Northern Australia Aquaculture Industry Situational Analysis

Project A.1.1718119

Supplementary Data
(supporting Stage 1 Report)

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The author(s) confirm(s) that this document has been reviewed and approved by the project's steering committee and by its program leader. These reviewers evaluated its:

- originality
- methodology
- rigour
- compliance with ethical guidelines
- conclusions against results
- conformity with the principles of the Australian Code for the Responsible Conduct of Research (NHMRC 2018),

and provided constructive feedback which was considered and addressed by the author(s).

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABFA	Australian Barramundi Farmers Association
ACIAR	Australian Centre for International Agricultural Research
APFA	Australian Prawn Farmers Association
CoOL	Country-of-Origin Labelling
CRCNA	Cooperative Research Centre for Developing Northern Australia
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAWR	Department of Agriculture and Water Resources, Australian Government (existed between 2015 and 2019; now Department of Agriculture).
DoF	Department of Fisheries, Government of Western Australia (now part of DPIRD)
DPIR	Department of Primary Industry and Resources, Northern Territory Government
DPIRD	Department of Primary Industries and Regional Development, Government of Western Australia
FAO	Food and Agriculture Organisation of the United Nations
FRDC	Fisheries Research and Development Corporation
GBRMPA	Great Barrier Reef Marine Park Authority, a Commonwealth Government funded authority responsible for the care and protection of the Great Barrier Reef Marine Park (GBRMP)
ILSC	Indigenous Land and Sea Corporation
IRG	Indigenous Reference Group, an advisory committee to the FRDC
MT	Metric tonnes
NA	Northern Australia
NAC	National Aquaculture Council
NT	Northern Territory
ONA	Office of Northern Australia
ORIC	Office of the Registrar of Indigenous Corporations
P5F	Porter´s Five Forces analysis considers the competitive environment of a sector
PESTEL	Analysis that identifies political, economic, societal, technological, environmental and legislative conditions that influence a sector
PPA	Pearl Producers Association
QDAF	Queensland Department of Agriculture and Fisheries
QLD	Queensland
RAS	Recirculating Aquaculture System
SWOT	Strengths, Weaknesses, Opportunities, Threats analysis
TFK	Traditional Fishing Knowledge
WA	Western Australia
WSSD	White spot syndrome disease
WSSV	White spot syndrome virus

1 DOCUMENT STRUCTURE

This Supplementary Data document provides additional methodology and results from the Cooperative Research Centre for Developing Northern Australia's (CRCNA's) northern Australia aquaculture industry situational analysis Stage 1 Report (Cobcroft et al 2019) and Final Report (to be completed following stakeholder feedback).

This document includes methods and background for the online survey tool, and the PESTEL, Porter's 5 Forces and SWOT analyses undertaken with stakeholders in project workshops, along with the subsequent Scenario planning analysis approach. This is followed by chapters providing additional literature review content (aquaculture species, policies, infrastructure), detailed results of project gathering components, including industry Vision development. The key results and findings from these chapters are summarised in the Stage 1/Final Report. Extra information used by or gathered during the project is included in the Appendices.

2 APPROACH & METHODOLOGY

2.1 ONLINE SURVEY TOOL

A mixed methods approach was used to collect qualitative and quantitative data on the characteristics, activities, and perceptions of a wide range of stakeholders engaged in aquaculture in Northern Australia. Data collection methods included (1) an online survey using the Survey Monkey tool, which was administered in May – July 2019, and (2) a series of regional focus group meetings, which were conducted from May – July 2019. The online survey and focus group results are presented in **Sections 4 and 5** of this document, respectively.

2.1.1 Survey Instrument

The online survey was administered to 117 individuals engaged in Aquaculture in northern Australia and took approximately 20 minutes to complete. The survey collected data on general demographic characteristics, including role specific information (e.g. for producers, suppliers, researchers, etc.), perceived challenges for aquaculture in Northern Australia, and investment priorities for future expansion and RD&E. A convenience sampling strategy was used, which relied on the network of project partners and social media to ensure wide-spread distribution of the link to the online survey.

2.1.2 Analysis

The data was analysed using standard quantitative and qualitative methods to ascertain key trends and patterns in responses. The survey data analysis was largely descriptive due to constraints of the sample size, and IBM SPSS was used for the statistical analyses where possible.

2.2 PESTEL BACKGROUND

A PESTEL analysis is a systematic analysis of the business environment of a company or an industry. The PESTEL-analysis identifies political, economic, social, technological, environmental and legislative conditions that influence an industry (**Figure 2-1**).

A PESTEL analysis forms an integral part of any situational analysis, providing a systematic framework to assess the key external (macro-environment) forces that may influence an organisation or industry. Identifying and

analysing political, economic, social, technological, environment and legal environments can identify both opportunities and threats which can be further evaluated via a SWOT analysis[1].

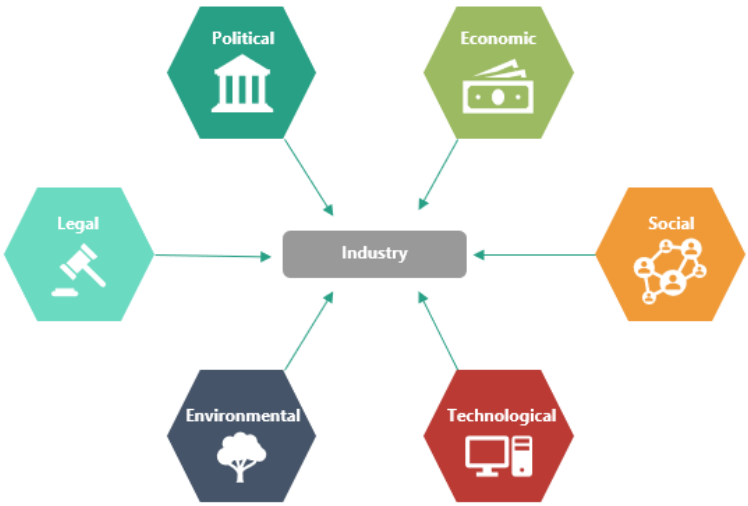

Figure 2-1: Diagrammatic representation of an industry sector environment considered by a PESTEL Analysis

A broad range of aspects (or business environmental conditions) are utilised to obtain a multi-visioned analysis of an organisation or industry's external environment (**Figure 2-2**).

P	E	S	T	E	L
Political	Economic	Social	Technological	Environmental	Legal
• Government policy • Political stability • Foreign trade policy • Tax policy • Labour laws • Terrorism and military considerations • Environmental laws • Funding grants and initiatives • Trade restrictions • Fiscal policy	• Economic growth • Interest rates • Exchange rates • Inflation • Disposable income (consumers) • Disposable income (businesses) • Taxation • Wage rates • Financing capabilities	• Population growth • Age distribution • Health consciousness • Career attitudes • Customer buying trends • Cultural trends • Demographics • Industrial reviews and consumer confidence • Organisational image	• Producing goods and services • Emerging technologies • Technological maturity • Distributing goods and services • Target market communications • Potential copyright infringements • Increased training to use innovation • Potential Return on Investment (ROI)	• Decline of raw materials • Pollution and greenhouse gas emissions • Promoting positive business ethics and sustainability • Reduction of carbon footprint • Climate and weather • Environmental legislation • Geographic location and accessibility	• Health and safety • Equal opportunities • Advertising standards • Consumer rights • Product labelling • Product safety • Safety standards • Labour laws • Future legislation • Competitive legislation

Figure 2-2: PESTEL Analysis Summary of topics used to assess the business environment for aquaculture in northern Australia. Template adapted from (PESTLE Analysis, 2019).

2.3 Porter's 5 Forces Model Background

An overview of the Porter's 5 Forces analytical model (P5F) is presented below in **Figure 2-3**.

[1] Originally created in 1967, Harvard Business School Professor Francis J. Aguilar wrote the novel 'Scanning the business environment'. This book introduced the analysis model of PEST but was referred to at the time as an ETPS analysis (Economic, Technical, Political and Social influences). Rearranging the letter made the PEST analysis easier to remember (and say) than the ETPS analysis. To this day the PEST analysis holds value to businesses however over time, this was revised to include E + L (Environmental + Legal influences), resulting in the now respected PESTEL Analysis.

***Figure 2-3: Diagrammatic representation of Porter's 5 Forces Model, adapted from* Jurevicius, 2013**

P5F analyses help generate a structured view of how the different external competitive forces can affect an industry and thus what opportunities and threats an industry is facing.

Created by Harvard Business School professor Michael Porter, Porter's 5 Forces model (P5F) (Error! Reference source not found.) identifies the five key forces that shape an industry's competitive environment, providing a framework for measuring competition intensity, attractiveness and potential profitability (Porter, 2008). Porter's model can be applied to any segment of the economy, the results of which may be used to inform a more detailed SWOT analysis.

2.4 SWOT Analysis Background

A SWOT analysis is a framework[2] used to evaluate an organisation's or industry's competitive position by assessing both internal and external strengths, weaknesses, opportunities and threats (**Figure 2-4**). Designed to facilitate a realistic, fact-based assessment, a SWOT analysis aids in strategic planning by identifying and leveraging strengths and opportunities to overcome weaknesses and threats.

[2] The SWOT framework is credited to Albert Humphrey, who tested the approach in the 1960s and 1970s at the Stanford Research Institute. Developed for business and based on data from Fortune 500 companies, the SWOT analysis has been adopted worldwide as a decision making and strategic planning tool.

***Figure 2-4: SWOT Analysis Framework adapted from* (RapidBI, 2016).**

Strengths and **weaknesses** refer to internal attributes and resources which **support** or **prevent** a successful outcome for an industry. Internal factors to consider include:

- Financial resources (funding, sources of income and investment opportunities)
- Physical resources (location, infrastructure, equipment)
- Human resources (employees, volunteers, management, government, scientists)
- Access to natural resources, trademarks, patents and copyrights
- Current processes (systems, engagement, collaboration)

Opportunities and **threats** refer to external factors which can be **leveraged for** or **jeopardise** the success of an industry. External factors to consider include:

- Market trends (products, technological advancements, consumer attitudes and preferences)
- Economic trends (local, national and international financial trends)
- Funding (grants, donations, legislature and other external sources)
- Demographics (population level and growth, education, age)
- Relationships between industry members
- Political, environment and economic regulations

2.5 Scenario Planning Background

The scenario planning analysis was undertaken using the Stanford Research Institute (SRI) approach, which is a qualitative but powerful method for large and broad-ranged industries and is one of the most commonly used methods for scenario planning.

The SRI approach consists of eight steps; 1) Analysing the decisions and strategic concerns, 2) Identifying the key decision factors, 3) Identifying key environmental[3] forces, 4) Analysing the environmental forces, 5)

[3] The term 'environmental' is used here in the context of the entire range of 'force-groups' and factors operating on an industry or business including global and macro- economic, political, social, technological, physical, ecological, social and human dimensions.

Defining scenario logic, 6) Elaborating the scenarios, 7) Analysing the implications for key decision factors and 8) Analysing implications for decisions and strategies.

Within step 5) of the approach, a 'cross-impact analysis' is performed to analyse the effect the different environmental forces have on each other and a 'morphological analysis' is performed to generate plausible combinations of factor variations within the scenario themes. The resulting scenarios are created in step 6) and the action plans are created in step 7) and 8). After the scenarios have been created a validation analysis is performed to ensure that the scenarios serve as an adequate basis for decision-making. The criteria the scenarios are evaluated by are: 1) Plausibility, 2) Consistency, 3) Creativity and coherence and 4) Relevance. To check for consistency, the scenarios are subjected to a consistency analysis.

2.5.1 Scenario Planning - Approach and Method

The final task for participants at each of the workshops was to undertake a short process to define (and/or confirm) several scenarios for the northern Australian aquaculture industry – essentially predictions of several different trajectories (and aligned to the 'Vision' statements) of industry development through to 2030.

The approach used in this exercise broadly followed the Stanford Research Institute (SRI) scenario planning methodology – a tool utilising a qualitative approach comprised of eight steps. Information for the steps has been developed from the online and industry surveys, the Focus Groups, and feedback from the PESTEL, SWOT and P5F exercises. An outline of the SRI methodology is provided in Error! Reference source not found.**Table 1**.

Table 1: An outline of the SRI scenario planning methodology

No.	Step	Details	Data sources and inputs
1	Analyse the decisions and strategic concerns	Define the scope of the analysis by: focusing on key decisions with long-range consequences; and identifying the goals of the industry during the planning horizon (2030) including:	Online Survey results Industry 'vision' statements CRCNA defined Scope 'outputs
2	Identify key decision factors	Key factors are: market size, capital availability, human resources, material resources, energy resources, environmental resources, economic conditions and price trends. The Survey data has added insight to this process.	Online Survey Industry data survey Government data survey
3	Identify key environmental forces	The key environmental forces shape the status of the key decision factors identified in step 2 and are typically economic, political, technological or social forces. They may include social and lifestyle factors, demographic patterns, economic conditions, ecosystems, natural resources, political and regulatory forces, international conditions and technological forces and have been developed .	SWOT analyses PESTEL analyses P5F analyses
4	Analyse the environmental forces	Analysis includes a discussion of critical uncertainties, trends, history and interrelationships among environmental forces. This analysis is intended to ensure that the driving forces for change in the scenarios are relevant to the purpose of the analysis and to ensure that the scenarios are plausible. For this assessment, each force is graded high, medium or low with respect to uncertainty and impact on the industry.	
5	Define scenario logics	Organizing themes that describe alternative futures. Examples of scenario logics are sellers' or buyers' market's and regulated or unregulated markets. These are not purely optimistic or pessimistic but represent both opportunities and threats for the industry. The scenario logics incorporate all the elements from the previous steps and provides the 'themes' for the scenarios to be created.	Informed by SWOT Focus Group input and feedback
6	Elaborate the scenarios	Elaboration of the scenario logics creates the full scenarios. The full scenarios comprise narratives describing the industry's situation in the future and the developments leading up to this future and were developed using the scenario logics in combination with the environmental force analysis.	Developed by Project Team (and to be tested via Final Focus Group meeting)
7	Analyse implications for key decision factors	Evaluate the implications of the scenarios created in step 6 with respect to the key decision factors identified in step 2.	
8	Analyse implications for decisions and strategies	The following questions were addressed: 1) Does information about the future validate the original assumptions supporting strategies or proposed decisions? 2) What do the scenarios imply for the design and timing of strategies?	

		3) What threats and opportunities do the scenarios suggest? 4) What critical issues emerge from the scenarios? 5) What special cases deserve to be addressed by specific contingency plans? 6) What kinds of flexibility and resilience do the scenarios suggest are necessary from a company/industry's planning perspective? 7) What factors deserve monitoring considering the information gained from the scenarios?	

Figure 2-5 illustrates a flow chart of the different steps in the scenario planning analysis method.

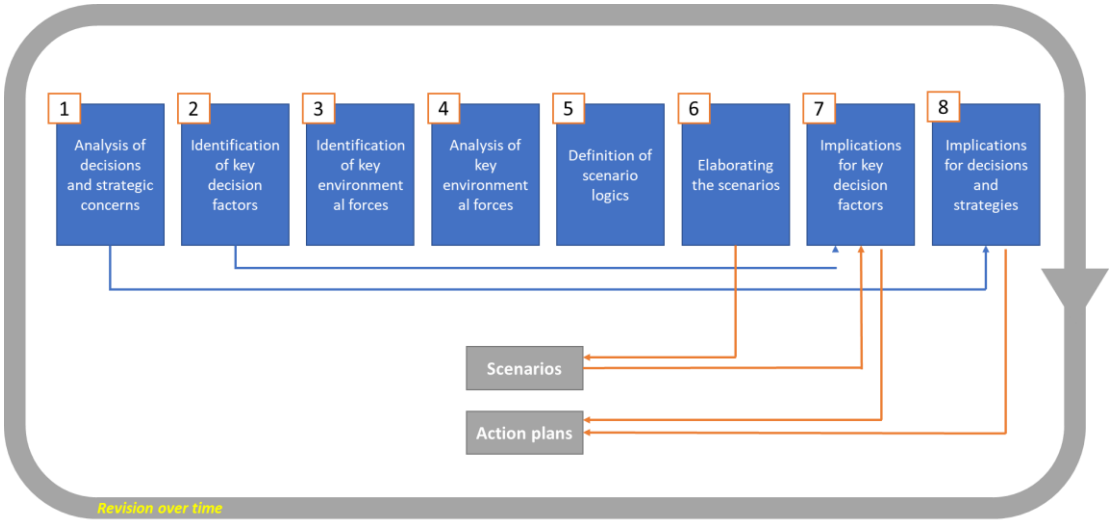

Figure 2-5: Flow chart of the steps and interrelationships in the scenario planning analysis method

The advantage of using the SRI approach is that it is a qualitative method, does not rely on mathematical algorithms and can develop flexible and internally consistent scenarios. The methodology is also well-suited for long term planning horizons, where the data being generated has originated from sources from within the industry. It is therefore well-suited to this project.

3 Literature Review

3.1 A Review of Current and Historical Aquaculture in Northern Australia

3.1.1 Species, Systems and RD&E

A project Literature Review was produced as a standalone document and includes a review of aquaculture species (established and emerging) in northern Australia, the history and status of Indigenous aquaculture in northern Australia, and the state of aquaculture biosecurity in northern Australia (Cobcroft and Jerry, 2019). The literature review is available from the Project team upon request. A summary of the aquaculture species considered in the Literature Review, relevant findings, and current RD&E gaps/priorities are presented in **Table 2**.

Table 2: Summary of literature review (biological and production) of northern Australian aquaculture

Species	Region	System	History	Current Activity	Weaknesses/threats	Strengths/opportunities	RD&E – Current needs
CRUSTACEAN: Black tiger prawns (*Penaeus monodon*) and Banana prawns (*Fenneropenaeus merguinensis*)	QLD (all except one farm)	Pond	• Farming of marine prawns in Australia began in the 1960's (School and King prawns) in SA and NSW. • In northern Australia, the first farming operations were initially at Seafarms, Cardwell and Flying Fish Point, before expansion to Townsville and Darwin in the late 1980's. • Industry has gradually expanded to current size of 900+ ha of ponds in production. • Production volumes and value of Australian prawn aquaculture has steadily increased and approximately doubled. • Significant outbreak of whitespot syndrome virus severely impacted farms on the Logan River, decimating stocks in 2017-18.	• Largest officially reported food producing aquaculture industry in northern Australia. • Several companies have, or are about to commence, active programs to produce domesticated lines. • Major farms situated north of Yamba NSW< and clustered around the Logan River, Mackay, Bundaberg, Townsville, Cardwell, Mission Beach and Port Douglas. • 24 active licences. • QLD industry expected to significantly expand due to reactivation of several nascent farms near Proserpine and Mission Beach by Tassal, along with the identification of six Aquaculture Development Areas (approx. 7,048 ha) in Queensland in 2018. • Currently no pond production in WA and NT, although major development proposed for the NT which aims to establish a 10,000ha farm over the next 10 years. • Industry presently served by 9 licensed hatcheries and employs between 300-350 staff. • Banana prawns only farmed at scale on one QLD farm.	• Tiger prawns have proven particularly difficult to domesticate due to reproductive, fertility and larval quality problems. • Reliance on wild-caught broodstock to produce the post-larvae for pond stocking. • Poor biosecurity options due to reliance on wild broodstock	• Marine prawn growth linked to temperature, with optimum growth realised above 25°C. Sustained higher temperatures experienced in far northern Australia allow most farms to produce 2 crops per year. • Marine prawns are robust to farm. • Banana prawns have been domesticated at Seafarms in Cardwell for over 20 years.	• Prawn aquaculture industry was the first Australian seafood sector to implement a compulsory federal levy based on production aimed at funding R&D. • Industry currently raises around $300,000 annually to invest in R&D. • R&D strategic priorities include research into genetics, selective breeding, and post-larvae production (especially domestication), Specific Pathogen Free (SPF) stock, improving farm efficiency, improved nutrition and disease, and biosecurity. • Several major government funded projects to domesticate black tiger prawns, as well as efforts by industry, but these have not been overly successful in regard to leaving a legacy of large numbers of domesticated families.
FINFISH: Barramundi (*Lates calcarifer*)	WA, NT, QLD (also: NSW, VIC, SA)	Marine sea-pens, brackish and freshwater ponds/ raceways, RAS	• Hatchery breeding technologies were first trialled in Australia at the Northern Fisheries Centre Cairns (Queensland Department of Primary Industry) in 2986 in an effort to develop an impoundment stocking program for Tinaroo Dam and local rivers and estuaries. • In 1986, the first Australian commercial aquaculture operation to farm barramundi was established by Sea Hatcheries Limited, Innisfail.	• The industry represents approximately 370 licence holders. Most of these registered farms are not commercial producers but have the species attached to their licences in Queensland if they hold or stock barramundi into farm dams. • Production volume of barramundi is primarily dominated by nine companies which produce approximately 95% of Australian grown product. • The majority of farmed barramundi originates from production in Queensland (approx. 50%), although there has been rapid expansion of farms at Humpty Doo (NT) and Cone Bay (WA) resulting in increasing production. • According to ABARE data, in 2017 the industry produced 4,000 tonnes of fish valued at $40 million, however this does not include farms in the NT or VIC due to confidentiality concerns. The Australian Barramundi Farmers Association estimates total industry production of 7,000+ tonnes annually. • Barramundi production is derived from only 170 ha of ponds/raceways/sea-pens or tank-based production systems. • More than 90% of Australian barramundi production comes from farms in northern Australia. These farms target production of large fish (2.5kg+) which are sold whole to wholesalers, retailers and food service providers. • The barramundi industry in northern Australia directly employs 150+ people.	• Approximately 11,500 tonnes of product is imported annually (primarily from Thailand, Vietnam, Singapore and Indonesia), the product must be sold under the name "Barramundi" which Australian consumers associate with Australian products.	• Particularly hardy species ideal for aquaculture as it is euryhaline (can tolerate freshwater to full marine salinities), fast-growing, weans onto an artificial pellet relatively easily, has a good food conversion ratio and can be farmed at high densities. • The Australian market for barramundi estimated to be around 16,000-20,000 tonnes pa, with only 8,500 tonnes currently sourced domestically.	• In its 2015-2020 Plan, the Australian barramundi industry identified seven strategic RD&E priorities: 1. Market differentiation for Australian barramundi 2. Consistent high-quality Australian product to meet consumer preferences 3. Effective management of biosecurity risk 4. Awareness of farm productivity and management options 5. Sustainable barramundi production systems 6. Effective regulatory frameworks to support Australian barramundi farmers 7. A resourced national industry body that delivers outcomes
MOLLUSC: Silver-lipped pearl oyster (*Pinctada maxima)*	WA, NT Also QLD (primarily eco-tourism)	Long-lines	• Valued at its highest in 2006-2007 at $122m per annum, the Australian pearl oyster farm industry has been steadily declining due to both economic and production limitations. • During the more productive years, approximately 980 people were directly employed in pearl farming or farm-related activities in the NT. Since then, the effect of	• The Australian pearl oyster farm industry is valued at approx. $70m per annum. • Currently over 65,000 ha of pearling lease (open water and aquaculture farms) located across the north-west WA bioregion and north-coast NT bioregion. • Australian pearl industry currently relies on the collection of wild-caught pearl oyster from WA	• There has been a global reduction in the value of pearls following the global financial crisis in 2007-2008. • The rapid emergence of low-cost Asian pearls poses a significant threat to the Australian pearl industry, particularly given the increasing cost of labour and infrastructure limitations in	• Pearl production requires pristine conditions, whereby animals must be reared in clean, nutrient rich, tropical waters. The mega-tidal waters of northern WA and other farms located in parts of the NT produce these highly desirable environmental conditions and as such produce superior quality pearls.	• A thorough understanding of the disease mechanism that causes JOMs is an important step in limiting the impact of this disease on the industry. Research partnerships are currently in place to address this need, but given the difficulty in identifying the agent, further research is urgently needed.

			the global financial crisis has resulted in further rationalisation of employment.	zones, although some hatchery produced animals are now utilised to supplement the wild animal quota. • WA and the NT are the only remaining Australian locations where an active viable pearl oyster industry is found. Although there are a few small farms remaining in far north QLD, these are mainly focused on eco-tourism activities.	remote regions hindering the ability to compete on price. • Since 2006-2007 the industry has suffered significant mortalities of juvenile animals due to an emerging disease, resulting in lost stock and revenue and the closure or sale of several farms. • Increased seismic survey activity off the WA coast has raised concerns regarding the potential effect on pearl oyster health, recruitment and ecosystem structure.	• Hatchery-based production of pearl oysters would remove the legislative and logistic limits imposed on pearl oyster production.	• Need for improved understanding of key production traits and genetic contribution. • Establishing a selective breeding program, providing an alternative mechanism to identify and select JOMs resistant animals.
CRUSTACEAN: Redclaw (*Cherax quadricarinatus*)	QLD and NT (also NSW)	Ponds	• Production has remained around 65 to 100 tonnes/year for the past decade, the vast majority of which is marketed domestically.	• Redclaw aquaculture in Australia is poised for significant expansion. The availability of suitable land and water throughout northern Australia has the potential to increase production to several thousand tonnes/year. • Historically, redclaw farms generated their own seedstock through managed reproduction in the ponds. However, new hatchery technology has been developed to mass produce craylings for supply to grow out farms. • Most existing redclaw farms are less than 4 ha in pond area. With significant economies of scale to be achieved, new investment should be sought for larger farms.	• Challenge for industry is to increase production, through expansion and new investment, to be able to consistently supply quantities required by identified export markets. • Although successful in producing large numbers of craylings, the production results from ponds stocked with craylings are highly variable; a nursery stage will be necessary to generate advanced juvenile crayfish for pond stocking.	• Robust species with broad geographic potential. • Relatively easy to breed, easy hatchery culture phase and straight forward production technology. • Requires simple foods and is economic to produce. • Texture and flavour of the flesh compares favourably with other commonly eaten crustaceans. • With an appearance similar to lobster, it is positioned at the premium end of the crustacean market spectrum. Current wholesale prices in Australia are around $25-$25/kg. • Growth potential for the industry lies with the substantial export demand, particularly from China.	• Targeted research in three areas is critical: 1. practical diet formulation 2. up-scale novel hatchery technology necessary for significant expansion 3. perfect nursery practices to generate mass production of advanced juveniles
CRUSTACEAN: Cherabin (*Macrobrachium spinipes*)	WA	Ponds	• No commercial production previously in Australia. • One hatchery in northern Queensland provided juveniles to stock farm dams from 1988 for three years. • Early culture attempts failed, reporting various problems including low larval survival, excessive cannibalism, lack of technical expertise and infrastructure to produce postlarvae consistently, and disease. • R&D supported by ACIAR and JCU established reliable juvenile production techniques for the lineage II Cherabin from northern Queensland. • No commercial take-up of that technology, likely due to variation in growth rate to market size.	• R&D underway to develop hatchery technology and grow-out in WA, in partnership with Traditional Owner businesses.	• Unequal (heterogeneous) growth rates. • Technical challenges with replicating successful hatchery production. • Four genetic lineages in Australia with likely different amenity to culture.	• High value species with the market price likely to be $35/kg for farmed product sold directly to restaurants in WA. • Traditional food of Indigenous communities and option for Indigenous branding. • Large (>60g) prawns will not compete with the marine prawn market.	• Develop reliable and repeatable hatchery technology and juvenile supply. • Growout diets, growout production systems, and feeding regimes to reduce growth rate variability. • Comparison of aquaculture performance of the four different lineages to determine the most suitable for commercial production.
CRUSTACEAN: Tropical Spiny Lobster (*Panulirus sp.*)	QLD	Ponds, RAS, sea-pens	• No aquaculture production history in Australia. • Hatchery technology ready for commercialisation. • Existing industry for grow-out of wild-caught puerulus (juveniles) in Vietnam and expanding in Indonesia and the Philippines.	• $15M pilot hatchery being built in Tasmania, juveniles to be grown to market size in Queensland. Anticipate hatchery product to market in 2021. • Purchase and investment in land-based nursery facility in Queensland. • Growout planned for Queensland and Torres Strait. • $100M investment predominantly for Queensland for full-scale hatchery and growout. • Goal 100 T industry by 2030.	• Ability to upscale hatchery technology. • Need to develop commercial-scale land-based nursery and growout systems suitable for Australian conditions. • Access to sites, staff and infrastructure for sea-pen growout in remote locations in Queensland. • Unknown health and production challenges for commercial growout.	• High value (>$80/kg, live), iconic Australian seafood product with established markets, especially in Asia. • High (insatiable) market demand from Asia.	• Land-based nursery and growout technologies. • Health diagnostics, surveillance and management.
CRUSTACEAN: Slipper Lobster (*Thenus sp.*)	QLD (also NSW)	Ponds, RAS, raceways	• Early culture attempts in Queensland during the 1990s, with commercial outcomes currently being tested in a purpose-built facility for *Thenus* in northern NSW for small soft-shell product, with commercial-in-confidence results. • Application of spiny lobster technology in Tasmania for successful slipper lobster production at R&D scale.	• Unknown production from NSW farm. • $6M purchase and investment in hatchery facility in Queensland. Anticipate operational in 2020. • Anticipate product to market by end 2020. • Goal 500 T industry by 2030.	• Need to develop commercial-scale land-based growout systems.	• Shorter lifecycle than spiny lobsters, easier hatchery production, less cannibalistic. • Growout in 9 months. • High value (>$25-50/kg), with established markets. • No scope for increased wild fishery yield.	• Land-based nursery and growout technologies. • Health diagnostics, surveillance and management.
CRUSTACEAN: Mud crab (*Scylla serrata*)	NT, QLD (trial only)	N/A	• Largely based on the stocking of wild-caught crablets, mud crabs have been farmed in China for more than 100 years and in several other Asian countries for around 30 years.	• Currently, no commercial mud crab farm operating in Australia, however there is some commercial interest.	• Expansion limited by supply of crablets. • Legislation currently prevents collection of wild mud crab seeds for aquaculture.	• Fast growing. • Past projects provide basis (knowledge and techniques) for expansion. • Strong domestic and international demand.	• Refine hatchery production technology to produce consistent and high-quality crablets for growout.

			• In Australia, legislation prevents collecting of wild mud crab seeds for aquaculture. • Growout of *S. serrata* was trialled in Australia during the late 1990's and 2000's in NT and QLD, with hatchery produced crablets from two major R&D projects funded by ACIAR and FRSC respectively. • All growout trials were small-scale and ceased at the closure of the projects.	• Significant investment in R&D is required to establish an industry in northern Australia.	• Hatchery larval survival is highly inconsistent and mostly very low.	• Potential for ranching in mangrove systems. • Indigenous engagement (traditional food source).	• Methods to mitigate aggression and cannibalism. • Polyculture of mud crabs with other aquaculture species.
FINFISH: Grouper (rock cod) (*Epinephelus sp.*) and coral trout	QLD	Ponds, RAS, pens in saline lakes	• Several grouper species cultured in China and south East Asia; recent production 108,000 tonnes in China. • Australia has focussed R&D on sustainable intensive hatchery production of high-quality grouper juveniles in Queensland.	• One hatchery supplier in Cairns, Queensland. • Grouper being assessed as an alternative species for prawn farms in southern Queensland and supplied to RAS farms. • Some fingerling supplied for growout in RAS in Hong Kong and ponds in Taiwan.	• Nodavirus causing mortality in growout - risk reduction underway through vaccine development R&D. • Relatively high price for juveniles. • Limited uptake of Australian producers for grow out.	• Groupers can be farmed in prawn ponds without significant modification of pond infrastructure.	• Market and value-added product development in giant grouper (e.g. live, processed whole, processed whole and packaged, processed (portions) and packaged), in domestic markets and for export, particularly important if the scale of production increases in Australia to avoid a price decrease. • Optimum land-based production systems for grouper. • Diagnostics, surveillance and development of health management plans for challenges to grouper health in different growout systems. • Improved hatchery efficiency of giant grouper and other grouper species to diversify species available for growout and mitigate potential market fluctuation. • Selective breeding of grouper to increase growth and disease tolerance.
FINFISH: Cobia (*Rachycentron canadum*)	QLD	Ponds, pens in saline lakes	• Internationally, 40,000 tonnes p.a. produced from aquaculture. • Cultured in coastal sea-pens throughout Asia, with the main producers being China, Taiwan and Vietnam. • Off-shore submersible pens used for culture in the Caribbean. • R&D commenced in Queensland in 2006, growing the industry to 100 tonnes p.a. and $1M by 2016.	• 100 tonnes production per year in northern Queensland from one farm. • Cobia being assessed as an alternative species for prawn farms in southern Queensland in RAS and pens in saline lakes.	• Restricted to land-based production systems in Queensland. • High growth rates, feed consumption and waste production place challenges on maintaining optimal high-water quality. • Health challenges in pond production systems. • Prawn pond infrastructure requires modification to optimise production efficiency. • Unreliable supply of juveniles. • Unknown Australian market acceptance for higher production volume.	• Fast growth to 4-6 kg and 2-3 kg in just over 1 year (60 weeks), in northern and southern Queensland respectively. • High quality, award-winning product and demonstrated market with high-end restaurants and caterers in Australia. • Production performance likely high in a sea-pen culture system.	• Under the current pond-based model of production, research is required in: 1. the evaluation of growout performance in deeper plastic-lined ponds designed for the species; 2. cost-effective effluent treatment and water re-use strategies; 3. use of recirculation aquaculture systems for indoor nurseries; 4. development of cobia feeds for sub-adults (>2 kg) tailored to minimise waste production and/or facilitate waste collection; 5. development of cobia strains more amenable to pond-based culture; and 6. the epidemiology of common diseases and adequate disease treatments.
FINFISH: Other freshwater and marine species (freshwater - silver perch, jade perch, Murray cod, eel-tailed catfish, sleepy cod, barramundi cod, and silver cobbler; marine – snubnose pompano)	QLD	Ponds, RAS	• There are several native species of freshwater fish produced for aquaculture in northern Australia. • They have different characteristics suited for culture, with information on silver perch and Murray cod readily available.	• Limited production in northern Queensland. • Periodic interest from potential investors and aquaculture farmers.	• Relatively small/boutique-scale of production.	• Several species highly valued in domestic markets and Asian restaurants. • High market demand for Murray Cod in Melbourne and Sydney and potential for export to Asia. • Silver cobbler has been identified as a promising new species as it is fast-growing and suitable for freshwater aquaculture. Potential ability to adapt existing catfish culture technology.	• Commercial scalability of other tropical species (e.g. sooty grunter, jungle perch and sleepy cod). • Improvements in production efficiency. • Integration with prawn aquaculture.
MOLLUSC: Black-lip rock oyster (*Saccostrea echinata*)	QLD, NT, WA	Long-lines	• Several small farms have existed across the Pacific region since the 1970s. • Low numbers of wild spat recruitment and lack of hatchery production have prevented expansion.	• Several small-scale experimental farms in indigenous communities in the Northern Territory and also in Bowen (Queensland). There is currently renewed interest in farming the oyster in Northern Australia.	• Shellfish quality assurance standards need to be met - including naturally occurring Cadmium levels in some regions of NA. • Reliable spat supply is a current bottleneck to industry expansion. • Translocation protocols yet to be developed - potential biosecurity risks in translocation.	• Limited technology and machinery required. • Fast growth rates. • Relatively hardy species. • Filter feeder requiring no feed input. • History of Indigenous Australians eating the species.	• Understanding the genetic distribution of tropical rock oysters – this is necessary to inform a risk assessment of rock oyster movement risks and help define oyster growing regions policy for northern Australia. • Securing consistent spat (juvenile) supply – this includes both evaluation of wild spat collection

						• Potential use in multitrophic aquaculture systems.	methods and developing broodstock conditioning and spawning/larval rearing procedures. • Optimising gear technology – this includes determining the relative performance of gear technology through field trials. • Use in multitrophic systems in conjunction with fed aquaculture.
MOLLUSC: Abalone (*Haliotis asinina*)	QLD, NT, WA	Land-based slab tanks, ranching or sea pens	• No known aquaculture production of tropical abalone in Australia. • Pilot scale trials have been conducted in Queensland and Western Australia.	• No history of production, but periodic interest from other established aquaculture farmers of fed species in Australia.	• Softer meat texture than temperate abalone which is less favoured in Asia- commands a lower price. • Active species, particularly at night, less suited to Australian farming system - slab tanks.	• Fast growth rates, will spawn in captivity, extended spawning period (Oct-April), established market. • Reaches market size in 1 year. • Large Asian market. • Can be used in IMTA approach with other fed species (e.g. fed algae growth on barramundi or prawn wastewater). • History of Indigenous Australians eating the species.	• Dedicated artificial feeds. • Viability of sea ranching - perhaps more suitable than land-based tanks given active behaviour. • Use in multitrophic systems in conjunction with fed aquaculture.
MOLLUSC: Tridacnid clams (*Tridacna sp.* and *Hippopus sp.*)	N/A	N/A	• Agencies across the Asia-pacific (including JCU) collaborated to close the lifecycle and develop appropriate hatchery technology for clam species. • Due to the cost of maintaining a hatchery, the development of commercial operations was spasmodic across the region and there are only a few programs currently active.	• One company selling tridacnid clams from south-western Australia (licence to collect *T.gigas* from the Cocos (Keeling) Islands.	• Limited access to high-quality broodstock (rare and protected from collection). • Wild harvest of the True Giant Clam (*T. gigas*) is illegal as they are a protected species under CITIES, although permits may be obtained for scientific purposes. • Survival rates from fertilised eggs through to settlement of juvenile clams is extremely low (~0.1%). • Relatively slow growth rates. • Challenging transport and logistics due to size and nature of product and distance to major markets.	• Significant demand for product as food source and for aquarium species. • High value product.	• Increase survival of seed stock. • Increase growth rates. • Improve spawning induction methodologies. • Improve parasite control.
MACROALGAE (seaweed): Ulva species (*Ulva ohnoi, Ulva tepida*)	QLD	Raceway ponds	• The production of seaweed in Australia is a nascent industry, with no production recorded in the annual ABARES statistics. However, in northern Australia harvest of approximately 25 tonnes is expected for 2019, the majority of which will be turned into plant bio stimulants.	• Two species of edible, green seaweed (in the genus *Ulva*) are commercially cultivated in Northern Australia. • Cultivation occurs in land-based ponds for the bioremediation of discharge water from the production of prawns and fish. • *Ulva ohnoi* is cultivated as a vegetative form (from broken fragments) without the natural occurrence of cyclic reproductive events as is characteristic for this genus. • *Ulva tepida* is cultivated as an attached and vegetative form, with a reproductive cycle that can be manipulated to support managed cultivation and harvesting. • Both species are edible and sold dried as aosa and aonori in Japan and SE Asia.	• Limited domestic market.	• *Ulva ohnoi* has a broad range of environmental tolerance from 15 to 45 ppt salinity and 15°C to 35°C. • *Ulva tepida* has an even broader environmental tolerance and can be cultivated in salinities ranging from 10 to 55 ppt salinity and tolerates freshwater exposure. It also tolerates temperatures up to 40°C. • *Ulva tepida*'s 14-21 day reproductive cycle can be manipulated to support managed cultivation and harvesting. • Particular potential for cultivation when used in an Integrated Multi Trophic Aquaculture system, whereby it acts as both a food source and waste absorbent.	• No fundamental R&D impediments for the commercial production of *Ulva*, or most species of endemic seaweed in northern Australia. The R&D of endemic species is essentially a technology transfer exercise, utilising established methods, particularly from SE Asia. • The key R&D focus revolves around the market potential and business planning of a seaweed industry for northern Australia. The first step in the potential of industry growth is a comprehensive business analysis for markets and production costs in remote locations in northern Australia. • Research on the reproductive, environmental tolerance, production methodologies, harvest and post-harvest processing of seaweeds would need to be delivered to establish an industry in northern Australia based on market demand.
MICROALGAE: *Haematococcus pluvialis*, Astaxanthin production	QLD	Raceway ponds	• Limited historical production within Australia. • An industry-led research project has culminated in the development of a greenfield site for production of *H. pluvalis* with the extracted astaxanthin sold into the human health supplement market.	• Small scale production (<1ha) in QLD with Astaxanthin marketed as a human health supplement.	• Due to high production costs and low tolerance to high temperatures industry growth in Northern Australia is limited.	• Growing global demand for natural astaxanthin. • By 2020 global industry is expected to be 670 t valued at USD 1.1 billion.	• Optimise culture techniques to minimise contamination and improve yields.
MICROALGAE: *Dunaliella salina*	WA	Natural salt lakes	• *Dunaliella salina* is a type of halophile green micro-algae especially found in sea salt fields. • Known for its antioxidant activity because of its ability to create large amounts of carotenoids, it is used in cosmetics and dietary supplements.	• More than 900ha of pond production in WA, which is the largest commercial production in the world. • The carotenoid is sold in several forms with prices for natural β-carotene ranges from about US$300 to 3000 kg^{-1}, depending on the product type and the market demand.	• Relies on natural slat lakes for production.	• Strong increasing demand with the market expected to grow to be more than US$300 million by 2020.	• Research focused on increasing production, downstream processing of the algae and the efficacy of the pigments.
CYANOBACTERIA: Spirulina (*Arthrospira platensis*)	NT	Raceway ponds	• Limited historical production in Australia (one facility). • Although the company has been established for over a decade, production at economically sound levels was only achieved with the	• Only one commercial culturing facility in Australia (Darwin). • Over 95% of product is shipped to Japan and Taiwan.	• Due to intensive labour costs in Australia, the potential for new production in northern Australia is limited. • High costs of nutrients.	• Boutique market (only 0.3% of total algae production worldwide). • High-value product.	• Previous R&D has focused on improving production, downstream processing, and product development.

			importation of a foreign strain (from Taiwan), rather than cultivation of a local species.				• R&D required for cultivation in nutrient rich wastewater rather than supplementation with inorganic nutrients. • Greater efficiency in gas exchange for shallow ponds. • Greater focus on downstream processing, in particular economic drying and pigment extraction.

