RD&E capability audit and assessment for the Australian Fishing and Aquaculture Industry 2013

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In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

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1 Executive Summary

This report provides an analysis of the research, development and extension (RD&E) effort supporting Australia's fishing and aquaculture industries in 2013.

The first RD&E capability audit and assessment for the Australian Fishing and Aquaculture Industry was conducted in 2009 by RDS Partners (then Rural Development Services). The final report for that project supported the development of the publication "Working Together: The National Fishing and Aquaculture RD&E Strategy" (the Strategy).

The Strategy establishes both a regional approach and a national approach based on areas of expertise or functional activity, in order to achieve efficiencies and progress the implementation of the Major-Support-Link approach outlined in the National Primary Industries Research, Development and Extension (RD&E) Framework (the Framework). The Framework is designed to encourage greater collaboration and promote continuous improvement in the investment of RD&E resources nationally.

Since the release of the Strategy, the FRDC and the Strategy Governance Committee considered that significant changes have occurred in national RD&E capability, especially within State Government agencies. The FRDC therefore commissioned RDS Partners to repeat the RD&E capability audit in 2013, to provide Australia's agencies investing in RD&E an understanding of current RD&E capability and capacity and future demand.

As in the 2009 RD&E capability audit, data were collected through voluntary return, and one-to-one follow-up, of a spreadsheet-based survey tool designed to elicit information regarding:

- full time equivalent (FTE) capability across 45 areas of expertise at the research scientist, specialist technician and extension professional level
- value and location of infrastructure and major capital items
- investment against the areas of Legislative[1] Requirements; Fisheries; Aquaculture; and Associated Environment and Ecosystems for the past 4 financial years.

Of the 108 organisations or individuals invited to participate in the 2013 capability audit, 56 provided a response and 51 of these provided capability information.

Thirty two organisations responded to both the 2009 and the 2013 capability audits. To allow better comparisons between the 2009 and 2013 audits, the main focus of this report is on data provided by these organisations.

[1] Investment in Legislative Requirements relates to those areas of fisheries management that are mandatory activities of State and Commonwealth fisheries organisations.

1.1 Capability

A brief summary of all FTE capability data provided for this audit is presented in Appendix 1 of this report.

The 32 organisations that provided data to both the 2009 and the 2013 capability audits reported a total of 567 FTE researchers in 2013 (excluding associated Environment and Ecosystems fields of research)[2]. This represents a small increase of 7 FTE since 2009.

Total FTEs in the Environment and Ecosystems fields of research decreased by 38 FTEs between the two audits – from 263 in 2009 to 225 in 2013. When the Environment and Ecosystems fields of research are included, the data shows an overall decrease of 31 FTE researchers since 2009, from 822 in 2009 to 792 in 2013. This overall decrease may explain, in part, the prior expectation that capability had decreased.

There was a relatively large increase in FTEs for both the Fisheries & Aquaculture (+21 FTEs) and the Post-harvest (+12 FTEs) Capability Areas.

There was a large decrease in the number of FTEs in both the Communication/Extension Professionals Capability Area (-27 FTEs) and the Environment and Ecosystems Capability Area (-38 FTEs).

The proportion of overall FTE capability at the sector level was reported as: 33% Aquaculture - Commercial; 60% Fisheries - Commercial Wild-catch; 6% Fisheries - Recreational; and 1% Fisheries - Indigenous Customary.

This shows an overall increase since 2009 in the proportion of FTE capability in the Fisheries - Commercial Wild-catch sector of around 6 percentage points with a decrease in the Fisheries - Recreational sector of around 4 percentage points. In contrast, the proportion of FTE capability in the Aquaculture - Commercial sector and the Fisheries - Indigenous Customary both remained almost the same between 2009 and 2013.

It should be noted that some of these differences may reflect the way that the data has been reported in each of 2009 and 2013: not all agencies reported FTE data at the sectoral level in both years.

When associated Environment and Ecosystems fields of research were excluded, States and Territories reporting an increase in FTE researchers since 2009 were: QLD; VIC and WA. The ACT; SA and TAS reported a decrease in FTE researchers since 2009, while NSW and NT FTEs remained relatively stable. Total reported FTEs for 2013 were: QLD - 28% (up from 23% in 2009), WA and TAS 17% each; VIC - 14%; SA - 11%; NSW - 7%; and the NT and ACT 4% each.

'Australian Government' agencies and 'Other' institutions (i.e. education facilities and private consultants) reported almost identical overall FTE capability in 2009 and 2013. There was an overall decrease of 17 FTEs within State agencies compared with an overall increase of 24 FTEs within the

[2] The "Environment and Ecosystems" capability area includes research supporting aquatic environment and ecosystem management with a low attribution of direct benefit to industry and when this capability is excluded it is in order to focus on the strategic activities with a high attribution of direct benefit to the Australian fishing and aquaculture industry.

University sector. However, it is worth noting that there are often short term fluctuations in capabilities at universities - as projects come and go - and, thus, university capability may be more variable than within other institution types.

Some relatively large increases and decreases were reported for individual institutions and underpin the changes observed at the regional scale.

In addition to the 32 organisations that reported in both the 2009 and 2013 audits, 19 other organisations responded to the 2013 audit. These additional respondents were primarily from the university, museum and private sectors and reported a total of 131 FTE researchers. These comprised 98 FTEs (excluding the associated Environment and Ecosystem fields of research) and 33 FTEs within the Environment and Ecosystem fields of research.

1.2 Infrastructure

Twenty-three institutions provided information on infrastructure and capital items in both the 2009 and 2013 audits. For those items valued at more than $100,000 per item plus all vessels - and where a capital value was provided - the total value of infrastructure was about $482m. This is significantly higher than the $317m in capital value reported by these same institutions in 2009.

Reported infrastructure data indicates an estimated capital value distributed across the Northern, Southwestern and Southeastern regions of about $229m, $100m and $153m, respectively. In 2009, these values were $135m, $52m and $130m, respectively.

This apparent increase in capital value may reflect a more detailed level of reporting of infrastructure than occurred in the previous audit. For example, there was a significant increase in the reporting of the value of accommodation facilities, research facilities and aquarium facilities in 2013 compared to the 2009 audit.

1.3 Investment

Key national research providers reported an average annual investment - when associated Environment and Ecosystems investment is included - of $136m pa across the financial years 2009/10 to 2012/13. Annual totals varied between $132m and $140m during this period. In comparison, the average annual investment from the 2009 audit was $129m.

This suggests that annual investment has been relatively stable (and below CPI) during the past four years across all investment areas – despite Fisheries and Aquaculture being an increasingly complex and research-intensive industry[3].

Between the 2009 and 2013 audits, annual investment in Aquaculture R&D increased ($28-30 million pa c.f. $34-36 million pa), investment in Legislative Requirements decreased ($27-35 million pa c.f. $27-29 million pa). Investment in Associated Environment and Ecosystems declined slightly from its peak in 2007/08 and 2008/09 ($41-44 million pa c.f. $38-43 million pa) and investment in Fisheries has remained relatively static over the nine year reporting period ($27-35 million pa).

[3] NOTE: JCU investment was not provided. If based on the 2009 audit, we would expect JCU spend to be at least $2m or approx. 2% (at least) of total spend by Research Providers. However, as JCU has indicated a significant increase in the number of aquaculture researchers it is likely that JCU spend will actually be much higher than reported in the 2009 audit.

1.4 Conclusion

A small increase in the number of FTE researchers was reported across the 32 organisations that responded to both the 2009 and 2013 audits.

Overall, there was a relatively large increase in FTEs for both the Fisheries & Aquaculture and the Post-harvest Capability Areas and a large decrease in the number of FTEs in the Communication/Extension Professionals and Environment and Ecosystems Capability Area. This suggests that there is a greater focus on the R&D part of RD&E than on communication and extension and a shift in focus from the environmental fields of research in some organisations.

Some large changes were reported for individual Areas of Expertise within each of the main Capability Areas (e.g. large increases in Fisheries Biology / Ecology; Fish Surveys; Genetics & genomics; Aquaculture systems & polyculture; Seafood safety; Ecosystem modelling and large decreases in Fisheries Assessment; Hatchery/ nursery; Oceanography; Communication / Extension; Benthic Ecology). While some of these changes will reflect real change from 2009 to 2013 some of these changes may be due to differences in how some FTE capability was categorised between the two audits.

At the sectoral level there has been a reported shift in FTE capability towards the Fisheries – Commercial Wild-catch sector away from the Fisheries – Recreational sector since 2009, suggesting a stronger focus on RD&E support of the commercial fishing sector.

Changes in FTE capability were reported for most State and Territories, indicating a regional shift in capability and between individual institutions from 2009 to 2013.

