Key Findings:

- **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).**
  - Northern Australia, comprising nearly 4.8 million km^2 of land (53% of Australia's total land mass)
  - Annual GVP (FY17) from northern Australia aquaculture was about $220 million (c.f. the northern Australian beef industry which had a FY18 GVP of approximately $5B).
    - FY17 NAA production was constituted predominantly by prawns (35%), and barramundi (33%), pearls (non-edible) 31%, with several other species (oysters, redclaw and other finfish) making up the remaining 1% of value.
      - Prawns (~$78M)
      - Barra (~$74M)
      - Pearls (~$70M)
      - Other (oysters, redclaw and other finfish) (~$2M).
  - In 2016-17 Australia's entire aquaculture industry GVP was approx. $1.35B, of which southern aquaculture production (dominated by Tasmanian salmon, South Australian southern bluefin tuna and NSW, SA & Tasmanian oysters) constituted about $1.03B.
- **A review of the NAAI indicates it is diverse, multi-sectoral, fragmented and dispersed. It has been slow-growing, particularly compared with southern Australia. Overall, its structure is predominated by SMEs and family business operators, with the Research Development and Extension (RD&E) and government sectors significant; the overall industry management 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'. The 'others' category comprised of several small emerging sectors or operations such as freshwater crayfish (redclaw and cherabin), other finfish (groper 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.
  - 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.
  - Industry consolidation is occurring and transition to large corporate operators has begun
    - This reflects a similar pathway to that of the Tasmanian salmon industry.
  - The current structural profile of the NAA industry representatives surveyed indicates:

❖ 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).

❖ **The growth of aquaculture development and operations in northern Australia have been inhibited or thwarted by a range of complex, multi-factorial, often negatively-acting synergistic hurdles.** The main issues are:

- Geographic/demographic/commercial – 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;
- Regulatory – the lack of clear, open and navigable paths to aquaculture investment, development and operations
  - Now a clear pathway in WA - https://www.treasury.wa.gov.au/uploadedFiles/Site-content/Economic_Policy/Streamline_WA/Aquaculture-90-day-summary-report.pdf
  - NT and QLD with remaining issues
  - However, many of these regulatory issues have not been purely 'aquaculture-specific' (see below); and

- Policy – a lack of coordinated policy development and implementation which could alleviate many of the above hurdles
  - despite considerable policy discussion (parliamentary inquiries, strategic and regulatory reviews); and
  - inadequate review/assessment of policy and regulation implemented, or assessment of their effectiveness.

❖ **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 with poor suitability for aquaculture production);
- high environmental and regulatory hurdles;
  - Despite the Productivity Commission 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).
  - This view is driven by data from Australia's overall aquaculture output growth rate over the past decade —underpinned by growth in salmon — which the Productivity Commission cites as 'similar to those of the dominant producer countries in Asia; 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 different regulatory influence.
- harsh weather conditions and climatic uncertainty - although the climate is largely stable and predictable, the intensity of the wet is variable, and interannual trends are less erratic than southern Australia
- 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 (roads, power, water, services, social infrastructure)
- high (and increasing) costs for insurance
- High costs of key inputs
  - Local inputs (power - noting renewable options are available, labour, water)
  - Transported/imported inputs (feed, power, labour, parts and services)
  - Supply chain inputs (transport services/options & connectivity)
- Skills shortage
  - Overall national shortage
  - Local (un)availability
  - Skills training and output shortfalls
- Capital availability
  - lack of historical industry success
  - lack of understanding by lenders
  - perceptions regarding (in)ability to manage risk
    - disease
    - currency
    - labour

- Inability to access key markets
  - Lack/high cost of supply chain to market
  - significant competitive pressure from imports
- 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 – in cooperation with:
    - other infrastructure planning
    - regional and population planning
      - migration (regional) and
      - immigration (international)
    - investment attraction
      - local & international
      - vetting, facilitation and support.