Key:

- Established current, significant species/operations
- Historical or current, minor species/operations
- Historical or current, emerging species/operations

3.2 Aquaculture Industry Strategic Policy – Historical Review

3.2.1 Government Policy

3.2.1.1 ***Commonwealth***

3.2.1.1.1 Aquaculture Action Agenda – Discussion Paper 2001

Relevant to this review, is a consideration of the findings of the 2001 Aquaculture Action Agenda (DAFF, 2001) and to provide a scorecard assessment of how the identified opportunities have been developed and impediments removed (**Table 3**).

Table 3: 2001 Aquaculture Action Agenda (+20 year scorecard). Score scale 1-5 where 1 is no action and 5 is complete.

Aspect	**Score** (1 – 5)	**Comments**	**Score** (1 – 5)	**Comments**
Vision		**Total Industry (southern)**		**Northern Industry**
By 2010 a sustainable and rapidly growing Australian aquaculture industry will achieve at least $2.5 B in sales by being the world's most globally competitive aquaculture producer.	3	Total industry • GVP (2010) ~ $800M • GVP (2017) ~$1 B • 2027 target GVP $2B Southern Australian aquaculture – growth has been strong	1	Northern • GVP (2016-17) ~$241 M • GVP (2030) o 10x – $2.5B o 5x – $1.0B o 2x – $1.0B Northern Australian aquaculture – growth has been weak, largely contributing to undershooting the overall target…
Impediments and Opportunities				
Communications and Promotion ▪ Lack of industry cohesion on national issues ▪ Opportunities to develop stronger linkages between stakeholders ▪ Lack of industry and product promotion.	3		2	
Resource Access and Sustainability ▪ Lack of available and suitable sites for aquaculture ▪ Delays in gaining access to resources ▪ Lack of security of tenure ▪ Minimising any adverse impacts of aquaculture on the environment and other resource users	4		2	
Investment Environment ▪ Encouraging investment in aquaculture ▪ Improving tax treatment of aquaculture businesses ▪ Improving marketing capabilities ▪ Identifying key markets in Australia and overseas ▪ Removing barriers to international trade in fisheries products ▪ Exploiting aquaculture industry's competitive advantages	4		3	

Regulatory framework ▪ Removing administrative burden of regulation on aquaculture businesses ▪ Ensuring regulation meets government and industry needs	4		2	
Research and Development ▪ Increasing funding for aquaculture R&D ▪ Keeping current R&D focussed on meeting core needs ▪ Improving transfer of R&D between researchers and industry ▪ Improving management and protection of intellectual property	4		4	
Education and Training ▪ Improving access to education and training resources that industry needs at all levels ▪ Improving work practices and workplace environment	4		2	

The above high-level review indicates that the southern aquaculture industry has been largely successful in leveraging its opportunities and managing impediments. However, by contrast, the northern aquaculture industry has not been anywhere near as successful in its achievements. Some reasons for this – as indicated from our surveys and focus group results – are outlined in discussion of the **Error! Reference source not found.** (Irvin et al., 2018) in Appendices **Section 11.1**.

3.2.1.1.2 Seafood Origin Information Working Group Papers

In June 2017, the Commonwealth Department of Industry Innovation and Science (DIIS) released the results of its *Seafood Origin Working Group Paper: Consumer access to seafood origin information in the foodservices sector* (DIIS, 2017). The Working Group was convened following the Government's response to Recommendation 9.1 of the Productivity Commission's *Marine Fisheries and Aquaculture Public Inquiry* contained in the Final Report of 2017. Recommendation 9.1 was that:

> *Governments should not extend mandatory country-of-origin labelling to seafood sold for immediate consumption. Country-of-origin labelling to seafood sold for immediate consumption should be on a voluntary, industry-initiated arrangement.*

The Government's response to the Productivity Commission's recommendation was to 'note the recommendation' (and that the *Country of Origin Food Labelling Information Standard 2016* exempted seafood sold for direct consumption in the food service sector), but undertook to implement a 'working group of stakeholders to consider options for improving country of origin labelling for seafood in the food services sector'.

The working group report concluded that on balance mandatory country of origin labelling (CoOL) would impose a significant, prohibitive and unnecessary financial burden on the food services industry (DIIS, 2017). Specific comments and findings (summarised) were:

- Seafood is widely consumed in Australia, and there is evidence some consumers may be incorrectly assuming all seafood in foodservice is Australian origin. However, these misperceptions do not appear to pose a risk to public health or consumer detriment, and there are commercial opportunities for businesses to increase consumer awareness about seafood origins through education and marketing. Interested consumers are also able to seek out origin information when it is not provided as a matter of course.

- There is no current statutory requirement on foodservice businesses to disclose seafood origin information to consumers. However, the department understands businesses generally have transparent traceability avenues for seeking origin information if/when requested by customers.
- When origin information is not voluntarily disclosed, consumers are able ask foodservice staff for additional information or choose alternative meals. Although some consumers may experience difficulty or ambiguity obtaining origin information when staff must make enquires, the ACCC advises it receives negligible complaints about seafood origin information in foodservice. Australian Consumer Law prohibits foodservice businesses from making false or misleading origin claims.
- The Australian Government's 2016 reforms to origin labelling were specifically designed to address consumer information asymmetry unique to retail purchases of food. This same origin labelling is unlikely to be appropriate in foodservice, since consumers are less dependent on labels for product information and foodservice businesses deal with day-to-day variability in food preparation.
- The NT Government has had seafood origin labelling requirements for foodservice since 2008, and the NSW Government is consulting on options for NSW. Industry-led avenues for improving consumer awareness about seafood origins may also be possible through Seafood Industry Australia (recently established with support from the Australian Government) and the Fisheries Research and Development Corporation (being enabled through new legislation to enhance its marketing).

The report also noted that:

- While Seafood Industry Australia (SIA) is still in its start-up phase, SIA could in time play a role strategising seafood marketing campaigns for domestic and international markets aimed at increasing consumption and community awareness. For the seafood industry, SIA is an industry-led opportunity to penetrate the consumer market with greater effectiveness than smaller campaigns trialled across the industry. SIA may be able to leverage the experiences of existing industry-led RDCs, which employ marketing campaigns to proactively promote their respective industries.

The main Report was followed by an addendum containing further background information and summarised the overall findings of the Working Group which were:

- 3.2. There are over 77 000 foodservice businesses in Australia, comprised of cafes, coffee shops, caterers, fast food, pubs, bars, nightclubs, restaurants and social clubs.
- 3.3. If mandatory seafood origin information was introduced, all 77 000 businesses would face a once-off direct cost to learn about the new regulation to determine if/how it applies to them. This might include senior staff reading through regulation; perhaps calling the department's helpline (as seen during the retail origin labelling reforms); attending an information seminar; seeking legal advice if concerned about interpretation or risk; and they might speak to their seafood suppliers about the type of origin information they can provide.
- 3.4. Those foodservice businesses which are affected by labelling would then face a further once-off direct cost to transition to the new regulation. This may consist of: updating their menus, which may include redesigning printed menus, ordering new non-temporary menu boards, and updating electronic boards or chalk boards; discussing the changes to their business with other staff; training existing staff on the new regulation; and establishing business systems which may have been implemented as a result of the new regulation.
- 3.5. Those affected businesses would also face ongoing direct costs: they may need to reprint or rewrite menus in line with the frequency that their seafood origin changes, which could be daily or weekly for many businesses; the chef may need to continually monitor the origin of seafood from each supplier and communicate this information to staff; and, the business may need to increase the time to train new staff members, as this may now include information on the regulation, the business system to monitor seafood origin information, what to do if the seafood origin information changes, and how to updated the menus.
- 3.6 In addition to direct costs, mandatory seafood origin labelling is likely to be seen as a frustrating addition to accumulative burden felt by foodservice businesses, with the time owners spend on compliance distracting from other parts of their business.
- 3.7. With 93 per cent of foodservice businesses being small and non-employing, the cost of regulation would fall most acutely on small businesses less able to absorb regulatory costs compared to medium and large businesses.29 Foodservice is sensitive to additional regulation since the sector already operates with lower profit margins compared to other industries and with a medium level of regulatory burden.

- 3.8. If mandatory seafood origin labelling is introduced in foodservice, the costs to business will depend on the information required at point of sale. Different options would likely pose different regulatory costs on business. For example, for regulation identifying seafood only when it is produced in Australia, low-cost foodservice businesses which only sell imported seafood may not need to update their menus or have significant ongoing compliance costs. Conversely, if regulation identifying the origin of every individual seafood menu items is adopted, then all foodservice businesses selling seafood would be impacted and face both one-off and ongoing compliance costs.
- 3.9. If faced with mandatory seafood origin labelling regulation, foodservice businesses may choose to 'lock in' with suppliers who can consistently provide low cost seafood (most likely to be imported) and result in decreased demand for Australian seafood. Foodservice businesses may be less willing to periodically change to Australian seafood if it requires costly menu reprints. Some businesses may simply remove all seafood from menus to avoid the cost and frustration of updating menus whenever their seafood sourcing changes. Consumers may have less choice in seafood (Australian and local) sold in foodservice and reduced access to seafood locality information (e.g. 'Moreton Bay prawns' becomes 'Australian prawns').
- 3.10. Mandatory seafood origin labelling in foodservice may also set a precedent for other labelling interventions in foodservice. In addition to seafood, pork and a range of vegetables also compete with imported sources and changes in seasonal supply, and consumers may equally want origin information on a wide range of foods consumed through foodservice.

SIA has made CoOL one of its Policy priority areas and many aquaculture producers surveyed felt strongly that the 'problems' used as reasons to not support CoOL for food services (DIIS, 2017) were inflated and that changes to enforce CoOL would have significantly greater benefits than disadvantages right across the seafood value chain.

3.2.1.1.3 Northern Australia Audit: Infrastructure for a Developing North Report, January 2015

The Northern Australia Audit: Infrastructure for a Developing North Report 2015 assessed critical economic infrastructure gaps and requirements to meet projected northern Australia population and economic growth through to FY31 (Infrastructure Australia, 2015). Infrastructure gaps were identified in terms of unmet demand, missed opportunity, excessive pricing or poor service standard. **Table 4** provides a summary of the findings of the report.

Table 4: Summary of findings of the Northern Australia Infrastructure Audit 2015

Area/topic	Key findings	Issues/implications for northern Australia aquaculture
Population	Northern Australia is mostly sparsely populated with 1.2 million people spread across 45 per cent of Australia's land mass. These 1.2 million people represented 5.6 per cent of Australia's 22.7 million residents in the audit base year of FY11. Northern Australia's population has grown faster (at 1.7 per cent year on year) than the Australian average over the past decade (1.4 per cent year on year).	• Significant part of the population is indigenous, and aquaculture has potential role in indigenous economic empowerment. • Population growth needs to be matched with skills needs to ensure optimum economic contribution.
Population change scenarios	Under a baseline projection, northern Australia's population would grow at 1.8 per cent year on year, compared to 1.6 per cent year on year for Australia as a whole, from 1.23 million in FY11 to 1.77 million residents in FY31.The audit also assessed infrastructure gaps to meet specific FY31 growth scenarios. Growth scenarios involve high and medium agriculture, tourism and energy export growth targets, as outlined in the 2030 Vision for Developing Northern Australia (Liberal Party 2013).	• Aquaculture growth scenarios should match/integrate with key regional hub growth to maximise infrastructure and economic benefits. • Key aquaculture 'hubs' could be major economic components of overall/ integrated agri growth scenarios and therefore focus on key infrastructure needs.
Economy	The Northern Australia economy made up 11.7 per cent or $178 billion of Australia's FY13 Gross Domestic Product, compared with some nine to 10 per cent during the 2000s.	
Overall infrastructure challenges	Infrastructure in Northern Australia faces cost and service challenges. With limited population and often small industry sizes (albeit with exceptions, most notably in the resources sector), it can be difficult to capture the infrastructure	• Nodal or 'hub' development for aquaculture (possibly integrated with other industry) offer s greatest opportunity to capture infrastructure 'economies of scale' and commercial viability.

	economies of scale that allow commercially viable infrastructure services at competitive prices. Distance, remoteness and conditions of extreme heat and high rainfall during four months of the year in much of the region add to the challenges. 'National network' infrastructure improvement can benefit both northern and southern Australia. By reducing economic distance, improved links between north and south and between jurisdictions can offer wide benefits. This infrastructure encompasses: capital city and major northern airports; the major 'north-south' and inter-jurisdictional highways; the North Coast Line; the Adelaide-Darwin Railway; and the National Broadband Network that is currently being rolled out. Road and rail links face capacity and/or reliability pressures, while additional peak period capacity at Perth and Brisbane airports will be important for the longer term. Transport infrastructure for resource development hinges on major customer demand. As the 'first mover' generally funds new port and rail supply chain infrastructure, the size and certainty of resulting revenue are key considerations in infrastructure planning. Rail and port expansions are under way in the Pilbara region, are planned for the Queensland coal regions and are possible in the North West Queensland Minerals Province. In contrast, the absence of major customer demand in the Northern Territory and other yet to be developed areas leads to reliance on existing smaller ports which lack the specialised facilities (e.g. ship handling equipment, deep water channel access) that can support large tonnages at reduced unit cost. Any government role in infrastructure investment in such circumstances needs to balance cost against overall expected benefits.	• Recent announcements of proposed large-scale solar electrical generation in central Australia and transmission corridor through NT (to export to Asia) provides potential 'spine' of low-cost, valuable (green-badged) energy which around which aquaculture hubs could be developed. • Airport infrastructure increasingly import for export orientated aquaculture production (currently regarded as a significant limitation). • 'Aggregation' of customer demand may be critical to assuring economic viability of transport infrastructure. • Major volume seafood exports (e.g. Project Sea Dragon) will rely on port access for exports.
Roads	Roads servicing the dispersed cattle industry can benefit from better flooding resilience in all three jurisdictions, to link with ports and markets in the north and also in southern Australia. The Port of Darwin, the largest livestock export port in the region, faces capacity pressure and lacks specialist infrastructure to service the industry. Road maintenance is critical to facilitate heavier vehicles and renew ageing pavements in a demanding climatic environment. Funding for pavement maintenance may sometimes compete with funding for specific safety improvements (e.g. lane widening). Maintenance backlogs are a feature of the northern road system, with attendant risks of load restrictions and road closures, particularly during high rainfall periods. Major centres can benefit from both road upgrades and public transport planning.	• All aquaculture in northern Australia relies on road access and road transport of input supplies and output products to market or secondary transport locations (airports/ports).
Port access/ roads	Improved port and / or airport road access in centres including Mackay, Darwin, Karratha and Port Hedland, together with rail access to the Port of Townsville, can both facilitate trade efficiently and improve community access, amenity and safety. Bus priority measures, to improve peak service reliability, manage congestion and limit the need to widen roads and bridges will also be important within 10 to 15 years in Cairns and Townsville.	• Most of these centres have current or proposed future aquaculture operations and aquaculture needs should be factored into future infrastructure needs assessments.
Electricity	Network planning and coordination can often offer reliable electricity at lower cost, while major resource producers frequently opt to meet their own power (and water) requirements. This paradox reflects the difficulties of implementing coordinated arrangements. Lower cost energy is especially important in enabling marginal resource projects to proceed. This issue has been in play in the Pilbara and the Mount-Isa Cloncurry regions and is emerging in the Galilee Basin. Northern Queensland power prices for industrial use are comparatively high, relative to other northern locations and despite connection to the National Electricity Market. This limits resource, agricultural and other economic opportunities. Long transmission lines from southern-located generators and marginal losses result in higher prices. The extent to which prices are also a function of market cost allocation rules and whether there could be an economic efficiency case for altering these	• Major input cost and therefore a critical issue for aquaculture industry in northern Australia. • Many aquaculture operators looking at self-generation (and aggregated purchasing and other cost-saving measures). • Low-cost (and low-carbon) electricity could be major competitive advantage for aquaculture industry. • Significant component of northern aquaculture domiciled in North Queensland and could receive significant uplift from lower electricity prices.

	rules, including the concept of splitting Queensland into two or more market regions, are matters for review.	
Gas pipelines	Linking northern and eastern gas markets could create significant benefits. A gas pipeline from Alice Springs to Moomba, or from Tennant Creek to Mount Isa, would enable gas flows in either direction, for both export and domestic markets. It could also drive development of potential new sources of gas from the Amadeus Basin and increase resilience to failures of supply in both northern and eastern gas markets.	
Water (domestic)	Many northern centres will need water supply upgrade or operational improvement. This includes Townsville, Cairns, Mackay and Rockhampton, as each grows, while bore system renewal is important for Alice Springs, Tennant Creek and the Kimberley region. Darwin, with an abundant catchment, is planning for an additional water source before 2020, which current demand management measures could work to delay for a period.	• These centres support significant aquaculture operations and therefore industry needs should be considered in infrastructure planning. • Darwin region holds considerable future potential for land-based aquaculture and water availability will be a key issue.
Water (irrigation/ agriculture)	Irrigated agricultural development will call for additional water supplies, as well as supporting power and transport infrastructure. Water supply options include use of currently unallocated water reserves, recommissioning of mothballed mining dams, expansion of existing dams and development of both new dams and groundwater resources. On past experience, it may be difficult for agriculture projects to bear the full capital and operating costs of a new dam and water distribution infrastructure. However, without this, private investment could be difficult to attract.	• Water demand for aquaculture needs to be considered within the overall 'agricultural' water needs. • Fresh water demand for aquaculture should to be considered within the overall 'agricultural' water infrastructure and customer base.
Telecomms	With distance, remoteness and the reliance on communications, broadband is critical. 70 per cent of premises in northern Australia received the lowest broadband quality rating in 2013, in a Department of Communications assessment, compared with 45 per cent in the south. Service levels will improve with the current roll-out of the National Broadband Network. Mobile broadband services lag those in southern Australia. 21 per cent of northern Australia premises had good mobile availability in 2013, according to the Department of Communications, compared with 91 per cent in southern Australia. Achieving higher-value agricultural production from irrigation is a scenario focus. An estimated 700,000 hectares of production, nearly nine times current irrigated production across the north and more than the total of all currently identified irrigation opportunities, would be needed to meet the (lower) scenario target. While market viability should be demonstrated on an individual project basis, the scenario indicates the importance of innovative and least cost approaches to meeting the infrastructure needs of agricultural expansion.	• Broadband communications for distant communications but also for use of IoT applications on-farm will be a necessity for aquaculture operations. • Mobile and broadband services are also an important tool for safety in northern Australia workplaces. • CSIRO has estimated large areas of land suitable for aquaculture and land-based aquaculture must be considered within overall agri-development scenarios.
Tourism expansion	Airport, road and communications infrastructure underpin visitor growth, to meet a scenario target of two million international tourist stopovers annually in northern Australia. Excepting Kununurra, tourism airports have adequate runway capacity. Upgrade of a number of regional roads would benefit accessibility for tourists and mobile and Wi-Fi communications may also be important.	• Focus group feedback indicated greater willingness for integration of tourism, aquaculture products (such as pearls) and local speciality seafood offerings as a key to local identity branding and tourism experiences.
Energy Exports expansion	Infrastructure plans are largely in place to meet a scenario doubling in energy exports (to $150 billion). These plans include liquefied natural gas supply base support infrastructure (Darwin and northern Western Australia) and coal terminal infrastructure in northern Queensland, together with associated rail infrastructure. Regional airport, road and water infrastructure (e.g. Galilee Basin) is also important. Evolving commodity market conditions will mostly drive timing and implementation of these plans.	

The key issues from the 2015 audit report relevant for northern Australia aquaculture were:

- Electricity – availability in 'remote' locations and costs, across most of northern Australia. The other key considerations for electricity for northern Australia aquaculture are:
    - self-generation opportunities (solar and to a limited extent wind) particularly given the huge potential for solar generation in most parts of northern Australia
    - opportunities for sustainability 'branding' of seafood derived from low-carbon electricity utilised in the growout and processing of products.
- Fresh water – whilst prawn and barramundi are grown in saltwater systems, the ready availability of freshwater for salinity balancing is a potential strategic advantage for operations. In addition, the other key species with high potential for large-scale growout in northern Australia, redclaw crayfish, is a freshwater species. Therefore, the freshwater needs of aquaculture should be considered within any overall agri-water requirements assessments and planning.
- Roads – all of northern Australia's aquaculture production relies significantly on road access and transport for supply of key inputs such as feed, larvae/fingerlings, materials and equipment, fuel and sometimes labour. Products are all transported by road to major cities for distribution locally or in a few cases, internationally.
- Airports - northern Australia has some 80 airports that receive regular public transport (RPT) services. Many of these airports also receive charter services, in some cases involving significant numbers of additional passengers to service resource industry fly-in fly-out (FIFO) demand. In addition, there are a large number of other aerodromes providing essential, all-weather transport links that are used for charter, Royal Flying Doctor Service and other services, providing transport connectivity throughout the north, including for remote Indigenous communities.
- Northern Australia airports, as with its ports, have no refrigerated container capability that could in principle reduce the costs of high-quality agricultural exports from the region. Anecdotally, substantial volumes of fruit and vegetables are trucked to Brisbane, Adelaide and Melbourne, taking advantage of competitive trucking back haul rates, for subsequent air freighting to Southeast Asia (together with domestic capital city use). A combination of factors – a substantial domestic market in the southern capitals, a highly efficient road freight sector (with refrigerated capability), low international air freight rates from airports in southern capitals, due to wide-body passenger aircraft use that northern air markets could not sustain – appear likely to preclude development of northern air freight capacity for the foreseeable future.
- Cold storage capability at Darwin Airport or elsewhere would therefore appear a longer-term option which is unlikely within the audit timeframe to FY31. However, one possible exception would be if year-round time-sensitive agricultural products were to be produced in the Ord region in sufficient volume, potentially underwriting a freighter service (e.g. from Kununurra).

In addition, Infrastructure Australia recently produced an Assessment of Australia's Future Infrastructure Needs: The Australian Infrastructure Audit 2019 (Infrastructure Australia, 2019). Key issues for northern Australia infrastructure related to the aquaculture industry include:

- Airports (**Table 5** and **Table 6**)
    - Air freight represents a small proportion of Australia's freight task by mass, a mere 1.5 million tonnes or 0.1% of freight moved in 2016-17. This, however, obscures the critical importance of air freight to Australia:
        - It represents over 21% of trade by value.
        - 70% of air freight has an international origin or destination and therefore contributes significantly to Australia's international trade and its trade relations.
        - Goods most suited to air freight are those that are time-sensitive, compact, perishable or high value.
    - 100% of regional air freight is carried in the base of passenger airplanes
    - Freight is 5% of the retail cost of doing business (on average) and is probably as high as 12% for northern Australia)

Table 5: Australian airports ranked by freight volumes (northern Australian shaded green)

Airport	Exports (tonnes)	Imports (tonnes)	Total (tonnes)	Share
Sydney	255,173	205,065	460,238	47.3%
Melbourne	166,233	114,346	280,579	28.8%
Brisbane	67,740	40,818	108,558	11.2%
Perth	54,302	30,317	84,619	8.7%
Adelaide	14,621	7,941	22,562	2.3%
Cairns	4,677	516	5,193	0.5%
Darwin	900	897	1,797	0.2%
Other	4,578	5,363	9,941	1.0%
Total	568,225	405,265	973,490	

Note: Values represent tonnes imported or exported in 2016.
Source: Inquiry into National Freight and Supply Chain Priorities (DIRDC, 2018).

Table 6: Key airports in northern Australia, indicating current major airports servicing aquaculture areas (green) and possible future service to aquaculture (purple)

Queensland		Northern Territory	Western Australia
Alpha	Hughenden	Alice Springs	Broome
Barcaldine	Julia Creek	Ayers Rock	Derby-Curtin
Blackall	Lockhart River	Darwin	Fitzroy Crossing
Blackwater	Longreach	Elcho Island	Halls Creek
Cairns	Mackay	Gove	Karratha
Clermont	Moranbah	Groote Eylandt	Kununurra
Cloncurry	Mount Isa	Katherine	Learmonth
Coen	Proserpine	Milingimbi	Mungalalu-Truscott
Cooktown	Richmond	Port Keats	Newman
Emerald	Rockhampton	Ramingining	Onslow
Gladstone	Townsville	Tennant Creek	Paraburdoo
Townsville	Weipa		Port Hedland

Source: GHD analysis, in Northern Australia Audit: Infrastructure for a Developing North Report (Infrastructure Australia, 2015)

3.2.1.1.4 An Assessment of Australia's Future Infrastructure Needs: The Australian Infrastructure Audit 2019, June 2019, Infrastructure Australia

The recent review of Australian infrastructure also contained a specific chapter on Developing regions and northern Australia (Infrastructure Australia, 2019). It focussed on developing regions with strong growth prospects and where industry composition is changing. In addition to developing northern Australia, including a mix of regions across the Northern Territory, and the northern parts of Queensland and Western Australia. Two overall key opportunity points were raised in the report that have relevance to aquaculture:

- Infrastructure can help to catalyse growth across northern Australia, and unlock development across a range of industries. Improving the resilience, reliability and efficiency of northern infrastructure could help to capitalise on the immense potential of northern regions, and improve the productivity, quality of life and competitiveness of its people and businesses.
- Development in northern regions could benefit from more detailed information and evidence-based studies of economic opportunities, as well as a better understanding of local needs and values, particularly of local Aboriginal and Torres Strait Islander peoples. Better information on opportunities and local needs can support more efficient investment and greater benefits for northern communities.

Importantly, the report also highlights approaches to development in northern Australia (Infrastructure Australia, 2019):

- Infrastructure development planning and implementation should be evidence-based…

  Given the finite resources of governments, it is important to undertake studies to understand how infrastructure can unlock strategic opportunities, and can deliver improvements in outcomes such as improving productivity, sustainability and quality of life, or reducing socioeconomic disadvantage. Examining the economic, social and environmental benefits of potential projects can help to support efficient investment in underdeveloped regions. Supporting this analysis with scenario testing using a range of external factors, such as changes in exchange rate, climate change, and developments in technology can ensure these opportunities are resilient to potential future changes.

- Past development efforts provide lessons for the future…

  Governments have committed considerable funding to reinforce the critical infrastructure of rural and remote regions over many years… However, some investments to unlock growth and further investment may have yielded limited benefits. The Productivity Commission criticised ad hoc financial assistance to regions as rarely effective at facilitating transition or long-term development.

Key Commonwealth aquaculture policy development, strategy and planning relevant to the current industry development scenario and timeframes (2030) are summarised in Appendices **Section 11.1**.

*3.2.1.2 **Queensland***

Aquaculture development and operations in Queensland requires a myriad of approvals and permits and the involvement of Commonwealth, State and Local government. By the government's own admission, the process is complex.

Following a review of aquaculture regulation by the Queensland Competition Authority in 2011 and priorities identified in the National Aquaculture Strategy (DAWR, 2017), the Queensland Government embarked on a series of regulatory reforms. Key new aquaculture policy and initiatives are discussed below.

3.2.1.2.1 Aquaculture Development Areas – Policy and implementation

In January 2019, the Queensland Government announced six land-based marine Aquaculture Development Areas (ADAs) across northern Queensland to promote and facilitate expansion of the aquaculture industry. ADAs are located in coastal areas where marine species can be cultivated in ponds that have access to seawater.

The ADA identification process was completed in consultation with industry, government and landowners (DAF, 2018), applying a range of criteria and constraints including:

- physical criteria (e.g. seawater access, land slope and elevation)
- environmental criteria (e.g. protected areas, regulated vegetation, agricultural land), and
- planning criteria (e.g. tenure, zoning).

The six ADAs totalled just over 7,000 ha and included two sites over 2000 ha, another over 1400 ha and the remainder ranging between 300 – 500 ha.

Identification of ADAs is reflected as a new information layer under the state's primary planning legislation to be incorporated into local government planning schemes and has generated interest among potential investors. The ADA process was designed to help investors identify potential areas for aquaculture operations and the ADA sites satisfy the requirements for operating an aquaculture business with minimal environmental and land-use constraints.

The ADA selection undertaken by the Queensland Department of Agriculture and Fisheries (QDAF) comprised a planning methodology using high level physical, environmental and planning criteria and quantitative ranking assessed in overlays within a Geographic Information System (GIS) tool (DAF, 2018).

The modelling undertaken by DAF applied the following criteria:

- Appropriate land elevation (height above sea level}.
- Appropriate topography (gentle sloping land).
- Short distance of land to water source.
- Land tenure/local government area (LGA) zoning.
- Land not subject to excessive tidal influence.
- Land not of high horticultural quality (Class A or Class B)
- Water quality/quantity accessible for intake.

The selected ADA sites satisfy the requirements for operating an aquaculture business with minimal environmental and land-use constraints; however certain constraints still exist. Even in ADAs, land-based marine aquaculture will require development approvals issued under the *Planning Act 2016* (Qld) and several

operational permits before operation may commence. Nonetheless, the ADA identification process completes a number of due diligence considerations for investors considering locations for aquaculture operations.

Identification of each ADA is reflected in the State planning policy—state interest guideline (agriculture) (DILGP, 2016). The land information for the ADAs can be viewed through the State Planning Policy Interactive Mapping System. It should be noted that even though the ADA's have been selected to maximise their potential for aquaculture development, they still may have certain constraints that need to be addressed or which may constrain development on sections of the land (for example, vegetation clearing).

A key aspect of the ADA selection process was a consideration of downstream discharge issues – in particular discharges into the Great Barrier Reef Marine Park (GBRMP). Historically, new land-based aquaculture developments in Queensland have been severely limited by restrictions imposed by the Great Barrier Reef Marine Park Authority. In selection of the ADAs, consideration has been given to selecting against areas within catchments leading to marine parks, Fish Habitat Areas and/or conservation zones, which may attract a higher level of scrutiny regarding discharge requirements and therefore score lower than catchments without downstream conservation considerations. With respect to catchment areas for the GBRMP, State Marine Parks, Ramsar, and Fish Habitat Areas, selections were undertaken using the following hierarchy:

- catchment with no downstream marine park/conservation area (preferred)
- catchment upstream, but discharge not directly into marine park/conservation area
- catchment upstream, but discharge directly into marine park/conservation area (least preferred).

Whilst the success of the ADA process cannot be fully ascertained, it has already generated some significant movement in the Queensland aquaculture industry with Tassal Group purchasing the land covered by the second largest ADA, located in the Mackay region as part of a $100 M prawn aquaculture initiative.

*3.2.1.3 **Western Australia***

In 2015 the Government of Western Australia tabled an 'Aquaculture – Statement of Commitment', outlining a five year plan to support the industry expansion in the State. Keys aspects were:

- Support for Existing Aquaculture Industry
- Developing Aquaculture Zones and Infrastructure
- Streamlining and Reducing Regulation, and
- Facilitating Industry Development and Investment

Since 2017, aquaculture industry support in WA is currently managed by the Fisheries Division which is now part of the Department of Primary Industries and Regional Development (DPIRD). Following a restructure in 2017 under the new McGowan government, the several separate responsibilities for aquaculture were merged and re-housed under a State 'agricultural portfolio' structure. This change had been advocated by industry and government officers for several years and its implementation has been generally regarded as beneficial for the aquaculture industry.

Key new aquaculture policy and initiatives in WA are discussed below.

3.2.1.3.1 Aquatic Resources Management Act 2016

In 2015 the previous state government introduced the *Aquatic Resources Management Bill* to Parliament with the intent of replacing both the *Fish Resources Management Act 1994* and the *Pearling Act 1990*. The objective of this Bill was to streamline commercial and recreational fishing management arrangements, and to introduce clearer provisions for biosecurity and aquaculture. However, the Bill received objections from the pearling industry and was not assented until 2016 and primarily did not come into force until January 2019. To date, some parts have not been implemented and the pearling industry have concerns regarding the potential erosion of property rights under the new Act.[4]

[4] Input from the Pearl Producers Association

3.2.1.3.2 Aquaculture Development Zones

As part of its commitment to developing a sustainable marine aquaculture industry, the Western Australian Government established several offshore aquaculture development zones for marine finfish. Two zones were established (one in the Kimberley and one in the State's Mid-West) with the objectives of providing opportunities for existing aquaculture operations (fish farms) to expand, and to make it faster, less costly and more efficient to set up new aquaculture businesses.

The Aquaculture Development Zones were designed to provide 'investment ready' platforms with strategic environmental approvals and management policies already in place, allowing commercial aquaculture operations to be set up without the need for lengthy, complex and expensive approval processes. The establishment of the zones was underpinned by extensive studies and modelling prior to approval to ensure the potential effects of aquaculture were identified, understood and were manageable. A "zones" approach allows the consideration of cumulative impacts, rather than assessing impacts on a case-by-case basis as applications are received or expansion occurs.

Operations in the zones are managed on behalf of the Minister for Fisheries through an integrated management framework driven by a Zone Management Policy, developed as part of the strategic environmental assessment process of the Environmental Protection Authority (EPA).

The Kimberley Aquaculture Development Zone (KADZ) is in Cone Bay, at the northern end of King Sound, about 215 kilometres north-east of Broome. Cone Bay is a proven location for the culture of barramundi and this zone was declared by the Minister for Fisheries on 22 August 2014 as the first aquaculture development zone to be established in Western Australia. To date, two licences have been granted for the KADZ. One licence was granted to Marine Produce Australia (which was recently acquired by Singaporean aquaculture company Barramundi Asia Pte in 2018). The second licence has been granted to the Aarli Mayi Project, a consortium of Kimberley 'saltwater country' people (the Dambimangari, Mayala, and Bardi Jawi traditional custodians of the land and saltwater on whose country the Kimberley Aquaculture Development Zone (KADZ) and service industries is situated) and Maxima Opportunity Group (an subsidiary of Maxima Pearling and former shareholder in Marine Produce Australia). The MPA licence is for 20,000 tonnes per annum and the Aarli Mayi Project is for 15,000 tonnes per annum production.

MPA currently produces about 2,000 tonnes per annum from its leases in Cone Bay.

The second WA aquaculture zone is the Mid-West Aquaculture Development Zone (MWADZ), located across an area of open water between Geraldton and the southern region of the Abrolhos Islands group (just south of the northern Australia 'border'). The 3,000 hectare zone is comprised of two parts, a northern area of 2,200 hectares and a southern area of 800 hectares. The southern area of the zone was subject to an existing aquaculture licence held by Indian Ocean Fresh Australia Pty Ltd, a group which has trialled and farmed Yellowtail Kingfish since 2008.

In October 2018, Tasmanian salmon farming major Huon Aquaculture was awarded the contract to establish a 24,000 tonne, 2,200 hectare fish farm in the MWADZ off Western Australia's Abrolhos Islands to grow out yellowtail kingfish.

3.2.1.3.3 DPIRD Strategic Intent document

In 2018, the newly structured Department of Primary Industry and Regional Development released its new 'strategic intent' document (WA Government, DPIRD, 2018), built around the core themes of: Protect; Grow; Innovate.

'Aquaculture' is referenced specifically in the document under the Strategic Plan, Strategic Priority 3: International Competitiveness (Growing internationally competitive industries and businesses), Key Initiative 3.5: Aquaculture industry development. The proposed 'Future state – in 2021' is:

> *"Government and industry are partners in developing WA's emerging aquaculture industry, building confidence and de-risking investment"*

The Western Australia Government has clearly signalled its role in co-investing in the aquaculture supply chain in the state, supporting investments in the Albany multi-species mollusc hatchery, the barramundi nursery stage for MPA's Cone Bay operations and Huon's kingfish hatchery/nursery at Geraldton. The WA government has also signalled its intentions to develop further aquaculture facilities at the Ocean Reef development to the north of metropolitan Perth (possibly as a replacement for the Challenger TAFE/DPIRD facilities at Freemantle).

3.2.1.3.4 Government aquaculture infrastructure

The Western Australian government – through successive governments – has supported a range of aquaculture RD&E and semi-commercial developments over the last 15 years. Most recently, these include:

- Batavia Coast Maritime Institute finfish nursery, Geraldton – a $7 M investment to nursery juvenile Yellowtail kingfish to supply Huon Aquaculture operations in the MWADZ
- Multi-species mollusc Hatchery, Albany – a $4 M investment to renovate and develop a hatchery to supply abalone, mussel and oyster spat to industry and undertake applied R&D.

A 2016 review of Western Australia's State aquaculture research, training and service delivery facilities and capabilities undertaken by Australian Venture Consultants Pty Ltd, provides a comprehensive overview of other facilities, capabilities and initiatives in aquaculture in WA (Australian Venture Consultants, 2016).

3.2.1.3.5 Draft Aquaculture Plan 2019

In September 2019, the DPIRD also released a draft *Aquaculture Plan for WA: Focusing resources on the key foundations for growth* for limited internal discussion. As the title suggests, the new plan appears to be trying to set a defined and limited 'focus' for the industry based on its previous work, investments and strengths. The plan sets out an Implementation Plan of actions to overcome barriers and build on industry foundations, strengths and opportunities (**Table 7**). DPIRD will be responsible for implementation of this Aquaculture Plan in consultation with the Aquaculture Council of Western Australia (ACWA) and other relevant agencies.

3.2.2 Industry Associations

3.2.2.1 ***SIA***

Seafood Industry Australia (SIA) is the seafood industry peak body, was formed in 2017, and represents the aquaculture, wild-caught and post-harvest operations sectors making up the Australian commercial seafood industry. SIA has a broad mandate and vision: 'for the Australian seafood industry to be united, effective and respected'. Its mission is 'to promote and develop the Australian seafood industry'.

Whilst SIA has no specific northern Australia agenda or even a specific aquaculture agenda, some of SIA's key policies have direct relevance to northern Australian aquaculture including; Country of Origin labelling in food service; Diesel fuel rebate; and Biosecurity.

NAC as well as the APFA and ABFA are members of SIA, however their roles are not yet clearly developed within the SIA structure. SIA has several aquaculture industry Board members (including one whose company is involved in prawn aquaculture in northern Australia) but only one Board member from northern Australia.

3.2.2.2 ***NAC***

The National Aquaculture Council (NAC) is the peak body representing the aquaculture industry across Australia. Shareholder/representative associations of NAC include:

- ASBTIA - Australian Southern Bluefin Tuna Industry Association
- TSGA - Tasmanian Salmonid Growers Association Ltd
- ABFA - Australian Barramundi Farmers Association
- SAAC -The South Australian Aquaculture Council
- SICOA - Shellfish Industry Council of Australia
- AAGA - Australian Abalone Growers Association
- AMIA - Australian Mussel Industry Association
- APFA - Australian Prawn Farmers Association Inc.

Table 7: DPIRD (Draft) Aquaculture Plan for Western Australia

Priorities	Actions	Barrier*	Foundation	Estimated Timeframe
Maintain Biosecurity and Fish Health capacity	DPIRD will maintain a strong fish health capability and monitor the service delivery capacity of fish health service against industry growth.	3	Biosecurity and Fish Health	Ongoing
Maintain Research and Development capacity – including university alignment	DPIRD will engage with the industry, through ACWA, to ensure its R&D and support activities are structured to meet the development requirements of the industry.	3	Research and Development	Ongoing
Regulatory Reform	DPIRD will continue working to complete the Reform Project recommendations and furthermore identify further areas where the regulatory framework can be simplified.	4	Regulatory Framework	Ongoing
Economic Feasibility	DPIRD will undertake analysis of economic feasibility of aquaculture projects to assess investment options and opportunities and potential returns to the State and community.	5	Economic Development	Ongoing
Hatchery and Nursery (Fremantle and Geraldton)	DPIRD will oversee the construction of a state-of-the-art marine finfish nursery facility Institute in Geraldton to breed yellowtail kingfish. The juvenile kingfish will be supplied to existing and new commercial operators within the Mid West Aquaculture Development Zone to grow in open water farms using sea cages.	5	Infrastructure	Short-term
Chemical Use in Aquaculture	DPIRD will work with the aquaculture industry, other state agencies and industry representative organisations to put in place an efficient and cost-effective mechanism to enable access to chemicals for aquaculture use through Minor Use Permits.	3	Biosecurity and Fish Health	Short-term
Identify Suitable Sites	DPIRD is undertaking a project to identify areas of Western Australia coastal waters suitable primarily for marine finfish aquaculture. DPIRD will continue to liaise with the Commonwealth to progress the legislative changes to enable aquaculture in Commonwealth waters.	1	Strategic Planning, Management and Coordination	Short-term
Planning for proposed new modern hatchery	DPIRD will investigate the potential for establishing a new hatchery to better meet industry demands.	5	Infrastructure	Short-term
Feed mill discussions	DPIRD will explore opportunities for establishment of an aquaculture feed mill in Western Australia and facilitate discussion with existing feed mills and the aquaculture industry	5	Infrastructure	Medium-term
Identify and facilitate training opportunities	DPIRD will aim to establish a process between ACWA and the Department of Training and Workforce Development (DTWD) to identify specific skills and training needed for industry and review Technical and Further Education college (TAFE) courses. As part of this process, DPIRD will undertake a Training Needs Analysis.	2	Strategic Planning, Management and Coordination	Medium-term
Identify and facilitate market opportunities	DPIRD will utilise the Invest and Trade WA and Brand WA agencies to work to improve Western Australia's profile domestically and internationally.	5	Market Capability	Medium-term
Building works for new modern hatchery and research facility.	Following the outcome of the planning stages of a new hatchery, DPIRD will manage the contracts for the building works for establishment.	5	Infrastructure	Long-term
Feed mill (facilitation of an existing mill to incorporate aquaculture pellets)	Depending on the outcome of planning discussion, DPIRD will liaise with Feed mills to implement the availability of aquaculture pellets from feed mills.	5	Infrastructure	Long-term

*Barriers to Development:

1. Few sheltered coastal marine sites.
2. No targeted training opportunities.
3. Fish Health and Research and Development capacity not well aligned with industry requirements.
4. Complex regulatory environment in Western Australia.
5. A relatively high cost environment.

