Replacement Capability Assessment Project

MARINE
NATIONAL FACILITY

Report of Working Group

CSIRO

Research Vessel Capability Assessment Project

The Marine National Facility Steering Committee has formed an Expert Working Group to canvass opinion from the Australian marine science community, and provide advice on future needs for blue-water research vessel capability.

Membership

Captain Fred Stein, Director MNF; Chair
Dr Ralph Jensen, (past) Chair, MNF Scientific Advisory Committee
Mr. John Reeve, Australian Antarctic Division
Captain Steve Hunt, Australian Shipping Industry

Scope

Australia's ocean territory runs from the high tropics to the Antarctic, and from the coast to the abyss. No single piece of research infrastructure could possibly cover all of this territory and the different kinds of science needed across this territory. The scope of the capability being defined here must be complementary to:

- the Southern Ocean- and ice-capable research vessel capability utilised by the Australian Antarctic Division (currently RSV *Aurora Australis*), and
- the coastal research vessel capability of the Australian Institute of Marine Science (currently RV's *Cape Ferguson* and *Lady Basten*), and various State Governments and Universities

Objective

To identify the core capabilities that are key success factors for a broadly capable, multi-role, blue-water research vessel tasked to support provision of the scientific advice that informs and underpins the sustainable development of Australia's oceans.

Terms of Reference

The advice provided must consider:

- capability of the current MNF vessel, RV *Southern Surveyor*, and other vessels in the national "fleet"
- scheduling and operating modes – current and future
- current limitations in terms of accommodation for scientific/technical staff;
- endurance (i.e. days at seas)
- electronic sampling systems, including data acquisition and processing;
- mechanical sampling systems
- laboratory requirements
- other capability – Space-based systems, aircraft, deep submergence facilities, AUV's, drifters & floats
- international trends in comparable types of capability
- a time horizon of approximately 10 years

Process

The working group will circulate a Request for Comments to:

- Commonwealth Government agencies with a stake in the operation of the MNF,
- State Governments,
- Universities with active marine science programs,
- Recent users of the MNF, and
- The Australian Marine Science Association

Contents

Executive Summary

Australia's regional seas and oceans encompass 13% of the earth's surface. Our oceans contain many distinct biological and geographical regions. The research needed to understand our oceans cannot be efficiently conducted from a single vessel. The operating niche for the capability considered in this report is 'Blue-Water' and complementary to:

Polar Class

High-Latitude, 3000m+ depth, Southern Ocean and ice-capable research vessels.

Coastal Class

Low-Latitude, 0-1500m depth research vessels.

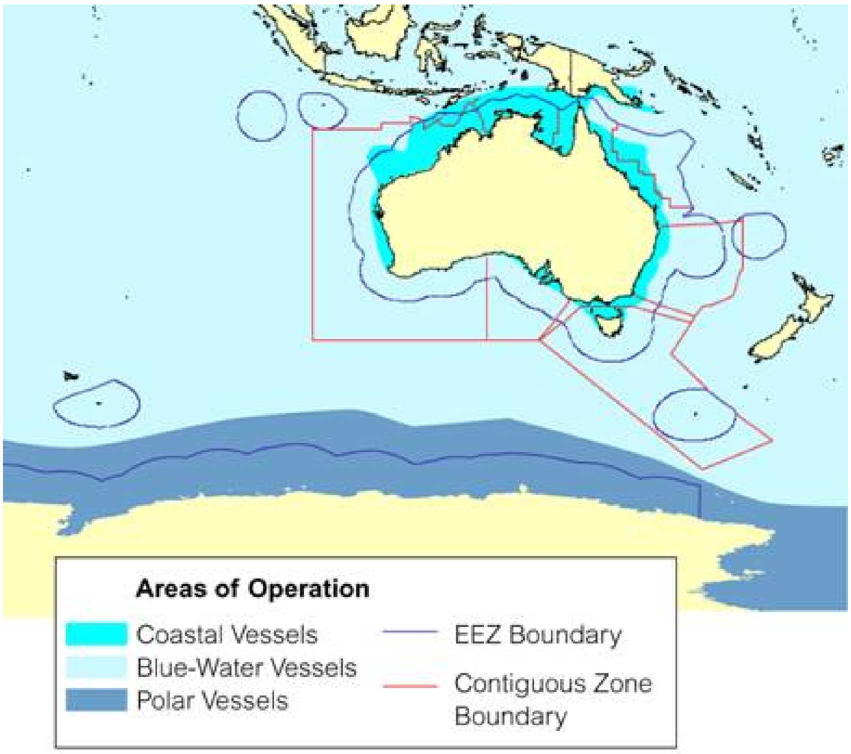

Fig 1. Regional Areas of Operation and Australian Maritime Jurisdictions

Key Capabilities

More than 80% of the capabilities identified in responses to the RFC as major requirements for blue-water research can be delivered by a single vessel of 70-80m in length.

The ability to efficiently interface purpose-built research systems with a core suite of sampling, data acquisition, management, presentation and communication systems.

The ability to combine data from on-board observations with data from space-based sensors, autonomous vehicles and shore based models in real time.

A design that accepts a range of ISO standard transport, storage, accommodation and laboratory modules could transport 30+ scientists and technicians to the furthest reaches of Australia's surrounding oceans and remain on station for ~50 days.

Primary Design Parameters

LOA:	**70m-80m**
Beam:	**13m-16m**
Draft:	**5.5m+**
Displacement:	**~3000t**
Propulsion:	**Diesel Electric** **Fixed pitch propeller(s)**
Speed:	**Transit: 15kt** **Cruising: 12kt**
Range:	**10,000nm**
Science Compliment:	**30+**
Classification:	**+100A1, UMS, Ice C, SPS**

Working Environment

Good stability and seakeeping qualities will be provided by a vessel of ~3000t displacement and relatively deep draft (5.5m+). Adding a modern, cost-effective anti-roll system will extend its weather working window, improve the safety, productivity and comfort of researchers and provide a comfortable home away from home.

Operational Scope

The operational niche of a vessel of this type does not include permanent ice. It is recommended that the vessel be classed for operation to the ice edge and not as an ice-breaker.

A vessel with the recommended characteristics is designed to operate efficiently at significant distances from major ports and away from the coastal shallows. Research in near-shore areas is most effectively supported by smaller, shoal draft vessels.

Construction Standard

- The proposed area of operation includes some of the world's most challenging ocean areas.
- It is reasonable to anticipate that vessel design standards will become more stringent over the next 25 years.

To minimise risk and ensure research teams are supported with safety standards at the highest level, construction in accordance with the highest standard available to special purpose vessels of this type is warranted. It will be appropriate to seek the advice of the Australian Maritime Safety Authority and a classification society when developing a detailed recommendation on a standard of construction.

Outside the Envelope

A vessel with the capabilities recommended cannot be equipped to access some areas of the deep oceans and conduct some specialised tasks without introducing inefficient design compromises. Research with highly specialised needs may be supported by:

- chartering and mobilizing the commercial tonnage most suited to the task
- collaborative agreements for reciprocal access to the capabilities of the research vessels of other nations

Reserving an element of funding to support short-term access to specific, specialised capability is the most efficient and effective method of delivering that capability.

Integrated Service Model

An integrated service delivery model has the greatest potential to cost-effectively provide marine science with core blue-water research capabilities while retaining the ability of a Marine National Facility to provide access to highly specialised capabilities for which there is not sufficient continuous demand to warrant a long term investment in capital plant. This will meet the general needs of the marine science community and support those for whom intermittent access to specialist capabilities is critical. The key elements of an integrated service delivery model are:

1 Broadly capable, multi-role, configurable, core functionality built on off-the-shelf technology.

2 Flexible access to specialised, short-term capabilities to support unique short term needs.

Trawl Fishing

The capabilities recommended support:

- Vertical benthic sampling in:
  - >99.5% of Australia's EEZ
  - >99.9% of regional oceans
- Towed benthic sampling in:
  - > 63% of Australia's EEZ
  - > 46% of regional oceans
- Routine trawling to 4000m
- Processing and laboratory facilities sufficient to investigate substantial volumes of biological material

The capabilities recommended will not support:

- Routine trawling beyond 4000m
- Catch sizes and handling facilities similar to those of commercial trawlers
- The ability to replicate commercial trawling methods
- The sophistication of gear control available to modern commercial stern trawlers

Future Capabilities

Background

Australia has operated a Marine National Facility since 1984, when ORV *Franklin* was commissioned. In 2003 *Franklin* was retired from service and the larger, more capable, RV *Southern Surveyor* commenced operation as the MNF. *Southern Surveyor* will reach the end of its useful life some time in the next 5 years. The Steering Committee has sought advice from the Australian marine science community on future needs for "blue-water" research vessel capability.

The Commonwealth Government's objectives for sustainable management of Australia's ocean territory are expressed via Australia's Oceans Policy, legislation such as the Environment Protection & Biodiversity Conservation Act, and various international treaties and conventions.

The MNF supports these objectives by providing researchers with the ability to address a number of National Research Priorities, including:

- An Environmentally Sustainable Australia,
- Frontier Technologies for Building & Transforming Australian Industries,
- Safeguarding Australia

The results of MNF based research are a key component of the scientific advice that informs and underpins the sustainable development and management of Australia's ocean resources.

The MNF presently supports blue-water research by providing:

- A platform to transport, accommodate and provide services to research teams and their equipment
- Hospitality services
- Laboratory services and facilities
- Science operations services and management facilities
- A specialised suite of equipment and systems to:
  - Measure the instantaneous value of environmental variables in the atmosphere, ocean, seabed and underlying lithosphere
  - Sample the atmosphere, ocean, biota and seabed for analysis
  - Capture, store, manage, present and communicate data acquired during voyages
- Staff with the skills and experience to:
  - Operate and maintain highly specialised measuring and sampling systems in accordance with international scientific standards
  - Analyse and process specific datasets into internationally accepted formats
  - Provide the data from voyages to researchers
  - Manage the vessel and provide science voyage logistic support

Demand

Scientists from the disciplines below have confirmed that there is an ongoing and increasing need for access to the samples and data that can only be acquired with a blue-water research vessel.