While Australian Government agencies reported almost identical overall FTE capability in 2009 and 2013, there appears to have been a shift in capability to the universities after some reductions in state departments between the 2009 and 2013 surveys.

Twenty-three institutions provided information on infrastructure and capital items in both the 2009 and 2013 surveys. While the total value of infrastructure reported was significantly higher than that reported by these same institutions in 2009, this increase in capital value may reflect a much greater level of reporting of infrastructure than occurred in the previous audit as well as any real increase during this time. As in 2009, some infrastructure was reported to be utilised at maximum capacity while other infrastructure is reported to be severely underutilised.

Reported investment was relatively static during the past four financial years - 2009/10 to 2012/13 - across all investment areas and did not match the corresponding CPI increase during this time[4].

While these conclusions primarily relate to the 32 organisations that reported in both the 2009 and 2013 audit, 19 other organisations responded to the 2013 audit primarily from the university, museum and private sectors and they reported significant additional capability and infrastructure.

[4] NOTE: JCU investment was not provided. If based on the 2009 audit, we would expect JCU spend to be at least $2m or approx. 2% (at least) of total spend by Research Providers. However, as JCU has indicated a significant increase in the number of aquaculture researchers it is likely that JCU spend will actually be much higher than reported in the 2009 audit.

2 Introduction

2.1 Fishing and Aquaculture RD&E Background: The Framework and the Strategy

Through what was the Primary Industries Ministerial Council (PIMC[5]), the Australian, State and Northern Territory Governments, Rural R&D Corporations (RDCs), CSIRO, and universities agreed to jointly develop the National Primary Industries Research, Development and Extension (RD&E) Framework (the Framework). The Framework is designed to encourage greater collaboration and promote continuous improvement in the investment of RD&E resources nationally.

The Framework spans 14 primary industry sectors and 8 cross-industry sectors. The Framework – Statement of Intent is the document to guide efforts, outlining; the purpose, the principles, the roles and responsibilities, and the monitoring and evaluation of the Framework.

A major driver for The Framework is that RD&E resources are finite and there is a need to achieve efficiencies. The Framework recognises that: basic and strategic research can be provided from a distance; adaptive development can be achieved regionally; and extension and adoption of research outcomes most often have a local focus. The terminology of Major-Support-Link (MSL) is used to describe how the approach is applied through taking agreed roles for delivery of research.

Working Together: The National Fishing and Aquaculture RD&E Strategy (the Strategy) was endorsed by Ministers on 23 April 2010. The Strategy establishes both a regional approach and a national approach based on areas of expertise or functional activity, in order to achieve efficiencies and progress the implementation of the Major-Support-Link approach outlined in The Framework.

In the lead up to its approval, the Strategy was endorsed by: all State Governments; DAFF; CSIRO; AFMA; and the following industry peak bodies - the Commonwealth Fisheries Association; the National Aquaculture Council; Recfishing Australia; and the National Seafood Industry Alliance.

In endorsing the Strategy, these parties agreed to work collaboratively and cooperatively to develop and implement the Strategy by:

- freely sharing the knowledge generated by publicly funded RD&E effort and minimising barriers to RD&E effort created by intellectual property protection
- providing timely and ready access to knowledge and information to facilitate extension and adoption of research to all potential end-users
- working collaboratively to improve access to national research capability (people and infrastructure) by industry and R&D partners across Australia
- working cooperatively to improve the administrative processes and effectiveness of information sharing and management

[5] PIMC is now termed AGMIN for Agricultural Ministers. The Primary Industries Standing Committee (PISC) which sat under PIMC and had oversight of the Framework has now been replaced by the Agricultural Senior Officials Committee (AGSOC). Implementation of the Framework is overseen by the Research and Innovation Committee.

- encouraging, and wherever possible, supporting engagement by all stakeholder groups in the implementation of the strategy

- working collaboratively with stakeholders and other RD&E providers and jurisdictions to address stakeholder RD&E priorities, and retain and build national capability to address future needs

- building on existing RD&E evaluation frameworks to develop monitoring and evaluation criteria to review the performance of the strategy

- encouraging and fostering regional RD&E coordination and collaboration

- contributing to an annual report on progress toward achieving the outcomes sought from the strategy and identifying solutions to overcoming identified blockages or delays to achieving them.

Implementation of the Strategy is being led by the Fishing and Aquaculture RD&E Strategy Governance Committee (previously known as the National Priorities Forum). The Strategy is supported by a National Research Providers' Network (NRPN)[6].

2.2 Tasks and objectives

In 2009, RDS Partners - then Rural Development Services - conducted the first RD&E capability audit and assessment for the Australian fishing and aquaculture industry. The final report from the 2009 capability audit supported the development of *Working Together: The National Fishing and Aquaculture RD&E Strategy* (the Strategy).

Since the release of the Strategy, the FRDC and the Strategy Governance Committee considered that significant changes have occurred in national RD&E capability, especially within State Government agencies. The view is that available funding is declining in most jurisdictions and the ability to deliver on the principles guiding The Framework is compromised. The Strategy Governance Committee considered that there was need for all signatories to the Strategy to reaffirm their commitment.

The advent of: the ARC Excellence in Research for Australia (ERA) for Australian universities; the Major-Support-Link Research Provider concept; the National Research Providers Network (NRPN) and NRPN Hubs; and the Fisheries and Aquaculture Extension and Adoption Working Group, may have precipitated some restructuring of Fishing and Aquaculture RD&E capability at a national, state and institutional level. However, it is suspected that any major changes that may have occurred have been in response to resource pressures from government.

The Strategy Governance Committee determined that the RD&E capability audit should be repeated in 2013, as Australia's agencies investing in RD&E needed an understanding of current RD&E capability and capacity and future demand to plan for and deliver effective and efficient services to

[6] RD&E changes since the release of The Strategy included: the ARC Excellence in Research for Australia (ERA) for Australian universities; Major-Support-Link Research Provider concept; National Research Providers Network (NRPN) and NRPN Hubs; and the Fisheries and Aquaculture Extension and Adoption Working Group.

the Fishing and Aquaculture industry. The industry and other end users need to know where this capability exists to address their RD&E requirements.

The objectives for the 2013 capability audit were:

- To audit and assess the existing RD&E capability in the field of fisheries and aquaculture, and their aquatic ecology and biodiversity, within a national context.
- To identify change from 2009 in RD&E capability in the fields of fisheries and aquaculture, within: capability area; area of expertise; infrastructure; and investment.
- To assess criteria (e.g. demonstration of ability, commitment and obligation) for Major, Support and Link research providers.

3 Methods

3.1 Participant identification and engagement

In the RD&E audit 2009, national capability was assessed through direct contact with: major RD&E providers, including universities, state and national research agencies; industry bodies; and through expressions of interest from other public and private providers and enterprises following national advertisement. An initial list of institutions and government research providers was developed with the 2009 Steering Committee, including those organisations within this initial list that should be surveyed for investment data. The list included suggested key contacts, which were generally the Head (or their nominated proxy) of research organisations or programs.

All Research Funders and Research Providers who participated in the RD&E audit 2009 were invited to participate in the RD&E audit 2013. In addition, all organisations that provided an expression of interest to the 2009 audit, but did not provide capability information, were invited to participate in the 2013 audit. Some additional key organisations not on the 2009 list (i.e. ERA Universities for Fisheries Sciences) were also invited to participate.

The FRDC provided an introductory letter to each Head of Agency which was sent via email from RDS Partners. Data were collected through voluntary return of a spreadsheet-based survey tool designed to elicit the required information (this was a refined version of the survey tool from the 2009 audit) and one-to-one follow-up if required

The National Research Providers Network (including National Research Providers Network Hubs), the Fisheries and Aquaculture Extension and Adoption Working Group and the PISC RD&E Committee were requested to actively promote the RD&E capability audit 2013 within their respective networks.

3.2 Capability

The survey of RD&E providers in the field of fisheries, aquaculture and associated environment and ecosystems fields was conducted using a spreadsheet-based capability matrix designed in consultation with 2009 audit steering committee and refined in consultation with the 2013 audit steering committee – the main difference being removal of the option to rank capability at the Fishery/Species level (i.e. below the Sub-sector level).

The capability matrix was designed to allow research providers to record RD&E capability, as research Full Time Equivalents (FTE), against the list of suggested Areas of Expertise at the Industry (i.e. Fisheries or Aquaculture) or Sector (i.e. Aquaculture – Commercial; Fisheries - Commercial Wild-catch; Fisheries - Recreational; and Fisheries - Indigenous customary) Levels.

Both steering committees spent considerable time discussing the best way to capture equivalent RD&E capability from the different research providers. The decision was made to seek data at the research scientist, specialist technician and extension professional level. This wording was used to allow pragmatic differentiation of internal classifications between, for example, universities and CSIRO.

