP 300Khz + EBC	$27,000	$38,571									2	2		2	$77,143	$67,500
Cart Acoustic Release	$6,275	$8,964									3	3		3	$26,893	$23,531
WQM	$29,660	$42,371									1	1		1	$42,371	$37,075
Aquatech 520T	$820	$1,171									20	20		20	$23,429	$20,500
Aquatech 520PT	$1,320	$1,886									8	8		8	$15,086	$13,200
SBE39	$950	$1,357									20	20		20	$27,143	$23,750
SBE39b	$1,857	$2,653									8	8		8	$21,223	$18,570
Acoustic modems (2)	$5,660	$8,086									1	1		1	$8,086	$7,075
Seabird clamp	$102	$146									28	28		28	$4,080	$3,570
Quick release (2)	$680	$971									2	2		2	$1,943	$1,700
Benthos ATM891 Deck Box	$12,000	$17,143										0		0	$0	$0
Surface float for Telemetry		$73,000										0		0	$0	$0
Telemetry Can (2)		$7,000												0	$0	$0
Stockton Bight Hardware		$25,000												0	$0	$0
Sub Total 2012			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 247,395.71				**$247,396**	**$216,471**

IMOS Integrated Marine Observing System

South Australia

Call for Proposals under the IMOS (EIF) Five Year Strategy:
Enhancement or extension of IMOS – July 2009 to June 2013

Sub-Facility Project Plan template

25th October 2009 FINAL

Call for Proposals under the IMOS (EIF) Five Year Strategy:
Enhancement or extension of IMOS – July 2009 to June 2013

Sub-Facility Project Plan template

4th November 2009 FINAL

Overview:

Proposed Infrastructure Investment:	Shelf and slope moorings, field surveys and associated analyses to produce data streams.
IMOS Facility:	ANMN –SAIMOS Mooring sub-facility
Operating Institution:	SARDI
Facility Leader (for this Proposal):	John Middleton, 08 8207 5449; 040 222 6490; john.middleton@sa.gov.au
Other(s) key people involved:	Charles James, SARDI Sophie Leterme, SARDI/Flinders Laurent Seuront, Flinders/SARDI
Collaborating Institutions:	SARDI Flinders University University of Adelaide Australian National University Queens University, (Ontario, Canada)

Please attach:

- Letter from senior person in Operating Institution, confirming that the proposed infrastructure can be developed and operated within that institution
- Resume of Facility Leader
- Letters received from Collaborating Institutions, detailing their support to the Proposal, and indicative level of co-investment

1. Nature of Investment:

At present six shelf and slope moorings are maintained off the Kangaroo Island – Eyre Peninsula region of South Australia (Fig 1). The NRS and one other are maintained continuously: the former since August 2008. In addition, eight 6-day field surveys are conducted each year to measure environmental variables (eg., temperature, nutrients etc) as well as the temporal and spatial abundances of phytoplankton, bacteria and viruses. The data streams address key components of the original SAIMOS Node Science and Implementation plan and the new plan submitted as part of IMOS-EIF.

Extension: In line with the new SAIMOS Node Plan, this sub-facility seeks to maintain (extend) these observing systems and data streams until June 2013 and in a sustainable manner. For this, we request extension of salaried positions along with funds for additional ship-time, consumables and an assumed 17% rate of lost mooring capital. The upgrade of the NRS at Kangaroo Island (KI) to live status is a priority.

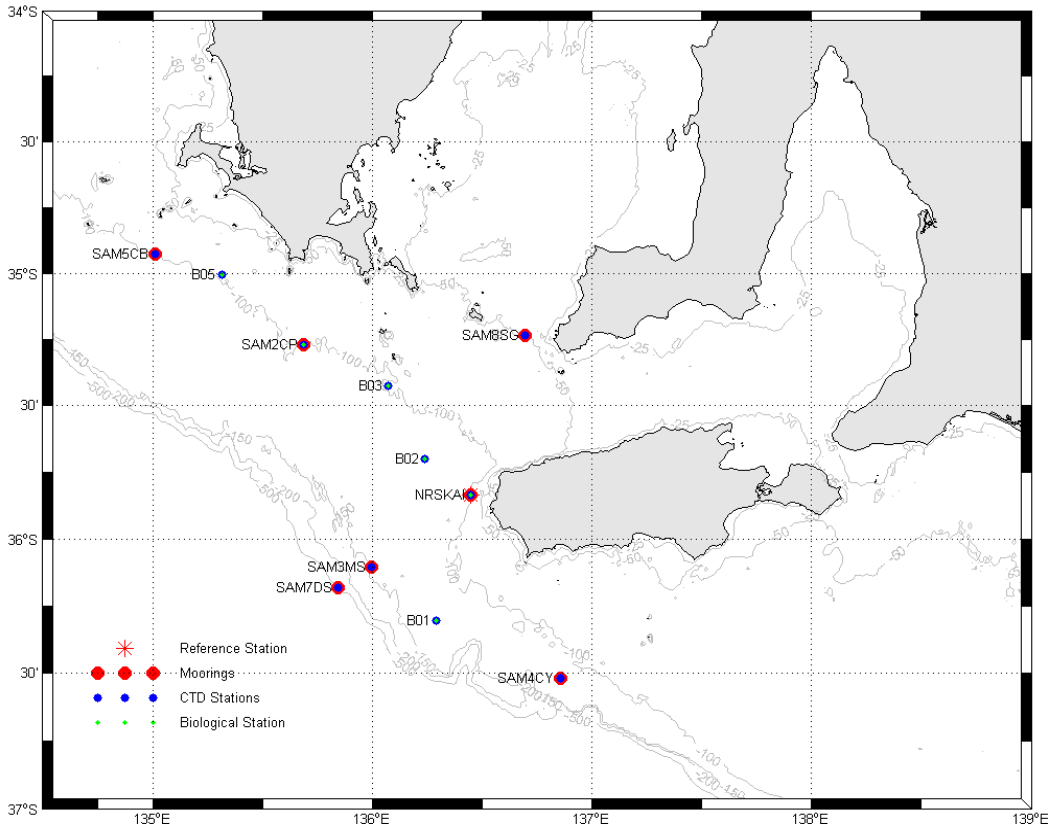


Figure 1. The revised mooring (red-blue dots) locations and biological sampling stations (green dots). The National reference Station is indicated as NRSKAI. Typically an additional 80 CTD surveys are made on each of the 8 annual cruises.

Enhancement: In accordance with the new SAIMOS Node Plan, we also seek to enhance the SAIMOS Mooring plan through the acquisition of two additional moorings of ADCP, CTD and temperature loggers. One mooring (SAM3MS), located on the 200 m isobath off Kangaroo Island, will provide additional information on the temporal variability of the Flinders Current and associated thermocline. With the existing equipment, three (rather than two) moorings will be maintained continuously. The second will be located off the Bonney Coast to provide vertical information that is to be supplemented by the HF RADAR system that is to be deployed by ACORN by June 2010.

An additional 1.0FTE is requested with priority to employ Shaun Byrnes. Shaun is currently funded through a $100K one-off grant from the IMOS office to assist with moorings and gliders as recommended by the mid-term external review. We note also that he has developed the capability for glider deployments and retrievals that will help drive costs down and also allow glider and ship-based surveys to mutually inform.

For the KI-Eyre Peninsula region, the SAIMOS Node seeks to obtain new data streams that are needed to determine primary/secondary productivity and carbon cycling. These will be obtained by placement of 3 Fast Repetition Rate Fluorometers (FRRFs) and 3 Autonomous Plankton Recorders (APRs) on the moorings shown in Fig. 1. An additional

1.0FTE will be needed to service and provide these data streams. These biological data streams are planned to be supplemented by pCO_2 and sediment traps from other sub-facilities.

An additional 2.0FTE is requested for the production of the biological data streams as well as to assist in the production of the molecular data streams from the DNA facilities at Flinders and Adelaide Universities.

Finally, in view of the complexity and size of the project, an additional 1.0 FTE will be needed to assist with the administration, capital acquisition, contracts and reporting.

The final delivery of the above investment will be the sustainable delivery of the data streams required by IMOS and the SAIMOS Node.

The extension and enhancements of the SAIMOS mooring plan provide direct support for the IMOS Strategic Priorities:

- Providing a national backbone for observing boundary currents and Enhanced observations of the Southern Ocean – through additional moorings on the shelf and Bonney Coast

- Exploring potential for "whole of system approaches" and Driving down the cost per observation – through deployment of additional sensors (biological and AATAMS) on existing moorings; multiple use of water samples for the production of biological, nutrient, molecular and isotope data streams; glider deployment/retrievals during sub-facility cruises.

2 Implementation strategy:

Summary

Extensive consultations were made with the SAIMOS Node to ensure that the data streams will meet the Node research needs as well as the IMOS Strategic Priorities. In summary, the strategy extends the observational streams until June 2013, with enhanced observations of both alongshore and cross-shore boundary currents. The latter, through upwelling drive local planktonic systems off the Kangaroo Island - Eyre Peninsula region. The observing strategy is to maintain observations of these systems and to also to extend observations to include critical carbon fluxes such as primary productivity. Molecular data streams of present and ancient phytoplankton species and abundance will be produced along with isotope concentrations for water mass analysis.

Objectives

The objectives and observational strategies follow from the SAIMOS Node's key research questions. In the following, we summarise these questions and outline the Observing Strategies to be adopted by this sub-facility. The IMOS Strategic Priorities are directly addressed.

2.1 Physical oceanography questions include:

What is the temporal and spatial variability and nature of the FC/LC and coastal shelf boundary currents including effects of forcing by seasonal and longer period mechanisms (ENSO and the Antarctic Circumpolar Wave)?

What is the connectivity of the boundary currents to those off W.A and the Tasman Outflow both from a physical viewpoint and from the perspective of the transport of marine biota, pathogens and invasive species?

Observational Strategies

a) To increase the number of moorings maintained continuously from two to three (including the reference station). This will involve one additional deep water mooring on the 200 m isobath and located between the NRS and inshore of the deep slope (600 m isobath) mooring (see Fig. 1). These moorings will consist of upward looking ADCPs, CTDs and temperature loggers so as to resolve temporal and cross-shelf variability of the currents and thermocline. The completion of the NRS to live status (with meteorology) is a priority in 2009-2010, but is dependent on CSIRO's manufacturing schedule. Repeated mooring deployments, temperature measurements and CTD surveys will, over 8-12 years, allow for the detection of the four year period Antarctic Circumpolar Wave, 4-7 year period ENSO events and determination of their impact on the shelf and slope circulation.

b) Connectivity with the boundary currents off Western Australia will be determined through comparison of slope/shelf data from SAIMOS, Tasmania and WAIMOS: we have agreed with WAIMOS on the need for both deep slope moorings with ADCPs and temperature loggers. A new deep slope mooring off the southern tip of Tasmania, and maintained by CSIRO, would allow the influence of the Tasman Outflow on the FC to be determined.

The along-shore connectivity of shelf currents will also be established through stable isotope analyses of IMOS water samples collected by SAIMOS. We have (in-kind) access to the Queens University Facility for Isotope Research (Ontario, Canada) and plan to analyse the water samples collected through SAIMOS (and elsewhere) for O and H isotope ratios which can be used as semi-conservative tracers. Analyses of these data in conjunction with other hydrographic properties provide a more robust method of determining mixing paths between water masses, and paths of connectivity, associated with the Flinders Current (sub-Antarctic), Leeuwin Current (semi-tropical) and gulfs. This analysis will draw upon the expertise of Dr Kurt Kyser and Dr Noel James (Queens University, Ontario) and Dr Michael Ellwood and Laura Richardson (ANU/SARDI). The analysis to produce the data streams will only be undertaken for 2 years at a cost of $8,000. However, we believe their inclusion in SAIMOS is justified under the IMOS strategic priority "Exploring the potential of new methods and approaches": in addition, the Queens Isotope Facility is available as in-kind valued at $39,600 – see below.

What is the temporal and spatial variability and nature of cross-shelf exchange (upwelling and downwelling) for both the SA and Bonney coast regions and what role do canyons and gulfs play?

Observing Strategies:

a) The role of canyons in cross-shelf will be investigated using CTD surveys and the sea glider allocated to SAIMOS.

b) For Kangaroo Island – Eyre Peninsula region, the slope data streams will be supplemented using the shelf moorings in Fig 1, the eight CTD field surveys that SAIMOS currently undertakes each year and other data streams (glider, tagged mammal, RADAR and SST). We have already identified paths of upwelling and downwelling for the S.A. region and the shelf moorings are deployed along isobaths to measure the former. The NRS off Kangaroo Island is deployed at a choke point of isobaths (Fig 1) and thus the along shore flow. In addition, it sits in the western part of the Kangaroo Island "cold pool" which may act as a reservoir of nutrient rich water, (SAIMOS Node Plan). The role of the gulfs in cross-shelf exchange and effects on alongshore variability will be determined using these data as well as a mooring deployed at the mouth of the gulf (Fig 1). This mooring (SAM8SG), the NRS and SAM5CB (Eyre Peninsula) will be maintained continuously and each have temperature loggers so as to resolve mixed layer depth: this data is needed for both physical and biological research questions.

c) For the Bonney Coast, we also plan to supplement the surface current data of the proposed HF RADAR using a new mooring. The mooring data is also supplemented by the live data from the N.T.C. Portland baseline sea level gauge. The Acoustic Observatories in this region are already being serviced by a part-time, local employee (Andrew Levings) and he will be employed for mooring servicing three times a year.

