

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

Facility Project Plan

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

Background:

This template has been provided to allow Facility and Sub-Facility Leaders, and other interested parties to prepare a Facility Project Plan following a call for proposals announced on 18 September 2009, with a closing date of 30 October 2009.

Prior to completing this template, please read the IMOS Five Year Strategy (the 'Strategy'), and Detailed Guidelines for Proposal Development (the 'Guidelines') – see the IMOS website at: <http://imos.org.au/eif.html>.

The Facility Project Plan must be in the following template and contain the information set out below:

Overview:

Proposed Infrastructure Investment:	Bio-Acoustic Ship Of Opportunity sub-facility (BASOOP)
IMOS Facility:	SOOP
Operating Institution:	CSIRO
Facility Leader (for this Proposal):	Dr. Rudy Kloser, CSIRO, 03 62325222, rudy.kloser@csiro.au
Other(s) key people involved:	Dr Anthony Richardson (Uni of Qld/CMAR), Dr Andrew Constable, Dr Simon Wright, Dr Graham Hosie, Dr Steve Nicol (AAD) Dr Chris Wilcox, (CMAR) Fred Stein (Marine National Facility)
Collaborating Institutions:	CMAR

Please attach:

- Letter from senior person in Operating Institution, confirming that the proposed infrastructure can be developed and operated within that institution (**please refer to overall SOOP facility letter**)
- Resume of Facility Leader
- Letters received from Collaborating Institutions, detailing their support to the Proposal, and indicative level of co-investment (**please refer to overall CMAR facility proposal**)

Nature of Investment:

This proposal is designed to value add data collections on research vessels and ships of opportunity (fishing vessels/cargo vessels) providing bio-acoustic measurements to estimate critical mid-trophic organism distribution and abundance around Australian EEZ shelf, slope and oceanic environments. These mid-trophic bio-acoustic data will complement data collected through the biogeochemistry, phytoplankton and CPR programs for distribution and abundance of surface chemistry, plankton and zooplankton, the food of micronekton, and AATAMS and other electronic tagging programs that focus on top predator species that feed on mid-trophic prey. An extension of this collection is to target specific ecological important regions, high quality fisheries data and match with CPR records by adding new instruments to fishing vessels and container vessels over the three year period (e.g. northern Tasman Sea and EAC). Linking the observations with fishing vessels and regions of high fisheries importance (e.g. Eastern Tuna; SEF) will facilitate the long term sustainability of the observations and ensure that the necessary complementary biological data can be collected cost effectively. It is envisaged that over the trial period discussions and projects would be initiated with AFMA to integrate the IMOS observations into the management of the fisheries and the potential for assisting sustained funding for the observations. Operational fisheries models (eg CPUE driven harvest strategies) depend on being able to predict catch, and we expect significant improvements through the inclusion of information on prey fields.

Shelf and ocean-basin scale methods of characterising mid-trophic level organisms (meso-zooplanktonic and micronekton communities ~2 to 20 cm length including small fish, crustaceans, squids and gelatinous) will provide valuable inputs to ecosystem-based fisheries management, marine planning and monitoring impacts of climate change. These mid-trophic level organisms regulate the primary production involved in biogeochemical cycles (e.g. CO² fixation) and are forage for top predators (e.g. tunas, seals, birds). Despite the enormous pelagic realm these organisms occupy and their pivotal role in the functioning of ecosystems linking biogeochemistry to the distribution and abundance of predators they remain one of the least known components of the ecosystem. Recent coupled ocean-biogeochemical-population models have identified a gap in knowledge of this area (Lehodey, 2004; Fulton et al., 2005). Ecosystem models need observations on the distribution and abundance of these micronekton mid-trophic functional groups at shelf and basin scale to validate predictions, but there are very few observations in southern hemisphere waters. These sparse observations come from a variety of sampling devices of limited spatial and temporal extent making it difficult to compare biomass estimates or determine the value of the data as an ecological indicator. The development of a cost effective bio-acoustic observation program that provides both large basin scale distribution and abundance coupled with targeted biological sampling for biodiversity, connectivity, trophic interactions and life history characteristics has been demonstrated to be achievable (Kloser et al. 2009). Kloser et al. (2009) demonstrated that the use of research and fishing vessels on transit can provide sustained repeatable basin scale observations of micronekton communities (Fig. 1).