The survey tool "capability matrix" is a multi-sheet spreadsheet that is too large to present meaningfully in the format of this report. FRDC will hold copies of all survey tools and documentation for reference as required.

The Industries, Sectors, and Sub-sectors and six of the 45 related 'Areas of expertise' included in this survey are shown in a "screen shot" of the left hand columns of the survey tool (Figure 1).

Detailed instructions on how to fill in each section of the audit spreadsheet and capability matrix were sent with the spreadsheet and the introductory letter to each Head of Agency.

		CAPABILITY AREA		Fisheries & Aquaculture					
		FIELD / AREA OF EXPERTISE	*Example only*	Taxonomy	Fisheries Biology / Ecology (includes Ageing unless wishing to explicitly emphasise fish ageing capability in next column)	Ageing (only if wishing to explicitly emphasise fish ageing capability)	Data management/ programming	Stakeholder surveys / logbooks	Fish Surveys
INDUSTRY	SECTOR (FTEs)	SUB-SECTOR (FTEs)							
Fisheries	Commercial Wild-catch		*6.0*						
		Finfish	*2.0*						
		Crustacea	*2.8*						
		Molluscs	*1.0*						
		Other	*0.2*						
	Recreational / Charter		*3.5*						
	Indigenous Customary		*2.0*						
Aquaculture	Commercial		*7.0*						
		Finfish	*2.0*						
		Crustacea	*2.0*						
		Molluscs	*1.5*						
		Other	*1.5*						

Figure 1. "Screen shot" showing the Industries, Sectors and Sub-sectors and six of the 45 areas of expertise included in the survey

A characteristic of the fishing and aquaculture industry is its high reliance on RD&E relating to the public nature of the resource that it utilises. Therefore, it should be noted that the RD&E capabilities supporting the Australian fishing and aquaculture industry probably cover the broadest range of any of Australia's primary industries.

Disciplines range from tactical research supporting State and the Commonwealth jurisdictional fisheries management responsibilities, to strategic research with a high attribution of direct benefit to the aquaculture and fishing industry, to strategic research that supports environmental and ecosystem management with a low attribution of direct benefit to these industries (Figure 2).

Tactical research supporting State and the Commonwealth jurisdictional management responsibilities	Strategic research with a high attribution of direct benefit to industry	Strategic research supporting aquatic environment and ecosystem management with a low attribution of direct benefit to industry

Figure 2. The spread of RD&E capabilities supporting Australian aquaculture and fisheries

All three areas shown in Figure 2 are recognised and have been included in this survey. It is for this reason that the actual survey matrix, which contains some 45 Areas of Expertise (Table 1), is too large to be included in this report.

The main focus of this report is on the central grouping in Figure 2 – the strategic activities with a high attribution of direct benefit to the Australian fishing and aquaculture industry, acknowledging that the boundaries between these areas are blurred, and not easy to define. While data pertaining to the entire spectrum is reported and assessed to some degree in this report, data relating to capability in the jurisdictional and environmental groups are outside the direct scope of the National Fishing and Aquaculture RD&E Strategy.

The related Capability Areas and Areas of Expertise which were mapped against the nominated Industries, Sectors and Sub-sectors are listed in Table 1.

.

3.3 Infrastructure

In addition to human capability, a section where organisations could record major infrastructure and capital items was included within the spreadsheet. Information about the type, value, additional available usage and location of capital items was sought.

Institutions were requested to provide details of infrastructure and major capital items for their organisation, including the physical location of each item.

For vessels, institutions were requested to list all vessels within each of four size categories (> 50 m; 20-50 m; 10-20 m; 5-10 m; < 5 m). Other than vessels, only items with a capital value of over $100,000 were to be listed.

A list of suggested items was provided. However, institutions were encouraged to add other items as relevant to their institution.

Institutions were requested, where feasible, to estimate the current spare capacity of listed items (for example, for an aquarium facility that is currently used at 80% capacity, it would be recorded that this item has 20% additional capacity).

Table 1: Capability Areas and Areas of Expertise used in the capability audit matrix

Capability Area	Area of Expertise
Fisheries & Aquaculture	Taxonomy
	Fisheries Biology / Ecology (include ageing unless explicitly in next column)
	Ageing (only if explicitly emphasising ageing capability)
	Data management/programming
	Stakeholder surveys / logbooks
	Fish Surveys
	Biometrics/ Statistics
	Fisheries Modelling
	Fisheries Assessment
Aquaculture	Hatchery/ nursery
	Grow-out/ production
	Broodstock management
	Feed & Nutrition
	Aquatic Animal Health
	Genetics & genomics
	Aquaculture systems & polyculture
Gear & engineering	Gear technology
	Observational technology
	Aquatic engineering
Social Research	Anthropology
	Demography
	Educational Research
	Indigenous studies (including cultures)
	Sociology
Economic Research	Resources allocation
	Economic surveying
	Economic assessment
	Economic modelling
	Productivity & Market analysis (incl. Supply chain)
	Market access & trade
	Commercialisation
Post -harvest	Seafood processing
	Seafood safety
Governance & Management	Governance & Management
Communication /Extension Professionals	Communication / Extension (those working in the field – not researching this)
Environment and Ecosystems ^	Environmental impacts (incl. bycatch & wildlife interactions) ^
	Oceanography ^
	Hydrology ^
	Chemistry/ Biogeochemistry ^
	Benthic Ecology (incl.habitat mapping & assessment unless in next column) ^
	Habitat mapping (only if explicitly emphasising habitat mapping capability) ^
	Pelagic ecology ^
	Freshwater Ecology ^
	Ecosystem modelling ^
Fisheries & aquaculture technicians*	Technical Expertise*

^ These Areas of Expertise are the ones excluded when we refer to capability excluding "Environment and Ecosystems"

* Technical Expertise FTE information was requested for specialist technicians, but is not reported against in this report or the 2009 report.

3.4 Investment

As in the 2009 audit, RD&E investment data for key institutions was collected. A survey tool allowing key agencies to record investment against the areas of Legislative[7] Requirements; Fisheries; Aquaculture; and Associated Environment and Ecosystems for the past four financial years was distributed to relevant agencies as a worksheet alongside the capability matrix spreadsheet.

3.5 Analysing current RD&E Capability data

Data[8] returned by research providers was analysed to provide aggregated capability information against the following criteria:

- FTE against sector:
    - Aquaculture - Commercial
    - Fisheries - Commercial Wild-catch
    - Fisheries – Indigenous Customary
    - Fisheries - Recreational
- FTE against state / territory[9]
- FTE against major institution type
    - National
    - State and territory government
    - University
    - Other[10]

In the 2009 capability audit report, FTE data was presented in two formats:

- Excluding FTE data reported against the "Environment and Ecosystems" capability area (i.e. only focusing on the strategic activities with a high attribution of direct benefit to the Australian fishing and aquaculture industry)

[7] Investment in Legislative Requirements relates to those areas of fisheries management that are mandatory activities of State and Commonwealth fisheries organisations.

[8] This report presents data received by 3 July 2014.

[9] CSIRO Marine & AAHL data was reported as a national aggregate. In this report we used a proportional split of FTEs of 59.5% TAS, 27.5% QLD, 8.5% VIC; and 4.5% WA as advised by CSIRO

[10] Education facilities; collaborative agencies; museums; private agencies

- Including FTE data reported against the “Environment and Ecosystems” capability area (i.e. including research supporting aquatic environment and ecosystem management with a low attribution of direct benefit to industry).

This 2013 capability audit again presents FTE data in these two formats where relevant, but concentrates primarily on data that excludes the “Environment and Ecosystems” capability area. In other words, we focussed on the strategic activities with a high attribution of direct benefit to the Australian fishing and aquaculture industry.

4 Results and Discussion

4.1 Organisations

Of the 108 organisations or individuals invited to participate in the 2013 capability audit, 56 provided a response. Fifty-one organisations or individuals provided capability information.

Organisations that provided capability, infrastructure and investment information for this survey are shown in Table 2. Results presented in this report are drawn from these responses.

Overall, thirty two organisations responded to both the 2009 and the 2013 capability audits. To ensure consistency of reporting, the organisations that responded to both audits – representing 83% of the FTE capability reported in 2013 – are the main focus of the following analysis.

A summary of FTE capability data for all organisations reporting in the 2013 is provided in Appendix 1.

4.2 Capability

4.2.1 Full Time Equivalent (FTE) Capability – Sectoral analysis

For the 32 organisations that reported in both the 2009 and 2013 capability audits, the proportion of overall FTE capability at the sector level was reported as: 33% Aquaculture - Commercial; 60% Fisheries - Commercial Wild-catch; 6% Fisheries - Recreational; and 1% Fisheries - Indigenous Customary.