Biology

- Habitat Mapping
- Conservation and bio-diversity
- Marine ecosystem assessment
- Ecosystem based fisheries management

Oceanography

- Physical Oceanography
- Chemical Oceanography

Geoscience

- Geology
- Geophysics

Meteorology

- Climate change and variability
- Ocean / Atmosphere dynamics
- Climate, weather and ocean prediction

Synthetic Disciplines

An increasing trend toward the assembly of broadly capable, multi-disciplinary research teams that cooperate to focus their knowledge and skill on previously intractable problems, is giving rise to an increasing demand for access to the full capabilities of a sophisticated blue-water research platform from scientists in synthetic disciplines such as:

- Hydro-Acoustics
- Biogeochemistry
- Biological Oceanography
- Biochemical Oceanography
- Integrated Coasts & Oceans Science
- Southern Ocean Studies
- Oil & Gas exploration and extraction
- Mineral exploration and extraction
- Plate tectonics
- Continental shelf geo-dynamics

Methodology

The working group sought the views of the Australian Marine Science Community by asking recent users of *Southern Surveyor* and key science agencies to respond to a Request For Comments that identified:

- The capabilities of *Southern Surveyor*
- Capabilities that might be delivered by similar, modern tonnage scoped to operate in the oceans surrounding the Australian continent

Respondents were asked to identify:

- the science for which individual capabilities were significant
- the level of significance of individual capabilities for specific disciplines
- the scientific imperative for capabilities to be different from those presently delivered by the MNF

Responses were collated and reviewed by the working group to identify 'core' capabilities and discipline specific capabilities.

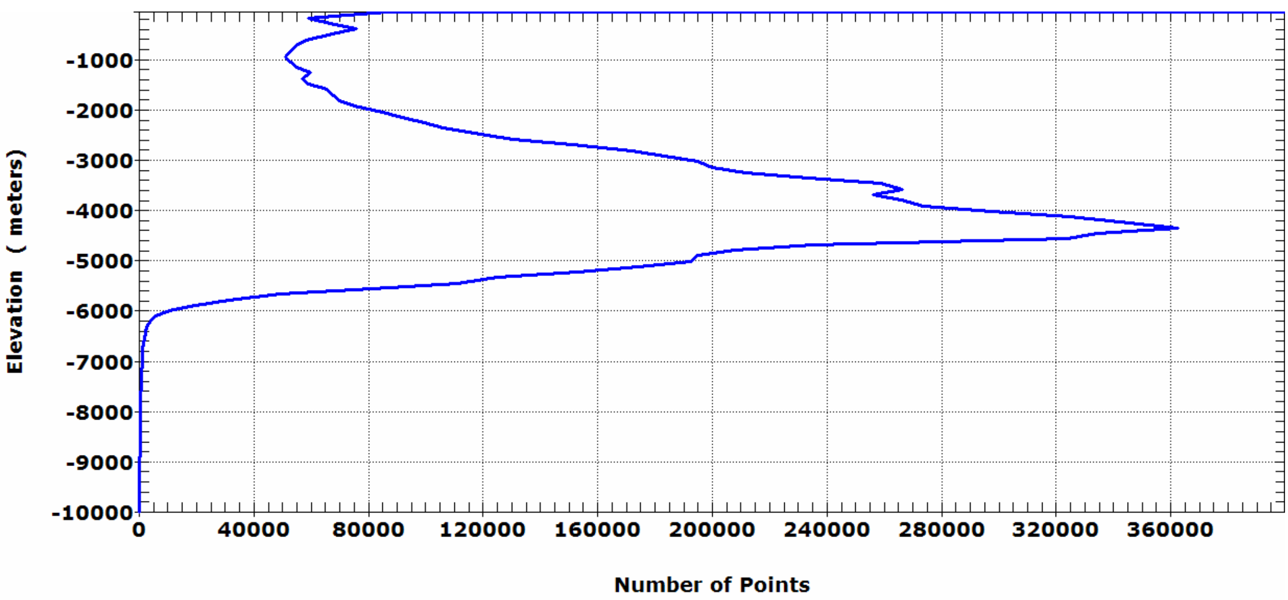

Fig 2. Spot Depths 15nm grid — Australian Region

Future Capabilities

Core capabilities

Transport and Accommodation

Range:	10,000nm
Endurance:	50~60 days
Accommodation:	30+ scientists Environment control: 22°C ± 2°C
Positioning:	<1m + linear & angular velocity & acceleration
Station keeping / Heading control:	DP I / ± 5° (Winds to F8 - 40kt/75kph)
Laboratories:	~310m^2 Salt / fresh / distilled water 240V AC to Australian Standards Environment control: Temp ± 1°C Vapour management
Operations Management:	~140m^2
Working Decks:	~100m^2
Operations Services:	415V AC; 32A sockets & 64A switchboard access
Internal Comms:	UHF / PA / Phone Video – all working spaces 1Gb to all spaces + redundant fiber
Ext Comms:	On demand phone High-bandwidth data
Workshops:	Electrical Mechanical
Hazardous substance storage: (Environment monitored)	Solids Liquids Gases
Equipment & sample stowage & handling:	~ 900m^3(22 TEU) Controlled Temperature: 20°C – 4°C 20m^3 0°C – -30°C 30m^3

Occupational Health, Safety and Ergonomic Factors

Safe, covered access to laboratory, workshop, equipment and sample stowage areas.

Ergonomic workflow design, facilities and equipment for samples, materials and equipment handling.

All references to wind speed parameters assume open ocean conditions

Equipment and Systems

Equipment handling:			
	Winches:	Traction winches[1] + appropriate wire storage	
		Tension control essential / Heave compensation desirable	
		Sample recovery: 1x50t max	
		Storage:	$10m^3$
		Towed body:	5000m (+Communications)
			Optical fiber desirable but not essential
		GP:	2 x 5t; 1 x 15t
		Capstan:	1 x 20t Vertical
	Wires:	Towed:	2 x 7000m useable – 0.25t payload
		Vertical:	6500m useable – 0.25t payload
		Communications:	2 x 7000m useable – 0.75t payload
	Cranes:	Utility:	1 x 5t static load
		Working:	1 x 25t static/5t live (Winds to F6 - 27kt/50kph)
		A-Frame:	
		Side:	2t, 4.5m clearance
		Stern:	20t, 6m clearance
		Gallows:	1 x 50t
		Side towing booms:	2 x 2.5m, 2t
Sensor deployment:		Through hull, retractable: 0.5m & 2m	
Sensors:		CTD to 7000m	
	Acoustic:	ADCP	
		Swath:	0.5° x 0.5° 10m-300m (100-250kHz)
			1° x 1° 10m-4000m (30kHz)
		Vertical:	12 / 38 / 120 kHz
		USBL:	~7000m
		Sub-bottom:	~8000m
	Sea surface:	Temp / Salinity / pCO_2	
Systems:			
	Physical Samples:	Benthic dredges & sleds:	Payloads to 0.25t
		Benthic Grabs:	Payloads to 0.25t
	ROV :	2000m (minimum—6000m preferred)	
	UUV/AUV:	Vehicles to 1.5t	
	IT & Network management		
		Data processing:	~10 dedicated scientific workstations & peripherals
			~ 5 configurable workstations
		Data presentation:	Integrated 'real time' presentation of voyage data

1. Requires further assessment - potential to handle a wide range of wire sizes, types and lengths

Future Capabilities

Discipline specific capabilities

Scientists consistently identified specific systems and / or sensors as a major requirement for, or essential to, their science.

A number of these are amenable to modular deployment in one or more ISO containers. Modularised equipment and systems do not have an impact on vessel parameters other than a requirement for appropriate container stowage access and equipment interface. Equipment amenable to modular delivery is separately identified as potential elements of an MNF equipment suite.

The systems to the right have the potential to either significantly impact vessel design or would be most efficiently fitted as part of initial build or outfit.

Geoscience

Operations services:	Air: 2 x compressors - 400ACFM @ 2000psi
Acoustic sensors:	Full Ocean Depth SWATH (12kHz) – Requires 18m^2 of hull real estate Gondola mounting
Physical Sampling:	20-30 meter Long Core System

Biological Oceanography / Marine ecosystem assessment

Hull & machinery:	ICES 209 compliance
Incubation:	Unobstructed deck space clear of working decks
Acoustic Sensors:	Raw data acquisition systems
Underway Sensors:	pCO_2 / dissolved O_2 / Fluorescence

Capability conflicts

Relatively few of the capabilities sought have the potential to create a conflict not amenable to resolution through design. The following may require either design or capability compromises.

- Operation in waters with ice / Gondola mounted acoustic sensors
- ICES compliance / sea-keeping & propulsion efficiency / Dynamic Positioning / Cost
- Shallow (<10m) water operation / sea-keeping

Capabilities appropriate to modular deployment

Systems:	ROV / AUV Control

Geoscience

Sensors:	Airgun array Seismic streamers Seismic data acquisition system
Physical Sampling:	Gravity / Piston Cores, to 6m Box / Multi Core systems

Marine Biology/Biological Oceanography

Systems:	Dive support
Laboratory:	Radiation Laboratory (C^{14} + Liquid scintillation counter)

Trawl Fishing

The working group received substantial feedback from stakeholders on the need for a research vessel to 'fish'. A range of views have been expressed. It is clear that the vessel should be capable of supporting a range of sampling methods. Many respondents provided comment in relation to specific equipment. This review did not address specific equipment and outfit unless it was demonstrated that:

- there is a priority demand for the science the equipment would support, and
- the equipment would directly affect the definition of necessary capability and core functionality

The ability to undertake physical sampling with 'trawls' is an important capability for many researchers. A review of the ability of a vessel with the capabilities recommended to trawl has been conducted and is included as Attachment 2.

Trawl Fishing Review

- Summarises feedback provided
- Assesses the feedback against the capabilities recommended.
- Identifies where the capabilities recommended may not deliver the sampling capabilities sought.
- Identifies the impact on the multi-role functionality of a future research vessel of modifying the capabilities recommended.
- Identifies the parameters that require further clarification in order that informed design choices can be made in the next phase of the design process.