This bio-acoustic sub-facility would also be part of a major international effort that aims to develop a global ocean Mid-trophic Automatic Acoustic Sampler (MAAS) being proposed as part of the CLimate Impacts on Oceanic TOp Predators (CLIOTOP) program. CLIOTOP is a ten year programme implemented under the international research programmes GLOBEC (2005 to 2009) and IMBER (2010 to 2014), two components of the International Geosphere-Biosphere Programme (Handegard et al., 2009). CLIOTOP focuses on oceanic top predators within their ecosystems and is based on a worldwide comparative approach among regions, oceans and species. It requires a substantive international collaborative effort to identify, characterise, monitor and model the key processes involved in the dynamics of oceanic pelagic ecosystems in a context of both climate variability and change and intensive fishing of top predators (e.g. Lehodey et al. 2008 (Fig. 2)). The goal is to improve knowledge and to develop a reliable predictive capacity combining observation and modelling for single species and ecosystem dynamics at short, medium and long term scales. It is proposed that observational platforms equipped with multi-frequency acoustics will provide data for identification and quantification of marine life on a global scale, and

reliably transfer data to the users. It is envisaged that this will be achieved through a combination of existing components and expertise (e.g. ARGOS buoys, vessels of opportunity, moorings, etc.) capable of large scale monitoring of mid-trophic level prey organisms, their horizontal and vertical size-resolved distribution and abundance in the pelagic environment.

Several other international groups are focused on this area of work where the ICES Working Group Fisheries Acoustic Science and Technology provides key advice on standard protocols for calibration and data processing through its working and study groups. Calibration of acoustic instruments and standard processing protocols have been developed in this area over a number of years and published as cooperative research reports (<http://www.ices.dk/products/cooperative.asp>). This group meets annually to advance the science of bio-acoustics and further develop and check protocols (<http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=141>). Likewise the CCAMLR sub group ASAMS meets to discuss specific issues of bio-acoustic surveys in the Southern Oceans.