This shows an overall increase since 2009 in the proportion of FTE capability in the Fisheries - Commercial Wild-catch sector of around 6 percentage points with a decrease in the Fisheries - Recreational sector of around 4 percentage points. In contrast, the proportion of FTE capability in the Aquaculture - Commercial sector and the Fisheries - Indigenous Customary both remained steady between 2009 and 2013.

It should be noted that some of these differences may reflect the way that the data has been reported in each of 2009 and 2013: not all agencies reported FTE data at the sectoral level in both years - some only reporting at the higher 'industry' level (refer Figure 1). Therefore, the sectoral analysis does not represent all of the FTE data reported (and is the reason that there are less FTEs in the sectoral analysis than in the regional and institutional analysis).

4.2.2 Full Time Equivalent (FTE) Capability – Capability Area and Area of Expertise

The 32 organisations that reported in both the 2009 and the 2013 capability audit reported a total (excluding associated Environment and Ecosystems fields of research) of 567 FTE researchers in 2013. This represents a small increase of 7 FTE researchers since the 2009 audit.

However, when the Environment and Ecosystems fields of research are included, the data shows an overall decrease of 31 FTE researchers since the 2009 audit: from 822 FTEs in 2009 to 792 FTEs in 2013. Total FTEs in the Environment and Ecosystems fields of research decreased by 38 – from 263 FTEs in 2009 to 225 FTEs in 2013.

Table 2. Respondent organisations to 2013 capability, infrastructure and investment survey

Institution Type	Institution	Investment data	2009 respondent[5]
Aust Gov Funder	AFMA	Y	Y
	DAFF - FRRF fund	Y	Y
	FRDC	Y	Y
	Seafood CRC	Y	Y
	Reef and Rainforest Research Centre	Y	Y
Aust Gov Research	Australian Antarctic Division		Y
	Australian Bureau of Agricultural & Resource Economics & Sciences [1]	Y	Y
	The Australian Institute of Marine Science	Y	Y
	CSIRO Marine & AAHL[2]	Y	Y
State Research	Arthur Rylah Institute for Environmental Research		Y
	DAFF - QLD	Y	Y
	DEPI - Fisheries VIC	Y	Y
	DPI Fisheries NSW	Y	Y
	DRDPIFR NT	Y	Y
	Department of Fisheries WA	Y	Y
	SARDI / PIRSA[3]	Y	Y
University	Central Queensland University		
	Charles Darwin University		
	Curtin University - CMST		Y
	Deakin University	Y	Y
	Edith Cowan University		Y
	Flinders University	^	Y
	Griffith University		
	IMAS (TAS) - Fisheries, Aquaculture and Coast Centre	Y	Y
	James Cook University[4]	^	Y
	Macquarie University		Y
	Murdoch University	Y	Y
	University of Adelaide		Y
	University of Melbourne		Y
	University of Queensland	Y	Y
	University of Sunshine Coast	Y	Y
	University of Sydney		
	University of Woolongong		Y
Education Facility	Challenger Institute of Technology		Y
Museum	Museum and Art Gallery of the Northern Territory		
	Museum Victoria		
	Western Australian Museum		
Collaborative Agency	Great Barrier Reef Marine Park Authority		
	Sydney Fish Market		
Private	Agtrans Research and Consulting		
	Biospherics P/L		Y
	BSI (NCSI)		
	C-AID Consultants		
	Cobalt Marine Resource Management		
	EconSearch Pty Ltd		
	Fish Focus Consulting		
	MRAG Asia Pacific		
	Ridge Partners		
	Rural Solutions SA		
	Tasmanian Seafoods Pty Ltd		Y
	Western Australian Fishing Industry Council		
Total	**51 institutions**	**19 institutions**	**32 institutions**
		^ not received	

1. ABARE and BRS reported as separate agencies in the 2009 audit
2. CSIRO Marine and CSIRO AAHL reported as separate agencies in the 2009 audit
3. SARDI and PIRSA reported as separate agencies in the 2009 audit
4. JCU Aquaculture and JCU Fisheries reported as separate agencies in the 2009 audit
5. The following organisations who reported in the 2009 audit did not report in the 2013 audit: State funder (DPIPWE-Tasmania); Universities (University of Newcastle); Education Facilities (Marine Discovery Centres, OceanWatch Australia); Museums (QLD museum); Private (Chris Calogeros, Kate Brooks, Bunya Creek Farm)

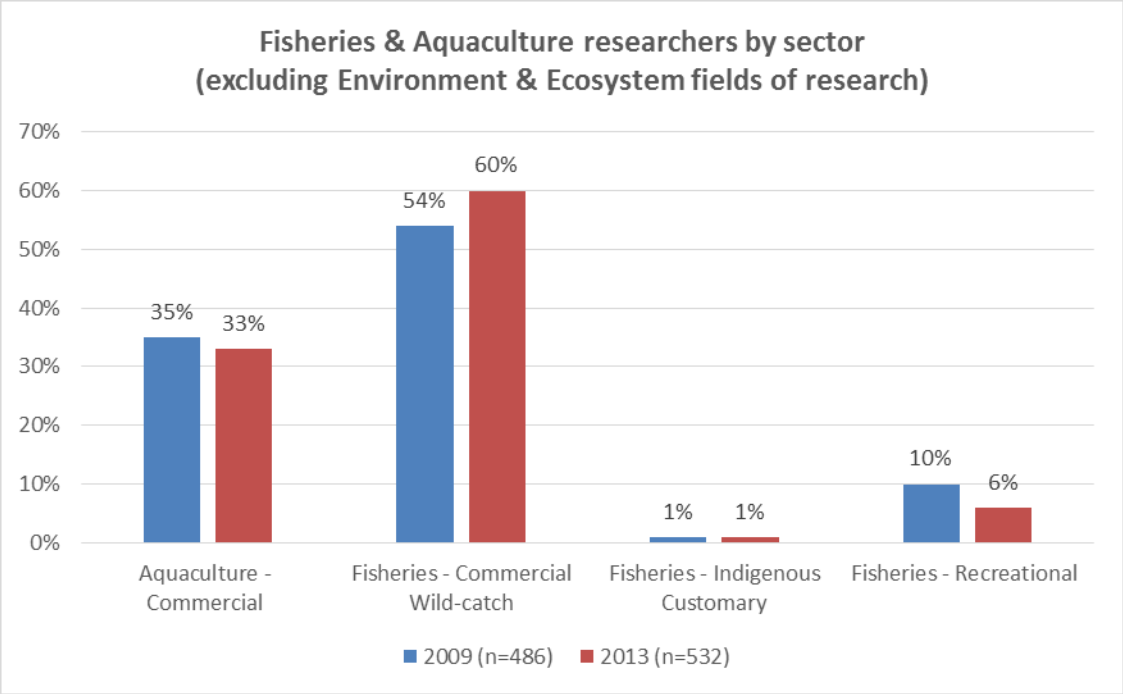

Figure 3. Proportion of Fisheries and Aquaculture researchers by sector (excluding Environment and Ecosystem fields of research), where FTE capability provided at the sector level

Table 3 shows researcher FTEs by Capability Area and Area of Expertise in 2009 and 2013.

There was a relatively large increase in FTEs for both the Fisheries & Aquaculture (+21 FTEs) and the Post-harvest (+12 FTEs) Capability Areas.

There was a large decrease in the number of FTEs in the Communication/Extension Professionals Capability Area (-27 FTEs) and, as stated previously, the Environment and Ecosystems Capability Area (-38 FTEs)

Areas of Expertise where the number of reported FTEs had **increased** by at least 5 FTEs from 2009 to 2013 were:

- Fisheries Biology / Ecology
- Fish Surveys
- Broodstock management
- Genetics & genomics
- Aquaculture systems & polyculture
- Seafood safety
- Environmental impacts
- Habitat mapping, and
- Ecosystem modelling.

Areas of Expertise where the number of reported FTEs had **decreased** by at least 5 FTEs from 2009 to 2013 were:

- Fisheries Assessment
- Hatchery/ nursery
- Gear technology

- Economic modelling
- Communication / Extension professionals
- Oceanography
- Chemistry/ Biogeochemistry, and
- Benthic Ecology.