Outcome of Review

The capabilities recommended will support:

- Vertical benthic sampling in:
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  - >99.9% of regional oceans
- Towed benthic sampling in:
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- Trawling beyond 4000m
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- The ability to replicate commercial trawling methods
- The sophistication of gear control available to modern commercial stern trawlers

The impact of providing the capability to replicate commercial trawling methods is:

- Additional capital and recurrent cost in winches and winch control systems
- Additional capital costs of hull arising from complexity of stern design
- A greater proportion of interior volume dedicated to this activity

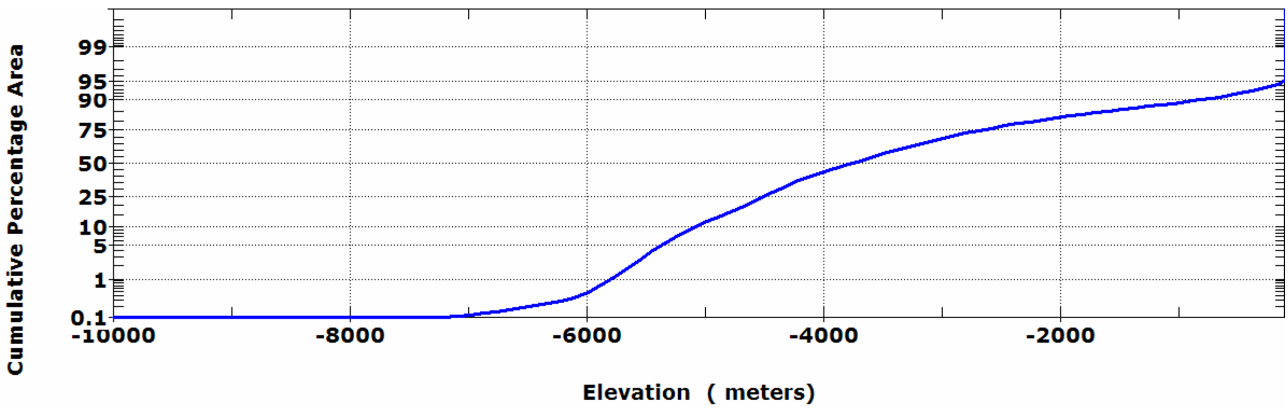


Fig 3. Cumulative % of Depth — Australian Region

Future Capabilities

Staff Support

The Request For Comments did not canvas the issue of support staff for the cluster of capabilities identified. This matter was raised as a priority issue by a number of respondents.

One of the strengths of existing arrangements is that scientists are able to rely on the skills and experience of a pool of staff to:

- interface user systems with a mature data acquisition system
- support the consistent and efficient operation of sampling and measurement equipment
- support the real time integration and display of voyage data from an increasingly wide variety of sensors with data from external sources such as space based sensors and remote sensor networks

Stakeholders, in particular those from the university sector, consistently comment that their ability to 'walk aboard with little more than a suitcase', is a critical capability.

Modularity will provide the ability to focus the configuration of blue-water research support platforms on voyage specific scientific needs. Experience to date indicates that this capability will demand more complex voyage logistics and equipment interface support. This will require more pre-voyage support and more sophisticated pre-voyage support if on-voyage risk is to be managed at acceptable levels. A significant factor in reducing pre-voyage staff overheads will be the inclusion, at the time of acquisition, of design features such as accessible cable ducting and the standardization of equipment deployment, interconnection and interface arrangements.

Data integration and display is an increasingly important capability for voyage management. The structured presentation of integrated data-sets that evolve in real time to reflect the results of investigations in progress provide research teams with a richly textured picture of their environment during a voyage. The capability to integrate and display data in real-time provides for the dynamic management of sampling strategies to achieve the most efficient use of ship time. In addition to the necessary hardware and software significant staff resources will be required to:

- capture data electronically and conduct (at least) preliminary reduction
- integrate voyage data with previous voyage data sets and remotely acquired data
- display the results

Future capability will require:

- development of an agreed set of interface standards to facilitate the presentation of data arising from a voyage, its integration and display
- policies that clearly articulate the facility's role in the provision of necessary hardware, software, system, processing, data integration and visualization support

Further Review

Catch Size

The maximum size of catches to be managed is a primary design criterion.

1 To deliver species identification and biodiversity assessment outcomes is it necessary for a research vessel to:
  - Provide the degree of gear control offered by modern twin wire trawl systems?
  - Replicate precisely typical commercial otter board trawl techniques?

2 What maximum catch size is appropriate in order to balance the ethical demand for non-invasive research with the confidence of researchers that the samples obtained provide a useful result?

Number of TEU 's/ stowage space

The estimate provided is based on approximately 500m^3 above deck and 400m^3 below deck. A detailed specification will strengthen this estimate. It is clear that quality access is at least as important as the volume of storage available. It is recommended that quality of access for persons and equipment to modularised / configurable spaces be identified as a primary design criterion.

Type of winches / cable handling methods

Traditional cable handling methods are based around hydraulically driven drum winches. Modern traction winch systems have the potential to:

- extend cable life
- optimize available deck space

- allow cable to be safely used at higher tensions
- deliver operating performance that is consistent throughout the cable scope, regardless of length deployed

Remotely Operated Vehicle

At approximately $8M for a 6000m capable work-class ROV the cost of this capability is significant. It is possible to deliver this capability in modular form, however consideration at design time of handling systems has the potential to significantly extend the weather working window of a high capital cost item at marginal cost.

Based on the mean depth of Australia's Maritime Jurisdiction it is suggested that a maximum depth capability of 5000m is appropriate for an ROV. A 2000m capability will not reach the foot of the continental shelf.

The ability to support ROV deployment will add significant value to research capability, particularly in terms of sampling accuracy and repeatability. The relatively high capital and recurrent cost structure (3 person operating and support team) warrant further consideration prior to a decision to place an ROV within the scope of a replacement project.

It is suggested that consideration at this stage of the design process be restricted to housing, and handling systems as similar functionality will be required to support AUV's and UUV's.

Capability Not Recommended

ICES 209 Compliance

The value of an acoustically quiet platform is significant. Substantial effort to ensure that research vessels are acoustically quiet, particularly in hydro-acoustic bands, is recommended. Vibration damped diesel-electric drives through a large, acoustically optimised fixed blade propeller with anti-vibration mounted auxiliary machinery will contribute to this. However the cost-benefit of full ICES 209 compliance is still uncertain. In light of known demand for blue-water research vessel tasking and the direction of research effort at this time full ICES compliance is not recommended.

Acknowledgements

Many people and organisations have contributed a substantial amount of time, effort and wisdom to this report. The Working Group would like to thank all those who responded to its Request for Comments. The Chair would like to thank the Working Group members for making their time and expertise available and notes that whatever wisdom may be found in this report is undoubtedly theirs while the mistakes are certainly his.

Thanks in particular to
Simon Allen for Figures 2, 3 & 4.

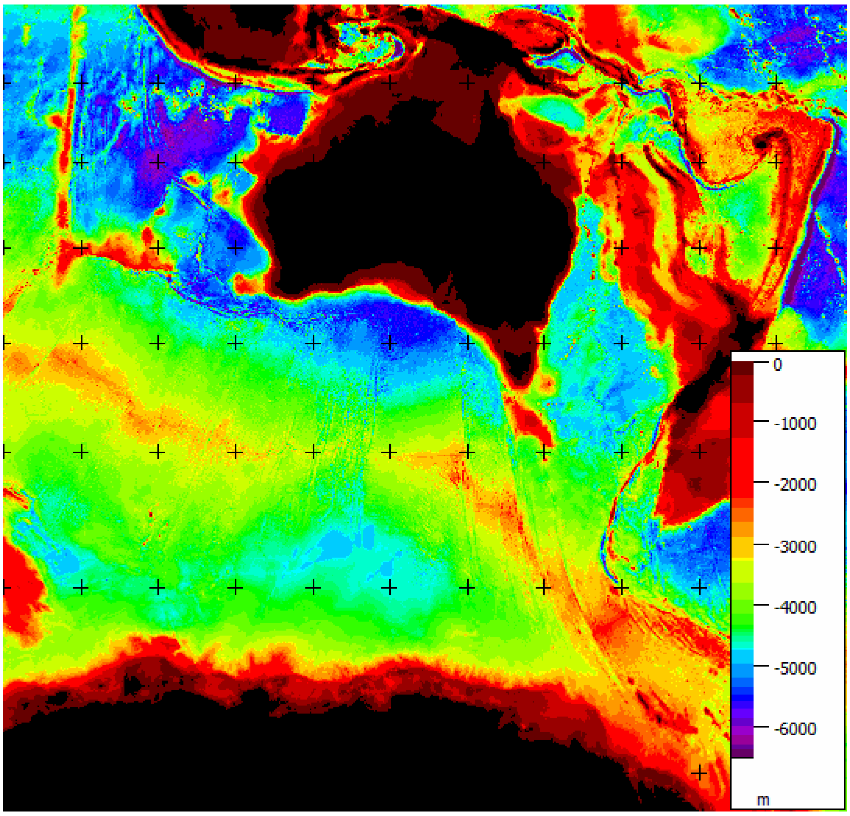


Fig 4. Water Depths — Australian Region

Attachment 1 Specific Equipment and Systems

Recommendations on the fitment of specific sensors or systems that do not have a direct impact on overall design are outside the scope of this report. The issue of specific outfit is most appropriately addressed at a later stage of the design process. A vessel with the specifications proposed will however be capable of supporting the following equipment / sensors / systems.

Hydrochemistry	Autoanalyser AutoSalinometer Dissolved O_2
Preserved Sample Storage	~30 m^3
Blast freezer	20°C -> -30°C 150kg/hr - 1.5m^3
Diving	Hospital fitted to accommodate Diver Medical Technician.
CTD	24 Bottle Rosette to 10l minimum Sensors: Conductivity Temperature Pressure PAR Dissolved O_2 Fluorescence Transmissometer Altimeter
Insolation	Radiation Sensors
Wind Speed and Direction	Automatic Weather Station
Sea Surface Temperature	Automatic Weather Station
Air Temperature / Humidity	Automatic Weather Station
Rainfall	Automatic Weather Station
Expendable Bathythermograph	XBT Launcher + data capture
Fluorometer	Underway measurement system
pCO_2	Underway measurement system (Ferrybox or similar)
Winch Monitoring	Tension Winch speed Wire Out

Contents

Introduction

The subject of trawl fishing as a scientific sampling technique is the topic of an ongoing and passionate debate in the Australian marine research community. The divergence of views is best illustrated by the following contrasting comments submitted to the Working Group.

"Fisheries research is an important discipline both within the Australian EEZ and upon the high seas. Trawling remains an important sampling method for many… species."

"Fisheries in Australia are a dying subject. … We aren't going to find significant new fisheries. The use of huge commercial sized nets is unethical because of the damage that these trawls cause to benthic ecosystems."

Methodology

There is some overlap in the feedback received with respect to trawling as a method of physical sampling for fishes, free swimming invertebrates and biological sampling in general. It is assumed that this has arisen from the use of demersal trawls to sample epi-benthic biota. In order to separate out the issue of Trawl Fishing as a research capability, this review and discussion is structured as a gap analysis.

1 Feedback is collated into a number of broad categories.
2 Feedback is assessed to identify the sampling strategies where the capabilities are not addressed by the recommendations of the Report.
3 Capability Gaps are summarised.
4 The impact of gap closure on multi-role functionality is reviewed.

Terminology

Many respondents use the term 'deep sea'. This term suggests both distance from the nearest coast and, by implication, substantial depth of water. For the purpose of this review the term 'deep sea' is taken to be synonymous with 'in depths of water greater than 200m' or, in other words, to include the bathyal and abyssal ocean zones.

