

**NORTHERN HEALTH
SERVICE DELIVERY**



**TRADITIONAL
OWNER-LED
DEVELOPMENT**



**AGRICULTURE
& FOOD**



**Northern Australia
aquaculture
situational analysis**

Project A.1.1718119

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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.

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- originality
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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
ADA	Aquaculture Development Area
ADZ	Aquaculture Development Zone
AIMS	The Australian Institute of Marine Science
ALOP	Appropriate Level of Protection – in relation to biosecurity
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)
GVP	Gross Value Product
ILSC	Indigenous Land and Sea Corporation
IRG	Indigenous Reference Group, an advisory committee to the FRDC
JPOMS	Juvenile Pearl Oyster Mortality Syndrome
MT	Metric tonnes
NA	Northern Australia
NAC	National Aquaculture Council
NT	Northern Territory
ONA	Office of Northern Australia
OOD	Oyster Oedema Disease
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
RTO	Registered Training Organisation
SWOT	Strengths, Weaknesses, Opportunities, Threats analysis
TFK	Traditional Fishing Knowledge
UTAS	University of Tasmania
WA	Western Australia
WSSD	White spot syndrome disease
WSSV	White spot syndrome virus

1 EXECUTIVE SUMMARY

The objectives of the Cooperative Research Centre for Developing Northern Australia (CRCNA) Aquaculture Industry Situational Analysis Project (A.1.1718119) (as specified by the CRCNA) were to identify key challenges and opportunities facing the north Australian aquaculture sector, and to explore potential solutions and identify the most strategic research projects for further investment. The scope of the study included infrastructure, policy, investment, environmental, production, knowledge, training and human capital gaps.

The study found that annual GVP (FY17) from northern Australian aquaculture was around \$223 million, predominantly barramundi (33%), prawns (32%), and pearls (non-edible) (31%), with several other species (tropical rock oysters, redclaw and other finfish) making up the remaining 3% of value. Aquaculture in northern Australia is highly diverse, multi-sectoral, fragmented, and dispersed. It has been slow-growing, particularly compared with aquaculture in southern Australia. The overall industry management is comprised of mostly highly-educated middle-aged men, and Aboriginal and Torres Strait Islander people are poorly represented.

Key challenges to aquaculture development in northern Australia identified by producers were regulatory burden and environmental risks (for barramundi), absence of breeding programs and broodstock supply and quality (for prawns), and environmental risks and disease (for pearl oysters). Inhibiting factors for operations have been: geographic, demographic and commercial challenges; lack of coordinated, science-based, aquaculture policy and implementation; and lack of clear and navigable regulatory pathways. Specific barriers identified by industry were: biosecurity risks; lack of development areas; high environmental and regulatory hurdles; harsh weather conditions, particularly variability in the wet season; remoteness; lack of local or regional infrastructure; high and increasing costs for insurance; high costs of key inputs (such as feed, power, labour, parts and services, supply chain components); skills shortage; limited capital availability; inability to access key markets; market competition; and lack of coordinated policy development.

The opportunity for aquaculture industry development in northern Australia is large, with estimates that northern Australia has 500,000 hectares and 700,000 hectares suitable for marine farming in earthen and lined ponds, respectively (Irvin et al, 2018), although no equivalent data exists for marine waters. For freshwater pond culture, suitable areas are up to 50-fold larger. Existing aquaculture producers are investing, as are new investors, to expand barramundi, prawns, and tropical rock oysters mainly focused on domestic market supplies. New prawn, tropical rock lobster, slipper lobster, sea cucumber and redclaw ventures targeting overseas markets are also being developed. A Scenario Analysis revealed that by capturing the opportunities and strengths, and addressing the barriers and weaknesses, the overall aquaculture industry could reasonably expand by 2030 to five times its current production and achieve GVPs of greater than \$1.3 billion per annum, with an additional 1,400 – 2,300 jobs ('Monsoon' scenario).

Seven strategic recommendations are presented by the CRCNA northern Australia Aquaculture Industry Situational Analysis Project to address key challenges to industry development, including: bolster biosecurity; increase availability of skilled staff; market development and access; target RD&E to key industry needs; infrastructure for Aquaculture Development Hubs; build Indigenous aquaculture opportunities; and stronger and adaptive governance. The industry associations and jurisdictions have specific RD&E priorities in place, and the project provides guidance for potential cross-sector and cross-jurisdiction actions for the benefit of aquaculture in northern Australia. Investment in existing key industries (barramundi, prawns and pearls) and in emerging sectors where government and industry support and investment are driving establishment (tropical rock oysters, lobsters, sea cucumbers, redclaw, and other finfish) have high potential to underpin growth.

1.1 STRATEGIC RECOMMENDATIONS

Table 1 provides a summary of strategic recommendations originating from the situational analysis review of related literature and extensive industry feedback provided through the online survey, focus groups, workshops, PESTEL, SWOT, P5F analyses and Scenario Analysis, and videoconference engagement.

Northern Australia Aquaculture Industry – Situational Analysis

Table 1: Summary of strategic recommendations of the Northern Australia Aquaculture Industry Situational Analysis (detail in Table 28)

Key priority actions for sector development	Intended industry impacts
<p>1. <u>Bolster Biosecurity</u></p> <p>The recommendation is to bolster aquaculture biosecurity through:</p> <ul style="list-style-type: none"> • review of policy and meeting the requirements for improved risk assessments and R&D programs to better understand biosecurity risk and management at the border • increased pathogen understanding, documented risks, transmission pathways, and practical surveillance implemented for the aquaculture industry in northern Australia • establishment of the most effective structures to develop high health lines for key production species. 	<ul style="list-style-type: none"> ▪ Protection of ~\$223 million industry from a species sector or regional sector collapse, underpinning expansion to \$1.3 billion GVP by 2030, and protecting between 1,950 and 2,860 jobs ▪ Research to support appropriate science-based policy responses to manage the risk conservatively ▪ Increased productivity per ha of an estimated 10%, of all aquaculture sectors in northern Australia with a value of at least \$100 million p.a. by 2030 ▪ High health lines as a foundation to selective breeding programs ▪ Reduced risk of disease outbreak, with results available in time to give farm managers time to respond to identified pathogens
<p>2. <u>Build skills to meet industry growth needs</u></p> <p>The recommendation is to build skills to meet industry growth needs in the northern Australia aquaculture industry. Meet the gap in skilled personnel to fill at least 1,400 new jobs in aquaculture in northern Australia by 2030. Retain skilled staff in northern Australia.</p>	<ul style="list-style-type: none"> ▪ At least 1,400 additional skilled personnel available for the northern Australia aquaculture industry to enable achievement of projected production of \$1.3 billion GVP by 2030 ▪ Skilled staff who value the aquaculture industry and community in northern Australia ▪ Revised curricula endorsed by industry
<p>3. <u>Market development and access</u></p> <p>The recommendation is to support the northern Australia aquaculture industry in market development and access (domestic and international).</p>	<ul style="list-style-type: none"> ▪ Secure consumer demand for NA aquaculture products ▪ Established and expanded domestic market to match the increased product supply ▪ Established international export market(s) for at least one species ▪ Profitable and growing aquaculture sector, achieving expansion to \$1.3 billion GVP by 2030
<p>4. <u>Match and target RD&E to key industry needs and outcomes</u></p> <p>The recommendation is that RD&E is focussed on industry outcomes, and is aligned with the National Aquaculture Strategy 2017, the FRDC RD&E Plan 2015-20, the FRDC RD&E Plan 2020-25 Plan (when complete), and jurisdiction and industry association plans.</p>	<ul style="list-style-type: none"> ▪ Research aligned to industry needs and delivering value for investment ▪ Limiting bottlenecks to new investment and expansion, to support a 5-fold increase in production by 2030, providing an additional value of \$1.1 billion GVP, 1,400 jobs, and associated economic indirect benefits for regional Australia ▪ Rapid adoption of innovative technologies, estimated at 10% improved productivity
<p>5. <u>Facilitate infrastructure development for key Aquaculture Development Hubs</u></p> <p>The recommendation is to facilitate infrastructure development for key Aquaculture Development Hubs in northern Australia.</p>	<ul style="list-style-type: none"> ▪ Meet industry infrastructure requirements by co-development of sites/hubs for maximum benefit and investment leverage ▪ Improved supply chain logistics (electricity, air/road/sea freight, feeds) ▪ Aquaculture industry engaged in prosperous and diverse regional and Indigenous communities
<p>6. <u>Build the northern Australia aquaculture industry as a means for Indigenous economic development and independence</u></p> <p>The recommendation is to build the northern Australia aquaculture industry as a means for Indigenous economic development and independence.</p>	<ul style="list-style-type: none"> ▪ Successful deadly businesses established, supported to grow and enabled to employ more people ▪ Aboriginal and Torres Strait Islander engaged in and positive about aquaculture in northern Australia
<p>7. <u>Stronger and adaptive governance of the northern Australian aquaculture industry</u></p> <p>The recommendation is that additional planning is required to determine an appropriate mechanism/structure for strengthened governance.</p>	<ul style="list-style-type: none"> ▪ Oversight of expansion of aquaculture in northern Australia to \$1.3 billion GVP by 2030, providing 1,400 jobs, and associated economic and social benefits to regions and communities in NA ▪ Stronger governance of the NAAI and coordination of infrastructure development in NA

2 INTRODUCTION

The Australian Government aspires to double the aquaculture industry from its FY2016-17 GVP of \$1.35 billion to over \$2 billion by 2027 (DAWR, 2017). Currently, around 17% of Australian aquaculture value comes from northern Australia. Aquaculture in northern Australia has the potential to increase primary production, regional employment, industry and infrastructure investment, and gross regional product (GRP).

In response to this opportunity, the Cooperative Research Centre for Developing Northern Australia (CRCNA) has commissioned this ‘situational analysis’ of the northern Australia aquaculture industry (the Project). The goals for the Project are to:

- develop a realistic, inclusive, industry supported Vision to 2030 for development in northern Australia aquaculture
- outline and highlight industry plans to realise the Vision, and
- provide recommendations for the CRCNA and government regarding ongoing support and planning, infrastructure, RD&E and investment needs to support the Vision and industry development.

2.1 SCOPE

This Project, as described in the CRCNA project proposal, identifies key challenges and opportunities facing the northern Australian aquaculture sector, explores potential solutions and identifies the most strategic industry development and research projects for further investment. Issues covered include: infrastructure, policy, investment, environmental, production, knowledge, training and human capital gaps. A key output of the Project is to provide recommendations for future research or alternative solutions to address the challenges and opportunities.

As a tool for addressing the scope, we derived a set of future development ‘scenarios’ for the northern Australian aquaculture industry going forward to 2030 and used these to help develop and frame our recommendations for actions, development plans and RD&E priorities.

2.2 APPROACH & METHODOLOGY

To address the project scope, we developed the following methodological approach:

- Data collection – developing a set of work components designed to gather and create data
- Data analysis – developing an overall analytical approach and framework
- Initial Results presentation & testing with stakeholders
 - developing a draft report, industry vision, industry scenarios and recommendations
 - obtaining feedback from stakeholders (via a videoconference, written and verbal responses) to check, refine and calibrate results and findings, key messages and recommendations
- Final Results presentation of key findings, central messages and recommendations.

2.2.1 Work components - Summary

2.2.1.1 Data collection approach

The overall approach to the project involved the following data collection components (**Figure 2-1**, part A):

- 1) Literature Reviews
 - a. Species and aquaculture systems, Indigenous aquaculture and biosecurity
 - b. Strategic plans and initiatives (historical and contemporary)
 - i. Government (policy, strategy and plans)
 - ii. Industry Associations and sectors (strategy, initiatives and plans)

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2) Stakeholder Input

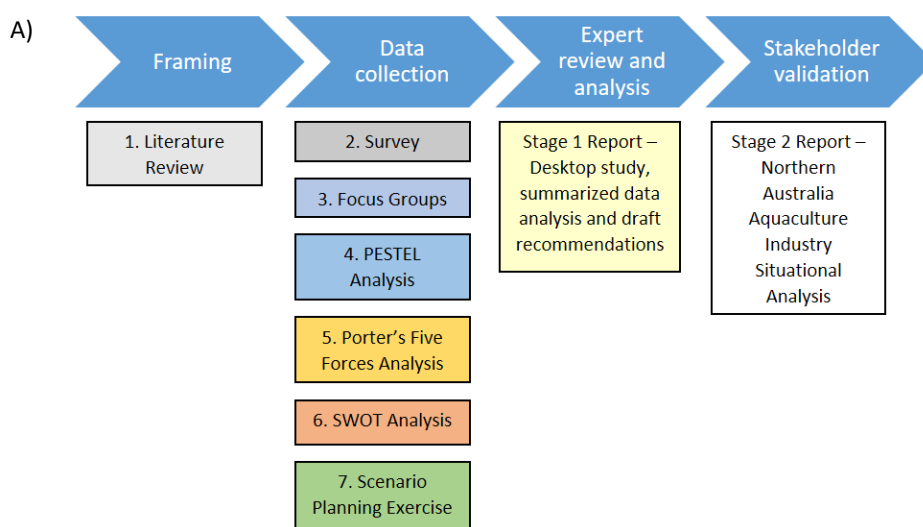
- a. Online Survey (for industry to identify key issues, barriers and needs)
- b. Government data (access key production-related data reported to government)
- c. Face-to-face workshops for stakeholder groups and individuals to provide general and structured feedback, including:
 - i. Presentations (by participants to provide an overview of their industry, business or interest)
 - ii. Focus Groups to augment, cross-reference and calibrate data collected via the Online Survey, and to develop an industry Vision 2030
 - iii. Identification of key external drivers and influences on the current and future development of the industry (utilising a PESTEL analysis framework)
 - iv. Assessment of the overall industry's (and its sectors' and components') current strengths and opportunities and weaknesses and threats (utilising a standard SWOT analysis approach); and
 - v. Identification of the current and emerging issues facing the industry (utilising Porter's Five Forces analysis approach to assess the competitive environment and factors);
 - vi. Seek input/suggestions from industry on:
 1. 'Shots in the arm' – short term initiatives to assist industry, and
 2. a 'Moon shot' – a major strategic initiative to catapult the northern Australian industry in scale, GVP, efficiency and/or sustainability.

2.2.1.2 Data Analysis Approach

We utilised a Scenario Planning approach and tool as the analytical framework for the data collected. From this, different industry scenarios were derived for the northern Australian aquaculture industry's development towards 2030. The scenarios were also used to assess current policy and plans to achieve the scenario goals and to outline requirements for new policy, plans and approaches to achieve the more optimistic scenarios.

The approach was also utilised to encourage decision-makers within the industry to explore stretch targets and to consider possible future scenarios that they would not otherwise solely within their own business or sector, potentially accessing benefits and synergies from broad industry and multi-sectoral development (and potentially with and from other sectors such as agriculture, beef production, fishing and horticulture).

As indicated above, each of the separate data collection exercises were utilised to inform the Scenario Planning process, which is summarised in **Figure 2-1**, part B.



Northern Australia Aquaculture Industry – Situational Analysis

B)

Component	1. Literature Review	2. Survey	3. Focus Groups	4. PESTEL Analysis	5. PSF Analysis	6. SWOT Analysis	7. Scenario Planning	8. Desktop Study Report
Objectives	Document historical (and current) overview of industry – incl. sectors, sub-sectors and components and associated aspects Review of historical and contemporary government and industry policy, strategy and plans	Document (and quantify) current overview of industry and characteristics, activities, and perceptions of a wide range of stakeholders engaged in aquaculture in northern Australia	Build on survey data by elaborating on the challenges, and exploring visions, opportunities, solutions and strategic advantages related to aquaculture development	Assess the macro-environment the industry is operating	Assess the competitive environment the industry operates in	Assess the industry's current and future competitive advantages and weaknesses and approaches to take advantage, overcome or mitigate them	Develop set of scenarios and action plans for the northern Australian aquaculture industry's development towards 2030. - encourage decision-makers within the industry to consider possible future scenarios (that they may not otherwise) - provide roadmap for achieving the overall industry's (and sub-sectors) 2030 goals	See Objectives for Steps 1 - 7
Outputs	Sub-report 1 - Narrative Report	Sub-report 2 - Narrative Report - Data (qualitative) - Data (quantitative)	Sub-report 3 - Narrative report - Data (qualitative)	Sub-report 4	Sub-report 5	Sub-report 6	Scenario Planning Sub-report 7 (incorporates components of 1 - 6)	Summary (and assembly of Sub-reports 1 – 7)
Informs Scenario Planning and Recommendations	Historical background	Contemporary situation	Contemporary situation Plans to overcome challenges	Global macro-forces acting on industry	Competitive forces acting on industry	Capability and strategies to leverage strengths/opportunities and mitigate or overcome weaknesses/threats	Present Scenarios (receive feedback/input on scenarios) Develop plans for scenarios	Industry (sectoral and sub-sector) roadmaps
Strategic outcomes	Minor strategic value	Individual perceptions and industry data (qualitative and quantitative)	Region and sector-specific challenges and solutions; Initiate solution provider engagement; whole-of-industry synergies	Will outline global aquaculture industry situation, drivers and future position and northern Australia's position within those forcefields	Will assess northern Australia industry's competitive profile(s) in global/regional/ local contexts	Will assess northern Australian industry SWOT on global/regional and local contexts	Informs CRCNA (and govt/industry/R&D sectors) on requirements to progress industry; Vision statement alignment with scenarios	Informs a 'whole of industry' Vision, Mission(s) and Plan(s)
Report Content	<i>Recommendations for further (biological) R&D</i> <i>'Scorecard' of past policy, strategy and plan implementation and effectiveness (and recommendations)</i>	<i>Findings (qual and quant)</i> <i>Key industry challenges to be validated and context added through the Focus Groups</i>	<i>Findings (qualitative) Vision 2028 statement; sector challenges and solutions; advantages and opportunities; recommendations to address challenges and capture opportunities</i>	<i>Findings – Industry Factors and Drivers</i>	<i>Findings – Industry Factors and Drivers</i>	<i>Findings – Industry Factors and Drivers Recommendations to capture opportunities</i>	<i>Findings – Three (3) Scenarios</i> <i>Recommendations to support most viable Scenarios</i>	<i>Project Key Findings Industry (viable) Scenarios</i> <i>Project Key Recommendations Further R&D Projects (\$ estim.)</i>

Figure 2-1: Summary of Project Workplan - methodology, data collection and outputs. A) Workplan and relationship of project components, and B) details of each component explaining objectives, outputs, contribution to recommendations and scenario planning, strategic outcomes and report content.

2.2.1.3 *Scenario Analysis approach*

We developed several, scaled industry development scenarios for the northern Australian aquaculture industry to 2030. In developing these scenarios, we assessed: the likelihood of achieving the scenario; the key strengths and opportunities to leverage to achieve the scenarios; key barriers and threats to industry achieving the scenarios; and, the key needs to support industry achieving optimum scenarios. Assessing key needs included: research and development (biological); infrastructure; training and skills needs; capital needs; and economic, fiscal and other support required.

2.2.1.4 *Development of Industry Vision*

A key requirement of the CRCNA's scope for the project was the development of an industry Vision statement.

As part of the Focus Groups, participants developed a series of vision statements. The Project synthesised a set of overall industry and some sub-sectoral Vision statements designed to reflect the industry's views and to support, guide and align to agreed industry scenario(s).

The Vision statement and Scenarios were tested, calibrated and refined following feedback from stakeholders. Stakeholders responded to the Project draft key findings and recommendations document and through participation in a videoconference in Q2 FY 2020.

2.2.1.5 *Final Report*

The final report, based on this Stage 1 report format, will contain:

- Summary of Findings from data collection and analysis regarding industry development and support needs, including additional research and development
- Definition and detail on the agreed industry Scenarios
- The northern Australia aquaculture industry Vision statement, and
- Key recommendations.

Additional detail of results and analyses are contained in the Project's Supplementary Data document and the Literature Review document.

2.3 METHODS

2.3.1 Literature Review (Historical and contemporary information)

To gather the necessary data to form a basis for a scenario planning analysis of the northern Australian aquaculture industry, several literature reviews were undertaken:

- relevant biological R&D on aquaculture species, systems and information relevant to northern Australia
- government (Commonwealth, States and Territory) initiatives relevant to northern Australia aquaculture including: policy; strategies and plans, and other industry support mechanisms); and
- industry association or industry sector-driven initiatives.

The literature review was performed to gain an understanding of:

- the historical perspective of the industry development frameworks in northern Australia
- the industry's current development and policy framework and assessment of:
 - defined goals for future development towards 2030
 - how the industry's value chain is defined and structured
 - where bottlenecks exist, what the prerequisites for achieving these goals are.

Literature review results are summarised in the Supplementary Data document (in Table 4: Summary of literature review (biological and production) of northern Australian aquaculture), and in **Section 3** of this report. The literature review formed part of the study and was conducted in parallel, rather than directly informing, the stakeholder data collection components of the study.

2.3.2 Online Survey of the northern Australian aquaculture industry

Quantitative and qualitative data was collected on the characteristics, activities, and perceptions of a wide range of stakeholders engaged in aquaculture in northern Australia. An online survey instrument using the proprietary online tool *SurveyMonkey™* was administered in May – July 2019. The Survey was undertaken to collect overall industry information from stakeholders, give context to Focus Group discussions, and to inform the scenario planning analysis. A full list of the Survey questions is available from the project team on request.

To gain an overview of the different stakeholders in the industry and to assist in inviting interested people to the participate in the Online Survey, a stakeholder landscape was established incorporating industry associations, producers, government departments and agencies, suppliers, research providers, education providers, NGOs and the wider community. 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.

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.

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.

The results of the Online Survey are presented in **Section 4.1**.

2.3.3 Government production data

The project obtained aquaculture production statistics from publically accessible statistics, select data (anonymised) from state government agencies, and estimates of northern Australia contributions for the prawn and barramundi sectors from industry associations. The data were used to estimate current production (volume and value) and sector direct employment, and for modelling projected growth and employment for the scenario analysis.

All Australian fisheries and aquaculture data is collated and summarised annually by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). ABARES' latest reporting edition, *The Australian fisheries and aquaculture statistics 2017 report* (Australian Government, Department of Agriculture and Water Resources, ABARES, 2018) contains a detailed analysis of fisheries product consumption, production and trade for the period FY 2006-07 to FY 2016-17 and includes data on the volume and value of production from state, territory and Commonwealth commercial fisheries (both wild-catch and aquaculture) for the 2016-17 financial year. It also includes data on the volume and value of Australian fisheries trade, by destination, source and product. Profiles of Commonwealth and state/territory commercial fisheries and state/territory aquaculture for 2015-16 and 2016-17 are provided. In addition, the report includes information on the recreational sector and customary fishing by Indigenous Australians.

Data on aquaculture production (relevant to northern Australia) is also collected as part of licence conditions by the Queensland, Western Australian and the Northern Territory governments. Whilst this data is broadly reported by the three jurisdictions there are inherent difficulties in using the data for meaningful analyses. Whilst separate data for the key species (prawns, barramundi, pearls and 'other species') is available for each of the three jurisdictions, the data cannot be separated for northern Australia sections of Western Australia and Queensland. Furthermore, because of the small size of industry and its sub-sectors, much of the data is summarised and anonymised for privacy reasons making detailed analysis difficult.

However, raw data was obtained from the Western Australia, Queensland and Northern Territory governments on the proviso that the privacy obligations were maintained. In order to maintain privacy, data

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was anonymised by combining multiple jurisdiction datasets, reporting median/means and ranges and the use of semi-quantitative graphics tools to represent comparative data.

2.3.4 Focus Groups

Focus groups were used to provide more detail around the greatest challenges experienced in the aquaculture industry in northern Australia, and enabled further elaboration of the industry Vision 2030, opportunities, solutions and strategic advantages related to aquaculture development. This information was used to augment, cross-reference and calibrate data collected via the Online Survey, and the Government Data collected. The Online Survey was critical to prioritise challenges over a broad group of stakeholders, although could not explore the details of challenges nor potential solutions that were obtained through the intensive small-group and personal data collection in the Focus Groups.

The initial intent was to limit the groups to eight (8) people for each stakeholder group. However, the high number of stakeholders interested in participation and the available project resources, meant that group size was higher in some cases. The selection of participants was based on: (a) relevance and level of expertise, and (b) willingness to participate. Advice was sought from local industry experts on the appropriate participants to invite. An overall database of northern Australian aquaculture industry participants was developed. From this database, several regional and industry sector 'focus' groups were identified including:

- Industry sub-sectoral focus (producers; government (policy/management); suppliers (e.g. feeds, equipment, services); RD&E (e.g. government, universities, VET, private); and the Indigenous sector;
- Geographic focus (northern WA; Northern Territory; Torres Strait and northern Queensland); and
- Species/production focus (prawns; barramundi, pearls, and other species).

Regional government agency representatives advised that we hold a more general aquaculture workshop format, around the Focus Group activities, to optimise the value for attendees by sharing current developments in the sector.

Five focus group meetings were convened at a series of regional locations, from May – July 2019, and attended by industry participants:

- Thursday Island, Torres Strait (20th May 2019) – attended primarily by indigenous groups and individuals with historical or current interests in aquaculture, or were seeking further information regarding potential opportunities in aquaculture;
- Broome (5-6 June 2019)– attended by representatives currently in the pearl, barramundi, and other emerging species (oysters, cherabin) production sectors, government policy and R&D sector and indigenous sector;
- Townsville (3-4 July 2019) – attended by representatives currently in the prawn, barramundi, and other emerging species (oysters, crayfish, clams) production sectors, government (policy and R&D) sectors, university/R&D and indigenous sector;
- Cairns (10 July 2019) – focussed on aquaculture biosecurity in northern Australia; and
- Darwin (23-24 July 2019) – attended by representatives currently in the barramundi, prawn and other emerging species (oysters, crayfish, clams) production sectors, government (policy and R&D) sectors, university/R&D and indigenous sector.

All meetings, except for the biosecurity-focussed group in Cairns, were framed in a broader workshop format with the following structure:

- Industry presentations – specific presentations by companies, organisations or groups regarding their specific aquaculture operations or interests
- Focus Group sectors – validation of challenges and the detail of challenges, development of Vision 2030 for northern Australia aquaculture industry
- Industry drivers and issues (using PESTEL analysis tool) opinion survey
- Industry competitive environment (using Porter's Five Forces tool) opinion survey
- Industry current and future competitive advantages and weaknesses (using SWOT analysis) opinion survey, and
- Scenario planning – developing three industry scenarios for development trajectories to 2030

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Invitations to participants to join the workshops and Focus Groups were circulated through the network of project partners and social media to ensure distribution to experienced stakeholders. Where feasible and relevant, efforts were made to vary the institutional affiliation and demographic (e.g. age, gender) characteristics of the Focus Groups by sending invitations to a diverse stakeholder group. Focus Groups took approximately 2 - 3 hours. They were facilitated by relevant members of the project team, or a professional facilitator for the Indigenous stakeholder groups. Discussions were audio recorded where permission was provided by the participants. A standard response template was used to collect information on the groups' vision for aquaculture development, most significant challenges (including solutions and support required to resolve them), strategic advantages for aquaculture development in northern Australia, and emerging opportunities.

Qualitative data from the focus groups were coded to identify key themes in the responses and presented as descriptive data (summarised in **Section 4.2**, with results detail in the Supplementary Data document). The result of the industry Vision 2030 development is presented in **Section 6.2** (detail in Supplementary Data).

2.3.5 Industry presentations

A series of presentations by companies, organisations or groups regarding their specific operations and interests were delivered at each of the Workshops. Presentation documents have been stored on the Project shared server and are available on request (pending presenter approval).