Since the formation of SIA in 2017, the NAC has been considering its position and ongoing role as either a standalone organisation or a 'subcommittee' within the SIA structure.

*3.2.2.3 **ACWA***

The Aquaculture Council of Western Australia Inc (ACWA) established in 1981, is the peak body for the State's aquaculture industry and is an industry group member of the WA Fishing Industry Council (WAFIC), Seafood Industry Australia, and the National Aquaculture Council.

ACWA members include Marron Growers and non-Maxima pearl growers. Northern Australian aquaculture producer MPA is a member of ACWA.

*3.2.2.4 **AAQ***

The Aquaculture Association of Queensland Inc, (AAQ) is the representative body for producers of freshwater finfish and crayfish. Its members include hatcheries providing fingerlings and fry, growers of table fish and

ornamental fish. Species produced and grown by its members include, barramundi, Australian bass, golden perch, barcoo grunter (jade perch), silver perch, sooty grunter (honey perch), jungle perch, mullet, Murray cod, sleepy cod, eels, Australian native and exotic aquarium fish, and freshwater crayfish (redclaw).

In 2002, the AAQ produced "Pathways to the Future: A Development Plan for the Queensland Native Freshwater Finfish Industry" which sought to grow the industry (from its 2002 production of ~ 55 tonnes) to 10,000 tonnes by 2007.

Key components of the Plan were the following goals:

- Smart Product Marketing
- Successful and progressive businesses
- Environmental sustainability and social responsibility
- Cooperating to achieve results.

The AAC has not been very active over the last decade but the industry has grown (particularly the redclaw and perch sectors) and in 2018 the total production of freshwater fish (species other than barramundi) was 231.7 tonnes (which decreased from 268.6 tonnes produced in 2016–17) and the value of the sector was $2.9 million (down from $3.4 million in 2016–17). Production of the redclaw crayfish sector decreased by 24.7% (from 64.8 tonnes in 2016–17 to 48.8 tonnes in 2017–18). Value of the redclaw sector decreased to $1,270,953 down from $1,704,748 in 2016–17. There were 29 producing farms in 2017–18.

3.2.2.5 ***NTSC***

The Northern Territory Seafood Council (NTSC) is an incorporated association focussed on managing the needs of its members and promoting and developing the Northern Territory seafood industry. The NTSC members are professional fishing, aquaculture and pearl oyster culture licence holders as well as Aquarium Fish/Display or Fish Trader/Processor licence holders. NTSC is a member of Seafood Industry Australia.

In 2017, the NTSC developed a strategy to build its social licence to operate. The new five-year Strategic Plan 2018 - 2023 focuses on three key programs to build a social licence and deliver member's value by:

- Improving structures for an effective NT Seafood Council
- Building trust in our industry between our members, community and government
- Demonstrating sustainability

The NTSC has some limited objectives applicable to aquaculture. The NTSC Board currently supports an aquaculture industry and a pearl industry representative.

3.2.2.6 ***ABFA***

The Australian Barramundi Farmers Association (ABFA) is the peak representative organisation for the Australian farmed barramundi industry. The ABFA represents members who produce around 95% of the annual 7,000 t production of Australian farmed barramundi, currently valued at $70 M. The ABFA predicts that production will reach 10,000 t in the next 2 years with a national production target of 20,000 t by 2025.

A majority of production occurs in Queensland, along with WA and NT. Victoria and South Australia also have barramundi production facilities.

The ABFA supports a Sustainable Farms program with products from several farms displaying a 'golden tick' indicating that it is approved by the Australian Sustainably Farmed Barramundi Certification Program.

The ABFA has a strategic Industry Partnership Agreement with FRDC whereby FRDC provides annual RD&E funding in accordance with the ABFA RD&E Plan. ABFA is currently operating under its 2015 – 2020 Strategic RD&E Plan. A summary of the key investment areas is provided in **Table 8**.

Table 8: ABFA Summary of Key RD&E Investment Areas 2015-2020

Investment Area	Summary of Key Investment Outcomes	Fund Sources	Near Term Year 1	Mid Term Years 2-3	Long Term Years 4-6
1. Market Differentiation for Australian Produced Barramundi	• Naming rights for 'Barramundi' for Australian produced *Lates calcarifer* • Branding and promotion program for Barramundi • Differentiate Australian caught or grown (produced) Barramundi v imported *Lates calcarifer*	ABFA Funds ABFA IBC	$80,000	$175,000	$375,000
2. Consistent High Quality Australian Product to Meet Consumer Preferences	• National ABFA Quality (QA) Scheme • Cool chain management and product integrity adopted along whole supply chain	ABFA RD&E ABFA Funds	$30,000	$80,000	$120,000
3. Effective Management of Biosecurity Risk	• Understanding of biosecurity risks and processes to minimise those risks. • Industry Informed of status of biosecurity • AQUAPLAN is adequate to deal with emergency response to a disease outbreak in industry • Address off label treatments and MUP	ABFA RD&E ABFA Funds	$20,000	$20,000	$30,000
4. Awareness of Farm Productivity Issues and Options	• Better awareness of Farm Productivity Issues and Options	ABFA Funds Members Universities	$30,000	$40,000	$60,000
5. Sustainable Barramundi Production Systems	• Understand the level of regulation seeking to address sustainability • Strategy to address unnecessary burdens • National strategy to manage water discharge • Promote ABFA members environmental sustainability	ABFA Funds Members	$10,000	$20,000	$30,000
6. Effective Regulatory Frameworks to Support Australian Barramundi Farms	• Understand regulation level in place impacting on barramundi aquaculture • Strategy to address unnecessary burdens • Promote ABFA members environmental sustainability	Members ABFA RD&E ABFA IBC ABFA Funds	$20,000	$20,000	$45,000
7. A Resourced National Industry Body that Delivers Outcomes	• ABFA Business Plan • Industry Communication Plan • Sound Governance • RD&E Strategy • Capacity Building	ABFA Funds ABFA RD&E ABFA IBC	$131,000	$280,000	$420,000
TOTAL INVESTMENT in RD&E and Marketing			**$321,000**	**$635,000**	**$1,080,000**

3.2.2.7 APFA

The Australian Prawn Farmers Association (APFA) was formed in 1993 to represent the interests and foster the development of the Australian prawn farming industry.

In 2001, the Australian prawn farming industry became the first Australian seafood sector to implement a compulsory federal levy based on production, to fund research and development. The levy helps to raise up to $300,000 annually for investment in prawn aquaculture R&D. In 2014, the APFA produced its 5-year R&D Strategic Plan 2015-2019 (**Table 9**). A new RD&E Plan is in development in 2019.

In addition, a farm valuation model was created so that the industry could understand the factors that are contributing the most to the economic success of a farm. For example, in the list below a 1% increase in Growth provides a better economic return than a 1% decrease in Cost of Feed.

The top ten KPI's generated from APFA's farm valuation model are based on data collected in season 2012-13:

1. Growth (g/week)
2. Days to harvest
3. Price ($/kg)
4. Survival (%)
5. Stocking rate (PLs/m^2)
6. # Hectares in crop/yr
7. Cost of Feed ($/kg)
8. Farm (FCR)
9. Avg. Farm Labour (Cost/ha)
10. Power (Cost/ha)

However, despite developing these KPIs, neither the industry association nor the Government report these data. This lack of reported data prevents benchmarking by industry members and hinders the overall industry to track and report performance (improvements).

Table 9: APFA Priority list for R&D Investment 2015-2019

Priority	Rating	APFA Comments
Genetics and PLs	H	The clear immediate and 5 year research priority area is 'Genetics and PL's'. This area had more than triple the support for research over the next 12 months compared to all other priority areas identified. Our R&D activities over the next 12 months and 5 years should include an appropriate level of research investment into this area. The more immediate need is increasing post larval quality and health, and consistent hatchery output. Domestication remains a high priority research area, and plans should be considered to ensure that R&D continues on this front for the benefit of the long term future of the industry.
Nutrition	H	Priority areas under the banner of 'Nutrition' fall into two areas, notably 'fish meal reduction' and 'feeding efficiency'. Both should be considered in the short and long term research plans for APFA. Both 'feeding efficiency' and 'farm efficiency', particularly in terms of automation, could obviously be investigated under the scope of the same project.
Farm Efficiency	H	'Farm Efficiency' is a broad area that should be considered for research investment over the next 5 years. Examples of potential 'Farm Efficiency' R&D that were identified were energy efficient technology, automation and increasing aeration efficiencies.
Disease and Biosecurity	H	The other standout priority area for research is 'Disease and Biosecurity'. Preventing exotic viruses and diseases, and viral clearance and mitigation are considered important to protecting our industry. Our research over the next 5 years should include projects and activities that help us deliver increased biosecurity and disease prevention / mitigation protocols.
Social License	M	
Staff and Training	M	
Marketing	M	
Farm Profit	M	
Waste Management	L	
Value Adding	L	
APFA Communications	L	
Regulations	L	

*3.2.2.8 **PPA***

The Pearl Producers Association (PPA), incorporated in 1988 is the peak representative organisation of the Australian South Sea Pearling Industry. The PPA membership includes 100% of all *Pinctada maxima* pearl oyster licensees, covering all licenses issued under the legislation that operate within the Australian North-west Bioregion. The PPA works on a number of fronts to assist members from Western Australia and the Northern Territory. The Pearling Industry has up to 150 vessels (of various sizes and functions) conducting pearling operations throughout northern Australia in both open water and on aquaculture farms within the North-west Bioregion. The PPA represents pearling licensees on a range of issues including:

- Legislation, Regulation and Policy Development
- Resource Access Policy
- Sustainable Resource Management and Ecological Sustainable Development
- Work Safety and Training Policy

The Pearling Industry is the only pearling industry utilising wild oysters for the production of Australian south sea pearls, and relies almost exclusively on oysters from the *P. maxima* fishery at Eighty Mile Beach south of Broome which is the only remaining significant wild-stock fishery for (*P. maxima*) pearl oysters in the world.

In 2017, the Australian South Sea Pearl Oyster fishery received sustainability certification against the Marine Stewardship Council Sustainability Standard.

The pearl industry has an Industry Partnership Agreement with FRDC (the Pearl Consortium IPA) established in 2011 and which currently extends until 2021 (FRDC, 2016a). The IPA is headed by the Paspaley Group that represents a consortium of eight pearling companies that have co-invested directly with FRDC to improve existing production technology and develop new technologies. Key R&D program components are summarised in **Table 10**.

Table 10: Pearl Consortium R&D Plan (Key Programs) 2016-2021

Theme	R&D Program
Environment	Environmental and genetic impacts on pearl production
	Third party environmental accreditation
Industry	Improve Pearl Quality
	Increase Production efficiency
	Improve hatchery based production
Communities	Provide confidence in the community that wildstock fishing of pearl oysters is sustainable
	Enhance community confidence that pearl farming is not detrimental to the environment
People	Support and increase industry capacity
	Improve personnel welfare and industry productivity
	Actively train identified staff in leadership roles
Adoption	Communicate the benefits created by the pearling sector
	Develop dialogue with the broader seafood industry, other marine users, FRDC, agencies, NGOs, and other external stakeholders.
	Communicate RD&E outputs in the appropriate format to hasten adoption

In 2018, a consortium of pearl producers Ellies Pearling Pty Ltd, Cygnet Bay Pearls[5] and James Cook University received funding from the CRCNA to undertake a three year investigation into "Breeding for resistance to juvenile pearl oyster mortality syndrome".

3.2.3 CSIRO

The Commonwealth Scientific and Industrial Research Organization (CSIRO) has an extensive aquaculture R&D program, housed within the Food Flagship sector. CSIRO Aquaculture performs collaborative research with governments, scientific organisations and industries in Australia and all over the world.

CSIRO Aquaculture's Vision is: "A vibrant, diverse and sustainable Australian and Global Aquaculture Industry."

CSIRO's mission is to deliver science impacts in the following three key areas; Breeding and Genomics; Nutrition; Health and Production.

CSIRO's R&D in aquaculture is described in the project Literature Review and the results of CSIRO's northern Australia aquaculture viability assessment is summarised in the project Stage 1 Report (Section 3.6.1.1.6).

[5] The Trustee for Cygnet Bay Pearls Unit Trust

4 ONLINE SURVEY TOOL

4.1 RESULTS AND DISCUSSION

The following results quantify and summarise key characteristics and perceptions of the survey respondents. Sub-sections include (4.1.2) overall sample characteristics, (4.1.3) respondent category characteristics (e.g. producers, suppliers, students, etc.), (0) perceived challenges, (4.1.5) goals for investment and expansion, and (4.1.6) perceptions of future involvement in aquaculture.

In the event that a response category received < 5 responses, they were not included in all the analyses, and response rates were variable due to missing data for some questions. Percentages in the tables may not add up due to rounding impacts. Where the data type and sample size allowed, analysis of variance tests were carried out to detect statistically significant differences in responses among respondent categories (e.g. perceived challenges, investment priorities).

4.1.1 Comment on sample bias and interpretation

Obtaining a representative sample of all individuals involved or potentially involved in aquaculture in Northern Australia was beyond the resources available for this study. Achieving representativeness requires a probabilistic sampling strategy and a larger sample. This is generally challenging when using online surveys, which were necessary given the geographic scope of the project. In light of this, it is important to acknowledge that there is a sampling bias in our data, as it represents (a) people who were accessible via our network of partners and online, and (b) people who were willing to take the time to fill out the online survey or engage in a face-to-face meeting (focus groups and workshops). Sampling bias is a common challenge in social science research, but it can be offset by appropriate interpretation of the results and by minimising other sources of bias. Where sampling bias was unavoidable, we were able to minimise other sources of bias in the data by triangulation (e.g. a mixed methods approach), and through appropriate questionnaire and methodological design (Neuman, 2006). Specifically, by using multiple, and in some cases sequential (e.g. surveys and focus groups), methods to ascertain perceptions of the research respondents, we were able to supplement, compare, and verify emerging themes and trends in the data. Moreover, this approach allowed us to explore people's perceptions in varied social settings; for example, as individuals via the online survey, or as a group seeking to reach consensus through face-to-face discussion via the focus groups and scenario planning.

Where we found congruence in people's responses in these varied scenarios, there was also some variation, which is inevitable under different social conditions, and to be expected given the complexity of human cognitive processes. As such, the proceeding stages of the methodological process (e.g. scientific and stakeholder validation) were crucial to ensuring the recommendations presented in the final report were the most accurate representation of industry needs and perspectives possible. The scientific validation produced the Stage 1 report, and involved an internal review of the results by the project experts, and the alignment of the major themes and perspectives with the best available scientific knowledge. The stakeholder validation stage, which produced the final report, engaged respondents and other industry stakeholders in a review of the Stage 1 report, to ensure the resulting priorities and recommendations were an accurate representation of their perspectives. As such, where we cannot claim that our results are statistically representative of the entire population of people engaged in aquaculture in Northern Australia, we can claim with confidence that the results represent an accurate depiction of the key vision, needs, aspirations and perspectives of the diverse and substantial proportion of individuals who engaged in this study.

4.1.2 Overall sample characteristics

There were 117 individual respondents to the online survey of the aquaculture industry in northern Australia. Some defining features of our sample included a prevalence of males, the high-level of expertise of our respondents (reflected by education levels and years working in the industry), and the absence of a significant proportion or Aboriginal or Torres Strait Islander participants (**Table 11**). The latter limitation of data collected

was improved by a higher level of engagement with Indigenous participants in the focus group meetings. The high level of expertise may be linked to the interest level of senior managers, the predominant responders.

Table 11: General demographic characteristics of the respondents (n= 117)

Characteristic	Category	n
Gender	Female	24
	Male	71
	Prefer not to say	1
Age	18-30	19
	31-40	19
	41-50	29
	51-60	20
	61+	9
Aboriginal or Torres Strait Islander	No	91
	Yes, Aboriginal	4
	Yes, Aboriginal & Torres Strait Islander	1
Education	Certificate I	1
	Certificate III	1
	Cert IV	1
	Diploma	5
	Graduate Diploma	1
	Bachelor Degree	23
	Honours	8
	Masters	14
	PhD	15
	Self-taught	1
	None	21
	Other	14
Duration in Aquaculture related Role	Less than 1 year	4
	1-3 years	11
	3-5 years	13
	10+ years	49

The sample was characterised by the largest number of respondents in the producer (29%) and education and research (26%) categories. This facilitated some statistical analysis to compare responses between these groups, which was not possible for other categories due to smaller sample sizes (**Table 12**). The geographic distribution of the sample was relatively broad, with the largest concentration of respondents in the Northern and Far North Regions (**Figure 4-1**). A number of regions were not represented including Pilbara, Katherine, Tennant Creek, Central West, Alice Springs – Uluru, and the Mid-West. Several participants (n = 12) did not reside in northern Australia but engaged in the industry remotely (e.g. government employees, students, etc.).

Table 12: Number and percent of respondents in each category

Role	Number	%
Aquaculture Producer/Farmer/Operator	34	29
Education and Research	30	26
Government Agencies	16	14
Aquaculture Service Supplier	13	11
Student	13	11
Potential New Entrant	6	5
Industry Representative	3	3
Aquaculture Product Purchaser	1	1
Potential Investor	1	1

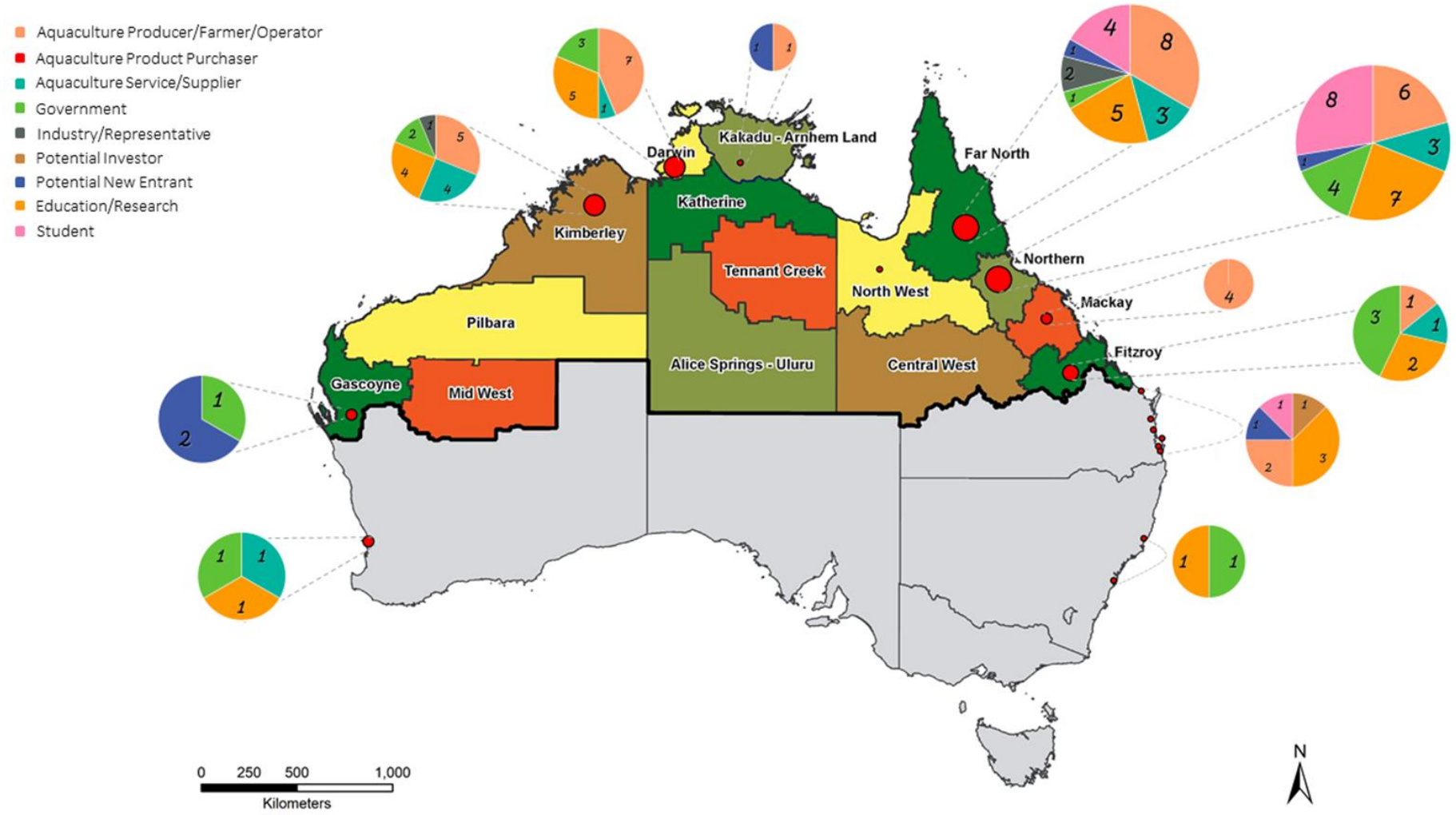

Figure 4-1: Distribution of respondents in Northern Australian Regions, and throughout Australia

4.1.3 Respondent category characteristics

4.1.3.1 ***Aquaculture producers***

Aquaculture producers (n = 34) represented organisations that were established in the time period ranging from 1940 – 2018 (**Table 13**). Most respondents occupied a high position within their organisation (**Figure 4-2**) and had 10 years' plus experience working in an aquaculture related role. The most common species produced by the respondents were barramundi and tiger prawns/*P. monodon,* with several sectors represented overall (**Figure 4-3**). The size of the respondents' organisation was variable, ranging from 1 – 5 employees to over 100 (**Figure 4-4**), with the average annual production from 20 – 3000 tonnes (**Figure 4-5**).

Table 13: General demographic characteristics of aquaculture producers

Characteristic	Category	n
Gender	Female	1
	Male	26
	Prefer not to say	1
Age	18-30	5
	31-40	3
	41-50	11
	51-60	5
	61+	4
Aboriginal or Torres Strait Islander	No	26
	Yes, Aboriginal	1
	Yes, Aboriginal & Torres Strait Islander	1
Education	Certificate I	1
	Certificate III	1
	Diploma	3
	Graduate Diploma	1
	Bachelor's	8
	Honours	3
	Masters	4
	PhD	3
	None	7

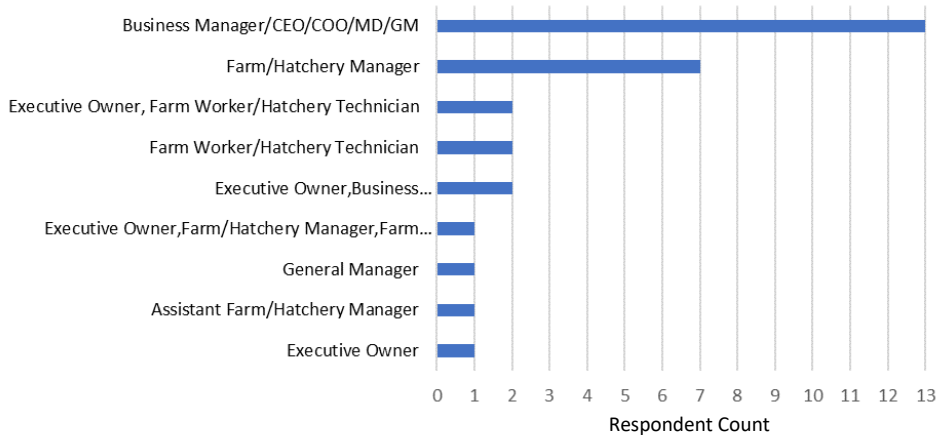

Figure 4-2: Organisational role of the aquaculture producer respondents

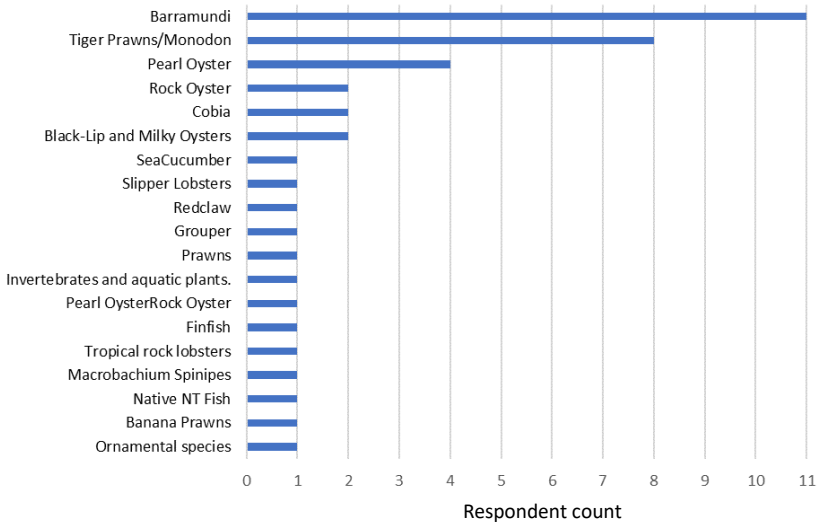

Figure 4-3: Species focus of the aquaculture producer respondents

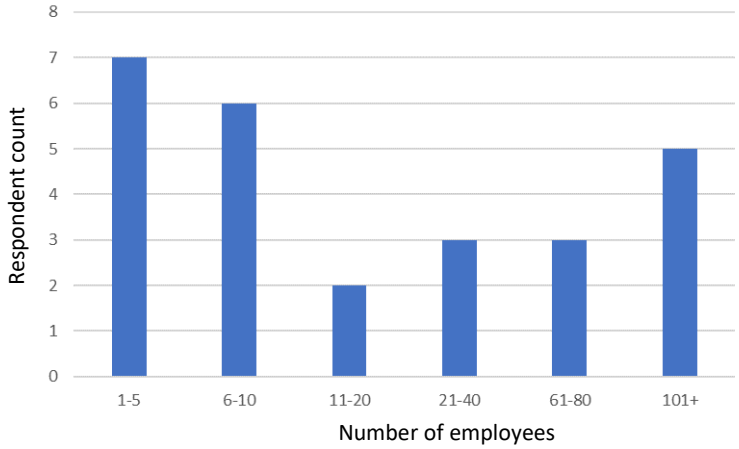

Figure 4-4: Current number of employees in respondents' organisation

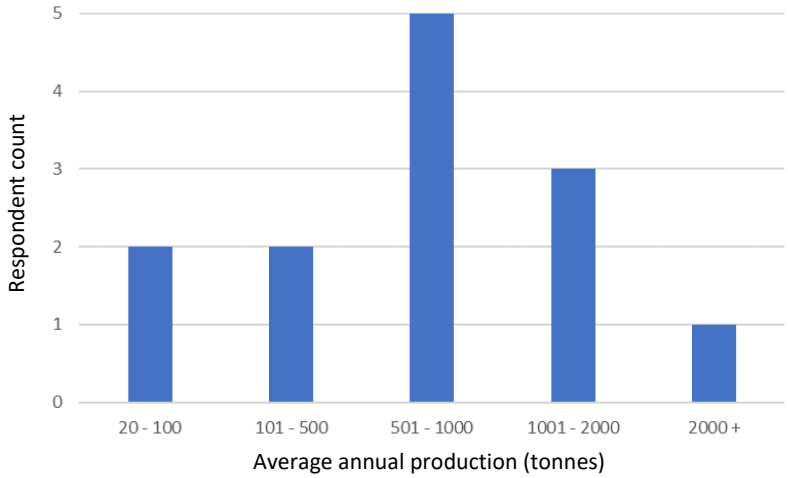

Figure 4-5: Average annual production of respondents' organisation (top range 3000 tonnes)

The characteristics of the producer respondents, especially the species and business sizes indicated, reflect the highly diverse and multi-sectoral nature of the aquaculture industry in northern Australia.

4.1.3.2 Aquaculture service providers

Aquaculture service suppliers represented organisations that were established in the time period ranging from 1966 – 2019. The respondents varied with respect to their organisational roles, including consultants (2), proprietors (2), and one respondent each with the role of researcher, technical lead, aquatic biosecurity liaison, business manager, hatchery feed supplier, and cross cultural liaison. Most had 10 years' plus experience working in an aquaculture related role. The size of the respondents' organisation was most commonly in the range of 1 – 5 employees. The average annual value of supply to the aquaculture industry ranged from $AUD 50k – 1.2 million (**Figure 4-6**).

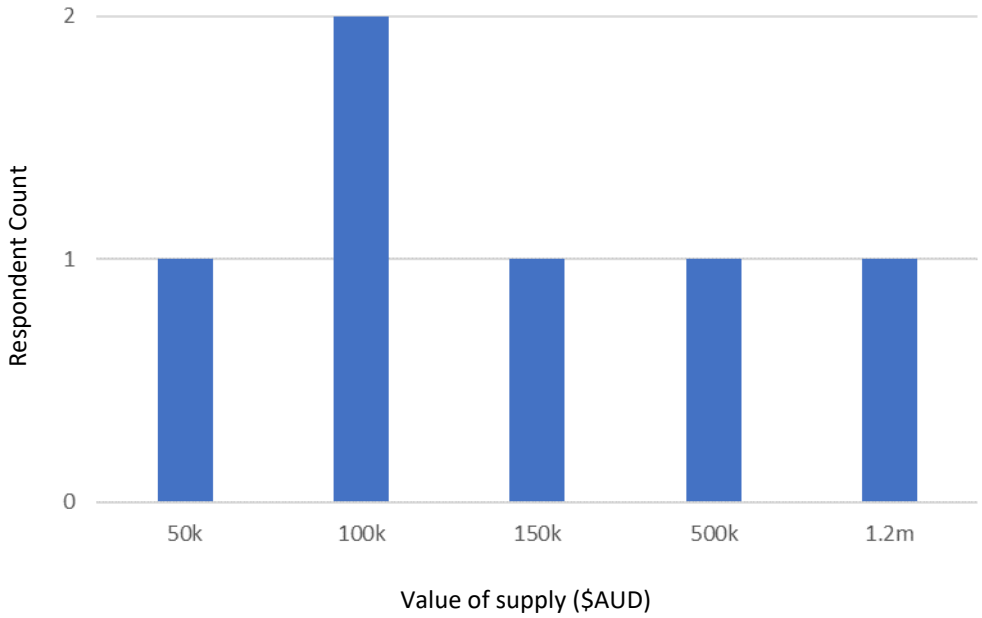

Figure 4-6: Average annual value of supply of respondents' organisation

4.1.3.3 Education, research and training providers

The participants in this category (n = 30) had research and education experience ranging from 1985 to the present day and were most likely to be researchers or university lecturers/professors. Other roles represented were vocational trainers and extension officers. Most had more than 10 years of experience and had participated in between 1 – 5 projects, although others had been involved in more than ten projects. Of those providing gender information (n = 24), one third were female and two thirds male, indicating more women are represented in this aquaculture sector. The size of the respondents' organisations was variable, with a tendency to be smaller (i.e. 1 – 10 employees).

4.1.3.3.1 Current research activity in northern Australia

The respondents reported 74 active research projects in a variety of regions across Northern Australia (**Figure 4-7**). It is likely that some projects were reported by multiple respondents, since many projects are collaborative, involving multiple research and industry partners. Based on the available data, the research foci of the projects varied, with the top three themes being: selective breeding and genetics; reproduction and spawning; and production systems (**Figure 4-8**). Thirty-eight projects were species-specific, with the most common being: pearl oysters, tiger prawns, and rock oysters (**Figure 4-9**).

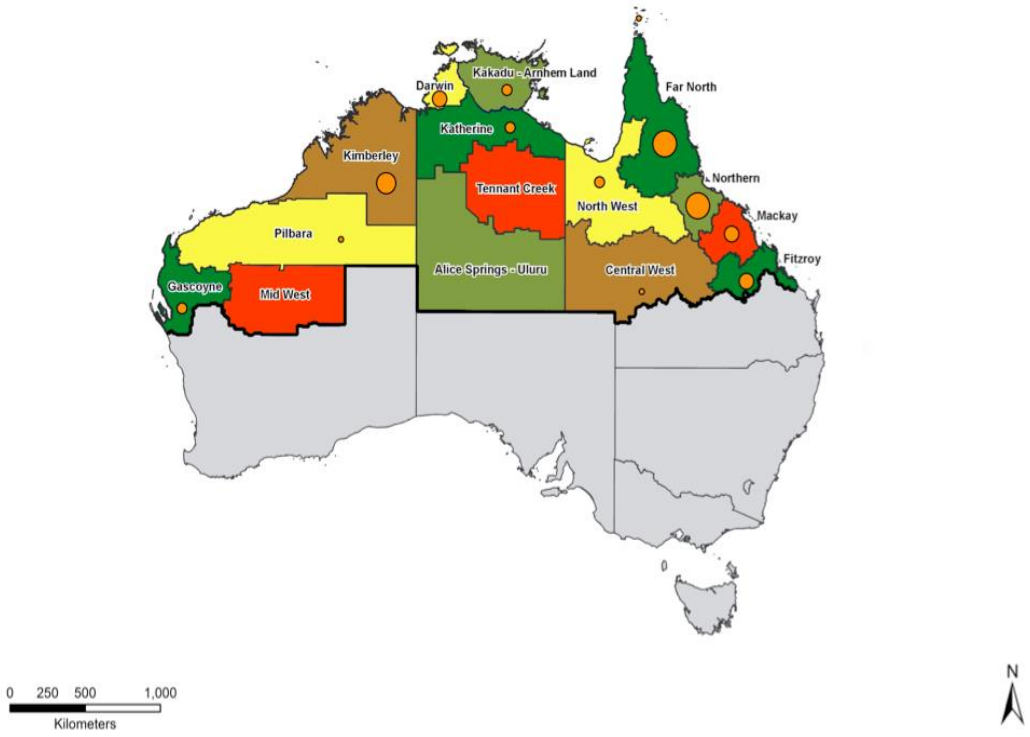

Figure 4-7: Location of active research projects (n = 74). The size of the bubble represents the relative number of projects. Three projects were not region specific.

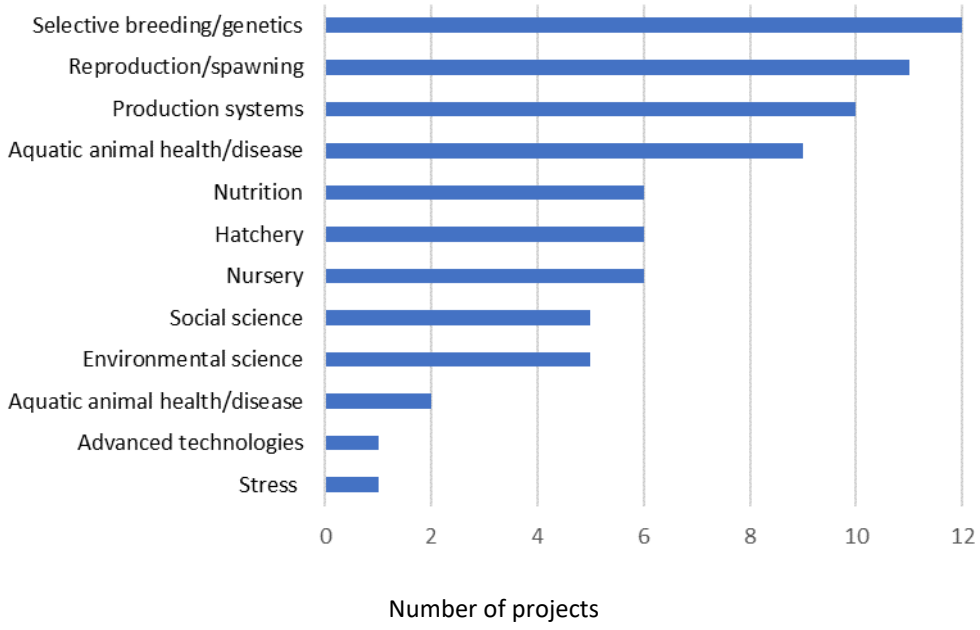

Figure 4-8: Research focus of active projects (n = 74)

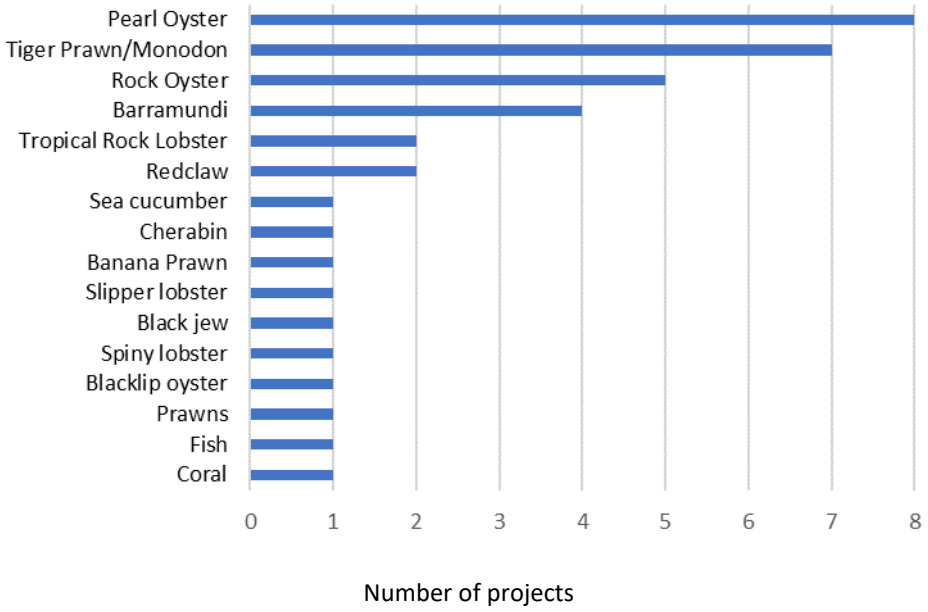

Figure 4-9: Species focus of active research projects (n = 38)

4.1.3.3.2 Current research funding in northern Australia

The amount of funding allocated to active research projects ranged from $AUD 100 – 500k to $AUD 10 M (**Figure 4-10**), with the majority of projects being funded primarily by government and/or industry contributors. Project duration ranged from < 1 year to 5 – 10 years, with the majority spanning 2 – 5 years.

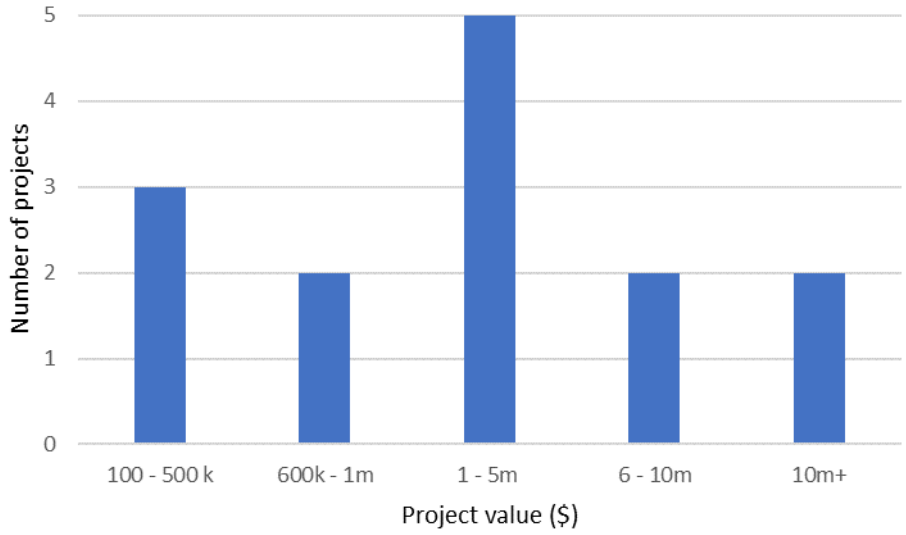

Figure 4-10: Reported total funding allocated to individual research projects (including in-kind)

4.1.3.4 Government agencies

Government agency respondents (n = 16) had varied roles within their organisations, with the largest proportion involved in planning and regulation, other roles included extension services, economic development, investment attraction, research, industry development, disease investigations, and policy development. Most had over 3 years of experience (88%), with the highest proportion in the 10+ years category (38%). Although species focus was varied, those individuals whose work focused on one or multiple species most frequently cited prawns (tiger and banana prawns combined), barramundi and rock oysters, reflecting the key production species and an important emerging sectors in rock oysters (**Figure 4-11**).