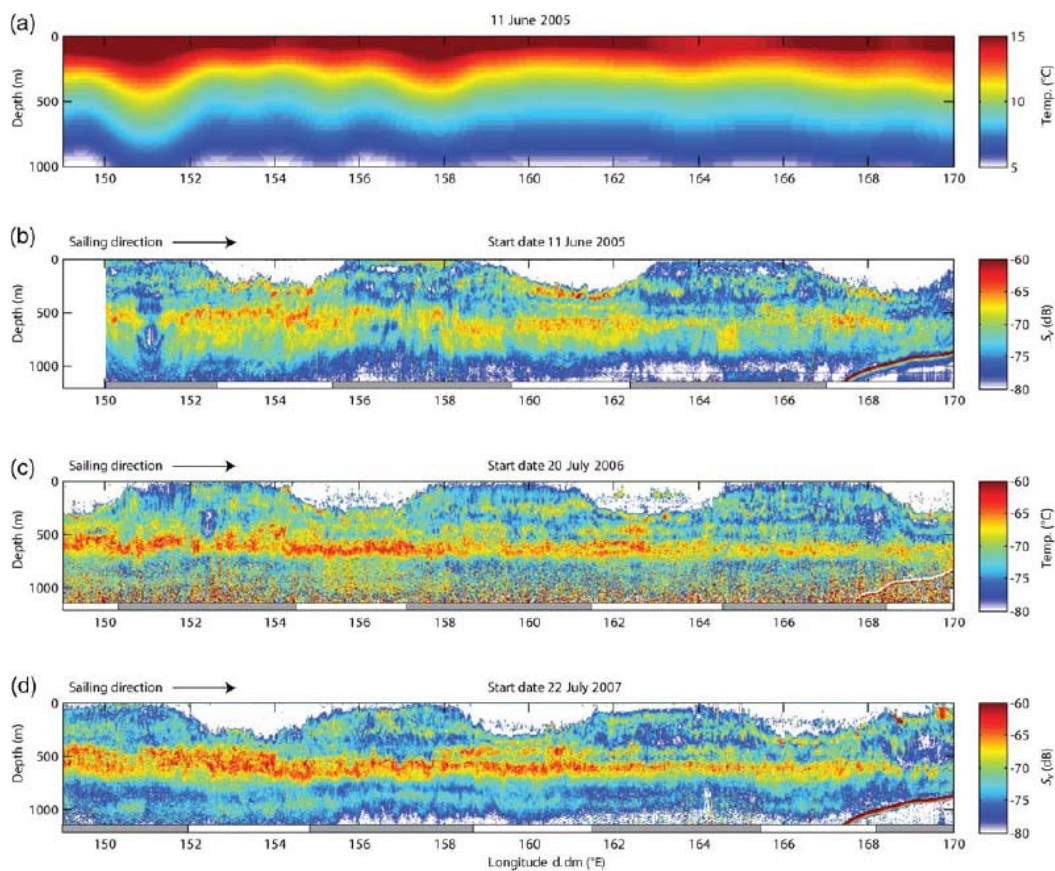


Figure 4. Cross section: (a) estimated temperature section for the transect in 2005, noting the large warm-water eddy centred at 151°E associated with low backscatter below and S_v (dB re 1 m^{-3}) from fishing-vessel acoustic data for years (b) 2005, (c) 2006, and (d) 2007. Data collected at 38 kHz along 41°S between 149 and 170°E. Day/night sampling of the transects over three days are indicated by clear and dark bars, respectively.

Figure 1. Demonstration of basin scale distribution and abundance of mid-trophic organisms provided by calibrated ships of opportunity (fishing vessels) over multi year time frame using well established standardised technologies and methodologies (figure 4 from Kloser et al. 2009). These basin scale snapshots provide information for ecosystem model parameterization, data assimilation and as an ecological indicator of change in the deep scattering layer over basin scales. Implementation of this method is very cost effective and forms a component of the necessary global coverage.

The bio-acoustic sampling proposed here is targeted on vessels operating in areas of high importance due to predicted impacts from climate change or of ecological significance. The Tasman Sea is a high priority as the region is predicted to be a globally significant region for increased temperature change (Fig. 3, Cai et al., 2005). Likewise the Eastern Australian boundary current

region is of high importance to Regional understanding of ecosystems with complementary recording with repeated CPR routes.

In Southern Ocean waters the data collections would also from part of the Sentinel and SOOS initiatives. It connects three of the world's major ocean basins as well as the upper and lower limbs of the overturning circulation. It is one of the most important regions for carbon dioxide drawdown and has shown some evidence of change over the past several decades, (see deepwater node document). The Southern Ocean is also regionally significant through climatic interactions with the Australian continent. Major krill, squid and finfish fisheries already exist in the region with the potential for expansion.