2.3.6 Overview of the industry drivers and issues framework – PESTEL framework

A PESTEL analysis was performed to develop a view of the business environment of the northern Australian aquaculture industry and factors potentially affecting it in the future. The PESTEL analysis identifies political, economic, social, technological, environmental and legislative conditions that influence an industry.

The overall aim of the PESTEL analysis was to:

- Determine which and to what extent external factors are currently influencing the industry;
- Identify which of these factors may change in the future; and
- Identify ways to encourage changes that result in opportunities for the industry, and to mitigate changes that result in threats to the industry.

At each workshop participants undertook a PESTEL analysis of the industry; providing their views using a live, cloud-based 'voting' system facilitated on a platform developed using the proprietary presentation and analytical tool *Mentimeter™* (Mentimeter, 2019). Participants used smartphones to connect to the presentations where they were able to vote on polls, answer questions and interact with the presenter. Visualising these responses in real time stimulated discussion and allowed the participants to further refine responses. Responses were collected from more than 50 participants.

For each macro-environment (Political, Economic, Social, Technological, Environmental and Legal) the participants rated eight predefined factors on a scale from "strongly hindering" (-5) to "strongly enhancing" (+5) expansion of aquaculture in northern Australia, resulting in a mean score for each macro-environment.

Further information on the PESTEL analysis methodology, including specific analysis structure and questions, along with detailed results are provided in the Supplementary Data document. Summary results are included in **Section 4.3** and the Scenario Analysis in **Section 5.2**.

2.3.7 Overview of the competition environment on and within the industry and its sectors – Porter's Five Forces framework

To obtain a structured overview of the competitive environment that the northern Australian aquaculture industry operates in, a 'Porter's Five Forces' (P5F) (Porter, 2008) analysis of the industry was performed. The P5F analysis assesses the five key competitive forces identified by Porter:

- Rivalry among existing competitors
- Threat of new entrants

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- Threat of substitution
- Buyer bargaining power
- Supplier bargaining power

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.

At each workshop, participants undertook a P5F analysis of the industry (and their particular views from within the industry) using the *Mentimeter*™ cloud-based ‘voting’ tool, as described for the PESTEL data collection. Responses were collected from more than 70 participants.

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.

Details of the specific analysis structure, questions and results of the P5F analyses are presented in the Supplementary Data document. Summary results are included in **Section 4.4** and the Scenario Analysis in **Section 5.3**.

2.3.8 Overview of the industry’s current and future competitive advantages and weaknesses and approaches to take advantage, overcome or mitigate them – SWOT Framework

A SWOT analysis was undertaken, utilising inputs from the workshops to establish a structured overview of the industry’s current and future competitive advantages and weaknesses and to assist in assessing and organising data gathered from the Literature Reviews and the Online Survey.

A SWOT analysis (Friesner, 2011) is a tool designed to specify a company/industry’s objectives and assesses its:

- **Strengths** – How to make the most out of strengths (Positive – Attack)
- **Weaknesses** – How to avoid or mitigate weaknesses (Negative – Defend)
- **Opportunities** – How to increase and capitalize on opportunities (Positive – Attack)
- **Threats** – How to reduce or eliminate threats (Negative – Defend).

Strengths and Weaknesses are classed as ‘internal factors’ as these elements can be (largely) controlled by the organisation/industry. Opportunities and Threats are classed as ‘external factors’ as these elements are (largely) controlled outside the organisation/industry.

SWOT analysis is a widely-used tool for providing new perspectives to a business or industry strategy and strategic decision-making and can be used to assess the health of a business/industry, illuminate factors which can advance the organisation and those requiring improvement to reach the desired result. SWOT can also be utilised to assess the viability of future plans and decisions.

After identification of the applicable and relevant SWOT for an industry, company or particular initiative, the process can also be used to identify strategies to capitalise on opportunities and strengths and overcome weaknesses and threats.

A limitation of both the PESTEL and SWOT analyses is that it is difficult to cover all aspects that may affect an organisation or industry. However, by combining them, it is possible to get a more thorough view of the industry and the environment in which it operates. The two methods are closely connected and many of the factors identified in the PESTEL analysis were utilised as inputs for the Opportunities and Threats section in the SWOT analysis.

At each workshop, participants undertook a SWOT analysis of the industry (and their particular views from within the industry) using *Mentimeter*™. Responses were collected from more than 75 participants.

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For each SWOT quadrant (i.e. strengths, weaknesses, opportunities and threats), the participants were provided with a list of predetermined factors¹ (**Table 2**) and asked to identify the five they regarded as **most** relevant to the northern Australian aquaculture industry.

Details of the specific analysis structure, questions and results of the SWOT analyses are presented in the Supplementary Data document. Summary results are included in **Section 4.5** and the Scenario Analysis in **Section 5.4**.

Table 2: Predefined SWOT factors for assessment of those most relevant to the northern Australia aquaculture industry

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Access and availability of fresh water	Access and availability of fresh water	Improve ability to identify and treat disease	Competition from domestic competitors
Access and availability of marine water	Complex and duplicate regulatory processes	Improve access to capital to enable expansion	Competition from international competitors
Close proximity to international markets	High cost and lack of ancillary services	Improve clarity and regulation of Country of Origin labelling	Consumers unable to correctly identify Australian produce
High growth rates due to warm average temperatures	High feed costs	Improve indigenous engagement, employment and commercial opportunities	Disease outbreak/introduction of exotic diseases
Large areas of suitable land	High insurance costs	Increase and improve breeding programs	Increase in frequency and intensity of extreme weather events
Large areas of suitable marine coast	High labour costs	Increase and improve hatchery/seedstock supply	Increase in insurance costs/lack of insurability
Strong domestic and international market prices	High power costs	Increase and improve trade relations with Asian markets	Increase in power/fuel costs
Strong environmental regulation (including biosecurity)	High transport costs	Increase aquaculture related tourism	Lack of ongoing and applied R&D
Strong government support (availability and quantity)	Lack of access to capital (real and perceived)	Increase diversification (species and services)	Loss of social licence to operate
Strong public support for aquaculture	Lack of applied R&D and R&D facilities	Increase land/waters zoned for aquaculture	Negative perception of and/or real environmental impact
Strong reputation of Australian produce	Lack of aquaculture zoned land/waters	Increase production efficiency through automation/other technology	Poor labour retention due to liveability of operations
Strong scientific support (availability and quantity)	Lack of breeding programs	Increase production of high value species	Pressure for land/waters to be used for alternative purposes
	Lack of established supply chains	Increase production of native species/strains unique to Australia	Regulatory processes hindering expansion and/or market development
	Lack of high quality broodstock	Increase tax and investment incentives	Wage competition from alternative industries
	Lack of public support for aquaculture	Introduce alternative energy sources	
	Lack of skilled/experienced labour	Leverage cooperative supply chains within and with other industries	Competition from domestic competitors
	Poor liveability/remoteness of operations		

2.3.9 Scenario Planning

As a part of the Project, we developed a set of scenarios for the northern Australian aquaculture industry's development towards 2030. Following review of the scenarios, several action plans for the key scenarios were developed to help guide industry decision-makers and to serve as an aid towards achieving the overall industry's (and sub-sectors') 2030 goals.

The scenario planning analysis was based on the following steps, undertaken as discrete but interrelated components of the overall project:

¹ assembled through desktop review and discussion between project team members and industry

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- a literature review of the northern Australian aquaculture industry (and components) summarising its historical development;
- a detailed Online Survey of 117 respondents, which has been analysed to provide a contemporary understanding and picture of the industry in northern Australia
- a review of the key industry sector and components’ strategic goals and plans going into the future (up to 2030);
- an assessment of the prerequisites to achieve the 2030 goals based on the PESTEL, P5F and SWOT analyses.

The Survey provided a significant amount of quantitative, semi-quantitative and qualitative data, which was used to support the selection and definition of the scenarios. Scenarios were explored and tested through the series of workshops, which provided assessments and feedback on issues such as:

- Reality checks – can the industry deliver its purported potential for growth, expansion, increased domestic supply and import replacement and creation of a major export industry?
- Opportunities – broad or niche within the growth scenarios outlined and key advantages which can leveraged for the industry
- Barriers and threats (current and future) – to achieving modest and potentially a ‘boom’ in growth
- Industry support requirements – e.g. government policy, R&D, infrastructure, investment support

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. Details of the method are presented in the Supplementary Data document. Summary results are included in the Scenario Analysis in **Section 5**.

To ensure that the scenarios created in the scenario planning analysis function as an adequate basis for decision-making, the scenarios are subject to a validation analysis based on four criteria. These are:

- 1) Plausibility – meaning that all the scenarios are plausible to occur;
- 2) Consistency – meaning that there is no inconsistency between the drivers in the scenarios;
- 3) Creativity and coherence – meaning that the scenarios are presenting original perspectives and are coherent; and
- 4) Relevance – meaning that the scenarios are to aid decision-making by providing insight to the future relevant to the industry.

The validation analysis will occur through critical assessment of the scenarios. This assessment is underway (in Stage 2 of the Project), following initial feedback on the Project ‘Key Findings and Recommendations’ document and through a videoconference in Q2 FY 2020. Further validation will be undertaken by presenting the scenarios to the industry stakeholders (in this Stage 1 Report) and assessing their feedback.

3 THE NORTHERN AUSTRALIAN AQUACULTURE INDUSTRY – LITERATURE REVIEW

3.1 AQUACULTURE INDUSTRY OVERVIEW

The global fisheries and aquaculture sectors have experienced notable growth over the past 50 years. Global seafood consumption has more than doubled (on a per capita basis) since the early 1960s to approximately 20.5 kg per person in 2017 (ABARES, 2018a). Global production has increased significantly to meet demand, supported by both traditional, wild catch fishing and, increasingly, aquaculture fish farming.

Whilst Australia plays a relatively small role in the global seafood production industry, at 0.15% of global fish and aquaculture volumes in 2016 (ABARES, 2018a), Australia’s production supports growing demand domestically and from Asia. Australia has a reputation within the Asian market as a reliable, high-quality supplier of seafood products.

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Australian seafood² production is comprised of state wild catch fisheries, government fisheries and aquaculture. In 2016-17, the industry produced gross value of over \$3.0 billion in seafood (from almost 94,000 tonnes of produce) (ABARES, 2018b). Of this production, approximately half of Australia's seafood (in terms of volumes) was exported (ABARES, 2018b). Whilst wild capture fishing practices still comprise the majority of the Australian market, in recent years the aquaculture sector has increased its share of this market from 36.4% in 2006-07, to 44.0% in 2016-17.

The northern Australian aquaculture industry (including Queensland, northern areas of Western Australia and the Northern Territory) produced around 11,182 t of product in 2016-17, valued at approximately \$223 M (adapted from ABARES, 2018b), and employed approximately 520 people in 2016 (ABS, 2017a). Barramundi (6,970 t valued at \$74.8 M), prawns (3,980 t valued at \$72.4 M) and pearls (non-edible; \$70.4 M) comprised the majority of northern Australia's aquaculture production. Since 2006-07, northern Australia's aquaculture production has increased at a steady rate of around 3.7% per annum.

3.2 GLOBAL SEAFOOD OUTLOOK

Rising incomes and urbanisation trends on a global scale are anticipated to drive an increase in the proportion of total fish production destined for human consumption over the coming years (FAO, 2019). As a result, global food fish consumption is anticipated to increase by 17.6% on 2016 levels by 2030. Whilst this is considerable growth (approximately 1.2% per annum), it is a slower pace of growth than was recorded over the 2003 to 2016 period (3.0% per annum) largely due to anticipated increases in fish prices, slowing population growth and reduced fish production growth.

The global food fish market is anticipated to experience excess demand over the coming decade. Short term estimates of the food fish market suggest that aquaculture (the main source of production growth for the industry) will only be able to satisfy approximately 40% of the global increase in seafood demand in the early 2020s, suggesting a demand-supply gap of circa 28 million tonnes.

Whilst overall food fish production is predicted to expand by 17.6% by 2030, the aquaculture industry is estimated to increase by 36.7% (from 80 million tonnes to 109 million tonnes) (FAO, 2019). As a result, the proportion of global food fish production achieved by the aquaculture industry is estimated to increase from 46.8% in 2016 to 54.4% in 2030.

3.3 NORTHERN AUSTRALIAN OUTLOOK

The global seafood outlook suggests considerable opportunities for local producers. The Australian aquaculture industry has unveiled plans for a significant expansion in northern Australia over the next decade, in particular for prawn production.

Tassal Group Limited (TGR), an ASX-listed salmon farming company and the largest aquaculture (and fishery) operator and seafood producer in Australia, recently released a major prawn farming/production strategy (TGR, 2019). TGR purchased and is redeveloping a prawn farm in Proserpine, and has plans to develop another major farm near Mackay. Tassal intends to accelerate a circa \$105 M investment in infrastructure, to enable prawn production capacity of approx. 6,000 t p.a. by FY2022. With the expansion of the Mackay farming assets, it is expected to support an overall long-term production target of approximately 20,000 t p.a. This volume is currently four times the current (2018 FY) prawn aquaculture production and is over one-third of Australia's total prawn consumption.

² For the purposes of this assessment, seafood is classified as fisheries and aquaculture products.

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Pacific Bio's (formerly Pacific Reef Fisheries) Guthalungra farm is undergoing final design in 2019 (Pacific Reef, 2014; Whitsunday Times, 2018) and requires investment before construction can commence. Seafarms are proposing the staged development of prawn farms and supporting facilities across the NT and WA as part of Project Sea Dragon producing up to 100,000 t of prawns per annum once fully developed (Truss, 2015).

In addition, Humpty Doo Barramundi farm has plans to reach 10,000 t of production per annum (NT News, 2018) and Barramundi Asia has plans to expand its Kimberley site production from approximately 2,500-3,000 t per annum to 15,000 t (UCN, 2019). Discussions with industry indicate further growth opportunities are being investigated for increasing prawn and barramundi production in northern Australia over the coming decade.

Assuming planned projects for the prawn sector in northern Australia progress, over 100,000 t per annum of production is estimated in coming years. This would result in a 20-fold increase on the existing Australian aquaculture prawn market and a 30-fold expansion of northern Australia's prawn production. This represents a significant expansion of domestic prawn production and would equate to a 1.5% increase in the global wild caught and aquaculture prawn market (FAO, 2017).

Farmed barramundi production in Australia is also anticipated to increase significantly over the coming years, with planned projects anticipated to increase production from approximately 4,100 t in 2016-17 (ABARES, 2018) to 10,000 t in the next two years and 20,000 t per annum by 2025 (ABFA, 2019). Consultation with industry suggests the industry is expected to continue to grow strongly thereafter, with potential to experience a similar growth path as seen for farmed salmon production. The vast majority of barramundi production is located within northern Australia.

Assuming all other forms of aquaculture production grow in line with historical rates, it is estimated total aquaculture production in northern Australia has potential to increase to approximately 56,600 t per annum over the next decade to 2029-30. This assumes that identified major projects proceed as planned and the potential for other developments and growth opportunities are realised by industry.

The significant increase in production will see an equally significant increase in demand for labour in the industry. Consultation with industry highlights that labour requirements can vary from farm to farm, project to project. Data on existing production (11,182 t in 2016-17) and employment (520 in 2016) in northern Australia suggests production ratios of around 22 t per employee in the industry. Consultation with industry indicates higher rates of production per employee, varying between 20 t to 50 t. A review of literature indicates Project Sea Dragon is expected to employ approximately 1,500 staff at full production of 100,000 t per annum (Seafarms, undated), equating to around 67 t per employee. Documentation for other projects such as Proserpine prawn farm (Queensland Government, 2019) and Guthalungra (Pacific Reef, 2014) indicate production rates of approximately 20 t to 30 t per employee are expected. Industry consultation also indicates that around 20% to 50% of labour is typically skilled technical or management related workers that require post-school qualifications.

Based on the above, it is estimated the northern Australian aquaculture industry may need approximately 1,430 to 2,340 additional qualified technical and management staff by 2030, although it should be noted that labour requirements per tonne of production may change over time.

3.4 A REVIEW OF CURRENT AND HISTORICAL AQUACULTURE IN NORTHERN AUSTRALIA

3.4.1 Literature Review

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

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northern Australia, and the state of aquaculture biosecurity in northern Australia. The literature review is available from the Project team upon request. A summary of the aquaculture species considered in the Literature Review and findings, including a summary of RD&E status, is in the Supplementary Data document.

3.4.2 Indigenous Aquaculture – recommended frameworks

Despite decades of research and engagement projects, in recent reviews Fleming (2015) and Colquhoun (2017) could not identify a single successful Indigenous aquaculture venture or business (majority Indigenous board governance, management and investment) in northern Australia. Both studies propose frameworks and a model to support the successful implementation of Indigenous community development of fisheries and aquaculture.

Fleming (2015) described the implementation of an applied framework, closely aligning with the IRG-FRDC principles and aspirations. The study established an approach with nine key elements for success encompassing cultural, business and market factors. The combination of improved frameworks to align cultural and corporate (economic) governance will underpin success (Fleming, 2015; Colquhoun, 2017).

Local capacity in remote Indigenous communities for corporate governance and business management were perceived as key barriers to achieving success in aquaculture ventures and in economic independence more broadly. In terms of developing Indigenous capacity, Fleming (2015) recommended:

- Develop a long term structurally-integrated regionally-based Indigenous fisheries development program – to establish an Indigenous fisheries-based sector across the Territory {which could equally apply across northern Australia}
- Identify business models that integrate both cultural and corporate fisheries business and governance arrangements – while in the interim, pragmatic models continue to be used {concept expanded by Colquhoun, 2017}
- Improve Indigenous participation in fisheries work through further social research into effective engagement strategies
- Develop fisheries agencies' capacity to facilitate Indigenous participation in commercial fisheries
- Develop fisheries agencies' capacity to facilitate fisheries businesses
- Develop industry's capacity to effectively negotiate mutually beneficial commercial arrangements with Indigenous people

Recommendations for developing economically viable ventures made to the IRG and FRDC by Colquhoun (2017), and applicable to other RD&E funding agencies such as the CRCNA, were:

- Implement a plan to identify Indigenous fishery communities across Australia that hold exclusive or non-exclusive rights to, and control of underutilised fishery resources.
- Encourage Indigenous fishery communities, which seek to develop their fishery resources, to establish at least one community corporation registered with the ORIC.
- Encourage each Indigenous fishery community (including local residents and remote Traditional Owners and members) to undertake a formal planning process.
- Encourage community to identify commercial partners, networks and collaborations.
- Empower Indigenous fishery community leaders to attend, contribute to and learn from joint seminars and workshops that include sharing “venture stories”.

Project focus groups and stakeholder input revealed several Indigenous corporations have commissioned consultant reports to assess the options and viability of aquaculture on land and sea country. These include options for low input land-based pond production of established species (e.g. prawns), ornamental fish culture, and CRCNA projects are underway for tropical rock oysters and cherabin.

3.4.3 Aquaculture Biosecurity in Northern Australia –opportunities for strengthening

The review of aquaculture biosecurity in northern Australia revealed key knowledge gaps, provided recommendations, and posed future opportunities for strengthening biosecurity for the northern Australian aquaculture industry. These were:

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- Pre-border testing and the Appropriate Level of Protection (ALOP) standard.

The framework for mitigating biosecurity breaches associated with pathogen-infected products, typically seafood and live-animals operate to the ALOP standard. For Australian aquaculture, the ALOP for exotic pathogens is prevention through a range of offshore measures coupled with ‘at-the-border’ surveillance of imports of raw seafood products. The Australian Government biosecurity measures to maintain ALOP aim to reduce risk to a very low level, but not zero. For imported prawn products, only two viral pathogens, of the many potential exotic pathogens, are routinely tested for in uncooked prawn products by AQIS (White Spot Syndrome Virus- WSSV and Yellow Head Virus 1 – YHV1). For imported raw finfish and mollusc products, while subject to specific restrictions, there is no testing for exotic pathogens of concern to Australian aquaculture producers. Due to the complexity of this issue in relation to international trade, and costs of exhaustive pathogen surveillance, it is unlikely that zero risk could ever be achieved or that all key stakeholders would ever fully-accept any ALOP standard that does not work towards zero risk. Review of the ALOP standard for imported prawns is underway. The 2017 senate inquiry of the biosecurity risks of seafood products made several recommendations to strengthen offshore biosecurity.

- Within-border surveillance

Australia operates a ‘passive’ surveillance system for early detection of pathogens, which is used to meet international reporting requirements and provides the information to demonstrate freedom from specific exotic aquatic diseases. This system is supported by measures to increase recognition of disease and legal requirements to report notifiable diseases of significant mortality events, and a national system to collate information on disease occurrence (AQUAPLAN 2014-2019). This within border pathogen surveillance system aids management of endemic pathogen spread, informs translocation policies, and identifies exotic pathogen breaches. Surveillance programs focused on ballast and biofouling issues of maritime shipping are in place.

For northern aquaculture significant R&D investment is required to understand the occurrence, distribution, and importantly impact of endemic pathogens, so that they can be more effectively excluded or managed by industry to limit detrimental effects on productivity. Pathogen prevalence and loadings in populations vary over time, and long-term surveillance ‘programs’ that operate on an ongoing basis for the known list of endemic pathogens are required to understand pathogen distribution over time. Approaches to pathogen surveillance that are integrated with industry regulatory requirements or operational research projects will be most cost-effective (as for plant agricultural industries).

- Aquatic animal health and biosecurity capabilities

Of critical importance for aquaculture biosecurity are the systems and capabilities for pathogen surveillance, rapid diagnosis, emergency response and recovery response. Such capabilities are vital for at-the-border testing, but there is even greater need in the regions to support the requirements for within border surveillance, industry operational management and emergency response. Increased numbers of professionals qualified in diagnostics and related laboratory health services, but also in ‘on-the-ground’ emergency response, are required. Forming and increasing NATA-accredited diagnostic capacity, coupled with rapid turnaround capacity for endemic pathogens, is widely viewed as critical for developing the northern Australian aquaculture industry. Establishment of a pest and disease diagnosis and challenge facility in northern Australia within a university campus would significantly enhance both general disease diagnostic capabilities, and aquatic animal health educational capacities, for northern Australia. Access to registered veterinary chemicals and treatments following the establishment of an industry disrupting pathogen is particularly poor. For the finfish aquaculture industries, whilst vaccines against bacterial diseases have the potential to be rapidly developed, the absence or inability to roll out emergency vaccines rapidly against viral pathogens poses the most significant threat. Future developments of treatments for tropical aquaculture species, and the supporting systems to enable such treatments to reach the farms following disease episodes, will be critical for the long-term development and expansion of the aquaculture in northern Australia.

- Domestication and breeding of high health lines

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For those industries which currently rely on wild-caught broodstock to supply seedstock for commercial farming, such as the prawn industry, the development of domesticated and selectively bred lines of ‘known’ and ‘high health or Specific Pathogen Free (SPF)’ status would be game changing in terms of mitigating risks from both endemic and exotic pathogens. The development of breeding programs to supply domesticated, high health and genetically elite seedstock for commercial farming has been a longstanding priority for the barramundi and prawn farming industries. Industry investment and governmental supports to foster development of such programs, and encouragement for a ‘whole of industry’ switch to high health stocks, would be invaluable for future development, expansion and protection of northern Australian aquaculture.

- Enterprise-level Biosecurity Planning

Improved biosecurity planning at the individual enterprise level is fundamental to mitigating risk and containing endemic disease issues within the farming operation (AQUAPLAN 2014-2019). Risks of disease can be mitigated by careful operational management, or by industry or enterprise level agreements for using animals only ‘free’ of pathogens of concern. To assist in mitigating biosecurity risks at the enterprise and industry level, and facilitate interjurisdictional translocation and trade, AQUAPLAN 2014-2019 proposed to develop, with involvements of key stakeholders, a model for an enterprise-level health accreditation scheme that meets international standards and is agreed by states and territories.

An aquatic deed is in development, engaging aquatic industries and governments to develop formalised government and industry cost sharing arrangements in respect to aquatic emergency animal disease response (Animal Health Australia, 2019). Previously, concerns raised have prevented development of such an aquatic deed that could both assist in managing and supporting the aquaculture industries in emerging disease incursions (Parliament of Australia, 2017).

- Increasing R&D and resourcing.

Research has a critical role to play for the northern Australia aquaculture industry in increasing knowledge of disease agents and their epidemiology, with a good example in the pearl industry being the call for a taskforce to research the causative agent of Oyster Oedema Disease (OOD). The FRDC Sub-Committee on Aquatic Animal Health has been, and continues to be, the most significant public funder of research underpinning the health and biosecurity concerns of the Australian aquaculture industry, with a broad research scope including understanding disease epidemiology, biosecurity, diagnostic methodologies and new technologies, surveillance, disease mitigation and training (Sub-Committee on Aquatic Animal Health, 2016a). Due to the relatively large number of species that are cultured, the even larger number of pathogens presenting, and the relative infancy of aquaculture as compared to terrestrial livestock industries, the challenge of developing a strong knowledge-base to support industry remains significant.

3.5 AQUACULTURE LICENCES AND PRODUCTION

A summary of total aquaculture licences in Queensland and Northern Territory and Western Australia is presented in **Table 3** below. This highlights a large number of development approvals in Queensland that are not used for active production. In total, there were 105 active producers although the total number of these in the north of Queensland was not differentiated. There were small changes in producer numbers between years, with a decline in prawns, redclaw and freshwater fish, increases in eels and oysters, with no change for barramundi. In the Northern Territory, there are a small number of endorsements and licences, ten in 2016-17, with sea cucumbers and edible rock oysters included in the ‘others’. Numbers for Western Australia were not available.

3.6 AQUACULTURE INDUSTRY STRATEGIC POLICY – HISTORICAL REVIEW

A key task of the project was to review past industry policy, strategy and plans developed and implemented by government, industry and other players and provide commentary (based on documented, publically available evidence, and experienced-stakeholder feedback) on their success and effectiveness.

3.6.1 Government Policy

Governments at all levels – Commonwealth, States/Territory and Local – in the northern Australian jurisdictions have been involved in aquaculture policy development, strategy and planning since the first aquaculture ventures commenced in Australia. Commercial aquaculture first appeared in Australia in the late 1800s with oyster farming in New South Wales.

Table 3: Total aquaculture licences (QLD, NT and WA)

State/Territory	Species	Method	Number (2015-16)	Number (2016-17)
Queensland (all of State)	Prawns	Pond culture	58 development approvals (19 producing)	61 development approvals (16 producing)
	Barramundi	Pond and cage culture (incl. tank culture)	219 development approvals (21 producing)	221 development approvals (21 producing)
	Oyster	Rack and stick culture	84 development approvals (26 producing)	105 development approvals (30 producing)
	Redclaw	Pond culture	156 development approvals (25 producing)	155 development approvals (23 producing)
	Freshwater fish	Pond and tank culture	214 development approvals (16 producing)	215 development approvals (14 producing)
	Eel	Pond and tank culture	53 development approvals (0 producing)	53 development approvals (1 producing)
Northern Territory	Prawns	na	0 endorsements	0 endorsements
	Barramundi	na	1 endorsements	1 endorsements
	Others	na	3 endorsements	5 endorsements
	Pearls	na	4 licence holders	4 licence holders
Western Australia (all of State)	Pearls	Longlines	na	na
	Yabby	Ponds and farm dams	na	na
	Marron	Ponds and farm dams	na	na
	Blue mussel	Longlines	na	na

na = not available

The first commercial aquaculture operations in northern Australia began in the 1950s with the culturing of pearls in *Pinctada maxima*. The industry expanded dramatically during the 1980s and 1990s, largely through the farming of southern bluefin tuna in South Australia and salmonids in Tasmania. These two states currently account for over 70 per cent of Australia’s aquaculture production value.