2.2 Biological oceanography questions include:

Carbon-cycling and primary productivity

The following questions and observational strategies represent a logical next-step enhancement of activities to date. The data streams will be produced from equipment or water samples collected during the eight annual SAIMOS field surveys.

What are the sources and concentrations of nutrients on the continental shelf (through the canyons and the gulfs) and how it impacts the abundance and community composition of viruses, bacteria and phytoplankton?

How are variations in primary productivity related to variations in oceanic nutrient supply (such as through the upwelled Kangaroo Island cold pool) and what are the lags of biological response?

What role bacteria plays in the degradation of particulate organic carbon and in the conversion of dissolved organic carbon in the particulate pool, therefore are they acting as both re-mineralisers of organic carbon and trophic mediators?

Observational Strategy:
Field sampling will be done at each biological stations in Fig. 1 for subsequent laboratory analyses and data stream production:
a) Sampling of nutrients concentrations at each biological stations
b) Sampling for flow cytometry assessment of the bacteria and viruses populations.
c) Sampling for phytoplankton biomass (Chlorophyll a) and communities (microscope counts)

What is the impact of viral infection and the subsequent lysis of marine microbes and other organisms on the carbon fluxes?

Observational Strategy:
Assess the relative contribution of viral lysis and microzooplankton grazing to the mortality of auto- and heterotrophic bacteria and phytoplankton populations through onboard incubations.

What are the critical fluxes such as primary productivity and the related changes in phytoplankton communities, ocean-atmosphere fluxes and vertical fluxes?

Observational Strategy:
Data from Fast Repetition Rate Fluorometers and Automated Plankton Recorders will be collected from the three continuously maintained moorings in order to assess primary and secondary primary productivity. Measurements of pCO_2 (including NRS) will be obtained at the NRS site from instruments deployed by the proposed sub-facility.

Seasonal variations in primary productivity will be examined via ^{14}C uptake experiments that will be conducted during the February, May, August, November cruises.

Sediment trap data will be obtained through the NCOTs sub-facility. The synchronisation of the timing of the traps will allow tracing particles in time and space.

2.3 Molecular Oceanography questions include:

Biodiversity Identification of Plankton Samples

Questions:
What is the abundance and community composition of phytoplankton and zooplankton communities in our study region and do these communities show spatial and temporal variation associated to different oceanographic conditions?

Observational Strategy:
Plankton normally collected from the 6 biological sampling stations (Figure 1) will be used for analysis. We will identify samples obtained during 5 collecting trips per year (total of 90 samples over 3 years). Plankton specimens will be identifying based on a robotic molecular approach using sequence data from the small-subunit rRNA and the cytochrome oxidase I genes. Data streams of species ID, community structure and composition for each sample and given year will be determined.

Biodiversity of the ancient record

What is the biological diversity of phytoplankton in sediments over the last 10,000-15,000 years with a focus on time periods featuring climate shifts?

Observational strategy:

Eight cores will be collected for the sediment analysis and sediment traps will be used to collect columnar organic debris for genetic analysis. Initial studies of four cores for the SAIMOS observational region will examine depositional biases. After this an additional four cores will be made so as to produce data streams of phytoplankton diversity for deeper sediments. These data streams will elucidate detailed historic records of change.

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

Table 1: Annual activities for the SAIMOS Mooring sub-facility

Region	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
KI - Eyre Peninsula												
SAM5CB												
SAM2CP												
SAM8SG												
NRSKAI												
SAM3MS												
SAM7DS												
SAN4CY												
Bonney Coast												
SAM9BC												

In Table 1 a list of monthly activities is given for each of the two regions. For the KI-Eyre Peninsula region, the grey squares indicates the months in which the 6-day field surveys are done. Each mooring, shown in Fig 1 is indicated in the table and the months of deployment shown. Proposed new moorings are in bold face. The moorings, SAM5CB (off the Eyre Peninsula, SAM8SG (mouth of Spencer Gulf) and NRSKAI (NRS off K.I.) will be maintained continuously. The surveys and mooring deployments will be done by the Adelaide based SAIMOS Mooring staff.

For the Bonney Coast region, Andrew Levings (Portland) will be employed to maintain a new mooring off the Bonney Coast. The mooring will be retrieved, serviced and redeployed sometime in February-March, July-August and November-December so that six, one-day vessel trips are needed.

2.5 List of major equipment to be purchased

A list of the major equipment to be purchased, timing and funding source is shown in Table 2 at the end of this document. The timetable of purchase is shown along with funding source: black for NCRIS and red for EIF. An ongoing cost of 17% is included to replace lost mooring equipment.

The 2009/2010 EIF funds for the NRS ADCP ($50K) is not included in the final EIF budget request. Major equipment for the two (200m and Bonney Coast) moorings include, 2 ADCPs, 4 NXIC CTDs, 4 CARTE Acoustic releases, 86 temperature loggers, 2 Sable satellite mooring locators. Funds for a Carousel Water Sampler are requested as this will expedite water sampling in the field.

For the carbon cycling/primary productivity data streams, 3 Fast Repetition Rate Fluorometers and 3 Autonomous Plankton Recorders are included.

3. Access and pricing:

- How will access be provided

Access is free and unrestricted through the IMOS portal. Data will be provided both from telemetry and download of delayed data.

- How will data be managed

Data management will be the joint responsibility of eMii and SARDI who run identical software (matlab toolbox and deployment database) in parallel to provide a continual backup of the processing, data delivery and QC of telemeter data. Delayed mode QC, in which the data subjected to a thorough check, can only be done every 3-6 months after a mooring is serviced. This will be handled the SAIMOS sub-facility and the data delivered to eMii, ensuring that all of our mooring data is of the highest quality.

- Dependencies on external / other facilities (national and international)

The data streams from the sediment traps, pCO_2 and mooring off Tasmania outlined are dependent on outcomes of the IMOS process. These data streams are supplementary and their existence or otherwise does not compromise other components of the SAIMOS mooring strategy. The data streams from the Queens Isotope facility and molecular facilities have been promised. There are no other dependencies.

- Collaborative structures for allocation of priorities

The design of ANMN is the result of a national, collaborative process via the sub-facility leaders of the network and input from regional nodes. National coordinating meetings for the facility are held twice a year between CSIRO, AIMS, SARDI, Curtain University and the SIMS to ensure that national priorities, such as effective coverage to feed into models, are met. This project is also overseen by the IMOS office.

4. Governance

- Performance indicators

These are the production of data steams outlined above.

- Describe key risks and risk management strategies

Risk - loss of vessel capability through break-down of SARDI's *MV Ngerin*. Management: Various trawlers can provide a somewhat reduced capability at $5-7K/day

Risk – loss of moorings due to equipment failure/bad weather. Management: to minimise loss, all moorings have two releases, ground line and sub-anchor and surface float. In addition, all ADCP float packs have Sable Iridium locators and Novotech radio transmitters and strobe lights for recovery. SAICORP also insures for loss but with an excess of $50K.

Finally, following CSIRO, we have budgeted on a loss rate of capital. We chose a 17% rate (about double CSIRO's), due to our less mature capability in moorings: we do note that we have not lost any instruments to date in over 52 months of deployments.

Risk – with the enhancement, the sub-facilities administrative tasks will be much more complex and involve contracts between SARDI and several other entities. Capital purchase at the amounts requested will also be very time consuming as will co-ordination of activities and reporting. This additional work load cannot be undertaken by current staff. Funds for a full time administrator are requested who will work with the SAIMOS Executive Officer.

- For existing Facilities, respond to any issues raised in the 2008 IMOS Review.

The review was very positive stating:

a) SAIMOS is on track to emulate the success of the GBROOS Node.
b) Through SARDI, SAIMOS is developing broad institutional capacity,

and recommending:

a) Discussions be held between SAIMOS and WAIMOS can be better linked – done see above.
b) IMOS invest $100K to support joint ANFOG/ANMN deployments in SAIMOS.

The latter was the response to our SAIMOS submission to the mid-term review where we stated:

The number of IMOS salaried positions (1.3FTE) needed to implement SAIMOS (moorings) was underestimated. … that SAIMOS of all the coastal nodes is unique in that the reference station an shelf region of study is far from our base in Adelaide (200 km or 12 hrs steaming). SAIMOS cruises and glider deployments are therefore longer than those for other nodes so that additional support is required for salaries. We request that … $100K be made available for salaries so as to support the mooring program.

Additional funds for salaries are requested in the budget below.

5. Budget:

- EIF Funds

The total request for EIF funds is $770,801 in capital and $3,033,228 in operating for a total of $3,804,029

5.6 Extension of existing Facility

Summary: The totals are $922,013 for operating and $217,000 for capital. Total = $1,139,013

Capital: The extension will require additional consumables, satellite time for the NRS and capital to replace lost moorings. Total= $217,000

Salaries: The extension of the sub-facility until June 2013 will require the salaries of Leterme (0.33FTE), Luick (0.5FTE) and James (0.5FTE) be renewed along with ~$40,000 per year for casuals (0.45FTE). As noted, this level of salary support is insufficient to make the SAIMOS mooring sub-facility sustainable in the long term. Total = $431,202

Operating:
Vessel: time for extension will be as before with 28 days EIF funded and 20 days SARDI in-kind. As a contingency for break-down of SARDI's *M.V. Negerin*, commercial vessel hire as well as rising fuel costs are allowed for in the budget ($5K/day in 2011/2012 and $6K/day in 2012/2013). Total = $308,000

Other: the budgeted figures are based on the expected 2010/2011 NCRIS budget (~$90,000/yr) with 3.5% inflation. Annual costs here include analyses to produce the nutrient/phytoplankton and other data streams ($30,000), interstate travel ($12,600), mooring locator satellite costs ($3,400), mobile phone ($1,200), lost mooring recovery costs ($1,340), travel to *M.V.* Ngerin ($2,740), CTD servicing and freight ($2,754), Industry information sessions ($5,400). Total = 182,811

5.7 Enhancement: 2010/2011 – 2012/2013

The enhancement consists of a) additional staff to make the facility sustainable, b) maintenance of a new mooring off the Bonney Coast and c) an additional slope mooring off the KI-Eyre Peninsula region. In addition, for the latter region, we extend the data streams to include those for primary productivity and carbon fluxes, isotopes as well as molecular information on phytoplankton biodiversity (present and ancient).

Administrative Support Total = $352,204

With the enhancement, the sub-facilities administrative tasks will be much more complex and involve contracts between SARDI and several other entities. Capital purchase at the amounts requested will also be very time consuming as will co-ordination of activities and reporting. Funds for a full time administrator are requested who will work with the SAIMOS Executive Officer.

Summary: The totals are $2,111,214 for operating and $553,801 for capital. Total = $2,665,015

The detailed budgets for each region are presented separately.

The Bonney Coast Region Total = $326,098

The costs of maintaining the mooring here are:
Capital: $130,000 (ADCP, 2 CTDs, 2 acoustic releases, deck unit)
Salaries: $46,149 (0.12FTE for 3 years)
Vessel: $124,249 (18 one-day trips)
Operating: $25,700

The Kangaroo Is-Eyre Peninsula Region (ex molecular/isotope) Total = $963,941

Capital: We plan to purchase the slope mooring, carousel, 20 temperature loggers, the three FRRF and APR's and additional consumables. Total = $423,801

Salaries: Salary for Shaun Byrnes is a priority. The QA/QC effort and deployment, retrievals, maintenance and storage of the $1.2M worth of equipment and field surveys is an enormous task and staff time was underestimated at the start of IMOS. In addition, we spend 40 days at sea each year, which, with downtime for mooring preparation and servicing and is in itself a very large and onerous task: simply, it is not reasonable to expect that the 1.78 FTEs originally allocated these tasks can maintain them in a sustainable manner. In recognition of this, the IMOS office provided an additional $100K in 2009 for additional FTE contribution toward moorings and glider work. Shaun Byrnes has been employed and will assist with mooring work (0.9FTE), and to a lesser extent (0.1FTE) with the glider deployments and retrievals. To make the biological field survey work sustainable, an additional 1.0FTE is requested (bio-technician) who will also carry out tasks associated with the biological sampling (bottle labelling, cruise participation, production of carbon cycling and primary production data streams. Total = $704,408

Operating:
Vessel: No increases in vessel time will be needed above those specified in the Extension budget.

Other: The C14 bench mark analysis of primary productivity will cost $86,280 for the three years. An additional $10K/yr is allocated to the additional operating/maintenance costs of the FRRF and APR's. Total = $116,280

<u>The Kangaroo Is-Eyre Peninsula Region (just molecular/isotope) Total = $750,204</u>

These only require data streams produced by the SAIMOS field surveys and/or others which may be obtained without cost to IMOS.
Capital: Nil

Salaries: An additional 1.0 FTE is requested for a bio-technician who will assist in the field surveys, biological sampling and production of the molecular biodiversity data streams. Total =$352,204

Operating: The Flinders and Adelaide molecular facilities require $240,000 and $150,000 respectively for the three year period. The former covers costs of generating DNA sequencing data for approximately 12,000 sequences (for two genes) per samples collected from the biological sampling stations. The latter covers molecular biology consumables ($133K and facility running costs ($15K). Hire of a sediment corer ($2,000) for two field surveys is included.