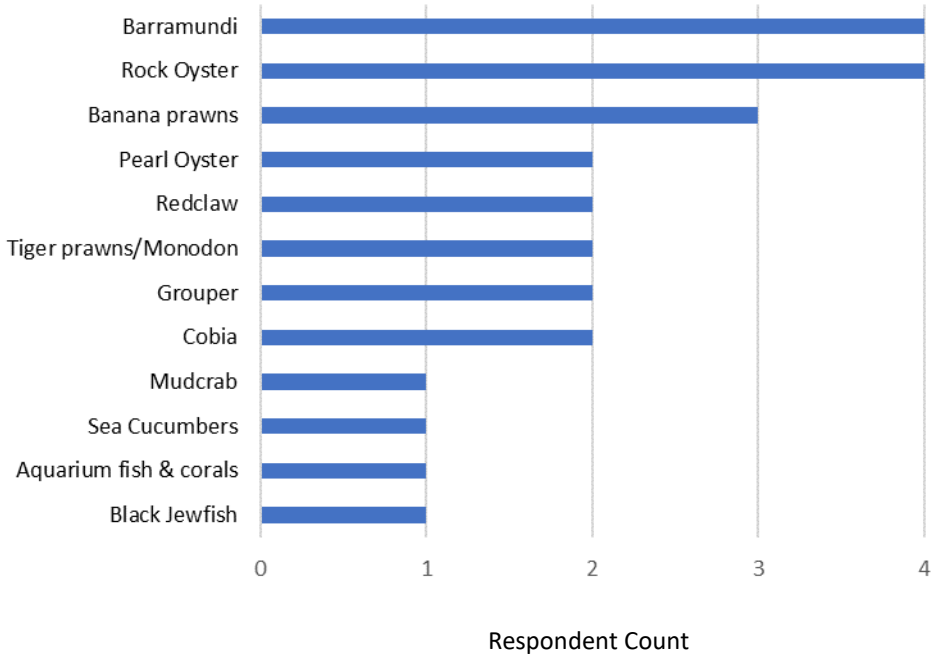

Figure 4-11: Species focus of the government agency respondents

4.1.3.5 ***Students***

The student sample (n = 13) was limited to eleven students from James Cook University (a partner in the project) and two who did not state their institution. Of those indicating gender, there was an equal 50% each of males and females. Most students were Australian, although a high proportion (42% were international) (**Table 14**).

Table 14: General characteristics of students of the aquaculture industry in northern Australia

Characteristic	Category	n
Gender	Female	6
	Male	6
Age	18-30	10
	31-40	2
Nationality	Australian	7
	Austrian	1
	French	1
	Indian	1
	South African	1
	Tuvaluan	1
Bachelor's Degree	Currently Enrolled	6
	Completed	4
Honours	Plan to complete in future	3
Masters	Currently Enrolled	4
	Plan to complete in future	4
PhD	Currently Enrolled	1
	Plan to complete in future	3

The students were interested in pursuing a variety of careers, including in research, as a proprietor, hatchery technician, hatchery manager, government planning, breeding program manager, and aquatic animal health manager. Only two respondents indicated they did not know what their career plans were. Confidence levels about being able to achieve their desired career goals averaged 5.3 on a scale of 1 – 10, with 10 being the most confident (**Figure 4-12**).

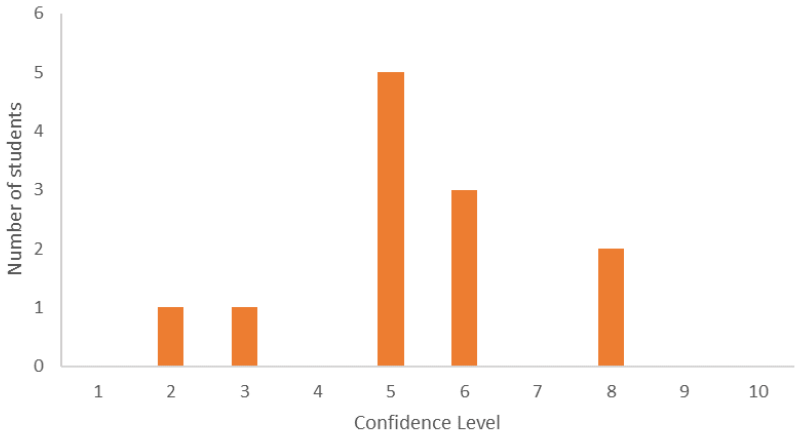

Figure 4-12: Perceived confidence of students in being able to achieve their career goals after graduation (1 = least confident, 10 = most confident, mean 5.3).

The student results have important implications for the future of skilled staff availability in northern Australia. Skilled staff shortage was a major industry barrier identified by producers in focus group and workshop discussions. Given many were international, this may affect the likelihood that these students will not remain in Australia to work in the aquaculture sector. The relative low confidence level that the students will be able to pursue their chosen careers does not align with the high demand for skilled staff in the sector. This suggests that there are issues in relation to poor communication of industry growth trajectories and career opportunities to current students.

4.1.3.1 Other respondent categories (n < 5)

Three respondent categories received less than 5 responses; industry association representatives, new entrants, and one potential investor. The potential investor stated they did not have plans to invest in Australia due to the "lack of different species available to which the consumer is prepared to pay a premium price. Australia has too fewer species of fish which are preferred by customers overseas and in Australia". The new entrants, had plans to initiate investment and business development within three years, with one Indigenous corporation unsure about an engagement timeframe (**Table 15**).

Table 15: Planned trajectories and primary information sources of new entrants

Planned Role	Expected timeline	Primary information source(s)
Indigenous corporation	Not sure	Government Departments, Consultants and current producers
Aquaculture producer/farmer	Within the next 3 years	QLD government, AAQ, degree in BSc Aquaculture
Aquaculture producer/farmer	Within the next 3 years	Govt departments such as Gascoyne Development Commission and Fisheries
Indigenous corporation as aquaculture producer/farmer	Within the next 12 months	NT Fisheries and other operators

4.1.4 Perceived challenges related to development of aquaculture in northern Australia

Respondents were asked to rate a series of challenges affecting the development of aquaculture in northern Australia on a scale of 0 (no challenge) to 10 (most severe challenge). The challenges are listed in **Table 16.** The challenge names have been abbreviated in the figures.

Table 16: List of challenges presented to survey respondents for rating

• Broodstock (quality/supply)	• Power (costs/reliability)
• Fingerling, PL and/or spat (quality/supply)	• Building/infrastructure costs
• Stock performance	• Transport costs
• Disease	• Supply chain and infrastructure
• Feed costs	• Market access and development
• Feed quality	• Market sales price
• Breeding programs (absence of)	• Competition (domestic and international)
• Labour costs	• Access to capital
• Labour recruitment/availability	• Regulatory burden (time/cost)
• Liveability/remoteness of operations	• Environmental risks/pressures (extreme weather etc.)

Respondents were given the option to rate the challenges from the perspective of the industry as a whole or on a species level. In addition, respondents were invited to free-list and rate up to three additional challenges not represented in the list provided. The open-ended responses to this question are compiled in Appendices **Section 11.3**.

Across all respondent categories, the most highly rated industry-level challenges were power (cost/reliability), liveability, and environmental risks (in relation to extreme weather events, disease, etc.) (**Figure 4-13**). When considering the moderate and severe ratings combined, other important factors were: feed costs, transport and infrastructure. There was no significant difference in the response of people with longer (>10 years) or shorter term industry engagement.

When separated by respondent category, the main challenges perceived by: producers were the absence of breeding programs, broodstock (quality/supply), and labour recruitment; for suppliers they were power, environmental risks, and building infrastructure; for government they were power, labour recruitment and supply chain and infrastructure; and for educators and researchers they were feed costs, transport costs and fingerling, post larvae (PL) and/or spat (quality/supply) (**Figure 4-14**). There were no significant differences among these respondent groups.

Perceived challenges were also variable at the species-specific level (**Figure 4-15**). For example, environmental risks and disease were very significant threats to pearl oyster aquaculture, broodstock (quality/supply) was most important for the prawn sector (for recent status see Stephens, 2019), and regulatory burden was highest for the barramundi producers. For barramundi, there were fewer severe challenge ratings (of the list provided) compared with other species sectors.

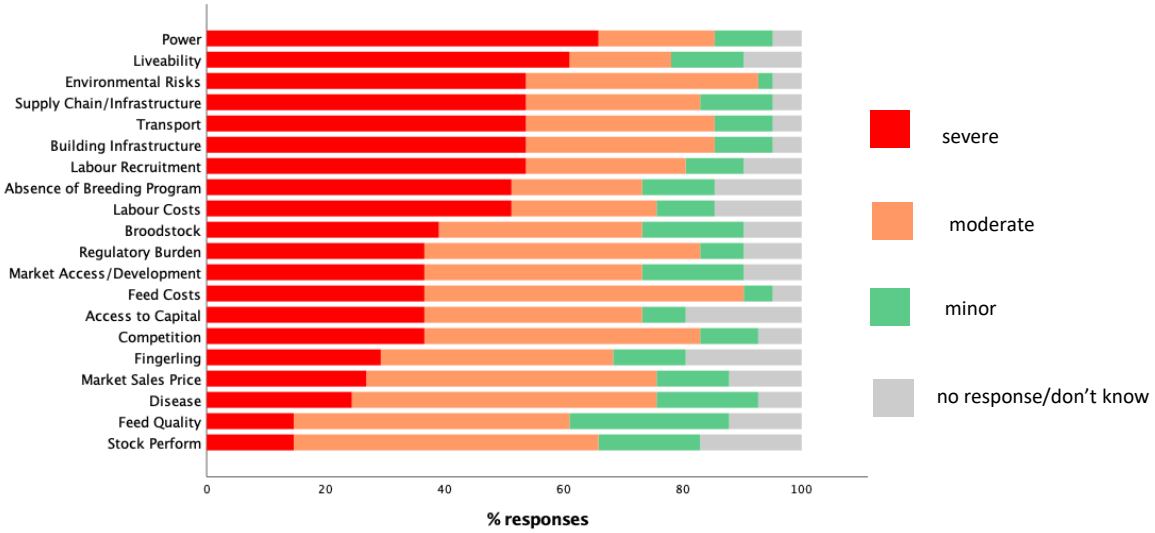

Figure 4-13: Perceptions of the severity of challenges affecting the development of aquaculture in northern Australia (ranked by the highest proportion of responses with a severe rating). Data is aggregated across all respondent categories (n = 37).

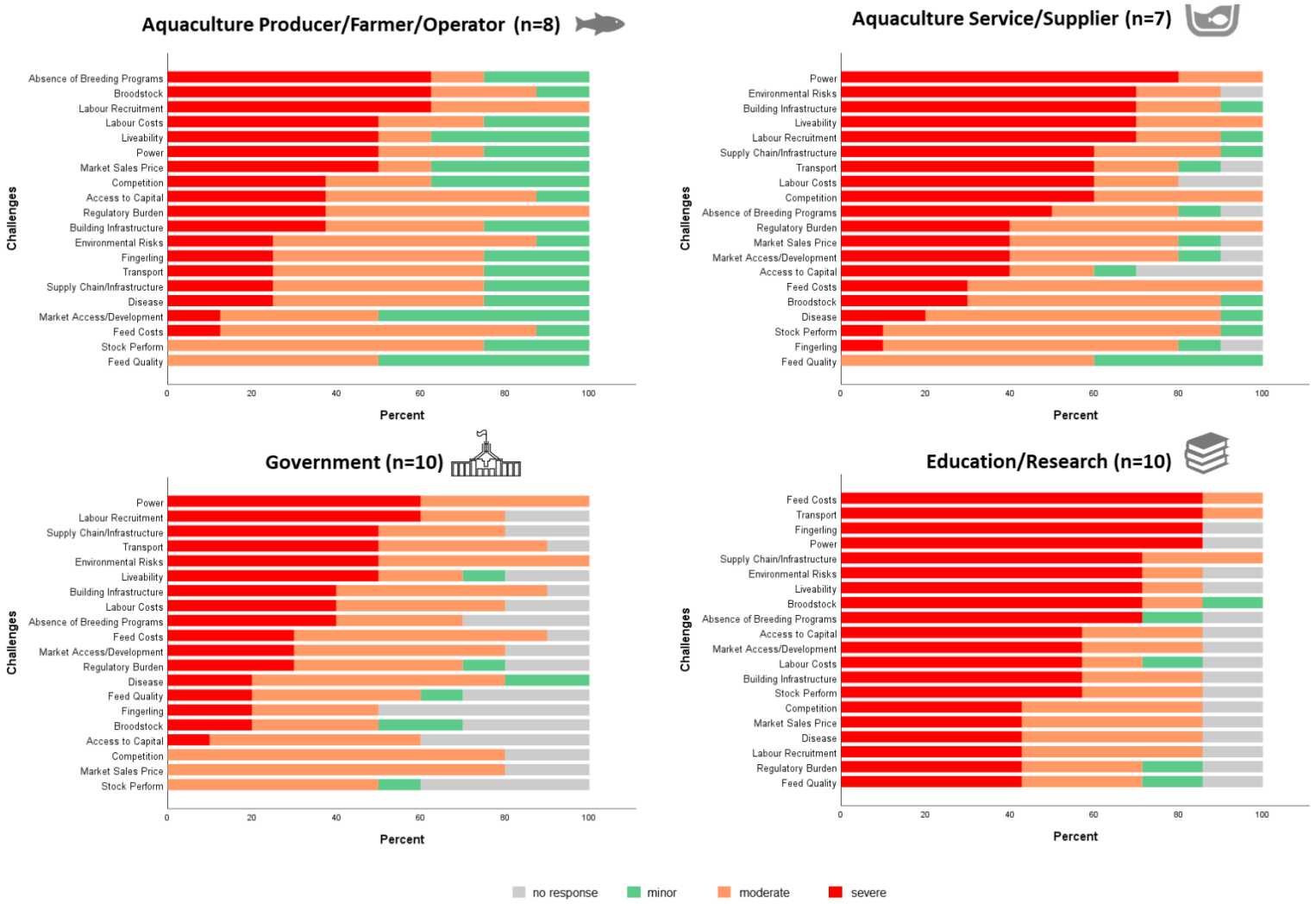

Figure 4-14- Perceptions of the severity of challenges affecting the development of aquaculture in northern Australia separated according to respondent group (ranked by the highest proportion of responses with a severe rating).

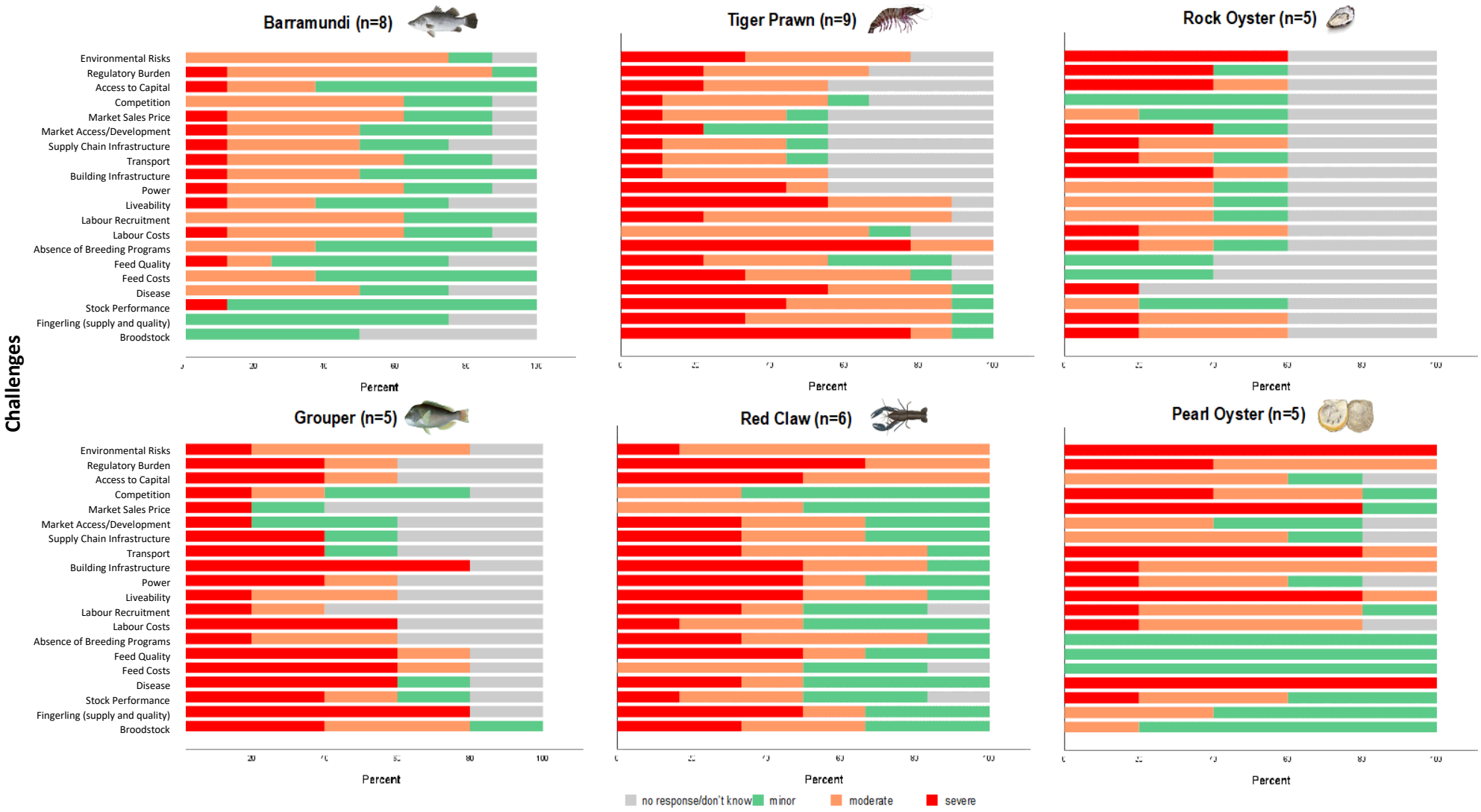

Figure 4-15: Perceived challenges separated according to species, with order of challenges the same for each figure part for comparison

4.1.5 Goals for investment in expansion and in RD&E

Respondents were presented with a series of categories representing aspects of support for the expansion (**Table 17**) and themes of RD&E (**Table 18**) for the aquaculture industry in northern Australia and asked how they would choose to allocate 100 'credits' between the categories (credits for the aspect of support for expansion and RD&E allocated separately). Respondents were also invited to free list other areas they would invest in that were not listed. These open-ended responses are compiled in Appendices **Section 11.4**.

Table 17: Categories of support for expansion of the aquaculture industry in northern Australia

Category	Description
Government	Government policy and regulation (e.g. streamline approvals, increased aquaculture site availability, increased bio-security, country of origin, projects of State/Territory significance, importing economically important species).
Expanding markets	Expanding markets (e.g. access to new export markets, market volume, brand Australia).
Research	Research, development & extension (e.g. nutrition, disease management, automation, breeding and genetics, field officers for assisting aquaculture development).
Selective breeding	Selective breeding programs (e.g. government-supported transitioning to commercial, improving disease resistance etc.).
Infrastructure	Infrastructure (e.g. roads, bridges, power, airport, ports, cold chain).
Training	Training, skills and workforce availability (e.g. training in northern Australia, university, TAFE, VET, apprenticeships, visas, overseas skilled labour).
Access	Access to capital (e.g. investment connection, capital structures, investment approvals).
Other	Respondents invited to free list other categories for expansion not listed.

Table 18: Categories of RD&E for the aquaculture industry in Northern Australia

Category	Description
Automation	Automation (reducing labour inputs, improving efficiency)
Disease management	Disease management (improving disease resistance)
Nutrition	Nutrition (e.g. reducing/removing fish meal to improve sustainability credentials, improving quality to decrease FCR)
Water quality	Culture water quality management
Environmental management	Environmental management (e.g. discharge bio-remediation)
Breeding genetics	Breeding and genetics (e.g. tools for breeding, tools for pedigree protections)
Live fresh transport	Live/fresh transport (e.g. cold chain, modified atmosphere packaging)
Other	Respondents invited to free list other categories for expansion not listed

Table 19 shows the percent of credits allocated to each category of support for expansion across all respondent categories. Government policy and regulation (e.g. streamline approvals, site access) at 23% and research (RD&E) at 22% received the highest allocation of credits. Both the producers and researchers prioritised the credit allocation toward government and research that drove this finding. Government respondents prioritised infrastructure development and research.

Table 19: Sum and percent credits allocated to expansion of the aquaculture industry in northern Australia

Categories	Total Sum	%
Government	2145	22.6
Research	2117	22.3
Selective Breeding	1170	12.3
Training	1109	11.7
Infrastructure	1015	10.7
Access	843	8.9
Expanding Markets	752	7.9
Other	349	3.7

Table 20 shows the percent of credits allocated to each category of RD&E across all respondent categories. 'Breeding genetics' and 'disease management' received the highest allocation of credits overall, which also aligned with the priorities of the producers, and the percentage 'credit' split is potentially useful to inform RD&E resource allocation.

Table 20: Sum and percent credits allocated to RD&E to support the aquaculture industry in northern Australia

Categories	Total Sum	%
Breeding and genetics	1501	20.0
Disease management	1200	16.0
Nutrition	1172	16.0
Environmental management	1065	14.0
Automation	911	12.0
Live/Fresh transport	666	9.0
Water quality	553	7.0
Other	332	4.0

Table 21 shows the percent of credits allocated to (a) expansion and (b) RD&E by different respondent categories. The results were varied, and MANOVA showed there was a statistically significant difference between these groups with respect to RD&E credits allocated to environmental management ($p = 0.03$). Education and research providers prioritised 'environmental management' RD&E higher than producers. Note that the test was only conducted for producers and education & research providers due to limited sample sizes.

Table 21: Sum and percent credits allocated to expansion and RD&E for different respondent categories. Items listed in order of total credits allocated within each respondent category

(a) Expansion				(b) RD&E			
	Total Credits	%	N		Total Credits	%	N
Producers							
Research	637	23	25	Breeding Genetics	786	29	23
Government	555	20	24	Disease Management	430	16	22
Selective Breeding	485	17	18	Automation	401	15	21
Training	324	12	21	Nutrition	317	12	19
Access	293	10	17	Live Fresh Transport	246	9	18
Expanding Markets	222	8	18	Environmental Management	240	9	17
Infrastructure	210	8	19	Water Quality	168	6	15

Other	74	23	2	Other	112	4	3
Education and Research							
Research	660	28	22	Nutrition	480	20	21
Government	530	22	21	Environmental Management	425	18	20
Training	340	14	19	Breeding Genetics	425	18	21
Selective Breeding	235	10	15	Disease Management	365	15	21
Infrastructure	210	9	14	Automation	230	10	18
Access	190	8	14	Water Quality	210	9	15
Expanding Markets	185	8	13	Live Fresh Transport	175	7	16
Other	50	2	1	Other	90	4	3
Suppliers							
Infrastructure	220	22	7	Disease Management	165	18	7
Government	200	20	8	Nutrition	165	18	7
Research	155	16	7	Automation	150	17	7
Other	135	14	4	Live Fresh Transport	140	16	8
Expanding Markets	95	10	7	Environmental Management	105	12	8
Selective Breeding	90	9	4	Breeding Genetics	90	10	4
Access	55	6	5	Water Quality	65	7	6
Training	50	5	6	Other	20	2	1
Government							
Infrastructure	240	20	9	Environmental Management	250	20.8	10
Research	215	18	10	Nutrition	185	15.4	11
Government	210	18	10	Disease Management	180	15.0	11
Training	185	15	11	Breeding Genetics	145	12.1	10
Access	125	10	9	Automation	140	11.7	9
Expanding Markets	100	8	7	Live Fresh Transport	125	10.4	9
Selective Breeding	75	6	8	Other	100	8.3	1
Other	50	4	1	Water Quality	75	6.3	8
Students							
Research	285	26	11	Nutrition	290	24	12
Government	205	19	11	Disease Management	245	20	12
Selective Breeding	150	14	10	Environmental Management	215	18	12
Training	145	13	10	Breeding Genetics	190	16	11
Access	110	10	8	Water Quality	110	9	10
Expanding Markets	105	10	9	Automation	90	8	10
Infrastructure	80	7	8	Live Fresh Transport	60	5	7
Other	20	2	1	Other	0	0	0

4.1.6 Plans for engagement in aquaculture

In the final section of the survey, respondents were asked about their intentions to continue to engage in aquaculture in northern Australia in the future, and whether they would consider engaging if they were able to decide all over again. The majority of respondents (87%) said they planned to continue to engage (**Table 22**) and more than half (62%) said they would do it again (**Table 23**). There was more uncertainty with respect to the latter question, with 28% saying they were unsure if they would do it again. Some respondents (n = 5) indicated that they would engage in aquaculture again, but not in northern Australia. Respondents were asked

to explain their responses to these questions and were invited to give any final feedback to the project partners before completing the survey. These open-ended responses are compiled in Appendices **Section 11.5** (Free Listed Survey Responses - Future Engagement) and **Section 11.6** (Free Listed Survey Responses - Final Comments), respectively.

Table 22: Intentions to continue to engage in aquaculture in northern Australia in the future

Category	Respondent count		
	Yes	**No**	**Unsure**
Producers	26		2
Supplier	7		2
Education & Research	23		1
Government	6	1	4
Student	10		1
TOTAL	**72**	**1**	**10**

Table 23: Reponses to question about whether they would consider engaging in aquaculture in northern Australia (NA) if they had the chance to do it all over again

Category	Respondent count			
	Yes	**Yes, but not in NA**	**Unsure**	**No**
Producers	14	4	8	1
Supplier	5		3	
Education & Research	13		8	2
Government	8		2	
Student	8	1	1	
TOTAL	48	5	22	3

5 FOCUS GROUPS

5.1 RESULTS AND DISCUSSION

The following results quantify and summarise the participant responses from the focus groups. Sub-sections include (a) context of focus groups, (b) detail of focus group findings, (c) comparison of challenges among focus groups, and (d) comparison of solutions to challenges to aquaculture expansion.

5.1.1 Context of Focus Groups

Our project held 12 focus group discussions in five regional areas of northern Australia (**Table 24**). An Indigenous aquaculture group was held in each of the locations, and the context of the groups varied by region according to the number of participants relevant to different categories. A total of 98 stakeholders were engaged through focus groups. Given the interest in the sessions and the opportunity to bring people together to network and share, some of the groups were larger than the eight-participant maximum originally planned. The group sizes ranged from 2 to 14, not including the facilitators and project team members. Participant gender was 79% male (n = 77) and 21% female (n = 21). There were 35 participants across the Indigenous aquaculture focus groups, although not all identified as Aboriginal or Torres Strait Islanders.

Table 24: Location, dates and context of the aquaculture focus groups (n = 12 groups) held across northern Australia

Location	Date 2019	Group Ref #	Context	Participants n	Project team/ Observers n
Thursday Island, Torres Strait	20 May	1	Indigenous	14	6
Broome, Western Australia	5-6 June	2	Indigenous	9	4
		3	Producers	7	3
		4	Service providers#	6	1
Townsville, Queensland	3-4 July	5	Indigenous	2	3
		6	Prawn producers	13	2
		7	White-flesh fish producers^	7	1
		8	Other producers	8	1
		9	Service providers	8	2
Cairns, Queensland	10 July	10	Biosecurity	5	2
Darwin, Northern Territory	23-24 July	11	Indigenous	10	4
		12	Producers & service providers*	7	4
Total Participants				**98**	
Participant Gender					
Male **n**				77	
Female **n**				21	

government, research & education

^ barramundi, grouper

* worked on specific challenges in smaller groups of 3-5 participants with facilitators

5.1.2 Detail of Focus Group Findings

5.1.2.1 Torres Strait

The focus group with 14 Indigenous fishers in the Torres Strait was facilitated by Indigenous Professional Services (IPS), hosted by the Torres Strait Regional Authority (TSRA), and was attended by a representative of the Department of Agriculture and Fisheries Queensland and two members of the project team as observers. All Indigenous participants were male. The fishers attending form part of the Protected Zone Joint Authority (PZJA) that is responsible for making decisions about the management of fisheries in the Torres Strait Protected Zone. TSRA had convened the fishers as part of a four-day consultative program, which provided a timely opportunity to hold the CRCNA aquaculture focus group in the Torres Strait.

Participants noted that that they were unable to make recommendations without consulting with the Malu Lamar (Torres Strait Islander) Corporation, the Native Title representatives (Prescribed Bodies Corporate (PBC)), who were not represented at the focus group. For any aquaculture development, it was noted that clarity around the jurisdiction of Malu Lamar, and other licences, would need to be sought. The effect of this operating environment on individual Torres Strait Islander businesses and the future direction of the region for aquaculture needs to be better understood.

The participants shared the 'Report on Torres Strait fisheries research protocols: a guide for researchers' (Nakata & Nakata, 2009) to ensure the project team were aware of the guiding framework and recommendations for researchers engaging in the Torres Strait. This report and 'A Guide for Fisheries Researchers working in Torres Strait' (AFMA, TSRA & TSSAC, 2012) are critical resources for any aquaculture research implemented in the Torres Strait.

The discussion focussed on wild-capture fisheries, where the fishers are currently engaged (**Table 25**). When asked about aspirations for aquaculture, there were mixed perceptions from the participants, including negative, neutral and positive comments. There was resistance from the group to discuss aquaculture in detail, as there was a perception from some participants that they were being pushed into aquaculture rather than focussing on better management of the existing capture fisheries. Participants noted that they would have

appreciated more introduction from the project team about aquaculture processes and the industry to better understand the sector prior to discussing challenges and opportunities. This guidance was taken on board by the project team for the subsequent focus groups, where there was workshop time included to allow updates of regional aquaculture activities, before the focus group discussions. While this may have influenced the perspectives expressed by participants, it was considered important for the sector that is so diverse and where producers and new entrants do not often meet together to share the current situation of aquaculture ventures in northern Australia.

The first key challenge identified in the Torres Strait was the lack of information about aquaculture. In response and as a solution to the challenge, the participants requested more information on the options for aquaculture in the Torres Strait (including content regarding scale, technology, species, environmental protection, example industry case studies, potential employment and the tasks that managers and employees undertake in an aquaculture business). When aquaculture species options were mentioned, there were individuals interested in:

- sandfish – both hatchery production and ranching, because the local fishery for this high value sea cucumber species is closed;
- crayfish – tropical spiny lobsters, as they already have a high value supply chain for wild caught crayfish;
- pearl oysters – currently some small farms operating in the Torres Strait

They also noted the importance of protecting the environment, including protection of the genetic resources. The remainder of the conversation was focussed on wild fisheries.

All participants were interested to learn of ILSC's new mandate to include sea country. Both TSRA observers and the participants wanted to understand how ILSC and TSRA programs can complement local enterprise development, for fisheries and more broadly.

The priorities identified by the participants in this workshop were focused on developing a more inclusive supply chain for Torres Strait Islanders, which would be equally applicable in fisheries and any new aquaculture ventures. There was a perception that the middlemen in the supply chain are reaping the greatest reward from the fisheries within the Torres Strait region. The participants supported transitioning the overall ownership of fishery enterprises and supply chain operations to 100% Torres Strait Islander ownership. In light of this aspiration, it will be important to undertake a supply chain analysis to clarify the costs associated with taking a harvested product to the export market.

Recommendations for aquaculture development in the Torres Strait:

- Develop basic print and digital educational resources that are regularly distributed to the Traditional Owners that outline current trends and opportunities in aquaculture. This communication resource would be for leaders, business owners and communities, to help Torres Strait Islanders decide if aquaculture provides a suitable business and work opportunity.
- Continue development of Torres Strait Islander business leadership capacity. (Applicable for capture fisheries and aquaculture.)
- Undertake a supply chain analysis to clarify the costs associated with taking a harvested product from the Torres Strait to the export market. (Applicable for capture fisheries and aquaculture.)
- Feasibility assessment of new, shared infrastructure for drying sea cucumbers. (Applicable for capture fisheries and aquaculture.)

Table 25: Torres Strait – Indigenous focus group results

GOALS (No aquaculture vision statement. These are the goals of the Torres Strait fishers.)	Direct export from Torres Strait of live crayfish to Sydney; Direct marketing to China, Indonesia and Singapore; Increase volumes; Torres Strait to have a stand-alone brand, factories and retail brand; Control of the supply chain to drive and determine the price; Traditional Owners to benefit from the natural resources.	
Challenges	**Solutions**	**Support**
1. Lacking the ability to take on or resource growing industry knowledge around trends and opportunities to diversify income. Participants are reluctant to grow and expand on existing business methods {both in current wild fisheries and new aquaculture}. They lack the ability to resource the information about external environmental factors that challenge their business position. The aquaculture method and processes are foreign to them. This relatively new information seems to threaten their already existing knowledge around current business operation and therefore becomes an obstacle on top of other impeding factors.	Develop basic print and digital resources that are regularly distributed to the Traditional Owners that outline current trends and opportunities that encourages them to learn in a more digestible format.	Government to engage support to develop industry specific educational resources for industry specific knowledge to overcome barriers to resourcing and learning difficulties.
2. Lack of community work ethic and leadership support. Participants noted that there were empty fishing boats anchored out in the water with no one working the vessels. Finding those with working capacity and the desire to work has been the challenge.	Limited earnings for Torres Strait Islander business owners was a concern as they were only being offered $40-50 kg for dried sea cucumber ("slug") and there was an inconsistent cost per kg. This could be a contributing factor disempowering teams along with pressures for individuals to lead teams. Air-drying facilities would see that the slug and sandfish volumes increase along with weight if air-dried. This would ensure that Torres Strait Islander businesses are obtaining $800-900/kg (Sandfish) instead of lower margins for limited produce. If air-drying facilities were made available, the fishermen could increase volumes and negotiate a consistent and contracted cost per kg as they would be able to offer more volume and a consistency with produce.	Torres Strait Islander business owners would require support to complete a business plan proposing this expansion and justifying cost of air-drying facility and capacity to increase earning capacity. TO groups would need to put forward their commitment to work in the air-drying facility and in cohesion with the vessels to ensure consistent productivity at each execution point. Those being the Fishing Boats, the transportation of fish/slug to air-drying facility and then a team to complete processing at the facility. If the Torres Strait Islander business owners are seeing value, increased margin and consistency in their trade this would encourage their desire to continue to trade.
3. Torres Strait Islander business are losing the potential to earn 700% margin due to Supply Chain Control Barriers of a "Middleman" that has direct distribution channel internationally. Torres Strait Islander business owner sells slug to major distributor for $40-50/kg. The major distributor then sells the slug for $340- $350/kg (700% margin is perceived to be lost). Live export is occurring with the middleman and not with the Torres Strait Islander business owners. Smaller barriers include: not having a plane; lack of volume; not enough drying machines and appropriate dryers (machine dryers cause excessive shrinkage in slug whereas air-drying causes slug to lose only a small amount in size); lack of air-drying infrastructure for fishers.	Participants discussed an opportunity to live export, process and grow if they had additional infrastructure. This could be a land-based air-drying facility, or a floating processing barge with enough surface area to sun dry slug. This asset could also process product and ship straight from the barge. This would increase volumes and also avoid potential Native Title conflict. Other ways to diversify income using the barge would be to train Indigenous youth off the barge that way they are obtaining skippering or Coxswains credentials when the processing plant is not in use.	
Strategic Advantages 1. Authentic produce could be supplied in live export to capture increased and valuable margin. 2. Torres Strait Islander fishers can alternate produce between slug and crayfish to diversify offering and income potential. 3. Can ship out directly to Cairns and then onto China with the right freighting options and volumes of produce. 4. Some of the area is still protected allowing the Traditional Owners some exclusive fishing capabilities.		
Emerging Opportunities 1. Growth of future live export market 2. Build infrastructure to increase capacity to enhance volumes 3. Horn Island is large, with limited fishing resources compared to other islands, however there is an opportunity to utilise the land to increase trade.		

5.1.2.2 Northern Western Australia - Broome

There were three focus groups held in Broome: Indigenous, Producers and Service Providers. Prior to the focus group session, the workshop program included presentations from local producers, government and research providers to share the current status of aquaculture in northern WA.

The Indigenous focus group was attended by nine participants representing Traditional Owner groups, consultants to Traditional Owners, government and research, was facilitated by IPS, and was attended by representatives from the project team. Of the participants, excluding the facilitation and project team, there were five males and four females.

Key challenges identified were: insufficient support for local and place-based research; limited business viability due to lack of understanding; collaboration and supply chain access; and lack of appropriate Aboriginal business models (**Table 26**). The group's vision included Aboriginal people as drivers, embracing cultural protocols, and positive employment and economic outcomes.

Table 26: Northern Western Australia – Indigenous focus group results

VISION Aboriginal peoples are drivers of fisheries management, embracing cultural protocols and are integral within the supply chain in a well governed, well-resourced and growing industry with an international market presence so that we proudly supply our Kimberley brand through the employment and positive economic outcomes for our first nations people.		
Challenges	**Solutions**	**Support**
1. Insufficient government and non-government support. Lack of local and place based research; commercialisation; IP ownership and investment for infrastructure	The participants discussed funding local and or culturally appropriate businesses or government organisations to undertake detailed processes regarding business feasibility, investment and helping to join interested parties (Industry) with Aboriginal people and or organisations, potential opportunities to partner with universities, TAFE etc.	Government to engage support to develop industry specific educational resources for Industry specific knowledge to overcome barriers to resourcing and learning difficulties and help define the business feasibility.
2. Limited business viability associated with industry. The viability and understanding associated with the cost benefit of operations and investment, size and scale of required operations, lack of collaboration (a win/ lose mentality) and access/ understanding of and to the supply chain.	The participants discussed funding local and or culturally appropriate businesses or government organisations to undertake detailed processes regarding business feasibility, investment and helping to join interested parties (Industry) with Aboriginal people and or organisations. There was discussions around the collaboration opportunities that exist across the top end however challenging locally based on a commercial in confidence approach in local area.	Traditional Owner business leaders would require support to complete a business plan and reviewing the various business opportunities business models. If the TO business owners are seeing value, reduced risk around scale and growth this would this would encourage their desire to continue to trade.
3. Lack of appropriate Aboriginal business models. A business model which is "safe" (both financial, culturally and mentally) and reduced risk, the ability to fund/ invest in projects to see the Belief, the Support and the Vision. Lack of participation and inclusion, empowerment and ownership.	Participants discussed an opportunity to partner with industry to help promote live export, process and grow if they had additional infrastructure. This would help to manage the knowledge gap, the ownership of IP and reduce the risk associated with working in partnership with Industry or investors and ensuring that governance is well understood and managed.	Improved partnership with aquaculture industry.
Strategic Advantages 1. Water, Title and Solar. {Good growing conditions} 2. Species only within the Kimberley. {Ability to nurture these in their natural environment such as fresh water prawns, swordfish and blue bone} 3. The brand - The Kimberley. {Pristine and unspoiled, cultural authenticity and diversification} 4. Geographical proximity to Asia. {Strategic and needs to be emerged through industry development and investment. Isolation was also seen as a strategic advantage} 5. A track record- industry understanding. {Not all new to the region}		
Emerging Opportunities 1. Downstream Processing, Embracing technology. {Upskilling, job creation and reduced overhead costs, Ice making, Processing facilities, Look at how technology can be embraced within the process.} 2. Indigenous capacity building. {TAFE engagement, CSIRO engagement, exchange program, grow people through opportunities} 3. Marketing Kimberley in aquaculture. {Participation in domestic and international market, the environment and climate within the Kimberley, opportunities to market, share communications and have active communications network, Engage with Austrade, Work in with WAITOC.}		
Additional notes		

- Focus on future collaboration opportunities as potential for competitive tension and all aboriginal organisations losing.
- There seems to be a lack of collaboration (local and national). Industry seems to work as win-lose and not a win-win engagement
- Automation, Power sources

The aquaculture Producers focus group in northern Western Australia had seven participants, 6 males and 1 female. Six from barramundi, pearls and prawn industries, and one from government (regional development). The group was facilitated by three members of the project team. Most participants were senior managers, with over 10 years' industry experience.

The group prioritised and considered six key challenges, regulatory burden, productivity, product differentiation, logistics/transport and supply chain and biosecurity (**Table 27**). The top three challenges from the online survey results for barramundi were confirmed: regulatory burden; competition; and transport. While for pearls, there was disagreement with the survey results because transport/logistics can be mitigated over time, and the key challenges were perceived as health and productivity. The vision included aspirations for growth, diversification, profitability and attracting investment. It also recognised the history and experience of aquaculture in northern WA and Indigenous interests. Other challenges discussed included staff recruitment and retention, extreme weather events, and low population density contributing to a lack of services.

Table 27: Northern Western Australia – Aquaculture Producers of pearls, barramundi and prawns focus group results

VISION Northern Australian Aquaculture offers a profitable and attractive investment environment that builds on the existing footprint and pioneer experience (IP) to diversify and grow in partnership with indigenous interests.		
Challenges	**Solutions**	**Support**
1. Regulatory burden. Although it was noted that there had been recent improvements (including change to DPIRD structure so that Aquaculture now sits under Agriculture rather than Fisheries), complying with government regulation/policy is still a significant burden to industry (time, cost and complexity). There was also a perceived lack of synergy between aquaculture leases and aquaculture licences.	• Improving timeframes, transparency and accountability. • Building a regulatory and policy framework that drives investment. • Learning from other jurisdictions (both positives and negatives). • Co-design and co-management of policy and regulation.	
2. Productivity.	• Breeding programs. • Integrated (government and industry) health and production plans. • Improve relationships and communication lines between government, researchers and industry.	
3. Product differentiation. Threat of competition from international producers, particularly ability of those producers to pass off their product as "Australian".	• Derive premium through Country of Origin labelling (establish provenance). • Utilising tech solutions (e.g. Blockchain, genetic tracking) to establish provenance. • Third party accreditation (e.g. MSC/ASC). • Appellation of region. • Import org and hospitality business solutions.	Government support for Country of Origin labeling.
4. Logistics/transport and supply chain. Time and cost of transportation (inputs and production), largely due to distance between farm and market/ancillary services.	• Utilising Curtin Air Base (3rd largest airstrip in WA with potential to support international flights). • 30 hour backload (Derby to Perth). • Provide incentives to aquaculture service providers.	Fund for incentives.

5. Biosecurity. Maintaining biosecurity to prevent disease outbreak.	• Focus on active surveillance (currently passive/reactive which is too late). • Improve speed and quality of fish/animal health response (from industry and government).	Improve reaction time/support from government when a biosecurity issue is reported under licence conditions.