Table 3. Researcher FTEs by Capability Area and Area of Expertise, 2009 and 2013

Capability Area	Area of Expertise	2009 (FTE)	2013 (FTE)	Change 09 to 13	Change 09 to 13
Fisheries & Aquaculture	Taxonomy	7	6	-1	+21
	Fisheries Biology / Ecology (include ageing unless explicitly in next column)	70	84	+14	
	Ageing (only if explicitly emphasising ageing capability)	7	11	+4	
	Data management/programming	32	31	-1	
	Stakeholder surveys / logbooks	12	16	+4	
	Fish Surveys	9	26	+17	
	Biometrics/ Statistics	24	21	-3	
	Fisheries Modelling	37	37	0	
	Fisheries Assessment	62	49	-13	
Aquaculture	Hatchery/ nursery	28	13	-15	+5
	Grow-out/ production	14	10	-4	
	Broodstock management	7	13	+6	
	Feed & Nutrition	28	24	-4	
	Aquatic Animal Health	33	31	-2	
	Genetics & genomics	41	51	+10	
	Aquaculture systems & polyculture	18	33	+15	
Gear & engineering	Gear technology	14	6	-8	-3
	Observational technology	9	13	+4	
	Aquatic engineering	1	2	+1	
Social Research	Anthropology	0	1	+1	+2
	Demography	1	1	0	
	Educational Research	3	4	+1	
	Indigenous studies (including cultures)	0	1	+1	
	Sociology	5	4	-1	
Economic Research	Resources allocation	3	2	-1	-6
	Economic surveying	2	3	+1	
	Economic assessment	6	5	-1	
	Economic modelling	7	2	-5	
	Productivity & Market analysis (incl. Supply chain)	2	4	+2	
	Market access & trade	3	2	-1	
	Commercialisation	2	1	-1	
Post -harvest	Seafood Processing	6	10	+4	+12
	Seafood safety	3	11	+8	
Governance & Management	Governance & Management	21	23	+2	+2
Communication /Extension Professionals	Communication / Extension (those working in the field – not researching this)	43	16	-27	-27
Environment and Ecosystems ^	Environmental impacts (incl. bycatch & wildlife interactions; biosecurity) ^	50	63	+13	-38
	Oceanography ^	31	15	-16	
	Hydrology ^	1	1	0	
	Chemistry/ Biogeochemistry ^	24	12	-12	
	Benthic Ecology (incl. habitat mapping & assessment unless in next column) ^	71	23	-48	
	Habitat mapping (only if explicitly emphasising habitat mapping capability) ^	10	22	+12	
	Pelagic ecology ^	18	15	-3	
	Freshwater Ecology ^	28	26	-2	
	Ecosystem modelling ^	29	47	+18	

^ These Areas of Expertise are not included when we refer to capability excluding "Environment and Ecosystems"

4.2.3 Full Time Equivalent (FTE) Capability – Regions

When associated Environment and Ecosystems fields of research were excluded, States and Territories reporting an increase in FTE researchers since 2009 were: QLD; VIC and WA. The ACT; SA and TAS reported a decrease in FTE researchers since 2009, while NSW and NT FTEs remained relatively stable (Figure 4). Total proportional reported FTEs for 2013 were: QLD - 28% (up from 23% in 2009), WA and TAS 17% each; VIC - 14%; SA - 11%; NSW w-as 7%; and the NT and ACT 4% each.

The same trends of increasing or decreasing FTEs, as seen in Figure 4, holds true for each State (except for VIC) and Territory when the Environment and Ecosystems fields of research are either excluded or included.

In VIC, when the Environment and Ecosystems fields of research are included, the overall number of FTE researchers has decreased since 2009 (116 c.f. 94), suggesting a refocusing of resources in that state away from those fields without direct alignment to fishing and aquaculture.

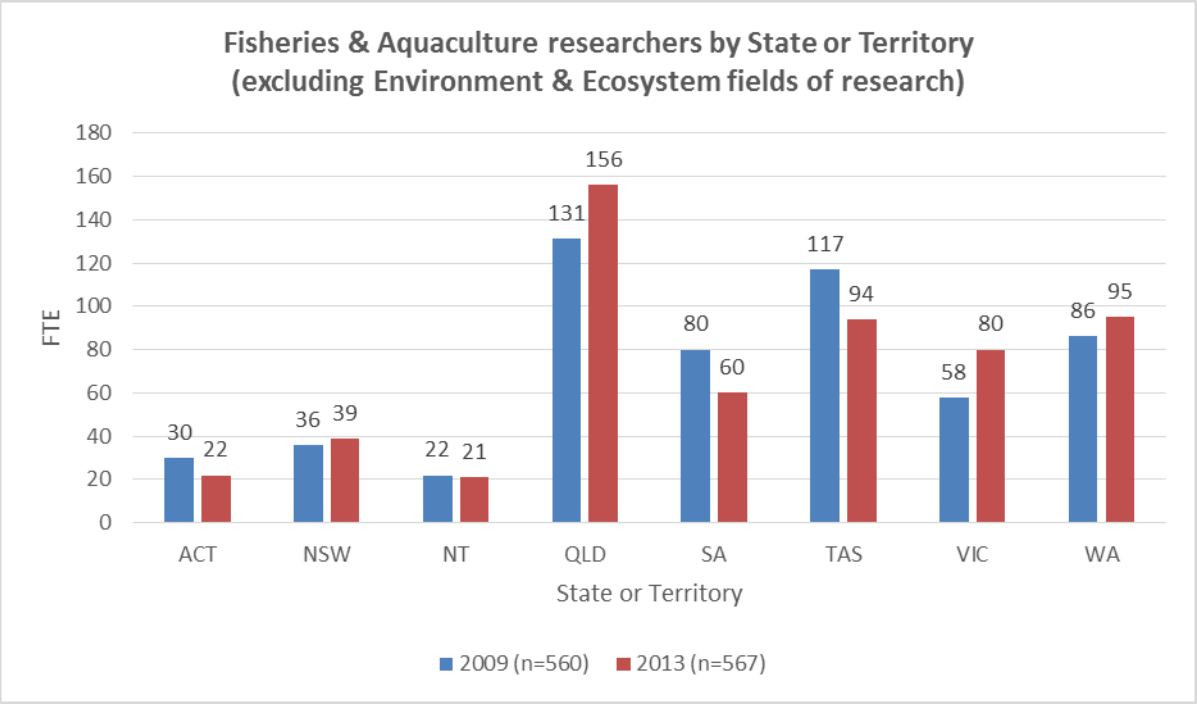

Figure 4. National Fisheries and Aquaculture researchers by State or Territory (excluding Environment and Ecosystem fields of research)

Note: Some minor rounding errors in sub-totals may occur.

4.2.4 Full Time Equivalent (FTE) Capability – Institutions

For the 32 organisations that provided data for both the 2009 and the 2013 capability audits, there was an overall decrease of 17 FTEs within State agencies compared with an overall increase of 24 FTEs within the University sector - when associated Environment and Ecosystems fields of research were excluded. Australian Government agencies and Other institutions (i.e. education facilities and private consultants) reported almost identical overall FTE capability in 2009 and 2013 (Figure 5).

There appears to have been a shift in capability to the universities after some reductions in state departments between the 2009 and 2013 surveys. However, it is worth noting that there are often short term fluctuations in capabilities at universities - as projects come and go - and, thus, university capability may be more variable than within other institution types.

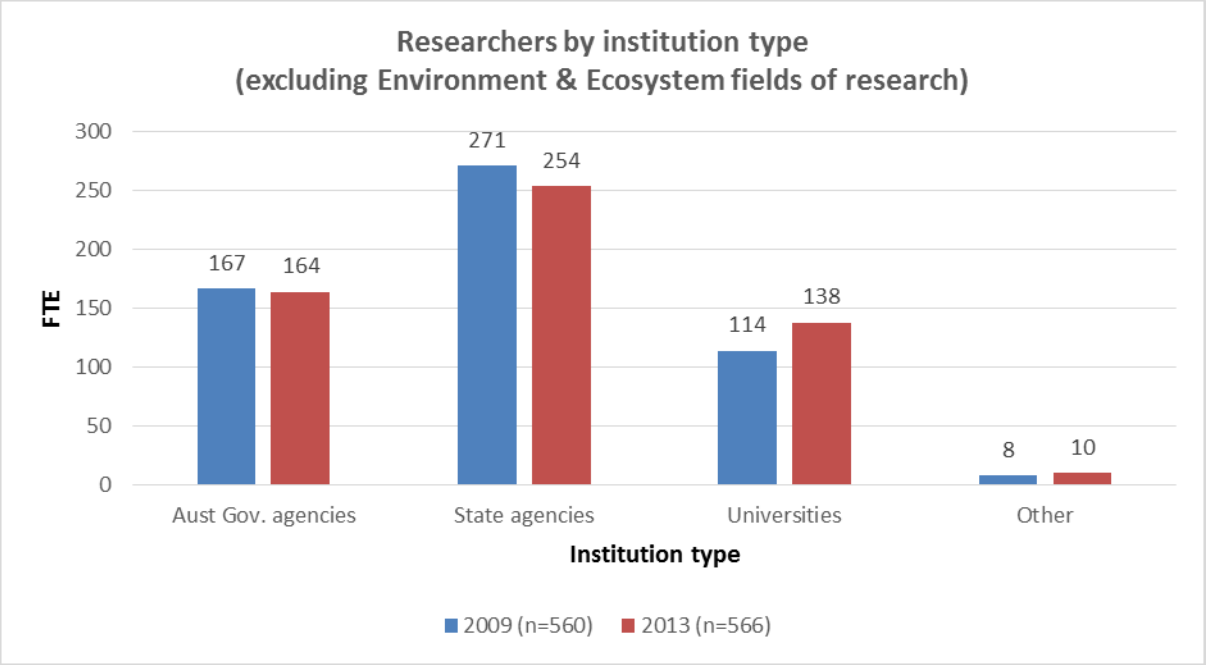

Figure 5. National Fisheries and Aquaculture researchers by institution type (excluding Environment and Ecosystem fields of research)
Note: Some minor rounding errors in sub-totals may occur.