The isotope analyses require $8,000 for two trips by Laura Richardson to Canada to produce the isotope data streams. The budget here includes travel costs and 8 weeks accommodation in Canada.

5.8 Co-investments – source and nature

The in-kind investments by SARDI and Flinders are summarized in the spreadsheets and the details listed below. The annual in-kind totals exceed that in the 2007 IMOS Business

Plan and there is a marked increase in salary commitments reflecting the complexity of implementation of the SAIMOS Mooring sub-facility.

In-Kind Details

SARDI In-kind :
Cash: contribution to SAIMOS Node $2.5K/yr
Salaries: as per the spread sheet. Note John Middleton's in-kind commitment for the extension will be 0.5, 0.4, 0.3 and 0.3 FTE for each of the four years.
Vessel: 20d/yr @ $3K/day then $5K/day 2011/2012 and $6K/day for 2012/2013

Capital:
IT $12K/yr ($60K computer/5 yrs) = $12K/yr
IT MATLAB licenses and maintenance $25K/5yrs = $5K/yr
Sub-total = $17K/yr

Operating:
Depreciation on CTD @ $133/d= $6.4K/yr
Use of SARDI Workshop $10K/yr
IT Management (Jason Isitt salary+3.5% infl'n) $10K/yr
Sub-total = $26.4K/yr

Flinders In-kind.
Cash: contribution to SAIMOS Node $2.5K/yr
Salaries: as per the spread sheet.
Operating: as per the spread sheet. The Aanderaa Data buoy will be available to SAIMOS for 6 months per year for the enhancement. It is valued at $120,000, yielding a total in-kind of $60K over the 3 year period.

University of Adelaide
Cash: Nil
Salaries: as per the spread sheet
Operating: as per the spread sheet

ANU In-Kind
*Salaries***:** Dr Michael Ellwood will contribute 0.01 FTE.

Queens University
Salaries: Dr Kurt Kyser will contribute 0.01FTE.
Operating: In-kind use of Queens Isotope Facility - 360 samples at $110 (CSIRO fee) = $39,600

5.9 Staffing details

A/Prof John Middleton, Mooring sub-facility leader, in-kind SARDI
Prof Laurent Seuront, Node Leader, 5% in-kind, Flinders University
Prof Luciano Beheregaray, 10% in-kind Flinders
Prof Alan Cooper, 10% in-kind University of Adelaide
Mr Shaun Byrnes, SAIMOS Mooring/Glider Technician, 100% SAIMOS (for 2009/2010)

Dr Charles James, Oceanographer: Field Services, 50% SAIMOS
Dr Sophie Leterme, Biological Oceanographer, 33% SAIMOS
Dr John Luick, Oceanographer: Hydrodynamic Modelling, 50% SAIMOS
Ms Louise Renfrey, Executive Officer, 100% in-kind, Flinders University
Ms Laura Richardson, PhD candidate (SARDI/ANU)
Mr Carlos Teixeira, PhD candidate (casual SAIMOS appointment)
Dr Mark Doubell, Oceanographer, 10% in-kind SARDI.
Dr Kurt Kyser&Dr Noel James, 1% in-kind, Queens University
Dr Michael Ellwood, 1% in-kind, ANU

5.10 Description of proposed new infrastructure for Nodes – see Table 3 below.

Table 2: Major equipment to be purchased**.**

		2009/2010	2010/2011	2011/2012	2012/2013
Item					
SAIMOS NCRIS					
AquaTech 60 T-loggers 26 P/T-loggers		$169,849	$56,616		
NCRIS Consumables extension		$21,000	$21,000		
Spare satellite locator&novotech		$15,000	$0		
Reference station (inc $6K/yr satellite costs)		$101,236	$6,000		
Lost mooring replacement parts		$2,696	$44,174		
SAIMOS EIF					
NRS ADCP		$50,000			
Carousel Water Sampler			$46,340	$0	$0
200m Mooring (150kHz ADCP, 2NXIC, satellite locator, 2 CARTs)			$140,000	$0	$0
Bonney Coast mooring(300kHz ADCP, 2NXIC, satellite locator, Novatech, 2 CARTs, ORE DeckUnit, Novatech DeckUnit)			$130,000	$0	$0
EIF enhancement consumables compt			$8,000	$8,000	$8,000
Consumables Extension				$30,000	$50,000
Mooring Satellite Costs				$6,000	$6,000
satellite costs @$600/yr/unit			$1,200	$1,200	$1,200
3 Fast Repetition Rate Fluorometers			$91,190	$0	$0
3 Autonomous Plankton recorders			$62,055	$0	$0
Lost Mooring replacement @17% of $1.2M				$80,000	$80,000

Table 3: Observations required by the Nodes in relation to this Facility

Facility	Observations required by the Node			
	NCRIS Funded (already allocated to Jun11)	EIF first $8M funded (already allocated to Jun10)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
	(see Appendix 1 of the Guidelines)			
Bluewater & Climate				
WAIMOS				
GBROOS				
NSW-IMOS				
SAIMOS	6 Moorings Kangaroo Is. NRS Deep Slope Cabbage Patch Canyons Coffin Bay Investigator Strait Field survey data (nutrients, CTD, biological)	ADCP data for NRS	6 Moorings Kangaroo Is. NRS Deep Slope Cabbage Patch Canyons Coffin Bay Investigator Strait Field survey data (nutrients, CTD, biological)	Bonney Coast Mooring Additional Slope mooring Carbon cycling, primary productivity and isotope data streams Molecular data streams of phytoplankton and ancient plankton
Other <enter name>				

Facility	Observations required by the Node			
	NCRIS Funded (already allocated to Jun11)	EIF first $8M funded (already allocated to Jun10)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
	(see Appendix 1 of the Guidelines)			

NCOTS

Overview:

Proposed Infrastructure Investment:	**Annually serviced, time series sediment trap mooring infrastructure.**
IMOS Facility:	**Facility: ANMN - Australian National Mooring Network.** **Sub-facility: National Coastal Time Series (NCOTS).**
Operating Institution:	**Facility ANMN** = CSIRO Marine and Atmospheric Research. **Sub-facility NCOTS** = Macquarie University.
Facility Leader (for this Proposal):	**Facility ANMN:** Dr T.P. Lynch Ocean Sensor Deployment Team Leader Castray Esplanade HOBART, TAS 7000 GPO Box 1538 HOBART TAS 7001. Ph: (03) 6232 5239 Fax: (03) 6232 5000 Mob: 0416 089 749 tim.lynch@csiro.au **Sub-facility NCOTS:** Dr L. Armand Senior lecturer/Climate Risk CORE researcher Faculty of Science, Department of Biological Sciences Macquarie University, NSW, 2109 Ph: (02) 9859 8351 Fax: (02) 9850 8245 Email: larmand@science.mq.edu.au
Other(s) key people involved:	1. Dr Peter Thompson, CSIRO Marine and Atmospheric Research, TAS. 2. Dr Martina Doblin, University of Technology Sydney, NSW. 3. Dr Moninya Roughan, Sydney Institute of Marine Sciences (SIMS) and University of NSW, NSW.
Collaborating Institutions:	1. Macquarie University. 2. Sydney Institute of Marine Science (SIMS). 3. CSIRO Marine and Atmospheric Research (CMAR). 4. University of Technology Sydney. 5. University of New South Wales.

Please attach:

- Letter from senior person in Operating Institution, confirming that the proposed infrastructure can be developed and operated within that institution
- Resume of Facility Leader n/a
- Letters received from Collaborating Institutions, detailing their support to the Proposal, and indicative level of co-investment

- Letter from Prof Lesley Hughes HOD, MQU attached.
- Letter from Peter Steinberg, SIMS, *requested and will be supplied covering support for various facility and sub-facility and nodes homed at/supported by SIMS*.
- Letter from HOD UTS for Martina Doblin, *requested*.
- Letter from HOD UNSW for Moninya Roughan, *requested*.
- Letter from Director CMAR for Peter Thompson, *requested*.

Nature of the Investment:
The nature of the investment is extending and enhancing the Australian National Mooring Network (ANMN) facility through a new sub-facility, the National Coastal Time Series (NCOTS). The NCOTS sub-facility is focused on providing the resource requirements for time-series collected particulate material, as a continuous sample data stream for the biological and geochemical science needs of the current and future National node science and implementation plans. This sub-facility investment enhancement is centred upon the addition of, or augmentation to, existing mooring lines with annually serviced sediment traps and supporting instrumentation. The degree of investment to each sediment trap location is dependent on the existing regional mooring infrastructure and the targeted investigations directed by State node scientific priorities.

The ***collective infrastructure requirements*** to develop this sub-facility between 2010 and 2013 are:

- 5 x Technicap 3/4, 24x 500ml sample, titanium motor, sediment traps for the collection of particulate material (biological and geochemical).
- 6 x Tilt and pressure sensors to provide sediment trap orientation data.
- 1 McLane wet sample splitter.
- Freight (Dangerous good refrigerated service).
- 3 Desk and lap-top computers.
- 1 Complete mooring line for the Pt Hacking location, comprising:
    - ADCP.
    - Ecopuk sensors x4 (with reference to the Bioptics sub-facility).
    - Camera and strobe flash set.
    - Acoustic releases x2.
    - ARGOS beacon and surveillance fee.
    - Thermistors x4.
    - Lithium batteries.
    - Mooring consumables and hardware.
- 1 FTE Service Technician – (Macquarie University Level 5.1 General Staff, with 28% on-costs and provision for a maximum of 2 months sea-time loading).
- 1 0.5 FTE electronics officer - (Macquarie University Level 4.1 General Staff, with 28% on-costs and provision for a maximum of 1 month sea-time loading).

The ***expected outputs*** of the sediment trap enhancement by NCOTS to ANMN are the following:

1. Split and inventoried annual sediment trap samples (24 samples/trap/year, 10 splits/sample).
2. A particle size and image dataset (sourced by FlowCAM instrumentation) from one split of each sample for “rapid” documentation of major biological and particle composition captured (Rapid = <1 month after recovery).
3. Picked zooplankton material for AusCPR Facility analysis. Possible study of split.
4. Geochemical analyses by an unspecified research institution.
5. Potential samples for molecular study, inclusive of ancient DNA linkages to seafloor sediment markers.
6. Storage and management of sample split studies to Institute and University researchers based on guidelines or use, and data analyses provided to IMOS in a timely manner.
7. Sea-floor photographic sequences.
8. Associated instrumentation data from ADCP, Ecopuk, thermistors etc. (to be handled by respective ANMN sub-facilities at the node level).
9. Co-development of standardised sediment trap protocols with SOTS, under international quality control standards suggested by OceanSITES.

The ***initial NCOTS infrastructure placements*** are proposed in the vicinity of three key National Reference Stations (NRS) that build upon Australia’s only phytoplankton time series data collections (Port Hacking, NSW; Two Rocks, W.A.) and where steps to advance to carbon modelling and biological inventory has reached a scientific priority (e.g. Kangaroo Island, S.A. and Two Rocks, W.A.). These three locations provide a broad national coverage of the two major boundary currents influencing the eastern and western seaboard of the Australian continent and the zone of mixed oceanographic sources and biogeographical overlap along the southern margin.

The long-term ***future directions for NCOTS*** will be linked firmly to increased access and capabilities of the new National Marine Research Vessel Facility post mid-2012. The increased programme capacity will enable between 3 and 5 new time-series locations to be added to the National sustained monitoring (elaborated on under "Allocation of priorities" section). Equally, implementation of a taxonomic toolkit and library to increase the analytical capability and output from the emergent data stream by new skilled staff (akin to the training investment of staff afforded to AUSCPR for zooplankton data stream generation) would be the focus of future programme expansion.

The NCOTS sub-facility of ANMN will be hosted in NSW at the co-institutional Sydney Institute of Marine Science, with Dr **Error! Reference source not found.** as a 0.2FTE manger and with a 1 FTE service technician and a 0.5 FTE electronic technician. The total ANMN enhancement by the NCOTS sub-facility for 2010-2013 detailed in this proposal is:

Sub-Facility	Enhancement	EIF Funds	Specified Personnel
NCOTS	Sediment traps, associated mooring infrastructure and technical staff. **Total Budget (2010 - 2013)**	**$1,605,288.00**	Dr L. Armand

Implementation Strategy:

- *Summary*

The existing Australian National Mooring Network (ANMN) presently provides a modern record of oceanographic properties measured in the major boundary currents around Australia (IMOS Annual Progress Report, 2008-09). The data being provided is integral to monitoring and numerical modelling science both nationally and globally, as evidenced by the uptake and utilisation in BLUElink and with reference to the advances identified in discussion white papers at OceanObs'09 (e.g. LeQuéré et al. 2009, Malone et al. 2009). This document provides a conceptual outline of our National Coastal Time Series sub-facility as a new sub-facility within the ANMN. This sub-facility will represent an addition to the study of coastal ecosystems notably from the base of the food chain and with respect to chemical and physical systems. As such the infrastructure will provide missing data between the physical observations provided by Coastal currents and water properties facilities (i.e. ANMN) and largely distribution based Coastal ecosystem facilities (i.e. AATAMS, AUV, AusCPR).