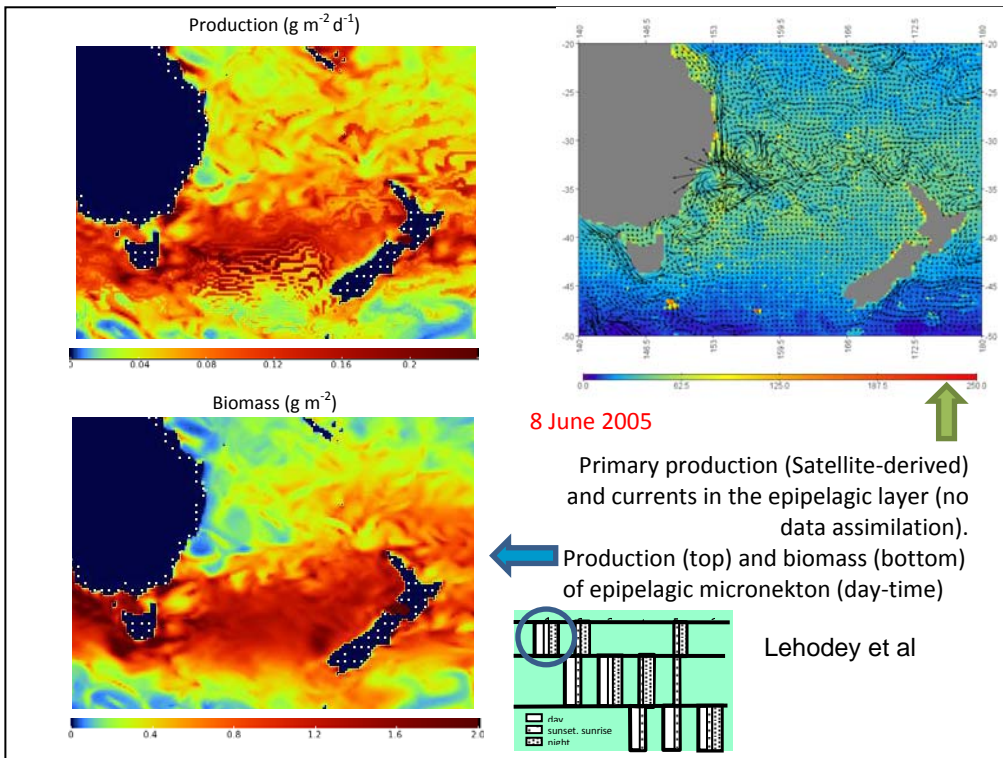


Figure 2. Demonstration of a model data flow from primary production to epipelagic micronekton to uptake the outputs of the acoustic data and produce estimates of biomass of important trophic groups in the Tasman Sea (Lehodey et al. 2008, Lehodey et al. in prep).

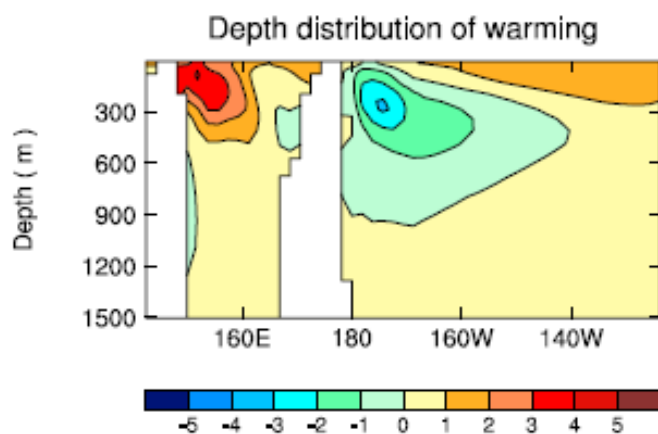


Figure 3. Predicted ensemble-mean changes in temperature (C) along the 36S section of the South Pacific due to global warming 2035-2055. Cai et al. 2005.

References:

Fulton, E., Smith, A., and Punt, A. (2005) Which ecological indicators can robustly detect effects of fishing. *ICES Journal of Marine Science*, 62, 540-51.

Lehodey P., Senina I. and Murtugudde R. (2008) A Spatial Ecosystem And Populations Dynamics Model (SEAPODYM) - Modelling of tuna and tuna-like populations. *Progress in Oceanography*, 78: 304-318.

Lehodey, P., J. Jouanno¹, I Senina¹, R. Kloser², J. Young² (in prep). Evaluating a pelagic mid-trophic level model with acoustic data in the east Australia region. *Deep Sea Research*.

Kloser, R. J., Ryan, T. E., Young, J. W., and Lewis, M. E. 2009. Ocean-basin scale acoustic observations of micronekton fishes: potential and challenges. - *ICES Journal of Marine Science*, 66: 000-000.

Nils Olav Handegard, N.O., Demer, D., Kloser, R.J., Lehodey, P., Maury, O. and Simard, Y. 2009. Toward a global ocean Mid-trophic Automatic Acoustic Sampler (MAAS), <http://www.oceanobs09.net/cwp/index.php>.

Robison, B.H. (2009) Conservation of Deep Pelagic biodiversity. *Conservation Biology*, 23(4), 847-858.

Implementation Strategy:

- Summary

Using bio-acoustics to monitor mid-trophic organisms at large spatial scales annually for application to whole of system approach to ecosystems and monitoring decadal trends. Data from research vessels and selected fishing vessels will be collected from multiple frequencies (Table 2, Fig. 4). The bio-acoustic component will focus on the micronekton fish in waters north of ~55 S (e.g. myctophids) as they represent a dominant functional group in the pelagic ecosystem and due to their gas-bladder a dominant acoustic scatterer. Using multi-frequency acoustic methods on research vessels (Aurora Australis and Southern Surveyor, Table 2) other mid-trophic groups (e.g. crustaceans, gelatinous and squid) will be estimated.

- Objectives

Collection of cost effective bio-acoustic data at single (38 kHz) and multiple frequencies (12, 38 and 120 kHz) from existing vessel infrastructure (research and fishing) annually within season on transit over regions of high regional, ecological and oceanic importance (Fig. 4).

Collection of bio-acoustic data from new vessels (fishing and cargo) that need appropriate infrastructure will be target at regional ecological hotspots (e.g. Tasman Sea) and or matched with repeated transects incorporating the biochemistry and CPR lines (Fig. 4).