Some relatively large increases and decreases were reported for some individual institutions (Figure 6) and it is these institutional changes in FTE capability that reflect the regional scale changes observed.

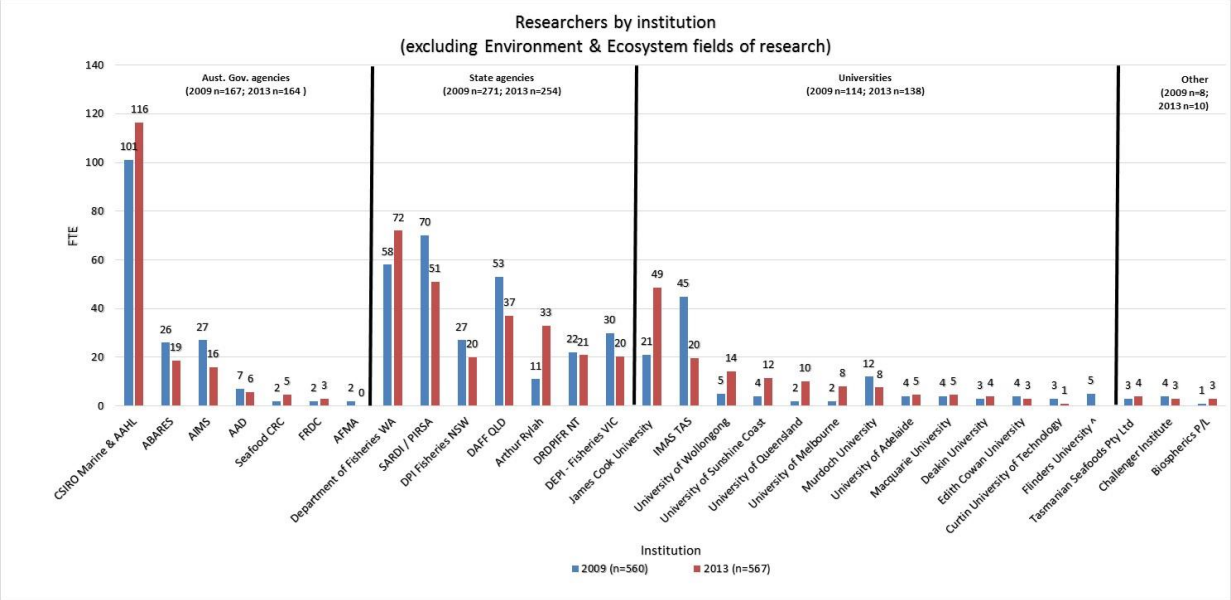

Figure 6. National Fisheries and Aquaculture researchers by institutions (excluding Environment and Ecosystem fields of research)

Note: Some minor rounding errors in sub-totals may occur.

^ Flinders University FTE data provided in 2013 contained errors and is not included

Institutions where the number of reported FTEs had increased by at least 10 FTEs from 2009 to 2013 were:

- CSIRO Marine & AAHL
  - main increases were reported in Fisheries & Aquaculture (Data Management / Programming; Fish Surveys; and Fisheries Assessment); and Aquaculture (Broodstock Management; and Feed & Nutrition)
- Fisheries WA
  - main increases were reported in Fisheries & Aquaculture (Fisheries Biology / Ecology; and Data Management / Programming); and Aquaculture (Genetics & Genomics)
- Arthur Rylah Institute
  - main increases were reported in Fisheries & Aquaculture (Fisheries Biology / Ecology; and Fish Surveys)
- James Cook University
  - main increases were reported in Aquaculture (Genetics & Genomics; and Aquaculture Systems & Polyculture)

Institutions where the number of reported FTEs had decreased by at least 10 FTEs from 2009 to 2013 were:

- AIMS
  - main decreases were reported in Fisheries & Aquaculture (Fisheries Assessment); and Gear & Engineering (Gear Technology)

- SARDI/PIRSA
    - main decreases were reported in Fisheries & Aquaculture (Fisheries Biology / Ecology; and Fisheries Assessment); Aquaculture (Hatchery / Nursery); and Governance, Law & Management
    - however, it should be noted that some significant increases were also reported in Fisheries & Aquaculture (Stakeholder surveys / Logbooks; and Fish Surveys) at the same time as an overall decrease in FTEs at SARDI/PIRSA
- DAFF QLD
    - main decreases were reported in Aquaculture (Grow-out / Production; Feed & Nutrition; and Genetics & Genomics); and Communication / Extension Professionals
- DEPI – Fisheries VIC
    - main decreases were reported in Fisheries & Aquaculture (Data Management / Programming; and Fisheries Modelling); and Aquaculture (Aquaculture Systems & Polyculture)
- IMAS TAS[11] (University of Tasmania)
    - main decreases were reported in Aquaculture (Hatchery / Nursery; and Aquatic Animal Health); Gear & Engineering (Gear Technology)

4.3 Infrastructure

Twenty three institutions provided information on infrastructure and capital items in both the 2009 and 2013 audits. Data provided for all vessels plus those items valued at more than $100,000 per item where a capital value was provided showed a total value of infrastructure of about $482m. This is substantially higher than the $317m in capital value reported by these same institutions in 2009.

This apparent increase in capital value may reflect more rigorous reporting than occurred in the previous audit. For example, accommodation facilities reported in 2009 had a total reported value of only $0.8m, compared to almost $40m in 2013. There was also a significant increase in the reported value of Research facilities and Aquarium facilities from that which occurred in the 2009 audit (Table 4).

In addition, there are a number of significant accommodation facilities and capital items that were reported, but for which no capital value was given (e.g. the *Aurora Australis* and *Southern Surveyor*; Orpheus Island Research Station). As such, the total value of infrastructure associated with fishing and aquaculture RD&E is sure to be higher than the $482m reported here.

It is also worth noting that over 95% of this capital value was reported by 14 main institutions.

Infrastructure items were broadly categorised based on the information provided by each institution. The total value for each item category and total number of items within each category is listed in Table 4, and have been grouped into the Northern, Southwestern and Southeastern regions (Figure 7) currently being considered as potential collaborative regions as part of the National

[11] On advice of IMAS key contact, IMAS TAS (UTas) FTEs reported here for 2009 have been adjusted by a factor of 0.75 to that reported in the 2009 Report

Fishing and Aquaculture RD&E Strategy. The range of estimated additional capacity (minimum and maximum values reported across all institutions for each category) is shown (Table 4).

Table 4. Estimated capital value for infrastructure valued at more than $100,000 per item, plus all vessels

Item	Northern region				Southwestern region				Southeastern region			
	Value[a]	No.[b]	Available (%)[c]		Value[a]	No.[b]	Available (%)[c]		Value[a]	No.[b]	Available (%)[c]	
			Min	Max			Min	Max			Min	Max
Accommodation	0.7	2	10	60	25.0	2	0	0	13.7	4	0	50
Aquaculture equipment	4.1	3	20	90	0.5	1	0	0	0.3	2	40	100
Aquaculture ponds	10.6	3	2	100	1.0	1	0	0				
Aquarium facility	75.1	10	0	98	8.5	3	0	50	32.9	10	0	75
Biocontainment facility	2.4	1	0	55					4.8	4	0	50
Boatshed	0.3	1	20	20	0.5	1	0	0	2.8	5	0	30
Education equipment	0.1	1			1.0	1	0	0				
Hatchery	4.1	4	10	80	22.0	2	0	15	7.0	7	10	50
Laboratory	40.5	16	0	90	1.0	1	0	30	10.6	8	0	50
Laboratory equipment	5.0	8	0	90	2.3	3	0	90	12.7	7	0	50
Library	0.1	1	40	40	5.0	1			13.0	4	0	20
Microalgal biofuels	2.0	1	0	0					1.3	1		
Recirculation system	9.0	3	0	100					0.1	1	20	20
Research facility	38.2	5	5	50	1.0	1	40	40	17.7	4	10	75
Scientific equip. (field)	15.8	8	10	85	8.8	9	0	50	19.5	15	20	100
Supercomputer									4.1	2	10	20
Vessels (< 5 m)	0.5	22	25	50	0.2	8			2.2	49	30	80
Vessels (5 - 10 m)	3.1	31	10	40	1.3	21	50	50	2.2	40	0	80
Vessels (10 - 20 m)	0.7	2	30	30	0.6	2						
Vessels (20 - 50 m)	3.4	1	20	20	21.5	2	10	10	7.0	1	50	50
Vessels (> 50 m)									*	2	0	0
Weather Stations	0.2	1	20	100								
Wharf	8.0	1	10	10								
Workshop	5.0	6	20	50	0.1	1			1.1	2	10	40
Total reported value	**228.7**				**100.3**				**152.8**			

Key: a – Estimated capital value ($ m); b – Number of Items; c – Estimated available capacity

Note: All SARDI infrastructure is attributed within the Southeastern region

Note: CSIRO small vessel infrastructure attributed equally across 3 regions

* The capital values of *Aurora Australis* and *Southern Surveyor* were not provided

Reported infrastructure data indicates an estimated capital value distributed across the Northern, Southwestern and Southeastern regions at values of about $229m, $100m and $153m respectively. These values were $135m, $52m and $130m, respectively in the 2009 audit.