Whilst much policy, strategy and planning has been based upon temperate aquaculture development, over the last 40 years interest and focus on tropical aquaculture has waxed and waned with political and investment cycles in northern Australia.

This section provides a review of key government documentation for northern Australian aquaculture policy development, strategy and planning.

3.6.1.1 Commonwealth

Over the last 10 years in particular, there has been considerable Commonwealth government focus on the development of aquaculture in northern Australia. Commonwealth aquaculture policy development, strategy and planning relevant to the current industry development scenario horizons to 2030 are summarised in **Table 4**.

The key strategy and policy-driving documents for northern Australia aquaculture (marked above in green) have been:

- the *Scaling Up Report* – Joint Select Committee Inquiry into Opportunities for Expanding Aquaculture in Northern Australia (June 2017);
- the Australian Government’s response to the Scaling Up Report;
- the *National Aquaculture Strategy 2017* – produced by the Department of Agriculture and Water Resources, Canberra, (August 2017) (DAWR, 2017); and

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- CSIRO's *Aquaculture Viability Report (2018)* – produced as part of the CSIRO Northern Australia Water Resource Assessment (NAWRA), part of the National Water Infrastructure Development Fund: Water Resource Assessments (Irvin et al, 2018).

It is also useful to compare these relatively contemporary strategic plans and aspirations with the last 'major' strategic plan for the industry the Aquaculture Action Agenda – Discussion Paper 2001 produced nearly 20 years ago (DAFF, 2001).

Finally, the *Our North, Our Future: White Paper on Developing Northern Australia, 2015* and the two major reviews of northern Australia infrastructure needs provided by *the Northern Australia Audit: Infrastructure for a Developing North Report 2015* and the *Australian Infrastructure Audit 2019* provide valuable insights into the infrastructure challenges and needs relevant to growing aquaculture in the north.

3.6.1.1.1 Aquaculture Action Agenda – Discussion Paper 2001

The Aquaculture Action Agenda 2001 developed a Vision Statement (based on 1999 National Aquaculture Beyond 2000 Workshop) that:

“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.”

A contemporary review of this vision indicates that it has not been achieved and total GVP of Australian aquaculture (2017) was approximately \$1.3 B. Growth of the Tasmanian salmon aquaculture industry in the last 20 years was spectacular and responsible for most of the overall growth in Australian aquaculture during the 2000 – 2010 period. Therefore, the comparative lack of growth in non-salmon aquaculture species (viz. the northern tropical species) has largely resulted in the overall aquaculture industry failing to achieve the aspirational 2010 goals set in 2001.

CSIRO's Aquaculture Viability Report 2018 of Northern Australia (Irvin et al, 2018; reviewed in **Section 3.6.1.1.6**) notes the comparative slow growth of the northern Australian industry compared to the Tasmanian salmon industry. An assessment (comparisons and contrasts) between the southern and northern aquaculture sectors is outlined in the Supplementary Data document. The southern aquaculture industry was largely successful in leveraging its opportunities and managing impediments. By contrast, the northern aquaculture industry has not been anywhere near as successful in its achievements. Some reasons for this – also indicated from our surveys and focus group results – are outlined in discussion of CSIRO's Aquaculture Viability Report.

3.6.1.1.2 Scaling Up Report

In February 2016 the Joint Select Committee on Northern Australia tabled the results of its 14 month *Inquiry into Opportunities for Expanding Aquaculture in Northern Australia*, tabling its findings in a report *Scaling Up* (JSCNA, 2016). The objectives of the inquiry were to 'build on issues previously raised with the Joint Select Committee on Northern Australia and allow for a more in-depth approach to examining an industry which has the potential to significantly contribute to growing the economy of Northern Australia'.

The Committee's report provided 11 recommendations to government for implementation. The Government's response to the report and 11 recommendations is discussed below.

3.6.1.1.3 Government Response to the Scaling Up Report

Following the tabling of the Scaling Up report, in June 2017 the government released its *Response to the Inquiry into Opportunities for Expanding Aquaculture in Northern Australia* (Australian Government, 2017). **Table 5** provides the lists of recommendations made by the JSC for Northern Australia from the Scaling Up Inquiry and report and the Government's Response to the recommendations. In addition, we have provided a 'scorecard' of the progress and completion of the recommendations.

Specific Government Responses and additional comments follow **Table 5**.

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Table 4: List of Commonwealth Government policy, reviews, and inquiries relevant to northern Australia aquaculture (2000 - 2019)

Policy, review, inquiry, plan or program	Relevance
Policy – Department/Minister for Fisheries	
Australian Government, Seafood Origin Working Group Paper, Consumer access to seafood origin information in the food services sector, June 2017	
Australian Government – <i>Response to the Joint Select Committee on Northern Australia report: Scaling Up – Inquiry into Opportunities for Expanding Aquaculture in Northern Australia</i> (Department of the Environment and Energy), June 2017	HIGH
Australian Government – <i>Response to the Productivity Commission report: Inquiry into regulation of the Australian marine fisheries and aquaculture sectors</i> , May 2017	MEDIUM
<i>National Aquaculture Strategy 2017</i> , (Assist Minister for Agriculture and Water Resources, Department of Agriculture and Water Resources)	MEDIUM
<i>National Aquaculture Statement 2014</i> ,	MEDIUM
<i>Aquaculture Action Agenda 2001</i> (DAFF on behalf of the National Aquaculture Development Committee)	HIGH (COMPARISON)
White Papers (Department of Industry, Innovation and Science, Office of Northern Australia)	
<i>2018 Annual Statement on Developing Northern Australia</i> , Minister for Resources and Northern Australia, 16 October 2018	MEDIUM
<i>Our North, Our Future: Developing Northern Australia 2018 Implementation Report</i> , October 2018, Office of Northern Australia	HIGH
<i>Development Statement for Northern Australia</i> , April 2018, Ministerial Forum on Northern Development	MEDIUM
<i>Country of Origin Labelling</i>	
<i>Our North, Our Future: White Paper on Developing Northern Australia</i> , June 2015, Joint Select Committee on Northern Australia, and Northern Australia Advisory Group	MEDIUM
<i>Agricultural Competitiveness – White Paper</i> , July 2015	MEDIUM
Green Paper	
<i>Agricultural Competitiveness – Green Paper</i> , October 2014, Department of Prime Minister and Cabinet	
<i>Agricultural Competitiveness – Issues Paper</i> , February 2014, Department of Prime Minister and Cabinet	
Parliamentary Inquiries	
Joint Select Committee on Northern Australia report: <i>Scaling Up – Inquiry into Opportunities for Expanding Aquaculture in Northern Australia</i> , February 2016	HIGH
House of Representatives Standing Committee, Agriculture Resources Fisheries and Forestry, <i>Inquiry into the Role of Science for Fisheries and Aquaculture</i> , November 2012	
Productivity Commission (Department of Treasury)	
<i>Marine Fisheries and Aquaculture</i> , 2017, Final Report, (Public Inquiry)	MEDIUM
<i>Assessing Environmental Regulatory Arrangements for Aquaculture</i> , February 2004 (Commission research paper)	LOW
Research and Development	
CSIRO	
<i>Northern Australia Water Resource Assessment: National Water Infrastructure Development Fund: Water Resource Assessments</i> , 2018 <ul style="list-style-type: none"> <i>Aquaculture viability (2018)</i> A technical report to the Australian Government from the CSIRO Northern Australia Water Resource Assessment, 2018 	HIGH
CSIRO Food Flagship – Aquaculture Research aims to boost the value, competitiveness and sustainability of the Australian and global aquaculture industry. Focused on farmed finfish, crustaceans and molluscs, CSIRO delivers innovative science impacts in the fields of Applied Breeding, Nutrition, Health and Environment, and Production Systems	MEDIUM
FRDC	
FRDC Research Development and Extension Plan 2020-25 (in preparation)	HIGH
FRDC Research Development and Extension Plan 2015-20 (FRDC, 2015) <ul style="list-style-type: none"> Performance Criteria 6(c) RD&E Planning Priorities <ul style="list-style-type: none"> 6 d) National Priorities and Sub-plans <ul style="list-style-type: none"> National Priority #3: Development of new and emerging aquaculture growth opportunities 	HIGH
FRDC National Fishing and Aquaculture Strategy 2016	MEDIUM
FRDC National Fishing and Aquaculture Strategy 2010	LOW
Cooperative Research Centres (CRCs)	
Seafood CRC (6/8/07 – 30/6/15) <ul style="list-style-type: none"> Aquaculture Innovation Hub – The Aquaculture Innovation Hub was an initiative to coordinate aquaculture research under the Seafood CRC, facilitate improved communication and assist development of new collaborative projects. 	LOW
CRC for Aquaculture (1993 - 2000) <ul style="list-style-type: none"> The Cooperative Research Centre (CRC) for Aquaculture – operated between October 1993 and 2000. The CRC conducted research in areas such as nutrition, feed development, hatchery technology, genetics, fish physiology and disease diagnosis and invested \$31m in R&D. 	MEDIUM
Infrastructure Australia	
<i>An Assessment of Australia's Future Infrastructure Needs: The Australian Infrastructure Audit 2019</i> , June 2019, Infrastructure Australia	
<i>Northern Australia Audit: Infrastructure for a Developing North Report</i> , January 2015	HIGH

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Table 5: Scorecard for implementation of Government Response to the Scaling Up Report recommendations. Score scale 0-5 where 0 is no action and 5 is complete.

Recommendations	Govt response	Score (0 – 5)	Comments
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.	Partly agreed	2	1. Not fully implemented. Taskforce not established. CRC-P project funded for JPOMS (OOD).
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.	Noted only.	0	2. Not done.
3. Department of the Environment and the Great Barrier Reef Marine Park Authority (GBRMMPA) support the Queensland Government in determining the need for and the positioning of special aquaculture development zones.	Noted. Deferred to Qld Govt.	2	3. Cth government response 'supportive of ADAs'. Queensland has implemented ADA's but position of GBRMMPA as yet 'untested' and no 'formal' agreement implemented.
4. GBRMMPA, in accordance with the planned actions outlined in its Regulatory Plan 2014-2015, revoke the Great Barrier Reef Marine Park (Aquaculture) Regulations 2000 (Cwlth).	Agreed	4	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.
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.	Agreed	1	5. Not as yet implemented.
6. Queensland Government conduct a survey of crocodile egg numbers in Northern Queensland to determine the sustainability of crocodile egg harvesting.	Noted		6. Noted by Cth government as allowed under current regulation.
7. Fisheries Research and Development Corporation (FRDC) should consider introducing a 'northern node' as an avenue for providing funding research relevant to northern Australia.	Noted		7. Not as yet implemented. Northern industries are served by Industry Partnership Agreements (IPAs) with FRDC, a Northern Hub for research leads and jurisdictional Research Advisory Committees (RACs). Stakeholder engagement revealed limited understanding of these in northern Australian aquaculture.
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.	Noted	5	8. Cth government funding implemented. Completed.
9. Australian Government provide funding assistance for the establishment of a pest and disease diagnosis facility in Northern Queensland.	Noted	1	9. Cth government pointed to AHL and noted Cth government through FRDC AAH training program provided \$15K to assist with NATA accreditation – otherwise no government assistance has been provided to establish a pest/disease diagnosis facility in north Qld
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.	Noted.	1	10. Not fully implemented. No requirements placed on the foodservice sector. Mandatory country of origin labelling at the food service sector has only been implemented in the NT. Qld LNP opposition has it as a policy commitment (election next year). No progress at the Cth level.
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.	Noted.		11. Cth government defers to adequacy of consumer law protection.

In relation to item 2, Government Response:

'Any decision to fund a dedicated Program to review and expand the science relating to the environmental impact of Aquaculture in areas adjacent to the Great Barrier Reef would require reallocation of existing resources. No aquaculture research is currently being undertaken, nor planned to be undertaken by the National Environmental Science Program Tropical Water Quality Hub. This has not been raised as a priority for the Tropical Water Quality Hub through the previous two calls for research priorities.'

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In relation to item 4, there is also a need for development of Code Assessment guidelines for aquaculture in and adjacent to the GBRMP. However, for issues of discharge from land-based aquaculture adjacent to the GBRMP, the Australian Government has accredited Queensland laws under these regulations, allowing for a single assessment process. The outcome is that no separate assessment is required by GBRMPA if an application complies with the accreditation details.

Regarding item 5, an offsets policy has been drafted but there is no information available on the supporting regulations or any recent updates on progress. The goal of the 1:1.5 ratio is stated to generate a water quality improvement in the receiving environment, which is highly conservative and not based on science. A 'delivery ratio' should be a tool to manage uncertainty where there is no evidence-based circumstance for an offset. However, it can be interpreted from Section 7.3.1 of the policy that it is designed to be a tool to go beyond 'no net decline' and force offsets to exceed the equivalent discharge to improve water quality. The "delivery ratio" also appears to be at the behest of the 'Administering Authority' which places the decision-making power regarding the ratio outside of scrutiny.

In relation to item 9, Government Response:

'Support for a diagnostic facility in northern Australia would be contingent upon the Queensland Government or another organisation being the principal funder and operator of facilities...'

In relation to item 10, Government Response:

'While the new Information Standard introduces clear labels for foods of most importance to consumers, it maintains the overall scope of mandatory country of origin labelling. Cooked or pre-prepared seafood sold by the food services industry continues to be exempt from these requirements. However, businesses can adopt the new labels required for the Information Standard on voluntary basis to highlight the Australian origin of their seafood.'

On 28 November 2016, the then Minister for Industry, Innovation and Science, the Hon Greg Hunt MP, proposed that a working group of stakeholders be formed to consider the issue of country of origin labelling for seafood sold in the food services sector. The working group will be chaired by the Assistant Minister for Industry, Innovation and Science, the Hon Craig Laundry MP, and is expected to report to parliament within 12 months.'

The Australian Government is committed to ensure that consumers continue to have access to sufficient information to make informed choices about the foods they purchase any reforms to country of origin labelling need to strike a balance between providing comprehensive information to consumers and minimises the regulatory burden for businesses particularly small businesses that predominate in the food industry.'

Table 5 indicates that the majority of the commitments within the government's response to the Scaling Up report recommendations have still not been implemented.

As part of this report, we have provided further guidance on implementation priorities and pathways for the key recommendations from the Scaling Up report (**Section 6** Findings and Recommendations).

3.6.1.1.4 National Aquaculture Strategy 2017

In 2017, partly in response to the *Scaling Up Report*, the Commonwealth government released the National Aquaculture Strategy (DAWR, 2017) – an Australia wide guidance document for the period 2017 – 2027 with the objective of:

- outlining 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.

Significantly, the National Aquaculture Strategy sought to outline a pathway to achieve the goal: *"to double the current value of our aquaculture industry to \$2 billion a year by 2027."*

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Other key points presented in the strategy were (1) acknowledgement that achieving an aquaculture growth target of \$2 billion a year by 2027 will require strong collaboration between aquaculture industry participants and Australian, state and territory governments, and (2) detailed actions government and industry need to take to meet this target.

The National Aquaculture Strategy was developed in consultation with industry, state and Northern Territory governments. It identified eight (8) priority areas to encourage new projects and grow existing businesses.

- 1) Promoting an efficient **regulatory framework** modelled on established best practice that is transparent and removes unnecessary burden on business.
- 2) Maximising the benefits of innovation in aquaculture through targeted **research, development and extension**.
- 3) Developing and improving **market access** for Australian aquaculture products domestically and internationally, capitalising on Australia's clean and green image.
- 4) Understanding and managing the **biosecurity** risks through a coordinated approach to protect the aquaculture industry and the Australian environment.
- 5) Improving **public perception** and understanding of Australian aquaculture as a sustainable industry producing safe and healthy products.
- 6) Continuing to improve the **environmental performance** of aquaculture, including identifying opportunities for optimising environmental performance through adoption of cost-effective strategies.
- 7) Encouraging and promoting **investment** in Australian aquaculture.
- 8) Improving **training and education** for the aquaculture workforce and ensuring future employment needs of the industry are met.

For each priority, the strategy identified a desired outcome and presented actions required to realise each outcome. The actions were identified during consultation with stakeholders, including aquaculture operators, suppliers, regulators and environmental non-government organisations. Responsibility for implementing the actions is shared between industry and Australian, state and NT governments and assumes continuous industry engagement.

Where these actions are the responsibility of multiple jurisdictions, their implementation was (and will be) subject to each jurisdiction's relevant policy objectives, priorities and resources. Jurisdictions are not bound by these actions. Some actions may already be underway in some jurisdictions, including actions not assigned specifically to them.

Where industry is listed as an action partner, this may represent the whole industry or a subset of industry. The National Aquaculture Council is the national peak body representing the interests of the Australian aquaculture industry. The NAC will support industry as appropriate to achieve actions under the strategy. Industry will also pursue priorities and actions that sit outside of this national strategy.

Actions are defined as:

- short-term—to be implemented within six months to two years
- medium-term—to be implemented within three to five years
- long-term—to be implemented within five to 10 years.

Some actions are identified as ongoing, meaning they are relevant for the life of the strategy.

Many of these actions are consistent with those found in other strategy documents and will also be implemented under those strategies. Examples include the [Success through innovation: the National Fishing and Aquaculture Research, Development and Extension Strategy](#) (FRDC 2016b), [AQUAPLAN 2014–2019: Australia's National Strategic Plan for Aquatic Animal Health](#) (Department of Agriculture 2019) and individual state and NT aquaculture strategies.

An assessment scorecard of implementation of the National Aquaculture Strategy 2017 actions from the northern Australia industry perspective, based on input from stakeholders, is provided in **Table 6**.

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Table 6: Scorecard for implementation of the National Aquaculture Strategy 2017 actions from northern Australia perspective. Score scale 0-5 where 0 is no action and 5 is complete.

Actions for Priority 1: Regulatory framework

Task	Partners	Time	Score	Relevance to northern Australia aquaculture
Amend the Commonwealth <i>Fisheries Management Act 1991</i> to allow individual jurisdictions to extend their existing aquaculture regulations to cover adjoining Commonwealth waters	Australian Government	Short term	0	Not yet implemented
Where appropriate, individual jurisdictions will investigate potential areas for designated aquaculture zones and establish streamlined approval processes for new aquaculture development in these areas	State and NT governments (in consultation with industry)	Short term	3	WA (offshore) and Qld (onshore) have implemented ADAs with some streamlining of regulation.
Jurisdictions (through the Aquaculture Committee of the Australian Fisheries Management Forum) will continue to discuss an approach to aquaculture regulation with the aim of promoting best regulation and planning practice nationally; may cover issues such as the allocation and length of aquaculture leases	State and NT governments (through the Aquaculture Committee)	Ongoing	2	Committee meets regularly to discuss these issues and progress where possible.
Consider relevant findings and recommendations of Productivity Commission Inquiry into regulation of the Australian marine fisheries and aquaculture, final report (2016) and Australian Government White Paper on Developing Northern Australia (2015), including those relating to recognising interests of Aboriginal and Torres Strait Islander peoples in new developments	Australian Government, state and NT governments	Short term	1	Aboriginal and Torres Strait Islander people recognised in changes to Act. Other recommendations partly implemented. FRDC funded project mapped jurisdictional laws and regulations against international (UN) obligations.

Actions for Priority 2: Research, development and extension

Task	Partners	Time	Score	Relevance to northern Australia aquaculture
Ensure industry participation in setting research priorities and allocating funding through FRDC, in line with existing planning and prioritising mechanisms to achieve right balance of investment across ecological, economic and social priorities	Australian Government, industry	Ongoing	4	FRDC includes industry representation and has Industry Partnership Agreements (IPAs)
Ensure participation of Aboriginal and Torres Strait Islander peoples in setting research priorities and allocating funding through FRDC and its Indigenous Reference Group to deliver improved economic, environmental and social benefits to Aboriginal and Torres Strait Islander peoples via aquaculture RD&E	Australian Government	Ongoing	4	FRDC has an Indigenous Reference Group to lead Indigenous priorities
Where appropriate, ensure greater emphasis on extension, leading to on-farm utilisation in research and development projects	Australian Government, state and NT governments, industry	Ongoing	3	Greater focus on E proposed in 2019-2025 FRDC Strategic Plan; recent FRDC survey on E
Use and support FRDC's New and Emerging Aquaculture Opportunities subprogram, in line with the Australian Government White Paper on Developing Northern Australia (2015) to deliver outcomes for prawn, barramundi and cobia aquaculture in northern Australia	Australian Government, state and NT governments, industry	Ongoing	2	Some FRDC focus on these areas, but also limited. Prawns and barramundi outside scope

Actions for Priority 3: Market access

Task	Partners	Time	Score	Relevance to northern Australia aquaculture
Increase awareness and uptake of government trade promotion and cooperation initiatives to help develop new trading relationships: Austrade's Export Market Development Grants scheme and TradeStart programme, and the Australia–China Agricultural Cooperation Agreement programme	Australian Government, industry	Ongoing	3	Austrade has been visible in NA aquaculture
Develop aquaculture export strategy, including analysis of non-tariff measures that may affect ability of aquaculture industry to achieve its market access objectives	Industry (with support from the Australian Government and state and NT governments)	Ongoing	nd	No evidence of progress. Check with States/NT

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Actions for Priority 4: Biosecurity

Task	Partners	Time	Score	Relevance to northern Australia aquaculture
Review National Policy for the Translocation of Live Aquatic Organisms: issues, principles and guidelines for implementation and facilitate implementation of finalised updated guidelines	All jurisdictions and sectoral committees through the Sub-Committee on Aquatic Animal Health	Short term	nd	QLD policy reviewed 2018; and policies in place for WA and NT; Check with Dept of Agriculture
Continue to improve processes to manage risks associated with importation of ornamental fish and seafood products	Australian Government	Ongoing	nd	Check with Dept of Agriculture and States
Continue to support implementation of AQUAPLAN 2014–2019 , Australia’s third national strategic plan for aquatic animal health	Australian Government, state and NT governments, industry	Short to medium term	3	Status update provided and review of AQUAPLAN 2014-2019 activity underway Dec 2019. Some ongoing and deferred tasks
Support the Sub-Committee on Aquatic Animal Health to improve availability of appropriate veterinary medicines by meeting objective 4, AQUAPLAN 2014–2019	Industry	Short to medium term	4	Four of five activities complete, and guidance documentation ongoing.
Finalise industry–government aquatic animal disease response arrangements under activity 2.1, AQUAPLAN 2014–2019	Australian Government, state and NT governments, industry	Medium term	3	Ongoing – consultation and negotiation re Aquatic Deed
Develop measures (including regulatory measures) to manage risks associated with ballast water and biofouling from vessels entering Australian waters	Australian Government	Short to medium term	nd	Biosecurity Amendment (Ballast Water and Other Measures) Act 2017 (Sept 2017); Check with Dept of Agriculture

Actions for Priority 5: Public perception

Task	Partners	Time	Score	Relevance to northern Australia aquaculture
Engage with the community through programmes, including open days and beach clean-ups	Industry	Ongoing		Northern Territory Seafood Council active in this space.
Engage with Seafood Industry Australia to promote the aquaculture industry to the community and improve its social licence to operate	Industry	Ongoing	1	SIA launched the ‘Pledge’ in Oct 2019. Check with States/NT?
Promote value of the aquaculture industry to regional communities through community engagement officers and other strategies	Industry	Ongoing		FRDC funded projects to value wildcatch and aquaculture in NSW (model state). Check with States/NT?

Actions for Priority 6: Environmental performance

Task	Partners	Time	Score	Relevance to northern Australia aquaculture
Pursue continuous improvement in environmental performance of the industry to reduce all potential impacts, including (as appropriate) through: <ul style="list-style-type: none"> effective and efficient regulation, tailored to the needs of specific sectors effective monitoring and reporting, tailored to the needs of specific sectors. Where necessary, developing industry-specific codes of conduct and best practice guidelines for managing environmental impacts for specific sectors and environments	Aquaculture Committee of the Australian Fisheries Management Forum, industry	Short term		The Aquaculture Committee is a consultative group made up of representatives from each state and territory to consider key issues fundamental to policy, regulation, and governance of aquaculture in Australian waters. It meets twice a year.
Explore the role of non-government environmental certification schemes in promoting and confirming industry best practice and sustainability	Industry	Short term		Check
Work with environmental organisations to identify opportunities for using commercial aquaculture to improve degraded environments	Industry	Ongoing		Check
Work with feed manufacturers to ensure quantity and sources of fish meal and oil in fish feed are sustainable	Industry	Ongoing		Check
Support ongoing innovation by fish feed manufacturers to bring new, high-quality products to market	Australian Government, state and NT governments, industry	Ongoing		Check with feed manufacturers for prawn, barra

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Task	Partners	Time	Score	Relevance to northern Australia aquaculture
Work to reduce nutrient output from aquaculture operations (for example, by improving production technologies)	Australian Government (particularly support from FRDC), industry	Ongoing		R&D for macroalgae in bioremediation.
Explore use of integrated multitrophic aquaculture to deliver economic and environmental benefits	Australian Government, state and NT governments, industry	Ongoing		New CRC for Blue Economy funded, with partners including aquaculture producers in northern Australia.

Actions for Priority 7: Investment

Task	Partners	Time	Score	Relevance to northern Australia aquaculture
Where appropriate, industry to apply for infrastructure funding to support aquaculture, including through the Australian Government White Paper on Developing Northern Australia (2015)	Industry	Short to medium term	2	Humpty Doo received NAIF funding.
Identify business training opportunities to help operators manage their businesses and secure investment	Industry	Ongoing		
Prepare a suite of value propositions for investment opportunities in aquaculture projects—providing commercially framed project information for potential Australian and international investors	Australian Government (in consultation with state and NT governments and industry)	Short to medium term		

Actions for Priority 8: Training and education

Task	Partners	Time	Score	Relevance to northern Australia aquaculture
Review the future workforce requirements of the aquaculture industry to: <ul style="list-style-type: none"> • identify appropriate initiatives across jurisdictions • minimise skill shortages • secure long-term jobs growth (including for Aboriginal and Torres Strait Islander peoples and locally based seasonal workers) 	Australian Government, state and NT governments, industry	Short term	3	See Skills Impact Australia, Aquaculture and Wild Catch Industry Reference Committee, Aquaculture, Fishing Operations and Biosecurity Project
Develop strategic, employment-based education and training programmes to connect and support young people to complete their education and effectively transition to meaningful employment in the industry	Industry (engaging with Australian Industry and Skills Committee, state and NT governments and training providers as appropriate)	Ongoing		See Skills Impact Australia, Aquaculture and Wild Catch Industry Reference Committee, Aquaculture, Fishing Operations and Biosecurity Project
Identify the role of overseas labour for the aquaculture industry and whether overseas worker schemes will be sufficient to meet future seasonal worker demand	Industry	Medium term		Check
Consider developing programs (or promoting existing programs) to promote aquaculture in schools, especially for roll-out in regional areas where the aquaculture industry is or might be a significant employer	State and NT governments, industry	Medium term		FRDC investment in PIEFA (Primary Industries and Education Foundation Australia). Check with States/NT
Industry to increase the number of work experience placements for aquaculture students to help provide realistic expectations of aquaculture workplaces	Industry (with support from state and NT governments as appropriate)	Medium term		No evidence of progress. Check with States/NT
Promote use of study tours and exchange of information and personnel to ensure Australian aquaculture regulators and farmers reflect world's best practice	Industry	Ongoing	3	Nuffield scholarship. Other?

nd = not determined

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3.6.1.1.5 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 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. Specific comments and findings (summarised) are located in the Supplementary Data document.

The report 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 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.