Although not strictly correct the terms 'Oceanic' and 'Pelagic' are used synonymously in this review. This reflects the author's understanding of the spirit in which these terms were used in the feedback received.

	Neritic 0m-200m	Bathyal 200m-4000m	Abyssal 4000m-6500m
Surface	Class I 0m-30m	Class I 0m-30m	Class I 0m-30m
Midwater	Class II 30m-190m	Class III 190m-3990m	Class IV 3990m-6490m
Epi-Benthic	Class V 30m-200m	Class VI 200m-4000m	Class VII 4000m-6500m
Endo-Benthic	Class VIII 30m-200m	Class IX 200m-4000m	Class X 4000m-6500m

Fig 5. Target Space Descriptors

Phase 1
Collation of Feedback

A number of researchers and organisations contributed views on:

- Biota for which there is a sampling demand
- The location of biota for which there is a sampling demand
- The most appropriate method of sampling biota
- Drivers from which the demand for sampling biota has and will arise

In addition stakeholders have provided feedback on the equipment and laboratory facilities required aboard a research vessel to:

- process and investigate the samples obtained
- deploy and recover sampling equipment

Feedback on laboratory equipment and facilities are separately summarised at Appendix 1 and assessed against the capabilities recommended by the Report.

Feedback of a general nature was also received on the deployment and recovery of sampling equipment, overall design and sampling strategies. Much of this feedback is addressed in the gap analyses below. As the feedback provides background for the discussion and raises issues for consideration in the next phase of the design process. It is summarised in Appendix 2. Where stakeholders have expressed conflicting views these are identified 'side-by-side' and the issues arising addressed in Phase 2.

Categories of feedback

Target Biota

- Benthic invertebrates – especially bathyal and abyssal
- Fishes, bathyal and abyssal
- Benthic epi-fauna and endo-fauna
- Fishes throughout the EEZ
- Macro-benthos throughout the EEZ
- Large fishes
- Mobile invertebrates
- All benthic bathyal and abyssal biota

Target Space

The target space model in Figure 5 has been used.

- All
- 6500m+ where present in EEZ

Physical Sampling Methodology

- Trawls
- Double warp / Single warp
- 25m - 50m otter trawls
- A major trawl capability
- Pelagic nets
- Larger*(?)* MOCNESS-type nets
- Medium-size*(?)* mid-water trawls
- Mid-water trawls of at least 3 m mouth width
- Otter trawls of the size that commercial prawn trawlers use
- Benthic sampling equipment
- Sleds
- Benthic nets
- Beam trawls
- Medium-size*(?)* bottom trawls
- Coring equipment
- Dredging equipment
- Grabs
- Remote video and photography
- ROV to Abyssal depths

Demand for Physical Sampling

- A system of marine areas and marine parks for the Australian Marine Economic Zone does not avert the need for further research.
- Although knowledge of Australia's deep sea fishes is an order of magnitude more advanced than that of most other deep sea groups of Australian animals, it is still very sparse.
- Research into the deepest waters of its EEZ is required if Australia is to retain its entitlement to them under UNCLOS.
- A comprehensive biodiversity inventory is essential for understanding ecosystem functioning including:
    - filling faunal gaps,
    - completing fishery based surveys,
    - testing biodiversity principles,
    - ground-truthing models
- The ability to sample fauna, with a range of sampling equipment, is required for studies of the biology of a major segment of Australia's marine biota to proceed. Physical specimens remain critical for identification, molecular analyses and investigations into ecological relationships (i.e. food webs, interactions, dietary studies, etc.).

Phase 2
Assessment of Feedback

Benthic Sampling

The capabilities required to sample benthic biota are addressed first in order to isolate this issue and identify potential gaps/ overlaps.

Target Biota
- Benthic invertebrates – especially bathyal and abyssal
- Benthic bathyal and abyssal epi-fauna and endo-fauna
- Macro-benthos throughout the EEZ to abyssal depths

Target Space
- Classes V-X
- 6500m+ where present in EEZ

Physical Sampling Methodology
- Benthic sampling equipment
- Sleds
- Benthic nets
- Beam trawls
- Medium-size*(?)* bottom trawls
- Coring equipment
- Dredging equipment
- Grabs
- Remote video and photography
- ROV to Abyssal depths

The Report recommends, inter-alia, the following core capabilities for a modern research vessel scoped to operate in the oceans surrounding the Australian continent:

Wires:	Towed:	2 x 7000m useable – 0.25t payload
	Vertical:	6500m useable – 0.25t payload
	Communications:	2 x 7000m useable – 0.75t payload
A-Frame:	Side:	2t, 4.5m clearance
	Stern:	20t, 6m clearance
Towing Gallows:		1 x 50t
Side towing booms:		2 x 2.5m, 2t
CTD:		7000m
Benthic dredges, sleds & grabs:		Payloads to 0.25t
Work-class ROV:		2000m (minimum)

These capabilities will allow vertically deployed benthic sampling systems to recover up to 250kg payloads at depths of up to 6500m (Class X).

These capabilities will allow continuously towed benthic sampling systems to recover up to 250kg payloads at depths of 4000+m.

Towed camera systems have not been considered in the Class VII sample space as the author is unaware of any equipment suitable for deployment at these depths.

Conclusion

Gaps

The capabilities recommended in the Report will deliver the desired benthic sampling capability in all but one target space (Class VII), the ability to conduct continuously towed operations at depths of greater than ~4000m. For this target space the sampling methodologies not delivered by the recommended capability are:
- Demersal Beam Trawls
- Demersal Otter Trawls

Overlaps

Demersal trawling is a recognised method of sampling epi-benthic fauna. Otter trawls may be deployed from one or two wires. The ability of single wire otter trawls to deliver this capability is discussed more fully below.

Pelagic Sampling

This assessment does not consider the physical sampling of plankton and micro-nekton as the capabilities recommended deliver the ability to deploy and recover all known sampling devices for these biota across all target spaces.

Target Biota

- Fishes
- Benthic macro-epi-fauna
- Mobile invertebrates

Target Space

- Classes I-VII

Physical Sampling Methodology

- Trawls
- Double warp Single warp
- 25m - 50m otter trawls
- A major trawl capability
- Pelagic nets
- Larger*(?)* MOCNESS-type nets
- Medium-size*(?)* mid-water trawls
- Mid-water trawls of at least 3 m mouth width
- Otter trawls of the size that commercial prawn trawlers use
- Epi-Benthic sampling equipment
- Benthic nets
- Beam trawls
- Medium-size*(?)* bottom trawls
- Remote video and photography
- ROV to Abyssal depths

The Report recommends, inter-alia, the following core capabilities for a modern research vessel scoped to operate in the oceans surrounding the Australian continent:

Winches:	Traction winches + appropriate wire storage	
	Sample recovery:	1x50t max
	Storage:	$10m^3$
	Towed body:	5000m (+Communications)
	GP:	2x5t; 1x15t
	Capstan:	1 x 20t (Vertical)
Wires:	Towed:	2x7000m useable – 0.25t payload
	Communications:	2x 7000m useable – 0.75t payload
Cranes:	Utility:	1 x 5t static load
	Working:	1 x 25t static/5t live
A-Frame:	Side:	2t, 4.5m clearance
	Stern:	20t, 6m clearance
	Gallows:	1 x 50t
	Side towing booms:	2 x 2.5m, 2t
Work-class ROV		

These capabilities expressly provide for sampling devices towed by a single wire to operate in depths of up to ~4000m. At full depths the recoverable static payload is scoped at 250kg, increasing to 20t at the surface.

Two Wire vs. Single Wire

Beam Trawls

Single wire is the typical method of deployment. The capabilities recommended in the report deliver full functionality throughout the target space appropriate to beam trawling.

Otter board Trawls

Stakeholders have provided positive and negative views on the use of single wire vs. two wire deployment. An international review of fisheries research vessels indicates that many offer only one trawl wire and that this can be up to 15km in length. Initial discussion with fishing gear technologists indicates that otter board trawls can be successfully deployed throughout the sample space from a single wire. The sophistication of gear control offered by two wire deployment will not be available and the replication of trawling techniques employed by commercial trawlers may not be possible with single wire gear.

Issues

1 What maximum catch sizes are appropriate?

2 Will a reduced level of trawl control, in comparison to a modern stern trawler, have a significant impact on desired research outcomes?

Maximum Catch Size

The design of replacement capability will be significantly influenced by the desired maximum catch size:

- After deck
  The most significant parameter of after deck design that is affected by the inclusion of the capabilities to recover trawls of significant size will be the length of the after working deck. The deck length required for all but the largest gear can be delivered by the capabilities identified in the Report.
- Stern design
  The efficient recovery and handling of large catches is most efficiently achieved via a stern ramp and requires the commitment of a significant proportion of after deck space.
- Catch handling and processing
  After recovery catches must be sorted, meaningfully sub-sampled, and processed. This will require the commitment of a significant proportion of interior volume. Smaller catch sizes may be recovered in conjunction with the stern A-Frame identified in the Report and will require less committed after deck space and less dedicated interior volume to process. The capabilities identified in the Report will provide the ability to handle and process up to 5t of biological material / day without dedicated re-tasking of internal spaces. Storage for up to $30m^3$ of biological material is provided. This can be extended in $30m^3$ increments by the addition of refrigerated containers.

If effective biodiversity assessment and species identification can be achieved with smaller catch sizes it will also address the issues of:

- Gear size, storage and the concomitant degree of handling difficulty
- By-catch disposal

Conclusion

The capabilities identified in the Report will deliver pelagic and demersal beam trawl capability to ~4000m.

The capabilities identified in the report will deliver pelagic and demersal otter board trawl capability to ~4000m.
The capabilities identified in the report have the potential to recover catches of up to 20t.

Before a final view as to the need to augment the capability recommended can be developed it will be necessary to answer the following questions:

1 In order to deliver needed species identification and biodiversity assessment outcomes is it necessary for a research vessel to:
   - Provide the degree of gear control offered by modern twin wire trawl systems?
   - Replicate precisely typical commercial otter board trawl techniques?

2 What maximum catch size is appropriate in order to balance the ethical demand for non-invasive research with the confidence of researchers that the samples obtained provide a useful result?

Gaps

The capability identified in the Report will not provide two-wire trawl operation.

Phase 3
Capability Gap Summary

Epi-Benthic Sampling
Continuously towed operations at depths greater than ~4000m.

Pelagic Sampling
Two-wire trawl operation.