The average level of capacity available for all items was around 30% with at least half the items reported to have no more than 25% capacity available. Over 15% of items were at maximum capacity. Notwithstanding this, some infrastructure is reported to be severely underutilised.

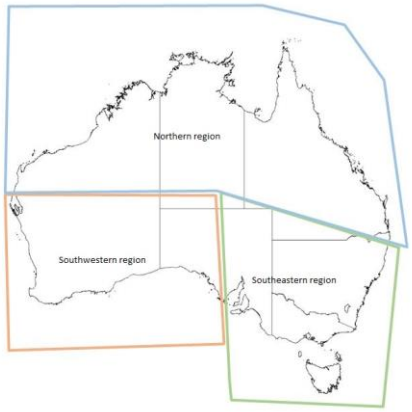

Figure 7. Potential collaborative regions.
The lines are for demonstration and would not reflect the pragmatic approach to regional RD&E. (source: Working Together: The National RD&E Strategy for Fishing and Aquaculture, 2010)

4.4 Investment

Key national research providers reported an average annual investment - when associated Environment and Ecosystems investment is included - of $136m for the financial years 2009/10 to 2012/13, ranging between $132m and $140m during this time (Figure 8).

This indicates that the overall investment in RD&E has been relatively stable during the past four years across all investment areas[12] – despite Fisheries and Aquaculture being an increasingly complex and research intensive industry - and has not matched the corresponding CPI increase during this time. The average annual investment from the 2009 audit was $129m.

Fisheries investment has remained relatively static over the nine year reporting period. Investment in Aquaculture increased in 2009/10 subsequent to the previous audit but remained static during the next three years. Conversely, investment in Legislative Requirements decreased following the previous audit and then remained relatively static. Investment in Associated Environment and Ecosystems also declined in 2009/10 and has been variable thereafter.

It is worth noting that around a third of the Fisheries and Aquaculture RD&E budget and resources is attributable to "business-as-usual" research associated with meeting Legislative Requirements such as fisheries stock assessments.

In addition to the *key research provider organisations* that were asked to provide investment information, the following *key national research funding agencies* were also asked to provide investment information.

- Australian Fisheries Management Authority
- Department of Agriculture
- Fisheries Research and Development Corporation
- Reef and Rainforest Research Centre
- Seafood Cooperative Research Centre[13]

[12] NOTE: JCU investment was not provided for the 2013 audit. Based on the 2009 audit, we would expect JCU spend to be at least $2m or approx. 2% (at least) of total spend by Research Providers. However, as JCU has indicated a significant increase in the number of aquaculture researchers it is likely that JCU spend will actually be much higher than reported in the 2009 audit.

[13] Seafood CRC formed in 2007

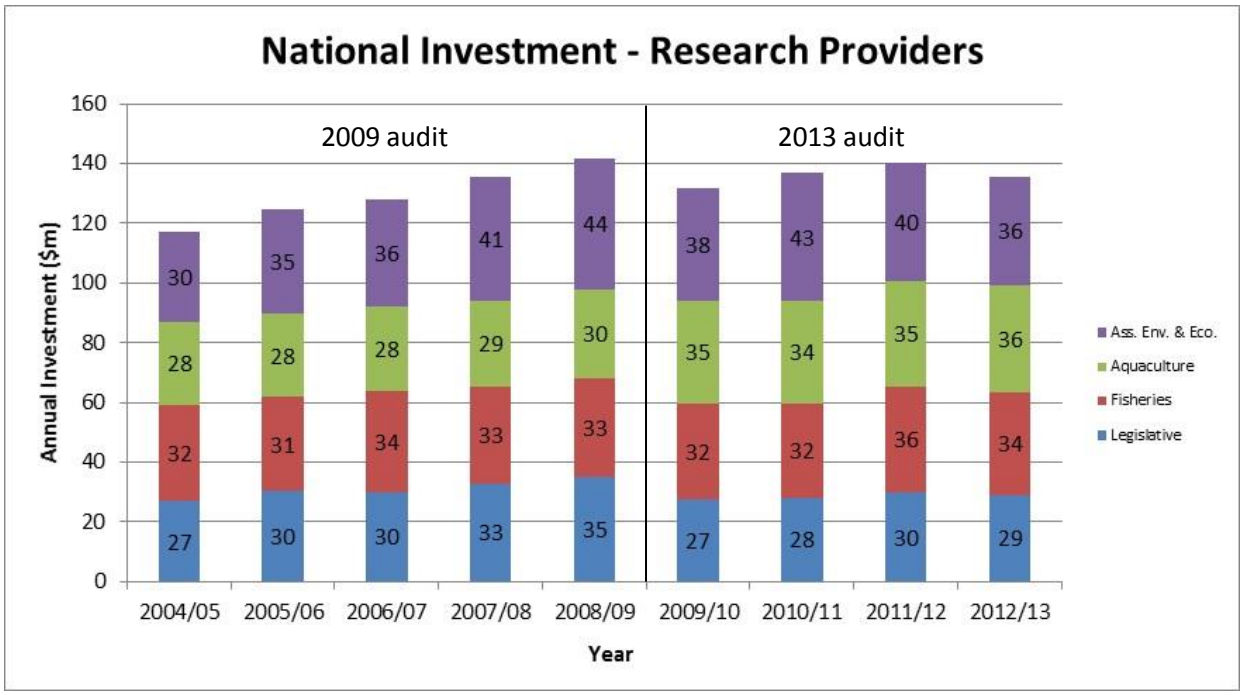

Figure 8. Key national research provider investment, 2004/05 - 2012/13

Key national research funding agencies reported a total average annual investment of approximately $33m for the financial years 2009/10 to 2012/13, ranging between just under $30m and $36m. The average annual investment from the 2009 audit was $35m (Figure 9).