Strategic Advantages

1. Clean/green reputation of Australian product.
2. Reputation as responsible and sustainable.
3. Place/landscape.
4. Geography/site suitability.
5. Tidal flows and water quality.

Emerging Opportunities

- Integrated multi trophic aquaculture
- Blue economy
- Market development
- Improving pathways to markets
- Diversification (species and services)
- Land-based pond farming
- Technology and innovation (including automation, AI, Blockchain, genetic tracking and telemetry)
- Tropical rock oysters
- Aquaculture tourism
- Leveraging existing supply chains (of other industries/producers)
- Development of labour market

The aquaculture Service Providers focus group in northern Western Australia had six participants, 5 males and 1 female, representing state government (regulation, industry development and research), regional development, vocational training, and new species. The group was facilitated by one member of the project team. Most participants were senior managers, with over 20 years' industry experience. The group discussed the top three challenges identified by producer respondents to the online survey (**Table 28**: Northern Western Australia – Service provider focus group results).

Table 28: Northern Western Australia – Service provider focus group results

VISION
A diverse and emerging large-scale sustainable aquaculture industry supporting premium products to export markets.

Challenges	Solutions	Support
1. Lack of labour. Keeping people and retention in company; liveability of northern WA, wage competition with mining, working conditions are not as good as mining (e.g. communications, risk from crocodiles and sharks).	Engagement of and employment of Indigenous community - natural ability and understanding of water and fish; Automation - requires high speed internet connections/IT solution; Improved HR culture - training/support in HR and business management to build a good work culture around growth; For Australians - Lifestyle marketing campaigns and champions for working in northern WA; Access to international staff working on 457 Visas - noting that they often need on-the-job training and there can be a barrier in English language. Transition to work programs (already underway in some sectors).	• Support for Indigenous community cultural needs to be understood and balanced with business operations. • R&D funding - automation of selected farm operations. • Resources for HR culture training and implementation. • Aquaculture industry marketing campaign for recruitment to regions. • Lobby for access to 457/equivalent Visa employees for NA aquaculture sector.
2. Power. High cost. Unreliable supply.	Off-the-grid renewables with appropriate subsidy Example - Solar with battery backup saved $$ in diesel.	• Subsidised off-the-grid options (solar and wind) • Aquaculture industry to join with other sectors to lobby for improved power supply options.

3. Regulatory burden. • In WA the red tape has improved. • Department of Fisheries as the proponent of the WA Aquaculture Zones is a positive step and has paved the way for future approvals. • Government has positive working relationships with the rock oyster and Aarli Maya projects. • Path of continuous improvement. • New ARMA coming in the fishing act.	Need to understand the regulatory pathway, plan and be organised in advance; include the regulatory pathway in business planning.	• Industry to continue communication with government, and lobbying through AQWA for areas that can still be improved - e.g. seafood quality assurance. • WA government to maintain support of sustainable aquaculture development.
Strategic Advantages		
1. Industry enthusiasm. 2. Government supportive of aquaculture development. 3. Clean & Green Reputation. 4. Closer to Asian market. 5. Community supportive of aquaculture development.		
Emerging Opportunities		
• Black tiger prawns • Barramundi • Molluscs - pearl and rock oyster		

5.1.2.3 Northern Queensland - Townsville

The Indigenous focus group had one Indigenous participant, a researcher, two facilitators from IPS and one representative from the project team. The participants were one male and one female. The group did not develop a vision statement due to the low number of participants. They identified regulatory requirements (related to location, especially near the Great Barrier Reef), the lack of pathways for leadership development, and lack of business governance capability as key challenges (**Table 29**).

Table 29: Northern Queensland – Indigenous focus group results

Challenges	Solutions	Support
1. Location. There are layers of regulatory conditions.	Detailed business case developed outlining all regulatory requirements	Funding resources and access to regulatory bodies
2. Leadership. Supporting young community leaders. Lack of pathways for leadership development.	Identify cultural requirements and develop leadership capability program for next generation.	Leadership development capability partners.
3. Governance. PBCs require governance and business capability development.	Strategic planning inclusive or workforce planning and training calendars.	Strategic partnership with capable Indigenous business support.
Strategic Advantages		
1. Commercial partners. {Red claw, Marine Rock Lobster, Cherabin} 2. Procurement process within the community. 3. Access to technical sources. 4. ILSC has financial resources to invest.		
Emerging Opportunities		
• Marine Rock Lobster • Micro business operations • Micro business - seed collection, nursing/sea cages, grow out • Marketing - Indigenous premium brand • Cherabin - hasn't been done in Australia yet		
Additional notes		

- Vision thinking - A commercially viable and sustainable NA aquaculture industry led by engagement and supporting Indigenous communities.
- Opportunity around the Gulf Country
- Licenses
- Strategic advantages - geographic access
- Identify potential certificate courses
- Training - e.g. aquaculture programs (redclaw)
- Strategic Plan/Business Plan for Traditional Owner Groups
- Aquaculture - labour intensive / challenges
- Social enterprise vs Community based model

Thirteen people participated in the prawn focus group in Townsville, which was facilitated by two project team members. There were 9 male and 4 female participants. The participants were senior managers from three producer companies, an association representative, service providers (researchers and suppliers), and an NGO delegate.

The group discussed the expansion of the prawn sector that is underway and highlighted the key challenges of absence of breeding programs, broodstock access and biosecurity and disease (**Table 30**). They also observed supportive regional governments that are encouraging industry growth, an opportunity to increase industry cohesion and cooperation across aquaculture sectors. Competition for staff was also noted, especially during a period of rapid expansion. While a lack of access to skilled labour and staff retention were not in the top challenges, they were considered an issue for prawn aquaculture in northern Australia.

Table 30: Northern Queensland – Prawn focus group results

VISION To grow a vibrant, cohesive industry to meet the demand for premium farmed prawns.		
Challenges	**Solutions**	**Support**
1. Absence of breeding programs. • Expensive to develop and maintain. • Requires dedicated staff and facilities. • Healthy broodstock for founders required.	• Collaborative industry wide developed facility. • Potential overseas investor. Inshore facility to increase biosecurity. • Development of a technical model & business plan required.	
2. Access to quality broodstock. • Broodstock collection has varied results, can return diseased individuals and needs to be conducted ~6 times annually. • Current pond-stock is unsuitable for broodstock due to disease levels. • Access by trawlers to desirable fishing grounds is limited, methods of fishing are limited, numbers are limited.	• Alternate fishing grounds, Torres Strait, WA, NT, QLD coast. • Alternate fishing methods (trapping) • Alternative transport of wild caught animals, individual holdings prior to pathogen testing to ensure clean stock are separated. • Broodstock pond development (covered, over winter, indoors, lined outdoor?)	
3. Biosecurity and disease. • Large portion of domesticated and wild stock contain pathogens. • High cost of long-term ongoing monitoring. • Sporadic and chronic losses. Linked to low FCRs & slow growth. • Potential for impacted breeding, results in impacted PL.	• Affordable long-term diagnostic testing • Quantify economic costs through endemic losses. • Potential for a confidential third-party assessment of biosecurity impacts on individual farms and overall industry. Use to evaluate industry productivity.	
Strategic Advantages 1. Great regional government support (encouraging growth in industry, recent years increased) 2. Low intensity of aquaculture operations in Northern Australia (low farm density, good for biosecurity, water quality, low population, lack of competition. Compete for staff) 3. Location (warmer temperatures providing potential for two crops a year; proximity to multiple ports and airlines; trusted location of origin) 4. Large R&D presence relative to size of industry 5. Seafood security		
Emerging Opportunities		

1. Cohesive breeding program
2. Building links with other aquaculture industries (e.g. barramundi and macroalgae)
3. Regional feed production and storage (reduces transport costs, in events of natural disasters potential increased availability)
4. New investment
5. Stakeholder expansion
6. Value adding
7. Increased industry and increased resourcing (e.g. pathology laboratories)
8. Diversification (multi-species, trophic levels)

There were seven participants in the white-fleshed fish focus group, with representation from barramundi and grouper hatchery and growout, and supplier companies. The group was facilitated by one member of the project team. There were 5 males and 2 females present.

The key issues identified by the barramundi and grouper sector were regulatory burden, competition (imports for barramundi, and imports and domestic for other white fish), and transport. Freight is impacted by weather events in northern Australia, is high cost and logistically difficult. International flights from Cairns have been cut, which reduces access to international markets from northern Queensland (**Table 31**).

Table 31: Northern Queensland – White fish, including barramundi and grouper, focus group results

VISION By 2028 we will capitalize on the unique assets of Queensland to grow a respected, sustainable industry delivering prosperity to the people of northern Australia and regarded as a responsible and desirable industry by other sectors.		
Challenges	**Solutions**	**Support**
1. Regulatory Burden. • High bar set on zero discharge by one large farm • Complex to navigate through approvals • Biosecurity/health status testing for export • Processing, health and safety, fire etc. • Tariff codes do not differentiate species within the white fish import product – how can government manage biosecurity risk? Need to have more granulated data on imports • Little transparency on how import biosecurity risk is managed pre and at border – lack of trust of govt. • Imports of feed and supplies are slowed down due to biosecurity surveillance, in contrast to import of international seafood – seems hit-and-miss/inconsistent approach • Approvals are required to undertake analyses – lack of accredited labs		
2. Competition. • Proving authenticity of origin • Competition domestically – not really an issue within the barramundi wild and farmed. Other white fish.	• Harmonization tariff codes • Country of origin extended to food service • Developing farm brands is happening • Educating about Grouper species	
3. Transport. • International flights out of Cairns have been cut • Costly, difficult, affected by weather events		
Strategic Advantages		

1. Environment.
    a. Temperature, space and access to water availability
    b. Native well recognised and valued species
    c. Access to good quality broodstock
    d. Current biosecurity status
2. Infrastructure.
    a. Regional centres
    b. Regional transport
    c. Brown field sites
    d. Good international connections
3. Moving to Critical mass.
    a. Getting to critical mass – number of farms in reasonably close proximity
    b. De-regionalised population, staff available
    c. Opportunity to collaborate
    d. Opportunity to attract suppliers and processors, however No scale to support processing
4. Political will for development in the north right now.
5. People
    a. JCU presence
    b. High level of Environmental and technological performance/practice
    c. Educated and professional industry
    d. Mature – manage own R&D

- Despite the strategic advantages, why has Queensland production flat-lined?

Emerging Opportunities

- For innovation have the opportunity to test bed in diverse areas e.g. to test genetic selection (salt, brackish, fresh)
- Aquatech
- Data sets that are collated and yet to be interrogated e.g. environmental
- Alternative power systems and interest from government and technology companies
- Backing from government for proven companies
- JCU location – work with industry, Aquapath services

Additional notes

- Is this point missing from the challenges? – approved licenses/sites not being taken up in QLD

There were eight participants in the Other producers focus group in northern Queensland, facilitated by one member of the project team. The participants represented established, emerging and new aquaculture species ventures including tropical oysters, redclaw, giant clam, tropical spiny lobster and slipper lobsters. The group consisted of 3 females and 6 males.

The group highlighted four key challenges: regulatory burden; broodstock quality and supply; power costs; and labour recruitment and availability (**Table 32**). They noted the need to create a regulatory and aquaculture planning environment that is attractive to investors, through initiatives such as complementing coastal aquaculture zones with zones for freshwater species, particularly redclaw. Redclaw is attracting interest from potential investors, who would invest in large-scale farms. This decision would have reduced risk, with identified site availability.

Table 32: Northern Queensland – Other producers focus group results

VISION
Our vision is for an innovative north Queensland aquaculture industry that balances environment with a strong growth and expansion agenda to create an attractive investment proposition truly supported by stakeholders and governments.

Challenges	Solutions	Support
1. Regulatory burden. Needs to be more efficient and have more certainty, the farmers feel like the government is just a shamble of a show. Producers need to know what to do in a straightforward way especially for a diverse range of species, and not just single industries such as salmon.	Develop aquaculture zones + licence to operate/ getting the decision makers in industry with government decision makers to discuss solutions. (e.g. with all redclaw industry in room, discuss the ideal zone for redclaw then cross check with current legislation and develop zones to give investors' confidence; incorporate this into digital mapping system so suitable locations can be found quickly and easily.)	Suggest a single legislative framework that can be adapted to new species and not go through a long slow inefficient legislative process.

2. Broodstock quality and supply, which impacts larvae/spat availability. Problem in redclaw and require the technology to establish SPF stock. This point varies between industries and priorities.	Assess feasibility of a shellfish hatchery for tropical oysters, and potentially other species such as giant clams, in northern Queensland. R&D for redclaw
3. Power costs.	Renewable energy in the future to improve environmental sustainability as well as costs. Explore battery technology and economics of implementation on-farm.
4. Labour recruitment/availability Labour hire is not an issue at this stage, but finding skilled labour is a challenge. With industry growth it may be an issue for the future.	TAFE diploma and placement on-farm should be incorporated in training.

Strategic Advantages

1. Quality, quality and quality (quality of the growing environment is high, less farm/harvest shut down after rain in QLD compared with NSW, brand leverage to attract a higher premium and differentiation)
2. Increased growth rate in tropical species
3. Freight cost advantages for local markets, locally sourced produce in northern Australia

Emerging Opportunities

1. Alternative power supplies/bioremediation (solar, wind, batteries, compressed air. Cross-pollination between industries is an opportunity to find value in secondary products}
2. Increasing the critical mass to allow for more investment (Singapore Airlines wants more redclaw than we can currently supply)
3. Smart technologies

The Service providers and new species focus group was attended by eight people and facilitated by two project team members. There were 2 female and 6 male participants. The participants represented secondary and tertiary education providers, researchers, regional councils, government, animal health and biosecurity, and funding providers.

This group considered skilled labour and liveability in northern Queensland as key challenges and captured the need to develop a skilled workforce in the vision and solutions (**Table 33**). They also emphasised collaboration, social acceptance and diversification in the vision.

Table 33: Northern Queensland – Service providers and new species focus group results

VISION

Aquaculture will transition from an emerging industry to a mature, unified, sustainable and socially accepted industry through the development of a skilled workforce, collaborative and innovative hubs and value adding, producing a quality product that contributes to the growth and diversification of regional and indigenous economies.

Challenges	Solutions	Support
1. Labour recruitment/availability. Lack of skilled and/or interested labour, other industries with higher pay may be attracting workforce, lack of education/marketing of aquaculture industry to school/university students, tendency for skilled labour to move overseas where there are more opportunities (real or perceived?)	Increase wages to avoid losing labour to larger (higher paying) competitors and/or other industries or countries, investment in education at all levels (high school, vocational and tertiary), creation of geographically focused incubators/hubs to drive development and attract people to the region	
2. Liveability/remoteness of operations. High cost of doing business in the region, people unwilling to relocate family to region without same level of services as elsewhere in Aus, transport issues (cut off during floods), connectivity issues.	Business incentives to attract investment in the region to compensate for high costs of doing business, geographically focused "hubs" so businesses are less isolated/more innovation and cooperation within industry	
3. Power (costs and availability). Cost of power extremely high, power outages during and following extreme weather events.	Difficult to solve issue in this forum as power in QLD owned by the state and backlash whenever privatisation is mentioned, potential for industry to invest in technology which would lower power consumption, encourage engineers into the industry to investigate more efficient aeration, greater implementation of alternative energy sources.	

4. Regulatory burden High cost of application fees ($16,000 minimum), difficulty of getting approval due to proximity to GBR, complexity of progressing through regulatory processes to gain approval for operations, changing regulation and contacts within regulatory bodies, poor/uninformed interpretation of regulations.	Streamline land allocation and approval process, unified rather than fragmented approach in order to assure investor return and business viability, increase transparency of processes, facilitator who is able to guide potential and established businesses through approval processes.

Strategic Advantages

1. Large areas of suitable land.
2. Climate (high average temperatures) resulting in high growth rates.
3. Reputation of Australian product.

Emerging Opportunities

1. Greater focus on extension services to decrease risk aversion to new technologies and innovation (Foster adoption of R&D and tech solutions)
2. Fisheries enhancement via aquaculture as cuts to wild catch and recreational quotas occur
3. Undertake research into methods that worked for particular farmers/businesses - why did they work and how can we replicate them?
4. Inclusion of "Sea" in the Indigenous Land and Sea Corporation (Opportunities for Indigenous businesses and community projects)

5.1.2.4 Northern Australia - Biosecurity

The Biosecurity focus group was facilitated by CSIRO, with seven participants plus two representatives from the project team. There were 6 males and 1 female participant. The group considered biosecurity issues across northern Australia. There were attendees from government, research providers, producer association and veterinary services representatives.

The group defined the major challenges they thought the north faced in regards to biosecurity (**Table 34**). These were: sovereignty of biosecurity (lots of layers – Federal, State, agencies), regulations, and jurisdictions; exotics versus endemics, where there is a focus at the border and endemics are largely ignored; knowledge, surveillance and information flow; complacency (especially where there are competing priorities for producers); holistic development; and chemical access and regulations.

Table 34: Northern Australia - Biosecurity focus group results

Challenges	Solutions
1. Sovereignty of biosecurity (lots of layers – Feds, State, agencies), regulations, Jurisdictions. • Non-inclusive • State Boundaries (may have different policy, no harmonisation) • Imports and regulations	• Appropriate Partnerships – Federal, Industry, state • Adoption of R&D • Increased Transparency • Harmonisation • Informed Risk assessment
2. Exotics vs Endemics. Focus is on the border and endemics being largely ignored. • Who pays for R&D, outbreaks etc • We don't know real impact of endemics • Lack of co-ordinated R&D • Regulations.	• Initiate a program of active surveillance • Create baselines for all new sites • Develop a weighted Risk focus
3. Knowledge, Surveillance and Information Flow. • Lack of R&D • Confusion on pathogen vs disease • Need the tools • Multidisciplinary approaches training • The sheer size of Nth Australia • Baseline data • Proximity to other jurisdictions • Lack of networks • Poor information flow.	• Structured approach to capacity building • Targeted and programmatic • National surveillance program.
4. Complacency • Competing priorities for producers	• Economic costs analysis • Better policy and clarity around responses and consequences
5. Holistic Development • Don't factor in 'other industries'	• Create partnerships and education • Role for all levels of Govt to facilitate • Develop the 'mantra' of resilient local communities

6. Chemical Access and Regulations • APVA process difficult and approach uncoordinated	• Develop a co-ordinated group with a voice (not just Nth Aus but all of Aquaculture)

Opportunities for Innovation

1. Deployable, automated real time sensing
    a. Cloud based
    b. Open Sourced
2. Big Data – Machine Learning/Artificial Intelligence
    a. Environment, farm and socialised
    b. Dashboards and Decision Support
3. Breeding programs and Animal Biology
    a. SPF and SPR
    b. New Species
    c. Polyculture
4. Training
    a. Networks
    b. Learn from others
5. New Models for R&D and industry engagement

5.1.2.5 Northern Territory - Darwin

In Darwin, the project team opted for a slightly modified approach to the focus groups, with only the challenges, solutions and support considered in smaller focus groups. This was in response to suggestions from experienced local aquaculture advocates. The participants that gathered for the aquaculture workshop developed the Northern Territory vision and considered strategic advantages and opportunities together.

The Indigenous focus group was facilitated by IPS. There were ten participants from Indigenous communities, research, funding providers and government, with two representatives from the project team as observers. There were 8 male and 2 female participants. The following narrative is largely based on the IPS report of this focus group conversation.

Several participants were actively engaged in sharing stories, particularly from a start-up sense, and outlined their engagement with fisheries. The majority of participants were engaged in oyster farming in some capacity.

A small discussion occurred around the potential impact of automation and technology. The sector is currently at a hobby-based scale, and start-up phase, where innovative practices have not yet been considered.

It was noted that the Northern Territory has an aquaculture research advisory group, with an Indigenous Reference Group. The focus group participants were not aware of this group, or their potential advocacy power, on behalf of the industry. There was a strong appreciation of the role of the Northern Territory Department of Primary Industry and Resources, Fisheries & Aquaculture group, particularly in mentoring, training and building confidence of Indigenous business owners. It was suggested that this strategy could be replicated by other agencies to offer holistic and sustainable support.

The idea of mentoring arose in the discussion of opportunities (**Table 35**). There is an opportunity for retired industry experts to mentor Indigenous businesses in aquaculture, regarding business growth and sustainability. There was unanimous support for upskilling Indigenous people within community. There is widespread enthusiasm and aspiration in aquaculture but a lack of accredited training that leads to appropriate and meaningful employment. This could also assist the current gap, when Fisheries complete their mentoring program, as trainees will explore business skills and capacity/confidence/capability building relevant to their industry.

It appears there is also a lack of flexibility and communication across government departments. Participants spoke about the complexity and burden of regulatory requirements that are hindering expansion and large-scale commercial activity. If policy could be flexible, it would create an opportunity to capture quality information for research and future industry expansion. As an example, the exemptions offered in New Zealand on Bluff Oysters have allowed not only baseline studies but have established an environmental baseline through distribution.

One opportunity and strategic advantage identified was the proximity of the Northern Territory to Asia. The industry could not only market and brand themselves as “green and clean” but explore an Indigenous narrative for competitive advantage. This in turn may stimulate the Indigenous economy and contribute to social impact. People want to see Indigenous business succeed and identify their logos in restaurants. This success

and recognition contribute to self-determination, pride and empowerment of individuals, businesses and communities.

As for the aquaculture focus groups in other regions, Indigenous businesses did not send their Traditional Owner members, but rather sent authorized representatives to speak on their behalf. The participants suggested that future focus groups should be held in remote locations and possibly in a culturally safe and appropriate manner (e.g. outside in yarning circles).

Table 35: Northern Territory – Indigenous focus group results

Challenges	Solutions	Support
1. Safety of oysters for sale. Participants discussed not wanting to set up large scale oyster farms, that may not be commercial due to safety concerns. There are concerns on due diligence within national QA guidelines.		
2. Supply chain - lack of understanding. How does NT do shellfish if there is no industry/facility within the NT? How are expectations managed, when there is limited understanding/transparency of supply chain. How do we get community members to understand their value, in the supply chain.	Training pathways. Open communication by representative sectors.	
3. Lack of expertise (limited level of job opportunities). Participants discussed the prevalence of enthusiasm and aspiration but lack of subject matter experts, within community.	Implement skill transfer, mentoring schemes and traineeship for education/employment pathways and sustainability.	
4. Legal/Regulatory Restrictions Participants discussed the burden of regulatory requirements, with little flexibility which would enable the collection of necessary research data	If policy could be flexible, it would enable the capture of quality information for research and future industry expansion.	

Strategic Advantages

1. Marketing/Branding. (Selling the industry as more than 'green and clean". It is a provenance "Indigenous" narrative for competitive advantage (top grade and top quality). This in turn stimulates the Indigenous economy and contributes to social impact. People want to see Indigenous businesses succeed. Businesses want to see their logo in restaurants (true self-empowerment and determination))
2. Impact Investment. (Have a strategic and collaborative approach (possible Joint Venture) for investment that could see an aquaculture pilot program in the region. The NT could lead with something that works specifically for Indigenous communities and the environment. The north (through Commonwealth investment) could be used as a training and capacity building hub for Australia and Asia)
3. Proximity to Asia. (Great location to reach Asian export markets, and to learn from these areas (stop reinventing the wheel))

Emerging Opportunities

1. Collaboration. (Need flexible approach that allows industry to operate and collect valuable information. Possibly identify an industry champion for the sector.)
2. Traineeship through to employment pathways. (Build competency of community by offering traineeships (possible on-the-air learning). Needs an accredited training package (similar to Ranger program). People have higher engagement when they know 'why' they are doing something versus just because they are told to do it. Need appropriate and meaningful education and employment.)
3. Mentoring Program. (Fisheries are currently mentoring on the ground with oysters, but there is no one to pick up where they complete their engagement, i.e. business capability skills creation and how to market for business growth.)

Additional notes

- Has anyone done a baseline study on NT waters (i.e. identified hot spots {good production sites} for barramundi, sea cucumbers, oysters, mud crabs etc.). What is the current environmental baseline?
- Need to consider the change to industry (particularly around redclaw farming) with a large focus on production at a hobby scale (less than 4 hectare sites do not require an EPA permit). At present farmers are trying to do everything (ponds of mixed generation species), but are moving to a hatchery set up in northern QLD in particular.
- Look into exemptions (e.g. Bluff Oysters in NZ)
- What's next? How will action occur from these focus groups? Is there an opportunity to bring all groups together to commence the collaborative approach to government and industry?

Based on discussion by the whole group, four key challenges were selected. The challenges were considered by seven producers and service providers, who met in smaller groups to identify details and potential solutions (**Table 36**). There were four project team members facilitating discussion. The participants were 6 males and 1 female.

Table 36: Northern Territory – Aquaculture producers and service providers focus group results

Challenges	Solutions	Support
1. Lack of skilled staff (technical skills). Issue with recruitment of technically skilled staff from domestic applicants. Currently employing international skilled staff on visas. Many skilled employees being lost (forced to leave Australia) due to a change in visas. This issue is crippling commercial-scale business growth in NT and is currently the biggest risk. Mismatch in the ANZSO skills list for Aquaculture technicians/attendants versus 'Aquaculture farmer'.	Skilled Migration Issues – understand and streamline the Visa application 'process'. New business models. Develop skills in-company - buy in or train Better exposure and promotion of Industry to attract workforce. Pathway programs – Universities. Better hands-on skills for Australian staff Dedicated Northern Australia Aquaculture training and Skills strategy High School science programs.	APFA/ABFA and SIA assistance with lobbying for better/streamlined Visa options. Define strategy to drive Government. Industry has to be efficient. Dedicated training Scheme. Industry partnerships with education providers. Coordinated – Training skills strategy for northern Australia (industry driven). Industry bursaries for students.
2. Biosecurity. Translocation and disease zones exist in NT (linked to water movement and catchments) - biogeographically planned, not based on diseases/parasites that may be present or a risk. Lack of information on trepan (sea cucumber) and black-lip oyster disease (potential disease) in the NT. Pearl oysters - known disease issue (JOMS) - causative agent is unknown Concerns with voluntary reporting because of reputation and (perceived) consequences. Limited capacity for diagnosis in NT Only one vet. Quarantining broodstock - space-limited. Perceived import (pre-border) risk, including: baitfish import; uncooked prawns; whole fresh fish. Boat movement risk - recreational fishers, commercial fishers (e.g. move from NT to WA) Disconnect between industry and government in terms of Public-Private Partnerships (e.g. observed transgressions in QLD biosecurity).	Succession planning needed in aquatic/aquaculture veterinary capacity. Benchmarking for oyster health. Lab support for timely analysis, testing and reporting. Utilise existing capacity interstate - build relationships. Need more emergency response training at farm level. Purpose-built quarantine facility. Adopting best-practice - government policy and on-farm operations. What is a good routine sampling regime? - to achieve coordinated surveillance, training and keeping tabs on the known pathogens. NT needs more dialogue to establish relationships - private-government - using conversation and relationship, rather than email trails (potential to be misunderstood).	An industry co-funded position at the Berrimah Vet Lab to develop testing capacity in NT laboratory - for pathogens of pearls, barramundi, trepang, prawns, crocodiles & possibly Spirulina sp. Multispecies capacity. Conference/Workshop - Teleconference to progress: a) Value-chain cooperation - conversation, and b) 2. Biosecurity and veterinary capacity - training; resources (e.g. sea cucumber diagnostics); relationships.
3. Food safety. Shellfish (oysters) are the highest risk for food safety in NT aquaculture. Lack of awareness of potential issues. No quality assurance program. Lack of capability in NT labs. NATA accredited testing for water only. Seafood sent to Perth and Victoria for food safety test - takes 7-14 days for a result and the product is eaten before the result is received. Vibrio needs to be understood for black lip oysters in NT waters to determine the food safety handling requirements Lack of cool/cold chain for volume shipping out of NT - to national of export markets.	Cadmium study underway. Any more to do? Vibrio prevalence study underway. Research project to understand what tests are available, which ones are needed and determine how response times can be improved. Need to achieve an economy of scale from the NT to enable more cool chain freight - opportunity to cooperate with producers of other perishables.	Partnerships – bring federal agency in testing conversation – greater need for infrastructure with growth in industry – delay issues and need enough people.

4. Cooperation and collaboration in Aquaculture – opportunity • How do we coordinate/encourage collaboration? • What structures do we need to facilitate? E.g. a get together, meeting, forum? • How can we "lift our heads up" to the bigger/broader issues and get beyond operational issues?	An exchange Hub (where does collaboration need to be improved? Need to make sure the right people are at the table. There are few producers in aquaculture in the NT, and these are at different stages of business maturity. Are there approval blockages?)

Additional Notes

Lack of skilled staff

- Need Production Planners – through technical skill/knowledge transfer by international/national skilled staff (e.g. from salmon) to local workforce.
- Research trials management - Specialised skills Visas now.
- Water chemistry/husbandry effects – interpretation.
- Databases – diagnostics.
- Management systems - SOPs, MoC. - link international students/training to 'residency'/work program.
- Skills shortage is not solely an aquaculture industry issue. Young people have different views on pathways to jobs - more 'personal' and they want to 'contribute'. We need to tap into these values to attract young people to the industry.

Biosecurity – Risk of importations

- Perceived import (pre-border) risk, including: Baitfish import - e.g. mullet - from Indonesia is a potential risk - unknown disease status and not sure if there is any testing. Is there a bait use awareness issue? Any information about import volume?; uncooked prawns; whole fresh fish (e.g. barramundi).

Biosecurity – Planning

- NATA Accredited lab - Berrimah Vet Lab (BVL), with limited number of NATA-accredited tests.
- Some tests conducted daily and others 2/week.
- Risk is the lab is reliant on one person for the aquaculture tests.
- Lab turnaround time is also a potential risk.
- If a farmer submits a 'sick fish' sample the testing is free, and if it is a suspected notifiable disease the testing will get priority.
- Routine surveillance would be at a cost to the farmer.

Food safety – Cool/cold supply chain

- Potential cool chain for transport out of NT - abundance of trucks bringing goods in - barramundi and frozen meat sent out.
- 90T gross (66T cargo) in 3 trailers in a pan-tech.
- 42 hours Darwin to Adelaide, drive in 2-up teams or truck crew changeover.
- Export requires planning and can take 3 weeks to get a refrigerated container to Darwin, e.g. Korea in 30 days and Malaysia in 29 days by sea freight transited in Singapore.
- Limited to 2.5 T per plane at the moment. Need to achieve an economy of scale from the NT to enable more.
- Point-to-point, the cost of freight is 3 times higher for Darwin versus Adelaide. Shipping to Adelaide and export from there is the same total price as direct export from Darwin.

Indigenous aquaculture

- Need to align Indigenous opportunity with aspirations, e.g. mustering and camping preferred over droning.
- Opportunity in the generation - needs to be a pipeline for engagement.
- Need to carefully identify the species and who has ownership, e.g. in relation to Totems and Moieties.
- We need to build cultural competence and establish culturally safe workplaces in aquaculture.
- There has been cultural training in the Board of NTSC.
- Supply chain awareness and transparency is important for Indigenous aquaculture – especially understanding the costs involved. Opportunity for R&D and/or workshop(s) to understand and share this information.

After the separate focus group sessions for Indigenous aquaculture and consideration of four key challenges, the whole group reconvened to develop the vision statement for Northern Territory aquaculture, and to consider strategic advantages and emerging opportunities (**Table 37**).

Table 37: Northern Territory – All of Aquaculture participant results

VISION

Growing opportunities for Territorians to serve the NT Aquaculture platter of choice.

Strategic Advantages

1. Space/area - room on land and available water
2. Warm water (temperature)
3. Pristine
4. Government with a vision to develop
5. Strong licence to operate
6. Strong success cases to inspire new entrants
7. Willingness to share from experience.

Emerging Opportunities

1. Indigenous engagement. {NT has the opportunity to be a standout for this. Activities in agriculture, tourism, carbon, conservation/heritage mapping, rangers and urban work. Opportunity for a moonshot for Indigenous engagement in aquaculture - with natural resource and cultural alignment. A current standout is Indigenous engagement in Enforcement/compliance and Marine Rangers on-country.}
2. Technology transfer and innovation during fast development. {History of strong RD&E from DAC and CDU with the oyster Vibrio project. Good transfer to private enterprise. Some untapped R&D capacity in NT - e.g. AIMS, CDU. The high-end product crocodiles have partnered with RD&E for success. Successful crocodile industry and they are open to share.}
3. Proximity to large market in Asia.

Additional notes

- Stripe Atlas - https://stripe.com/atlas - A great example of how to share knowledge and how we get companies over the world to do business (anyone can subscribe). How do you collect and bundle the knowledge of "aquaculture business" into a package that is fit for all?
- From an industry point of view, what does success look like? Branding could fail? Very important to investigate the right model.

5.1.3 Comparison of challenges among focus groups

The online survey results (**Table 38**) were used to initiate discussion within the focus groups about the key industry challenges. Each focus group decided whether the relevant sector challenges matched their perspective, then agreed upon the three (up to five) challenges they considered most relevant (**Table 39** and **Table 40**).

Table 38: Top three challenges presented to the focus groups based on results of the online survey priorities

Respondent category	Top three challenges
Overall	1. Power 2. Liveability 3. Environmental risks
All producers	1. Absence of breeding programs 2. Broodstock 3. Labour recruitment
Barramundi	1. Regulatory burden 2. Environmental risks 3. Market sales price // Labour costs
Pearls	1. Environmental risks // Disease 3. Transport // Liveability
Prawns	1. Absence of breeding programs 2. Broodstock 3. Disease
Redclaw	1. Regulatory burden 2. Access to capital 3. Liveability // Building infrastructure
Rock oyster	1. Environmental risks 2. Building infrastructure // Access to capital
Grouper	1. Fingerling 2. Building infrastructure 3. Feed quality // feed costs
Aquaculture supplier	1. Power 2. Environmental risks 3. Building infrastructure
Government	1. Power 2. Labour recruitment 3. Supply chain/infrastructure
Education/Research	1. Feed costs 2. Transport 3. Fingerling

Table 39: Top three challenges agreed and discussed by the Indigenous focus groups

Location	Top three challenges	Theme
Torres Strait	1. Lack of resources to understand aquaculture opportunities	1
	2. Lack of community work ethic and leadership	2
	3. Lack of engagement in supply chain	3

northern Western Australia	1.	Lack of local and place based support	1
	2.	Limited business viability associated with industry	4
	3.	Lack of appropriate Aboriginal business models	5
northern Queensland	1.	Regulatory requirements based on location	6
	2.	Lack of pathways for leadership development	2
	3.	Lack of governance - business capability	4
Northern Territory	1.	Safety of oysters for sale	7
	2.	Supply chain - lack of understanding	3
	3.	Lack of expertise (limited level of job opportunities)	1

The challenges discussed by the Indigenous focus groups were coded to identify the common priority challenge themes arising across the regions (**Table 39**). The common challenge themes, and number (n) of focus groups identifying these, were:

- lack of local knowledge and support for aquaculture operations and technical skills development (n = 3)
- lack of pathways for leadership development (n = 2)
- need for business management training (n = 2)
- desire to engage in the supply chain (n = 2)

For the producer focus groups, ten different challenge themes arose across the industry sectors and regions (**Table 40**). The common priority challenge themes arising from the Producer focus groups were:

- regulatory burden (n = 3)
- access to quality broodstock (n = 2)
- biosecurity and disease (n = 2)
- product differentiation (n = 2)

Table 40: Top three challenges agreed and discussed by the Producer focus groups

Context	Top three challenges		Theme
Producers, WA	1.	Regulatory burden	1
	2.	Low productivity	2
	3.	Product differentiation	3
Prawn producers, QLD	1.	Absence of breeding programs	4
	2.	Access to quality broodstock	5
	3.	Biosecurity and disease	6
Barramundi and grouper producers, QLD	1.	Regulatory burden	1
	2.	Competition (included product differentiation)	3
	3.	Transport	7
Other producers, QLD	1.	Regulatory burden	7
	2.	Broodstock quality and supply, which impacts seed availability	5
	3.	Power costs	8
Producers & service providers, NT	1.	Lack of skilled staff	9
	2.	Biosecurity	6
	3.	Food safety	10

These common challenges were used, in conjunction with other project data, to inform the final recommendations for solutions to industry's key challenges.

6 INDUSTRY VISION DEVELOPMENT

6.1 APPROACH

Most of the twelve focus groups developed an industry 2028 Vision statement (**Table 41**). The main themes from these statements were coded, and then the frequency of occurrence of the themes was determined (**Table 42**). The dominant themes and language used in the focus group vision statements (**Figure 6-1**) were used to develop the draft northern Australia aquaculture industry Vision 2030.

Table 41: Northern Australian aquaculture industry Vision 2028 statements developed by focus group participants

Location (state/territory)	Vision statement
Torres Strait	Direct Export of Live Crayfish to Sydney, Direct Marketing to China, Indonesia and Singapore. Increase volumes, Torres Strait to have a stand-alone brand, factories and retail brand, Control of the supply chain to drive and determine the price, Traditional Owners to benefit from the Natural Resources.
Western Australia	A diverse and emerging large-scale sustainable aquaculture industry supporting premium products to export markets.
	Aboriginal peoples are drivers of fisheries management, embracing cultural protocols and are integral within the supply chain in a well governed, well-resourced and growing industry with an international market presence so that we proudly supply our Kimberley brand through the employment and positive economic outcomes for our first nations people.
	Northern Australian Aquaculture offers a profitable and attractive investment environment that builds on the existing footprint and pioneer experience (IP) to diversify and grow in partnership with indigenous interests.
Queensland	By 2030 we will capitalize on the unique assets of Queensland to grow a respected, sustainable industry delivering prosperity to the people of northern Australia and regarded as a responsible and desirable industry by other sectors.
	Our vision is for an innovative North Queensland aquaculture industry that balances environment with a strong growth and expansion agenda to create an attractive investment proposition truly supported by stakeholders and governments.
	Aquaculture will transition from an emerging industry to a mature, unified, sustainable and socially accepted industry through the development of a skilled workforce, collaborative and innovative hubs and value adding, producing a quality product that contributes to the growth and diversification of regional and indigenous economies.
	A vibrant, cohesive industry to meet the demand for premium prawns.
Northern Australia	Biosecurity - None
Northern Territory	Growing opportunities for Territorians to serve the Northern Territory Aquaculture platter of choice.

Table 42: Frequency of broad themes occurring in the vision statements from each of the focus groups

Broad theme	No. (n) Focus Groups
Increasing volume of production	9
Expanded market	5
Premium and valuable products	4
Social license to operate; Socially accepted	4
Diverse sector	3
Indigenous people to benefit from the natural resources	3
Attractive for investment	2
Collaborative and in partnership	2
Environmentally sustainable	2
Increased value of production for Indigenous Australians	2
Indigenous people engaged in the integrated supply chain	2
Profitable	2
Indigenous people as drivers and managers	1
Innovative	1
Recognition of existing know-how	1
Social benefit	1

Figure 6-1: Word cloud based on the language of the vision statements from each of the focus groups

6.2 VISION STATEMENT

The draft northern Australia aquaculture industry Vision 2030 presented to industry in November 2019…

> *"In 2030, northern Australian aquaculture will be a mature ($1b a year GVP), cohesive, sustainable and respected industry, developed and operated by innovative people, providing more premium products to Australian and international markets, contributing to the prosperity and diversification of regional and Indigenous communities in the north and the national aquaculture sector and economy."*

This above vision statement was interrogated at a videoconference and via email feedback in December 2019, and refined as follows…

In 2030, northern Australian aquaculture will be a nationally significant ($1b a year GVP), cohesive, sustainable, respected industry, providing premium products to Australian and international markets, that contributes to the prosperity and diversification of regional and Indigenous communities across the north.

The final version will be refined and validated through stakeholder feedback on the Stage 1 report and at the project final workshop.

7 PESTEL ANALYSIS

This section presents a PESTEL-analysis of the northern Australian[6] aquaculture industry identifying political, economic, social, technological, environmental and legal conditions that influence the industry in this region. The aim of this analysis is to present a structured picture of the external environment the industry operates in.

7.1 RESULTS

7.1.1 Political factors

The political macro-environment refers to how and to what degree a government intervenes in the economy. Audience participants were asked to rank eight political factors in relation to their influence on the expansion of aquaculture in northern Australia. As illustrated in **Figure 7-1**, results indicate that of the factors assessed, political bureaucracy is most hindering expansion, while federal funding, grants and initiatives are providing the most industry enhancement.

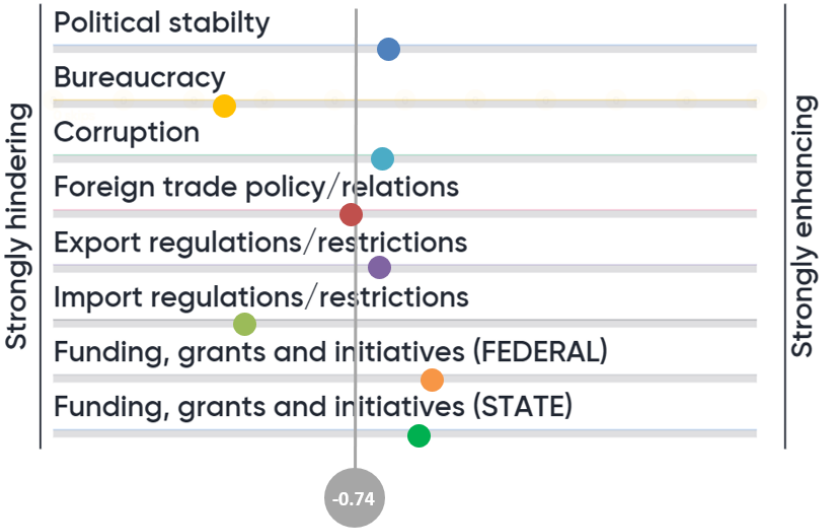

Figure 7-1: Political macro-environment factor results

Examples of bureaucracy hindering expansion discussed by participants during the activity included:

- Complexity of regulatory process
- Burden of complying with regulatory requirements
- Lack of certainty (regarding legislative requirements, progress of applications, likelihood of success)
- Inconsistency in attitudes and knowledge of government representatives
- Lack of clear property rights
- The need for a dedicated northern Australian industry representative in Canberra.