3.6.1.1.6 CSIRO's Aquaculture Viability Report

The *CSIRO Aquaculture Viability Report 2018* assessed the opportunity for tropical marine and freshwater aquaculture in land-based systems in northern Australia (Irvin et al, 2018). The three objectives covered in this report were to:

- Provide a review of current aquaculture production and practice in Australia
- Devise a water and land suitability analysis framework for selected crops, and
- Assess the land suitability outputs that were generated.

CSIRO's key findings were:

- **Vast areas of land which could support potential land-based aquaculture opportunities were identified.** Land areas of more than 500,000 hectares were identified as suitable for marine farming in earthen and 700,000 hectares for lined ponds. Of these areas, 9,500 hectares for earthen ponds and 225,000 hectares for lined pond were identified as Class 1 land (i.e. suitable with negligible limitations) for marine farming. For freshwater farming, vast areas of land were identified as suitable in all three study areas for both earthen (3,000,000 hectares) and lined ponds (13,000,000 hectares). For a sense of comparison in terms of the opportunity presented in northern Australia, the current Australian prawn farming industry utilises approximately 900 hectares.
- **Prawns, barramundi and redclaw were recommended as best candidates for northern Australia aquaculture.** Fundamental aspects of the biology and culture of these three species are well known, 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.
- **There are good opportunities for synergies with other industries in northern Australia.** These include opportunities to use raw agricultural plant products directly as feed sources, or when processed as feed ingredients in formulated pelletised diets for prawns and barramundi (depending on development of a feed mill in northern Australia). In addition, there are opportunities for use of large quantities of agricultural plant materials in 'bio floc' aquaculture systems or as a primary carbon source in 'Novacq™' production.
- However, several key challenges were highlighted, including:

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- **competition from Asian imported products**
- **regulatory barriers**
- **chemical toxicants in soils/water, and**
- **pathogens/diseases.**
- Financial modelling of aquaculture operations undertaken highlighted:
 - **high operating costs** (high variable input costs – power, labour, feed and transport add-on costs),
 - **costs changes** (relatively minor), **operator skill differences and locational effects can have high leverage impact on financial profitability**, and
 - some of these **challenges can be mitigated by increases in scale** which can improve efficiency and lower costs, **but which come with associated financial barriers to entry and risks.**

Overall, the report concluded that:

- there is considerable opportunity for future aquaculture development in northern Australia, and
- 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.

The CSIRO report was limited to a review of land-based aquaculture opportunities. However, northern Australia has a vast area of virtually unused coastline, coastal and offshore waters that likely have considerable areas suitable for aquaculture. It is recommended that the potential for coastal and offshore aquaculture is also further explored to determine areas and culture systems with strong viability for aquaculture.

3.6.1.1.7 Northern Australia Infrastructure

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.

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

- Electricity – availability in ‘remote’ locations and costs, across most of northern Australia. Other key considerations were self-generation opportunities (solar and to a limited extent wind), and 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, a 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

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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 that 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, June 2019* (Infrastructure Australia, 2019). Key issues related to the aquaculture industry include:

- Airports – air freight represents a small proportion of Australia's freight task by mass, at 1.5 million tonnes or 0.1% of freight moved in 2016-17. However, this obscures the critical importance of air freight to Australia as 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; and goods most suited to air freight are those that are time-sensitive, compact, perishable or high value.
- Air freight from northern Australian airports is less than 1% of freight volume.
- 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).

The recent report, contained a specific chapter on Developing regions and northern Australia (Infrastructure Australia, 2019). It focussed on developing regions that have strong growth prospects and where industry composition is changing.

Two overall key opportunity points raised in the report that have relevance to aquaculture were:

- 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 highlighted approaches to development in northern Australia including evidence-based infrastructure development planning and implementation, and learning from past development efforts to provide lessons for the future.

3.6.1.2 **State and Territory Governments**

3.6.1.2.1 Queensland

Aquaculture development and operation 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 2014 and priorities identified in the National Aquaculture Strategy (DAWR, 2017), the Queensland Government embarked on a series of regulatory reforms. A brief summary of key new aquaculture policy and initiatives are included here, with more information in the Supplementary Data document.

Aquaculture Development Areas (ADAs) are a key new aquaculture policy that has been implemented. In January 2019, the Queensland Government announced six land-based marine 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 six ADAs totalled just over 7,000 hectares and included two sites over 2000 hectares, another over 1400 hectares and the remainder ranging between 300 – 500 hectares.

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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).

Constraints to developing the ADAs, include the requirement for 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. In addition, even though the ADAs were selected to maximise their potential for aquaculture development, there may be constraints with development on sections of the land (e.g. 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 ADA identification, areas within catchments leading to marine parks, Fish Habitat Areas and/or conservation zones, were selected against.

Whilst the success of the ADA process cannot be fully ascertained, it has already generated 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.

3.6.1.2.2 Western Australia

A brief summary of key new aquaculture policy and initiatives are included here, with more information in the Supplementary Data document.

In 2015 the Government of Western Australia tabled an *Aquaculture in Western Australia Statement of Commitment*, outlining a five year plan to support industry expansion in the State (DoF, 2015). 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 McGowan government, the 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.

The Aquatic Resources Management Act 2016 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. The objective of this Bill was to streamline commercial and recreational fishing management arrangements, and to introduce clearer provisions for biosecurity and aquaculture.

The Western Australian Government established several offshore aquaculture development zones (ADZs) for marine finfish. Two zones were established (one in the Kimberley, and one in the State's Mid-West south of the northern Australia 'border') 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).

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In northern Australia, the Kimberley Aquaculture Development Zone (KADZ) is located in Cone Bay, about 215 km north-east of Broome. To date, two licences have been granted for the KADZ. One licence was granted to Marine Produce Australia (MPA). 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 KADZ and service industries is situated) and Maxima Opportunity Group. 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 in the southern region of the Abrolhos Islands group (south of the northern Australia 'border'). The 3,000 hectare zone has yellowtail kingfish as the target species for farming by current (Indian Ocean Fresh Australia Pty Ltd) and planned (Huron Aquaculture) development, with the latter licenced for 24,000 tonne.

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' for aquaculture 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 (\$4 M), the barramundi nursery stage for MPA’s Cone Bay operations and Huron’s kingfish hatchery/nursery at Geraldton (\$7 M). 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).

The Western Australian government, through successive governments, has supported a range of aquaculture R&D and semi-commercial developments over the last 15 years. 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).

In September 2019, the DPIRD 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 draft plan sets out an Implementation Plan of actions to overcome barriers and build on industry foundations, strengths and opportunities. DPIRD will be responsible for implementation of this Aquaculture Plan in consultation with the Aquaculture Council of Western Australia (ACWA) and other relevant agencies.

3.6.1.2.3 Northern Territory

The Darwin Aquaculture Centre (DAC) has undertaken a range of research and development projects on pearl oysters, tropical oysters, sea cucumbers, giant clams, prawns, barramundi, bluefin tuna, mud crabs, reef fish, copepods, rotifers, algae, and a number of disease investigations in the 28 years since it was established.

The research programs currently underway at the DAC are guided by a five-year plan covering a range of stakeholders including Indigenous people. Research and development priorities are regularly reviewed with industry, and the Northern Territory Aquaculture Strategic Plan 2011-2015 details the current direction of aquaculture research in the NT. The NT government advised it is currently updating the Aquaculture Strategic Plan.

3.6.2 Industry Associations

Strategic RD&E Plans are in place for the following key aquaculture industry associations with relevance to northern Australia.

- Seafood Industry Australia (SIA)
- National Aquaculture Council (NAC)
- Aquaculture Council of Western Australia (ACWA)
- Aquaculture Association of Queensland (AAQ)
- Northern Territory Seafood Council (NTSC)
- Australian Barramundi Farmers Association (ABFA)
- Australian Prawn Farmers Association (APFA)
- Pearl Producers Association (PPA)

The aspects of the plans relevant to aquaculture in northern Australia are summarised in the Supplementary Data document. Common themes across the plans, which were restated in the project focus group stakeholder engagement, were: biosecurity and health, demonstrated sustainable production systems (including certification and accreditation), market access, product quality, on-farm productivity/efficiency, genetics/selective breeding and juvenile supply, nutrition, science-based regulatory frameworks, social licence (building trust), and structures and resourcing for associations. The specific nature and ranking of the priorities varied among association RD&E plans.

3.6.3 Research Support

The Australian Government primarily supports Research, Development and Extension (RD&E) in aquaculture through the Fisheries Research and Development Corporation (FRDC), Commonwealth Scientific and Industrial Research Organisation (CSIRO), Cooperative Research Centres (CRC), other RDCs, and the Australian Research Council (ARC).

The FRDC leads the development of the national fishing and aquaculture RD&E Strategy and Plan, in partnership with key stakeholders. The current Strategy and Plan are summarised here. FRDC is in the process of delivering FRDC's 2020-25 RD&E Plan, with national stakeholder engagement occurring throughout 2019.

A summary of CSIRO's aquaculture capability is included in the Supplementary Data document.

A selection of publicly available RD&E undertaken by Australian universities and private companies in northern Australian aquaculture is described in the project Literature Review. In general, universities respond to the strategic priorities of government and industry, articulated in the Strategy and Plan and association plans, to direct research effort.

3.6.3.1 National Fishing and Aquaculture Research, Development and Extension (RD&E) Strategy 2016

The National Fishing and Aquaculture Research, Development and Extension (RD&E) Strategy 2016 (hereafter the Strategy) (FRDC, 2016b) sets out a plan for RD&E that supports Australian fishing and aquaculture to 2020. The Strategy forms part of the National Primary Industries Research RD&E Framework, with the purpose to facilitate greater coordination among Commonwealth, State and Territory governments; industry; RDCs; the CSIRO; research organisations and universities to benefit all of Australia.

The national RD&E priority areas identified in this 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.

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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, all with direct relevance to northern Australia, identified in the Strategy were:

- 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.

The strategy also provides guidelines for coordinating RD&E capability, and implementation and governance of the RD&E activities and funding).

3.6.3.2 **FRDC's Research, Development and Extension Plan 2015–20**

Fisheries Research and Development Corporation (FRDC) is a co-funded partnership between its two stakeholders, the Australian Government and the fishing and aquaculture sectors. It was formed as a statutory corporation on 2nd July 1991, under the provisions of the Primary Industries Research and Development Act 1989 (the PIRD Act 1989) and is responsible to the Minister of Agriculture and Water Resources.

FRDC's role is to plan and invest in fisheries RD&E activities in Australia. This includes providing leadership and coordination of the monitoring, evaluating and reporting on RD&E activities, facilitating dissemination, extension and commercialisation. The FRDC achieves this through coordinating government and industry investment, including stakeholders to establish and address RD&E priorities. In addition, the FRDC monitors and evaluates the adoption of RD&E to inform future decisions.

FRDC has a significant responsibility in ensuring, on behalf of the Australian Government, that research is undertaken to assist in the management of the fisheries and aquaculture resource for ongoing sustainability. This means that a significant proportion of funding is directed at research that has a benefit for the three sectors of the fishing industry: commercial (wild catch and aquaculture), recreational and Indigenous and also delivers a public good benefit to the Australian community.

Knowledge for Fishing and Aquaculture into the Future: FRDC's Research, Development and Extension Plan 2015–20 (FRDC, 2015) is focused on maximising impacts by concentrating on knowledge development around three national priorities:

1. Ensuring that Australian fishing and aquaculture products are sustainable and acknowledged to be so.
2. Improving productivity and profitability of fishing and aquaculture.
3. Developing new and emerging aquaculture growth opportunities.

Under priority 3, the FRDC plan states:

Developing new and emerging aquaculture growth opportunities

Finfish aquaculture has been one of the great success stories of the Australian seafood industry over the last two decades. Worldwide it is likely to be aquaculture that supplies the greater proportion of the increased demand for seafood.

Aquaculture has seen steady advancement over the past 30 years, with some sectors (such as Atlantic Salmon) having unprecedented growth over a much shorter period. There is still considerable potential within this sector, especially with the diversification in finfish species. There are a number of aquaculture ventures that could be expanded with RD&E, as has been proven by examples from overseas.

Aim: *By 2020, deliver RD&E sufficient for the significant commercialisation of at least two emerging aquaculture growth opportunities with demonstrated potential for profitable business operations.*

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Strategy: *Identify research constraints to industry growth — such as lack of potential markets, cost of production, survival, deformities and uniformity of growth — and invest in RD&E to determine successful and competitive commercial activity.*

Deliverables:

- A nationally-coordinated strategy for the growth of new aquaculture subsectors.
- RD&E to address barriers to aquaculture development including improved: hatchery production technologies; breeds; feeds and feeding systems; husbandry; health systems; and market access and/or value add.

Target:

Advance two or more emerging aquaculture opportunities/species for which RD&E has identified clear opportunities and technologies for good production and profitability growth.

Delivery of new and emerging aquaculture growth opportunities has been 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).

FRDC have commenced development of their 2020-2025 Research, Development and Extension Plan (RD&E Plan). For more information see: RD&E Plan 2020-2025 Planning page (FRDC, 2019a).

4 RESULTS AND DISCUSSION

This section of the report provides a high-level summary of the findings from the data collection and analysis work components, which informed the Scenario Planning and the project recommendations.

4.1 ONLINE SURVEY TOOL

4.1.1 Overall Sample Characteristics

Notable features of our sample of 117 respondents, were the prevalence of males (61%), 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 of Aboriginal or Torres Strait Islander participants. The latter limitation was improved by a higher level of engagement with Indigenous participants in the Focus Group meetings. The sample was characterised by the largest number of respondents in the producer (n = 34, 29%) and education and research (n = 30, 26%) categories. This provided an important foundation for gathering robust data, particularly from experienced producers responding on behalf of all tropical species sectors, especially barramundi, prawns and pearls. **Table 7** provides a summary of the respondent characteristics and sectors represented.

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**).

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Table 7: The profile of the northern Australia aquaculture industry stakeholders responding to the online survey.

Sub-sector	Sub-sector/industry Profile	Player/Operator profile	Personnel profile
Producers	Diverse – constituted by separate and distinct species-based production sub-sectors: pearling, barramundi & prawn farming, and ‘others’. ‘Others’ – comprised of variety smaller emerging industries such as freshwater crayfish (redclaw), tropical oysters, lobsters, other marine finfish (groper and cobia), freshwater fish (jade perch, silver perch) and some algae production	Comprised of predominantly SME and family-business operators (< 40 employees) undertaking production of a range of species, and utilising a variety of culture systems	Predominantly male (>95%) with the majority mid- to late-age (>71% and less than 29% under age 40), mostly with university degree (58%) or VET (19%) qualifications and more than 10 years’ experience
Suppliers	Primarily specialist feed and equipment providers with some other agri-/technology generalists.	Comprised of a combination of small representative offices of large international suppliers (e.g. feeds and equipment) or SME businesses providing specialist services or products. Reported annual sales ranges of \$50,000 - \$1,200,000.	Predominantly male (70%) with the majority mid- to late-age (>70% and less than 30% under age 40), mostly (56%) without university degrees or VET qualifications, but had the majority (55%) with more than 10 years’ aquaculture industry experience
Education/ Research & training providers	Large and diverse sector. Many of institutions/ entities and people involved in the northern aquaculture industry	Several larger groups (e.g. JCU, CSIRO, and UTAS. Other government groups represented in ‘Government agencies’ (FRDC, State/NT, R&D agencies)	Predominantly male (66%) with the majority under 40 year of age (54%) and with 89% with university graduate or post-graduate qualifications, with more than 10 years’ industry experience and involved in research and/or lecturing
Government agencies	Large sector. Involved in policy, planning, regulation and economic development roles and R&D (included in Education/R&D providers above)	Comprised of WA, Qld and NT government agencies (and some Australian government agencies).	Predominantly male (69%) with the majority over 40 years of age (69%) and with 53% with university graduate or post-graduate qualifications and 38% with more than 10 years’ industry experience
Aboriginal and Torres Strait Islander people	Poorly represented in industry overall.	Primarily represented in the Education/Research & training sector with some participants in Government agencies, and a few in the Producers sector. A few representatives in Production Sector	Predominantly male (with limited data on gender, education and industry experience).

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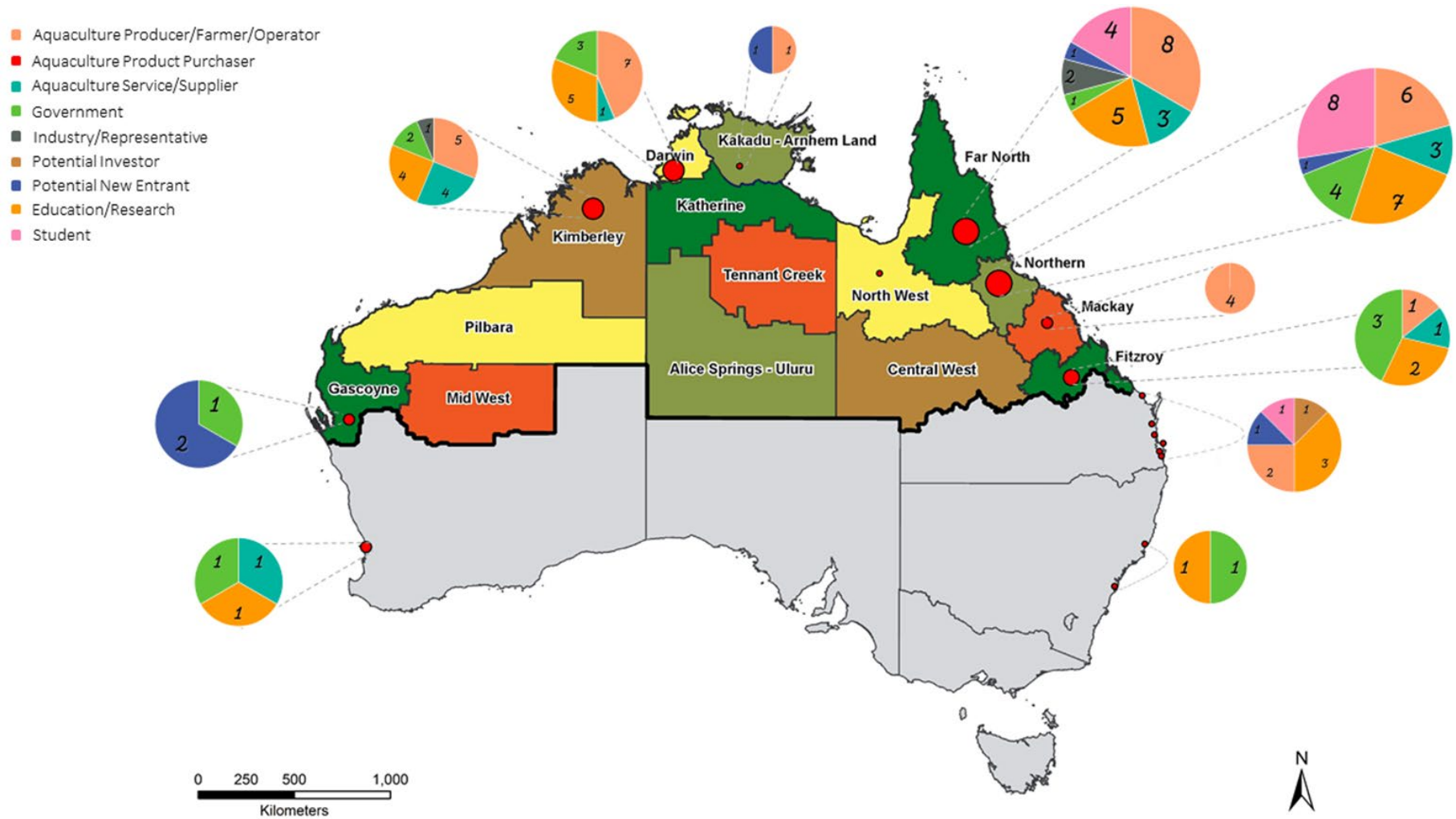


Figure 4-1: Distribution of respondents to the aquaculture stakeholder survey in northern Australian Regions, and throughout Australia

4.1.2 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 8**. Respondents were given the option to rate the challenges from the perspective of the industry as a whole or on a species level. Open-ended responses, inviting additional challenges, are located in the Supplementary Data document. Note challenge names have been abbreviated in the figures.

Table 8: 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.)

Overall, the most highly rated industry-level challenges were power (cost/reliability), liveability, and environmental risks. For producers, the most highly rated challenges were absence of breeding programs, broodstock (quality/supply), and labour recruitment. Perceived challenges were also variable at the species-specific level (**Figure 4-2**). 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. Fewer challenges overall were also perceived for barramundi compared with other species.

4.1.3 Goals for Investment in Expansion and RD&E

Respondents were presented with a series of categories representing aspects of support for the expansion (**Table 9**) and themes of RD&E (**Table 10**) 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).

Table 9: 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.

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Challenges

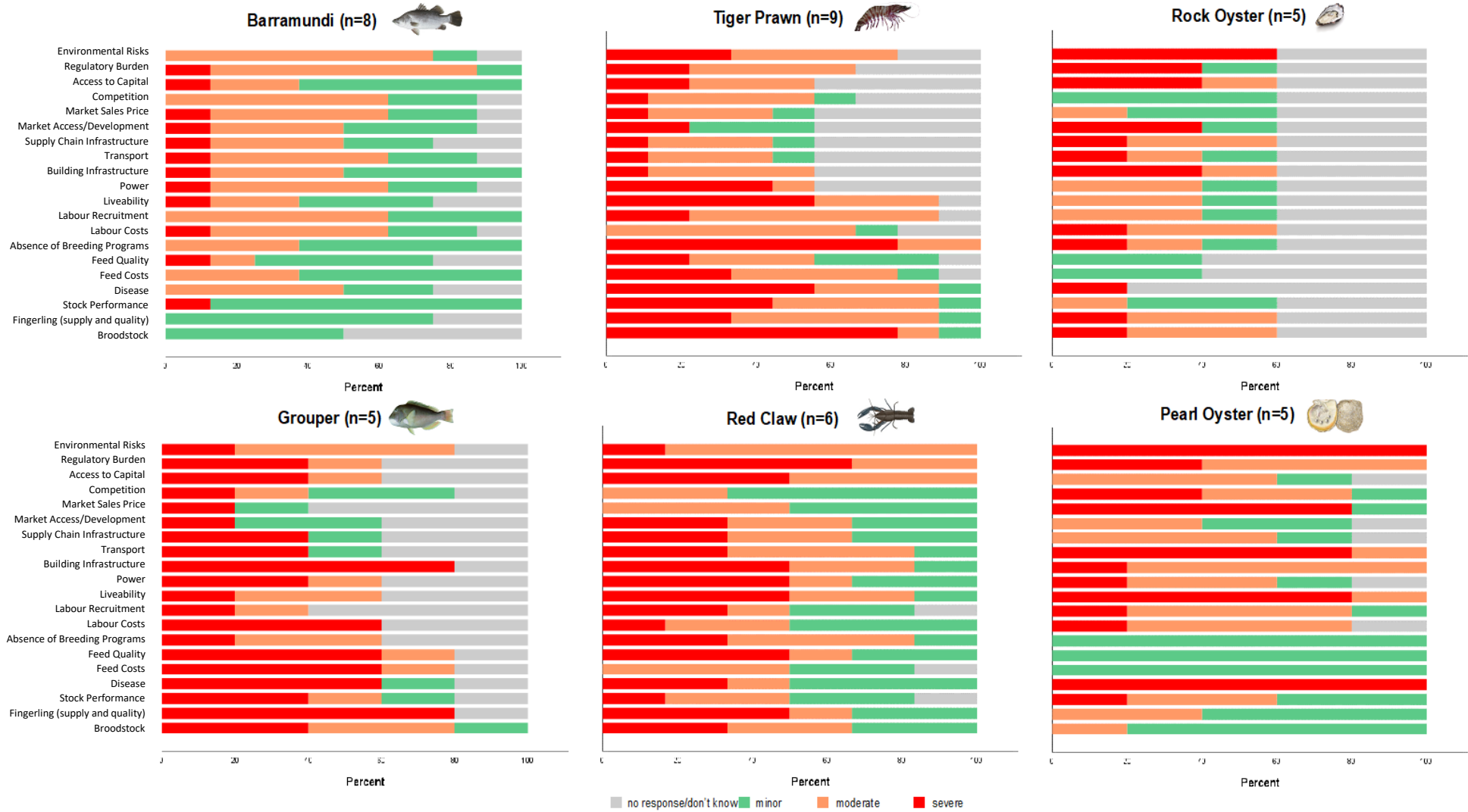


Figure 4-2: Perceived challenges separated according to species, with order of challenges the same for each figure part for comparison

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Table 10: 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 11 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 11: 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 12 shows the percent of credits allocated to each category of RD&E across all respondent categories. Breeding and genetics, and disease management received the highest allocation of credits overall, which also aligned with the priorities of the producers, which is potentially useful to inform RD&E resource allocation.

Table 12: Sum and percent credits allocated to RD&E to support the aquaculture industry in northern Australia

Categories	Total Sum	%
(a) All respondent categories		
Breeding 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

4.2 FOCUS GROUPS

4.2.1 Context of Focus Groups

Our project held 12 focus group discussions in five regional areas of northern Australia (**Table 13**). 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. 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).

Table 13: 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 and service providers [*]	7	4
Total Participants				98	
Participant Gender					
Male	n			77	
Female	n			21	

[#] government, research and education

[^] barramundi, grouper

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

4.2.2 Summary of the Focus Group Findings

4.2.2.1 Torres Strait

When asked about aspirations for aquaculture, there were mixed perceptions from this group of 14 Torres Strait Islander fishers, 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.

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 (sea cucumbers); crayfish (tropical spiny lobsters); and pearl oysters. They also noted the importance of protecting the environment, including protection of the genetic resources.

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4.2.2.2 *Northern Western Australia - Broome*

In the Indigenous Focus Group, 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. The group's vision included Aboriginal people as drivers, embracing cultural protocols, and positive employment and economic outcomes.

The aquaculture Producers Focus Group, prioritised and considered six key challenges, regulatory burden, productivity, product differentiation, logistics/transport and supply chain and biosecurity. 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 could 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.

The aquaculture Service Providers group discussed the top three challenges identified by producer respondents to the online survey: lack of labour; high cost and unreliability of power; and regulatory burden.

4.2.2.3 *Northern Queensland – Townsville*

The Indigenous Focus Group 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.

The Prawn Focus 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, aligning strongly with the APFA strategic plan and the online survey responses. 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.

The key issues identified by the barramundi and grouper sector (White-Fleshed Fish Focus Group) 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.

The Other Producers group highlighted four key challenges: regulatory burden; broodstock quality and supply; power costs; and labour recruitment and availability. 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.

4.2.2.4 *Northern Australia – Biosecurity*

The Biosecurity group defined the major challenges they thought the north faced in regards to biosecurity. 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. The solutions and opportunities for innovation suggested by the group have informed the project recommendations.

4.2.2.5 Northern Territory – Darwin

The Indigenous Focus Group noted 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 need for mentoring Indigenous businesses in aquaculture, the lack of flexibility and communication across government departments, and the advantage of the proximity of the Northern Territory to potential Asian markets were all discussed. Key challenges were: safety of oysters for sale; lack of supply-chain understanding; lack of expertise; and legal and regulatory restrictions. Marketing and Indigenous branding were viewed as a strategic advantage. The success of market access and brand recognition contribute to self-determination, pride and empowerment of individuals, businesses and communities.

Based on discussion by the whole workshop group, three key challenges were selected: lack of skilled staff (technical skills); biosecurity; and food safety. The opportunity for cooperation and collaboration in Aquaculture was also emphasised.