Phase 4
Impact of gap closure on multi-role functionality

Continuously towed operations at depths greater than ~4000m

This will require:

- Winches of greater capacity (subject to maximum catch size).
  The capital cost of winches & winch energy sources will be greater
- Larger wire storage volumes
  A larger proportion of the available internal volume will be required by the for wire storage.
- Wire handling facilities of greater sophistication
  The capital cost of equipment and the recurrent cost of equipment maintenance will be higher
- Wires of greater length
  Exceeding 7000m wire length will require specialist cable, either tapered steel wires or sophisticated synthetic cable for which the capital and recurrent cost will be greater.

In the circumstance that it is sought to extend this capability to a two-wire trawl configuration these impacts will act as an impact multiplier for each of the winch systems required for two wire operation.

Two-wire trawl operation

This will require:

- Duplication of winches.
  - The capital cost of winches & winch energy sources will be greater
  - A larger proportion of available internal volume will be required by the system.
  - Trawl control systems with a greater level of sophistication than that required for single wire operations will be required.
- Larger wire storage volumes
  - A larger proportion of the available internal volume will be required by the system.
- Stern design
  - The need for a stern ramp will be a function of catch size and trawl gear design.
  - The inclusion of a stern ramp will lead to a more complex (and thus more expensive) stern structure.
  - The inclusion of a stern ramp will consume a permanent fraction of the internal volume of the vessel.

Appendix 1

Laboratory Facilities and Equipment for biological processing and research

Activities that require facilities and equipment

- Sorting
- Identification
- Weighing
- Measuring
- Photography
- Freezing
- Preservation
- Storage of preserved material
  - Deep-freezers
  - Cool rooms
- Aquaria for the study of live animals
- Molecular biological collection and analysis.

The following core capabilities are recommended for a modern research vessel scoped to operate in the oceans surrounding the Australian continent.

Laboratories

- 310m^2
- Environment control ± 1°C
- Vapour management
- GP Wet Laboratory – dirty 40m^2
  - 9 m^2 benches
  - Access to After Deck
- GP Wet Laboratory – clean 40m^2
  - Access to GP Wet Lab - dirty
  - 10m Roller Conveyor
  - 9 m^2 benches
  - Data Acquisition system
- Preservation laboratory 11m^2
- Preserved sample storage: 3 m^3
- Fume Hood

Dark room

- 10m^2

Controlled temperature room

- 17m^2
- 20°C – -4°C

Walk in freezer/chiller

- 30m^3
- 0°C – -30°C

Blast freezer

- 1.5m^3
- 20°C -> -30°C 150kg/hr

The Report does not make recommendations on the specific outfit of or designations for individual spaces. Similarly the Report does not make recommendations on items of specific items of equipment other than those likely to significantly influence overall design.

Conclusion

The capabilities recommended will support the equipment and facilities requested by stakeholders for biological processing and research with the potential exception of aquaria for the study of live animals.

Gaps

Aquaria for the study of live animals.

The provision of tanks with free surfaces aboard ships has the potential to significantly affect the stability and safety of the ship. It is not possible, at this phase of the design process, to meaningfully consider the impact of aquaria on vessel design without substantially more data on factors such as:

- size of animals to be studied and issues associated with transfer to tankage
- size and location of aquaria
- natural vs. artificial light
- temperature control
- desired composition of linings
- degree of access
- acceptable range of accelerations for inhabitants
- demand for circulating salt water

The consideration of aquaria, their desirability and the impacts of their permanent installation is a matter for a later phase of the design process.

Appendix 2

General Feedback on design, capability and sampling strategies

Some concern is circulating about the ability of the new vessel to have "the incorporation of effective trawl capability". This concern is misplaced if by "effective trawl capability" people mean … twin heavy commercial style trawling winches.

The new ship doesn't have to look like a fishing trawler in order to do good fisheries research.

A commercial fishing vessel, or a poorly designed fishery research vessel, is not adequate for our necessary at-sea research.

Deepwater environments cannot be adequately sampled with single warp gear

… much can be learned from the configuration of winches, cables, A-frames and laboratories from RV Polarstern (admittedly larger) vessel.

… the capacity to trawl at "research scale" is desirable, but that capacity to trawl at "commercial scale" from a research platform is out of step with the forward strategy of research organizations that ought to have a commitment to sustainability.

[The vessel should have]:

- Traction winches
- Side A-frame
- A stern ramp for net recovery
- Removable ramp covers
- 11-12 km of steel cable
- ~8km coaxial cable.
- Adaptability.

[The vessel should not have]:

- Twin winches
- the capability to handle large commercial-size trawls

[The most appropriate sampling capability is]:

- Several smaller ... trawl samples
- The capability to land anything from small commercial-sized catches to sub-samples of the biota.

Attachment 3 Terms of Reference

Working Group to advise on
Australia's Blue-water Research Vessel Capability needs

Background

Australia has operated a Marine National Facility (MNF) since 1984, when ORV *Franklin* was commissioned. The MNF is overseen by a Steering Committee appointed by the Minister for Education Science & Training, and is currently managed by CSIRO on behalf of the nation.

In 2003, *Franklin* was retired from service, and the larger, more capable RV *Southern Surveyor* commenced operation as the MNF. *Southern Surveyor* will reach the end of its useful life some time in the next 5 years, and the Steering Committee is seeking advice from the Australian marine science community on future needs for "blue-water" research vessel capability.

Context

Australia has a vast ocean territory, though it is relatively poorly understood. Maintaining and enhancing blue-water marine research capability is a key element in providing the scientific basis to underpin the Commonwealth Government's objectives in sustainable management of this ocean territory. These objectives are expressed via Australia's Oceans Policy, legislation such as the Environment Protection & Biodiversity Conservation Act, and various international treaties and conventions.

As such, the MNF addresses a number of National Research Priorities, including:
- An Environmentally Sustainable Australia,
- Frontier Technologies for Building & Transforming Australian Industries, and
- Safeguarding Australia.

It is also important to note that the National Collaborative Research Infrastructure Strategy (NCRIS) specifically mentions blue-water research vessel capability as "landmark infrastructure" – see http://www.dest.gov.au/NR/rdonlyres/8CA3BC8F-A6A7-417A-955F-2B605DFF8276/9520/NCRISStrategicRoadmap.rtf

Scope

Australia's ocean territory runs from the high tropics to the Antarctic, and from the coast to the abyss. No single piece of research infrastructure could possibly cover all of this territory and the different kinds of science needed across this territory. The scope of the capability being defined here must be complementary to:
- the Southern Ocean- and ice-capable research vessel capability utilised by the Australian Antarctic Division (currently RSV *Aurora Australis*), and
- the coastal research vessel capability maintained by the Australian Institute of Marine Science (currently RV's *Cape Ferguson* and *Lady Basten*), and by various State Governments and Universities.

Terms of Reference

The MNF Steering Committee wishes to form a working group to canvass opinion from the Australian marine science community, and provide advice on future needs for blue-water research vessel capability. This advice will be in the form of a written report.

The advice provided must consider:

- capability of the current vessel of the MNF, RV *Southern Surveyor* (see http://www.marine.csiro.au/nationalfacility/), and of the other vessels in the national "fleet";
- Scheduling and operating modes – current and future
- current limitations in terms of accommodation for scientific/technical staff;
- endurance (i.e. days at seas);
- electronic sampling systems, including data acquisition and processing;
- mechanical sampling systems;
- laboratory requirements;
- Other capability – Space-based observing systems, aircraft, deep submergence facilities, AUV's, drifters & floats
- international trends in comparable types of capability; and
- a time horizon of approximately 10 years.

Membership

The working group will be chaired by the Director of the MNF, Captain Fred Stein, and will include:

- the Chair of the MNF Scientific Advisory Committee,
- a representative from the Australian Antarctic Division, and
- a representative from the Australian shipping industry.

The working group will receive executive support from the CSIRO Ship Management Group.

Process

The working group will seek written input from:

- Commonwealth Government agencies with a stake in the operation of the MNF,
- State Governments,
- Universities with active marine science programs,
- Recent users of the MNF, and
- The Australian Marine Science Association

Timing

The working group will report to the MNF Steering Committee at its meeting (#59) on 25th August, 2006.

Research Vessel Capability Assessment Project

Request for Comments

Assessing Australia's Needs

Context

Australia has a vast ocean territory, though it is relatively poorly understood. Maintaining and enhancing the nation's blue-water marine research capability is a key element in providing the scientific basis to underpin the Commonwealth Government's objectives in sustainable management of Australia's ocean territory. These objectives are expressed via Australia's Oceans Policy, legislation such as the Environment Protection & Biodiversity Conservation Act, and various international treaties and conventions.

In this context the MNF addresses a number of National Research Priorities, including:

- An Environmentally Sustainable Australia,
- Frontier Technologies for Building & Transforming Australian Industries, and
- Safeguarding Australia.

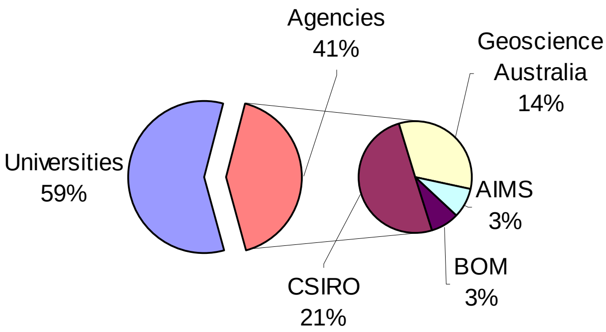
Background

Australia has operated a Marine National Facility (MNF) since 1984, when ORV *Franklin* was commissioned. The MNF is managed by CSIRO on behalf of the nation and administered by a Steering Committee appointed by the Minister for Education Science & Training.

The MNF provides grants of research vessel time to Australian scientists and their international collaborators on the basis of a competitive process that considers, inter alia, the excellence of the science proposed and its benefit to the nation.
The need for this was recently confirmed in the National Collaborative Research Infrastructure Strategy (NCRIS) Strategic Roadmap that, while clearly identifying the acquisition of replacement capability as "Landmark" Infrastructure and outside the scope of NCRIS; *"To implement the proposed marine observing system … Australia would need to have at least one operating blue water research vessel in commission."* See: NCRIS Strategic Roadmap

In 2003, *Franklin* was retired from service and the larger, more capable, RV *Southern Surveyor* commenced operation as the MNF. Since the commissioning of *Southern Surveyor* the MNF has provided grants of approximately 566 days of research time to Australia's marine science community. These voyages have been led by Chief Scientists from universities and science agencies.