Whilst overall results indicate that the current political macro-environment is hindering aquaculture expansion, there was significant discussion during all three workshops around the recent positive shift in government attitude towards aquaculture and increased willingness to support and assist the industry. Broome workshop participants provided positive feedback regarding the change in WA State government department structure resulting in aquaculture sitting within DPIRD alongside other agriculture and food industries (previously within the Department of Fisheries). Participants were hopeful this change would result in greater focus on productivity, infrastructure development and market growth for the industry which has been stifled by an overly protective attitude to marine resource allocation and use. Similarly, in Townsville,

[6] For this analysis, Northern Australia has been defined in accordance with the CRC Northern Australia guidelines.

the audience noted a positive change in QLD's state government support for aquaculture with the newly gazetted Aquaculture Development Areas and committed support from within DAF to progress these.

7.1.2 Economic factors

The economic macro-environment relates to the state of the economy (local, regional, national or global). Audience participants were asked to rank eight economic factors in relation to their influence on the expansion of aquaculture in northern Australia. As illustrated in **Figure 7-2**, results indicate that taxation and inflation rates are having the most negative influence on industry expansion, while economic growth and interest rates are currently enhancing expansion through increased market demand and greater financing capabilities.

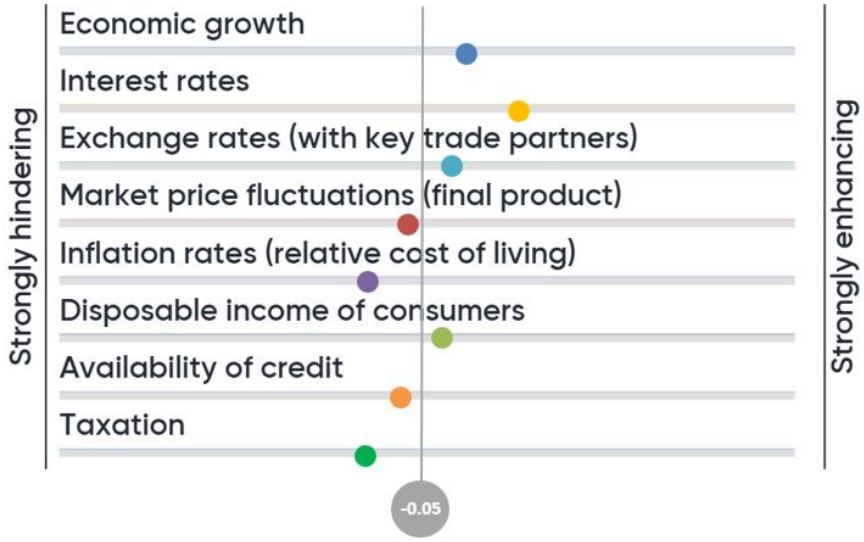

Figure 7-2: Economic macro-environment factor results

There was discussion during the Broome and Darwin workshops on the positive impact the mining downturn could have on the northern Australia aquaculture industry, through greater availability of labour and improved wage competitiveness.

7.1.3 Social factors

The social macro-environment refers to the mentality and characteristics of the individuals or consumers in a given market or region. Factors within this macro-environment are also known as "demographics" and include population growth, age distribution and education levels. Audience participants were asked to rank eight social factors in relation to their influence on the expansion of aquaculture in northern Australia. As illustrated in **Figure 7-3**, results indicate that the population size and growth rate of northern Australia is the factor most hindering expansion of the industry, while consumer attitudes towards imported products are having the greatest enhancing influence.

Figure 7-3: Social macro-environment factor results

While the results indicate that current attitudes towards aquaculture are somewhat hindering industry expansion, discussion during the workshops indicated an overall positive attitude shift from the media and general public largely as a result of a greater understanding of the industry and the increasing pressure on wild fish stocks to sustain a growing demand for seafood.

A key issue identified during workshop discussions was the inadequate supply of skilled labour in the industry, largely attributed to a lack of tailored training and education programs across all levels and the negatively perceived liveability of much of the northern Australian region. Lack of veterinarian capacity and expertise in the region was also highlighted, particularly in relation to biosecurity.

While the population size and growth in northern Australia is deemed to be hindering expansion through lack skilled labour, ancillary services and infrastructure, the increasing global population and resulting demand for seafood was discussed as a significant opportunity for the northern Australian aquaculture industry. Given socio-economic changes throughout Asia and the positive reputation of Australian seafood products in international markets, discussion centred around the opportunities for northern Australian aquaculture in nearby export markets.

7.1.4 Technological factors

The technological macro-environment relates to the existence, availability, development and adoption of technology in the industry and region. Audience participants were asked to rank eight technological factors in relation to their influence on the expansion of aquaculture in northern Australia.

The results illustrated in **Figure 7-4** indicate that most technological factors assessed are enhancing the aquaculture industry in northern Australia, particularly research, development and extension (RD&E) activities. Existing power and energy technology, however, was deemed to be significantly hindering industry expansion.

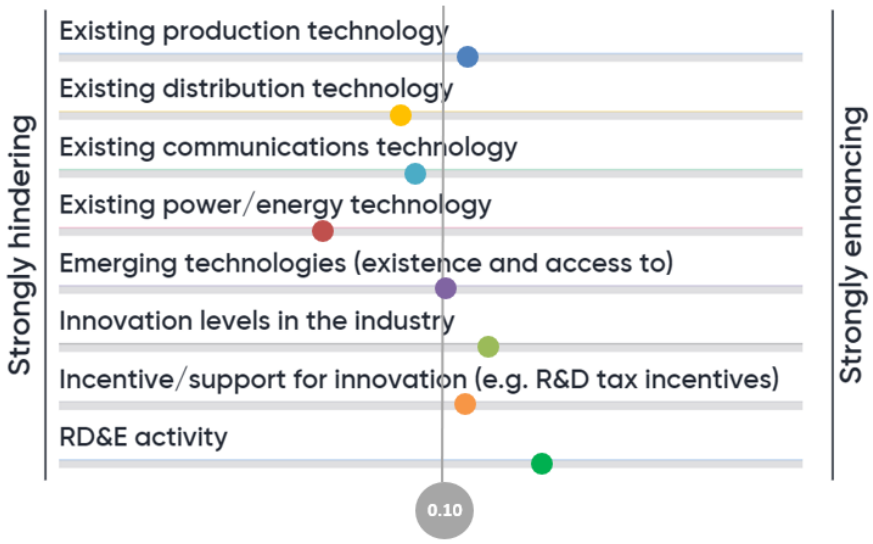

Figure 7-4: Technological macro-environment factor results

The negative impact of existing power/energy technology was discussed both in terms of availability and reliability. Participants identified that renewable energy sources would likely reduce operating costs in the long run, but that adopting these technologies is not being adequately incentivised. Suggestions to improve the rate of alternative energy uptake included increasing subsidies (state and federal) for adoption of off-the-grid renewables and uniting with other sectors in the region to lobby for improvements to power supply options and prices.

7.1.5 Environmental factors

The environmental macro-environment relates to the physical environment an industry operates in and can include factors such as natural resource availability, water quality, climate and pollution. Audience participants were asked to rank eight environmental factors in relation to their influence on the expansion of aquaculture in northern Australia. As illustrated in **Figure 7-5**, extreme weather events/natural disasters (including flooding, cyclones and heatwaves) is deemed the factor most hindering expansion of the industry.

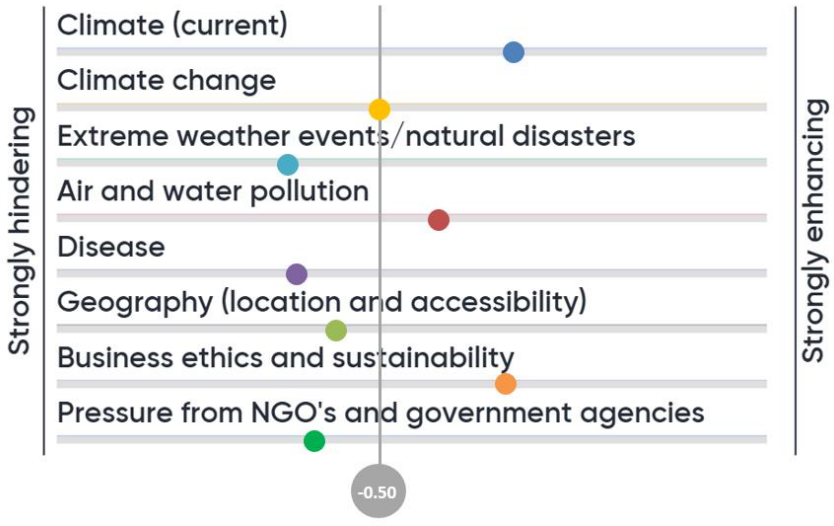

Figure 7-5: Environmental macro-environment factor results

Disease outbreak was also deemed to be severely hindering industry expansion and is illustrated by major mortality events resulting from recent POMS and WSSV outbreaks in the pearl oyster and prawn industry respectively.

The northern Australian climate (characterised by warm average water and air temperatures) was deemed to be strongly enhancing aquaculture in the region and there was significant discussion in all workshops around the ability to leverage the "clean", "green" image associated with Australian seafood products in international markets. Conversely, participants noted that this "pristine" natural environment presents a range of operational challenges including isolation, distance to markets and services, access to and reliability of telecommunications networks, lack of infrastructure and inability to attract and retain skilled labour.

7.1.6 Legal factors

The legal macro-environment relates to current and impending laws and regulations which impact an industry and/or region. Legal factors include regulations relating to employment, competition, health and safety, product quality and labelling. Audience participants were asked to rank eight legal factors in relation to their influence on the expansion of aquaculture in northern Australia. As illustrated in **Figure 7-6**, nearly all legal factors assessed were deemed to be hindering expansion, with environmental and Country of Origin laws and regulations the most significant hindrance.

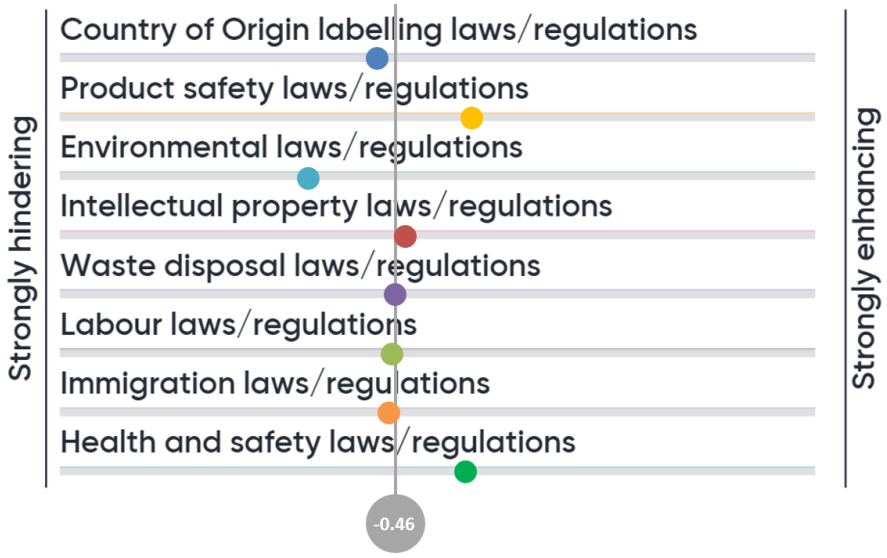

Figure 7-6: Legal macro-environment factor results

The perceived failure of Australia's Country of Origin labelling requirements was discussed at length in all workshops, with particular vehement from the barramundi and pearl industry participants. Key concerns raised included:

- Labelling not required across all points of sale
- Lack of consumer awareness and understanding
- Lack of regulation of labelling
- Lack of customs monitoring and compliance
- Fines/disincentives for failure to comply too lenient
- Lack of traceability laws

Identified through the SWOT analysis activity as the top opportunity for the expansion of aquaculture in northern Australia, actions required to improve the clarity and regulation of Country of Origin labelling are discussed in the project Stage 1/Final Report (Section 4.5.2).

There was significant discussion during the Townsville workshop around the regulatory and legislative burden and challenges arising from operating adjacent to the Great Barrier Reef Marine Park, including:

- General opposition to aquaculture operations, including extensive aquaculture (which is generally accepted to lead to water quality improvements)
- Burden of regulatory approval and compliance for operations (e.g. monitoring and reporting on point source discharge), particularly compared to those for other agricultural industries (e.g. sugar cane)
- Lack of zoning developments
- Perceived conflict of use and disruption to visual amenity

Mr Bruce Elliot (acting COO of GBRMPA) indicated during his workshop presentation the Authority's potential willingness to review their current stance on aquaculture by way of updating their Aquaculture Position Statement; accounting for advancements in culture methods and technology and the most recent scientific evidence relating to the likely environmental impact of aquaculture on the reef.

7.2 CONCLUSIONS

The collated results from the PESTEL analysis activity across the three workshops indicate that the Technological macro-environment is the only macro-environment currently deemed to be enhancing the northern Australian aquaculture industry. The Political macroenvironment was regarded as the most hindering to industry expansion (**Figure 7-7)**.

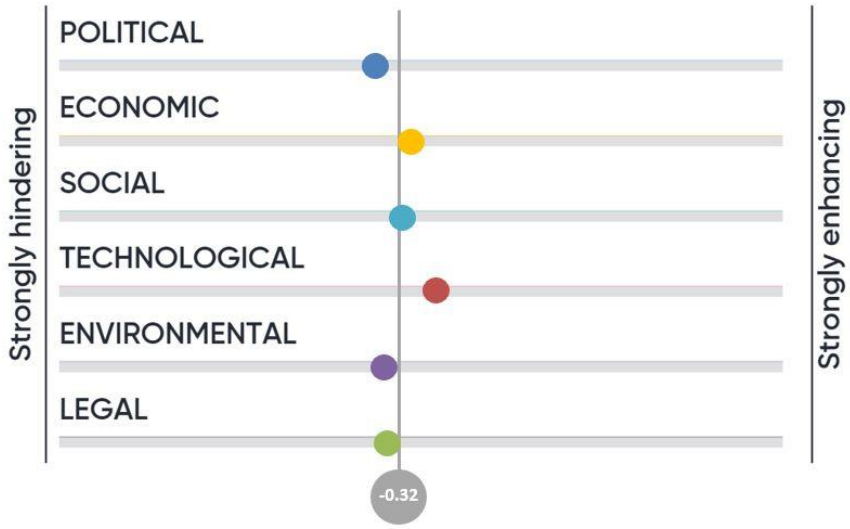

Figure 7-7: PESTEL macroeconomic Mentimeter results

8 COMPETITIVE FORCES ANALYSIS (PORTER'S FIVE FORCES)

At the Townsville and Darwin workshops, the P5F polling exercise was completed on an aquaculture industry-wide basis (all species combined), whereas in Broome the exercise was completed for the Pearl industry and the Barramundi industry separately due to the disparate nature of each industry's competitive environment.

8.1 RESULTS

8.1.1 Macro-effects industry-wide analysis

In the Townsville and Darwin workshops, participants were asked to rate a series of statements relating to each competitive force on a scale from "strongly disagree" (-5) to "strongly agree" (+5), resulting in a mean (μ) score for each competitive force on an industry-wide basis. As illustrated in **Figure 8-1**, the threat of substitution was deemed the greatest competitive force in the northern Australian aquaculture industry.

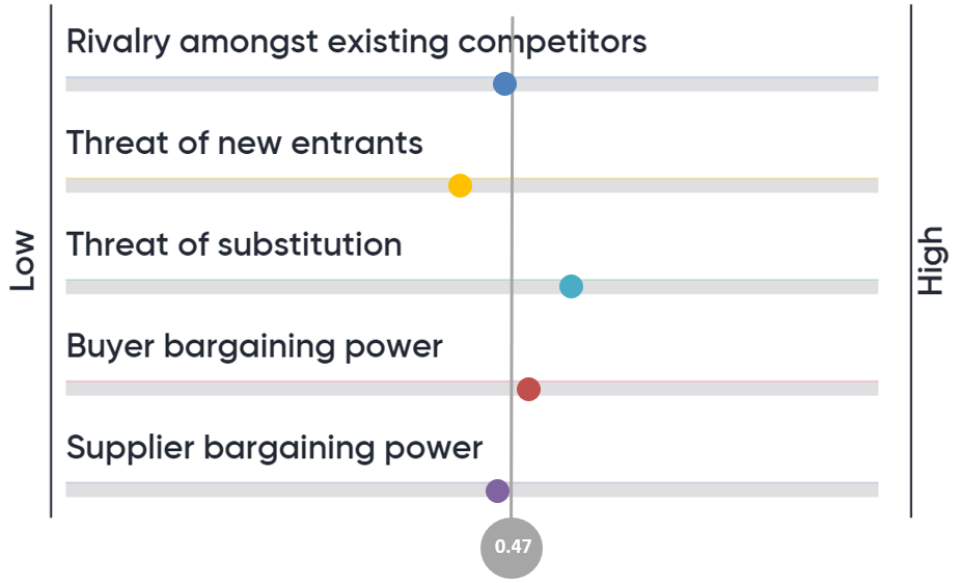

Figure 8-1: Porter's 5 Forces Analysis (Townsville and Darwin) results

8.1.1.1 Rivalry amongst existing competitors

Competitive rivalry is a major determinant of how profitable an industry is. In competitive industries, firms must compete aggressively for market share, resulting in lower profits. Rivalry is high when there are a lot of equally sized competitors, growth is slow, and consumers can switch to a competitor's product or service for little cost. When rivalry is high within an industry, competitors are more likely to engage in advertising and price wars in order to gain market share. Rivalry is also more intense when barriers to exit are high, forcing companies to remain in the industry even if profit margins are declining. Barriers to exit can include long-term loan agreements and high fixed costs.

As illustrated in **Figure 8-2**, competitive rivalry within the northern Australian aquaculture industry is relatively low (μ = 0.36). The characteristics contributing most to competitive rivalry in the industry are the lack of differentiation between competitors' products (μ = 1.54) resulting in ease of substitutability, and slow rate of growth (μ = 1.13) causing existing industry members to compete for market share and profits.

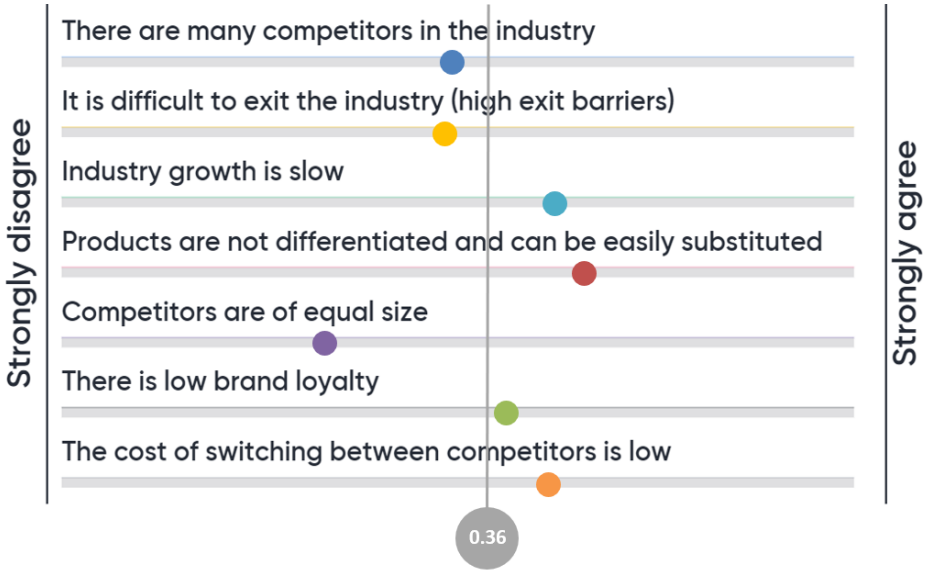

Figure 8-2: Competitive rivalry results (industry wide)

8.1.1.2 Threat of new entrants

Industries that yield high returns attract new entrants, resulting in greater competition for market share and profits. The threat of new entrants to an industry is largely determined by how easy it is to enter the market (e.g. capital requirements, government regulation, cumulative experience); an industry with high barriers to entry is attractive as it allows existing competitors to charge higher prices and negotiate better terms. Threat of entry also depends on the capabilities of the likely entrants; organisations with existing distribution channels and brand awareness pose a greater threat to existing players.

As illustrated in **Figure 8-3**, threat of new entrants to the northern Australian aquaculture industry is relatively low (μ = -0.08), largely due to the large capital requirements and high industry regulation. Characteristics increasing the threat of new entrants include the lack of patents, trademarks and brand reputation possessed by current industry members (μ = 1.86), low brand loyalty (μ = 1.08) and indistinguishable nature of products (μ = 0.90).

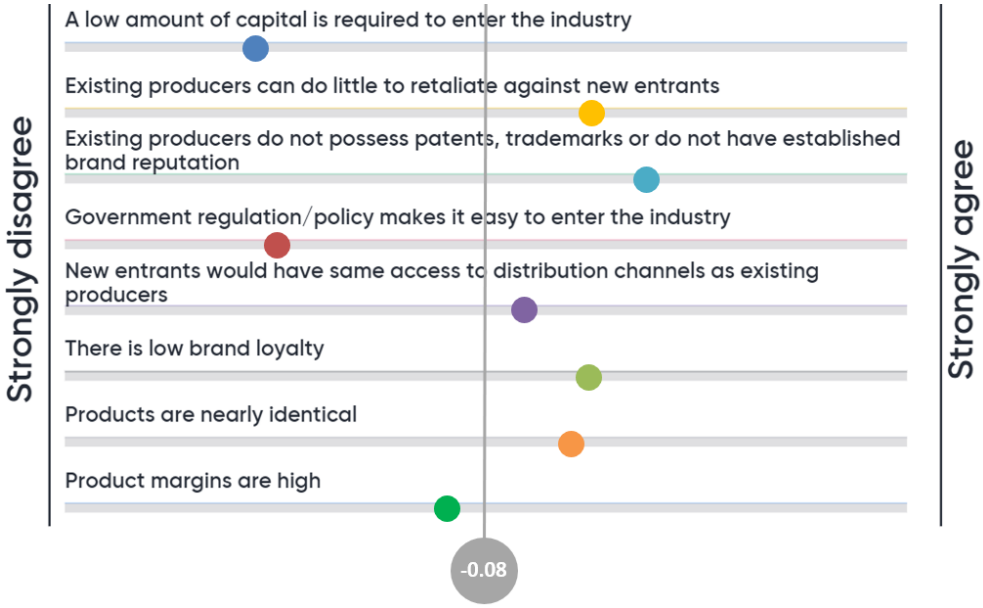

Figure 8-3: New entrant results (industry-wide)

*8.1.1.3 **Threat of substitution***

Customers may be able to substitute the product of a particular organisation or industry, for another. This is not the same as switching to a competitor's product but involves switching product entirely. Substitutes to products of the northern Australian aquaculture industry include wild catch seafood, alternative protein sources such as chicken, pork or lamb, other domestic aquaculture produce (alternative species) and international aquaculture produce (alternative species)[7].

Companies that produce goods or services for which there are no close substitutes will have more power to increase prices and lock in favourable terms. Where close substitutes exist, customers have the option to forgo buying a company's product, weakening the company's power. The threat of a substitute is high is it offers an attractive price-performance trade-off relative to the industry's product or if the buyer's switching costs are low.

As illustrated in **Figure 8-4**, threat of substitution to the northern Australian aquaculture industry is relatively high (μ = 1.19). This substitutability is largely driven by the number of substitute products available (μ = 2.27), relatively cheap price of substitutes (μ = 1.94) and low cost of substitution (μ = 1.79). The high quality of aquaculture products in northern Australia relative to substitute products, slightly reduces the overall threat of substitution.

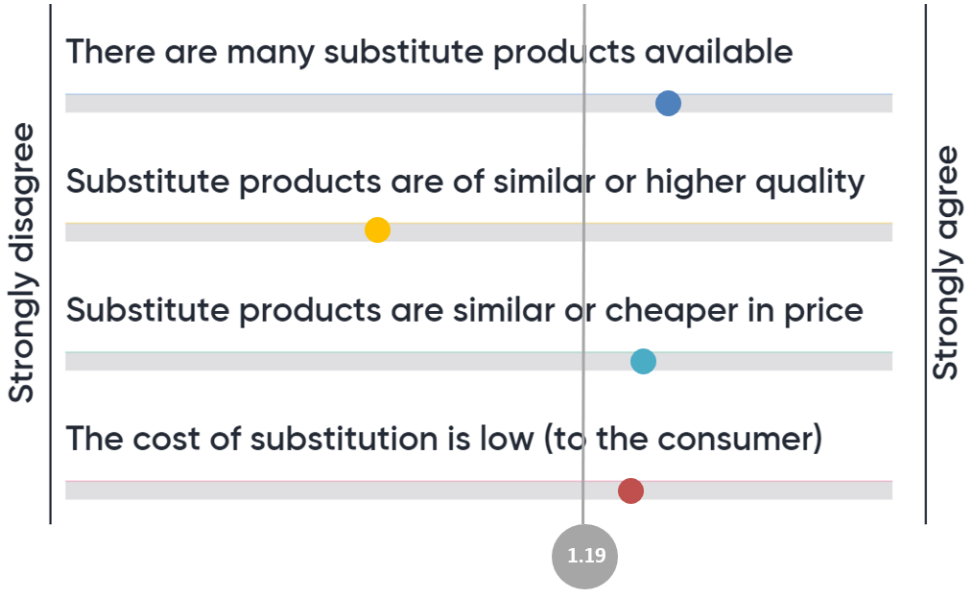

Figure 8-4: Substitution results (industry-wide)

*8.1.1.4 **Buyer bargaining power***

Buyer bargaining power is also described as the 'market of outputs' and refers to the customer's ability to dictate price and terms. This power is determined by how many customers a company or industry has, how significant each customer is, and how much it would cost to find new customers or markets for produce. Buyer bargaining power is highest when buyers are large relative to the competitors serving them, products are undifferentiated and represent a significant cost for the buyer, and the cost of switching to an alternative competitor or product is low.

As illustrated in **Figure 8-5**, buyer power in the northern Australian aquaculture industry is relatively high (μ = 0.67). This power is driven by the fact that buyers are price sensitive (μ = 2.10) and many substitute products exist (μ = 2.08) for which switching costs are low (μ = 1.08). Furthermore, buyers tend to purchase large

[7] For example, a substitute to prawns grown by a northern QLD farmer may include wild caught prawns, chicken and lobster (farmed domestically or internationally) Farmed prawns produced by an alternative farmer/organisation in northern Australia would be considered a competitor's product, *not* a substitute.

quantities (representing a high proportion of total sales) and can control access points to the final customer (μ = 1.67). The inability for buyers to backward integrate slightly reduces overall buyer power.

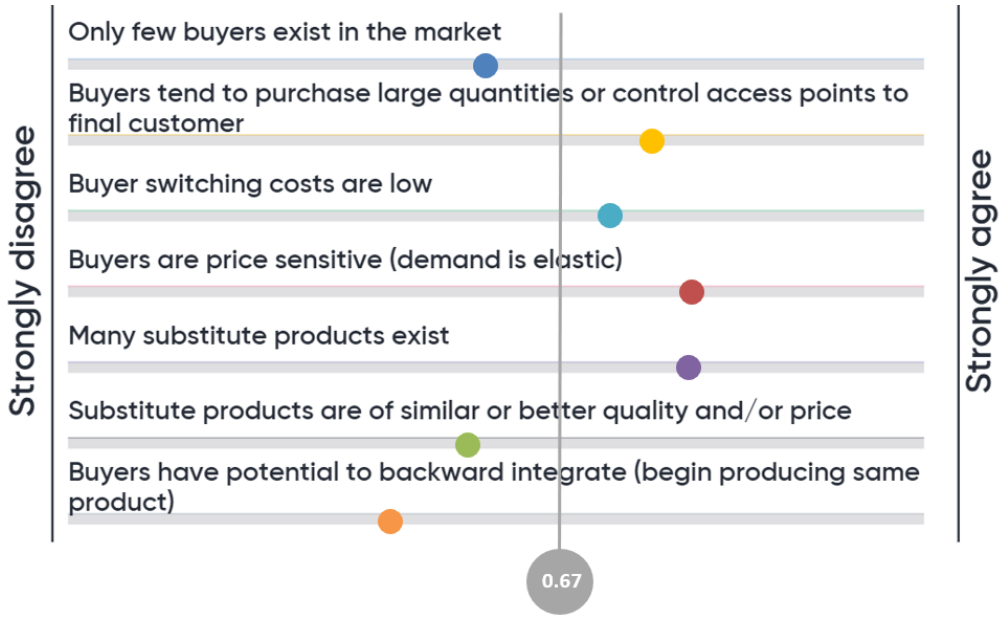

Figure 8-5: Buyer power (industry-wide)

8.1.1.5 ***Supplier bargaining power***

The bargaining power of suppliers is also described as the 'market of inputs' and refers to the supplier's ability to dictate price and terms. Suppliers of raw materials, components, labour and services (including consultant expertise) may exercise power when there are few substitutes, the product or service is unique, and the cost of switching suppliers is high.

As illustrated in **Figure 8-6,** supplier power in the northern Australian aquaculture industry is relatively low (μ = 0.22), driven by the high number of suppliers (μ = 1.52) with products and services that are not particularly unique (μ = -0.55).

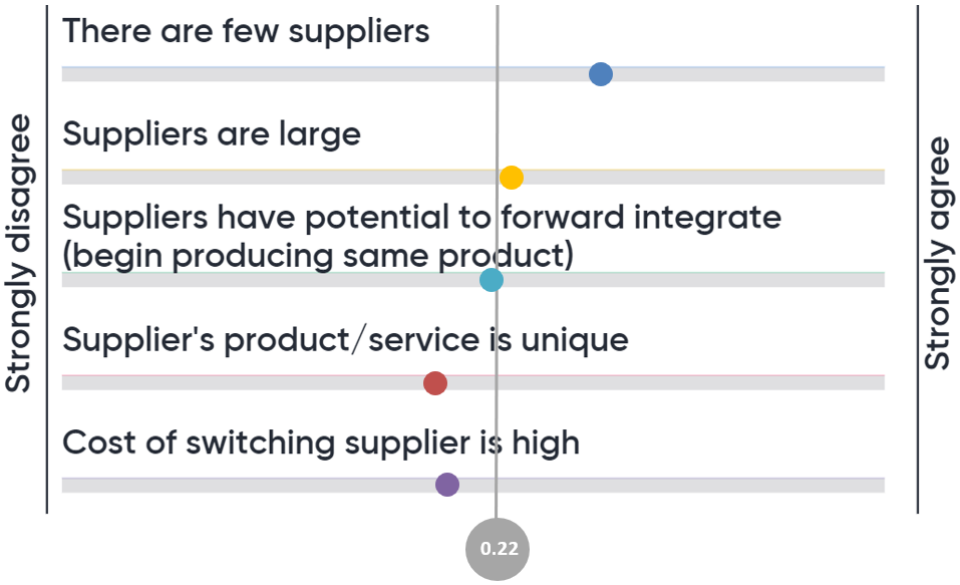

Figure 8-6: Supplier power (industry-wide)

It is worth noting that results may be confounded due to the wide range of goods and services supplied to the northern Australian aquaculture industry, making it somewhat difficult to characterise suppliers and draw definitive conclusions about supplier power.

8.1.2 Competitive forces species-specific analysis

In the Broome workshop, separate P5F exercises were undertaken for the pearling and barramundi industries, with results illustrated in **Figure 8-7**: Porter's 5 Forces Analysis (Pearling) results and **Figure 8-8** respectively. Participants were asked to rate a series of factors relating to each competitive force on a scale from "low" (0) to "high" (5), resulting in a mean (μ) score for each competitive force.

Like the results from the industry-wide analysis, threat of substitution was deemed the greatest competitive force in both the pearling and barramundi industries. Threat of new entrants was deemed the lowest competitive force in the pearling industry largely due to the established distribution chains of existing players, high capital requirements and relatively low industry growth. Rivalry amongst existing competitors was the lowest competitive force in the barramundi industry largely due to the low number of industry players in the domestic market. In the Broome workshop session, representatives from Marine Produce Australia identified that it would more likely be a benefit to their business if competitors *were* to enter the industry as it could result in the development of common user infrastructure and increase demand for ancillary services in the region.

Due to the low number of participants for this workshop, conclusions from the individual factor rating exercised cannot be drawn.

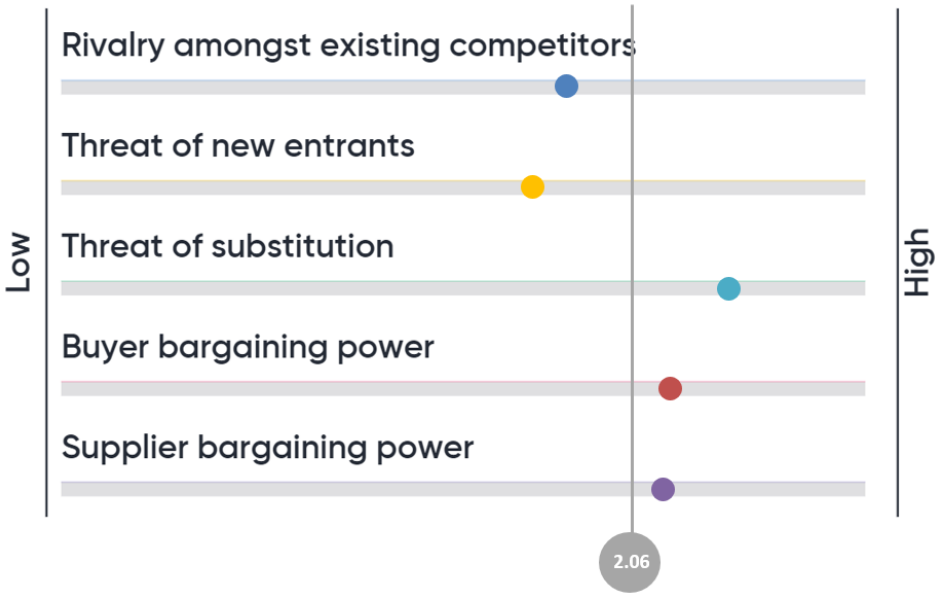

Figure 8-7: Porter's 5 Forces Analysis (Pearling) results

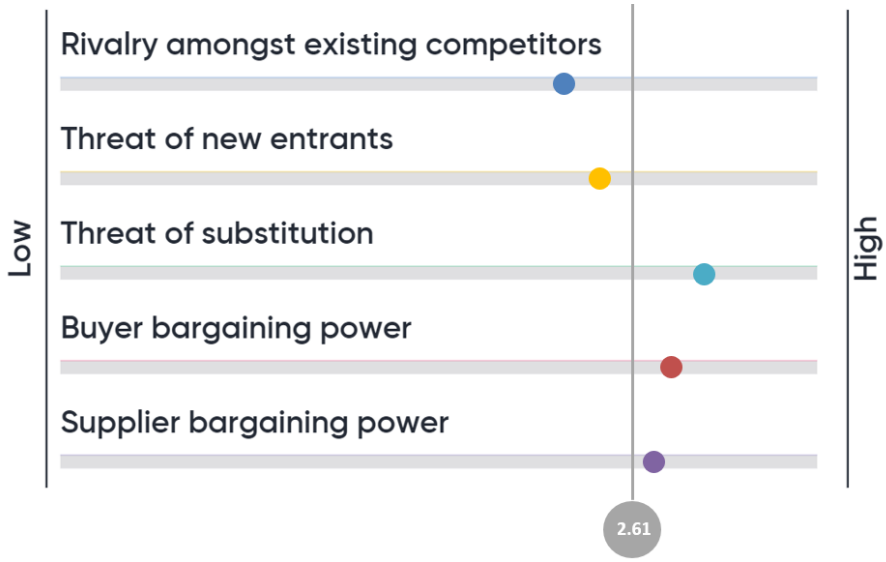

Figure 8-8: Porter's 5 Forces Analysis (Barramundi) results

8.2 CONCLUSIONS

Threat of substitution was deemed the greatest industry force in the northern Australian aquaculture industry across all assessments (all species; pearls; and barramundi) and workshops. Threat of new entrants ranked the lowest force in both the all-species assessment and pearling industry assessment, with rivalry amongst existing competitors rated the lowest competitive force in the barramundi assessment.

The top 5 characteristics contributing to the competitive environment of the aquaculture industry (all species) are summarised below (**Table 43**).

Table 43: Top characteristics contributing to northern Australian aquaculture industry's competitive environment

Rank	Aquaculture industry (all species)
1	There are many substitute products *available*
2	Existing producers do not possess patents, trademarks or do not have established brand reputation
3	Many substitute products *exist*
4	Substitute products are similar or cheaper in price
5	Buyers are price sensitive (demand is elastic)

9 SWOT ANALYSIS

9.1 SWOT RESULTS

Collating results from the Broome, Townsville and Darwin workshops, **Figure 9-1** illustrates the top strengths, weaknesses, opportunities and threats for the northern Australian aquaculture industry.

Figure 9-1: SWOT Analysis Results

Refer to **Sections 9.1.1.1** through **9.1.1.4** for detailed analysis of results from each SWOT quadrant.

Having identified the top five opportunities in the previous voting exercise, the audience were then asked to provide key actions that could be taken to enable these opportunities to be realised. Results from this activity are discussed in the project Stage 1/Final Report (Section 4.5.2).

9.1.1.1 Key Strengths

As illustrated in **Figure 9-2**, the following attributes were identified as the top strengths of the northern Australian aquaculture industry:

- Strong reputation of Australian produce (17.6%)
- High growth rates due to warm average temperatures (13.8%)
- Large areas of suitable land (11.7%)
- Strong scientific support (11.1%); and
- Access and availability of fresh water (10.0%)

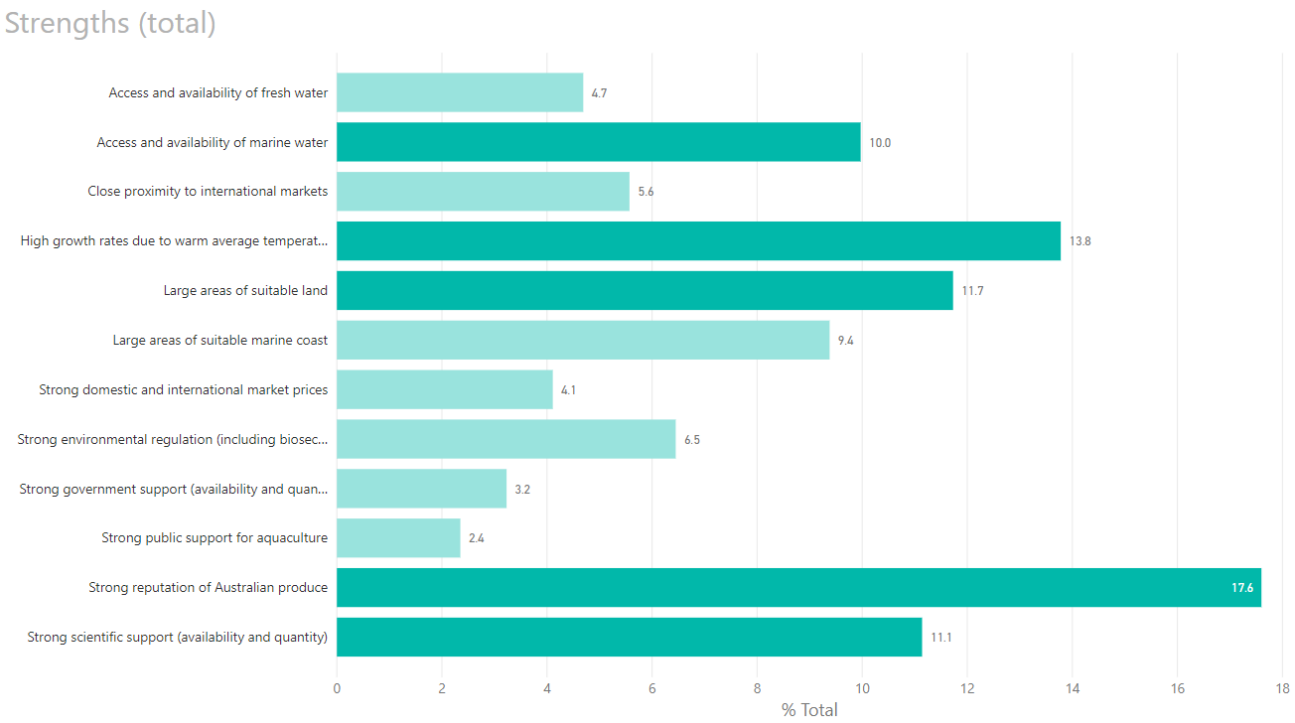

Figure 9-2: Strengths (% total votes attributed)

Figure 9-3 illustrates the distribution of votes across the three workshops. While relatively congruous across most factors, the following is noted:

- 'Strong scientific support' received significantly more votes at the Townsville workshop session (14% of total votes compared to 5% and 8% in Broome and Darwin respectively). This may be due to greater representation of researchers at this workshop which was also hosted on campus at James Cook University, potentially causing some level of bias in the results.
- 'Close proximity to international markets' received a significantly lower proportion of votes at the Townsville workshop (3%) than Broome (8%) or Darwin (9%). This may be attributed to the lack of direct international flights from Townsville Airport and the ongoing uncertainty around airport upgrades.
- While 'Large areas of suitable land' received over 12% of total votes in both the Darwin and Townsville workshops, only 5% of total votes in Broome were attributed to this strength. WA has typically pursued marine-based aquaculture opportunities (as opposed to land-based), however whether this is as a result of there being less suitable land available is to be determined. The result may also be caused by pastural land being more tightly held in WA than in other states.