4.2.3 Comparison of challenges among focus groups

The common challenge themes identified by the Indigenous Focus Groups were: **lack of local knowledge and support for aquaculture operations and technical skills development; lack of pathways for leadership development; need for business management training; and the desire to engage in the supply chain.**

For the producer focus groups, ten different challenge themes arose across the industry sectors and regions. The common priority challenge themes arising from the Producer focus groups were: **regulatory burden; access to quality broodstock; biosecurity and disease; and product (market) differentiation.**

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

4.3 PESTEL ANALYSIS

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

4.3.1 Political factors

The political macro-environment refers to how and to what degree a government intervenes in the economy. Of the factors assessed, political bureaucracy was identified as most hindering expansion, while federal funding, grants and initiatives are providing the most industry enhancement.

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

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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, the attendees 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.

4.3.2 Economic factors

The economic macro-environment relates to the state of the economy (local, regional, national or global). Taxation and inflation rates were perceived as 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.

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.

4.3.3 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. The population size and growth rate of northern Australia was perceived as the factor most hindering expansion of the industry, while consumer attitudes towards imported products are having the greatest enhancing influence.

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 of 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.

4.3.4 Technological factors

The technological macro-environment relates to the existence, availability, development and adoption of technology in the industry and region. Most technological factors assessed were perceived to be enhancing the aquaculture industry in northern Australia, particularly research, development and extension (RD&E) activities. However, existing power/energy technology was deemed to be significantly hindering industry expansion.

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.

4.3.5 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. Extreme weather events/natural disasters (including flooding, cyclones and heatwaves) was deemed the factor most hindering expansion of the industry.

Disease outbreak was also perceived 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 considered 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.

4.3.6 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. Nearly all legal factors assessed were deemed to be hindering expansion, with environmental and Country of Origin laws and regulations the most significant hindrance.

The perceived failure of Australia’s Country of Origin labelling requirements was discussed at length in all workshops, with particular vehemence 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 **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.

4.3.7 Conclusions - PESTEL

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 macro-environment was regarded as the most hindering to industry expansion.

4.4 COMPETITIVE FORCES ANALYSIS (PORTER'S FIVE FORCES)

4.4.1 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. The threat of substitution was deemed the greatest competitive force in the northern Australian aquaculture industry.

4.4.1.1 *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.

Competitive rivalry within the northern Australian aquaculture industry was perceived as relatively low ($\mu = 0.36$). The characteristics contributing most to competitive rivalry in the industry are the lack of differentiation between competitors' products ($\mu = 1.54$) resulting in ease of substitutability, and slow rate of growth ($\mu = 1.13$) causing existing industry members to compete for market share and profits.

4.4.1.2 *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.

Threat of new entrants to the northern Australian aquaculture industry was perceived as relatively low ($\mu = -0.08$), 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 ($\mu = 1.86$), low brand loyalty ($\mu = 1.08$) and indistinguishable nature of products ($\mu = 0.90$).

4.4.1.3 *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

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sources such as chicken, pork or lamb, other domestic aquaculture produce (alternative species) and international aquaculture produce (alternative species)³.

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 if it offers an attractive price-performance trade-off relative to the industry's product or if the buyer's switching costs are low.

The threat of substitution to the northern Australian aquaculture industry was perceived as relatively high ($\mu = 1.19$). This substitutability is largely driven by the number of substitute products available ($\mu = 2.27$), relatively cheap price of substitutes ($\mu = 1.94$) and low cost of substitution ($\mu = 1.79$). The high quality of aquaculture products in northern Australia relative to substitute products, slightly reduces the overall threat of substitution.

4.4.1.4 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.

Buyer power in the northern Australian aquaculture industry was perceived as relatively high ($\mu = 0.67$). This power is driven by the fact that buyers are price sensitive ($\mu = 2.10$) and many substitute products exist ($\mu = 2.08$) for which switching costs are low ($\mu = 1.08$). Furthermore, buyers tend to purchase large quantities (representing a high proportion of total sales) and can control access points to the final customer ($\mu = 1.67$). The inability for buyers to backward integrate slightly reduces overall buyer power.

4.4.1.5 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.

Supplier power in the northern Australian aquaculture industry was perceived as relatively low ($\mu = 0.22$), driven by the high number of suppliers ($\mu = 1.52$) with products and services that are not particularly unique ($\mu = -0.55$).

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.

4.4.2 Competitive forces species-specific analysis

In the Broome workshop, separate P5F exercises were undertaken for the pearling and barramundi industries.

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 considered the lowest competitive force in the pearling industry largely due to the established distribution chains of existing players,

³ 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.

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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 a barramundi producing company 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.

4.4.3 Conclusions – P5F

Of the top 5 characteristics contributing to the competitive environment of the aquaculture industry (all species), the 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. This finding supports the project recommendation to enhance market development and access, as well as address issues of CoOL. 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.

4.5 SWOT ANALYSIS

4.5.1 SWOT Results

Collating results from the Broome, Townsville and Darwin workshops, **Figure 4-3** illustrates the top strengths, weaknesses, opportunities and threats for the northern Australian aquaculture industry.

<p style="text-align: center;">STRENGTHS</p> <ol style="list-style-type: none">1. Strong reputation of Australian product2. High growth rates due to warm average temperatures3. Large areas of suitable land4. Strong scientific support5. Access and availability of marine water	<p style="text-align: center;">WEAKNESSES</p> <ol style="list-style-type: none">1. Complex and duplicate regulatory processes2. High power costs3. High transport costs4. High labour costs5. Lack of skilled/experienced labour
<p style="text-align: center;">OPPORTUNITIES</p> <ol style="list-style-type: none">1. Improve clarity and regulation of Country of Origin labelling2. Improve indigenous engagement, employment and commercial opportunities3. Increase and improve breeding programs4. Increase production efficiency through automation/other technology changes5. Increase and improve hatchery/seedstock supply	<p style="text-align: center;">THREATS</p> <ol style="list-style-type: none">1. Disease outbreak/introduction of exotic diseases2. Increase in power/fuel costs3. Regulatory processes hindering expansion and/or market development4. Competition from international competitors5. Consumers unable to correctly identify Australian produce

Figure 4-3: SWOT Analysis Results

Refer to the Supplementary Data document for detailed analysis of results from each SWOT quadrant, explaining differences among focus groups and species sectors.

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Having identified the top five opportunities in the previous voting exercise, the participants were then asked to provide key actions that could be taken to enable these opportunities to be realised.

4.5.2 Actions to realise opportunities

Collating results from the Broome, Townsville and Darwin workshops, the top 5 opportunities identified for the northern Australian aquaculture industry are:






- 1) Improve clarity and regulation of Country of Origin Labelling (CoOL)
- 2) Improve indigenous engagement, employment and commercial opportunities
- 3) Increase and improve breeding programs
- 4) Increase production efficiency through automation and other technology changes
- 5) Increase and improve hatchery/seedstock supply

However, due to the similarity in actions required to achieve opportunities (3) and (5), a combined analysis of the two was undertaken. As such, the next most prevalent opportunity identified and assessed was:

- 6) Increase tax and investment incentives.

Table 14 through **Table 18** below outline the key responses from the action identification exercise and workshop discussion for the above opportunities.

Table 14: Actions identified by stakeholders, and proposed responsible groups, to improve clarity and regulation of Country of Origin Labelling (CoOL)

 Government	 Producers/Industry	 Research and Education	 Indigenous groups	 Other
Legislation approved for CoO labelling at all points of sale (wholesale, retail, restaurant)	Utilise new food trust blockchain technology to improve traceability of Australian produce	Establish origin testing methods to validate product at point of sale	Use local indigenous names for aquaculture products and branding (e.g. location or species)	Supermarkets to tighten supplier requirements and enforce through audit (delisting where not compliant)
Heavier fines/ disincentives for failure to comply with CoO labelling requirements	Lobby government for CoO labelling legislation and monitoring	Develop a “toolbox” for aquaculture producers to prove origin	Increase indigenous participation in labelling and branding of aquaculture products	National body driven marketing campaign for CoO labelling legislation changes
Stronger action against those selling imported products as Australian	Ensure product is clearly branded as Australian	Create “digital footprints” (e.g. genetic tools) to enable successful application of blockchain technology and trace origin		
Legislative CoO obligations for certain products to export/sell	Consider regional specific labelling as a marketing tool (e.g. Kimberley farmed Barramundi)			
Introduce traceability laws	Draft industry preferred proposal for format and deliverables of CoO labelling legislation			
Introduce national rules tied to biosecurity risk	Codesign industry and state straw-man proposal for government consideration			
Increased customs monitoring and compliance with stronger penalties for non-compliance	Increase consumer awareness and support for improvements to CoO labelling			
	Create a clear and simple problem statement providing a clear rationale to garner community support			

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Table 15: Actions identified by stakeholders, and proposed responsible groups, to improve Indigenous engagement, employment and commercial opportunities









 Government	 Producers/Industry	 Research and Education	 Indigenous groups	 Other
Greater recognition of cultural value and legislation on appropriating Indigenous knowledge/intellectual property	Undertake cultural training, applying a strategic approach to capacity building by identifying indigenous values and matching opportunities appropriately	Increase delivery of aquaculture education to indigenous youth, commencing aquaculture engagement at school level	Pursue business opportunities that are commensurate with indigenous lifestyle and values, ensuring business viability is scoped	Marketing campaigns aimed at changing perception of working with indigenous groups
Financial (e.g. grants, tax relief) and business mentoring support for commercial partnerships between industry and indigenous organisations	Engage in facilitated conversations at community and company level to build relationships, trust and understanding around employment opportunities and training needs	Attract international scientists and students to work with indigenous people in the marine environment	Identify funding opportunities and opportunities to engage in joint venture arrangements with new and/or existing aquaculture organisations	Support and mentor indigenous involvement at all stages across the aquaculture supply chain
Legislate indigenous employment quotas above the 26 th parallel	Engage indigenous groups and individuals at conceptual stage of businesses and projects	Continue and improve existing training opportunities (e.g. establish a northern Australian Indigenous Aquaculture Training College, mobile intensive courses in regional and remote locations)	Strengthen governance and develop plausible, workable business development tools for small to medium indigenous enterprises	Educate indigenous groups on opportunities in aquaculture at all levels (technical, academic, industry)
Introduce requirements for percentage ownership in companies which have on-country connection	Develop opportunities to build capability beyond entry level positions, pathways in diverse areas	Create an indigenous lead education economy around the Kimberley coast	Secure land tenure in order to leverage bank loan and other capital	
Provision of financial incentives to commercial operators for long term engagement	Continual approach to capacity building activity, building relationships and opportunities naturally over time	Ensure indigenous people have access to best research so aquaculture projects have same collaboration network		
Introduce strategy to integrate industry directly with social welfare system	Consider procurement opportunities to support indigenous businesses through real contracted work (goods and services)			
Provision of government vouchers to enable capacity building from operations through to senior management and board	Ensure indigenous groups are involved in decision making processes			
Simplify aquaculture regulation to enable and encourage small-scale indigenous aquaculture startups				
Dedicated indigenous aquaculture licences, quotas and areas				

Table 16: Actions identified by stakeholders, and proposed responsible groups, to increase and improve breeding programs/Increase and improve hatchery/seedstock supply

 Government	 Producers/Industry	 Research and Education
Establish centralised, government funded breeding programs and centres	Undertake collaborative R&D to establish breeding programs with industry IP arrangements in place	Improve vibrio control technologies
Provide funding for research and development	Develop aquaculture precincts (“hubs”) to centralise research and industry, dispersing risk of disease and utilising natural biosecurity barriers provided by state borders	Commercialisation of viral clearance technologies Further research and development of broodstock/seedstock nutrition, genetics and disease Pathogen challenge facility located in northern Australia
Introduce national biosecurity standards and translocation protocols	Develop overseas market for high quality, Australian seedstock	Develop tools to identify and screen pathogen free founder stock
Introduce stricter testing policy	Understand demand for seedstock ahead of time as well as drivers of hatchery performance in order to scale production accordingly	Research on new aquaculture species
Amend live imports list to reduce biosecurity risk and outbreaks of exotic	Increase in commercial uptake of research activities and findings	Increase provision of technical aquaculture training relating to breeding and animal husbandry techniques

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diseases in broodstock and seedstock supply		
	Identify and address existing bottlenecks in specific hatchery supply	
	Industry cohesion and investment in purpose-built facilities such as nuclear breeding centres	

Table 17: Actions identified by stakeholders, and proposed responsible groups, to increase production efficiency through automation and other technology changes








 Government	 Producers/Industry	 Research and Education	 Indigenous groups	 Other
Government investment in R&D	Establish an aquaculture technology incubator to foster collaboration and industry enhancement	University engineering students work with industry to create solutions to issues	Collaborate with industry to gain understanding of industry's major challenges and where new technology may provide a solution	Improve communications networks (mobile reception and internet connectivity) in regional Australia enabling adoption of new technologies
Support delegations to countries using relevant technology	Improve awareness and understanding of technology advances and opportunities for adoption through increased cross pollination and collaboration with foreign aquaculture industries and other heavily automated industries	Ensure research is applied and matched with current industry needs	Improve communication of relevant new technologies to aquaculture industry	
Provide grants and tax incentives for investment in R&D and uptake of new technologies	Increased industry investment in new technologies	Assist in modifying existing equipment and technologies for specific species production	Investigate international aquaculture technology adoption and tailor to suit Australian environment and species	
	Undertake on-farm trials of new technology solutions	Use environmental and production data sets to identify patterns using artificial intelligence	Develop and provide tech solutions such as: - robust, rust/fouling proof sensors and equipment - low maintenance sensors - automated aeration system monitoring - imaging technology to detect stressed/diseased animals - remote sensing/monitoring systems - big data mining programs	
	Engage with schools and universities through STEM programs			
	Greater collaboration with university research (create incentives)			

Table 18: Actions identified by stakeholders, and proposed responsible groups, to increase tax and investment incentives

 Government	 Producers/Industry
Enhance promotion of existing tax and investment incentives	Encourage government recognition of cost limitation to operating in northern Australia
Provide tax incentives for living and operating in northern Australia (e.g. tax offsets, lower tax rates, accelerated depreciation)	Provide industry submission to current Productivity Commission review of remote area tax concessions
Provide subsidies to businesses in the region (e.g. power, transport, communications technology)	Establish technology exchange hubs reducing duplicate R&D across the industry
Establish a Federal Northern Australia Freight subsidy (like the Tasmanian Freight Equalisation subsidy)	Present as a unified industry collaborating to establish common user infrastructure demonstrating efficient use of capital
Greater support for start-ups (investment and tax breaks)	
Enhanced R&D tax incentives and grants	
Waiver fuel excise duty for northern Australian producers	
Provide relocation incentives to businesses and individuals to encourage people to the region	
Provide incentives for infrastructure development in northern Australia	
Establish an investor tax deduction scheme to attract capital to northern Australian aquaculture producers	
Limit tax concessions provided to resource companies	

5 SCENARIO PLANNING ANALYSIS

5.1 DEFINITION OF SCENARIOS

Based on the Workshop feedback, four scenarios were developed, named: ‘The Dry’; ‘Showers’; ‘Storms’ and ‘Monsoon’ which describe a range of possible future states for the aquaculture industry in northern Australia to 2030.

- **‘The Dry’** – is a ‘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. The result of the worsened situation is that the production volume (and GVP) from the northern Australian aquaculture industry in 2030 drops from its current levels.
- **‘Shower’** – describes a ‘status quo’ future where the industry where it has not managed key issues and therefore has lost the political will for an upscaling of production. The result of this is that the production volume and GVP of the northern Australian aquaculture industry stagnates.
- **‘Storm’** – describes a ‘positive future’ scenario where the northern Australian industry successfully eliminated restrictive issues across the region and industry (and within sectors) and has consequently achieved successful expansion, increased production volumes and GVPs. However, the industry has overcome most – but not all – of the challenges, and this has caused some investment reluctance for upscaling in parts of northern Australia.
- **‘Monsoon’** – is the best-case scenario and describes a future where the northern Australian aquaculture industry has reached its 2030 vision(s) all its goals. This is been driven by a ripple effect created by the choices the industry made regarding collaboration to solve the key issues which enabled the overall industry and key sectors to expand greatly and became very successful.

Detailed descriptions of the Scenarios are presented in **Section 5.6**.

For each scenario, a corresponding action plan has been created. The plans are intended to: describe the implications of the scenario with respect to the key decision factors; determine whether the information about the future validates the original assumptions; determine what the scenarios imply for the development and timing of policy and strategies; describe what threats and opportunities the scenarios suggest; describe what critical issues emerge from the scenarios; determine which cases deserve to be addressed by specific contingency plans; determine what kind of flexibility and resilience is necessary from the industry’s planning perspective; and determine what factors deserve monitoring.

5.2 PESTEL ANALYSIS – FINDINGS

The analysis undertaken with the Workshop groups indicated that ‘Technology’ was the key factor regarded as having the strongest enhancing force on the northern Australian aquaculture industry, whilst ‘Political’ factors were regarded as being the most hindering force. ‘Economic’ factors were perceived as currently enhancing, although there was uncertainty regarding the future. Each of these forces and their contributing factors are discussed below.

5.2.1 Technology – as industry enhancer

The Workshop feedback on the impact of ‘Technology’ as a strong enhancer for the northern aquaculture industry were based around the following factors:

- RD&E capability and output; ability to keep innovating for the industry
- The uptake of innovation in the industry (from both local and international best practice and new developments) which contributed to the current status of the industry being regarded as having advanced production technology; and
- Incentives (financial) to support innovation (e.g. R&D tax incentives, grant funding, etc) and technology advancements.

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In the Technology review, Workshop participants pointed to the ability (hope) that technology (scientific R&D) could also deliver key outcomes in the areas of breeding and genetics, biosecurity and feeds.

Industry members also felt that significant potential technological advantages could be developed around energy supply (in particular solar power) which was rapidly expanding. Most believed that distributed renewable electricity generation and supply could provide a significant potential cost and reliability improvement for operations, but could also be strongly leveraged as competitive sustainability credentials in local and international product marketing and sales. Producers pointed to the high cost of power in northern Australia (and even in North Queensland which has well developed power generation, transmission and distribution systems – but a lack of competition in retail supply).

5.2.2 Economic factors – currently enhancing; future unsure but generally positive

Workshop participants voted that overall, economic forces for the industry were currently positive. Factors such as low interest rates, strong exchange rates with key partners, low inflation and continued market demands (international and local) were contributing to a current positive view. On the negative side of the Economic force, factors such as taxation rates, availability of credit (and poor understanding of the industry by lenders/investors) were hindering industry growth.

Most Workshop participants felt that many of the key positive economic factors were largely internationally driven and therefore out of Australia's hands and ability to directly influence, but that regional macro-economic drivers such as Asian middle-class population growth and demand expansion for high-quality seafood were likely to continue for the next decade and should help maintain an overall positive economic outlook for the industry.

5.2.3 Political (and legal/regulatory) factors – an industry hindrance

Most Workshop participants felt that the current (domestic) Political force was hindering the industry. Whilst Commonwealth and State government grants and initiatives were viewed positively, current (and historical) government bureaucracy were considerable impediments to the growth of the industry. Industry pointed to key issues such as: ongoing complexities in business regulatory processes (particularly for new developments); particular examples of poor regard or understanding of the industry by politicians and government officials and a lack of political champions/effectiveness particularly in Canberra.

The Legal (Regulatory) Force was also voted as being a hindrance – largely tied with views and similar examples from the Political Force review. In particular, right across the Workshops, the issue of lack of stronger Country of Origin labelling (CoOL) and stricter biosecurity regulations on imported seafood was cited as a failure of industry lobbying success and a major political disappointment for industry.

On a positive note, recent policy implementation around creation of aquaculture zones and development areas, approvals facilitation and red-tape removal were regarded as having enhancing effects, albeit that the outcomes of these policies have yet to be fully realised.

5.2.4 PESTEL Conclusions

As the PESTEL surveys indicate and supported by the review of the considerable amount of political interest in northern Australian aquaculture, the strong feedback from industry is that there is a will and capability to expand the industry in the North, but that it had been largely hindered by a lack of political support. Many felt that the largely Commonwealth led parliamentary and government inquiries and reviews, whilst identifying key issues, had largely been ineffectual in carrying through with the implementation of reforms – largely due to many of the issues around development approvals and operations regulations were State/Territory controlled. Industry also pointed to the other related and contributory factors that the high regulatory hurdles to entry had largely driven the industry to be dominated by large companies (and that SME farmers were being driven out of the sector) and the regulatory hurdles had also adversely affected the industry's (again particularly SMEs) to gain funding (debt or equity). The other significant factor that was repeated in all the Focus Groups (and Online Survey) was the issue of CoOL and biosecurity.

Many industry participants compared and contrasted the comparative rapid rise and success of the southern (primarily salmon) aquaculture industry with that of northern Australia. Participants pointed to the considerable competitive advantage the salmon industry received when it lobbied for and successfully received support for a substantial ban on imported salmon products on the grounds of the unacceptable biosecurity risk posed to the domestic industry and the environment (see **Section 3.6.1.1.6** for further discussion).

5.3 COMPETITIVE FORCES ANALYSIS – FINDINGS

The analysis undertaken with the Workshop indicated that the ‘Threat of Substitution’ was regarded by the industry as the most substantial competitive force acting on the northern Australian aquaculture industry whilst ‘Threat on New Entrants’ was ranked as the least competitive force. Each of these factors is discussed further below.

5.3.1 ‘Threat of Substitution’ – unfair product substitution eroding industry value

The main issues associated with ‘Threat of Substitution’ are:

- there are many substitute products available (e.g. imported prawns, barramundi and pearls) to wholesale and retail buyers and consumers;
- these ‘substitute’ products are often of a similar or cheaper in price. Therefore, the cost of substitution for the consumer is low (and in many cases may be considered to be ‘better value’);
- however, the substitute products are (mostly) of lower quality (and at best are not overtly advertised as being imported) and therefore if priced similarly to the local product are contributing to poorer – albeit largely unrecognised – outcomes for the consumers; and
- the substitute products are often achieving high(er) margins for the importer/wholesaler/retailer, which in turn is exacerbating the competitive impact of the imports on local producers.

The other significant impact from ‘substitution’ of local seafood by imported products is the increased risk of biosecurity breaches and disease transfer to Australian environments, wild populations and locally produced animals. This threat was realised with the recent well-documented case of prawn whitespot virus introduction into Australia via imported uncooked prawns and its transfer to prawn farms in southeast Queensland (see the Biosecurity section of the project Literature review for further discussion).

5.3.2 ‘Buyer Bargaining Power’ – supermarket dominant power, but partly offset by consumer demands

The competitive forces review indicated that ‘Buyer Bargaining Power’ was also a significant factor for northern Australia aquaculture producers and product sales. Buyer Bargaining Power is the customer’s ability to dictate price and terms and is determined by number of customers a company or industry has, how significant each customer is, and the costs for a producer to find new customers or markets.

As indicated in **Section 5.3.3**, Australian seafood markets are relatively concentrated: with supermarkets dominating retail sales of most Australian seafood products with Woolworths, Coles and IGA (along with new and emerging players Costco, Aldi and Lidl) purchasing large amounts of seafood directly from producers (aquaculture and wild catch). This concentration means that supermarket buyers hold considerable power in the supply chain, particularly when they also hold the power to substitute domestic with imported product. This power is somewhat offset by the relatively limited number of domestic aquaculture (and wild catch) product suppliers which produce only ~60% of the total retail demand and the growing demand for local, sustainably produced product, which provides suppliers with some counter-power.

5.3.3 ‘Rivalry amongst existing competitors’ – limited by lack of consumer brands

Surveys indicated that respondents felt that rivalry amongst existing competitors was a significant competitive force. However, this response appears to have been driven by the major competitive force in the Australian industry of competition from imports and to some extent from wild-catch supplies.

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This is supported by the fact that firstly, there are only a handful of significant producers in entire northern Australian aquaculture sector, with two or three major producers dominating each of the pearl, prawn and barramundi farming segments. Secondly, there is a lack of competitive effect at the consumer level as very few aquaculture producers are vertically integrated in the supply chain through to consumers with only a couple having branded products available directly in retail markets.

Virtually none of the northern Australian aquaculture seafood producers operate value-add processing of products and largely rely on wholesale sales and some 'branding' at this level and in food services offerings. Most fresh and chilled seafood sales (which account for about half the total seafood offerings in supermarket seafood sales) are provided with some country of origin information, but are predominantly 'unbranded' (Norris, 2019).

However, the pearl sector has some more significant rivalry amongst existing competitors with several strong brands competing in local and regional markets and some in international markets.

5.3.4 'Supplier bargaining power' – retailer response to consumers gives some power back to suppliers

As indicated above, respondents felt that supplier bargaining power was generally low (due to import competition and product substitution) with some counterpower provided by increasing consumer demand (driving retailer decisions) for domestic, sustainably produced products.

In addition, the nature of Australian seafood sales, with retail and food services demand peaks in late spring (southern Spring horse-racing carnivals), Christmas and Easter providing suppliers with the ability to deliver product some bargaining power.

5.3.5 Threat of new entrants – potential for disruption

Surveys indicated that respondents felt that currently, the threat of new entrants causing significant competition was not as strong as the other factors. This appears to have been driven by the fact that the barriers to entry for new competitors is high, due to shortage of available and approved sites/licenses for aquaculture in addition to considerable domestic sales opportunity (and import replacement) in the Australian domestic market.

There were discussions at all the Workshops regarding the potential impact of the development of Seafarms' Project Sea Dragon which could have a major impact on prawn production and markets. However, as the project is yet to commence growout development and the proponents have indicated that its product markets are export-focussed, the threat was still perceived to be low. However, the recent entry into the prawn aquaculture business of Australia's largest aquaculture company and major salmon producer Tassal Group Limited (TGR), was regarded as the major potential 'new entrant' threat. Given TGR's large existing aquaculture operations and experience, access to capital and a large potential growout opportunity in North Queensland and its vertically integrated processing and marketing operations providing direct access to large retail markets and consumers, this new entry potentially represents the most significant new development in the Australian aquaculture sector in the last 20 years.

Comparatively, the barramundi sector has also seen a relative newcomer, Mainstream Aquaculture enter the market and quickly become a significant player, particularly given its dominance of the breeding and fingerling supply markets in Australia (and via international supplies).

Industry indications were that the pearl industry already experiencing GVP contraction and consolidation, may continue to experience further consolidation through mergers and acquisitions, as opposed to any new market entries.

5.3.6 Conclusions

The top four characteristics contributing to the competitive environment of the northern Australian aquaculture (all species) as ranked by respondents were:

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- There are many substitute products available
- Existing producers do not possess patents, trademarks or do not have established brand reputations
- Substitute products are similar or cheaper in price
- Buyers are price sensitive (demand is elastic).

These findings are consistent with the overall Australian seafood supply and demand profile that is complex.