NCOTS seeks to add sediment trap instrumentation within the vicinity of shallow NRS locations. The primary concern of NCOTS is to instigate a time-series collection of particulate material relevant to monitoring the biological and geochemical variations of boundary currents. The NCOTS data stream will merge with and largely compliment NRS oceanographic data acquisition, AusCPR transect surveys and NRS monthly sampling. The value of instigating prolonged observations from NCOTS infrastructure will be central to characterising:

- weekly, monthly and seasonal cycles and the impact of extreme climatic events;
- decadal connectivity to climatic forcing in reference to responsive ecosystem and biodiversity shifts;
- and as biological and geochemical data for integrative modeling (providing time and depth dimensions).

The NCOTS implementation strategy represents the work programme to be undertaken and completed over the current Education Investment Fund (EIF) support package (2009-2013). Our strategy is based on the building of national capacity and the baseline inauguration of this continuous data stream. The data stream being identified as particulate "slurry" that is split into sub-samples and either analysed by some IMOS facilities and ANMN sub-facilities, or by institutional based scientists and students. The data stream provided by the NCOTS sediment trap platform averages observations from phytoplankton migration and blooms to synoptic and mesoscale events, and through to major climate change impacts over wider temporal frames (weekly to decadal) (Figure 1a). Modern biological sampling capabilities, including existing IMOS facilities, capable of assessing floristic shifts to long-term-change adaptations are schematically represented in Figure 1b with respect to spatial coverage and capture periods. Sediment trap moorings are restricted spatially to the regional export at the NCOTS locations, but allow for greater averaged data streams (only provided by the SOTS platform). Integration of observations from all IMOS facility data streams would provide maximum coverage of the changes across multiple spatial and temporal scales relevant to determining marine

ecosystem and biodiversity variations. The NCOTS data stream will also provide the chief link between time-series accumulation histories (fossil and geochemical) accumulated in sediment cores and the environmental conditions relevant to their formation or existence (Figure 1b).

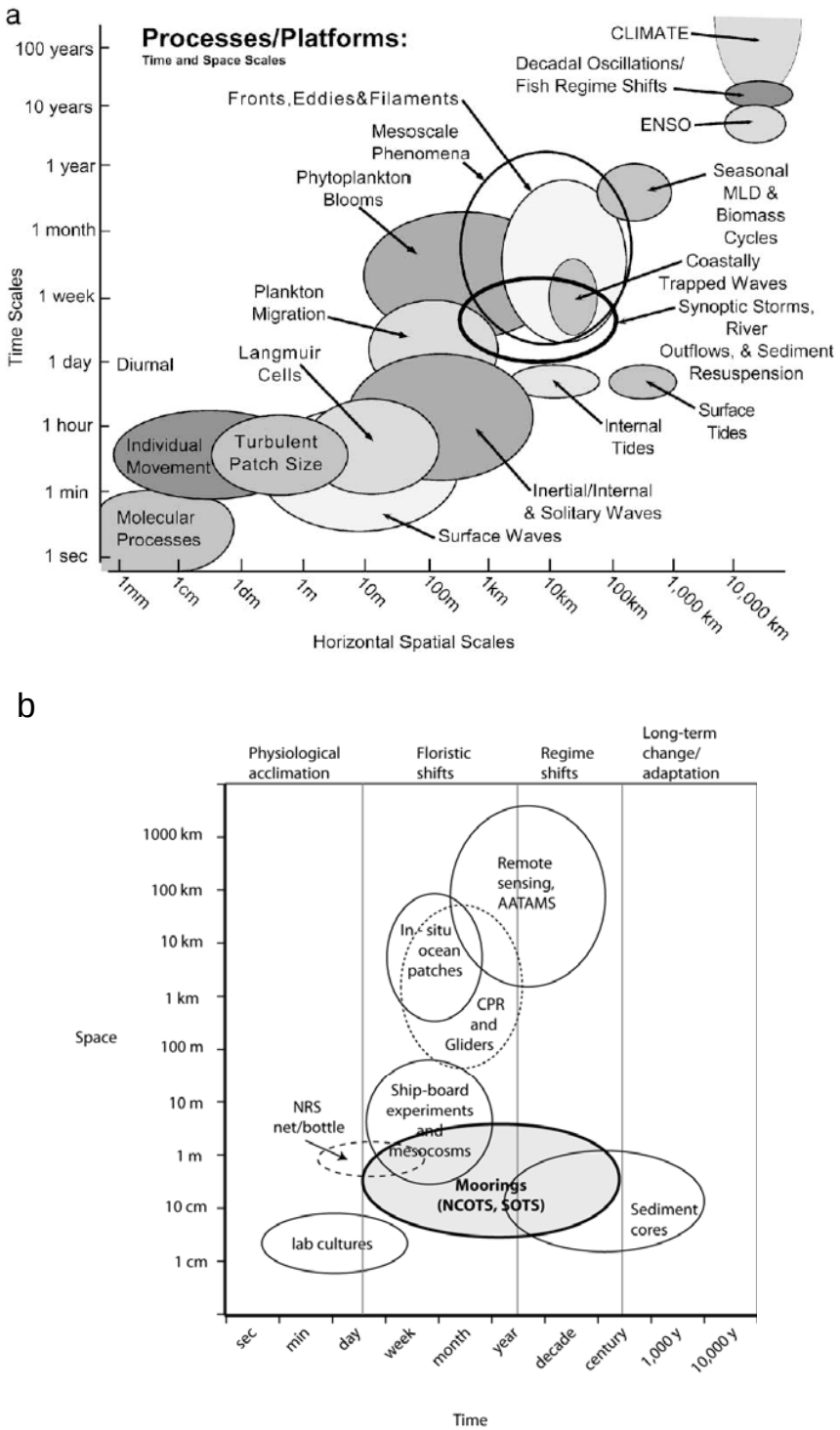


Figure 1a, b. Temporal and spatial relationship schema. **a)** NCOTS aims to provide biological data streams with respect to marine processes across the horizontal spatial scale from weekly-monthly plankton blooms through to climate impact events on decadal scales such as ENSO or the Antarctic Polar Wave. **b)** Approximated biological sampling domains with respect to spatial coverage and capture periods. The NCOTS platform provides data streams not covered

by existing IMOS facilities in the coastal region (Fig 1a, from fig. 2 Dickey, 2003, Fig 1b modified from illustration of M. Doblin, UTS).

- *NCOTS Objectives*.

The ***NCOTS objectives*** are:

1. to initiate a sub-facility where national coastal time-series activities, related directly to the sustained acquisition of particulate export below the photic zone via sediment trap (or photographic means), are centralised.
2. to build capability and technical skill in coastal time-series sediment trap moorings where Australia has none, with exception to the Southern Ocean Time-Series (SOTS) deep ocean moorings.
3. to manage and forecast the sustained service and rotation of moorings in collaboration with national node science and implementation plans.
4. to provide sample splitting, curation and preliminary descriptive documentation (i.e. image and particulate size diagnostics) as rapid results.
5. to manage and follow the distribution of data stream sample splits to various scientists, sub-facilities or institutes.
6. to supply standard formatted files of preliminary assessments for distribution to the marine community via the IMOS eMii data portal.
7. to follow or adapt standard methods of biological and geochemical analyses in close consultation with the SOTS facility or other ANMN sub-facilities as guide to those working on data stream splits.
8. to develop post-2013 planning for future NRS related time-series placements relevant to evolving node science and implementation plans and in consultation with ANMN strategic plans for annual servicing missions.

o <u>Providing a national backbone for observing boundary currents.</u>

The National Marine Bioregionalisation report (Hayes et al., 2005, Ch 6.1, 6.2) provides a succinct overview of the historical and current Australian phytoplankton provinces from largely temporally limited surveys (Figure 2). Five phytoplankton provinces categorise the major boundary currents around the Australian continental margin.

The goal of NCOTS is to enhance or inaugurate the national backbone of biological and geochemical time-series observations. It will achieve this goal through the targeting of representational bioregions and in direct reference to existing NRS locations.

IMOS has already invested with various research organisations/universities in the biological and water chemistry monitoring of NRS via monthly repeat sites surveys, which have provided monthly snap-shots (1 day/month) of phytoplankton composition and variability. Some of these data sets are uninterrupted over the last 10 years (e.g. Port Hacking, NSW, Ajani et al. 2001; Western Australia in the Swan River and Perth Coastal waters, Thompson et al. submitted). Their results, however, do not necessarily capture specific climatic events (upwelling, blooms, storms) and in some cases the long-term records have yet to be analysed or earlier methodologies mean only qualitative assessments, such as presence–absence indices, can be provided (e.g. Pt Hacking, NSW, Ajani pers. comm. 2009). Additional national backbone infrastructure to increase the spatial coverage of biological data has been achieved through the IMOS AusCPR-SOOP facilities. Their data streams will now enable sustained information on changes to biogeographic provinces and census data, undoubtedly refining Australia's plankton bioregionalisation and diversity but also providing clear evidence of changes to boundary current influences across latitudinal zones.

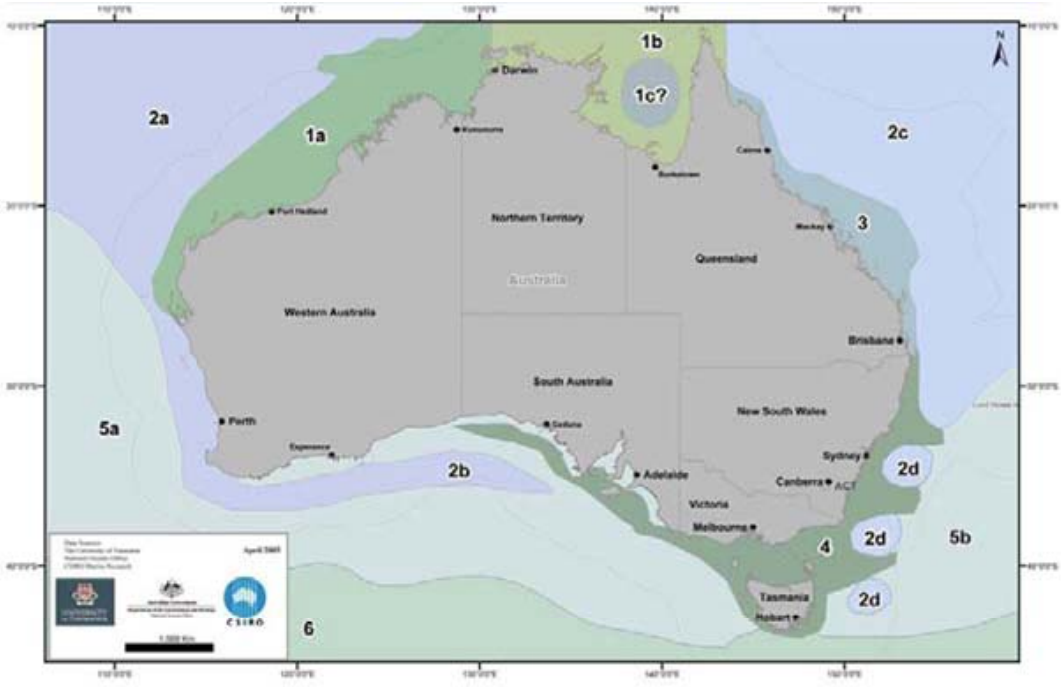


Figure 2. Generalised provinces based on diatom, dinoflagellate and coccolithophorid dominances indicated by 1-6, biomes = a-d; 1 = Northern tropical flora; 2 = Tropical oceanic (2a Indian Ocean, 2b Leeuwin Current, 2c Coral Sea, 2d East Australian Current); 3 = GBR lagoon tropical neritic; 4 = Temperate neritic province coastal up-welling dominated; 5 = Oceanic transitional; 6 =Subantarctic province. (From figure 6.7 Phytoplankton Provinces, Hallegraeff in Hayes et al. 2005.)

What is distinctly lacking from the existing approaches of composition variability assessment or spatial distributions are the capture of significant biological bloom events and the contribution of particle and carbon fluxes from the photic zone of these key boundary current and plankton bioregionalisation zones. NCOTS aim is to value-add to the existing NRS national backbone by remedying this hole in the data collection. Sediment traps do a better job of capturing events that can be easily missed by monthly sampling as they integrate over weeks or months. In some ecosystems, notably Port Hacking with its short blooms and Kangaroo Island with its dual upwelling productivity responses, such capture of these events will be very important to understanding changes in the ecosystem brought about by oceanic or atmospheric conditions.

National Node Science and implementation plans from NSW, SA, WA and TAS-IMOS identify sediment trap time series observations as an observational data priority. To initiate NCOTS, the first three sediment trap time-series locations are based on existing monthly time-series surveys (~10 years) and an interest for both biological and carbon modelling parameterisation in the regions chosen against ongoing physical property data streams. The three locations also provide a bioregionalisation link between the two boundary currents on the eastern and western perimeters of the Australian continent (Hayes et al. 2005). The Kangaroo Island location being mid-way between the temperate eastern community, the western tropical influenced Leeuwin Current community and the southward transitional oceanic province community (Figure 2). The Sydney location reflects the EAC and northward flowing coastal current regimes, whereas as the Perth location varies with oceanic and tropic Leeuwin influences (Figure 2). An ability to assess the long-term impacts of major boundary currents on the continental shelf environment, ecosystem and biodiversity can be served by NCOTS.