- **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, which provides a competitive advantage(s) for a successful industry, will need to be developed and built.
    - 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.
- **Other key findings are**:
  - **Northern Australia has significant aquaculture opportunities & strengths**
    - Northern Australian aquaculture is naturally suited to growing pearls, prawns and barramundi and as key species (and it is recommended that the industry continue to focus on these).
    - Vast areas of land suitable for land-based, pond aquaculture have been identified by CSIRO
      - However, there has not been a similar comprehensive assessment of marine (coastal/offshore) sites potentially suitable for cage-based aquaculture
      - Nonetheless, there is considerable potential to expand the opportunities for tropical oysters, freshwater crayfish, and tropical lobsters as new key culture species (and it is recommended that this needs to be reviewed and if feasible, pursued).
      - Further assessment is required on environmental and planning regulatory requirements for the land-based areas identified, including tenure and land access.
      - 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 low(er) value domestic markets (and potentially exports). (It is recommended that this needs to be reviewed and if feasible, pursued.)

- **Government-developed 'aquaculture zones' have been successful in creating significant new aquaculture development in northern Australia (and elsewhere)**
  - Western Australia (Kimberley Aquaculture Development Zone (KADZ) and Mid West Aquaculture Zone (MWADZ))
  - Queensland ADAs
  - also, SA and Tasmania
  - better site assessment protocols and ground-truthing pre zoning would improve zone uptake and benefits
- **Several other potential commercial competitive advantages in northern Australia which could be exploited were identified and discussed by industry members**. These 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:
    - Low(er) cost (and greater self-sufficiency/reliability) – than grid-connected supply
    - Lower carbon footprint – a considerable marketing/provenance selling point for products
    - 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 (Queensland) for aggregations of aquaculture farmers to 'aggregate' their individual demand and collectively purchase electricity at significantly lower tariffs.
  - **Development of key airport/sea port hub infrastructure could provide competitive exports.**
    - Despite 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.**
    - c.f. Tasmanian transport subsidy scheme
  - **Stricter biosecurity 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**.
    - The recent incursion of WSSV via uncooked prawns imported as a food product' highlights the issues and risks (Green/uncooked prawns imported to be consumed as a human food product but used for fishing bait allowed the virus to be introduced into the environment and then subsequently into farms supplied by seawater from the infected environment).
    - There are similar risks for barramundi (and other native fish) from exotic pathogens currently not found in Australia, from imported seafood products.
      - Biosecurity screening provisions are not adequate to screen or prevent the entry of most of these pathogens.
  - **Key parts of the industry are currently experiencing difficulties and pressures from the (short-)term and conditions of visas for skilled, senior personnel. Potential changes to the system raised included:**
    - Changes to the 189 visas – longer terms, more specialised skill categories

- More opportunities for specialised business migration
- Opportunities for semi- and unskilled workers regional migration programs (specifically to support aquaculture).
- Aquaculture management training and education provision enhanced
- Training, pathway and mentoring schemes for Aboriginal and Torres Strait Islander people to underpin engagement with aquaculture

▪ **There appears to still be considerable product origin ambiguity in Australian seafood purchasing** (and 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.

- c.f. Productivity Commission arguments

❖ **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 researchers were engaged in up to 74 active research projects (some may be reported by more than one respondent) across northern Australia

- predominantly focussed on the key marine or estuarine species of pearl oysters, prawns, rock oysters and barramundi,
- mostly funded by government (56%) and industry (26%)
- with durations of 2 – 5 years
- with 36% having a value of $1 – 5 M and several projects with reported values of $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 northern Australia industry needs to be relevant, focussed, cooperative and largely 'applied and readily applicable' to industry.

- Opportunities identified for:
  - ♦ Additional research positions for in-demand research areas (e.g. aquatic animal health)
  - ♦ Start-up and RD&E 'incubators/accelerators'

❖ **Biosecurity – the current (and potentially expanded) industry is at risk from disease outbreaks (endemic – existing and new, as well as exotic 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.

- Policy and technical capacity – are barely adequate for the current industry and are without significant capacity development, which is a substantial risk for the industry
  - There needs to be clear understanding in language/policy regarding the difference and particular issues for management of operational disease/health management versus incursion of a new, exotic, catastrophic disease outbreaks.
- Domestication & breeding of high health lines – the development of selectively bred domesticated lines for the prawn and barramundi industries has been recognised as a fundamental for any industry with aspirations to industrialise. It has also been recognised by other northern Australian aquaculture sectors.
  - The reliance of wild-caught broodstock for most sectors constitutes arguably the greatest biosecurity threat to those industries.
  - Past 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.
- 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 transmission pathways, and
  - Practical and effective national border surveillance and detection needs to be implemented for an expanded NAA industry (consider field function shared between 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.
- 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 barramundi industry was dealt a further blow when Australia effectively lost the ability to utilise the word 'barramundi' (an Australian Indigenous word) as a Geographical Indicator registrable for goods using the certification trademark system.