MNF Research Voyages by affiliation of Chief Scientist 2002-2006

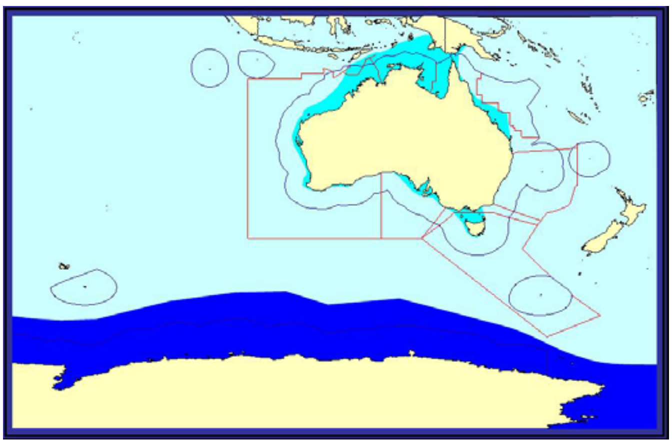


Southern Surveyor will reach the end of its useful life some time in the next 5 years, and the Steering Committee is seeking advice from the Australian marine science community on future needs for "blue-water" research vessel capability.

Scope

Australia's ocean territory runs from the high tropics to the Antarctic, and from the coast to the abyss. No single piece of research infrastructure could possibly cover all of this territory and the different kinds of science needed across this territory. The scope of the capability being defined here must be complementary to:

- Polar Class, Southern Ocean and ice-capable research vessel capability utilised by the Australian Antarctic Division (currently RSV *Aurora Australis*), and
- Coastal Class research vessel capability maintained by the Australian Institute of Marine Science (currently RV's *Cape Ferguson* and *Lady Basten*), and by various State Governments and Universities.



Optimum Areas of Operation

Coastal Class
Blue-Water
Polar Class

EZ Boundary

Contiguous Zone Boundary

Request for Comment **Attachment 4**

The MNF Steering Committee has formed a working group to canvass opinion from the Australian marine science community, and provide advice on future needs for blue-water research vessel capability.

Membership

Captain Fred Stein, Director MNF; Chair
Dr Ralph Jensen, (past) Chair, MNF Scientific Advisory Committee
Mr. John Reeve, Australian Antarctic Division
Captain Steve Hunt, Australian Shipping Industry

Process

The working group seeks input from:

- Commonwealth Government agencies,
- State Governments,
- Universities,
- Recent users of the MNF, and
- The Australian Marine Science Association

Methodology

Attached is a survey that compares the capabilities of RV *Southern Surveyor* with the capabilities that replacement capacity may require to cost-effectively support the research activities of the Australian Marine Science and Technology Community for the ten years from 2010 to 2020.

The capabilities suggested are not prescriptive. They have arisen from feedback provided by MNF users, discussion with international builders and operators of research vessels and a review of the international research vessel fleet. You are asked to comment on, and where appropriate amend the suggested capabilities. It will also be of great assistance to the working group if you will identify the significance of each capability to your discipline(s). This enquiry seeks to identify capabilities required, not mode of supply. It may not be decided to deliver individual capabilities within a single platform, some may not be amenable to co-location.

Specific sensors and instruments are not within the scope of this capability assessment unless their fitment to a research platform is likely to have an impact on the research platform's intrinsic design or operation.

Timing

You are requested to submit your response by C.O.B. 4th August 2006 to Fred.Stein@csiro.au.
The working group will report to the MNF Steering Committee at its meeting (#59) on 25th August, 2006.
The report will be published on the MNF website at:
www.marine.csiro.au/nationalfacility

Attachment 4 Request for Comment

Responding to the Survey

Table 1 – Capability Comparison and Significance

In Table 1 the capabilities of the existing Marine National Facility for research, RV *Southern Surveyor* are compared with proposed future capability. Respondents to this survey are asked to assess the significance of the capabilities identified to their research discipline(s).

Please indicate, in the column provided in Table 1(Discipline and Significance), the discipline(s) for which you are providing the assessment and its significance for that discipline. Please indicate your assessment of each capability's significance by providing a ranking on the five point scale below. Where you disagree with, or wish to amend the capability proposed, please do so and indicate your amendment by highlighting the amended text in this fashion.

Please state the benefits of your proposed amendment in Table 2 – Reasons for Change. If you wish to suggest additional change / capabilities to systems not identified in Table 1 please do so at the end of Table 1 in section 7.0 and state the benefits in Table 2 in section 7.0. An example of discipline, significance and potential benefits arising is provided at item 1.1.

Significance Scale

5 Essential
Without this the ship is fundamentally incapable of contributing usefully to future science projects in major areas of the indicated discipline.

4 Major Requirement
Having this feature would greatly enhance the capability of the vessel to support the discipline and allow the science community to carry out very substantially higher quality research than would otherwise be the case.

3 Very Desirable
Having this feature would add important ancillary components to our science, and/or make scientific operations substantially easier/more reliable/higher quality/safer/more productive.

2 Desirable
Having this feature would add to our science, and/or make scientific operations easier/more reliable/higher quality/safer/more productive.

1 Un-Desirable
Having this feature would be an impediment to our science, and/or make the scientific operations contemplated more difficult/less reliable/of lower quality/ more dangerous/less productive.

No Significance
If you assess a capability as having no impact on, or significance for, your discipline please make no comment.

Table 2 – Reasons for Change

Comment identifying the benefits of suggested change has been made in Table 2 where the capability proposed for future capacity differs from that provided by RV *Southern Surveyor*.

In Table 2 respondents are asked to:

- make further comment if they wish to either support or dispute the benefits suggested.
- identify the benefits of amendments they propose in Table 1 to future capability

In order to facilitate the assessment of this survey respondents are asked not to delete existing text but to add their comment to the appropriate box.

Respondents are asked to draw attention to their comments by highlighting inserted text in this fashion.

Submitting your Response

Electronic submission is requested.
Please email your response as an MS Word attachment to Fred.Stein@csiro.au by C.O.B. 4th August 2006 with the subject line; *Research Vessel Assessment Survey*.

Paper submissions may be mailed to:

Research Vessel Assessment Survey
GPO Box 1538
Hobart 7001

It is recommended that when submitting your response you first delete these introductory pages. These form sections 1 to 3 of this document.

Obtaining a Copy of the Report

If you would like to receive a copy of the Working Group's report please include the words; *Please Notify Me*, in the body of the submitting email. You will be sent an email notifying you when the report is placed on the Marine National Facility website (www.marine.csiro.au/nationalfacility) and the address from which you may download it.

Table 1 – Capability Comparison and Significance

Capability	*Southern Surveyor*	*Replacement Capacity*	*Discipline & Significance*	*Reason for Change*
Particulars of Vessel				**1.0**
General			Southern Ocean Studies - 1	1.1
Classification	+100A1+LMC UMS	+100A1+LMC UMS Ice 1C		
Principal Dimensions				1.2
Length Overall (LOA)	66.1m	65~80m		1.2.1
Beam	12.3m	13~16m		1.2.2
Draught	5.3m	4~5.5m		1.2.3
Tonnages				1.3
Gross	1594(m^3)	1600-3100(m^3)		1.3.1
Range				1.4
Steaming at service speed	6,500nm	10,000nm		1.4.1
Endurance	22.5d	40d		1.4.2
Other Particulars				1.5
Service Speed	12 knots	12 knots		1.5.1
Scientists	15	30 (single cabins)		1.5.2
Dynamic Positioning	DP II	DP I		1.5.3
TEU	2	6		1.5.4
Equipment Storage	300m^3	400m^3		1.5.5
Working Deck Space	80m^2	100m^2		1.5.6
Internal HVAC	22ºC+/- 2ºC	22ºC+/- 2ºC		1.5.7
ICES Compliant	No	Yes		1.5.8

Table 1 – Capability Comparison and Significance

Capability	Southern Surveyor				Replacement Capacity				Discipline & Significance	Reason for Change
Deck Machinery										**2.0**
Winches	No	Usable Wire(m)	Haul @ W/L	Out/In Rates (m/min)	No	Usable Wire(m)	Haul @ W/L	Out/In Rates (m/min)		2.1
Trawl/Dredging Winches	2	4000	30t	0-100	2	6500	30t	0-100		2.1.1
Payload @ Max Depth	0.25t (Tension Control)				0.25t (Tension Control)					
Net (storage) Winch	1	$9.5m^3$	15t	0-100	1	$10m^3$	15t	0-100		2.1.2
Coring Winch	1	6500	15t	0-100	1	6500	18t	0-100		2.1.3
Payload @ Max Depth	4.5t				5t (Tension Control)					
Towed Body Winch (comms)	1	3000	5t	0-100	1	5000	5t	0-100		2.1.4
Payload @ Max Depth	1t				1t (Heave Compensation)					
CTD/Hydro Winch (comms)	2	6500	1.5t	0-100	2	10000	2t	0-100		2.1.5
Payload @ Max Depth	0.5t				0.75t (Heave Compensation)					
Gilson (GP) Winches	2	60	5	0-20	2	60	5	0-20		2.1.6
	1	60	15	0-20	1	60	15	0-20		
Cranes										2.2
Fore Crane	1	3t @ 1.5m – 0.75t @ 8m			1	5t @ all reaches				2.2.1
After Crane	1	7t up to 12m			1	15t @ 15m – Heave compensation				2.2.2

Table 1 – Capability Comparison and Significance

Capability	*Southern Surveyor*	*Replacement Capacity*	*Discipline & Significance*	*Reason for Change*
Other Facilities				**5.0**
Moonpool sensor trolley	Midships Stbd 1.5m x 1m Sensors 0.3m clear of hull Underway sensor changes OK	1.5m x 1.5m Sensors 0.5m clear of hull Underway sensor changes OK		5.1
Sensor pole	Midships Stbd 0.25m dia. Sensors 2m clear of hull Dive team req. for sensor changes	Drop Keels(2) $20m^2$ Sensors to 4m clear of hull Underway sensor changes OK		5.2
Diving	HP Compressor @ 5cfm	Hospital fitted to accommodate DMT on an as needed basis.		5.3
ROV / AUV Launch & support	Nil	Vehicles to 1.5t		5.4
Sensors				**6.0**
Acoustic Sensors				6.1
Biological research	Simrad EK500 (12, 38 and 120 kHz) Kongsberg EM300 Raw Data Logger	Equivalent Equivalent		6.1.1
Bathymetry 0-4000m 4000m – 10000m+	Kongsberg EM300 (130kHz) Simrad EA500 (12kHz)	1ºx1º 10m-4000m Full Ocean Depth swath mapper		6.1.2