Draft community white papers under the Ocean Obs'09 symposium indicate that the observational needs of Dynamic Green Ocean Models will rely more heavily on the seasonal and multi-year variability and

trends as requisite data not only to treat climate issues, but also to test model performance (LeQuéré et al. 2009). BLUElink, the Australian Government's ocean forecasting initiative, is investing in forecast modelling of the Australian marine environment. Although current primary parameters utilised in the forecasting are principally physical, BLUElink aims eventually to provide coastal information relevant to ecological sustainability and the impacts of regional and global climate. This aim is in touch with the movement towards a new Coastal module of Global Ocean Observing System (GOOS; Malone et al., 2009). NCOTS data streams are unlikely to be of immediate use to the Relocatable Ocean and Atmosphere Model (ROAM) of BLUElink that will describe the continental shelf. However, in the event that Nutrient-Plankton-Zooplankton (NPZ) models or those more elaborate such as the Dynamic Green Ocean Project PlankTOM Model (http://lgmacweb.env.uea.ac.uk/green_ocean/model/model.shtml?r1) are then developed and embedded into regional Australian general circulation models, the aims of BLUElink and Coastal GOOS will be met. The biological and geochemical data streams collected through the NCOTS time-series platform will be instrumental to the parameterization of future linked ecosystem models and the evaluation of its forecasting abilities. Inaugurating the collection of NCOTS data will provide a necessary time series ready for implementation and model building when the modeling community is at the point of integrating biochemical data within their regionalized geophysical models.

o Continuing to build institutional strengths into national capability.

Australia is one of the last major nations to commence long-term sediment trap time-series observations of their immediate continental shelf environment. The current synthesis of time-series operations under the OceanSITES Global Ocean Observing System is illustrated in Figure 3. The Southern Ocean SOTS platform is the sole Australian contribution to this international programme. A recent review of marine phytoplankton results from sediment trap studies revealed that although over 400 sediment traps have been moored at over 240 stations of the Earth's oceans (Honjo et al. 2008), only around 50 of these have reported fluxes of phytoplankton. Significantly, these latter studies reported the connectivity between communities and ecosystems to oceanic events such as upwelling or climate perturbations such as ENSO (Romero and Armand, in press). NCOTS has the same expectation to deliver biological and chemical connectivity in context of a changing climate.

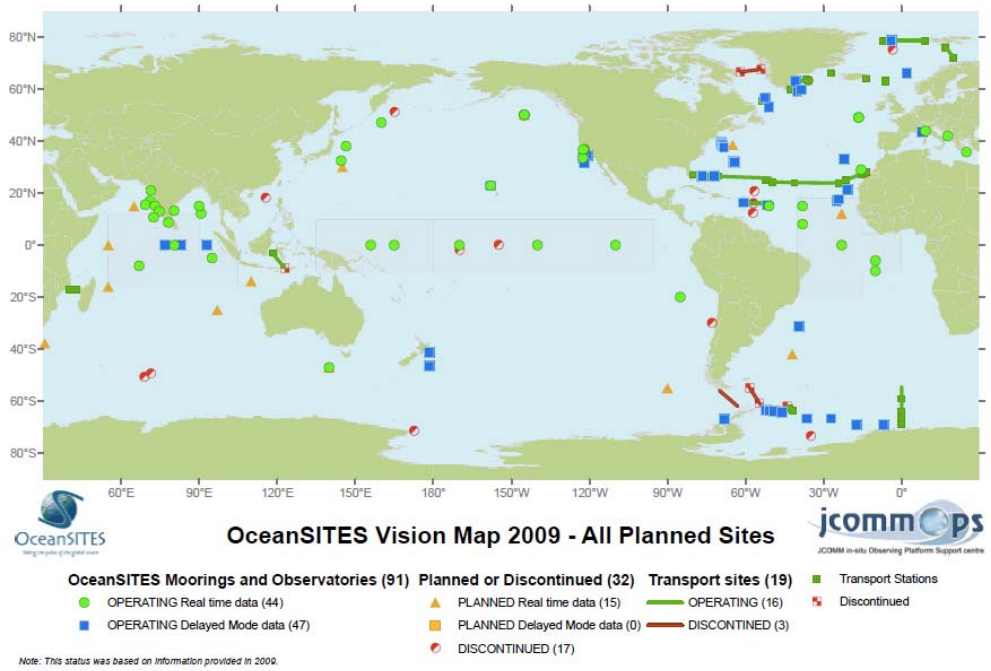


Figure 3. The current status of mooring contributions to the global OceanSITES programme. The IMOS SOTS facility is the only Australian contribution. (Source: http://www.oceansites.org/network/index.html).

The monitoring of functional groups down to species, for their abundance, dispersion and bloom characteristics in the marine environment is challenging and expensive to collect and analyse. These data streams remain one the last emergent fields to be incorporated into large-scale ocean observing systems (Sieracki et al. 2009).

Australian capability behind the implementation of sediment trap moorings was principally developed in the late 1990's by Assoc. Prof. T. Trull and colleagues at the Antarctic Climate and Ecosystem CRC, the Woods Hole Oceanographic Institution and CMAR. This capability was developed with reference to the conditions of the Subantarctic and Polar Frontal zones of the Southern Ocean. With the inception of IMOS, this mooring capability and sustenance was supported as the Southern Ocean Time Series (SOTS) facility with science support under the Bluewater and Climate node. The SOTS facility is constrained by their Bluewater and Climate node brief to operate in the deep ocean environment and does not have the capacity to expand into the coastal region. The ANMN facility currently oversees the coastal NRS and other mooring instrumentation construction, planning and service, but has increased their capabilities to support national node activities through the build-up of sub-facilities. ANMN does not currently support sediment trap or photographic time-series platforms, which is the focus of the NCOTS sub-facility.

Increasing attention in the East Australian Current along the eastern continental shelf has scientists from several national nodes (Qld, NSW, Tas) interested in building and maintaining capabilities behind time-series biological investigations. With a distinct lack of expertise nationally in this coastal arena, NCOTS wishes to build the time-series capacity at the Sydney Institute of Marine Science (SIMS) with one of the four foundation partners, Macquarie University. Both Macquarie University and SIMS will maintain the data steam collection and access to the samples on a permanent basis.

In developing and centralising this capability external to the SOTS facility, new techniques suitable for coastal sustained time-series can be grown as a sub-facility of ANMN. SIMS is a new institution and is looking to provide direction and support for the NSW marine community, but is certainly capable of providing a national service such as that presented by NCOTS. The facilities will be new, and space to home the sub-facility is clearly available. A letter of support from the SIMS Director is supplied.

The emerging groundswell towards integration of high-resolution taxonomic biological data into ocean observing systems will rely on the development of international standard methodologies and quality control procedures of optical plankton imaging instruments such as FlowCAM (commercial) and the real-time automated FlowCytobot (prototype operational in Martha's Vineyard, USA) (Olson and Sosik, 2007; Sieracki et al. 2009). Such instrumentation development and uptake is being advanced by the need to monitor for harmful algal blooms in coastal environments. Australian research institutes are only now investing in the former of these instruments and to date no National capacity has been developed. Dr Armand at Macquarie University aims to organise this capacity and provide input towards the international community through the IMOS NCOTS sub-facility assessments.

o Exploring the potential for whole-of-system approaches.

The NCOTS time-series moorings provide data stream observation of biological and geochemical data based on time (t) and depth (z) scales (Figure 4). Data from various instrumental platforms provided by many existing IMOS facilities, supply information with other spatial and temporal capacities. The NCOTS biological (fluxes of organisms by major functional groups down to species level) and geochemical data (solution pH, salinity and nutrients; dried fraction derived POC, PIC, PON, Si, Al, trace elements) represent observational variables (OSV in Figure 4) relevant to an idealised whole-of-system approach. Where ecosystem responses and forecasting against Relocatable Ocean and Atmosphere models (ROAM) is the goal, iterative testing of the assimilated data allows for model development and improvements to the sampling process. Improvements can be taken as changing sample observation

rates, modifying sampling methods and/or platforms, or the addition to or movement of sample locations (Dickey, 2003).

The NCOTS biological data stream has complicity with other IMOS facilities (e.g. NRS plankton sampling, SRS ocean colour, AusCPR, AATAMS fish movements, ANMN passive acoustic moorings) and proposed sub-facilities (e.g. Bio-optical profiling of Chl *a*, CDOM and POC), whereby it provides the

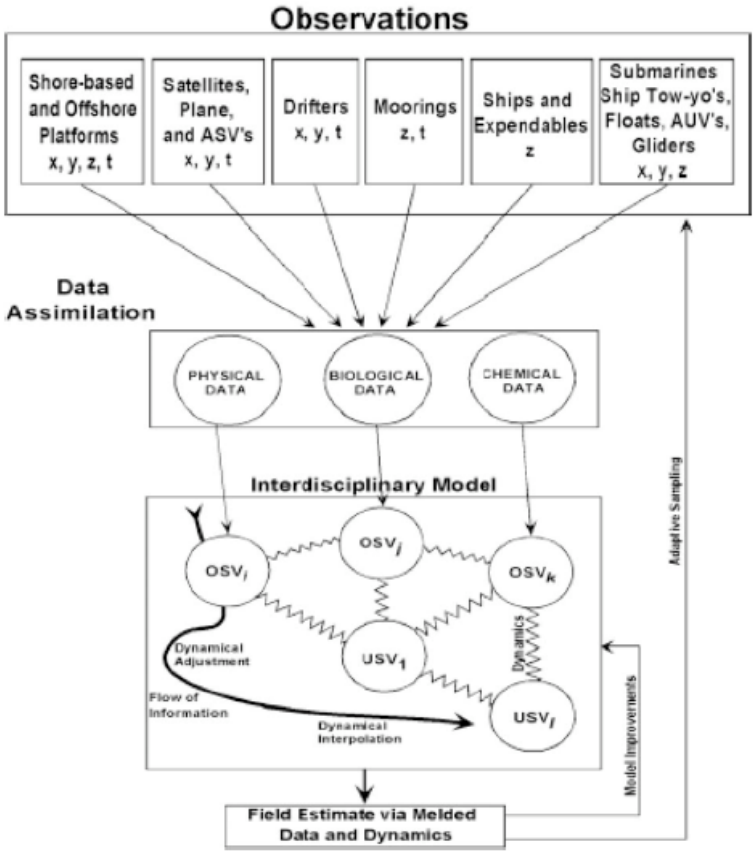


Figure 4. Schematic diagram indicating the integrated approach NCOTS mooring data provides to whole system approaches and associated model development (From fig. 3, Dickey 2003). (OSV = observed variables for physical (i), biological (j) and chemical (k) data ; USV = unobserved variables and associated errors)

sub-surface link to productivity measurements at the surface of the ocean or the movement and activity of the other higher trophic level organisms in depth and time. On a geochemical front, links with the surface observations of CO_2 and monthly surface hydrochemistry will allow chemical and carbon budgets to become 3-dimensional. The inclusion of camera time-series observations will bring information relevant to the links between surface ocean productivity and transport processes related to organism distribution, biodiversity, and function in coastal seafloor ecosystems.

NCOTS data, through IMOS, will be useful to the international data portals such as Ocean Biogeographic Information System (OBIS; Vanden Berghe et al. 2009), which integrates, assesses and analyses marine biological data and supplies information into the Global Biodiversity Information Facility (GBIF). Additionally, NCOTS data streams can be incorporated into the OceanSITES (Send et al. 2009) and future Coastal Module GOOS initiatives (Malone et al. 2009).

- Driving down the cost per observation.

The NCOTS moorings have been simplistically designed to minimise cost, but could be additionally expanded to include additional instrumentation relevant to IMOS ANMN-NRS or passive acoustic observations, either at design level relevant to the node science directives or into the future. Adding to pre-existing deep moorings has decreased the outlay of this programme. Future sediment trap instrumentations of new regions (i.e. Kimberleys or Portland) could be achieved by adding to existing physical or acoustic moorings. The latter platform also being deployed on annual timescales in regions selected for their high biological activity.

ANMN could purchase all mooring equipment so that scales of economy/ discounts could be made in ordering multiple instruments and mooring components (e.g. glass floats) and consumables.

As raised earlier, the future of NCOTS will rely on the ability to service mooring with the future National Bluewater vessel replacement. Combining ship time for annual servicing legs between NCOTS and other mooring facilities, inclusive of combined freight costs will lead to future cost savings across the board.

We have incorporated the hot-swapping instruments in this proposal as a mean of means decreased ship-time servicing and for continuity of the time-series data collection. Once a mooring is established sample costs decrease to consumables, repairs and service requirements.

The establishment of a taxonomic toolkit and library for each mooring site should lead to future savings in personnel costs in establishing the taxonomic staff.

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

We have identified biannual milestones across Dec 2009 through to June 2013, as a list of the major activities envisioned for each of the sediment trap placements.

Table 1. EIF ANMN-NCOTS enhancement implementation strategy.