A snapshot (as outlined by the Australian Government, Department of Agriculture, 2015) is provided below:

- Australia's apparent consumption of seafood (processed weight) increased from 13 kilograms in 2000-01 to 15 kilograms in 2012-13 (Stephan and Hobsbawn 2014). It is estimated that Australians consumed around 345 000 tonnes of edible seafood products in 2012-13 (Stephan and Hobsbawn 2014).
- However, the amount of seafood (edible and non-edible) produced in Australia has remained relatively stable over the last 20 or so years at around 230 000 tonnes per year. Therefore, by volume, imported seafood has continually increased and accounts for around 66 per cent of current consumption.
- Furthermore, the relative amounts produced by aquaculture sources and from wild capture has changed considerably. Farmed salmon is now Australia's largest fishery by volume and value.
- In developed countries, demand for seafood is often greater than domestic production can support. The United States, Japan and European Union, including the United Kingdom, are all net importers of seafood products.
- Australia differs from many other developed countries in that a significant proportion of Australian product, which could otherwise supply the domestic market, is sold to export markets due to price. These products are generally still available in Australia, but Australian consumers are often unwilling to pay as high a price as export markets for the volumes produced.
 - Australia exports high value products such as rock lobster, abalone, and tuna.
 - Australia exports little of lower value staples such as white fish and canned fin fish products.
- Over the last six years aquaculture has expanded greatly in East Asia, particularly in China, Vietnam and Indonesia. Australia's high dollar and labour costs means that farmed seafood can be imported at very low prices.
- Australian aquaculture production whilst growing particularly in terms of volume, faces strong competition from cheap imports, particularly from Asia. Australia's seafood imports largely consist of lower-value products such as frozen fillets, frozen prawns and canned fish.
 - Imported products, predominantly from Thailand, New Zealand, Vietnam and China, meet Australian consumers' demand for low-cost seafood products.
 - Frozen and thawed basa (catfish) fillets from farms in Vietnam are now the most commonly and widely eaten import. The low cost, white boneless flesh and neutral flavour of basa makes it attractive to a large cross section of the Australian community.
- These attributes highlight the lack of a low-cost, high-quality (and therefore potentially high-volume consumption) white fillet fish – wild-caught or farmed. Given the current status of wild-caught fisheries, there is an obvious opportunity for the development of a new low-cost, high-volume fish aquaculture product for Australian domestic consumption. Such products could fulfil (and displace) the large demand for fish and chip, and other processed (battered, crumbed, etc) offerings currently occupied by imported basa (and other) fillets.

5.4 SWOT ANALYSIS FINDINGS

The results of the SWOT analysis are provided **Section 4.5**. A summary of the SWOT factors is also provided below. **Section 4.5.2** also provides workshoped recommendations for actions to realise the top five opportunities.

The analysis undertaken with the Workshop participants indicated that currently, overall the Weaknesses of the industry outweighed the Strengths (if otherwise the industry would be widespread and booming). Similarly, there were several major Opportunities identified, which if able to be realised could add huge value to northern Australia, but with these came with some considerable Threats. However, importantly, most

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respondents in the Surveys and Workshops felt optimistic about the prospects for the Weaknesses and Threats to be overcome and Strengths and Opportunities to also prevail.

5.4.1 Key Strengths and Weaknesses; Opportunities and Threats - Summary

The key Strengths of northern Australian industry centred on the regions *natural* advantages (climate, geography, growing conditions) and particularly the vast area and potential of this natural advantage. Countering this was the weakness that very little of this potential was readily accessible for aquaculture development, limited by firstly a lack of regulatory approved areas for development as a result of complex, duplicative and expensive regulatory processes and secondly by high costs to develop and operate infrastructure required for key inputs (e.g. power, transport, labour).

The key Opportunities for northern Australian aquaculture raised in the Focus Groups, Workshops and Surveys and the documented Threats, prompted enthusiastic discussions, primarily because most respondents felt that most of the opportunities could be achieved or threats overcome by ‘political/administrative’ measures and changes.

For example, the vast majority of respondents believed that the ‘improvement of Country of Origin Labelling’ (CoOL) was a major opportunity (which could be relatively easily implemented) to create consumer-driven, positive discrimination of seafood purchases which would result in lower import volumes, making the local operators more profitable and viable, but also having the indirect effect of potentially lowering the biosecurity risks from disease transmission from imported seafood products.

Alongside this, the Literature Review of northern Australia Aquaculture undertaken for this project, review of Australian seafood statistics and trends, and Workshop discussions also indicated an Australian seafood product ‘market gap’ – a low-cost, high quality, firm white fillet fish which could potentially also displace imported products which would also bolster the impacts of changes to CoOL regulation. The development of a farmed fish – most probably a low-trophic level (herbivorous) freshwater or marine fish, produced at low cost – represents a real and significant opportunity for northern Australian aquaculture. As outlined above, realisation of this opportunity would also pivot from natural strengths of the region and also help overcome weaknesses and threats to the northern industry but also the broader Australian seafood industry.

5.5 SCENARIO PLANNING ANALYSIS

5.5.1 Analysis of Strategic decisions, drivers and concerns

Strategic goals for the future of the northern Australian aquaculture sector have – in the absence of any subsector/industry or State/Territory goal setting – been derived from whole of industry goals established by key Commonwealth policy such as the *National Aquaculture Strategy 2017* (DAWR, 2017). Our review of government (Commonwealth and State/Territory policy, policy creation mechanisms and plans), industry and corporate espoused goals has indicated:

- Most previously set goals for development, production volumes/value have fallen short – considerably;
- A lack of clear identification of where/whom and what the effort and output required to meet these previous goals would come from; and
- A general lack of review or assessment mechanisms for past goals and targets (and identification of failures, non-conformances or persistent barriers).

The *National Aquaculture Strategy 2017* sets as the national target for the industry the aim “to double the current value...to \$2 billion per year by 2027”. Moreover, the strategy states that the target will be achieved by both, encouraging development of new industry projects, and growth of existing business.

As indicated in earlier sections, the current value (GVP) of the northern Australian aquaculture industry is approximately \$200 million and the southern industry (predominantly Tasmanian salmon) about \$800 million. Given the ecological, and social restrictions to expansion and production efficiency limitations which are likely to slow the growth of the Tasmanian salmon industry, proportionate growth to meet the NAS target is unlikely

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to come from this sector. Therefore, there is an implicit (but as yet defined) expectation that the northern Australia (and to some extent some other temperate regions such as Mid-West Western Australia) will expand to meet this target.

Scenarios and targets for northern Australian aquaculture growth have been developed independently of the aspirations of the *National Aquaculture Strategy 2017*, and have then been compared and contrasted against the notional aspirations of the Strategy goals for 2027-2030. However, a holistic assessment of the Strategy \$2 billion target would indicate that a doubling of the northern Australian GVP (to \$440 million) will not be enough to achieve it (relying also on doubling of southern/other GVP) and that a target more consistent with the Strategy would be a five-times expansion in GVP for the northern Australian industry.

5.5.2 Identification of key decision factors

In Workshops and Surveys, several key decision factors for industry expansion were indicated or explicitly outlined:

- Revenue, economic value growth
- Sustainability
- Product market demand and value
- Production efficiency
- Regulatory barriers to entry
- Impact on company/industry/national reputation
- Availability of capital
- Technological efficiencies/gains
- Social licence/local community acceptance

The factors of revenue generation, capital and product markets are pure economic factors and understandably are at the *raison d'être* of corporations. Interestingly, sustainability, corporate reputation and (local) social licence factors also figured highly in most discussions regarding corporate or industry expansion. Finally, the issues of regulatory barriers particularly for new growout development/expansion were also raised in all discussions.

Therefore, the key decision-making factors were combined into three key themes: economic, reputational and expansion availability.

In the Surveys, Focus Groups and Workshops, respondents were asked to identify what factors they considered most important for the industry when decision-making and factors that had the most impact on outcomes of decisions made (**Table 19**).

Table 19: Identification of factors important in industry decision-making

Factor ID	Key Decision Factors
1	Revenue and economic growth
2	Environmental sustainability
3	Value creation in local communities
4	Political interests
5	Marketing and the reputation of the industry/sector
6	Efficiency of production
7	HSE
8	New and improved technology

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5.5.3 Identification of key industry forces

The results of the Survey, PESTEL, SWOT and P5F Competitive Forces analyses indicated the following key major forces industry participants felt may most significantly affect the future of the northern Australian aquaculture industry (**Table 20**).

Table 20: Identification of key forces most significant to the future of the northern Australian aquaculture industry

Force ID #	Forces identified	Group	Freq ID	Likelihood	Impact	Score	Rank
1	Accessibility – availability of permitted, suitable sites for new/ expanded development	Political	High	Medium	High	18	2
2	Availability – large areas of land/water with good natural advantage (climate, ecology and disease status)	Environmental	High	High	High	27	1
3	Biosecurity policy – risks and threat of economic disaster from disease incursion	Political	High	High	High	27	1
4	Trade (importation) policy – policy regarding imports of seafood	Political	High	Low	High	9	3
5	Sustainability – industry performance and perceptions dictating/driving social licence	Industry	High	High	High	27	1
6	Animal Health – low levels of disease and good animal health	Environmental	Medium	Low	High	6	5
7	Seed stock – availability of high quality, disease free seedstock (combined with availability/supply of high-quality broodstock)	Industrial	High	High	Medium	18	2
8	Technology – biological and technical R&D to support environmental, biosecurity and farming activities	Industrial	Medium	Medium	Medium	8	4
9	Input costs – key inputs: costs for power, labour and feeds, many underpinned by transport costs due to remote locations.	Industrial	Medium	High	High	18	2
10	Strong prices – future development scenarios are underpinned by reasonable expectations of continued demand (local and international) and high prices	Market	Medium	Medium	Medium	8	4
11	Australia's food reputation – international regard as a clean, green (sustainable) growing environment, processing CoC and product quality	Market	Medium	Medium	Medium	8	4
12	Import competition – high substitutability of many products with lower-costs imports (and aided by limited product information e.g. CoOL)	Market	High	High	High	27	1
13	Access to labour – specialist, and general in remote northern Australian locations, associated with liveability and services	Industrial	Medium	Medium	Low	4	6
14	Access to capital – access to farming and associated infrastructure capital	Industrial	Low	Low	Medium	2	7
15	Political influence – ability to influence key policy	Political	Medium	High	High	18	2
16	Industry consolidation	Industrial	Low	High	High	9	3

Each of the forces were then combined into 'major force' categories: F1 – Environmental; F2 – Political; F3 – Market; and F4 – Industrial (**Table 21**).

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Table 21: Summary of key forces combined into Key Force Categories

Environmental <ul style="list-style-type: none"> • Availability 27 • Sustainability 27 • Animal Health 6 TOTAL 60	Political <ul style="list-style-type: none"> • Access 18 • Biosecurity policy 27 • Influence 18 • Trade (import) policy 9 TOTAL 72
Market <ul style="list-style-type: none"> • Strong Prices 8 • Food reputation 8 • Import competition 27 TOTAL 43	Industrial <ul style="list-style-type: none"> • Seed stock 18 • Technology 8 • Input costs 8 • Labour Access 4 • Access to capital 2 • Consolidation 9 TOTAL 59

The three factors combined in the **Environmental Category** included:

- Availability – the large areas of land/water in northern Australia provides the industry with a major natural advantage. This factor was regarded as a major driving force for the potential expansion of the industry.
- Sustainability – the high-environmental qualities of the growing habitats/regions, combined with Australia’s strict environmental and food processing regulatory frameworks, high-levels of industry self-regulation (QA/QC, EMS, HACCP) and external certification (BAP, MSC) were regarded as strong drivers for the industry.
- Animal Health – this refers to health as it related to natural pathogens and factors and due to high environmental quality and (comparatively) fewer of the key known aquaculture pathogens, was regarded as a strong advantage (but it was noted that this was closely allied with the related issues of ‘biosecurity policy’ and biosecurity risk issues associated with sourcing broodstock from wild populations).

The four factors combined in the **Political Category** included:

- Access – the inability/difficulty in accessing suitable sites for new/expanded development: the industry cannot meet growth expectations without identified areas for future expansion which require reasonable and economically feasible regulatory and administrative approvals for development and operation,
- Biosecurity policy – Biosecurity risks and threat of economic disaster from disease incursion: expansion can only occur if operators feel confident that economic losses or industry collapse is minimised through strong biosecurity measures.
- Political Influence – growth needs to be supported by political initiative to drive and enact measures to enable, protect and promote industry. Whilst recognising it as an important driver, many respondents felt that the industry could be doing better in this area.
- Trade (import) policy – this area reflected the industries general dissatisfaction with CoOL regulations which effectively allowed loopholes for the origins of imported products to be ambiguous and did not impose mandatory CoOL for the food services sector. This factor also overlapped with the Biosecurity policy driver.

The four factors combined in the **Market Category** included:

- Strong prices: future development must be able to be underpinned by reasonable expectations of continued demand for seafood (local and internationally – particularly Asian middle class growth) to support sustainable prices and profit margins
- Preservation of Australia’s international food reputation: a clean, green growing environment, processing CoC and product quality are fundamentals for the ongoing growth of the industry.

The six factors combined in the **Industry Category** included:

- Seed stock – ongoing issues with the industry continuing to obtain seedstock from a variety of hatcheries which source broodstock annually from wild stock populations facing increasing restrictions (and the lack of industry/government broodstock/seedstock facilities).
- Technology – the ability of technology to enhance productivity, assist with disease identification and management and lower costs of production was regarded a very significant driver.

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- Cost competitiveness of key inputs: costs for power, labour and feeds must continue to be competitive for northern Australia's industry to grow and thrive. This is driven by the base cost of these inputs, some of which are currently not directly managed/controlled by the industry, but are also considerably impacted by increases due to remoteness and transportation costs. Enabling the industry to take greater control of factors such as power generation (renewables), feed input costs and labour solutions will also be significant enablers for the industry.
- Labour access – inability to source labour locally and regionally; shortage in key (high-level) skills and issues with business visas contributed to this factor being regarded as a significant driver.
- Access to capital – difficulties in accessing capital due to risk aversion by local lenders/investors due to a lack of understanding of the industry and its fundamentals was regarded as a current driver.
- Industry consolidation – the global aquaculture industry has seen considerable M&A activity which has consolidated ownership but has also been responsible for growth and expansion due to access to capital, professional management and political influence. Interestingly, despite the high impact and likelihood of this occurring in the Australian (northern Australian) industry, it was raised by only a few respondents.

It is also relevant to note that several issues which have been raised by southern Australian and the international aquaculture industry as key factors, did not really emerge from the surveys and discussions with the northern Australian industry. These include:

- Access to, availability (and cost) of feed inputs (traditional and new): as one of the major inputs, a major global industry concern is the availability/sustainability of in particular fish meal and oil, land-use for feed production and potential for algal/microbial biomass production for inputs.
- Intra-industry cooperation: the global salmon industry, the Thai and Vietnamese prawn aquaculture sectors are perceived to have a high levels of intra-industry cooperation (possibly due to consolidation, presence of large, dominant players and centralised government decision-making). Nonetheless, in these sectors, industry cooperation, communications are regarded as benefiting the entire industry and therefore individuals equally.

5.5.3.1.1 Driver Rankings

Overall the driver categories were ranked:

1. Political (72) – driven by high scores for three key forces: Biosecurity policy (27); Access to new sites for development (18); and Political Influence (18) and Trade (import) policy.
2. Environmental (60) – driven by only two highly-rated forces: Availability of suitable land/water (27); Sustainability (27); and Animal Health (6).
3. Industrial (59) – driven by the greatest number of forces but which received medium to low scores: Seed stock (18); Consolidation (9); Technology (8); Input costs (8); Labour Access (4); Access to capital (2); and
4. Market – driven by three forces, one highly ranked and two moderate forces: Import Competition (27); Strong Prices (8); and Food Reputation (8).

5.5.4 Definition of scenario logics

Scenario logics that were used for the Scenario development were based on cross-impact analysis of the different forces (method outlined in the Supplementary Data document) to identify the influence the forces may have on each other and which force groups will be the critical drivers of change within the scenarios. As a second step, the likely trajectory (up or down) of each force was assessed and used to undertake a morphological analysis, from which the themes for the scenarios were selected.

5.5.4.1 Cross-impact analysis

Table 22 represents the results of the cross-impact analysis of the force groups. A rating of '0' implies that the force-groups are independent. A rating of '1' implies that they have some minor dependences. A rating of 2 implies that the force group is a moderate driver of the other. A rating of '3' implies the force group is a strong driver of the other.

Table 22: Cross-impact analysis of forces-groups

Forces	F1	F2	F3	F4	Score
F1 (Political)		2	0	1	3
F2 (Environmental)	1		1	2	4
F3 (Industry)	1	1		1	3
F4 (Market)	3	2	0		5

This associated key identifies the Force group and the ratings.

F1 = Political forces	0 = Independent
F2 = Environmental forces	1 = Dependent
F3 = Industrial forces	2 = Moderate driver
F4 = Market forces	3 = Strong driver

The Cross-force analysis indicated that each category has moderate amounts of cross effects and influences from other categories with only a few strong cross-driver effects. The Market category is the most significant category affected by the other categories, due to the strong impact that Political Forces (viz, import competition policy and biosecurity policy) have on the volume and price in the local market. In addition, the effect of Environmental factors (viz. sustainability) on market perceptions is also a driver. The Environmental category was moderately affected by the Market category as well as Political and Industrial Category factors. The Political category was also influenced somewhat by Environmental factors and to some extent by Market category factors, but were viewed as not being influenced by Industrial issues.

Environmental forces are considered to be a strong driver of the Political forces, as the political will to allow the upscaling of the industry’s production is directly dependent on the development of the Environmental forces. A negative shift in the Environmental forces is likely to cause the ongoing restrictions to access for new development and the introduction of new regulations further restricting the existing industry. Market forces are also considered to be dependent on the effects of Environmental forces, based on how the demand, customer preference and price development are impacted by environmental forces.

5.5.4.2 Future Trajectories

For each of the Categories, several different factor trajectories were considered (**Table 23**).

Table 23: Factor trajectories considered in the Scenario Planning analysis

	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

Assessing the possible combinations, there is one worst case: 1C, 2C, 3C, 4C and one best case: 1A, 2A, 3A, 4A. It is possible to select several mi-case scenarios, however, in order to potentially explore the widest range of credible scenarios, two more scenarios: a positive (1B, 2B, 3A, 4A) and a negative scenario have been explored (1B, 2B, 3A, 4A).

5.5.5 Scenario theme selection

Using the scenario cases above, four scenario conditions (forces) were considered (**Table 24**). The scenarios describe possible future state and status of the northern Australian aquaculture industry, and details follow in the Conclusions.

Table 24: Scenario force conditions derived for the four aquaculture industry scenarios

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

5.6 CONCLUSIONS

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 25** below.

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.

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Table 25: 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

Of the four possible future Scenarios developed, the two ‘worst case/low-aspiration scenarios (the ‘Dry’ and ‘Shower’) were regarded as having lower probability/plausibility than the two better/best case scenarios (‘Storm’ & ‘Monsoon’). This is primarily because current indications are that the industry, within the timeframe of the last year (2018-19), has commenced changes and development that should align with the trajectory for the Storm scenario and potentially into the Monsoon scenario, if industry collaboration can be achieved to overcome barriers and capture opportunities.

The project Recommendations (**Section 6.3; Table 27**) were developed to support achievement of the ‘Monsoon’ scenario, a target GVP incorporated in the industry Vision 2030.

6 FINDINGS AND RECOMMENDATIONS

6.1 KEY FINDINGS

The scale of the aquaculture opportunity is vast...

Northern Australia is massive: the opportunity for aquaculture is huge – but the development of the northern Australian aquaculture industry (NAAI) has, despite considerable confidence and rhetoric, largely failed to meet its potential or aspirations, particularly when compared and contrasted with the southern Australian industry (and international benchmarks).

The area defined as ‘northern Australia’ – the regions of Western Australia, the Northern Territory and Queensland above the Tropic of Capricorn comprises nearly 4.8 million km² of land (53% of Australia’s total land-mass) (NAIF, 2019).

Current annual Gross Value Product (GVP) (FY2016-17) from aquaculture in northern Australia was around \$223 million (adapted from ABARES, 2018) (c.f. the northern Australian beef industry which had a 2018 FY GVP of approximately \$5 B). It is constituted predominantly by the production of barramundi (33%), prawns (32%), and pearls (non-edible) 31%, with several other species (oysters, redclaw and other finfish) making up the remaining 3% of value.

In comparison, in FY2016-17 Australia’s entire aquaculture industry GVP was approx. \$1.35 B, of which southern aquaculture production (dominated by Tasmanian salmon, South Australian southern bluefin tuna and NSW, SA & Tasmanian oysters) constituted about \$1.12 B.

Vast areas of land suitable for land-based, marine pond aquaculture have been identified by CSIRO (Irvin et al 2018). CSIRO estimates that northern Australia has 9,500 ha and 225,000 ha of Class 1 land (i.e. suitable with negligible limitations) for marine farming in earthen and lined ponds, respectively. For freshwater farming, suitable areas were 3,000,000 ha for earthen and 13,000,000 ha for lined ponds. Further assessment is required on environmental and planning regulatory requirements for the land-based areas identified, including tenure and land access. For a sense of comparison in terms of the opportunity presented in northern Australia, the current Australian prawn farming industry utilises approximately 900 ha. (For comparison of national and global regions, see page 24.)

However, there has not been a similar comprehensive assessment of marine (coastal/offshore) sites potentially suitable for cage-based aquaculture.

A diverse and fragmented industry structure...

A review of the NAAI indicates that it is diverse, multi-sectoral, fragmented and dispersed. It has been slow-growing, particularly compared with southern Australia. Overall, its structure is predominated by small and medium-sized enterprises (SMEs) and family business producers, with large support sectors in Research Development and Extension (RD&E), and government service. The overall industry management, reflected in online survey responses, is comprised of mostly highly-educated middle-aged men, and Aboriginal and Torres Strait Islander people are poorly represented.

A survey sample indicated the industry is diverse (multi-sectoral) and fragmented and, compared to other industries, probably constitutes several separate and distinct sub-sectors: pearling, barramundi farming, prawn farming and ‘others’ (Table 26). The ‘others’ category comprised of several small emerging sectors or operations such as freshwater crayfish (redclaw and cherabin), other finfish (grouper and cobia), tropical oysters, and algae production all showing promise.

The ‘industry’ is geographically widely dispersed with limited operational concentration and is comprised of several species- and jurisdictional-based industry associations and representative bodies.

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Growth of the NAAI over the last decade has been slow (particularly compared with southern Australian aquaculture) and has been derived primarily from new entrants and consolidations. Mergers/acquisitions have been uncommon, but their impacts on increased overall production volumes and GVP are demonstrably significant. There has been a contraction in the number of producers in most sectors, and considerable numbers of issued aquaculture licences are currently non-operational (87% in QLD). Industry consolidation is occurring and transition to large corporate operators has begun. This reflects a similar pathway to that of the Tasmanian salmon industry.

Table 26: The current structural profile of the northern Australia aquaculture industry, determined by 117 stakeholders responding to the online survey.

Sub-sector	Sub-sector/industry Profile	Player/Operator profile	Personnel profile
Producers	Diverse – constituted by separate and distinct species-based production sub-sectors: pearling, barramundi & prawn farming, and 'others'. 'Others' – comprised of a variety of smaller emerging industries such as freshwater crayfish (redclaw), tropical oysters, lobsters, other marine finfish (grouper and cobia), freshwater fish (jade perch, silver perch) and some algae production	Comprised of predominantly SME and family-business operators (< 40 employees) undertaking production of a range of species, and utilising a variety of culture systems	Predominantly male (>95%) with the majority mid- to late-age (>71% and less than 29% under age 40), mostly with a university degree (58%) or VET (19%) qualifications and more than 10 years' experience
Suppliers	Primarily specialist feed and equipment providers with some other agri-/technology generalists.	Comprised of a combination of small representative offices of large international suppliers (e.g. feeds and equipment) or SME businesses providing specialist services or products. Reported annual sales ranges of \$50,000 - \$1,200,000.	Predominantly male (70%) with the majority mid- to late-age (>70% and less than 30% under age 40), mostly (56%) without university degrees or VET qualifications, but had the majority (55%) with more than 10 years' aquaculture industry experience
Education/ Research & training providers	Large and diverse sector. Many institutions/ entities and people involved in the northern aquaculture industry	Several larger groups (e.g. JCU, CSIRO, and UTAS. Other government groups represented in 'Government agencies' (FRDC, State/NT, R&D agencies)	Predominantly male (66%) with the majority under 40 year of age (54%) and with 89% with university graduate or post-graduate qualifications, with more than 10 years' industry experience and involved in research and/or teaching
Government agencies	Large sector. Involved in policy, planning, regulation and economic development roles and R&D (included in Education/R&D providers above)	Comprised of WA, QLD and NT government agencies (and some Australian government agencies).	Predominantly male (69%) with the majority over 40 years of age (69%) and with 53% with university graduate or post-graduate qualifications and 38% with more than 10 years' industry experience
Aboriginal and Torres Strait Islander people	Poorly represented in industry overall.	Primarily represented in the Education/Research & training sector with some participants in Government agencies, and a few in the Producers sector. A few representatives in the Production Sector	Predominantly male (with limited data on gender, education and industry experience).

Factors inhibiting growth...

The growth of aquaculture development and operations in northern Australia have been inhibited or thwarted by a range of complex, multi-factorial, often negative synergistic hurdles.

Inhibiting factors for aquaculture development and operations in northern Australia have been: geographic, demographic and commercial challenges; lack of coordinated, science-based, aquaculture policy and implementation; and lack of clear and navigable regulatory pathways. Contributors to the geographic, demographic and commercial challenges are: the remoteness, low population (a common issue for all industries that do not have the financial capacity to build their own economies of scale, e.g. gas or iron ore), lack of local infrastructure, labour, services and consequent high costs of accessing/importing key inputs for the industry.

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In terms of regulation, there is a lack of clear, open and navigable paths to aquaculture investment, development and operations. This has now been clarified in WA (DoF, 2016), and there are issues remaining in NT and QLD. However, many of these regulatory issues have not been purely aquaculture-specific. There is a lack of coordinated policy development and implementation which could alleviate many of the above hurdles, which persists despite considerable policy discussion (parliamentary inquiries, strategic and regulatory reviews). In addition, there has been inadequate implementation following review and assessment of policy and regulation, and no assessment of the effectiveness of reviews.

Specific barriers/issues identified by industry in surveys (most identified in previous studies) were:

- Lack of availability of **development areas, sites** (dependent on the selection criteria imposed, e.g. some designated areas have poor suitability for aquaculture production).
- **High environmental and regulatory hurdles** persist, despite the Productivity Commission (PC) 2016 findings that there is little evidence suggesting that regulations have systematically impeded the viability or growth of aquaculture businesses (for example, by preventing investment, experimentation and hence advancement in the key drivers of nutrition, fish and marine health, and genetics) (PC, 2016). The PC view was driven by data from Australia's overall aquaculture output growth rate over the past decade — underpinned by growth in salmon. The PC cites this growth as 'similar to those of the dominant producer countries in Asia; the growth rate in value terms was second only to Norway among OECD countries; and that the development of the industry has been shaped more by technological, geographic and other non-regulatory influences'. This is not the case for the northern Australia industry, which has experienced a different regulatory influence.
- Aquaculture is a relatively new agricultural industry and where there is discharge of water to the environment, this occurs at one point. This is different from traditional cropping, horticulture and grazing sectors that have a diffuse discharge of nutrients and sediments. The nature of point-source discharge and the proximity to marine protected areas (e.g. Great Barrier Reef Marine Park) means that the aquaculture industry has strict regulatory and legislative obligations, including **high environmental criteria on aquaculture developments and operations in northern Australia**. In Queensland, the introduction of no additional nutrient or sediment load release limits for new development in GBR catchments is a barrier to growth. The aquaculture industry is committed to sustainable production systems, effective regulatory frameworks, waste management, sustainable resource management and ecologically sustainable development (ABFA, APFA and PPA plans and key initiatives). Innovative technologies have been adopted by land-based farms for nil discharge and/or bioremediation of nutrients before water is discharged. This requires a large investment from producers in terms of infrastructure, technology and allocations of farm area for bioremediation (more than 50% of farm area in some instances). There is an apparent disconnect between scientific evidence, policy and regulation in aquaculture, particularly compared to those for other agricultural industries (Scaling Up Report- JSCNA, 2016). Further research is required to understand environment carrying capacities, nutrient assimilation capacity in discharge receiving environments, and aquaculture-environment interactions, which can be used to inform science-based policy (not yet implemented from Scaling Up report recommendations).
- **Harsh weather conditions** and climatic uncertainty. While the weather is largely stable and predictable in northern Australia, cyclones have an impact and the intensity of the wet is variable.
- **Remoteness** from other key requirements, in large part a function of industry scale (although close to potential markets in Asia).
- **Lack of local or regional infrastructure** to support aquaculture operations (roads, power, water, services, social infrastructure).
- High and increasing **costs for insurance**.
- **High costs of key inputs**, including: local inputs (labour, water, power - noting renewable options are available); transported/imported inputs (feed, power, labour, parts and services); and supply chain inputs (transport services/options and connectivity).
- A **shortage of skilled staff**, reflecting an overall national shortage for aquaculture, in addition to unavailability of local/regional skilled staff, and shortfalls in skills training and output. Access to skilled, senior personnel is affecting key parts of the industry now, particularly with difficulties and pressures from the (short-)term and conditions of visas. This could be turned to an advantage, with implemented changes, discussed below.