Table 1 – Capability Comparison and Significance

Capability	*Southern Surveyor*	*Replacement Capacity*	*Discipline & Significance*	*Reason for Change*
Current Profiling	Ocean Surveyor nbADCP (Hull Fit) Lowered ADCP on CTD Package	Equivalent Equivalent		6.1.3
Subsurface Instrument positioning	Acoustic Pinger	USBL Acoustic Positioning system to 7000m		6.1.4
	Acoustic Receive Transducer (low power, wide beam) 12kHz	Equivalent		6.1.5
Sub-bottom composition (to Full Ocean Depth)	Kongsberg PS018 SBP	Equivalent		6.1.6
Conductivity, Temperature and Depth (CTD) sensors				6.2
Niskin Bottles	24 Bottle Rosette to 10l 12 Bottle Rosette @ 2.5l or 10l	Equivalent		6.2.1
Rosette Sensors	Conductivity Temperature Pressure PAR Dissolved O_2 Fluorescence Transmissometer Altimeter	Equivalent		6.2.2

Table 1 – Capability Comparison and Significance

Capability	*Southern Surveyor*				*Replacement Capacity*				*Discipline & Signifi-cance*	*Reason for Change*
A Frames	Ht	In (m)	Out (m)	SWL	Ht	In (m)	Out (m)	SWL		2.3
Oceanographic	4.5	1	2.5	0.8t	4.5	2.5	2.5	2t		2.3.1
Aft Deck	6	5.5	4.5	15t	6	5.5	4.5	20t		2.3.2
Trawling /Dredging Gallows	N/A			30t	N/A			30t		2.3.3
Side Towing Booms	Nil				Up to 2.4m extension beyond each side.					2.3.4
Services										**3.0**
Underway Analysis Sea Water (Debubbled)	20l/m @ 100kPa				40l/m @ 100kPa					3.1
Lab Analysis Sea Water	40l/m @ 400kPa				40l/m @ 400kPa					3.2
Raw (Deck) Sea Water	100l/m @ 600kPa				200l/m @ 600kPa					3.3
Fresh Water	40l/m @ 400kPa				40l/m @ 400kPa					3.4
Laboratory (Distilled) Fresh Water	100l/d @ 100kPa				200l/d @ 100kPa					3.5
3ph Power (50Hz)	3x415v@32A,				15x415v@32A, 2x415v@64A					3.6
UPS (Smoothed/Freq Con-trolled)	45 kVA @ 240V / 415V (50Hz)				120 kVA @ 240V / 415V (50Hz)*2					3.7
Air	No				2 x Compressors of 400ACFM @ 3000psi					3.8

Table 1 – Capability Comparison and Significance

Capability	*Southern Surveyor*	*Replacement Capacity*	*Discipline & Significance*	*Reason for Change*
Air	No	2 x Compressors of 400ACFM @ 3000psi		3.8
Network	10/100	1GB		3.9
Internal Communications	Ph + PA + UHF	Ph + PA + UHF		3.10
External Communications	B,C,miniM,RT,MSat,GSM,CDMA	Circuit Sw on Req.+ 512k		3.11
Navigation Data (Serial & Network interface)	DGPS position heading, pitch, roll, heave, velocity	Position to <1m heading, pitch, roll, heave, velocity		3.12
Laboratories & Workshops				**4.0**
Operations Room	Central Video Primary Systems Interfaces Voyage Tracking & Management $40m^2$	Central Video Primary Systems Interfaces Voyage Tracking & Management $60m^2$		4.1
Data Processing Room	Data Acquisition & Management Removable Media General computing PC Unix $17.5m^2$	Data Acquisition & Management Removable Media General computing PC Unix $20m^2$		4.2
Deck Electronics Workshop	$2m^2$	$15m^2$		4.3

Table 1 – Capability Comparison and Significance

Capability	Southern Surveyor	Replacement Capacity	Discipline & Significance	Reason for Change
Clean Electronics Workshop	14.4m^2	15m^2		4.4
Mechanical Workshop	15m^2(shared with ship staff)	20m^2(shared with ship staff)		4.5
GP laboratory(dry)	2 Fume hoods Fridge, freezer Liquid Scintillation Counter 25m^2	1 Fume hood Fridge, freezer 25m^2		4.6
Hydrochemistry laboratory	Water Underway Analysis Sea Water (Debubbled) Lab Analysis Sea Water Fresh Water Laboratory (Distilled) Fresh Water Autoanalyser AutoSalinometer 17m^2	Water Underway Analysis Sea Water (Debubbled) Lab Analysis Sea Water Fresh Water Laboratory (Distilled) Fresh Water Autoanalyser AutoSalinometer Dissolved O_2 1 Fume hood 20m^2		4.7
Dark room Annex	9.5m^2	10m^2 Annex to Chem Lab – re-configurable as lab extension when not in use as darkroom.		4.8
CTD room (Wet laboratory)	Seabird SBE911 24 bottle rosette 18m^2	Seabird SBE911 24 bottle rosette 20m		4.9

Table 1 – Capability Comparison and Significance

Capability	*Southern Surveyor*	*Replacement Capacity*	*Discipline & Significance*	*Reason for Change*
GP Wet Laboratory - clean (Fish Lab / Geoscience Lab)	10m Roller Conveyor 9 m^2 benches Data Acquisition system $42m^2$	10m Roller Conveyor 9 m^2 benches Data Acquisition system $40m^2$		4.10
GP Wet Laboratory - dirty (Fish sorting room)	$13m^2$	9 m^2 benches $40m^2$		4.11
Preservation laboratory	Sample Storage: 3 m^3 Fume Hood $11m^2$	Sample Storage: 3 m^3 Fume Hood $11m^2$		4.12
Controlled temperature room	20ºC – -4ºC $16.5m^2$	20ºC – -4ºC $17m^2$		4.13
Walk in freezer/chiller	0ºC – -30ºC $25m^3$ (Not all usable volume)	0ºC – -30ºC $30m^3$ (Useable volume)		4.14
Blast freezer	20ºC -> -30ºC 150kg/hr $1.5m^3$	20ºC -> -30ºC 150kg/hr $1.5m^3$		4.15
Science Office	Nil	$15m^2$ (Dedicated Space)		4.16
Conference Space	$15m^2$ (Shared recreation space)	$20m^2$ (Multi-purpose Space)		4.17

Table 1 – Capability Comparison and Significance

Capability	*Southern Surveyor*	*Replacement Capacity*	*Discipline & Significance*	*Reason for Change*
Miscellaneous Sensors				6.3
Insolation	Radiation Sensors	Equivalent		6.3.1
Wind Speed and Direction	Automatic Weather Station	Equivalent		6.3.2
Sea Surface Temperature	Automatic Weather Station	Equivalent		6.3.4
Air Temperature / Humidity	Automatic Weather Station	Equivalent		6.3.5
Rainfall	Automatic Weather Station	Equivalent		6.3.6
Expendable Bathythermograph	XBT Launcher + data capture	Equivalent		6.3.7
Fluorometer	Underway measurement system	'FerryBox' or equivalent		6.3.8
Winch Monitoring	Tension Winch speed Wire Out	Equivalent		6.3.9
Capabilities not Otherwise Identified				**7.0**

Table 2 – Reasons for Change

Item	*Reason for Change*
1.0	
1.1	Ice Class C will enable replacement capacity to work in first year ice at the ice edge. This will provide the capability to conduct work in all of Australia's oceans without the need for seakeeping and acoustic compromises to hull form that arise from higher levels of Ice Class. This will optimise weather working and geographical ranges on a platform that is acoustically quiet.
1.2	Subject to specific design the range of capabilities identified in Table 1 can be accomodated in a vessel lying within these size ranges. Modern designs tend to have a higher beam/length ratio as, generally, length is the most expensive dimension. While minimizing draft can be attractive for shallow water work that is not identified as a driver for the majority of anticipated tasking. In general larger vessels will be more sea-kindly than smaller vessels increasing working windows and making more efficient use of research deployments. This can be offset by roll stabilization systems.
1.2.1	
1.2.2	
1.2.3	
1.3	See comments at 1.2. Modern designs tend to be of high cubic capacity for given dimensions due to the ability of advanced mathematical models to optimize hull form.
1.3.1	
1.4	The suggested ranges will deliver 'Ocean' class performance, providing the ability to reach, and remain on station for extended periods in all of Australia's seas and surrounding oceans. Judicious fuel planning would deliver global reach.
1.4.1	
1.4.2	
1.5	
1.5.1	
1.5.2	An increase in science team numbers is the single most consistant request arising from the marine science community. This will deliver scope for large multi-disciplinary teams, places for students and the ability to invite extensive participation from international collaborators. It will also provide, with reduced science teams, the potential for longer times on station.
1.5.3	

Table 2 – Reasons for Change

Item	***Reason for Change***
1.5.4	
1.5.5	
1.5.6	
1.5.7	
1.5.8	The ICES acoustic standard is the internationally accepted standard for radiated acoustic noise from research vessels. It will minimize, to the extent possible, acoustic impacts on fish behavior and provide maximum signal-to-noise ratios for acoustic sensors.
2.0	
2.1	All winches to have fine control in heave & render across full speed range & brakes capable of resisting heave and render loads at least the equivalent of winch heave capability. This will enable fine positioning of instrument packages & sampling devices in conjunction with either direction of drum rotation (for drum winches).
2.1.1	
2.1.2	
2.1.3	
2.1.4	Communication via fibre optic cable enables higher data rates. Heave compensation facilitates fine control of instrument positioning & reduce snatch loads on equipment. This will also broaden weather working window subject to capability of heave compensation.
2.1.5	Heave compensation facilitates fine control of instrument positioning & reduce snatch loads on equipment. This will also broaden weather working window subject to capability of heave compensation.
2.1.6	
2.2	
2.2.1	Subject to location & tasking – cranes capable of full loads at all reaches preferred for ease of use & operational safety.
2.2.2	Radius subject to position & tasking. Must be able to service full scope of working deck & container stowage areas. Heave compensation fitted to support ROV/AUV launch/recovery.
2.3	
2.3.1	
2.3.2	

Table 2 – Reasons for Change

Item	***Reason for Change***
2.3.3	
2.3.4	The fitting of (removable) side towing booms will enable seismic arrays, biological sampling systems and other sensors to be towed clear of the vessel's wake.
3.0	Analysis Seawater, Fresh water and Lab(distilled) fresh water available in all labs other than electronic / IT
3.1	Increased capacity to meet anticipated future demand
3.2	
3.3	Increased capacity to meet anticipated future demand
3.4	
3.5	Increased capacity to meet anticipated future demand
3.6	32A @ 415V supply to all container positions + Science Workshops & working Decks. 2 x 64A @ 415V to working decks.
3.7	All laboratory & IT harness 240V power to be supplied via UPS with cascading preferential trip to secure data & protect equipment. AC to be pure sine wave & frequency stabilized in accordance with Australian Standard for domestic supply. Provision for 2x 32A supplies to be fed similarly.
3.8	This capability intended to provide 100% redundancy of supply to 2 airguns @ 10s firing rate. Capability intended to support supply of air only with users providing gun array and acquisition system.
3.9	Network backbone to provide 1GB bandwidth in accordance with present commercial standards.
3.10	
3.11	Feedback received to date indicates that the majority of users seek the ability to place circuit switched calls on request and that mode of provision not critical. In anticipation of likely future demand the ability to provide a 512k packet switched connection on demand is specified.
3.12	
4.0	
4.1	50% increase in useable deck area in response to increased numbers of researchers aboard and received feedback identifying the need for a increase in user configurable space in an Operations Room.
4.2	This is envisaged as a dedicated DP facility adjacent to the Operations Room. Provided with workstations/printers/ scanners & available to support full range of scientific and academic IT activity. Management of ship-based IT harness conducted from separately located IT management facility adjacent to central vessel CPU & network switch room.