New Infrastructure	Operator	Site	Milestones							
			15/12/2009	15/06/2010	15/12/2010	15/06/2011	15/12/2011	15/06/2012	15/12/2012	15/06/2013
NSW-IMOS sed trap mooring	NCOTS (NSW-ANMN)	Pt Hacking 400-500m	RV *Southern Surveyor* ship time request submitted.	Configuration of purchases confirmed, Technician Employed, Equipment ordered.	Equipment delivered, Build underway.	Moorings built and tested, deployment imminent.	Mooring deployed. New National RV ship-time three mooring service request submission.	Mooring beacon surveillance. Hot-swap instruments prepped.	Mooring retrieval and redeployment. Preliminary analysis and download of instrumentation. New National RV ship-time request submission.	Mooring beacon surveillance. Hot-swap instruments prepped/ serviced. Data and reports for eMii.
SAIMOS sed trap mooring	NCOTS (SAIMOS-ANMN)	South Australian Mooring 7 Deep Slope (SAM7DS 600m	Confirm SAIMOS RV *Ngerin* ship-time agenda.	Configuration of purchases confirmed, Equipment ordered.	Equipment delivered, Moorings built and tested, deployment imminent.	Mooring deployed. Reassess future ship time requirements.	Mooring beacon surveillance. Hot-swap instruments prepped.	Mooring retrieval and redeploy. Preliminary analysis and download of instrumentation.	Mooring Iridium beacon surveillance. Hot-swap instruments prepped/ serviced. Data and reports for eMii.	Mooring retrieval and redeploy. Preliminary analysis and download of instrumentation. Data and reports for eMii.
CMAR/ WAIMOS	CMAR/ NCOTS	Two Rocks 200m	Confirm CMAR RV *Linneaus* ship-time agenda.	Configuration of purchases confirmed, Hot-swap instruments ordered.	Equipment delivered. Moorings built and tested, deployment imminent.	Mooring deployed. Hot-swap instruments prepped.	Mooring beacon surveillance. 3 month interval services. Preliminary analysis.	Mooring beacon surveillance. 3 month interval services. Data and reports for eMii.	Mooring beacon surveillance. 3 month interval services. Preliminary analysis.	Mooring beacon surveillance. 3mon. interval services. Data and reports for eMii.

List of major equipment to be purchased / developed.
The three NCOT locations are represented by the purchase of three main asset suites. These assets are detailed separately below. The general costs assume $A1 = $US0.8, and €0.6.

Base investment - sediment trap unit:
Technicap 4/3, 24 sample (titanium motored) sediment traps are cylindrical in form and are considered suitable for the capture of exported particles in coastal/shelf environments where currents can be >12cm/sec (Busseler et al. 2007). They have a single stainless steel bar attachment and do not require tripods and bridle chain supports as with the conical McLane deep-water sediment trap instruments employed by the SOTS facility. The sediment traps will be fitted with 500ml cups. Rotation is expected on an annual basis, but may be at 3- or 6-month intervals depending on existing node mooring service plans. Each sediment trap will be equipped with tilt and pressure sensor meters to provide direct information on the tilt and final depth of the sediment trap in the water column.

Asset 1. Sediment trap instrumentation of the existing South Australian Mooring 7 Deep Slope (SAM7DS) mooring.
The South Australian slope moorings have the general configuration shown in Figure 5**.** SAIMOS node science is now geared towards the documentation of biological and geochemical fluxes related to the upwelling driven productivity cycles of the region. As the Kangaroo Island NRS is currently situated at 100m depth; a depth too shallow to determine export fluxes from surface and sub-surface processes, the existing mooring SAM7DS has been selected as a slope mooring of interest to study the upwelling influence impacting on the NRS location (NRSKAI). SAM7DS is generally deployed between the depths of 500-600m. A wire extension of between 100-200m will be added to the existing configuration in Figure 5. The MRV *Ngerin* services the existing mooring. It is equipped with an articulated crane that can lift up to 1000kg that will enable servicing of the mooring with the sediment trap instrumentation within their existing 48 days ship time allocation. SAM7DS is equipped with a LongRanger ADCP. This instrument is not hot-swapped, but returned for a 1-month service, prior to redeployment. Therefore the time-series data record will experience an annual 1-month gap in its data stream until a second LongRang ADCP is available for hot-swapping. For this mooring enhancement the budget (Table 2) covers shared duplicate sediment traps and orientation meters with the NSW/WA mooring assets (i.e. 2 additional instruments for hot-swapping between the 3 sites).

Figure 5. Current deep mooring configuration.

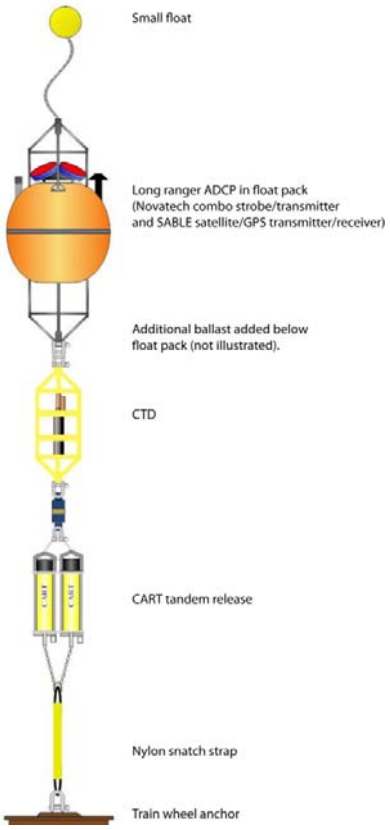


Table 2. Asset 1 start-up costs.

Item	Supplier	No.	Unit cost $	Total $
PPS 4/3-24S sediment trap	Technicap	2	25,776.00	51,552.00
Trap and sensor batteries	ANMN	6	75.00	450.00
Ostar 3-axis compass c/w 2-axis tilt sensor	UVS	2	3,971.00	7,942.00
Pressure sensor	UVS	2	3453.00	6906.00
Insulators/ 2t shackles	ANMN	2	10.10	20.20
Benthos Glass floats 17'/ribbed hard hats (-25.4kg buoy) excl. freight	UVS	5	681.00	3405.00
Wire and terminations (In-kind)	SAIMOS ANMN	200	$5.90/m$ 188/ termin.	(1600.00 in-kind)
25% consumable surcharge	ANMN	1		418.00
Importation of equipment freight (estimated)	Various			10,000.00
Total Asset 1 start-up (excl. in-kind)				***80,693.20***

Additional annual costs (variation):
Replacement sediment trap cups per year $300.00 x2 = $600.00
Consumables (biocide, plastic storage boxes) per year $500.00 x3 =$1,500.00
Dangerous goods refrigerated freight per year (Adel./Syd.) $1000.00 x2 = $2,000.00
Replacement anchor (stanchion and wheels) per year $1360 x3 = $4080.00
Additional batteries: $75.00 ea. x 3 per year x2 = $450.00
10% Loss Contingency: $8,070.00 per year = $24,210.00
Total variation: $32,840.00

Set-up and Variation Total for Asset 1 = $113,533.00

Asset 2. Sediment trap mooring within the Two Rocks mooring line.
CSIRO (WAMSI) has proposed an additional sediment trap mooring to be placed in vicinity of the existing 200m Two Rocks mooring to observe nutrient cycling on the shelf by assessing principally particulate organic carbon (POC) and nitrogen (PON) fluxes concomitant with phytoplankton export. CSIRO CAPEX (capital equipment purchasing expenditure) funds were secured by Dr P. Thompson (CSIRO, Hobart) to purchase a Technicap sediment trap and tilt meter in 2009. This supplementary mooring programme is currently undergoing additional internal CSIRO approval. Costs associated with the mooring construction, deployment and servicing will be funded by CSIRO, with a vision to have the trap moored by the winter of 2011. The sediment trap is to be serviced by the RV *Linneaus*. They propose to sample for 3 months before recovering the trap for a 3 month service turn-around before redeployment. This service scheme would achieve 12 months worth of measurements over 2 years.

The NCOTS proposal aims to assist with the hot-swapping of the infrastructure and continued longevity of this data stream by providing a second instrumented sediment trap and an ARGO beacon/surveillance, to ensure year-round observations can be obtained. Costs to initiate this stream of data are provided in Table 3.

Table 3. Asset 2 start-up costs.

Item	Supplier	quant.	Unit cost $	Total $
PPS 4/3-24S sediment trap	Technicap	1	25,776.00	25,776.00
Trap and sensor batteries	ANMN	6	75.00	450.00
Ostar 3-axis compass c/w 2-axis tilt sensor	UVS	2	3,971.00	7,942.00
Pressure sensor	UVS	2	3453.00	6906.00
Insulators/ 2t shackles	ANMN	2	10.10	20.20
ARGOS Beacon (500m)	Sercel	1	10,000.00	10,000.00
ARGOS battery	Sercel	1	150.00	150.00
ARGOS monitoring platform fee	CSL	12	16.00	192.00
25% consumable sucharge	ANMN	1		117.55
Importation of equipment freight (estimated)	Various			5,000.00
Total Asset 2 value				***56, 553.75***

Additional annual costs (variation):
CSL Silent PPT monitoring subscription for ARGOS beacon monitoring, €47.50/month ($76/m), 36 months = $2736.00

Sercel replacement battery $150.00 x2 = $300.00
Replacement sediment trap cups per year $300.00 x2 = $600.00
Consumables (biocide, plastic storage boxes) per year $500.00 x2 =$1,000.00
Dangerous goods refrigerated freight per year (Perth/Syd.) $1000.00 x2 = $2,000.00
Additional batteries: $75.00 ea.x 3 per year x2 = $450.00
Replacement anchor (stanchion and wheels) per year $1360 x3 = $4080.00
10% Loss Contingency: $5,656.00 per year = $16,968.30

Total variation: $28,634.00

Set-up and Variation Total for ***Asset 2 = $85,187.75***

Asset 3. Pt. Hacking Sediment trap mooring at 400-500m.

A new mooring at a nominal depth of 400-500m would be placed along the Pt Hacking line with reference to the NRS at 100m. To clearly ascertain the export of particulates, the mooring is best situated in deeper waters beyond the influence of the productive photic zone and possible trawling interference. The distance from the coast also strengthens the influence of the EAC and upwelling on the records collected. As the NRS currently collects on a monthly basis qualitative net hauls of phytoplankton composition (currently >170 samples archived and awaiting assessment since 1998), the initiation of this quantitative collection and assessment of material will significantly improve the "best" long-term record of biological reference record. The archived samples will be provided to a PhD student at Macquarie University (2010-2012) to actualise the records significance in term of biodiversity, climatic modulation on community composition and the influence of the EAC. We plan to also attach a 3 image per day time-lapse, camera and strobe device as operated by researchers at the Woods Hole Oceanographic Institute (http://www.whoi.edu/page.do?pid=17618) to provide an image data stream of major flux evens to the sea floor upon which the timing relative to sediment trap records and the effects of the benthic community can be assessed. The DSPL DigiSeaCAM camera and Benthos 383 strobe device will be provided in a specially designed housing manufactured by WHOI Multidisciplinary Instrumentation in Support of Oceanography (MISO) engineers and has been provisionally quoted at Aust $15K. The SIMS' Director has indicated that as part of their EIF funding to SIMS there is a high probability they will purchase the second sediment trap to hot-swap on this mooring line as a co-investment infrastructure. Ecopuks and Termistors will also be added to provide basic information on the temperature and surface productivity (i.e. Ecopuk triplet senor provides CDOM, backscatter and Chl *a* data). These data streams will be processed by the 5% in-kind contributions to NCOTS by Dr. M. Doblin and Dr. M. Roughan.

This mooring will require significant technical staffing start-up assistance, which can be scaled back once the mooring is constructed, tested and operational. Staffing of NCOTS is detailed in a subsequent section. Table 4 provides the detailed mooring costs, while Table 5 indicates additional costs associated with the hot-swapping of instruments and other start-up costs. The standard McLane wet sample divider, to be used for the splitting of all cup collected material under NCOTS is included in this latter table. ANMN perusal of the original mooring design indicated between 40.5 to 81 days may be required to construct, manufacture and fit the mooring dependent on the sensors attached.

Current marine vessel service to the existing NSW mooring is inadequate to deploy and recover this proposed Pt Hacking mooring. Ship-time will need to be secured through successful application to the National Bluewater research vessel (RV *Southern Surveyor*) science support scheme. An application to secure 3 days ship-time in the current round, open Nov. 2009, will be placed for deployment in mid-late 2011. In theory, 180 days of ship time should be available in 2011/12 and ~300 day from 2013 once the new replacement vessel is operational. NCOTS would combine with other ANMN sub/facilities, post 2013, for joint submission to the National Bluewater research vessel for annual servicing legs of all mooring facilities.