MAJOR ACTIVITIES

1. Within the TasMOS node undertake repeated acoustic transects across the Tasman Sea and Southern Ocean linking the shelf, slope and open ocean. Estimate the wet weight biomass of mid-trophic functional groups their energetic transfer between the epi and mesopelagic layers for decadal trends and region and global ecosystem models (Fulton et al. 2005, Lehodey et al. 2008).
2. Within the Blue Water and Climate node conduct repeated acoustic surveys of mid-trophic micronekton (primarily myctophids) for baseline and long term (decadal) trends in the changes of distribution, biomass and behaviour of this crucial mid-trophic component for modelling the structure and function of the ecosystem for understanding impacts on regional fisheries production, marine mammal and bird distributions and potential effects of climate change. Target areas will be the Eastern seaboard linking the EAC with Tasman Sea and Coral Sea

fisheries (e.g. Tuna) as well as Kerguelen region and large scale Indian, Pacific and Southern Ocean transects.

3. The collection of underway bioacoustic data from appropriately instrumented SOOP vessels operating within the Regional Australian boundary currents.
4. Within objectives 1 and 2 add acoustic sensors to two new vessels (fishing and container) that would complement existing regional, CPR and XBT routes.

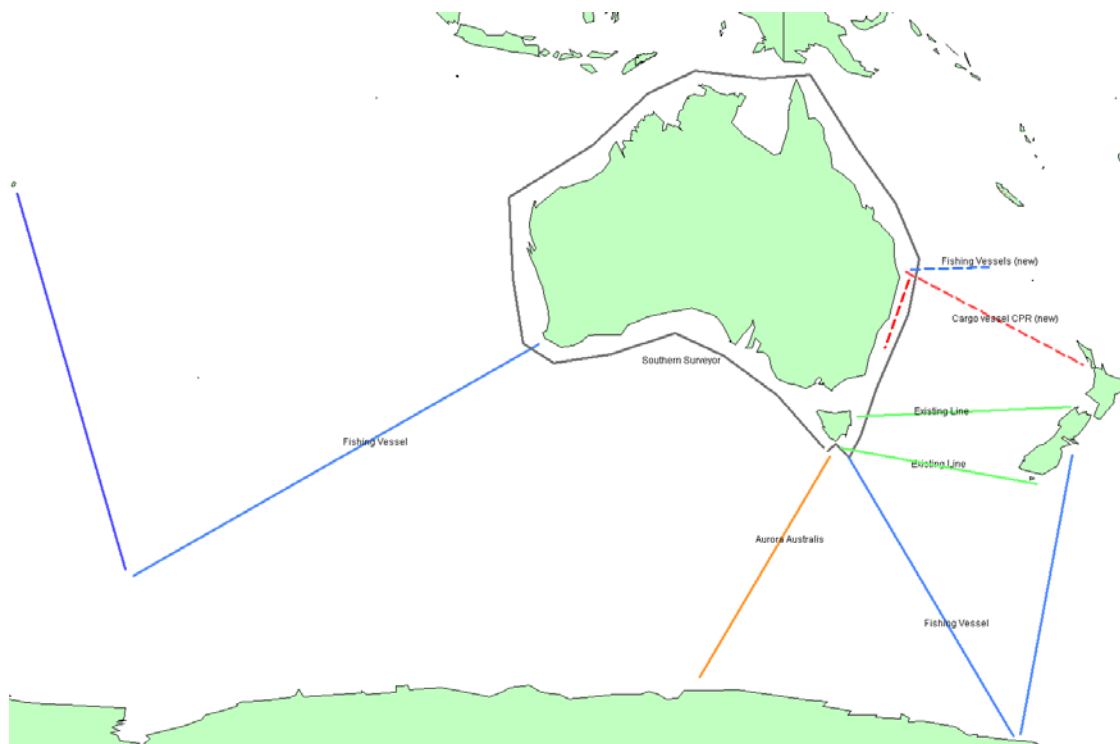


Figure 4. Proposed annual within season collections for IMOS SOOP, solid existing and dashed new. Priority - Green long term 5 year transect lines, blue new fishing vessel routes, orange Aurora Australis route and gray is approximate Southern Surveyor route/year. New routes proposed are dashed with Eastern Tuna fisheries region blue and combined CPR/Acoustic routes red dashed.

Access, pricing regimes:

- How will data access be provided?

Via the eMII browser time and location attributed calibrated acoustic backscatter data at 38 kHz for 10 m depth bins and 1 km horizontal resolution to a nominal depth of 1000 m will be available (Kloser et al. 2009). Finer resolution raw data will be available in either a web WMS form or netCDF form from the data custodian.