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- Lack of historical industry success in **accessing capital**, related/contributing to a lack of understanding of aquaculture by lenders and the perceptions regarding industry's (in)ability to manage risk (e.g. disease, currency, labour).
- **Inability to access key markets** due to the lack of and/or high cost of the supply chain to market, and significant competitive pressure from imports.
- **Market competition** is characterised by considerable ambiguity around the origin of products in Australian seafood purchasing (at worst some misleading practices and at best, importers receiving high margins for imported seafood presented alongside Australian products). Historical campaigns for stronger Country of Origin Labelling (CoOL) regulation have not been successful in implementing changes which protect Australian prawn, barramundi and pearl farmers from ambiguous and misleading competitive practices (in contrast to arguments in the PC, 2016 report).
- The effective **loss of the exclusive use the word 'barramundi'** (an Australian Indigenous word) as a Geographical Indicator registrable for goods using the certification trademark system (i.e. that could only be used for Australian grown product) is a challenge for the barramundi industry.
- **Lack of coordinated policy development**, where human capital and environmental factors must be recognised, with deliberate action needed to address planning and implementation. Aquaculture planning should be in cooperation with other infrastructure planning, regional and population planning (migration and immigration), investment attraction (local and international) accompanied by vetting, facilitation and support.
- **Biosecurity and health** (discussed below)

Factors for successful aquaculture growth...

Reviews of successful aquaculture industry development elsewhere indicate the presence of both: (1) natural advantage (e.g. climate, environmental conditions, well-suited species); and (2) strategic commercial competitive advantages (usually several).

Addressing one or even several of the identified hurdles facing the NAAI will not be enough to change the current industry paradigm. Whilst northern Australia has many natural advantages, commercial capacity needs to be developed and built, which in turn provides a competitive advantage for a successful industry. Therefore, future development of an internationally competitive and thriving NAAI that meets the government/ industry aspirations for northern Australia will need strategic thinking and strategic investment in enabling infrastructure. In addition, strategic development planning (for aquaculture, economic infrastructure and social infrastructure) and implementation are required.

Biosecurity – a priority and major risk...

The current (and potentially expanded) industry in northern Australia is at risk from disease outbreaks caused by pathogens from endemic (existing and new) sources as well as exotic pathogens that are imported. Maintaining biosecurity is the key competitive advantage for most aquaculture species in NAAI. The clean, green and disease-free status are key points of differentiation to the same species products from an overseas (e.g. Asian) market source.

Current policy and technical capacity are barely adequate for the existing industry and are without significant capacity development, which is a substantial risk for the industry. There needs to be a clear understanding in language/policy regarding the difference and particular issues for management of operational disease/health management versus incursion of a new, exotic, potentially catastrophic disease outbreak.

The recent incursion of whitespot syndrome virus (WSSV) likely via uncooked prawns imported as a food product highlights the issues and risks. There are similar risks for barramundi (and other native fish) from imported seafood products that may carry exotic pathogens currently not found in Australia. Biosecurity screening provisions are not adequate to screen or prevent the entry of most of these pathogens.

The development of selectively bred, domesticated lines for the prawn, barramundi and other NAAI industries has been recognised as fundamental for sectors with aspirations to industrialise. The reliance on wild-caught broodstock for most sectors constitutes arguably the greatest biosecurity threat to those industries. Past

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attempts to develop ‘industry cooperative’ breeding programs have largely failed, and new approaches are needed to overcome historical issues and to implement workable programs for industry. Domestication and breeding are also important beyond ‘health’ and are significant factors in the broader economic efficiency of the industry and its major production sectors. There is potential to streamline provisions to amend the live import list to trial/access new pathogen-free species/strains to support broodstock access and breeding programs.

Substantial effort and cross-jurisdictional expenditure will be required to support regional operational health/disease management for an expanded northern aquaculture industry in addition to national/regional border surveillance/quarantine to protect the industry. Regionally based programs and facilities are needed for rapid response diagnostics. Northern Australia programs and facilities, with available capacity and capability, are needed for increased pathogen understanding, documented risks, and investigating transmission pathways. Practical and effective national border surveillance and detection needs to be implemented for an expanded NAA industry (with an option to consider field functions shared between the conventional border and quarantine control and Regional Land and Sea Ranger groups).

Industry must drive investment in incident readiness. An industry-wide response should offer/drive cross-jurisdiction harmonisation so far as the legislation and policy shall allow. Farms should have in place an enterprise-level biosecurity response plan, conduct regular drills and invest in farm staff as the first responders. Government and industry partnerships are key to maintaining a professional and effective response, and formalisation of this partnership is currently in consideration through the Aquatic Deed.

A major driver of the success of the Tasmanian salmon aquaculture industry was the biosecurity protocols it was able to implement. These included domestication and breeding programs (initially State-operated) but also, import restrictions imposed on fresh salmon products, which significantly afforded the emerging industry a substantial commercial advantage, by effectively protecting it from both exotic disease incursion and competition by (lower cost) imported salmon products. The prawn and barramundi farming industries have not had the benefits of similar domestic industry protective policies. The lack of traction with politicians on biosecurity (and other key industry issues) possibly points to ineffectual lobbying and influence, particularly in Canberra.

Other key findings...

Northern Australia has significant aquaculture opportunities and strengths in its species.

Northern Australian aquaculture is naturally suited to growing pearls, prawns and barramundi and as key species it is recommended that the industry continue to focus on these.

Nonetheless, there is considerable potential to expand the opportunities for tropical oysters, freshwater crayfish, grouper, sea cucumber, algae and tropical lobsters as new/emerging key culture species. There is also a species ‘portfolio gap’ in Australian aquaculture – a high volume production, low-cost (low-trophic level), (possibly) freshwater, white fish fillet product to service lower value domestic markets (and potentially exports). It is recommended that these opportunities should be reviewed and if feasible, pursued.

Government-developed ‘aquaculture zones’ have been successful in creating significant new aquaculture development in northern Australia (and elsewhere).

In Western Australia, the Kimberley Aquaculture Development Zone (KADZ) and, south of the northern Australia boundary, the Mid West Aquaculture Zone (MWADZ) are established. The Queensland government also announced Aquaculture Development Areas (ADAs) in 2019. Zones also exist in South Australia and Tasmania. However, better site assessment protocols and ground-truthing pre zoning would improve zone uptake and benefits. Infrastructure development in ‘hubs’, to support utilisation of defined aquaculture zones, is a recommendation of the project to further stimulate industry uptake.

Other potential commercial competitive advantages in northern Australia, which could be exploited, were identified and discussed by industry members.

Potential competitive advantages include:

- **Renewable energy.** Electricity is a major input cost of aquaculture (particularly land-based pond operations). Renewable generation offers the potential for northern Australian aquaculture to lower cost and achieve greater self-sufficiency/reliability than grid-connected supply. It offers a lower carbon footprint, which in turn delivers a considerable marketing/provenance selling point for products. There is potential for aquaculture operations to be developed around a renewable generation 'hub' or transmission line, or micro-grid/distributed generation model.
- **Collective purchasing of electricity.** There are some opportunities (especially in Queensland) for closely located aquaculture farmers to 'aggregate' their individual demand and collectively purchase electricity at significantly lower tariffs.
- **Development of key airport/seaport hub infrastructure** could provide competitive exports. Despite the presence of many regional and major city airports across northern Australia, very few have international freight export capabilities.
- A **transport subsidy scheme (road/air)** for key 'hubs' may be viable and provide cost competitiveness for Australian aquaculture produced seafood. A transport subsidy scheme exists for Tasmania.
- **Changes in biosecurity risk assessment and stricter provisions** to restrict importations of certain raw/ uncooked/ untreated seafood products could substantially lower the risk of disease transfer to the Australian environment and farming operations and provide a business advantage at multiple levels.
- **Opportunity to establish improved access to skilled staff.** An advantage could be achieved with potential changes to the system such as: changes to the 189 visas allowing for longer terms and more specialised (aquaculture) skill categories; more opportunities for specialised business migration; and opportunities for semi- and unskilled worker regional migration programs (specifically to support aquaculture). In addition, aquaculture management training and education provision could be enhanced. Training, pathway and mentoring schemes should be established for Aboriginal and Torres Strait Islander people interested in the sector to underpin their engagement with aquaculture.
- **Country of Origin Labelling (CoOL)**, whether legislated or broadly implemented on a voluntary basis, would allow informed choice for Australian consumers and could bring a competitive market advantage.
- **Australian, northern Australian and Indigenous branding** was suggested as an important component of addressing market development and access, that would provide unique advantages for NAAI.

A detailed Literature Review of northern Australian aquaculture was undertaken for the project covering the historical R&D (including species biology and culture, systems, and product/market development), Indigenous aquaculture, biosecurity, as well as a compilation of government reviews, policy development and implementation strategies, plans and initiatives.

R&D support is a major strategic advantage for the Australian aquaculture industry and its future advancement. In 2018-19, our survey revealed researchers were engaged in up to 74 active research projects across northern Australia (noting some may be reported by more than one respondent). The projects were predominantly focussed on the key marine or estuarine species of pearl oysters, prawns, rock oysters and barramundi. Most were funded by government (56%) and industry (26%), with durations of 2 – 5 years, and had values of \$1 – 5 M (36%), with several projects valued at \$6 -10 M or above \$10 M.

RD&E funding of northern Australian aquaculture has probably had lower benefit/cost outcomes than southern aquaculture.

Capacity issues were identified in relation to increasing the number and scope of research projects to meet the current and expanding industry needs. Ongoing RD&E for the northern Australian industry needs to be relevant, focussed, cooperative and largely 'applied and readily applicable' to industry. There were opportunities identified for additional research positions for in-demand research areas (e.g. aquatic animal health), and start-up and RD&E 'incubators/accelerators'.

Aquaculture business opportunities for Aboriginal and Torres Strait Islander peoples are at research and pilot production scale with support from government agencies, consultants and private investors.

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It is imperative that we learn from past experience with Indigenous aquaculture and avoid issues of attempting technically challenging, or new unproven species, without cultural alignment of these ventures, and projects must be well-resourced with local capacity building. Aboriginal and Torres Strait Islander people shared their vision for unique, Indigenous branded aquaculture products and business that provide for employment and positive economic outcomes for our first nations people.

Expansion and growth of the industry is likely to be hindered by shortages of labour volume and key skill capabilities.

There is already a current undersupply of skilled personnel (particularly in the technical/VET skills and senior management areas. Data collected from this project indicates a need for skilled personnel to fill **at least 1,400 additional jobs** in aquaculture in northern Australia by 2030.

Skills shortage issues are currently (and will potentially continue to be) exacerbated by small regional populations and the inability to locally source skills. Difficulties in attracting and retaining new skilled staff to live and work in northern Australia (due to actual/perceived inadequacy of social infrastructure and liveability), and/or hiring skilled staff from overseas (due to issues with visa conditions and term of employment).

Stakeholders suggested that a re-evaluation of the attitude to foreign nationals being farm labour may be needed. In some cases, there might be a choice available to recruit from overseas or from locally sourced labour. However, in most locations in northern Australia, there are high rates of unemployment, and the reality remains that many people are either unable to understand what the aquaculture labour market may offer or unwilling to do that type of work.

Existing systems are in place to assess the national skills needs in aquaculture, e.g. through the Aquaculture and Wild Catch Industry Reference Committee, and jurisdiction industry reviews. A recent review of the aquaculture vocational qualifications resulted in revised qualifications and skills standards, approved in June 2019 (Skills Impact, 2019). Development and delivery of sector-specific content, aligned to the revised training package, is ongoing.

A Scenario Planning exercise was undertaken for this project to predict what the industry for northern Australia may look like in 2030 and to stimulate industry discussion on the pathways and barriers to achieving the industry and government's aspirations.

Four possible future Scenarios for the northern Australian aquaculture industry were developed. The two 'worst-case/low-aspiration scenarios (the 'Dry' and 'Shower') were regarded as having lower probability/plausibility than the two better/best-case scenarios ('Storm' & 'Monsoon'). This is primarily because current indications are that the industry, within the timeframe of the last year (2018-19), has commenced changes and development that should align with the trajectory for the Storm scenario and potentially into the Monsoon scenario.

The 'Storm' scenario – describes a future where the northern Australian industry has successfully achieved expansion and increased production volumes, eliminating 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 growth is a northern Australian aquaculture industry with a 2030 GVP of \$535 million, based on 22,600 tonnes of seafood, and \$168 million GVP of pearls. 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 the production of 56,600

tonnes of fish, prawns and other seafood products as well as substantial volumes of premium pearls. At least 1,430 and up to 2,340 direct new jobs, at a range of skill levels, will be created.

6.2 INDUSTRY VISION STATEMENT

A northern Australia aquaculture industry Vision 2030 was developed to support its Monsoon aspirations, based on the implementation of the Key Recommendations. This was endorsed by stakeholders in December 2019 and February 2020.

“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.”

6.3 STRATEGIC RECOMMENDATIONS (7)

Table 28 provides a summary of the seven strategic recommendations originating from the situational analysis review of related literature and extensive industry feedback provided through the online survey, focus groups, workshops, Scenario Analysis, and videoconference engagement. These were refined following the project videoconference and other feedback in November-December 2019. Additional feedback on these recommendations was received in January 2020, and at the end-of-project workshop on 5-6 February 2020 (Cobcroft, 2020). The order of recommendations was determined through stakeholder input at the December videoconference, specifically perceived impact on industry expansion. Stakeholder contributions are included in this version of recommendations in the final Situational Analysis report (submitted to CRCNA in March 2020).

6.3.1 Recommendation 1. Bolster Biosecurity

Industry stakeholders prioritised bolstered biosecurity as the primary project recommendation. Furthermore, biosecurity is perceived as a critical issue not only for the aquaculture industry (producers) but also for wild fishers, recreational fishers and the Indigenous community. Both exotic and endemic pathogens and parasites are recognised as posing a risk to the aquaculture industry in northern Australia.

This recommendation covers at-the-border, regional and enterprise-level biosecurity needs to prevent pathogen incursion, to manage disease outbreaks, and control loss of production efficiency. The recommendation includes:

- Review of policy and meeting the requirements for improved risk assessments and R&D programs to better understand biosecurity risk and management at the border.
- Increased pathogen understanding, documented risks, transmission pathways, and practical surveillance implemented for the aquaculture industry in northern Australia.
- Establish the most effective structures to develop high health lines for key production species.

At a national level, AQUAPLAN 2014-2019 (DAWR, 2014) has progressed activities to support aquatic biosecurity, and the intent of the recommendation is to highlight areas of importance to the NAAI that are incomplete or not yet meeting the industry needs in NA. Resolution of the Aquatic Deed would bring more certainty to pathways forward for government and industry. This is a priority action for biosecurity, requiring industry collaboration among sectors and cooperation with government agencies. The Deed will clarify cost-sharing arrangements in the event of a disease outbreak, which is an urgent need before an outbreak event. Animal Health Australia, the proposed custodian of the Deed, is currently developing a value proposition canvas for presentation to aquaculture sectors.

Inclusion of a range of stakeholders (aquaculture industry (producers), wild fishers, recreational fishers and the Indigenous community) is recognised by stakeholders as an important mechanism to communicate the

scientific evidence and urgency required in policy and risk assessment review, and implementation of actions at the border and at enterprise level, to protect species in aquaculture and their natural habitat.

High health lines are included here as a key component of biosecure production systems, acknowledging that the value of these lines also contributes to the capacity for selective breeding programs, and resultant improvement in production performance. Given past challenges to establishing domesticated high health lines in prawns, a proposed option is a new 'cooperative' model led by government(s)/CSIRO and with the involvement of industry (via key industry players and possibly whole of industry arrangements) (e.g. Stephens, 2019).

A suggested pathway for prawns is proposed by CSIRO:

- **Establishing High Health Lines of prawns**
 - Pathway – High health breeding program
 - QLD (and Federal) governmental support for initiatives that will result in ongoing availability (i.e. on market terms) of high health broodstock/seedstock; that can enable QLD and potentially Australian industry access
 - Self-identifying industry champion/s are required to catalyse the network of expertise/capacity to enable the program; CSIRO has flagged interest in this area (open door to discuss collaboration)
 - Industry association to liaise with the industry champion/s to achieve mutually agreed/beneficial position
 - CRCNA resources will not be critical in underpinning this initiative, but could support particular R&D needs that are identified as the initiative develops; but broader governmental support is important to kick-start this initiative

6.3.2 Recommendation 2. Build skills to meet industry growth needs

In association with the projected growth of industry to 2030, an additional 1,430 – 2,340 new jobs will be established in NA. The range in labour estimates accounts for efficiencies of scale and/or the adoption of technology that may reduce staff per tonne of production (lower value), and business-as-usual labour requirements per tonne. The recommendation suggests improvements in the existing aquaculture education and training system, increased industry input to and monitoring of education/training delivered, mechanisms to attract more people to the sector, pathways for engagement of Aboriginal and Torres Strait Islander people, and the urgent need to enhance the skilled migrant worker visa conditions and programs.

While the projected growth of industry production in NA by 2030 will require at least another 1430 new staff, the flipside is that in order to provide ongoing career opportunities for those people the projected growth must be actually achieved (successful investment and expansion) and maintained.

6.3.3 Recommendation 3. Market Development and Access

In a phase of industry expansion, the stakeholders have prioritised market development and access in order to understand the potential impact of higher production volumes and to inform market strategy. Activities suggested include improved access to seafood trade data, and understanding of domestic and international markets. Exploration of international market opportunities may be enhanced by trade delegations to potential international markets. Additional RD&E is required for sector and enterprise branding, adoption of provenance tools, online sales, and the application of blockchain. To strengthen the demand for northern Australian aquaculture products, there is a need for further lobbying for CoOL in seafood in conjunction with enhanced consumer awareness campaigns.

There is a large amount of market and seafood trade data available on the FRDC website (www.frdc.com.au/services), and it is important that future efforts do not to duplicate what is already done and available.

6.3.4 Recommendation 4. Match and target RD&E to key industry needs and outcomes

RD&E for the NAAI should be aligned with the National Aquaculture Strategy 2017 (DAWR, 2017), the National Fishing and Aquaculture Research, Development and Extension Strategy 2016 (FRDC, 2016), the FRDC RD&E Plan 2015-20 (FRDC, 2015) (the FRDC 2020-25 Plan when complete), and existing industry association and State/Territory plans. For northern Australia, the recommendation focusses on increased collaboration across sectors and jurisdictions, improved extension (translation) of research, and evaluation of RD&E to ensure benefit (e.g. improved production efficiency on-farm).

Established sectors (barramundi, pearls and prawns) are well represented by existing strategic plans and Industry Partnership Agreements with FRDC to support investment in priority RD&E. More work is needed for emerging sectors to communicate their research needs to Research Advisory Committees (RACs), FRDC's Indigenous Reference Group (IRG) and other funding agencies. The Supplementary Data document includes a summary of RD&E status in emerging sectors (Cobcroft et al, 2020; in Table 4: Summary of literature review (biological and production) of northern Australian aquaculture) and the situational analysis recommendations here cover cross-sector and pan-northern needs.

6.3.5 Recommendation 5. Facilitate infrastructure development for key Aquaculture Development Hubs

The establishment of aquaculture development areas and zones by governments has provided an important stimulus to industry development. However, to capture the opportunity that these areas provide, key infrastructure and support services in key locations are critical for industry growth in northern Australia.

Mixed stakeholder feedback was received about the nature of this recommendation. Some were in favour of ground-truthing, infrastructure development, hub biosecurity plans, water remediation, and seed supply for development of greenfield sites (e.g. for pre-identified aquaculture development areas (ADAs)). Others suggested the type of hub support is different for different places and may be centred on infrastructure for supply chain needs, potentially in partnership with other sectors, rather than a hub for production. Further comments indicated that infrastructure development may occur in a region to support the activities near/of a single large company, as opposed to a shared hub facility.

Regardless of the focus of investment activity, the recommendation remains a priority for increasing production, production efficiency and/or supply chain connectivity, as it seeks to maximise the benefit of limited funds for appropriate infrastructure for key regions. The goal is to capture efficiencies and synergies with broader development in northern Australia. The planning of hubs is considered a task for government agencies in conjunction with industry, ideally with the oversight of a northern Australian aquaculture governance body (see **Section 6.3.7**). Suggested candidate locations for Hub investment are summarised in **Table 27**.

Hubs are proposed to support the full development (realisation) of established ADAs (where these suit species' production requirements) not as a mechanism to allocate new areas at this stage. Hubs should be developed to gain maximum leverage of infrastructure investment, for aquaculture and other industry sectors, with finance and funding schemes such as NAIF, contributing to: electricity supply; air, road and sea transport; feed mills or local feed storage. Hubs would align supply chain logistics, industrial inputs, land-based support for offshore operations, labour, community and social needs, training and research facilities. Hub development should consider the amenability of Hubs to human capital and research capacity, and this also aligns with the social goals of community development in remote and regional locations (Infrastructure Australia, 2019).

Hubs may provide infrastructure for remote production (in designated zones or ADAs) or be clusters of production operations in a development area. Whilst licencing requirements are established to protect the surrounding environment, where multiple farms are located together there is an opportunity to share bioremediation infrastructure. Area carrying capacity assessment is required and environment monitoring should be implemented to avoid any potential cumulative impact of intensive or large-scale development.

6.3.6 Recommendation 6. Build the Northern Australia aquaculture industry as a means for Indigenous economic development and independence

Indigenous Australians are responsible for managing 45% of the land and sea country in northern Australia. There are multiple avenues for Indigenous communities to engage with aquaculture. An important step is understanding if a community is interested and the communication of what an aquaculture business is, how it works, and how they might want to be involved. This involves engaging communities and developing sensible and realistic business concepts that deal with biology, business and culture constraints. Previous projects have established that a long-term commitment and positive organisational relationships are required to develop successful Indigenous agri-business opportunities. Business and community governance must be in place and suited to an aquaculture enterprise to achieve success. The recommendation provides potential pathways and options for Aboriginal and Torres Strait Islander engagement, including: investors in projects; owners and managers; venture partners; supply-chain partners; and a local workforce.

Northern Australia Aquaculture Industry – Situational Analysis

Table 27: Potential candidate locations for infrastructure and service provision at Aquaculture Development Hubs in northern Australia.

Region	Key City/towns	Aquaculture Industry	Electricity	Airport	Other transport/services
Gascoyne	Carnarvon, Shark Bay and Exmouth	Rock Oysters Prawns (Exmouth Seafarms breeding centre) Pearl Oysters		Carnarvon Learnmonth	Cool chain vegetables in Gascoyne Horticulture zone from Carnarvon to Perth
Pilbara	Karratha	Rock Oysters	Solar Hub	Karratha	Heavy shipping ex Dampier and Port Hedland Marina facilities in Dampier
West Kimberley	Broome, Derby	Paspaley, Cygnet Bay, Willie Creek – Pearls Marine Produce Australia – Barramundi Aarli Mayi – Barramundi Tropical Oysters – Maxima Opportunity Emama Nguda – Cherabin Broome Tropical Aquaculture Park – DPIRD Yawuru Aquaculture North West Regional TAFE Broome – Training, R&D New hatchery development New marine growout sites – (more accessible via One Arm Point road (and jetty) Land-based growout sites	Solar Hub	Curtin air base (international potential) Broome domestic	Cold chain storage (servicing aquaculture, beef, horticulture) – Curtin airport Dampier Peninsula– Road (completion) and One Arm Point – potential for jetty development Industry equipment fabrication, repairs & maintenance North West Regional TAFE Broome – local education and training DPIRD BTAP offers significantly underutilised infrastructure Universities – dedicated local R&D Integration with tourism industry
East Kimberley	Kununurra	Project Sea Dragon Prawns FW fish culture (Lake Argyle) – 10000T aquaculture industry development plan was done for Lake Argyle in 1999-2000. Could be refreshed for other species – (e.g. Silver Cobbler) to meet the portfolio gap.	Pacific Hydro – Lake Argyle Dam Ord scheme	East Kimberley Regional Airport Kununurra	Supply chain for horticulture product to Darwin and eastern states. Wyndham Port
Northern Territory	Darwin (Legune/Kununurra)	Humpty Doo – barramundi DAC – Indigenous groups – TROs Seafarms (Project Sea Dragon) – prawns Other (historical) – prawns/barramundi Large areas for new potential marine and coastal onshore development Darwin Aquaculture Centre (DAC) – hatcheries, R&D	Solar hub (integration with new proposed solar gen-distribute projects) – aggregated demand New gas-fired opportunities	Darwin – (internat. expansion) - integrated road logistics and cold storage facilities	Cold chain storage (servicing aquaculture, beef, horticulture) – Darwin airport Road Transport hub; Logistics/transport subsidy Industry equipment fabrication, repairs & maintenance CDU/TAFE – local education and training CDU – dedicated local R&D Integration with tourism industry Feed inputs growing
Mid-north QLD tropics	Townsville (TSV) – Rockhampton (ROK) Cities of Townsville, Burdekin, Whitsunday, Mackay/ Rockhampton	Tassal – prawns Ornatas – lobsters Spring Creek - barramundi PB/PRF – prawns, cobia GFB – barramundi Australian Prawn Farms (APF) Australian Crayfish Hatcheries – redclaw JCU/CQU/TAFE – training & R&D New QLD ADAs (large areas for new development Mackay Airport Other airports	Solar hub (integration with new proposed solar gen-distribute projects) – aggregated demand New gas-fired opportunities	Townsville – some current internat. ROK – some current internat. Whitsunday – capacity for international	ROK – currently undertaking feasibility for integrated airport cold-store facilities Industry equipment fabrication, repairs & maintenance JCU/CQU/TAFE – local education and training JCU/CQU – dedicated local R&D Integration with tourism industry Feed inputs growing
Far north QLD/Gilbert River/Cape		Seafarms Valverde – redclaw (Atherton) IFED development (stalled) – redclaw CSIRO-identified high-potential site for FW culture systems Gulf and Western Cape York coast – potential for high-quality sites Indigenous interest Rio Tinto (Weipa)	Solar hub Renewable biomass fired opportunities	Cairns export hub Mt Isa Weipa	Needs key road links developed to larger regional service towns (Cairns, Mt Isa) Industry equipment fabrication, repairs & maintenance JCU/CQU/TAFE – local education and training JCU/CQU – dedicated local R&D Integration with tourism industry Feed inputs growing

6.3.7 Recommendation 7. Stronger and adaptive governance of the northern Australian aquaculture industry

In order to achieve the industry Vision 2030, and capture the opportunities in northern Australia, enhanced and adaptive governance is required. The intent of the recommendation is to streamline processes for new aquaculture development, leverage opportunities across jurisdictions and sectors, and provide a stronger voice to policy-makers in southern Australia.