Table 4. Asset 3a start-up costs indicating approximate position on mooring line. Quote has been modified from an OEG Invoice from ANMN no. 194 061009. Float numbers have not been correctly assessed under a physical model. Some frame construction costs are estimates.

position	*item*	*description*	*company*	*quant*	*$*	*total*
1	3 x 8" pacific floats	8"		3	$18.00	$54.00
	316 shackle			1	$8.00	$8.00
	Plink	2 tonne	crosby	1	$18.00	$18.00
2	16mm pp braid			40	$2.45	$98.00
	316 shackle			1	$8.00	$8.00
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
3	SAZ mast		oeg	1	$850.00	$850.00
	Stevo PINK flag		oeg	1	$25.00	$25.00
	glass float assembly	17" benthos	UVS	4	$790.00	$3,160.00
	ARGO BEACON	BAZ3000	Cercel	1	$10,000.00	$10,000.00
	argo battery		Cercel	1	$150.00	$150.00
	NOVATEC STROBE		novatec	1	$2,000.00	$2,000.00
	batteries novatecs	c cell	duracel	1	$20.00	$20.00
	shackle	2 tonne		1	$5.20	$5.20
	13mm pwb pc gal	PWB		3	$7.95	$23.85
	shackle	2 tonne		1	$5.20	$5.20
	insulators		oeg	1	$4.90	$4.90
4	Aquatech 520P Thermistor		UVS	1	$2,000.00	$2,000.00
	Ecopuk			1	$28,500.00	$28,500.00
	Instrument frame		oeg	1	$375.00	$375.00
	Batteries			1	$100.00	$100.00
	insulators		oeg	1	$4.90	$4.90
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
5	glass float assembly	17" benthos	UVS	8	$790.00	$6,320.00
	13mm pwb pc gal	PWB		3	$7.95	$23.85
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00

	shackle	2 tonne		1	$5.20	$5.20
6	7mm TBW	3.2 tonne	cookes	10	$3.75	$177.50
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
7	7mm TBW	3.2 tonne	cookes	50	$3.75	$327.50
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
8	glass float assembly	17" benthos	UVS	4	$790.00	$3,160.00
	13mm pwb pc gal	PWB		3	$7.95	$23.85
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
9	7mm TBW	3.2 tonne	cookes	20	$3.75	$215.00
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
10	7mm TBW	3.2 tonne	cookes	50	$3.75	$327.50
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
11	glass float assembly	17" benthos	UVS	8	$790.00	$6,320.00
	13mm pwb pc gal	PWB		3	$7.95	$23.85
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
12	7mm TBW	3.2 tonne	cookes	50	$3.75	$327.50
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
	13mm pwb pc gal	PWB		0.5	$7.95	$3.98
	shackle	2 tonne		1	$5.20	$5.20
	insulators		oeg	1	$4.90	$4.90

13	ADCP		UVS	1	$36,000.00	$36,000.00
	ADCP battery		UVS	1	$500.00	$500.00
	ADCP frame		oeg	1	$875.00	$875.00
	insulators		oeg	1	$4.90	$4.90
	shackle	2 tonne		1	$5.20	$5.20
	13mm pwb pc gal	PWB		0.5	$7.95	$3.98
	shackle	2 tonne		1	$5.20	$5.20
	insulators		oeg	1	$4.90	$4.90
14	Aquatech 520P Thermistor		UVS	1	$2,000.00	$2,000.00
	Ecopuk			1	$28,500.00	$28,500.00
	Instrument frame		oeg	1	$375.00	$375.00
	Batteries			1	$100.00	$100.00
	shackle	2 tonne		1	$5.20	$5.20
	insulators		oeg	1	$4.90	$4.90
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
15	7mm TBW	3.2 tonne	cookes	50	$3.75	$327.50
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
	insulators		oeg	1	$4.90	$4.90
16	SED TRAP		Technicap	1	$20,000.00	$20,000.00
	TRAP battery			1	$75.00	$75.00
	Opstar TILT		UVS	1	$2,000.00	$2,000.00
	PRESSURE		Brankner/ UVS	1	$3,000.00	$3,000.00
	insulators		oeg	1	$4.90	$4.90
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
17	7mm TBW	3.2 tonne	cookes	5	$3.75	$158.75
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
	insulators		oeg	1	$4.90	$4.90

	insulators		oeg	1	$4.90	$4.90
18	CAMERA / strobe flash/battery/ frame		WHOI	1	$15,000.00	$15,000.00
	insulators		oeg	1	$4.90	$4.90
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
19	7mm TBW	3.2 tonne	cookes	10	$3.75	$177.50
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
20	glass float assembly	17" benthos	UVS	8	$790.00	$6,320.00
	13mm pwb pc gal	PWB		3	$7.95	$23.85
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
21	7mm TBW	3.2 tonne	cookes	25	$3.75	$233.75
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
	PC galv chain	16mm		0.6	$18.50	$11.10
	shackle	3.2 tonne		1	$7.20	$7.20
22	acoustic release	8242	UVS	2	$18,000.00	$36,000.00
	release battery			2	$250.00	$500.00
	release links	EG&G	edgetech	2	$65.00	$130.00
23	big link	crosby	csiro	1	$75.00	$75.00
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	2 tonne		1	$5.20	$5.20
24	7mm TBW	3.2 tonne	cookes	50	$3.75	$327.50
	shackle	2 tonne		1	$5.20	$5.20
	pearlink	2 tonne	crosby	1	$18.00	$18.00
	shackle	3.2 tonne		1	$7.20	$7.20
25	nylon webb	8000 kg		15	$5.85	$87.75
	shackle	3.2 tonne		1	$7.20	$7.20

	pearlink	3.2 tonne	crosby	1	$18.00	$18.00
	shackle	3.2 tonne		1	$7.20	$7.20
26	PC galv chain	16mm		4.5	$18.50	$83.25
	shackle	3.2 tonne		1	$7.20	$7.20
	shackle	seacatch		1	$25.00	$25.00
	pearlink	3.2 tonne	crosby	1	$18.00	$18.00
	shackle	3.2 tonne		1	$7.20	$7.20
27	anchor stack	320 kg		3	$325.00	$975.00
28	Anchor Stanchion		OEG	1	$385.00	$385.00
TOTAL Asset 3 mooring value						***$191,155.50***

Table 5. Asset 3b additional start up costs, related to hot-swapping of instruments etc..

Item	Supplier	quant.	Unit cost $	Total $
Trap and sensor batteries	ANMN	6	75.00	450.00
Ostar 3-axis compass c/w 2-axis tilt sensor	UVS	1	3,971.00	7,942.00
Pressure sensor	UVS	1	3453.00	6,906.00
Aquatech thermistor Reader	UVS	1	1,175.00	1,175.00
Aquatech 520P Thermistor	UVS	2	1,625.00	3,250.00
ECOpuk triplet sensor		2	28,500.00	57,000.00
Insulators/ 2t shackles	ANMN	1	10.10	20.20
ARGOS monitoring platform fee	CSL	12	16.00	192.00
McLane Wet Sample Divider (WSD-10)	UVS	1	6250.00	6250.00
Spare vials for WSD-10	UVS	1 x100	140.00	140.00
25% consumable surcharge	ANMN	1		1,600.00
Importation of equipment freight (estimated)	Various			15,000.00
Additional Total Asset 3 value				***$99,925.20***

Additional annual costs (variation):
CSL ARGOS beacon watch-dog mode monitoring, €47.50/month ($76/m), 36 months = $2736.00
Sercel replacement battery $150.00 x2 = $300.00
Replacement sediment trap cups per year $300.00 x2 = $600.00
Consumables (biocide, plastic storage boxes) per year $500.00 x3 =$1,500.00
Replacement anchor (stanchion and wheels) per year $1360 x3 = $4080.00
Additional batteries: $75.00 ea.x 3 per year x2 = $450.00
10% Loss Contingency: $29108.00 per year x3 = $87,324.00

Total variation: $96,990.00

Set-up and Variation Total for Asset 3 = $ 388,070.70

Access, pricing regimes:

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

Access to collected data will be free and unrestricted through the IMOS portal after processing.
NCOTS will provide a preliminary FlowCAM assessment record for one split and make this available for download through eMii. An image library and data record of size parameters determined from the run of a 5ml split. An analysis of ~10,000 particles in a sample will generate 50MB of data.
NCOTS will curate and provide the collection and splitting of trapped material for researchers and students.
NCOTS (via Macquarie University) will provide a PhD student stipend to analyse the existing >10 year month quantitative data from the Pt Hacking location, and will look to secure additional student fellowships to assist with analysing prepared phytoplankton splits.
Dr M. Doblin or UTS will contribute Dinocyst analyses on split material.
There is no current partner agency identified to undertake routine geochemical analyses of collected material. Nevertheless, interest from the following groups was noted once collection and access to the datastream of split particulate material became available:

- Australian National University – Drs M. Ellwood and S. Eggins (isotope tracers, trace metals in forams)
- Macquarie University – Dr S. George (isoprenoid geochemistry)
- Geosciences Australia – benthic habitat mapping group (sediment chemistry and sea-floor image analysis).

Additional interest from the SAIMOS Ancient DNA group was raised with the potential to assist with their assessment of DNA degradation products from collected biological material in traps alongside their sea floor core survey research.

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

Data management will be a joint responsibility between eMii, CMAR, SIMS and SARDI.
NCOTS will be required to develop, or adopt with eMii advice, suitable relational image software and data basing for images for trap material, inclusive of initial bottle capture, FlowCAM image and particle size data, picked swimmer library, sea-floor time-series images, detailed studied counts and images.
Data from ADCP will follow currently employed ANMN protocols and eMii reporting.
Data from tilt, pressure and thermistor and Ecopuk meters will need to meet or define new ANMN protocols, and eMii reporting.
Access to collected trap material for all other assessments may need to pass through a scientific committee for equitable or merit based study. NCOTS based at SIMS will preserve the split material until suitable appropriate research groups obtain support for appropriate analyses. The data steam collection and continued longevity will be the success in generating funded analytical assessment in the research arena.
Quality control of data would be in reference to SOTS (Bray et al. 2000), OceanSITES (users manual 2008) and other developing biological standards for methods, reporting and image analysis (Critchley et al. 2009; Sieracki et al. 2009).

Should NCOTS be taken up as a sub-facility, Dr Armand will submit a ARC industry linkage grant to support employment of a part-time Executive Officer, a data & image management technician, and three additional Phd students to work on the biological assessment of material from each of the NCOTS locations in collaboration with relevant node scientists (e.g. Martina Doblin, Laurent Seuront, PeterThompson/Anya Waite). The Linkage would bring in collaboration with WA, Tas and SA researchers (node scientists), institutes and state government funding.

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

NCOTS, as a developing sub-facility, will be dependent on SIMS as a facility home and also to future National Vessel Facility (*Southern Surveyor* & replacement) support to place, recover and redeploy the Pt Hacking mooring due to its weight and need for an appropriate A-framed service vessel. In the future the

NCOTS programme would seek to combine with other servicing missions under set blocks with the National Blue water research vessel replacement.

This sub-facility is dependent on ANMN technical assistance and bulk-buying power to assist with the design testing and construction of the moorings. We aim to cover this cost in staffing identified in the last budget section of the application. Assistance with mooring placement and recovery would be sought in the first year with the aim of training sub-facility staff to maintain this role. We would seek advice from SOTS and send out the NCOTS technician with this team for early training, where possible.

Data handling and the initiation of protocols from eMii staff would require development over the first three years.

NCOTS will be vigorously seeking co-investment via an ARC LINKAGE grant in the 2011 round to support both additional scientific and staffing needs. Scientific needs will be linked to bring in post-doctoral students to work explicitly on analysing the biological and potentially the geochemical data. We will be seeking co-investment from ABRS to assist with student salary assistance related specifically to taxonomic investigation. An international connection with Spain and their biological sedimentation programme will be included. Two positions (1.0 FTE, 0.5 FTE) to assist with administration and data image management as mentioned previously. We will seek to have a secondment for management purposes through MQU/SIMS. Linkage Partnerships will be sought with Government bodies such as DECC (NSW), ADFA, regional councils, and other water governing bodies. The Sydney and Manley Aquaria will also be approached.

Dr Armand at Macquarie University/SIMS will provide preliminary FlowCAM analysis as in-kind.

- **Collaborative structures for allocation of priorities**

The allocation of mooring locations and instrumentation has, to date, been part of an open process, via the IMOS-wiki and IMOS node and facility meetings.
Given this input and encouragement from four regional nodes (NSW, TAS, SA, WA) priority for three time-series mooring with selected instrumentation has been made for the current round of IMOS facility infrastructure funding. Future time-series mooring locations have been suggested based on existing or future NRS proposals. These suggestions will undergo further national, collaborative discussion through the ANMN facility and the regional nodes, and the IMOS office management, during the term of the current instigative programme for future implementation beyond 2013.

Future expansion (2013-15) would target additional western, eastern and southern sites to develop transect and regional data series, for example:
Western Transect (Leeuwin Current): Ningaloo and Kimberley locations.
Eastern Transect (East Australian Current): Coffs Harbour, Jervis Bay and Maria Island locations.
Southern Transect (Flinders Current): Portland location, southern tip Tasmania.