The data streams we have at present are designed with the research community we interact with and have been tailored to suit their/our needs. The resolution is produced to match the resolution of either other sampling devices (CPR plankton nets satellite) or models at horizontal (~1km), ~0.25 deg. and ~10 to 100 m vertical. Given that our scale of raw data resolution is about 10-20 m horizontal and 0.2 m vertical this is easily achieved.

Specific data products that estimate the wet weight biomass of mid-trophic micronekton fishes and the estimated diurnal energetic transfer between the epi pelagic (0-200 m) and meso pelagic (200 to 1000 m) layers will be estimated for the Tasman Sea region (Kloser et al. 2009). A specific funded project at CSIRO and a funded post doc through CSIRO and AAD will advance the data products area and the necessary protocols to estimate other mid-trophic functional group

biomasses and their energetic exchange between epi and meso pelagic regions and its uncertainty.

- How will data and products be managed?

Data collection will be made using the following procedures. The vessel's acoustic system will be calibrated using standard methods (Foote, 1987) at least annually. The critical acoustic system settings will use values that have been optimised for open-ocean transits. The settings used will be recorded to form part of the metadata. When appropriate we will organise shipboard pre-voyage briefings with the ships officers, vessel managers and ourselves. We will provide the ships officers with a document describing the necessary echosounder settings and set up procedures. Effective communication between ourselves, the ships officers and the vessel managers will be maintained to ensure that data is collected according to these protocols. The acoustic data is recorded to 2.5" external hard drive. A simple exchange system between old and new hard drives will be used at major port calls. The exchanged hard drives will be returned to CSIRO for archive and then returned to the vessel.

Quality control procedures will be applied to the logged acoustic data to ensure that the signal has not been unduly affected by degradation due to rough seas or other sources. The quality checked data will be processed to provide calibrated measures of acoustic backscatter for cell sizes resolutions of 10 m vertical, and 1 km horizontal. This data will be posted on the eMII web page. The raw acoustic data will be managed with a meta data base and, subject to eMII discussions, software could be provided to browse the data via the web using a WMS or WCS/WFS protocol.

Table 1. Summary of proposed data collection vessels. Agreement is already in place to collect the acoustic data with the company or organisation associated with each of these vessels. *Italic vessels are new and would be fitted with acoustic systems.*

Vessel	Acoustic capability	Route	Company/Organisation	Comments
Southern Surveyor	12, 38, 120 kHz	Australian and pacific waters	CMAR/National Facility	Ad-hoc coverage of regions of interest as determined by transit and voyage plan
Aurora Australis	18,38, 120 & 200 kHz	Southern Ocean, regular transects to Antarctic continent with occasional transits to Heard Island	Antarctic Division	
Rehua	38 kHz	Australia- New Zealand	Sealord NZ	June NZ-Aust. transect, Aug Aust.-NZ transect
Southern Champion	38 kHz	Mauritius - Heard-McDonald Is, Perth	Austral Fisheries	
Austral-2	38 kHz	Mauritius - Heard-McDonald Is, Perth	Austral Fisheries	
Janas	38 kHz	NZ-Ross Sea	Sealord NZ	
Saxon Onwards	38 kHz	Australian waters, Hobart - Cascade Plateau	Onwards fishing	June Hobart-Cascade transect
<i>Cargo/fishing vessel</i>	<i>38 kHz</i>	<i>Southern ocean/ Tasman Sea</i>	<i>To be decided</i>	<i>Monthly to match with CPR and biochemistry</i>
<i>Cargo/fishing vessel</i>	<i>38 kHz</i>	<i>Southern Ocean/ Tasman Sea</i>	<i>To be decided</i>	<i>Monthly to match with CPR and biochemistry</i>

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

The bio-acoustic data will be collected from existing vessel facilities such as Southern Surveyor, Aurora Australis and large fishing vessels. Agreements to collect data on transits and provide this data to the public have been agreed. As an example fishing vessel data has been collected on the Trans Tasman transect annually since 2004 and there have been no issues with data access and distribution. Verbal support has been obtained from all the participants and in writing support will be obtained prior to project commencement.

- Collaborative structures for allocation of priorities

Priority of acoustic data collection and data processing and posting will be determined by nodes.