Table 2 – Reasons for Change

Item	***Reason for Change***
4.3	Adjacent to main working deck with provision for heavy equipment access & servicing / configuration.
4.4	Dry electronics maintenance & servicing workshop.
4.5	Adjacent to main working deck with provision for heavy equipment access & servicing.
4.6	User configurable, plumbed laboratory space. No radiation work. All radiation work to be conducted from purpose-built container laboratory with appropriate ARPANZA approvals & carried as required. Plumbed for all 'waters'.
4.7	Present lab not fitted with fume hood in response to available space. This places restrictions on activities.
4.8	Envisaged as configurable annex to Chem lab in future capability.
4.9	
4.10	The 'Fish Lab / Fish sorting room' complex aboard *Southern Surveyor* is increasingly being used as a general purpose 'wet' laboratory space and configured as required. An increase in the total space from $55m^2$ to $80m^2$ in recognition of the greater number of scientists aboard potential replacement capability is proposed in conjunction with a configuration that supports a two stage sample handling regime. The 'interior' GP Wet Lab to be configured for 'clean' activities such as sediment sorting, core assessment or fish & biota, assessment, measurement and taxonomy.
4.11	See 4.10 above. The 'exterior' GP Wet lab to be provided with direct access to the working deck and appropriate materials handling access both from the working deck and to the 'interior' GP Wet Lab. This space configured for 'dirty'/noisy activities and sample pre-processing such as primary catch / sample sorting & cleaning, core sectioning etc.
4.12	Annex to clean GP Wet Lab. Suitable for storage of formalin preserved samples.
4.13	Fitted with removable storage for suitable samples such as seabed cores and appropriate materials handling facilities.
4.14	Freezer volume optimized for maximum usability.
4.15	
4.16	Dedicated space provided to Chief Scientist and Principal Investigators for management of the science team.
4.17	Configured as theaterette / Lecture Room with seating for total compliment of facility. This will enable all-staff briefings/ debriefings, science presentations, provide a recreation venue on longer voyages and enable effective video-conferencing.
5.0	
5.1	Some moonpool functionality can be provided by drop-keel arrangements(5.2). It will be of assistance if respondents will identify where one or the other arrangement is most suitable for their work

Table 2 – Reasons for Change

Item	***Reason for Change***
5.2	The use of drop keels to mount those sensors that benefit from being outside the turbulent layer is now an industry standard. It enables sensors to be changed/serviced underway, reduces the need for divers and costly dockings and minimizes the need for potentially vulnerable protuberances from the hull in shallow and ice conditions. See also 5.1.
5.3	Hospital with capability to accept Diver Medical Technician and associated equipment if required by voyage. If diving to be conducted during a voyage it is envisaged that diving equipment & support facilities would be provided as containerized packages by the user.
5.4	Sub-surface vehicle launching and recovery capability provided my working deck crane/A-Frame. Vehicle umbilical & cable handling facilities to be provided as containerized packages by user.
6.0	
6.1	
6.1.1	
6.1.2	Vessel niche perceived to be Shelf/Slope and deep ocean. Existing SWATH capabilities extend to 4500m max with limited efficiency. Proposed to extend this capability by augmenting with a SWATH system optimized for operation in the 200m to 10000m range.
6.1.3	
6.1.4	Increasingly science is demanding the accurate subsurface positioning of instrument packages, sensors and sampling tools. The present capability does not have the ability to measure subsurface position. Position is estimated from wire tension, length and subsurface currents. This is perceived as one of the most pressing enhancements of the existing capability.
6.1.5	
6.1.6	
6.2	
6.2.1	
6.2.2	
6.3	
6.3.1	
6.3.2	

Table 2 – Reasons for Change

Item	***Reason for Change***
6.3.4	
6.3.5	
6.3.6	
6.3.7	
6.3.8	Underway measurement of fluorescence and other parameters such as dissolved O_2 / CO_2 and their utility is presently the subject of debate amongst the scientific community. It is recommended that adoption of a de-facto standard system such as 'Ferrybox' will provide an appropriate interim solution that will support investigation of this issue.
6.3.9	
7.0	
7.1	

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Ocean Regions

◆	Neritic or Sub-Littoral:	0m - 200m water depth
◆	Bathyal:	200m - 4000m water depth
◆	Abyssal:	4000m – 6500m water depth

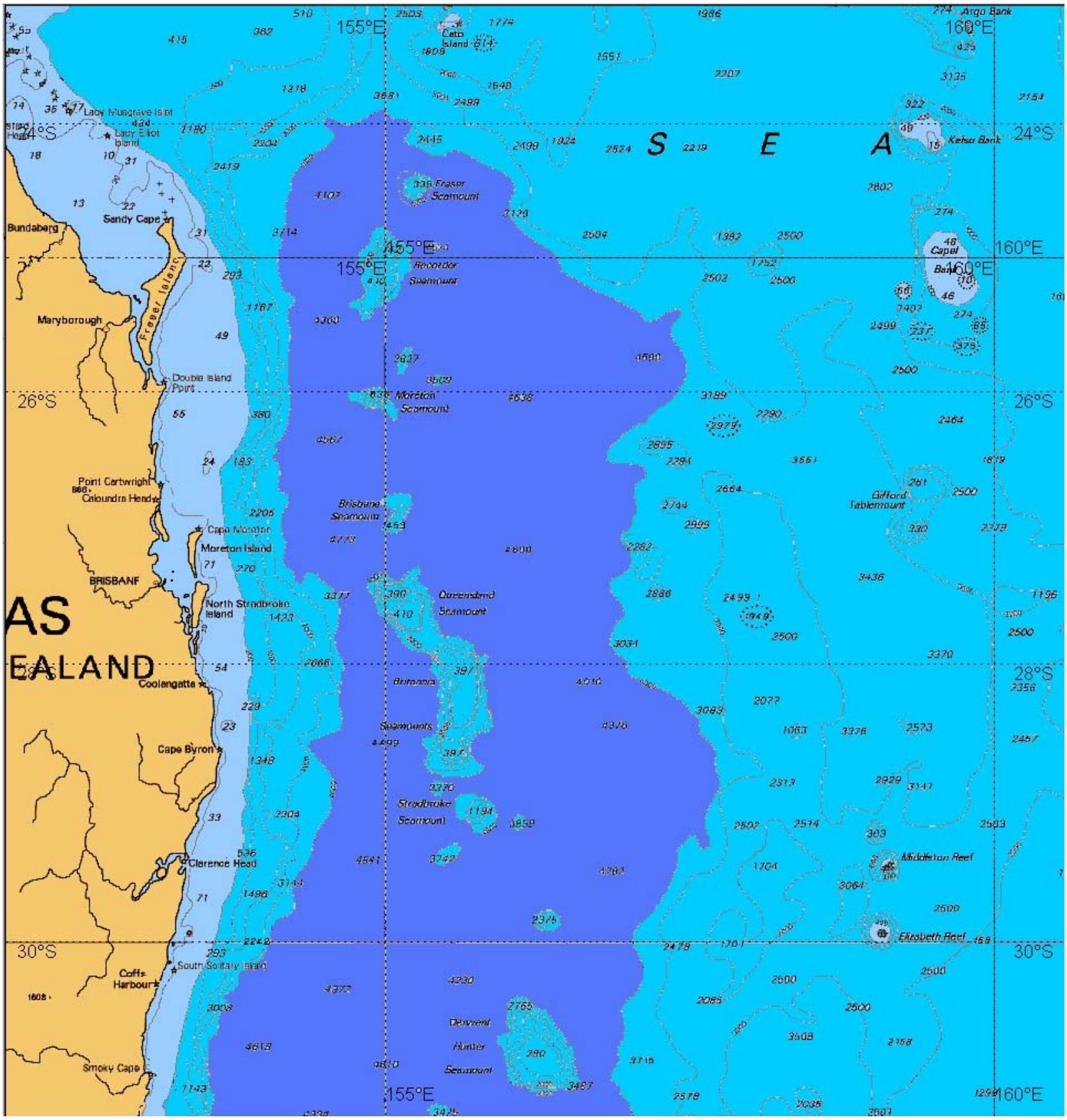

Figure 6 - Neritic, Bathyal and Abyssal ocean regions off the Australian Central East Coast

Glossary

Attachment 6

Pelagic

Synonymous with 'Oceanic' in the context of this report. Occurring in or frequenting the ocean and especially the open sea as distinguished from littoral or neritic waters.

Midwater

The water that is well below the surface (>50m) but also well above the bottom (>50m).

Benthic

Synonymous with 'Demersal'. Of or relating to or near the bed of a sea or ocean. NB:'Benthic' used typically in relation to biota and sediments. 'Demersal' used typically in relation to trawl nets.

Abbreviations

ADCP	Acoustic Doppler Current Profiler
AMJ	Australian Maritime Jurisdiction
AUV	Autonomous Underwater Vehicle
CTD	Conductivity / Temperature / Depth measuring instrument
EEZ	Exclusive Economic Zone
ICES	International Council for Exploration of the Sea
GP	General Purpose
ISO	International Standards Organisation
MNF	Marine National Facility
MOCNESS	Multiple Opening and Closing Net System
RFC	Request for Comments
ROV	Remotely Operated Vehicle
SAC	(MNF) Scientific Advisory Committee
SC	(MNF) Steering Committee
SPS	Special Purpose Ship
TEU	Twenty Foot Equivalent Unit = 1 ISO standard shipping container
UHF	Ultra High Frequency
UMS	Unmanned Machinery Space
UNCLOS	United Nations Convention on the Law of the Sea
USBL	Ultra Short Base Line Acoustic Positioning System
UUV	Unmanned Underwater Vehicle
XBT	Expendable bathythermograph