Governance

- ***Performance indicators***

Key indicators in the first three years of NCOTS will be:

- Placement and delivery of equipments orders.
- Hiring of 1FTE technical mooring staff at MQU/SIMS in the first year.
- Successful outsourcing of Pt. Hacking mooring construction and instrument testing.
- Successful application for RV *Southern Surveyor* ship time.
- Successful deployment, retrieval, servicing and redeployment of sediment traps.
- Cup collection processing, splitting and curation of splits.
- FlowCAM analysis available within 1-month of collection and splitting of sample.
- Sea-floor imagery available via eMii.
- Additional external funding sources e.g. Linkage grant to support development.
- PR coverage after successful recoveries.
- Attraction of students and researchers to work on annual data series.
- Interest in incorporating additional sediment traps into other NRS regions in future EIF support rounds.

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

Risk 1. Capability building of NCOTS (hiring of technical staff or outsourcing construction) is longer than expected.
Management Strategy 1. Ensure the technical position is funded at an appropriate level with special loading for a maximum of 2 months ship-time/year catered for. Ensure the outsourcing process is clear and targeted to local companies. Where outsourcing fails, aim to redirect funds to existing ANMN facility staff to aid in construction and testing where ANMN planning permits. Place these as first major management tasks.

Risk 2. Deployment of the Pt Hacking mooring is dependent on access to the RV *Southern Surveyor*. Limited ship time in 2011/12 may mean a year delay before deployment from new vessel is possible.
Management Strategy 2. Continue planning for additional service and deployment. Discuss alternative marine vessel deployment options with NSW-IMOS node and existing NRS mooring contractors. Additional funding would need to be supplied and potentially NSW-DECC may assist.

Risk 3. Moorings and/or equipment are dislodged, lost at sea, and/or damaged.
Management Strategy 3. Ensure that Iridium or BASM ARGOS beacons are installed on mooring lines and serviced by CSL watchdog mode in the event of unexpected surfaced mooring. Contingency for hiring a ship to locate drifting mooring is incorporated in the 10% overall loading of each asset. CMAR and SAIMOS have additional options for hiring recovery vessels for their moorings if recovery is plausible. Duplication of instruments from the outset, ensures loss or malfunction of an instrument can be replaced and if need be serviced and redeployed at sea (with extra ship-days required) during the three year period prior to subsequent funding. The 10% overall contingency cost incorporates the possibility for sensor replacement, but would not be able to cover the complete loss of the Pt Hacking Mooring. Insurance options would be investigated through the University and the IMOS office.

Budget:
Please complete the spreadsheet provided, and detail here any further information you have available on the background to the Budget:

- EIF Funds
  - Extension of existing Facility
  - Expansion of existing Facility / New Facility
- Co-investments – source and nature
- Staffing details

Description of proposed new infrastructure for Nodes – please complete the Table on the next page, referring to Attachment 1 to the Guidelines for further information

EIF Funds.
Please refer to Table 6 and the attached IMOS budget worksheet to show the breakdown of annual costs in the enhancement of the new sub-facility under ANMN.

Co-investments.
All co-investments (cash and in-kind) are documented in the attached IMOS budget worksheet.
Cash investment has principally been derived from SIMS with respect to the sharing (17.5% attributed to NCOTS) of current staff and the access to facilities. Confirmed salary = $51K, Provisional salary for 2011-12 = $60K. Confirmed facility access = $29K and provisional facility access 2011-12 = $35K.

Additional cash investments would be sought directly with Government departments on a leveraged basis against the IMOS investment in NCOTS, and also through an ARC Linkage grant. Under the latter scheme an average of $200K p.a. (max $500K p.a.) can be sought for 4 years, where significant co-investment is provided through industry and government partners.

In-kind investments constitute Dr Armand's confirmed 0.2 FTE salary to manage the facility. Please note University staff cannot commit more than 0.2FTE to any one proposal. Dr Armand also confirms the preliminary analysis of the collected material on her FlowCAM (10K p.a.) and the direct participation of a

PhD student scholarship and thesis support (2010-2012, $32.8K p.a.) toward the assessment of the backlogged Pt Hacking quantitative net-hauled monthly data stream. SIMS have provisionally agreed to allocate $27K towards the purchase on an additional sediment trap to assist with hot-swapping instruments in NSW.

The in-kind salary contribution (0.05FTE) to NCOTS for specific analyses is provided by UTS and UNSW for the participation Drs Doblin and Roughan.

CSIRO Marine and Atmospheric Research will provide a significant in-kind contribution towards the placement and servicing of a new Two Rocks mooring. As the programme is still undergoing internal approval the full in-kind contribution has not been finally determined. We have only included here the contribution of the sediment trap and Dr Thompsons' minimal participation as in-kind contributions to NCOTS. Ship-time costs, provided to servicing the mooring, are also absent from this in-kind contribution.

SAIMOS will be contributing their existing mooring line and instrumentation by way of co-investment, and will provide some minor hardware to attach the sediment trap ($1.6K). The un-costed ship-time for servicing has not been assessed, but is another significant in-kind contribution towards the NCOTS programme.

Staffing and other general costs.

1. 1 FTE Technical officer (3 yr contract). Macquarie University Level 5.1 general staff (Extensive relevant experience, degree or post-trade certificate) Base salary of $54,000.00 + 28% on-cost ($15, 120.00) and special loading allowance of $120/day with max 2 months sea-pay/yr ($7,200.00) Total: $76,320.00 p.a. and 4% increment per year ($2746.00, $2875.00).

This technician will be responsible for servicing sediment traps and associated sensors, placing orders, liaising with node scientists and ANMN sub/facility staff, splitting samples and curating splits. They will be homed at SIMS with minimal supervision.

2. 0.5 FTE Electronics officer (2 yr contract) Macquarie University Level 4.1 general staff. Base salary $24,500.00 + 28% on-cost ($6,860.00) special loading allowance of 120/day with max 1-month sea-pay/yr ($3,600.00) Total: $34,960.00 p.a.
This technician will be responsible for supporting the Technical Officer with the testing of all electronic equipment and with setting programming of the trap rotations on all traps. They would be responsible for downloading data from sensors and treating for eMii submission. They will be homed at Macquarie University or SIMS.

3. 1 FTE PhD student. A Macquarie University Research Fellowship (MQRES) has been offered as an in-kind investment to the NCOTS programme to assist with the direct assessment of the archived Pt Hacking monthly phytoplankton data-stream. Macquarie University offers a standard scholarship at $27.8K. Students are also provided with consumable and thesis support from the Department of Biological Science to the tune of $5K p.a. NCOTS will provide an additional $5K p.a. top-up salary for 3 years, to ensure we attract and retain an outstanding taxonomically trained candidate in the competitive PhD market. Total $15,000.00.

3. Outsourced mooring construction.
Due to the existing overburdened staff and project management at ANMN, and the tested mooring construction currently outsourced by the NSW mooring sub-facility, NCOTS would seek to outsource on competitive grounds the construction of the Pt Hacking mooring. This would be in consultation and approval with ANMN, where they could not realistically construct the mooring in 2010. Given ANMN OEG estimated that around $7,850.00 of the Pt Hacking mooring was material costs (from Table 4) and that between 2-3 staff may be required to construct the mooring over a period of 2.5 months, we estimate an outsourcing figure ~ $50,000.00 would be an appropriate tender max for this work.

In the event that ANMN staff are able to proceed with construction and design of the Pt Hacking mooring, these funds would need to be doubled and used to support the staffing of ANMN during the construction of the mooring ($100,000.00, i.e. $50K contingency).

4. Computers.
Two PC computers and one laptop are required as support for the technicians and the NCOTS ($2500/unit). An additional hard disk back up unit of 250Gb would also be purchased ($700.00) Total $8200.00 in 2010.

5. Travel.
Travel principally for the two NCOTS technical staff and the manager between ANMN in Hobart and mooring servicing missions in Adelaide and Perth, will require an annual allocation of $10,000.00 for 3 years. Total $30,000.00.

6. National equipment freight for hot-swapped instruments.
An allowance of $15,000 per year for 3 years is set aside for the freight of equipment between cities. Total $35,000.00.

TABLE: Observations required by the Nodes in relation to this Facility

Facility	**Observations required by the Node**			
	NCRIS Funded (already allocated to Jun11)	EIF first $8M funded (already allocated to Jun10)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
	(see Appendix 1 of the Guidelines)			
Bluewater & Climate				
WAIMOS				Geochemical (PON and POC) and biological data from Two Rocks.
GBROOS				
NSW-IMOS				One sed trap to provide on-going quantitative assessment of biological data from Pt Hacking with future investment in Coffs Harbour/Jervis Bay/Eden to study the variations in EAC.
SAIMOS				One sed. trap to provide biological assessment, carbon budget and material for ancient DNA.
Other <enter name>				
TAS-IMOS				Future Maria Island, Two Rocks sed trap mooring investment with WAMSI.

Table 6. Capital expenses in EIF Facility break down by year.

Items	2010	2011	2012	2013	Total
Manufacture	50,000.00				50,000.00
Computers	8,200.00				8,200.00
Asset 1	80,693.00				80,693.00
Cups		300.00	300.00		600.00
Consumables	500.00	500.00	500.00		1,500.00
Replacement anchor		1360.00	1360.00	1360.00	4080.00
Batteries		225.00	225.00		450.00.00
Contingency		8,070	8,070	8,070	24,210.00
Cold Freight			1,000	1,000	2,000.00
Asset 2.	56,553.75				56,553.75
CSL		912.00	912.00	912.00	2,736.00
Sercel batt			150.00	150.00	300.00
Cups		300.00	300.00		600.00
Consumables	500.00	500.00	500.00		1,500.00
Batteries		225.00	225.00		450.00
Replacement anchor		1360.00	1360.00	1360.00	4080.00
Contingency		5,656.00	5,656.00	5,656.00	16,968.00
Cold freight			1,000.00	1,000.00	2,000.00
Asset 3a	191,155.50				191,155.50
Asset 3b	99,925.20				99,925.20
CSL		912.00	912.00	912.00	2,736.00
Sercel batt			150.00	150.00	300.00
Cups		300.00	300.00		600.00
Consumables	500.00	500.00	500.00		1,500.00
Batteries		225.00	225.00		450.00
Contingency		29,108.00	29,108.00	29,108.00	87,324.00
TOTAL	**488,027.45**	**51,813.00**	**54,113.00**	**51,038.00**	***644,991.45***

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

Enhancement to Facility / New Facility (*Note 1*)

		2009/10	2010/11	2011/12	2012/13	Total
EIF Funding (*Note 2*)			EIF	(EIF)	(EIF)	(NCRIS+EIF)
Capital	(Refer Table 6 breakdown)		539840	54113	51038	644,991
Salaries	((1.5 techs, PhD top-up, +50K conting.)		166280	118426	86941	371,647
Operating	(travel, national instrument freight)		25,000	25,000	25,000	75,000
	NCRIS/EIF Funding Total		**731120**	**192539**	**157979**	**1,091,638**
Cash Co-investment (*Note 3*)		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Total**
SIMS	(17.5% salary, confirmed)		51000			51000
SIMS	(17.5% salary, provisional)			30000	30000	60000
SIMS	(Facility, confirmed)		29750			29750
SIMS	(Facility, provisional)			17500	17500	35000
	Cash Co-investment Total		**80750**	**47,500**	**47,500**	**175,750**
In-kind Co-investment (*Note 3*)		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**Total**
Macquarie University	(LA salary 0.2FTE 1.3 mult. confirmed)		27,300	27,300	27,300	81,900
Macquarie University	(FlowCam analyses, confirmed)		10,000	10,000	10,000	30,000
Macquarie University	(PhD student scholarship, confirmed)		32,800	32,800	32,800	98,400
SIMS	(Sediment trap for hot swapping NSW, highly likely)		27,000			27,000
CMAR	(Sediment trap at Two Rocks, confirmed)		27,000			27,000
SAIMOS	(mooring wire/term.)		1,600			1,600
UNSW	(MR salary 0.05 FTE 1.3mult. highly likely)		7,000	7,000	7,000	21,000
UTS	(MD salary 0.05 FTE highly likely)		7,000	7,000	7,000	21,000
CMAR	(PT salary 0.05 FTE 1.3mult. potential)		10,000	10,000	10,000	30,000
						0
	In-kind Co-investment Total		**149,700**	**84,100**	**84,100**	**337,900**
	TOTAL Resources		**961570**	**329,139**	**294,579**	**1,605,288**

NOTES:

1. This worksheet only to be used for Proposals relating to either enhancements to Facilities and new Facilities. If your Proposal relates to extension of an existing IMOS NCRIS Facility, please use worksheet 'NCRIS-EIF extension'

2. Please refer to worksheet 'EIF 2009 allocations' for the 2009/10 Budgets already approved under EIF for your Facility / Sub-Facility, and include the relevant 2009/10

amounts on this worksheet.

3. For amounts included in Cash and In-Kind Co-investments, please include the likelihood of these resources being made available (eg confirmed, provisional, possible). Also, please list here only the additional co-investments proposed, and avoid duplication of co-investments already included on the 'NCRIS-EIF extension' worksheet. If co-investments to the NCRIS-EIF extension work also assists enhancements / new work, please explain below.

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TABLE: Observations required by the Nodes in relation to this Facility

Facility	**Observations required by the Node**			
	NCRIS Funded (already allocated to Jun11)	EIF first $8M funded (already allocated to Jun10)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
	(see Appendix 1 of the Guidelines)			
Bluewater & Climate				
WAIMOS				
GBROOS				
NSW-IMOS				
SAIMOS				
Other <enter name>				