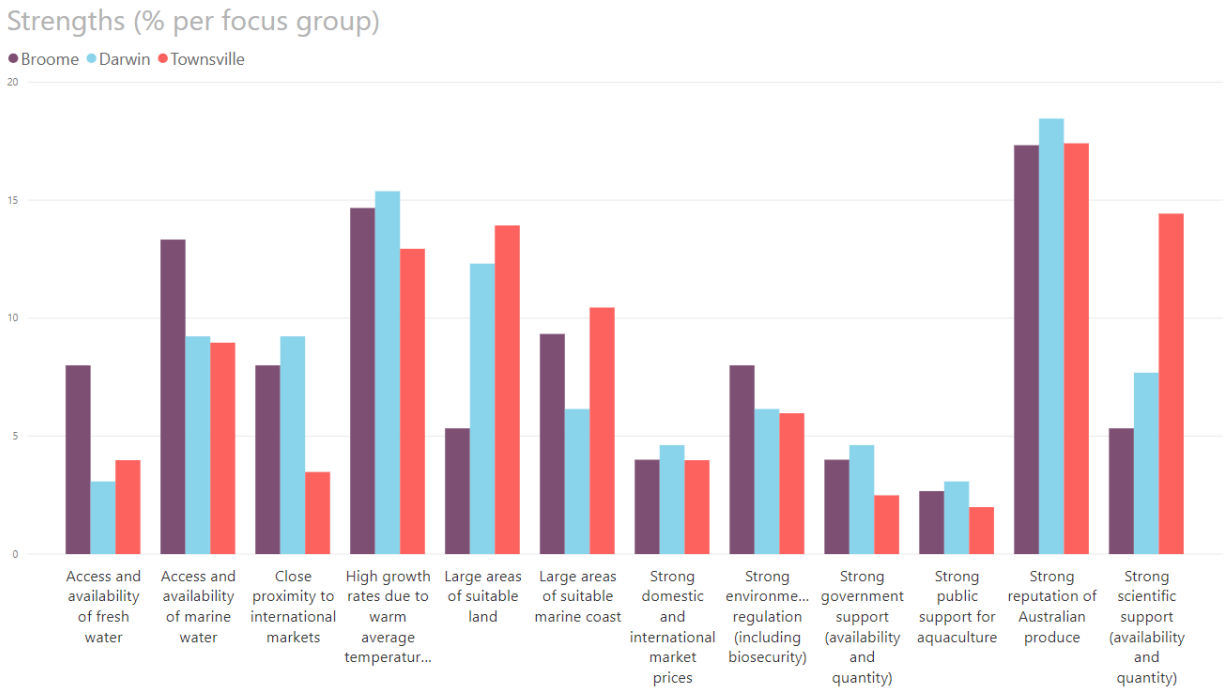

Figure 9-3: Strengths (% votes attributed per workshop)

9.1.1.2 Key Weaknesses

As illustrated in **Figure 9-4**, the following attributes were identified as the top weaknesses of the northern Australian aquaculture industry:

- Complex and duplicate regulatory processes (13.2%)
- High power costs (12.3%)
- High transport costs (11.7%)
- High labour costs (10.8%); and
  Lack of skilled/experienced labour (10.2%)

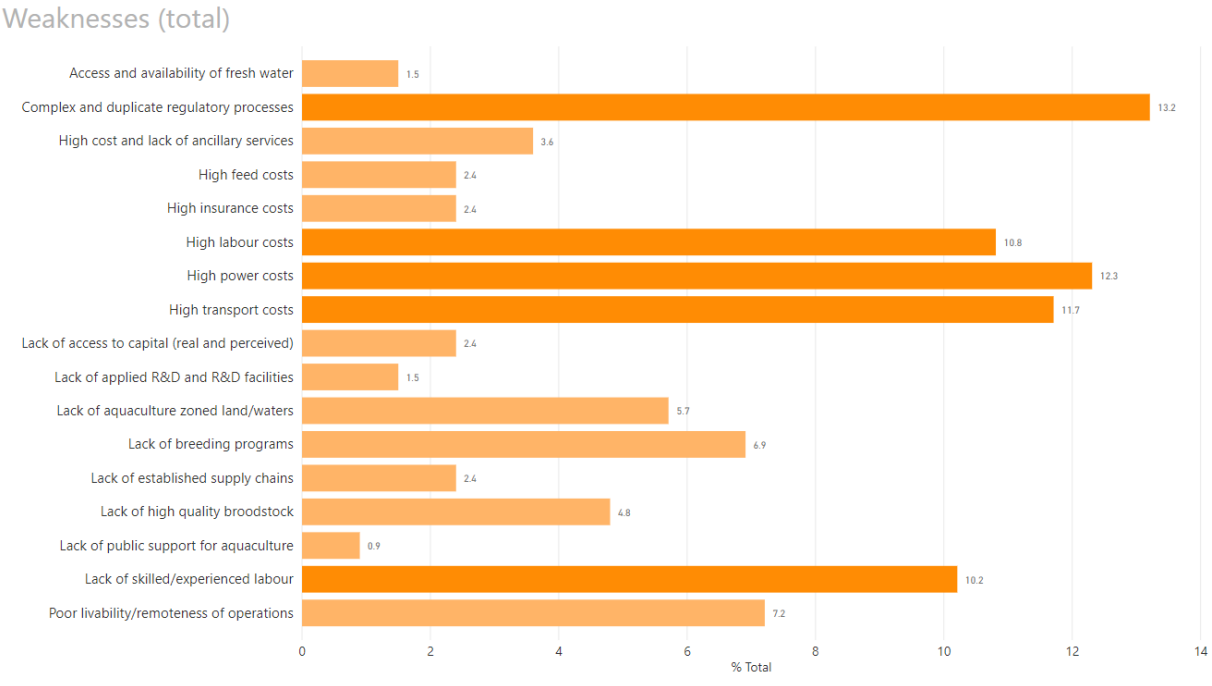

Figure 9-4: Weaknesses (% total votes attributed)

Figure 9-5 illustrates the distribution of votes across the three workshops. While relatively congruous across most factors, the following is noted:

- Following a revision of the factors after the Broome workshop, 'Access and availability of fresh water' and 'High insurance costs' were added to the list of weaknesses for the Townsville and Darwin workshops. As such, there were zero votes for these factors at the Broome workshop.
- 'High insurance costs' received significantly more votes in the Darwin workshop (6.9%) than in Townsville (1.5%). This may be due to the greater representation of pearling producers at this workshop who have been subject to a significant rise in insurance costs over the past decade (pers. Comms. James Brown, Cygnet Bay Pearls).
- While 'High cost and lack of ancillary services' received over 5% of total votes in both the Broome and Darwin workshops, only 1.5% of total votes in Townsville were attributed to this weakness. This is likely due to Townsville's larger population size (180,000 compared to Broome's 14,000 and Darwin's 132,000) resulting in greater access to goods, services and logistics networks, and relative proximity to other major hubs.
- 'High power costs' received a significantly lower proportion of votes at the Darwin workshop (1.4%) compared to the Broome (11.9%) and Townsville (16.5%) sessions. This can be somewhat attributed to the relative electricity prices across the states but may also be driven by the relative energy consumption of predominant aquaculture species/systems (e.g. land-based pond farming, which accounts for a significant portion of Queensland's aquaculture activity, requires high electricity input to run aeration pumps compared to pearling which is NT's major aquaculture activity which has very low energy requirements).
- There was a wide variability in the proportion of votes attributed to 'High transport costs' with 23.9% of total votes in Broome, 13.9% in Darwin and 6.7% in Townsville. This is aligned with the relative isolation of each region as well as population size, density and access to road/rail/air freight services. Broome results may be slightly skewed due to the presence of Marine Produce Australia representatives whose company source fingerlings from Victoria and truck them live to Broome (via Perth) resulting in an uncharacteristically high transport distance and resulting cost.
- 'Lack of applied R&D and R&D facilities' received 4.5% of total votes at the Broome workshop, compared to 1.4% and 0.5% in Darwin and Townsville respectively. This variance may be as a result of the comparative distance to the relevant state capital, and the possible bias caused by greater representation of researchers at the Townsville workshop which was held at James Cook University.
- 'Lack of aquaculture zoned land/water' received a significantly lower proportion of votes at the Broome workshop (1.5%) compared to in Townsville (6.2%) and Darwin (8.3%). This result may be linked to the recent declaration of the Kimberley aquaculture development zone in WA, providing both expansion and establishment opportunities in the region.
- While 'Lack of breeding programs' and 'Lack of high quality broodstock' each received less than 3.0% of total votes in the Broome and Darwin workshops, 9.8% and 6.7% of the total votes in the Townsville workshop were attributed to these weaknesses respectively. This result is likely driven by the prawn industry which operates almost entirely in QLD and has been pushing for an industry-wide breeding program to be established to ensure certainty in volume and quality of stock.

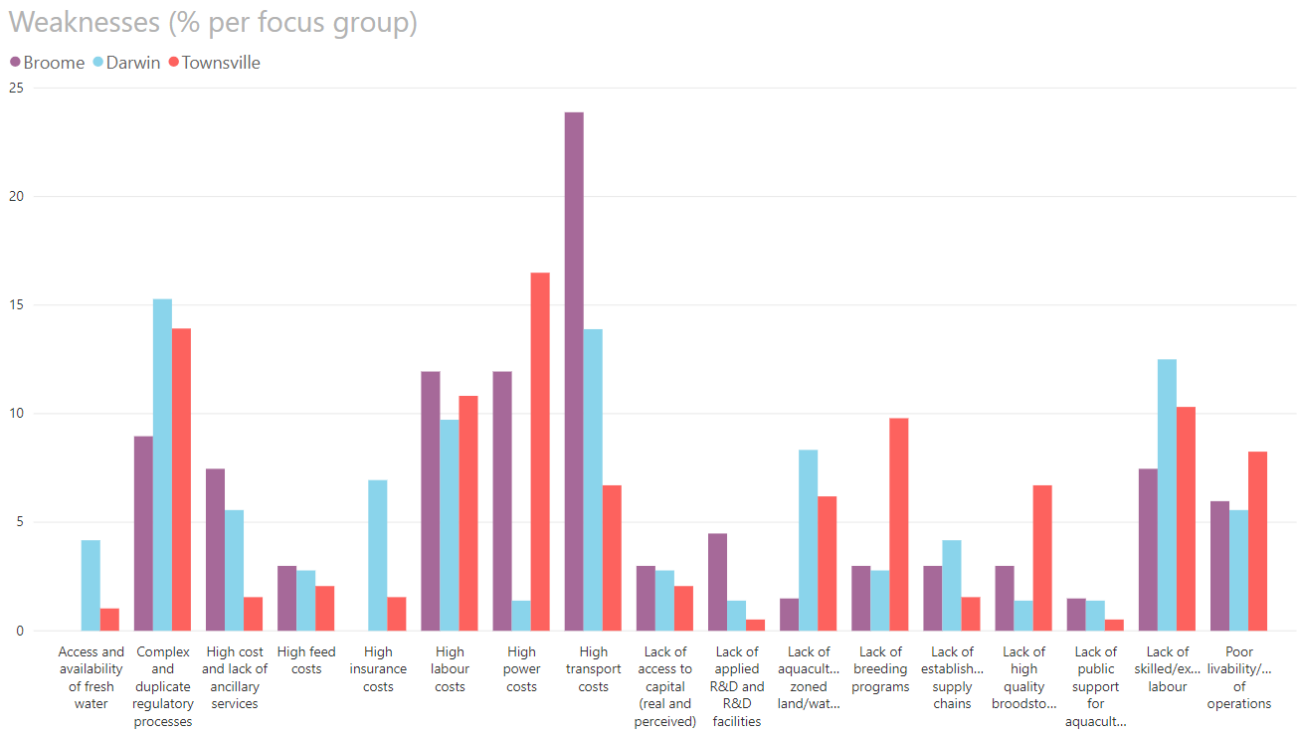

Figure 9-5: Weaknesses (% votes attributed per workshop)

9.1.1.3 Key Opportunities

As illustrated in **Figure 9-6**, the following were identified as the top opportunities for the northern Australian aquaculture industry:

- Improve clarity and regulation of Country of Origin labelling (10.6%)
- Improve indigenous engagement, employment and commercial opportunities (9.2%)
- Increase and improve breeding programs (8.7%)
- Increase production efficiency through automation/other technology (8.7%); and
- Increase and improve hatchery/seedstock supply (8.1%)

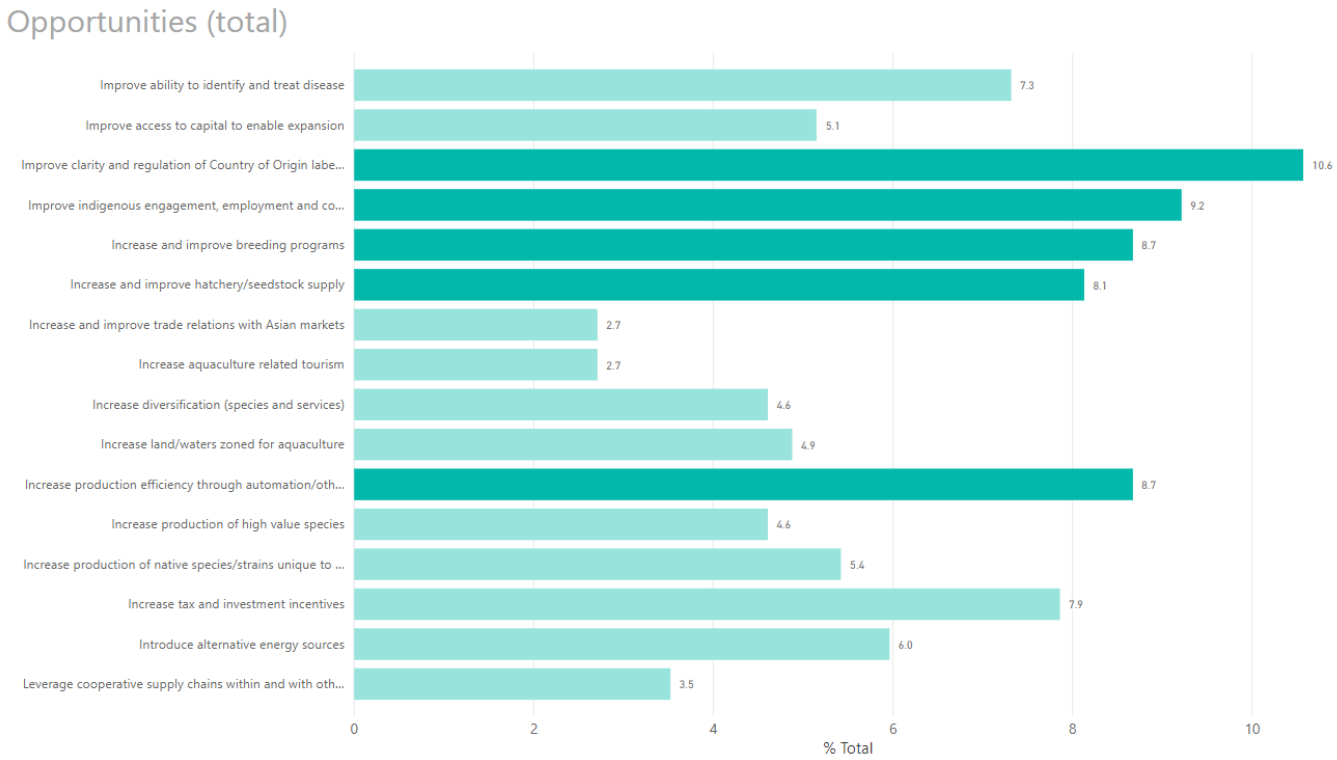

Figure 9-6: Opportunities (% total votes attributed)

Figure 9-7 illustrates the distribution of votes across the three workshops. While relatively congruous across most factors, it is worth noting the following:

- Following a revision of the factors after the Broome workshop, 'Increase diversification (species and services)' and 'Increase production of high value species' were added to the list of opportunities for the Townsville and Darwin workshops. As such, there were zero votes for these factors at the Broome workshop.
- 'Improve clarity and regulation of Country of Origin labelling' received a significantly lower proportion of votes at the Townsville workshop (7.6%) than in Broome (13.6%) or Darwin (14.4%). This may be due to the greater presence of pearling and barramundi industry representatives at these sessions, whose industries have arguably been most severely impacted by the perceived failure of Country of Origin labelling.
- Similarly, 'Improve indigenous engagement, employment and commercial opportunities' received only 7.1% of votes at the Townsville workshop, compared to 11.1% in Broome and 12.2% in Darwin. This is likely due to the relatively low representation of Indigenous groups and organisations at the Townsville workshop compared to Broome and Darwin.
- 'Increase and improve breeding programs' received a significantly lower proportion of votes at the Darwin workshop (2.2%) than in Broome (9.9%) and Townsville (11.1%). This was most likely due to the predominance of the one prawn and one barramundi representative in Darwin and predominance of pearl producer in Broome (who all seemed to believe that their respective breeding programs were well

established) and the significant representation of prawn producers in Townsville (where there was a focus on this issue).

- Both 'Increase and improve hatchery/seedstock supply' and 'Introduce alternative energy sources' received a significantly higher proportion of votes in Townsville (11.6% and 8.6% respectively) than in Broome (3.7% for both) and Darwin (4.4% and 2.2% respectively). These comments appear to reflect a strong prawn farming focus at the Townsville workshop on the key issues of 'breeding programs/broodstock' and 'power costs'.
- There was a wide variability in the proportion of votes attributed to 'Leverage cooperative supply chains within and with other industries' with 7.4% of total votes in Broome, 4.4% in Darwin and 1.5% in Townsville. The differences may reflect a distinct focus in Broome about aquaculture industry and cross-industry (e.g. tourism, beef production) cooperation which was not as prominent in the other workshops.

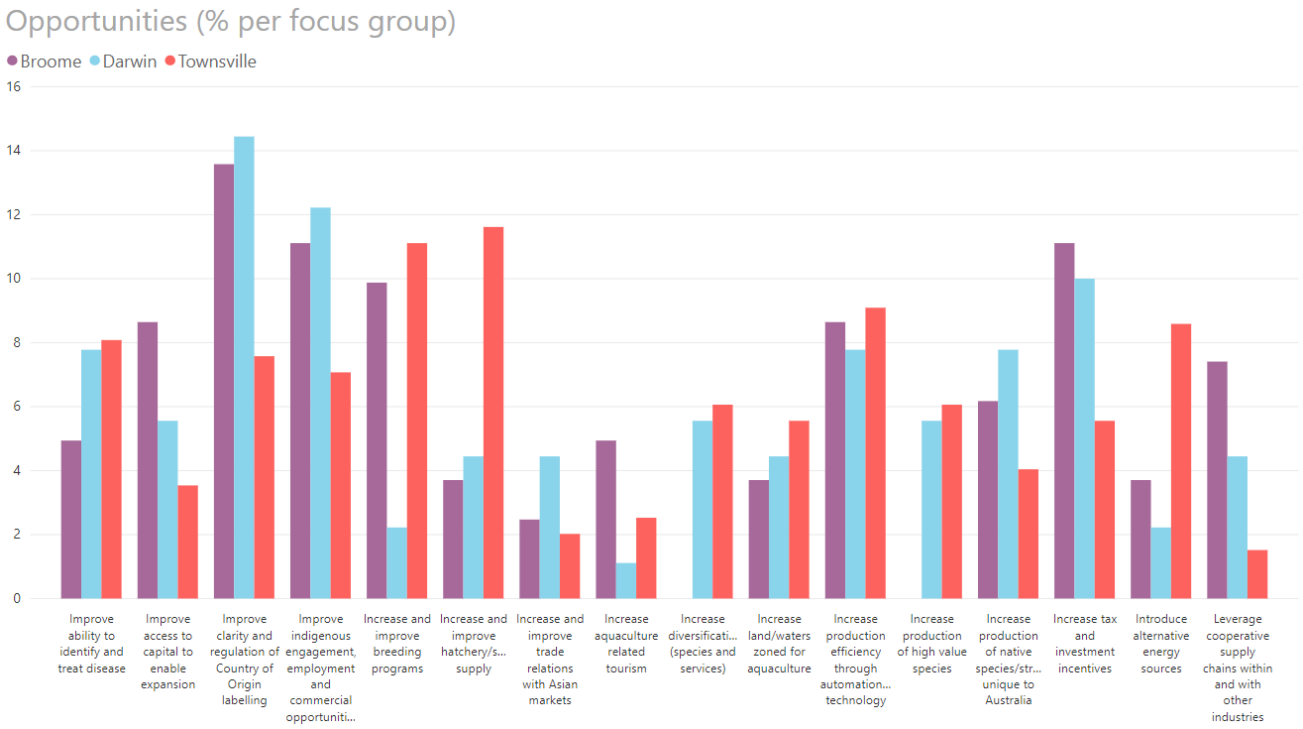

Figure 9-7: Opportunities (% votes attributed per workshop)

*9.1.1.4 **Key Threats***

As illustrated in **Figure 9-8**, the following attributes were identified as the top threats to the northern Australian aquaculture industry:

- Disease outbreak/introduction of exotic diseases (17.6%)
- Increase in power/fuel costs (10.3%)
- Regulatory processes hindering expansion and/or market development (9.8%)
- Competition from international competitors (9.2%); and
- Consumers unable to correctly identify Australian produce (8.4%)

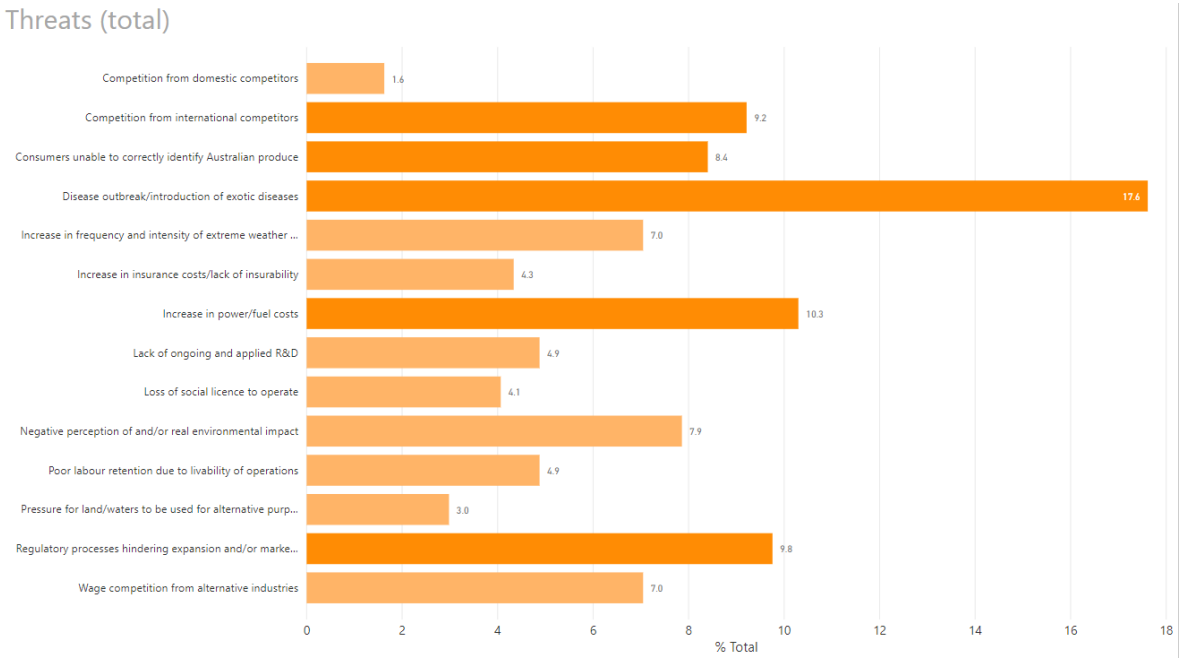

Figure 9-8: Threats (% total votes attributed)

Figure 9-9 illustrates the distribution of votes across the three workshops. While relatively congruous across most factors, the following is noted:

- Following a revision of the factors after the Broome workshop, 'Poor labour retention due to liveability of operations' and 'Regulatory processes hindering expansion and/or market development' were added to the list of threats for the Townsville and Darwin workshops. As such, there were zero votes for these factors at the Broome workshop.
- 'Competition from international competitors' received a notably higher proportion of votes at the Broome workshop (16.0%) than in Townsville (8.1%) or Darwin (5.9%). This can be attributed to a strong message from the predominantly pearl producer workshop that lack of systems to assure provenance of pearls was being exploited by Asian producers , significantly impacting Australian producers.
- There was a wide variability in the proportion of votes attributed to 'Increase in insurance costs/lack of insurability' with 9.3% of total votes in Broome, 4.7% in Darwin and 2.4% in Townsville. This is likely due to the greater presence of pearling industry representatives at the Broome and Darwin workshops, of which have been subject to a significant rise in insurance costs over the past decade as a result of extreme weather events (pers. Comms. James Brown, Cygnet Bay Pearls).
- Similarly, there was wide variability in the proportion of votes attributed to 'Increase in power/fuel costs' with 13.9% of total votes in Townsville, 8.0% in Broome and 3.5% in Darwin. This can likely be attributed the relative energy consumption of predominant aquaculture species/systems (e.g. land-based pond farming, which accounts for a significant portion of Queensland's aquaculture activity, requires high electricity input to run aeration pumps compared to pearling which is NT's major aquaculture activity which has very low energy requirements).

- Both 'Loss of social license to operate' and 'Pressure for land/waters to be used for alternative purposes' received a significantly higher proportion of total votes in the Darwin workshop (8.2% for both) than in Townsville (2.4% and 1.4% respectively) and Broome (4.0% and 1.3% respectively). These scores in Darwin possibly reflect the views of the NT workshop which discussed the issues of large areas of land/water subject to unresolved native title claims, no 'prescribed aquaculture zones' and the generally smaller, closer-knit communities of Broome and Darwin.
- 'Wage competition from alternative industries' received a significantly higher proportion of total votes in the Broome workshop (10.7%) than in Townsville (6.2%) and Darwin (5.9%). This is likely a result of the inflated wage levels in the booming WA mining industry which accounts for over 85% of the State's income from total exports.
- There was a wide variability in the proportion of total votes attributed to 'Lack of ongoing and applied R&D' with 10.7% of total votes in Broome, 5.9% in Darwin and 2.4% in Townsville. This may be a result of potential bias caused by greater representation of researchers at the Townsville workshop which was also hosted by James Cook University.

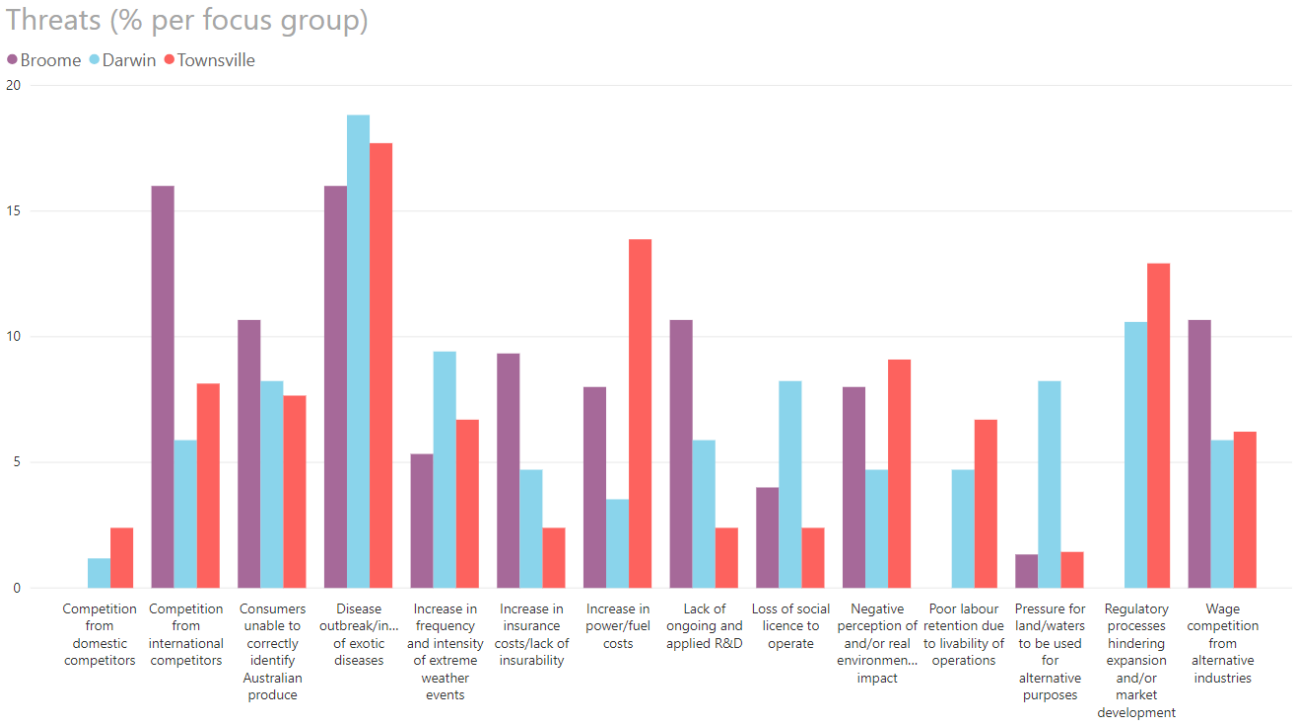

Figure 9-9: Threats (% votes attributed per workshop)

9.2 SCENARIO PLANNING ANALYSIS

9.2.1 Future trajectories

This section provides more background to the scenario analysis and selection presented in the project Stage 1/Final Report.

For each of the force group categories (F1 Political, F2 Environmental, F3 Industry, and F4 Market), several different factor trajectories can be considered: 1) Improvement; 2) No change; and 3) Deterioration. **Table 44** demonstrates changes to the Political category of forces in different future trajectories.

Table 44: Examples of business influence force trajectories into the future within the 'political' category

Category	Forces	Options
F1: Political	• Accessibility	1) Improvement: Government facilitates dramatic increase in access to operations approved land/water for aquaculture. 2) No change: no new aquaculture areas made available by government. Development capacity remains unchanged. 3) Deterioration: certain operations/areas are abandoned, and development area is actually reduced.
	• Biosecurity policy	1) Improvement: Government introduces significant changes to biosecurity policy and surveillance funding. 2) No change: biosecurity policy, surveillance funding remains constant. 3) Deterioration: restrictions on some imports of uncooked seafood is lifted.
	• Influence	1) Improvement: Government introduces significant funding for northern Australian aquaculture as a result of strong industry lobbying. 2) No change: current levels of lobbying maintained; no change in northern funding. 3) Deterioration: restrictions on some imports of uncooked seafood is lifted.

Creating a matrix of the future trajectories, for the force groups influencing the northern Australia aquaculture industry, reveals the possible combinations (**Table 45**). There is one worst case: 1C, 2C, 3C, 4C and one best case: 1A, 2A, 3A, 4A. It is possible to select several mid-case scenarios, however, in order to potentially explore the widest range of credible scenarios for aquaculture in northern Australia, two more scenarios: a positive (1B, 2B, 3A, 4A) and a negative scenario have been explored (1B, 2B, 3A, 4A).

Table 45: Possible combinations of force group categories and future trajectories

	F1 (Political)	F2 (Environmental)	F3 (Industrial)	F4 (Market)
Trajectory A	1A: Improved	2A: Improved	3A: Rise	4A: Rise
Trajectory B	1B: Unchanged	2B: Unchanged	3B: Unchanged	4B: Unchanged
Trajectory C	1C: Deteriorated	2C: Deteriorated	3C: Fall	4C: Fall

9.2.2 Scenario theme selection

The selected scenarios (based on the matrix analysis above) describe possible future state and status of the northern Australian aquaculture industry (**Table 46**).

Table 46: Features of the selected scenarios for the northern Australian aquaculture industry

Scenario No.	Scenario ID	Political forces development	Environmental forces development	Industrial forces development	Market forces development
1 (1C, 2C, 3C, 4C)	The Dry	Worsening	Worsening	Fall	Decrease
2 (1B, 2B, 3B, 4B)	Shower	Unchanged	Unchanged	Unchanged	Unchanged
3 (1B, 2B, 3A, 4A)	Storm	Unchanged	Unchanged	Rise	Rise
4 (1A, 2A, 3A, 4A)	Monsoon	Improved	Improved	Rise	Rise

The four Scenarios developed were:

'**The Dry**' – is the worst-case scenario and describes a future where the industry experiences a worsening in the situation of all the force-groups that affect the industry, and particularly where the key industry access and broodstock/seedstock issues are the main driver. The result of the worsened situation is that the production volume (and GVP) from the northern Australian aquaculture industry in 2030 has dropped to around $177 million GVP.

'**Shower**' – describes a future where the industry has not managed to improve the industry access and broodstock/seedstock issues and therefore has lost the political will for an upscaling of the production. The result of this is that the production volume from the northern Australian aquaculture industry in Showers has stagnated and increased only with CPI, to a GVP of approximately $267 million in 2030.

'**Storm**' – describes a future where the northern Australian industry has successfully achieved expansion and increased production volumes and by doing so, it has eliminated the restrictive issues across the region and industry (and within sectors). However, the industry has not improved all the drivers, and this has caused some investment reluctance for upscaling in parts of northern Australia. The result of this is that GVP in 2030 from the northern Australian aquaculture industry is $535 million, based on 22,600 tonnes of seafood, and $168 million GVP of pearls. Estimates are that at least 260 and up to 624 direct new jobs, at a range of skill levels, will be created through planned aquaculture expansion in northern Australia by 2030.

'**Monsoon**' – is the best-case scenario and describes a future where the northern Australian aquaculture industry has reached its 2030 vision. This is a ripple effect of a choice the industry made to collaborate to solve the key issues, enabling the overall industry and key sectors to significantly expand and become very successful. This, combined with good RD&E and production outcomes, strong marketing efforts and an increase in global demand, has resulted in approximately 5 times the production volume from the northern Australian aquaculture industry. This represents a 2030 GVP of $1.34 billion via production of 56,600 tonnes of fish, prawns and other seafood products as well as substantial volumes of premium pearls (contributing $420 million GVP). At least 1,430 and up to 2,340 direct new jobs, at a range of skill levels, will be created.

A summary of the overall aquaculture production metrics for the Scenarios is presented in **Table 47**.

By comparison, the Australian total aquaculture production in 2016–17 was 96,869 tonnes generating a GVP of $1.35 billion (adapted from ABARES, 2018, with stakeholder input). Farmed salmonids, the most valuable aquaculture species group in 2016–17, generated $756 million from 53,000 tonnes of production, of which 97% was produced in Tasmania.

Table 47: Summary of scenarios and aquaculture production metrics

Scenario #, Name & Description	Multiplication factor	Species	Production (t) or Momme		GVP $AUD*	Labour (#FTE) Lower Limit**	Labour (FTE) Upper Limit***
1. Dry							
Worst-case scenario, industry worsening and decreased production volume/GVP	**0.8**	Barramundi	5,578	$	59,872,480	108	158
		Prawns	3,186	$	57,883,200	132	194
		Pearls	0.32	$	56,291,200	42	62
		Other	288	$	2,618,400	30	44
		Total		**$**	**176,665,280**	**312**	**458**
2. Shower							
Business as usual, production stagnant, production value increasing in line with CPI (2% pa)	**1.20**	Barramundi	6,972	$	89,441,445	135	198
		Prawns	3,983	$	86,469,728	165	242
		Pearls	0.4	$	84,091,493	53	77
		Other	360	$	7,449,012	38	55
		Total		**$**	**267,451,678**	**390**	**572**
3. Storm							
Doubling of current production volume and value	**2**	Barramundi	13,944	$	178,882,890	270	396
		Prawns	7,966	$	172,939,455	330	484
		Pearls	0.55	$	168,182,987	105	154
		Other	721	$	14,898,024	75	110
		Total		**$**	**534,903,356**	**780**	**1,144**
4. Monsoon							
Five times current production volume and value	**5**	Barramundi	34,860	$	447,207,224	675	990
		Prawns	19,915	$	432,348,639	825	1,210
		Pearls	0.7	$	420,457,467	263	385
		Other	1,802	$	37,245,060	188	275
		Total		**$**	**1,337,258,390**	**1,950**	**2,860**

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11 APPENDICES

11.1 APPENDIX A – SUMMARY TABLE OF COMMONWEALTH POLICY, STRATEGY AND PLANS RELEVANT TO NORTHERN AUSTRALIAN AQUACULTURE

Document name/title	Owner/authors	Objectives/Findings/Recommendations	Comments
Aquaculture viability (2018): A technical report to the Australian Government from the CSIRO Northern Australia Water Resource Assessment, part of the National Water Infrastructure Development Fund: Water Resource Assessments (Irvin et al, 2018)	Department of Infrastructure, Regional Development and Cities, CSIRO Irvin S, G Coman, D Musson, A Doshi and C Stokes	The report assesses the opportunity for tropical marine and freshwater aquaculture in land-based systems in northern Australia. The three objectives covered in this report are to: 1. Provide a review of current aquaculture production and practice in Australia. 2. Devise a water and land suitability analysis framework for selected crops. 3. Assess the land suitability outputs that are generated. This report focuses on marine and freshwater fish, molluscs and crustacean species which are suitable for land-based culture, have a level of domestication, and are produced primarily as edible seafood. The minimum acceptable level of domestication or captive rearing is the use of wild caught parents to produce hatchery reared seed. Species which rely on the capture of wild seed for production have been excluded from consideration; the one exception being oyster, where some production comes from 'wild-spat' which originate from larvae occurring naturally in the local waterways. Other exclusions include aquatic plants, ornamental fish, amphibians, reptiles and mammals. **Key Findings** Current aquaculture production and practices in Australia are reviewed for a range of culture species and industries, with emphasis on potential land-based systems and tropical species appropriate for culture in northern Australia. The opportunity for aquaculture development in northern Australia is outlined, noting the slow pace of development compared with southern Australia over past decades. Two candidate species for land-based aquaculture in northern Australia are identified in the report; the black tiger prawn (*Penaeus monodon*) and the barramundi (*Lates calcarifer*). Fundamental aspects of the biology and culture of these two species, and a third candidate species suitable for freshwater pond culture (the red claw crayfish, *Cherax quadricarinatus*), are outlined. All three species have well-established culture practices and markets, and each are suited to land-based culture in the marine and brackish or freshwater environments of northern Australia. Land and water suitability for aquaculture development was assessed in the three study areas based on a wider range of criteria specific to the aquaculture requirements of the three candidate species. LSM identified significant areas of land for potential aquaculture development within each of the Fitzroy, Darwin and Mitchell catchments. When overlaid with water suitability modelling, **land areas of more than 500,000 ha and 700,000 ha were identified as suitable for marine farming in earthen and lined ponds respectively**. Of these areas, **9,500 ha and 225,000 ha** were identified as **Class 1 land (i.e. suitable with negligible limitations) for marine farming in earthen and lined pond respectively**. For **freshwater farming**, **vast areas** of land were identified as suitable in all three study areas for **both earthen (3,000,000 ha) and lined ponds (13,000,000 ha)**. For a sense of comparison in terms of the opportunity presented in northern Australia, the current Australian prawn farming industry utilises approximately 900 ha. The report thus finds the scale of potential land available in the Assessment area presents a significant opportunity to expand Australian aquaculture enterprises. The report also finds scope for integrating aquaculture with other agricultural industries in northern Australia and a range of potential opportunities are noted. Despite these opportunities, challenges to the development of aquaculture in northern Australia are posed by competition from Asian imported products and regulatory barriers. Other key risks outlined in the report include potential chemical toxicants present in the waters or sediments of potential sites, and pathogen and disease risks that may present. A framework for assessing the financial viability of aquaculture enterprises in northern Australia was developed based on indicative costs for a range of aquaculture enterprises that differ in species farmed, scale and intensity of production. Operating costs are high, and annual expenditure on inputs can exceed the initial cost of development. Variable costs dominate the total costs of aquaculture production, and even small changes in quantities and prices of inputs and produce can have a relatively large impact on net profit margins. These values could differ substantially between different locations and experience of operator, and even small differences from the indicative costs or prices provided could significantly impact profitability. Based on the natural advantages that northern Australia possesses, and through the large land areas identified as suitable for aquaculture in the three study areas assessed using LSM, this report finds considerable opportunity for future aquaculture development in northern Australia. **While there are challenges to the development and operation of aquaculture enterprises, the potential to exploit these natural advantages and develop modern and sustainable aquaculture industries presents a compelling opportunity.**	Report: - identifies vast areas of potential land-based aquaculture opportunity - recommends prawns, barramundi and redclaw as best candidates for northern Australia aquaculture - opportunities for synergies with other industries - highlights key challenges: >> competition from Asian imported products >> regulatory barriers >> chemical toxicants in soils/water >> pathogens/diseases - undertakes financial modelling of aquaculture operations which highlight: >> high operating costs (high variable input costs – power, labour, feed and transport add-on costs) >> costs changes, operator skill differences and locational effects can have high leverage impact on financial profitability.
National Aquaculture Strategy (DAWR, 2017)	Department of Agriculture and Water Resources, Canberra, (August 2017). CC BY 4.0.	A national vision for unlocking the industry's potential, identifying priority areas for the industry and Australian governments to address and outlining a range of achievable actions. Sets 'target' of doubling the value of the aquaculture industry to $2 billion by 2027.	Compare to Aquaculture Action Agenda – Discussion Paper 2001 which set a $2.5b target by 2010
Australian Government response to the Joint Select Committee on Northern Australia report: Scaling Up – Inquiry into Opportunities for Expanding Aquaculture in Northern Australia (June 2017) (Australian Government, 2017)	Parliament of Australia	Government response to recommendations of JSC.	Some government undertakings listed in response have been implemented. Several others – including some significant ones – have not been implemented. See below for 'scorecard'
Scaling Up – Inquiry into Opportunities for Expanding Aquaculture in Northern Australia (JSCNA, 2016)	Joint Select Committee on Northern Australia	**Recommendations** 1. Establishment of an Australian **Pearling Industry Recovery Taskforce** to fund a research program focussed on identifying the causative agent of the oyster oedema disease and possible remedial actions to reduce the incidence and mitigate the impacts of the disease. 2. Department of the Environment, in collaboration with the Queensland Government, fund a program to review and **expand the science relating to the environmental impact of aquaculture in areas adjacent to the Great Barrier Reef**. 3. Department of the Environment and the Great Barrier Reef Marine Park Authority (GBRMPA) support the **Queensland** Government in determining the need for and the positioning of **special aquaculture development zones**. 4. GBRMPA, in accordance with the planned actions outlined in its Regulatory Plan 2014-2015, **revoke the Great Barrier Reef Marine Park (Aquaculture) Regulations 2000** (Cwlth). 5. Department of the Environment ensures the framework for **developing offsets in the Great Barrier Reef** is comprehensive, transparent and accessible for potential aquaculture investors. 6. Queensland Government conduct a survey of crocodile egg numbers in Northern Queensland to determine the sustainability of **crocodile egg harvesting**. 7. Fisheries Research and Development Corporation (**FRDC**) **should consider introducing a 'northern node'** as an avenue for providing funding research relevant to Northern Australia. 8. Australian Government provide **funding assistance for developing road and port infrastructure to service the Kimberley Aquaculture Development Zone and Project Sea Dragon** subject to establishing a positive cost-benefit analysis. 9. Australian Government provide **funding assistance for the establishment of a pest and disease diagnosis facility in Northern Queensland**. 10. Australian Government, through COAG, **remove the exemption from country of origin labelling** requirements under Standard 1.2.11 of the Australia New Zealand Food Standards Code for **cooked or pre-prepared seafood** sold by the food services industry. 11. Department of Industry reports within 12 months on the feasibility of introducing **country of origin labelling for aquaculture products such as pearls and crocodile teeth**.	1. Not fully implemented. CRC-P project funded for POMS. 2. ***Not done.*** 3. ***Queensland has implemented ADA's but position of GBRMPA as yet 'untested'***. 4. Aquaculture Regulations recommended to be repealed (EPBC Act deemed to have adequate provisions for impact assessment of new aquaculture proposals on the GBRMP). Regulations will sunset on 1 October 2019. ***There is also a need for development of Code Assessment guidelines for aquaculture in and adjacent the GBRMP***). ***5. Not as yet implemented.*** ***6..Status unknown*** ***7. Not as yet implemented.*** ***8.*** **Completed.** **9. Implemented (partly at JCU)** **10.** ***Not fully implemented. No requirements placed on the foodservice sector*** ***11. Not implemented***
FRDC National Fisheries and Aquaculture RD&E Strategy 2020 – 2025 (FRDC, 2019a)	FRDC	New Strategy currently being developed. The FRDC 2020-25 RD&E Plan will also be informed by: ▪ a contemporary snapshot of fishing and aquaculture today, updating earlier work conducted in 2014 (FRDC Project 2014/503.20); ▪ a horizon-scanning process looking over a ten-year time horizon (2030) that considers geopolitical, social, economic, environmental and/or technical changes likely to occur over 2020-2030, drivers of those changes, and implications for fisheries and aquaculture production, trade, pricing, fishing participation, expenditure, and the environment; ▪ The Independent review of FRDC's performance, and proposed independent review of RACs and IPAs (see above) ▪ relevant strategic plans and strategies that are extant for the nominated five-year period.	See below (2016 Strategy). Drivers (for northern Australian aquaculture industry) are largely unchanged from those outlined in 2016…