- The lack of traction with politicians on biosecurity (and other key industry issues) possibly points to ineffectual lobbying and influence, particularly in Canberra.

❖ **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 1200 jobs in aquaculture in northern Australia by 2030.
- Skills shortage issues are currently (and will potentially continue to be) exacerbated by small regional populations, the inability to locally source skills, and 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 skills/staff from overseas (due to issues with visa conditions and term of employment).
- Re-evaluate attitude to foreign nationals being farm labour. In some cases, there may be a decision to recruit from overseas or from locally sourced labour. 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.

❖ **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 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 in the range of $485 - $650 M**.
- '**Monsoon' – is the best-case scenario and describes a future where the northern Australian aquaculture industry has reached its 2030 vision(s)**. 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 export volume from the northern Australian aquaculture industry achieving a 2030 GVP in in the range of **$0.880m – 1.1b** via production of 120,000 tonnes of fish, prawns and other seafood products as well as substantial volumes of premium pearls.

❖ **A Vision Statement** for northern aquaculture to 2028 (2030) was developed to support its Storm/Monsoon aspirations and based on implementation of the Key Recommendations.

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

Key recommendations (6):

1) Create a strategic coordination/advisory/oversight body for northern Australian aquaculture development (the Northern Aquaculture Development Advisory Committee – NADAC)

a) Role(s)

Building on this situational analysis to continue a collaborative governance structure with Aquaculture Advisory Group members and others, including government agency representatives, established and emerging industry representatives, and research experts to:

- Ensure cross-jurisdictional coordination of aquaculture industry development and growth
- Over-see the implementation of the CRCNA aquaculture industry situational analysis project recommendations
- Facilitation of the implementation of Aquaculture Development Hubs (refer to Recommendation #2)
- Monitor consequent growth of the industry
- Communicate key developments among jurisdictions and sectors
- R&D coordination
- Provide advisory input on - skills needs, aquaculture regulation, policy, biosecurity, CoOL (northern Australia voice to a national issue for seafood), and community engagement
- Support investment attraction, better access to capital markets and government finance, and matching funding initiatives
- Provide an annual status report to CRCNA, that can be shared with stakeholders including industry, investors, research community, state and territory Research Advisory Committees of FRDC, the FRDC's Indigenous Reference Group, FRDC, AgriFutures Australia, ACIAR, ONA, Commonwealth Department of Agriculture and politicians
- Advocacy - undertake 3-monthly visits, by a nominated advisory group member, to discuss current issues with politicians and decision-makers in southern Australia, especially in Canberra

b) Home/accountability/'champion' {Action owner - lead}

- ONA ?
- Other ? (DPM&C)

c) Membership & links {Key partners}

- Commonwealth government (ONA, DPM&C, DoA, DoEE, GBRMPA, Austrade, ILSC, NAIF, Infrastructure Australia, ARENA/CEFC. DoHA)
- Qld, NT, WA governments
- R&D (CSIRO, FRDC, Universities)
- Industry
    - Aquaculture

- Infrastructure
  - Airports/ports/road transport
  - Regional planning
  - Engineering/construction

2) Facilitate the development of key Aquaculture Development Hub(s)

- Potential to align with some development-approved (land/marine) zones/areas
- Zones/areas selected/co-developed to leverage/maximise benefits of:
  - Infrastructure
    - Electricity
    - Air, road and sea transport
    - Feed (feed mill?)
      - Local feed inputs
  - Key industrial inputs
  - Supply chain/logistics
- Access to finance for focussed infrastructure investment. Initiatives like NAIF fundamental to industry development.
- Zone/area selection to leverage or build:
  - Labour, community and social needs (and outcomes)
    - Regional/remote
    - Indigenous
  - Near shore land access in identified precincts
  - Alignment with education, training and RD&E providers and facilities
- Key 'hub' candidates identified:

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		C'von Learmonth	Cool chain veges in Gascoyne Horticulture zone from C'von 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 (ex Manbana Kimberley Aboriginal Aquaculture Corporation (KAAC)) North West Regional TAFE Broome – Training, R&D New Hatcheries development - ? New marine growout sites – (more accessible via One Arm Point road (and jetty) Land-based growout sites	Solar hub	Curtin air base (internat. 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	Pacific Hydro – Lake Argyle Dam Ord scheme	East Kimberley Regional Airport Kununurra	Supply chain for horticulture product to Darwin and eastern states. Wyndham Port

		Lake Argyle in 1999-2000. Could be refreshed for other species – (e.g. Silver Cobbler) to meet the portfolio gap.			
NT	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 opps?	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-Nth 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) Aust Crayf Hatcheries – redclaw JCU – 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 opps?	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
FNQ/Gilbert River/Cape		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 opps	Cairns 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

3) Bolster biosecurity (operational disease/health and exotic incursion needs/capacity)

- Policy
- Facilities/capabilities
    - National/regional quarantine/surveillance
    - Regional/local disease/pathogen testing/detection
    - Industry response plans
        - Drills/workshops
- Develop key breeding/domestication for high health lines of key species (prawns, barramundi, pearls, oysters)

  - Given 'difficulties' in establishing these, a new 'cooperative' model led by government(s)/CSIRO and with involvement of industry (via key industry champions and possibly whole of industry arrangements)
  - Potential to streamline provisions to amend the live import list to trial/access new pathogen-free species/strains

4) Build skills to meet/match industry growth needs

- Coordinate, boost and resource available training.
- Align training with business needs and monitor progress that training is actually meeting the needs.
- Include professional development training for current staff.
- VET – shortages predicted in short-term
- University
  - Science
  - Technical
  - Business/entrepreneurial
- Indigenous Australians (including partnership with industry to help Aboriginal and Torres Strait Islander people learn what an aquaculture business is, how it works, and how they might be engaged). Potential to address skills issues through positive engagement with Traditional Owners as a local workforce, as well as investors in projects.
- Industry tailored training
- Improvements to work visas
- Engagement with Regional Jobs Committees (under the QLD Skills Strategy) to identify and engage skills training needs; equivalent agencies in other jurisdictions?

5) Build/foster NAAI as means for Indigenous economic development and independence

- Involvement/integration with Aquaculture Development Hubs
- Mobilise and deploy Indigenous equity to existing/new projects
  - Appropriate corporate and financial structures
  - Appropriate partnerships
- Developing Indigenous skills, training, awareness & leadership
  - Schools
  - VET
  - University
- Development support, mentoring structures (applicable to development and business broadly, not only aquaculture)
  - Management and Governance
  - Entrepreneurship
  - Cultural aspects and integrations
- Develop cornerstone/prototype Indigenous projects, ventures & corporations

6) Match & target R&D to key industry needs and outcomes

- Identifying applied research opportunities (e.g. Association & government plans)
- Industry collaboration and knowledge sharing
- Cross-sector and cross-jurisdiction RD&E
- RD&E grant accessibility at different scales – laboratory, on-farm, start-ups, pilot, commercial upscaling. (Consider revision of revenue thresholds)
- RD&E themes

- Species/biological/systems
- Disease/biosecurity/health
- Breeding and genetics
- Technology (including remote monitoring and management with supporting telecommunications infrastructure; automation)
- Commercial

Regions for comparisons with Northern Australia.

Northern Australia is equivalent to the areas of France, Spain, the UK, Portugal, Germany, Italy, Greece, Poland, Norway, Sweden, Denmark and Ukraine combined. The defined northern Australia coastline is about 12,400 km in length, and aquaculture GVP was $220 million in FY17. By contrast, Norway has a coastline of about 25,000 km and the Norwegian aquaculture industry (salmon grown primarily in coastal cages) export value was NOK 62.7B (AUD$10.65B) in 2017. Vietnam, with a coastline of about 3,300 km and over 1 million ha of coastal ponds, had nearly US$10B (AUD$14.8B) GVP of aquaculture production in 2017 (primarily prawns, *Pangasius* and tilapia).

There are differences in the locations, e.g. countries (such as Vietnam) have different labour costs, and environmental and social standards or different physical characteristics (such as Norway). Southern Australia has more population and infrastructure. However, these comparisons serve to highlight the challenges identified for northern Australia and, importantly, point to the relatively untapped potential for aquaculture industry development in northern Australia once challenges are overcome.