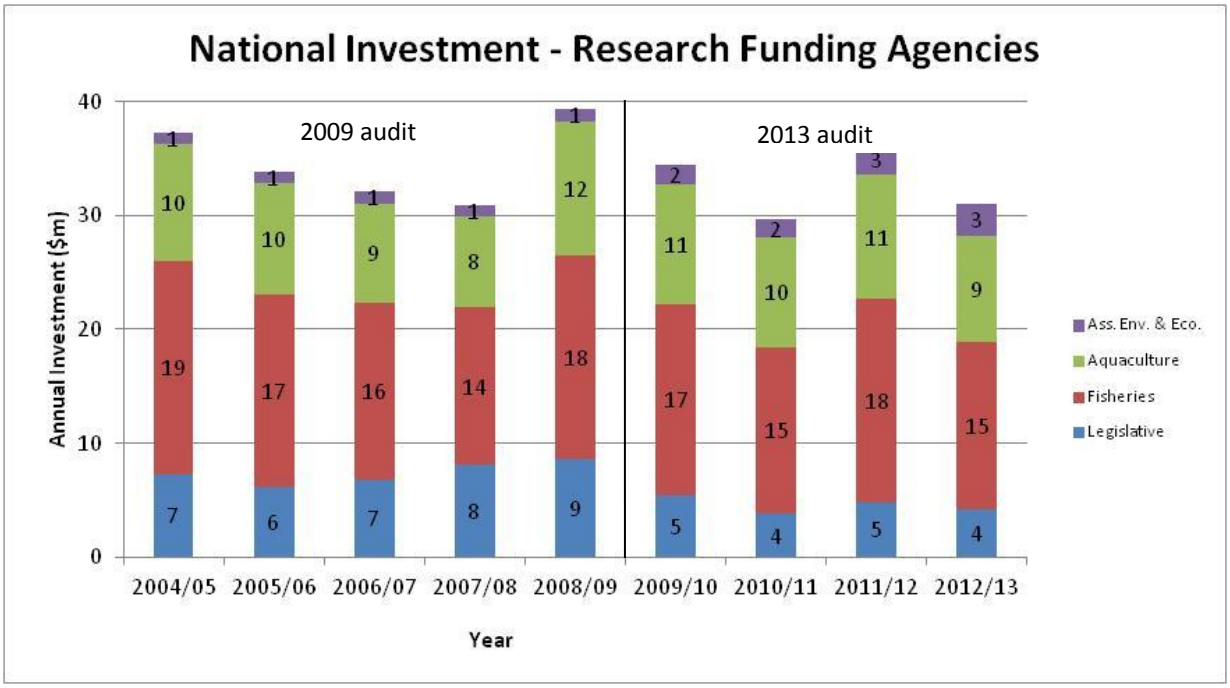

Figure 9. Key national funding agency investment, 2004/05 - 2012/13

Reported investment from funding agencies in Associated Environment and Ecosystems increased from $1m per annum in the previous audit to $2-3m per annum over the next four years. Investment in Legislative Requirements decreased after the previous audit and has remained relatively static. Both Fisheries and Aquaculture investment has remained relatively static over the nine year reporting period.

Appendix 1

Additional organisations

In addition to the 32 organisations that reported in both the 2009 and 2013 audit, 19 other organisations responded to the 2013 audit. These additional respondents were primarily from the university, museum and private sectors (refer to Table 2).

Capability

These 19 additional organisations reported a total of 131 FTE researchers, comprised of 98 FTEs (excluding the associated Environment and Ecosystem fields of research) and 33 FTEs within the Environment and Ecosystem fields of research.

Researcher FTEs by Capability Area and Area of Expertise as reported by all 51 institutions in the 2013 audit is presented in Table 5 and Figure 10. A total of 923 FTE researchers were reported in 2013, comprised of 666 FTEs (excluding the associated Environment and Ecosystem fields of research) and 257 FTEs within the Environment and Ecosystem fields of research.

Infrastructure

Seven of these additional organisations also provided information on infrastructure and capital items, reporting a capital value of approximately $153m – most of which was represented by three of these organisations [Museum Victoria and University of Sydney, (Southeastern region), and Griffith University (Northern Region)] - and comprised largely of accommodation, laboratories, education equipment and a library.

Table 5. Researcher FTEs by Capability Area and Area of Expertise as reported by all 51 institutions in the 2013 audit

Capability Area	Area of Expertise	2013 (FTE)	Total FTE)
Fisheries & Aquaculture	Taxonomy	14	308
	Fisheries Biology / Ecology (include ageing unless explicitly in next column)	90	
	Ageing (only if explicitly emphasising ageing capability)	11	
	Data management/programming	33	
	Stakeholder surveys / logbooks	17	
	Fish Surveys	30	
	Biometrics/ Statistics	23	
	Fisheries Modelling	39	
	Fisheries Assessment	52	
Aquaculture	Hatchery/ nursery	14	188
	Grow-out/ production	11	
	Broodstock management	13	
	Feed & Nutrition	27	
	Aquatic Animal Health	35	
	Genetics & genomics	55	
	Aquaculture systems & polyculture	34	

Capability Area	Area of Expertise	2013 (FTE)	Total FTE)
Gear & engineering	Gear technology	7	26
	Observational technology	15	
	Aquatic engineering	4	
Social Research	Anthropology	4	21
	Demography	1	
	Educational Research	4	
	Indigenous studies (including cultures)	6	
	Sociology	6	
Economic Research	Resources allocation	3	34
	Economic surveying	5	
	Economic assessment	8	
	Economic modelling	4	
	Productivity & Market analysis (incl. Supply chain)	7	
	Market access & trade	6	
	Commercialisation	1	
Post -harvest	Seafood Processing	10	28
	Seafood safety	18	
Governance & Management	Governance & Management	32	32
Communication /Extension Professionals	Communication / Extension (those working in the field – not researching this)	29	29
Environment and Ecosystems ^	Environmental impacts (incl. bycatch & wildlife interactions; biosecurity) ^	68	257
	Oceanography ^	18	
	Hydrology ^	4	
	Chemistry/ Biogeochemistry ^	15	
	Benthic Ecology (incl. habitat mapping & assessment unless in next column) ^	27	
	Habitat mapping (only if explicitly emphasising habitat mapping capability) ^	25	
	Pelagic ecology ^	17	
	Freshwater Ecology ^	34	
	Ecosystem modelling ^	50	

^ These Areas of Expertise were not included when we refer to capability excluding "Environment and Ecosystems"

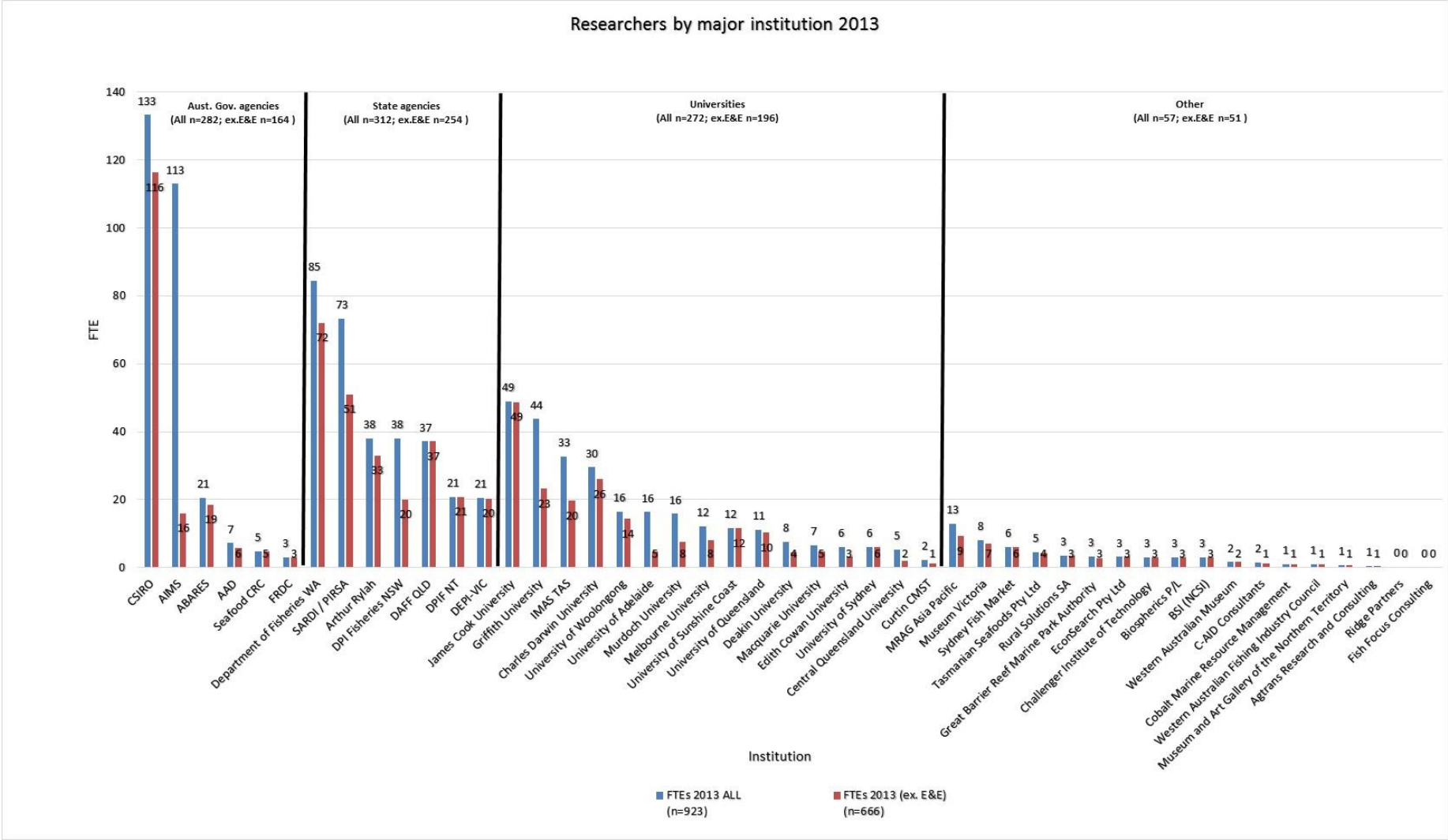

Figure 10. Researcher FTEs as reported by all institutions in the 2013 audit

Note: Organisations with less than 0.5FTE have been rounded down to 0 FTE. Some minor rounding errors in sub-totals may occur.