Priority will be allocated to the Trans Tasman transect and Southern Ocean transect for the TasNode shelf slope and near oceanic.

Bluewater and Climate node priority will be the Australian Eastern seaboard (Tasman Sea), Southern Ocean (CPR routes and Kerguelan regions), Australian boundary currents and large scale oceanic transects covering the Indian, Pacific and Southern Ocean.

Governance

- Performance indicators

Yearly performance indicators – posting of calibrated acoustic backscatter data and associated data products on the eMII web site.

Uptake of the bioacoustic data in regional and global ecosystem models and by national and international researchers.

Uptake by management agencies of the derived information using the bio-acoustic data or supporting ongoing data collections for long term ecological monitoring.

Publications on the structure, function and prediction of the regional and oceanic ecosystem which includes the bioacoustic data

- Describe key risks and risk management strategies
 - Data access Risk:

Access to data from participating vessels is discontinued.

To date no issues with data access and public posting have been raised for transit data. At the time of writing verbal agreements have been obtained from Fred Stein for Southern Surveyor to make acoustic data part of underway data set, Les Scott from Petuna_Sealord for Trans Tasman transect, Martin Excel Austral Fisheries. Aurora Australis data set has been provisionally approved by Steve Nicol (AAD). Confirmation of open access data agreements will be confirmed in writing when project is approved.

- Loss of instruments on new vessel Risk:

After placing infrastructure on a new vessel there are changes that remove it from service.

Most of the hardware can be unbolted although an installed transducer would be only recovered at the next scheduled dry dock. Installation costs would be lost in that event. Priority will be placed on installing acoustic system on vessels that have proven stable longevity on selected routes.

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

- EIF Funds
 - Expansion of existing Facility / New Facility

The detailed budget outlined below covers objectives 1 to 3 and covers collection of bio-acoustic data from platforms that have the existing acoustic infrastructure installed and objective 4 that adds two instruments on selected fishing or cargo vessels and this project is calibrating, collecting and processing the data.

Table 2. Funding for objectives 1- 4.

Objective 1-4

	2010/11 (EIF)	2011/12 (EIF)	2012/13 (EIF)	Total (EIF)
NCRIS/EIF Funding (Note 2)				
Capital	120,000	120,000		240,000
Salaries	162,655	170,750	179,249	512,654
Operating	35,000	35,000	30,000	100,000
NCRIS/EIF Funding Total	317,655	325,750	209,249	852,654

- Co-investments – source and nature

Cash Co-investment (Note 3)

	2010/11	2011/12	2012/13	Total
CSIRO	147,158	154,516	162,242	463,916
Cash Co-investment Total	147,158	154,516	162,242	463,916

In-kind Co-investment (Note 3)

	2010/11	2011/12	2012/13	Total
CSIRO WfO	250,000	310,000	350,000	910,000
AAD	50,000	50,000	50,000	150,000
MNF Southern Surveyor	42,000	42,000	42,000	126,000
MRF Aurora Australis AAD	60,000	60,000	60,000	180,000
Petuna Sealords	35,000	35,000	35,000	105,000
Austral fisheries	35,000	35,000	35,000	105,000
In-kind Co-investment Total	472,000	532,000	572,000	1,576,000
TOTAL Resources	936,813	1,012,266	943,491	2,892,570

- Staffing details

Project management and reporting 0.1 fte
 Acoustic technician/analyst 1.0 fte
 Data manager 0.2 fte
 Database/programmer 0.2 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

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				Conduct repeated acoustic surveys of mid-trophic micronekton for baseline and long term (decadal) trends in the distribution, biomass and behaviour of this crucial mid-trophic component for modeling the structure and function of the ecosystem and understanding impacts on regional fisheries production, marine mammal and bird distributions and potential effects of climate change. Target areas will be the Eastern seaboard linking the EAC with Tasman Sea and Coral Sea fisheries (e.g. Tuna) as well as Kerguelen region and large scale Indian, Pacific and Southern Ocean Transects.
WAIMOS				
GBROOS				
NSW-IMOS				As part of new infrastructure record acoustic data on repeated CPR routes.
SAIMOS				
Other <enter name>				
TasIMOS				To undertake repeated acoustic surveys of midtrophic organisms across the Eastern Tasmanian shelf, slope and Tasman Sea to estimate their decadal changes in energetic transfer between the epi and mesopelagic layers for region and global ecosystem models (Fulton et al. 2005, Lehodey et al. 2008,).