FRDC RD&E Priorities and sub-plans National Priority 3: Development of new and emerging aquaculture growth opportunities (FRDC, 2019b)	FRDC	RD&E focussed on; yellowtail kingfish in southern parts of Australia (SA, NSW and WA); cobia and giant grouper as alternative finfish species for production by prawn farmers (especially in southern QLD, noting the commercial grouper hatchery is in north QLD); Murray cod (NSW and Victoria); and in tropical blacklip oysters (FRDC, 2019b).	Projects in northern Australia are related to tropical blacklip oysters and indirectly grouper (hatchery in northern QLD)
Success through Innovation. The National Fishing and Aquaculture Research, Development and Extension Strategy 2016 (FRDC, 2016b)	FRDC	Key drivers (>2016) were: - The fishing and aquaculture industry is made up of four main sectors: aquaculture, commercial fishing, Indigenous and recreational fishing. The post-harvest sub-sector which mainly services commercial operations is increasingly becoming a sector in its own right - The main sectors are complex, consisting of sub-sectors targeting different species or groups of species, using different techniques, having different values and managed by different jurisdictions. This complexity has a significant bearing on the targeting of RD&E priorities and investment processes. - The current and future environment for commercial fishing and aquaculture in Australia is driven by the growing demand for seafood worldwide. In addition, there is increasing scrutiny on the sustainability of fishing and aquaculture operations and their broader impacts on aquatic ecosystems. - Indigenous and recreational fishing sectors are seeking greater engagement with, recognition of, and responsibility for their stewardship of marine resources. Stewardship is of particular significance to Indigenous Australians because of their traditional use and management of this country's aquatic resources. - The overlying need for all sectors is to manage aquatic resources sustainably and ensure the health of the marine environments on which they all depend. The national RD&E priority areas identified in the 2016 Strategy are: 1. Australia's fisheries and aquaculture sectors are well managed, and acknowledged to be, ecologically sustainable. 2. Security of access to, and allocation of fisheries and aquaculture resources is improved. 3. Benefits and value from fisheries and aquaculture resources (productivity and profitability) are maximised, and aquaculture production increased. 4. Governance and regulatory systems are streamlined. 5. Health of the habitats and environments on which fisheries and aquaculture rely are maintained. 6. Aquatic animal health management is improved.	Drivers for the **aquaculture** sector • Research to support risk-based approaches to regulation, particularly for environmental monitoring and the development of new sites. • Improve biosecurity preventative measures and response plans along the supply chain. • Rationalise access to AquaVet pharmaceuticals. • Develop new species/products or improve the performance of existing species. • Improve community perceptions and acceptance of aquaculture operations. • Reduce the reliance on wild-caught fish for feed. • Improve nutrition, feeding strategies, fish health and overall fish husbandry to increase profitability.
2014 Australian Fisheries and Aquaculture Sector overview. A report supporting the development of working together: The National Fishing and aquaculture RD&E Strategy (FRDC and Ridge Partners, 2015)	FRDC Prepared by Ridge Partners	Report presents a strategic review and analysis of the business environment for the fishing and aquaculture industry in Australia undertaken to provide baseline data and analysis to support FRDC and industry planning activities, in particular for the National Fishing and Aquaculture (F&A) Research Development and Extension (RD&E) Strategy for the period 2015-2020 (*The National Fishing and Aquaculture Research, Development and Extension Strategy 2016)* The objectives were to: 1. To assess and analyse the current business and operating environments for the four major sectors of F&A (including aquaculture) 2. To develop scenario forecasts for the future business and operating environments for F&A – including opportunities and threats; and 3. Based on the forecasted scenarios, identify the R D & E strategies.	
Current requirements for labelling of seafood and seafood products December 2014 (RRATRC, 2014)	The Senate Rural and Regional Affairs and Transport References Committee	**Recommendation** The committee recommends that the exemption regarding country of origin labelling under Standard 1.2.11 of the Australia New Zealand Food Standards Code for cooked or pre-prepared seafood sold by the food services sector be removed, subject to a transition period of no more than 12 months.	See above.
CRC for Seafood (2007-2015)	Department of Industry Science, Tourism	Four key programs: 1) Production Innovation – aimed for a substantial increase in the production and profitability of selected wild-catch and aquaculture species. 2) Product and Market Development – given responsibility for increasing demand and access to premium markets for Australian seafood while fulfilling consumer demands for safe, high-quality, nutritious seafood products and increasing profitability throughout the value chain 3) Communication and Education – deliver additional outcomes in the form of skilled scientists, industry-ready graduate students, informed industry personnel and increased social capital among all participants 4) Commercialisation and Utilisation – the delivery of the outputs from the other three programs.	The total cash expenditure by the CRC over its eight year life was $83 million. This was composed of $35.5 million contributed by the Australian Government and $44.5 million contributed by the 25 Core Participants and 14 Supporting Participants. In addition, in-kind contributions to the value of $68 million were provided by the Participants. Key outputs (relevant to northern Australia aquaculture)
Aquaculture Action Agenda – Discussion Paper 2001 (DAFF, 2001)	Department of Agriculture Fisheries and Forestry (on behalf of the National Aquaculture Development Committee)	Vision (based on 1999 National Aquaculture Beyond 2000 Workshop) – *By 2010 a sustainable and rapidly growing Australian aquaculture industry will achieve at least $2.5B in sales by being the world's most globally competitive aquaculture producer*. **Impediments and Opportunities** *Communications and Promotion* ▪ Lack of industry cohesion on national issues ▪ Opportunities to develop stronger linkages between stakeholders ▪ Lack of industry and product promotion. *Resource Access and Sustainability* ▪ Lack of available and suitable sites for aquaculture ▪ Delays in gaining access to resources ▪ Lack of security of tenure ▪ Minimising any adverse impacts of aquaculture on the environment and other resource users *Investment Environment* ▪ Encouraging investment in aquaculture ▪ Improving tax treatment of aquaculture businesses ▪ Improving marketing capabilities ▪ Identifying key markets in Australia and overseas ▪ Removing barriers to international trade in fisheries products ▪ Exploiting aquaculture industry's competitive advantages *Regulatory framework* ▪ Removing administrative burden of regulation on aquaculture businesses ▪ Ensuring regulation meets government and industry needs *Research and Development* ▪ Increasing funding for aquaculture R&D ▪ Keeping current R&D focussed on meeting core needs ▪ Improving transfer of R&D between researchers and industry ▪ Improving management and protection of intellectual property *Education and Training* ▪ Improving access to education and training resources that industry needs at all levels ▪ Improving work practices and workplace environment	Scorecards (2019) 2010 GVP ~ $800M 2017 GVP ~$1 B 2027 target GVP $2B
CRC for Aquaculture (1993 – 2000)	Department of Industry Science, Tourism		
Aquafin CRC – Atlantic Salmon Aquaculture Subprogram FRDC	FRDC - CRC	A strategic plan to develop collaborative research projects that address industry bottlenecks and avoid duplication and unnecessary expenditure of a finite research fund. This Atlantic Salmon Aquaculture Subprogram will deliver the mechanism for the required collaboration while efficiently addressing research priorities identified by industry.	

11.2 Appendix B – Mentimeter Results

PESTEL overall macro-environment results

Macro-environment	Weighted Average (Townsville)	Weighted Average (Darwin)	Weighted Average (TOTAL)
POLITICAL	-0.94	-0.25	-0.74
ECONOMIC	-0.19	0.31	-0.05
SOCIAL	-0.52	0.38	-0.26
TECHNOLOGICAL	-0.10	0.63	0.10
ENVIRONMENTAL	-0.56	-0.34	-0.50
LEGAL	-0.51	-0.32	-0.46

PESTEL factor results (by macro-environment)

POLITICAL	**WEIGHTED AVERAGE**
Bureaucracy	-2.62
Import regulations/restrictions	-2.13
Foreign trade policy/relations	-0.98
Export regulations/restrictions	-0.43
Corruption	-0.32
Political stability	-0.11
Funding, grants and initiatives (STATE)	0.22
Funding, grants and initiatives (FEDERAL)	0.46
TOTAL WEIGHTED AVERAGE	**-0.74**
ECONOMIC	WEIGHTED AVERAGE
Taxation	-0.96
Inflation rates (relative cost of living)	-0.94
Availability of credit	-0.40
Market price fluctuations (final product)	-0.25
Disposable income of consumers	0.17
Exchange rates (with key trade partners)	0.21
Economic growth	0.67
Interest rates	1.10
TOTAL WEIGHTED AVERAGE	**-0.05**
SOCIAL	WEIGHTED AVERAGE
Population (size and growth) of region	-1.13
Attitudes towards work, career, pay and lifestyle (of workforce)	-0.73
Attitudes towards aquaculture (media and public)	-0.71
Urbanisation rates	-0.48
Age distribution of region	0.05
Immigration rates	0.09
Consumer buying habits/demand	0.21
Attitudes towards imported products	0.59
TOTAL WEIGHTED AVERAGE	**-0.26**
TECHNOLOGICAL	WEIGHTED AVERAGE
Existing power/energy technology	-1.54
Existing distribution technology	-0.54
Existing communications technology	-0.26

Emerging technologies (existence and access to)	0.09
Incentive/support for innovation (e.g. R&D tax incentives)	0.40
Existing production technology	0.44
Innovation levels in the industry	0.82
RD&E activity	1.41
TOTAL WEIGHTED AVERAGE	**0.10**
ENVIRONMENTAL	WEIGHTED AVERAGE
Extreme weather events/natural disasters	-1.86
Disease	-1.79
Pressure from NGO's and government agencies	-1.43
Geography (location and accessibility)	-1.14
Climate change	-0.52
Air and water pollution	0.20
Business ethics and sustainability	1.21
Climate (current)	1.34
TOTAL WEIGHTED AVERAGE	**-0.50**
LEGAL	WEIGHTED AVERAGE
Environmental laws/regulations	-1.79
Country of Origin labelling laws/regulations	-0.80
Immigration laws/regulations	-0.64
Labour laws/regulations	-0.52
Waste disposal laws/regulations	-0.47
Intellectual property laws/regulations	-0.37
Health and safety laws/regulations	0.45
Product safety laws/regulations	0.48
TOTAL WEIGHTED AVERAGE	**-0.46**

SWOT Analysis results - Strengths (# votes)

STRENGTHS	Broome	Townsville	Darwin	TOTAL
Strong reputation of Australian produce	13	35	12	**60**
High growth rates due to warm average temperatures	11	26	10	**47**
Large areas of suitable land	4	28	8	**40**
Strong scientific support (availability and quantity)	4	29	5	**38**
Access and availability of marine water	10	18	6	**34**
Large areas of suitable marine coast	7	21	4	**32**
Strong environmental regulation (including biosecurity)	6	12	4	**22**
Proximity to international markets	6	7	6	**19**
Access and availability of fresh water	6	8	2	**16**
Strong domestic and international market prices	3	8	3	**14**
Strong government support (availability and quantity)	3	5	3	**11**
Strong public support for aquaculture	2	4	2	**8**

SWOT analysis results – Weaknesses (# votes)

WEAKNESSES	Broome	Townsville	Darwin	TOTAL
Complex and duplicate regulatory processes	6	27	11	**44**

High power costs	8	32	1	**41**
High transport costs	16	13	10	**39**
High labour costs	8	21	7	**36**
Lack of skilled/experienced labour	5	20	9	**34**
Poor liveability/remoteness of operations	4	16	4	**24**
Lack of breeding programs	2	19	2	**23**
Lack of aquaculture zoned land/waters	1	12	6	**19**
Lack of high quality broodstock	2	13	1	**16**
High cost and lack of ancillary services	5	3	4	**12**
High feed costs	2	4	2	**8**
High insurance costs	N/A	3	5	**8**
Lack of access to capital (real and perceived)	2	4	2	**8**
Lack of established supply chains	2	3	3	**8**
Access and availability of fresh water	0	2	3	**5**
Lack of applied R&D and R&D facilities	3	1	1	**5**
Lack of public support for aquaculture	1	1	1	**3**

SWOT analysis results – Opportunities (# votes)

OPPORTUNITIES	Broome	Townsville	Darwin	TOTAL
Improve clarity and regulation of Country of Origin labelling	11	15	13	**39**
Improve indigenous engagement, employment and commercial opportunities	9	14	11	**34**
Increase production efficiency through automation/other technology	7	18	7	**32**
Increase and improve breeding programs	8	22	2	**32**
Increase and improve hatchery/seedstock supply	3	23	4	**30**
Increase tax and investment incentives	9	11	9	**29**
Improve ability to identify and treat disease	4	16	7	**27**
Introduce alternative energy sources	3	17	2	**22**
Increase production of native species/strains unique to Australia	5	8	7	**20**
Improve access to capital to enable expansion	7	7	5	**19**
Increase land/waters zoned for aquaculture	3	11	4	**18**
Increase diversification (species and services)	N/A	12	5	**17**
Increase production of high value species	N/A	12	5	**17**
Leverage cooperative supply chains within and with other industries	6	3	4	**13**
Increase aquaculture related tourism	4	5	1	**10**
Increase and improve trade relations with Asian markets	2	4	4	**10**

SWOT analysis – Threats (# votes)

THREATS	Broome	Townsville	Darwin	TOTAL
Disease outbreak/introduction of exotic diseases	12	37	16	**65**
Increase in power/fuel costs	6	29	3	**38**
Regulatory processes hindering expansion and/or market development	N/A	27	9	**36**
Competition from international competitors	12	17	5	**34**
Consumers unable to correctly identify Australian produce	8	16	7	**31**

Negative perception of and/or real environmental impact	6	19	4	**29**
Wage competition from alternative industries	8	13	5	**26**
Increase in frequency and intensity of extreme weather events	4	14	8	**26**
Lack of ongoing and applied R&D	8	5	5	**18**
Poor labour retention due to liveability of operations	N/A	14	4	**18**
Increase in insurance costs/lack of insurability	7	5	4	**16**
Loss of social licence to operate	3	5	7	**15**
Pressure for land/waters to be used for alternative purposes	1	3	7	**11**
Competition from domestic competitors	0	5	1	**6**

Porter's 5 Forces results – Broome (Pearls)

Force factors	Weighted average rating (0-5)
Buyer's ability to substitute	3.88
Buyer's information availability	3.88
Number of substitute products available	3.78
Perceived level of product differentiation	3.78
Relative price performance of substitute	3.44
Your company's ability to substitute	3.29
Buyer propensity to substitute	3.11
Price sensitivity	2.88
Quality differences	2.86
Barriers to exit	2.86
Switching costs	2.22
Switching costs	2.00
Number of customers	1.88
Number and size of suppliers	1.71
Uniqueness of each supplier's product	1.71
Size of each customer order	1.63
Differences between competitors	1.63
Economies of scale	1.50
Barriers to entry	1.30
Number of competitors	1.00
Switching costs	1.00
Switching costs	0.90
Industry concentration	0.86
Brand loyalty	0.86
Government policy	0.80
Diversity of competitors	0.71
Industry growth	0.71
Capital requirements	0.70
Cumulative experience	0.70
Brand loyalty	0.60
Access to distribution chains	0.60

Porter's 5 Forces results – Broome (Barramundi)

Force factors	Weighted average rating (0-5)
Number of substitute products available	4.27
Buyer's ability to substitute	4.14
Price sensitivity	3.86
Perceived level of product differentiation	3.64
Buyer's information availability	3.57
Cumulative experience	3.56
Relative price performance of substitute	3.55
Buyer propensity to substitute	3.45
Your company's ability to substitute	3.40

Switching costs	3.14
Number of customers	2.71
Quality differences	2.70
Brand loyalty	2.70
Number and size of suppliers	2.60
Uniqueness of each supplier's product	2.60
Switching costs	2.55
Capital requirements	2.44
Access to distribution chains	2.33
Economies of scale	2.11
Size of each customer order	2.00
Differences between competitors	1.71
Switching costs	1.70
Barriers to entry	1.67
Brand loyalty	1.67
Industry growth	1.40
Government policy	1.33
Industry concentration	1.30
Barriers to exit	1.30
Switching costs	1.22
Diversity of competitors	1.10
Number of competitors	0.70

Porter's 5 Forces results – Townsville (all species)

Force statements	Weighted average rating (-5 to +5)
There are many substitute products available	2.37
Existing producers do not possess patents, trademarks or do not have established brand reputation	2.06
Many substitute products exist	1.97
Substitute products are similar or cheaper in price	1.89
Buyers are price sensitive (demand is elastic)	1.73
The cost of substitution is low (to the consumer)	1.71
Buyers tend to purchase large quantities or control access points to final customer	1.70
Products are not differentiated and can be easily substituted	1.29
There is low brand loyalty	1.27
Existing producers can do little to retaliate against new entrants	1.24
There are few suppliers	1.10
Products are nearly identical	1.03
Industry growth is slow	0.91
There is low brand loyalty	0.88
The cost of switching between competitors is low	0.88
Buyer switching costs are low	0.67
New entrants would have same access to distribution channels as existing producers	0.52
Only few buyers exist in the market	0.33
Suppliers are large	0.17
Suppliers have potential to forward integrate (begin producing same product)	0.14
It is difficult to exit the industry (high exit barriers)	0.09
There are many competitors in the industry	-0.35
Substitute products are of similar or better quality and/or price	-0.42
Cost of switching supplier is high	-0.48
Supplier's product/service is unique	-0.76
Product margins are high	-0.82
Substitute products are of similar or higher quality	-0.94
Buyers have potential to backward integrate (begin producing same product)	-1.12
Competitors are of equal size	-1.71
Government regulation/policy makes it easy to enter the industry	-3.00
A low amount of capital is required to enter the industry	-3.39

Porter's 5 Forces results – Darwin (all species)

Force statements	Weighted average rating (-5 to +5)
Buyers are price sensitive (demand is elastic)	2.93
There are few suppliers	2.46
Many substitute products exist	2.33
Products are not differentiated and can be easily substituted	2.14
There are many substitute products available	2.06
Substitute products are similar or cheaper in price	2.06
Buyer switching costs are low	2.00
The cost of substitution is low (to the consumer)	1.94
Industry growth is slow	1.64
Buyers tend to purchase large quantities or control access points to final customer	1.60
The cost of switching between competitors is low	1.50
Existing producers do not possess patents, trademarks or do not have established brand reputation	1.44
Existing producers can do little to retaliate against new entrants	1.06
Suppliers are large	0.85
There is low brand loyalty	0.69
Products are nearly identical	0.63
There are many competitors in the industry	0.50
It is difficult to exit the industry (high exit barriers)	0.43
Suppliers have potential to forward integrate (begin producing same product)	0.15
New entrants would have same access to distribution channels as existing producers	0.13
Supplier's product/service is unique	-0.08
Cost of switching supplier is high	-0.15
There is low brand loyalty	-0.21
Product margins are high	-0.31
Substitute products are of similar or better quality and/or price	-0.87
Only few buyers exist in the market	-1.47
Government regulation/policy makes it easy to enter the industry	-1.56
A low amount of capital is required to enter the industry	-1.75
Substitute products are of similar or higher quality	-1.82
Buyers have potential to backward integrate (begin producing same product)	-2.20
Competitors are of equal size	-2.21

11.3 APPENDIX C – FREE LISTED SURVEY RESPONSES (CHALLENGES)

Industry level challenges (free listed)

Challenge	Rating (scale 1 – 10)
Research funding	10
Optimised production techniques	9
Technical expertise and training	7
Business management capacity	8
Aquaculture expertise	8
Appropriate recognition of Traditional Owner rights	10
Access to an Indigenous capital fund for Traditional Owner enterprises	10
Peak representative bodies for Traditional Owners - and other institutional support	10
Waste management	10
Industry Categorisation for quality (incl Environmental/animal health standards)	8
Ethical produce - welfare standards	7
Residues and food safety	7
Access to suitably trained labour	10
Water quality	7
Biosecurity risks	10
Veterinarians and laboratories	10
Access to greenfield sites for industry expansion	9
Expansion in current location	9
Water access	8
Marine heatwaves	10
Lack of RAS aquaculture for grow out vs pond and cage- RAS can be totally controlled	4
Lack of highly skilled workers and scientists (and research programs) incorporated into aquaculture businesses	7
Skilled farm managers	8
Access to high quality personnel	8
EPA over-compliance	10
Lack of representation by peak bodies in promoting our products	7
Governmental red tape, inflexibility and Bureaucracy and sometimes sheer stupidity it is like the industry is almost purposely stymied or forced to work with one? two? arms and sometimes even a leg tied behind their back whilst other industries e.g. mining or competitors domestic and or especially importers are not subjected to the same levels of scrutiny or bureaucratic red tape or nonsense so local producers are never on a level playing field as	10
Biosecurity particularly future proofing for external threats i.e. prawn Whitespot/ EMS etc. Big belly, scale drop etc.	10
Lack of governmental and even institutional support and /or cohesion or dissemination of information particularly in QLD in recent years the closure of research stations (NFC, Walkerman etc.) closure of/ reduction in extension services etc. It gives the perception of undervaluing the industry or its potential. So in Short if the government expects Northern Aquaculture to go ahead then it to must at least show that is too sees value or potential in the industry by increasing its on investment and support services to the industry.	10
Discharge limits/restrictions	8
Politics, meaning sometimes having to conduct a project with a low chance of success	8
Social license	3
Access to technology and innovation	6
Seafood safety- heavy metals	5
R&D (Sharing of Information)	7
Recruiting workers with the correct skill set	10
No of suitable of sites	6
Keeping qualified people in remote locations - different to recruitment/availability	8
Applied science (as opposed to research-based science)	6
Land ownership	5
Land / Expansion Costs (Purchase)	10
Reliable broodstock i.e. require improvement of captive broodstock	7
Infrastructure (roads, power supply)	8
Government support and regulation	9

Govt Funding (Grants / Loans / Assistance) - Lack of	10
Options to explore niche markets	5
Access to service industries	7

Species Specific Challenges (free listed)

Species	Challenge	Rating (scale 1 – 10)
Marron sea cucumber	Remoteness	6
	Experience	6
Eel	Closed fishery for eels	10
Black lip and milky oyster	Lack of Oyster hatchery	10
	Supply of oyster seed	10
	Government streamlining of acquiring new oyster leases for the Oyster industry	10
Ornamentals	Access to Information	8
	Propagation	6
	New species research	7
	Live feeds research	7
	Small scale exports	9
Spiny Lobster/slipper lobster	Staff training	10
	Lack of technical skilled staff	10
Barramundi	SKILLED recruitment/availability/competition for limited resources	NR
	Innovation	10
	Biosecurity risks from imports need to be established through appropriate testing and research of transmission pathways	10
	Cohesive and collaborative investment from the industry	10
	Regulation by environmental permits	10
	Differentiating our product from imported product	10
	Disease incursion from poor control of incoming hosts	NR
	Seed stock quality	6
	Inability to differentiate Australian barramundi from imports through naming conventions	8
	Biosecurity	8
	Competing with other bigger producers	9
	Remoteness	10
	Slim margins prohibit value adding to product	8
	Competition form imported seafood/ import regulation	10
Cobia	Innovation	7
	Local knowledge	5
	Experience	6
Grouper	Expertise	10
	Larval rearing	10
	Food chain	9
	Repeated lack of enforcement	10
	Costs of exporting	9
	Access and export hubs	8
Tiger prawn/monodon	Red tape	9
	Experience	7
	Remoteness	10
	Importation of raw prawns into Australia	10
	Improving production systems	8
	Industry training	5
	Closing the lifecycle	10
	Holding staff for long periods of time	7
	Low pay within the industry	8
Redclaw	Red tape	10
	Remoteness	10
	Attracting new entrants	10

	Overcoming industry history	10
	License application requirements	10
	Funding for R&D	10
Pearl Oyster	Aquatic Animal Health and Biosecurity	10
	Access to water	8
	Property rights	10
	Remote farm sites	5
	Power water costs	5
	Skilled workers retention in industry	10
Rock oyster	Infrastructure (access to hatchery)	10
	Knowledge about Culture of tropical rock oysters	7
	Tropical Shellfish Quality Assurance Program	9
	Knowledge about risks related to heavy metals, Bacteria, toxic algae in tropical oysters	9

11.4 APPENDIX D – FREE LISTED SURVEY RESPONSES (EXPANSION AND RD&E INVESTMENT)

Expansion

- Administration and operational management
- Decreasing bureaucracy and having a more common-sense approach, granting greater access of the actual farmers to the research and the researchers to the farms, greater emphasis on meaningful research to more easily and practical results for the industry and better communication between all. Investment into showing and/ or improving the sustainability of primary industry's as a whole ie Aquaculture fisheries, agriculture. Examining the possible expansion of the development area further south to include Wide Bay because of the already significant native fish production in the area as well as the potential of the waters of Hervey Bay for aquaculture including input activities ie. seacages, The examination of improving wild fisheries and increasing tourism thru aquaculture eg. restocking, greater availability of species for consumers.
- providing an economic base for Traditional Owner participation
- Provision of subsidies for transport (improved infrastructure helps but cost of transport will remain a major issue)
- Independent environmental impact assessments
- development of business models for small-scale indigenous operations
- You do not specifically mention proving and maintaining the sustainability of the industry and your Govt Regulatory section does not talk about increased industry awareness and compliance with current and basic regulatory requirements. Get the industry able to demonstrate it knows and meets current requirements and then demonstrate they may not be needed or should be improved.
- Ethical stability and cost
- Expanding biosecurity capacity and resources

RD&E

- Innovation
- Upskilling locals in research and evaluation
- Establishing biosecurity risks from imported products including transmission pathways
- Facilitate Aboriginal business development, industry development and commercialisation in the niche Mud Crab fishery across the Northwest within waters of Kimberley Mud Crab Managed Fishery on the Dampier Peninsular. Assist in creating and building business, economic, governance and marketing capacity.
- General biology of target species to improve performance
- Examine other potential species either new to Aquaculture or new to Aquaculture in Australia, look at current bottlenecks to production, from both a farmers and a researchers prospective. Review Aquaculture best practices and production (levels, species, methods, and techniques) worldwide and compare them to Australian production and practices. Examine possible certifications applicable to Australian Aquaculture and their benefits or otherwise to Australian Aquaculture.
- Workshops, examine weaknesses, knowledge gaps and extension requirements of the North Australian Aquaculture industry and develop training and extension services to suit the requirements.
- Supply of juveniles, hatchery, nursery
- field officers supporting aquaculture projects development
- Species performance and Culture methods for the tropics
- Biosecurity extension

11.5 Appendix E – Free Listed Survey Responses (Future Engagement)

Some of the following open-ended response text was edited and minor changes made to de-identify respondents.

Q. Do you intend to engage in aquaculture in N Australia in the future?
Reasons for saying yes

- If there is funding
- I enjoy this Industry. I believe in its potential growth and its ability to feed people good quality healthy food
- To develop future jobs and training for local indigenous community
- Continue to promote aquaculture development in our region
- Establishing a training facility in XXX
- I love research. I am driven to encourage economic development for the region as well as and specifically to the XXX Community to support employment and to have a local industry that will sustain employment in the community.
- Very embedded in the industry
- I am an Aquaculture Lecturer
- Consulting
- Would like to continue providing business advice and management expertise to various aquaculture projects
- Recently purchase a farm in XXX and would like to start an eel farm
- Our business hopes to further invest with jobs in aquaculture through increasing hatchery activities
- I believe there will be an increasing market demand for aquaculture products in future
- My role in government requires my involvement in aquaculture
- Opportunity and availability of funding
- Yes, because it is an Industry I believe in and see the potential of
- I enjoy teaching students
- All my work is aquaculture research
- Actively engaged in major project
- I am passionate about the Oyster industry
- Interesting and engaging career
- It's a very challenging industry, just makes me happy to work in the industry and I believe in job satisfaction which I do attain in working in this industry
- I plan to involve myself with the industry as an owner manager
- Passionate about the Oyster Industry
- The industry is at an exciting time where it can expand, and I want to be part of this
- I am developing new species for a fickle ornamental fish market
- Committed to it
- In too deep now to be able to get out!
- Love it
- Been in industry for 30plus years too late to go elsewhere
- The fishing stock Group I am with continue to stock barra and sooties.
- I have been in seafood/aquaculture industry for 30 years so hope to continue
- I am passionate about growing the aquaculture industry in Australia
- I'm setting up a new giant clam hatchery this year
- I am passionate about the development of sustainable aquaculture and intend to continue well into my twilight years.
- Interest and experience is here
- I've been engaged in the industry in several jurisdictions, in several continents and Aus is often towards the back when it comes to the things it actually needs to focus on to drive its acceptance.

- More work available than marine biology
- Likely a lifelong career
- It's my career
- Given my position and my passion for success I need to continue with what I currently now best
- 34 years already
- Growing Field
- I am passionate about aquaculture and understand its importance
- I am interested in sustainable aquaculture however I believe that the commercial and business aspect of the industry has the potential to disregard sustainable development

Reasons for being unsure

- Depends upon the future regulations and expansion
- As an organization XXX will continue. It may not be me
- Subject to demand for consultants
- Waiting to secure a lease
- I work for a government department and our involvement is determined by treasury
- I am quiet prepared to invest the money as long as I can grow the species the investors overseas are prepared to pay a premium price for. It is no good growing Hyundi if the customer wants BMW and prepared to pay for it.
- Will depend on job role

Q. If you could do it all over again, would you engage in aquaculture in Northern Australia?

Reasons for saying yes

- Northern Australia has huge potential due to large land area and climate
- The Northern Australian Industry is where I feel some connectivity
- Lots of opportunities
- I love it
- I believe Northern Australia has immense untapped aquaculture potential, but I would not limit my training experience to the north
- I was an industry pioneer when knowledge was scant and often just plain wrong. I believe experience and knowledge is now available to ensure redclaw farming would be a successful and pleasurable experience
- Adds diversity and employment to the local economy
- for economic development reasons
- I have had many opportunities for the taking in this emerging industry
- There is extreme potential in northern Australia for multi species development
- Aboriginal people have the right to be on a par with non-Indigenous peoples relative to economic opportunities
- As well as working in more established areas
- Lots of activities and lots of potential to grow further.
- Opportunities are huge
- Black-Lip Oysters are an amazing oyster and I love living in the tropics
- Good job opportunities are available
- good opportunities
- there is a lot of R&D needed to help northern aquaculture grow and i have skillsets to help here.
- I would like to explore aquaculture in all of Australia, not just the north.
- Probably start at a younger age, started a small fish farm at 40 years of age.

- I have worked in aquaculture throughout Australia and would do it all again
- I feel Northern Australia has huge potential in the aquaculture industry
- The opportunities and potential for sustainable aquaculture, particularly freshwater aquaculture, in Northern Australia are significant.
- Potential for new industries, Potential for aboriginal aquaculture enterprises
- I live here now
- N Australia presents significant premium quality opportunity
- Northern Australia has its own set of challenges
- I enjoy what I do and the north has its challenges which makes it interesting
- Huge potential up here
- It's the only suitable environment for the species

Reasons for being unsure

- I have seen aquaculture of different scales fail and succeed and I believe success depends upon initial capital and a high technical capacity.
- I was an industry pioneer when knowledge was scant and often just plain wrong. I believe experience and knowledge is now available to ensure redclaw farming would be a successful and pleasurable experience
- Adds diversity and employment to the local economy
- for economic development reasons
- I have had many opportunities for the taking in this emerging industry
- There is extreme potential in northern Australia for multi species development
- Maybe not as there are a lot of other industries that are not as demanding or sometimes downright heartbreaking, stressful or mentally taxing or demanding as aquaculture and perhaps more financially rewarding, but I also enjoy the challenges of aquaculture and the satisfaction and rewards that Aquaculture can provide.
- I am grateful of what I have learnt in the industry, but would maybe focus more on teaching marine science and sustainability
- Whilst I do enjoy working in the Industry, I have been involved with Aquaculture since i was 16, My passions in life have now changed.
- Consider other options available
- A career choice is often a result of opportunity rather than a set choice. I consider myself fortunate and have enjoyed aquaculture.
- I enjoy working in the industry, but the lack of job opportunities / locations where I can work are currently limited. The opportunity to switch companies without uprooting family are very limited.
- Excellent industry for job satisfaction, but has limits with location options and developing transferable skills
- Lack of government support, over regulation by environmental regulation has halted the industries development while the rest of the world is expanding in this field
- Lots of challenges and hard work
- Small area at the moment, every year is meant to be the big year of aquaculture.
- GBR restricts site availability + Distance to markets

Reasons for saying yes, but not in NA

- Still in QLD, but just south of the "northern Australia" boundaries. Why can't Fraser Coast be included?
- I live in a small town. I want to live closer to civilization
- The Aquaculture industry is far more progressive and productive in southern states. Genuine opportunities exist in such areas whereas we are continually seeing a flash in the pan effect with

'overhauling' the aquaculture industry in the north and funds being directed into research that is not a priority or not needed

Reasons for saying no

- Not is Australia. Too restrictive and inflexible with species which we can or grow. It shoud be up to the market to dictate.
- Limited opportunities, limited pay, remote locations

11.6 Appendix F – Free Listed Survey Responses (Final Comments)

Some of the following open-ended response text was edited and minor changes made to de-identify respondents.

- I want to learn more and contribute more
- The aquaculture industry in the Burdekin has expanded from tiger prawns to now including cobia and macro and micro algae. With research, the algae industry continues to develop and establish new products.
- Our organisation is a traditional owner group. XXX and business development Aboriginal Corporation. It was established in 200X. A Business Case for aquaculture was developed by the organisation in conjunction with a consultant. However, we intend to continue to work from this as it would be of benefit to the regional, local economy.
- As can be seen from my answer to "where I would spend my 100 credits", in the short to mid-term our major opportunities are hindered by current policy. The industry could double in size with current players with greater ability to differentiate form cheap imports. Industry is investing itself in what it can do - marketing and quality standards - but being able to identify the barramundi name as Australian and/or country of origin labelling in the food sector would be a huge improvement
- Incorporating locally trained staff should be valued by the industry and Government. Aboriginal peoples should be provided additional opportunity to be involved with industry development, particularly where it involves industry on traditional lands and waterbodies.
- Focus on Northern Australia but include others.
- We are trying to obtain a lease and approval from DOLH
- I have studied Aquaculture, grown a number of fish species over the years. Unfortunately, Australia lacks in a diverse range of fresh water fish. We should do more studies into native grunters of Australia and new guinea. As well as the pacific region along with the new guinea basses and some of the Nile perches of Africa. There is also many other species of fish.
- Having worked for many years in this industry both in Australia and overseas I see the great potential of Aquaculture too this country particularly in Northern Australia. If only governments, local, state and federal, but particularly state and federal also saw or believed in this potential and worked on reducing, within reason, the bureaucracy and red tape surrounding it. Which in turn will provide more certainty within the industry and provide greater incentive to potential investors. If they can then further work to reduce major expenses such as Fuel, labour, electricity etc. It will give our home-grown industries a more even footing to compete with external competitors. Then we may finally begin to see its real potential and value to this country.
- I hope this will be a driver for good research and good engagement with the research community
- The ILSC recently had its mandate doubled - to include water in addition to terrestrial estate with no increase in investment (capital). Capital needs to be doubled. Investment needs
- I cannot stress enough how much the Oyster industry needs a Northern Australian Oyster Hatchery
- The huge diversity in aquaculture makes targeted support difficult but there are areas that would benefit the whole industry such as legislating country of origin at point of sale including restaurants, clear support for and defending of aquaculture product as the sustainable way forward, a measured approach to environmental impact that recognises that while aquaculture may be a point source of nutrient discharge, the operation is a highly intensive and efficient user of resources.
- I would like to see public servants attitude change to helping people. There are some very negative people in some departments but also some refreshingly positive people. Remove duplication of red tape from all the departments and between Commonwealth and State/Territory
- I currently have one other R&D project about to commence in NA and have commercially supplied a XXX company with fish juveniles for 9 years. I have also worked in the private aquaculture industry in FNQ and in the Kimberley.

- Australia has all the resources available to be world leaders in aquaculture BUT the added costs of regulation and the inability of the government to allow logical environmental permits has halted the development in Australia.
- Before investing in a project our corporation would like to find out more about opportunities for small-scale aquaculture developments
- Hope I haven't skewed any of your data but as a XXX feed supplier of the highest quality XXX products (imported) there are serious problems with bringing feed into or from transporting feeds into N Australia. Tasmania has a Govt freight subsidy because of remoteness maybe this could be looked at. Also quarantine inspectors in Darwin are thin on the ground which delays consignments. LCL shipments are sporadic. Costs are significantly increased compared to Southern states.
- This should all be about ESD {ecologically sustainable development} not straight development or you risk being perceived as and lumped into all the other primary/ extractive industries, powerful political lobbies pushing on beyond legislation because they can and they operate remotely with no-one to watch or record the perceived legacies. Fact and fiction are very different, but dealing in/presenting your facts has not improved the industries overall image, address the perceptions by actually getting ahead of what's legally required and driving real knowledge and improvement in standards as an industry.
- Domesticated broodstock would solve a lot of our problems with inconsistency
- There are so many unutilised impoundments in the gulf catchment that could be used to increase the catch rates for recreational and professional fishermen cheaply but so much more effectively than current practise.
- It’s important to build biosecurity capacity and capability across all stakeholders in Northern Australia, this area is the frontline of defence for the rest of Australia
- As you can see from my answers, I believe the single biggest obstacle for the expansion of the prawn industry is a domestication project.
- I hope the project team can create awareness for the potential of the species in coastal communities‘ economic development.