Northern Australia Aquaculture Industry – Situational Analysis

The original proposed recommendation (Stage 1 Report) was that the Minister for Northern Australia establishes a body charged with the development of aquaculture in northern Australia. The role of such a body would be to:

- ensure co-ordination between Commonwealth agencies and between jurisdictions
- identify priorities for Government investment, taking into account efficiencies and opportunities arising from scale, co-location, coordination and existing facilities and infrastructure
- identify actions that would increase participation by and create business and economic opportunities for Aboriginal and Torres Strait Islander people in the northern Australian aquaculture industries
- liaise with industry to understand industry priorities and encourage private sector investment
- over-see the implementation of the CRCNA aquaculture industry situational analysis project recommendations.

An important consideration presented by delegates at the end-of-project workshop in February 2020 was 'why/what do we need' to support the adoption of the priorities of the situational analysis study. The industry emphasised that they do not want any dilution of effort and are mindful of taking resources (financial and time) from functioning structures. Any new governance structure needs to add value and not take away from what is already in place and effective. There must be a strong value proposition for a new structure or change.

There are several governance structures currently in place. At a national level, the Australian Fisheries Management Forum (AFMF) has an Aquaculture Subcommittee comprised of State/Territory managers, a Commonwealth representative and FRDC. Stakeholders indicated that this Subcommittee generally meets less than twice per year. There is also a Subcommittee for Aquatic Animal Health that works on AQUAPLAN, which is an advisory committee to the Animal Health Committee (AHC) of the Department of Agriculture Water and the Environment (DAWE). It is comprised of representatives from Australian, State, Northern Territory and New Zealand governments, the CSIRO - Australian Animal Health Laboratory, and Australian universities. There are generally two face-to-face meetings each year, and these are more frequent in the event of a disease response. The National Aquaculture Council (NAC) includes representatives from all major industry sectors. There is a good working relationship between industry and government agencies. Cross-sector collaboration has been ad hoc and declined since the end of national conferences (last one in 2014).

Stakeholder engagement suggests the established industry associations for key species in NA (ABFA, APFA and PPA) and the NAC will continue to provide input on issues important in the north, for example: skills needs; aquaculture policy and regulation; biosecurity; CoOL; prioritised RD&E; aquaculture reputation; and community engagement. FRDC maintains a leading role in developing RD&E priorities across Australia, working through Industry Partnership Agreements, jurisdiction Research Advisory Committees and a Northern Hub for research leads.

Rather than establishing another association or body, one concept proposed by CSIRO would be to establish a NA forum, which would be cross-sectoral/interest, yet would provide a means for NA aquaculture interests to be represented and connected to the higher levels of governments (federal, state, and potentially even council). This would require a coordinating mechanism (coordinator or coordinating team) that currently does not exist. The coordinating team would need to be represented by industry and government (and potentially also ancillary organisations such as universities/research agencies); and from a cross-sectoral perspective, the coordinators will not necessarily be of aquaculture background; but certainly aquaculture interests must be represented in an ongoing way in the forum. It was proposed that the CRCNA would have a role in identifying these coordinators; and have a role in the resourcing the forum over the initial 5 years.

The conclusion from the stakeholder discussion at the end-of-project workshop was that **more work is needed by industry and government stakeholders to clarify a body/structure that will improve aquaculture governance and development in northern Australia**. A short consultancy project and roundtable workshop is recommended, with delegates based on the advisory group that established the terms of reference for the situational analysis project (a government representative from each jurisdiction and representation of major industry associations). It is proposed that the workshop: (1) document the existing structures in aquaculture governance applicable to northern Australia (NA); (2) document actual activity; (3) include case studies of

different types of successful governance models from other sectors; and (4) recommend an approach to strengthen aquaculture governance for NA.

6.3.8 Estimated cost of implementation

Industry stakeholders endorsed the recommendations and pathways (action steps) prior to and at the end-of-project workshop in February 2020 (**Table 28**). Additional pathways were contributed by the workshop participants (documented in the Workshop report; Cobcroft, 2020). Based on estimates by stakeholders (December 2019 videoconference), the required government investment in the recommendations would be at least \$90 million, and much higher if all infrastructure development was included along with partner leveraged funds and private investor capital.

Given the comprehensive list of recommendation pathways proposed by stakeholders, a detailed assessment of economic estimates would be required to inform the cost of full implementation.

The direct return on investment is an industry valued at over \$1b per annum by 2030, employing between 1,950 and 2,860 people in northern Australia.

6.4 RECOMMENDATIONS SUMMARY TABLE

Table 28: Summary of strategic recommendations of the Northern Australia Aquaculture Industry Situational Analysis

Key priority actions for sector development	Potential action owner (not yet identified) and potential key partners	Potential pathways to implementation and timeline	Intended industry impacts
<p>1. <u>Bolster Biosecurity</u></p> <p>The recommendation is to bolster aquaculture biosecurity through:</p> <ul style="list-style-type: none"> • review of policy and meeting the requirements for improved risk assessments and R&D programs to better understand biosecurity risk and management at the border • increased pathogen understanding, documented risks, transmission pathways, and practical surveillance implemented for the aquaculture industry in northern Australia • establishment of the most effective structures to develop high health lines for key production species. 	<p>Commonwealth Department of Agriculture</p> <p>State and territory responsible departments and agencies</p> <p>Industry (enterprise level, associations, consortia)</p> <p>Animal Health Australia</p> <p>FRDC, Aquatic Animal Health Subprogram</p> <p>Australian Animal Health Laboratory, CSIRO, Victoria</p> <p>Universities</p> <p>Diagnostic laboratories</p> <p>Veterinary service providers</p> <p>Innovation Hubs (tech-based solutions)</p> <p>Border Force (ballast water control)</p> <p>Recreational fishers</p> <p>Consumers</p> <p>General public</p> <p>CSIRO</p> <p>Local government staff</p> <p>Indigenous Rangers</p> <p>NRM's Oceanwatch</p>	<p>Policy</p> <ul style="list-style-type: none"> ▪ Resolution of Aquatic Deed ▪ Industry Associations united on biosecurity ▪ Implement existing sector biosecurity plans and complete plans for other NA sectors ▪ Ensure emergency response plans are in place for all species – consider a levy in place to support this ▪ Improve the working relationship between producers and agencies ▪ Support sector-specific biosecurity plan writing for NA enterprises ▪ Complete emergency response drills ▪ R&D to better understand biosecurity risk and threats from imports ▪ Commence R&D on transmission pathways ▪ Review policy and risk assessment with clear government – industry communication ▪ Implement accountability measures ▪ Review biosecurity architecture aligned with NA industry growth ▪ Propose a summit for state, territory, federal government and industry to: understand the risk assessment process; breakdown the opacity of decision making and policy; plan a pathway to policy change which would inform any RD&E or industry planning/implementation undertaken ▪ Assumptions present in risk assessments need to be assessed through research 	<ul style="list-style-type: none"> ▪ Protection of ~\$223 million industry from a species sector or regional sector collapse, underpinning expansion to \$1.3 billion GVP by 2030, and protecting between 1,950 and 2,860 jobs ▪ Improved understanding of biosecurity risks ▪ Research to support appropriate science-based policy responses to manage the risk conservatively ▪ Increased productivity per ha of an estimated 10%, of all aquaculture sectors in northern Australia with a value of at least \$100 million p.a. by 2030 ▪ Reduced cost of production ▪ High health lines as a foundation to selective breeding programs ▪ Reduced risk of disease outbreak, with results available in time to give farm managers time to respond to identified pathogens ▪ Knowledge of the impact of chronic health challenges caused by endemic pathogens on-farm, linking pathogen prevalence with pond or tank productivity, leading to informed decision making by managers

		<ul style="list-style-type: none"> ▪ Identify/establish a clear reporting process to influence future biosecurity policy formation ▪ Include protection of wild stocks (value for ecosystem services, biodiversity, iconic species protection, traditional fisheries, wild capture fisheries) ▪ Increase the consideration of biosecurity risk in NA with current biosecurity management agencies ▪ Identify pathways for disease incursion (biosecurity risk) from NA neighbours ▪ Establish a clear arrangement of responsibility and compensation, including government (border responsibility) and industry (farm, enterprise-level responsibility) {related to the Aquatic Deed} ▪ The Deed will help identify government and industry roles and responsibilities more clearly ▪ Pre-agreed responses to be determined for specific pathogens and included in the compensation arrangement ▪ Industry Risk Assessments (IRAs) need to be flexible and updated when new risks emerge ▪ Address frozen imports through enhanced border surveillance and reduced volumes ▪ Ensure each stakeholder has capacity to fulfil biosecurity commitments as it is a shared responsibility ▪ Develop accreditation for industry ▪ Leverage other agencies ▪ Consideration of human health in conjunction with aquatic animal health for access to more resources <p><u>Pathogen understanding & surveillance</u></p>	
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		<ul style="list-style-type: none">▪ Prioritise tests not currently available in NA for timely diagnostics – on-farm and NATA-accredited labs▪ New co-funded positions to establish diagnostics in NA▪ Develop ‘farm guides’ for early identification and implement monitoring▪ Integration of land and sea Rangers in surveillance and monitoring▪ Increase the focus to clearly identify the impact of endemic disease and address improved management▪ Establish a co-ordinated approach to analysis of the large amount of data collected▪ Establish baseline surveillance data (currently no or limited baseline data)▪ Enhance diagnostic resources for endemic and exotic pathogens▪ Annual training for industry, including updates on biosecurity and an update and refresher on responses▪ Clarify the financial benefits to industry of undertaking disease monitoring/testing▪ Quantify the economic cost (including social impact and business risk) of a disease incursion, the biosecurity risk, and the cost of surveillance and management▪ Achieve faster approval for rapid test kits on farm (this currently requires approval from the state)▪ Surveys are needed to collect data on (potential) transmission pathways and to quantify the risk of exposure▪ Establish a national network of diagnostic laboratories with consistent methodologies▪ Establish an education program for producers, including provision of sampling kits to enable producers to send viable samples	
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		<ul style="list-style-type: none"> ▪ Establish program for breeding for resistance ▪ Investigate species resistant to disease – Specific Pathogen Resistant (SPR) strains and alternative crops for business resilience 	
<p>2. <u>Build skills to meet industry growth needs</u></p> <p>The recommendation is to build skills to meet industry growth needs in the northern Australia aquaculture industry.</p> <p>Meet the gap in skilled personnel to fill at least 1,400 new jobs in aquaculture in northern Australia by 2030.</p> <p>Retain skilled staff in northern Australia.</p>	<p>Commonwealth government departments and agencies</p> <p>State and territory government departments and agencies</p> <p>State/Territory Industry Training Advisory Bodies (ITABs)</p> <p>Australian Industry and Skills Committee</p> <p>Aquaculture and Wild Catch Industry Reference Committee</p> <p>Skills Impact (Skills Service Organisation)</p> <p>Universities</p> <p>RTOs and TAFEs (VET)</p> <p>CSIRO</p> <p>Regional Jobs Committees (QLD)</p> <p>Regional Development Authorities</p> <p>Indigenous Reference Group for Developing Northern Australia</p> <p>Government – Indigenous agencies</p> <p>Industry associations and individual producer and supplier companies</p> <p>Regional Councils</p> <p>Regional schools</p> <p>Natural Resource Management (NRM) organisations</p>	<ul style="list-style-type: none"> ▪ Engage with Skills Australia and responsible government agencies on the critical immediate issues and emerging staff need for the aquaculture industry in NA ▪ Discussion leading to improvement of the skilled worker visa conditions and programs to better facilitate skilled migrant employment to fill the current gap in skilled personnel, especially in the short-term (2020-2024) ▪ Coordinate, boost and resource available training ▪ Align training with business needs and monitor progress ▪ Address inter-jurisdictional barriers, e.g. some State/NT subsidies for VET training are only available for residents of a State working in that State ▪ Include professional development training for current staff to foster career progression ▪ Develop industry-tailored training (e.g. VET-industry collaborative training centres and/or on-farm) ▪ Increase the number of qualified VET trainers (RTOs) ▪ Enhance innovation and entrepreneurship skills in aquaculture curricula ▪ Increase technology skills training, with a view to more automation ▪ Improve the image of sustainable aquaculture, through ‘career opportunity’ campaigns to attract new people to the sector – include celebrity endorsement 	<ul style="list-style-type: none"> ▪ At least 1,400 additional skilled personnel available for the northern Australia aquaculture industry to enable achievement of projected production of \$1.3 billion GVP by 2030 ▪ Skilled staff who value the aquaculture industry and community in northern Australia ▪ Revised curricula endorsed by industry

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		<ul style="list-style-type: none">▪ Industry funded prizes/traineeships/scholarships for schools, VET and university▪ Increase training engagement (enrolments) and promote aquaculture career pathways, from secondary education, for Australians committed to living and working in northern Australia▪ Establish demonstration farms for training (could be aligned with Hubs)▪ Establish appropriate models of training and mentoring for Indigenous Australians▪ Establish international exchanges for NA aquaculture trainees/students/staff professional development▪ Establish skills/career training pathways from High school to higher education – partnership across institutions and with industry▪ Build training packages that are contextualised to the commodity (species)▪ Train school teachers to help retain students interested in aquaculture▪ Increase engagement with high schools through: presentations; sponsorships, prizes; targeted media▪ Actively engage industry-driven advice on required skills (underway for VET through Skills Impact) – appropriate skills for the positions available▪ Include school programs for aquaculture industry awareness, VET options, Junior Rangers programs, promotion of aquaculture careers▪ Increase aquaculture skills for local people▪ Increased access to skilled migrants with appropriate classification on Visa skills list▪ Include pathways for ‘awareness – education – skills’	
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		<ul style="list-style-type: none"> ▪ Train the trainers for Indigenous communities – train indigenous people to train in community ▪ Investment in vocational training – communication of available funding and establishing policy to maintain/increase funding for training ▪ Attract existing skilled people from the south and from overseas ▪ Support skills development in supply chains and for chefs (these drive product demand) ▪ Retain skills – develop Indigenous employment and engagement strategies (e.g. trainers, assessors) ▪ Build skills – encourage meaningful engagement with Indigenous communities around training development and delivery on-country ▪ Upskilling of companies (industry staff) on standards and certification ▪ Seek funding for a YouTube channel and seed with some videos to become a virtual hub for technique sharing ▪ R&D to understand barriers for attraction/retention of staff and frame solutions based on known barriers ▪ Map skills required for NA aquaculture ▪ Retain skills/staff through creation of a decent employer company approach and capacity building for companies to create this environment ▪ Include education in civil society on standards and certification ▪ Link the delivery of skills and training to aquaculture development hubs ▪ Explore apprenticeships and subsidised supervision of traineeships with on-farm training 	
<p>3. <u>Market development and access</u></p> <p>The recommendation is to support the northern Australia aquaculture industry in market development and access (domestic and international).</p>	<p>Industry Consultants Universities Austrade</p>	<ul style="list-style-type: none"> ▪ Define data gaps and analysis needs for seafood trade and market data for key production species, through a pre-competitive roundtable discussion ▪ Understand consumer trends and future needs 	<ul style="list-style-type: none"> ▪ Secure consumer demand for NA aquaculture products ▪ Established and expanded domestic market to match the increased product supply

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	<p>Industry associations</p> <p>Investors: Capital and market; Impact; 'Green' investment</p> <p>State and Territory governments</p> <p>Global standards & certification bodies</p> <p>National certification bodies</p> <p>Exporters</p> <p>Other successful industries</p> <p>Aligned industry such as wild fishers</p> <p>Supermarkets</p> <p>Statutory Authorities</p> <p>FRDC</p> <p>Indigenous partners</p> <p>Tourism sector</p> <p>Commonwealth Department of Agriculture</p> <p>Seafood Brokers</p> <p>Government (re CoOL)</p>	<ul style="list-style-type: none"> ▪ Economic analysis of the potential impact of higher product volumes, to inform sector market strategy ▪ Undertake trade delegations to potential international markets, combined with a consumer analysis in export countries ▪ Develop sector branding ▪ Use R&D to address consumer needs, create verification and traceability tools for consumers to understand unique NA aquaculture product(s), integrity, and that engage with innovation in the tools available (including blockchain) and under development to determine provenance ▪ Promote CoOL in seafood – add the northern Australian voice to the national campaign; add at least one other jurisdiction for CoOL ▪ Understand digital opportunities for northern Australian aquaculture – sales, promotion, and reduced supply chain connections and costs ▪ Enhanced consumer and community awareness campaigns ▪ Product development and value-add opportunities ▪ Strengthening the quality/accuracy of available, anonymised, jurisdiction and national production data ▪ Understand international production trends ▪ Explore market development options in view of at least doubling production, e.g. support for export market development, value adding and product diversification (ABFA) ▪ Undertake an analysis of market opportunities for products from northern Australia ▪ Production forecasting to allow focussed timing of marketing 	<ul style="list-style-type: none"> ▪ Established international export market(s) for at least one species ▪ Profitable and growing aquaculture sector, achieving expansion to \$1.3 billion GVP by 2030 ▪ Value-added products developed ▪ Sector and Indigenous aquaculture brands established
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		<ul style="list-style-type: none">▪ Engagement campaigns to strengthen social licence from general community▪ Investigate methods to change and measure change in consumer trends over time▪ Investigate unique naming opportunities for NA aquaculture▪ Use 'local' in branding and marketing▪ Capture the 'remote and clean waters' in marketing of product from NA▪ Embrace Indigenous country of origin in marketing▪ Regional festivals to build markets, connection with community and social licence▪ Explore tourism with enterprise level, sector, and northern Australia approach▪ Learn from sectors and supply chains that work well, esp. re value adding▪ Development of best technologies and networks for traceability and provenance:<ul style="list-style-type: none">▪ There is considerable interest and investments now in developing capacity for traceability and provenance in Australia▪ Coordinating key expertise networks for cross-sectoral development of these tools would optimise resources/uptake▪ As this activity is relevant beyond aquaculture, CRCNA would be well positioned to see cross-sectoral interests/expertise in this space coming from the different NA situational analyses, and to coordinate an initial forum to explore the opportunity, potential champions, and to identify cross-sectoral research opportunities▪ CSIRO has traceability and provenance as an essential element of one of its research missions; and has significant	
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		<p>expertise in this space; and would be an obvious contributor to an initial forum on cross-sectoral NA opportunities</p>	
<p>4. <u>Match and target RD&E to key industry needs and outcomes</u></p> <p>The recommendation is that RD&E is focussed on industry outcomes, and is aligned with the National Aquaculture Strategy 2017, the FRDC RD&E Plan 2015-20, the FRDC RD&E Plan 2020-25 Plan (when complete), and jurisdiction and industry association plans.</p>	<p>CRCNA FRDC Commonwealth Department of Agriculture State and territory responsible departments and agencies Industry CRCNA’s Aquaculture Advisory Group (government and industry represented) CSIRO AIMS Universities Consultants</p>	<ul style="list-style-type: none"> ▪ Clearly define the budget available for NAAI RD&E from CRCNA and FRDC ▪ Call for applied RD&E for the NAAI in alignment with the National Aquaculture Strategy 2017, the FRDC RD&E Plan 2015-20 (the 2020-25 Plan when complete), and existing jurisdiction and industry association plans ▪ Encourage industry collaboration and knowledge sharing ▪ Capture opportunities in cross-sector and cross-jurisdiction RD&E ▪ Strengthen government extension capabilities and build extension into all projects ▪ Enhance R&D provider-industry collaboration to improve ROI ▪ Collaborate with other agriculture industries (e.g. common technology) ▪ Establish RD&E grant accessibility at different scales – laboratory, on-farm, start-ups, pilot, commercial upscaling ▪ Establish research infrastructure suitable for modern, tropical and remote aquaculture needs ▪ Engage the Startup community ▪ Incentivise and increase fluidity between researchers and industry ▪ Ongoing review of ROI on research investment ▪ RD&E themes include: <ul style="list-style-type: none"> • Species/biological/systems • Health/biosecurity/disease • Breeding and genetics • Environment – aquaculture interactions (including water quality, nutrient bioremediation, wildlife) • Technology (including remote monitoring and management with 	<ul style="list-style-type: none"> ▪ Research aligned to industry needs and delivering value for investment ▪ Limiting bottlenecks to new investment and expansion, to support a 5-fold increase in production by 2030, providing an additional value of \$1.1 billion GVP, 1,400 jobs, and associated economic indirect benefits for regional Australia ▪ Rapid adoption of innovative technologies across a broad geographical area, estimated at 10% improved productivity of all aquaculture sectors in northern Australia with a value of at least \$100 million p.a. by 2030 ▪ Enhanced reputation of northern Australia through industry-relevant research excellence that attracts researchers to move and work there

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		<p>supporting telecommunications infrastructure; automation)</p> <ul style="list-style-type: none"> • Feeds and feed management • Post-harvest and value-adding • Markets, provenance and supply-chains • Commercial 	
<p>5. <u>Facilitate infrastructure development for key Aquaculture Development Hubs</u></p> <p>The recommendation is to facilitate infrastructure development for key Aquaculture Development Hubs in northern Australia.</p>	<p>Office of Northern Australia Infrastructure Australia Northern Australia Infrastructure Facility Commonwealth Department of Agriculture State and territory responsible departments and agencies Regional development agencies Local government Industry Investors Consultants Registered Training Organisations Universities AIMS Statutory Authorities (e.g. ILSC) Airports Traditional Owners and Indigenous organisations</p>	<ul style="list-style-type: none"> ▪ Obtain funding for master-planning, aligned with developing NA initiatives and existing development ▪ Include Traditional Owners in Hub planning ▪ Clearly identify and prioritise infrastructure, supply chain, and service gaps and synergies for each region to inform Hub location ▪ Decide on the optimum number of Hubs ▪ Gauge political appetite to agree on at least one Hub site per high growth region, target three (3) agreed in 2020 ▪ Develop costed feasibility and investment models to attract funding and investors ▪ Identify Hubs, user groups, and allocate development responsibility ▪ Establish the Hub infrastructure, that may include State/Territory owned assets ▪ Monitor the uptake of greenfield aquaculture areas associated with Hub investment ▪ For at least one greenfield site – undertake technical studies, site and biological assessments, establish zone specific policies ▪ Promote Hubs and monitor uptake and business/production efficiency ▪ Environment monitoring and review of Hubs associated with production ▪ Establish value-add processing facilities ▪ Engage with RD&E to address any identified impediments 	<ul style="list-style-type: none"> ▪ Meet industry infrastructure requirements by co-development of sites/hubs for maximum benefit and investment leverage ▪ Improved supply chain logistics (electricity, air/road/sea freight, feeds) ▪ Establish increased capacity in the cold and perishable supply chains in northern Australia to allow the increased volume of production (from ~11,000 tonnes 2016-17 to over 56,000 tonnes in 2030) to reach domestic markets and to open up new export markets. ▪ Leverage or build an area/zone providing community benefits (labour, social, remote, Indigenous) ▪ Alignment with education, training and RD&E providers and facilities ▪ Aquaculture industry engaged in prosperous and diverse regional and Indigenous communities

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		<ul style="list-style-type: none"> ▪ Engage incubators for new aquaculture businesses ▪ Benchmark hub outcomes and review next phase of development ▪ Link hubs with the biosecurity priority recommendation – especially more laboratory capacity ▪ Undertake environmental risk assessment, and define the carrying capacity of production-focussed hubs, with consideration of potential cumulative impacts ▪ Include facilities, plans and regulation to mitigate environmental impacts ▪ Engage with regional needs for training and education 	
<p>6. <u>Build the northern Australia aquaculture industry as a means for Indigenous economic development and independence</u></p> <p>The recommendation is to build the northern Australia aquaculture industry as a means for Indigenous economic development and independence.</p>	<p>Indigenous Reference Group for Developing Northern Australia FRDC’s Indigenous Reference Group Torres Strait Regional Authority North Australia Indigenous Land and Sea Management Alliance Indigenous Land and Sea Corporation Aboriginal and Torres Strait Islander Corporations and Land Councils Industry Government – federal, State and Territory Investment partners RD&E funding agencies CSIRO, AIMS, other RD&E providers Consultants</p>	<ul style="list-style-type: none"> ▪ Invest in existing programs of research and pilot-scale aquaculture ventures to maintain long-term development, relationship, mentoring and support ▪ Address tenure, and establish/partner with appropriate business governance models and economic frameworks ▪ Facilitate connection between aspiring Indigenous groups and existing business ▪ Build the capacity and availability of mentors in government agencies and service providers ▪ Incentivise industry involvement in indigenous development/mutually beneficial partnerships that are long-term ▪ Undertake feasibility studies and invest in economically viable opportunities ▪ Education and awareness opportunities ▪ Indigenous equity mobilisation and deployment ▪ Prototype projects, ventures and corporations ▪ Share aquaculture business stories and learn from past experiences 	<ul style="list-style-type: none"> ▪ Successful deadly businesses established, supported to grow and enabled to employ more people ▪ Aboriginal and Torres Strait Islander engaged in and positive about aquaculture in northern Australia

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- Mentoring among Indigenous business to encourage new Aboriginal and Torres Strait Islander groups to engage
- Supply decision support tools for Aboriginal Corporation boards and an “Aquaculture Business development toolbox”
- Integration with Aquaculture Development Hubs (e.g. training, establishment of microbusinesses, employment)
- Support community champions and drivers
- Scholarships for Indigenous students
- Align ventures with cultural needs and community definition of success
- Investigate the feasibility of microfinancing to support small business establishment
- Support projects with continued engagement and emphasis on handover of operations to Indigenous partners/owners while still supporting as appropriate in the transition phase
- Support Indigenous branding, certification and provenance
- Aquaculture opportunities shared by Indigenous organisations/people at appropriate events, such as the annual Rangers Conference
- Create a “process map” to assist Indigenous communities in engagement with aquaculture business development, and for non-Indigenous aquaculture business to engage with Traditional Owners and local community
- Establishment of Indigenous-led low input aquaculture industry in the North:
 - There is considerable opportunity to develop low input pond-based aquaculture industry in Northern Australia. The extensive, low input model of farming removes many of

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		<p>the inherent constraints of working in NA. e.g. access to seed and skilled labour, input costs and infrastructure.</p> <ul style="list-style-type: none"> CSIRO has flagged strong interest in this area and are in the early stages of developing a long-term masterplan, with the development of a low input demonstration prawn farm integral to the project. CRCNA resources could support R&D needs that are identified as the initiative develops; but broader governmental (State, Federal, Local) and investor support is critical for the initiative to succeed. 	
<p>7. <u>Stronger and adaptive governance of the northern Australian aquaculture industry</u></p> <p>The recommendation is that additional planning is required to determine an appropriate mechanism/structure for strengthened governance.</p> <p>First step: recommend a short project and roundtable workshop be funded to: (1) document the existing structures in aquaculture governance applicable to northern Australia (NA); (2) document actual activity; (3) include case studies of different types of successful governance models from other sectors; and (4) recommend an approach to strengthen aquaculture governance for NA.</p>	<p>Minister for Northern Australia</p> <p>Office of Northern Australia (ONA)</p> <p>Commonwealth government departments and agencies</p> <p>State and territory government departments and agencies</p>	<ul style="list-style-type: none"> A short project funded to recommend an approach to strengthen NA aquaculture governance Establish a new body and/or enhance existing structures Scheduled meetings to deliver objectives Regular reports to appropriate agencies and/or industry Facilitate independent evaluation of progress 	<ul style="list-style-type: none"> Oversight of expansion of aquaculture in northern Australia to \$1.3 billion GVP by 2030, providing 1,400 jobs, and associated economic and social benefits to regions and communities in NA Stronger governance of the NAAI and coordination of infrastructure development in NA

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