BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

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Blue Economy Cooperative Research Centre

Submission to House of Representatives Standing Committee on Agriculture and Water Resources: Australian Aquaculture Sector

1. Executive Summary

The Blue Economy CRC performs world class, collaborative, industry focused research and training to underpin the growth of the Blue Economy through increased offshore sustainable aquaculture and renewable energy production. Australian aquaculture has a long history of innovative and entrepreneurial approaches to existing and new aquaculture as well as considerable research capability and capacity. Offshore aquaculture production is one of many offshore and marine sectors showing considerable capacity for expansion in the near term. Offshore production globally is a rapidly evolving sector, reflecting its early stage where growth potential and technological evolution is rapid. This means that industries everywhere, including in Australian are often acting in advance of, or at least along the margin of, policy and regulation. The Blue Economy CRC research program to date has undertaken a review of fish pen designs and mooring systems and identified various potential improvements to current fish pen designs need to operate in offshore sites. It has identified the importance of marine spatial planning and site selection, fit for purpose regulation, and the need for research focused on using multiple approaches to monitor the health and welfare of species and to combine these to provide mitigation responses and strategies.

2. Introduction

This submission addresses each of the Inquiry's terms of reference. It draws on the current and future research programs of the Blue Economy CRC to give particular emphasis to the terms of reference "Australian Aquaculture: Opportunities and Barriers to Expansion"; and "Current Regulatory Framework – Directions for the Future". The submission begins with a short background to the Blue Economy CRC then addresses the terms of reference, noting the considerable innovation within the

Australian aquaculture sector as it has developed and expanded. Offshore aquaculture, like other offshore activity, is likely to face high start-up costs and risks. The Blue Economy CRC's innovative research programs links experimental systems and commercial facilities.

3. The Blue Economy Cooperative Research Centre

Established in 2019, the Blue Economy CRC is a Cooperative Research Centre established and supported under the Australian Government's CRC Program. With a ten-year life and budget of more than $300 million, the Blue Economy CRC brings together 40 industry, government, and research partners from ten countries with expertise in aquaculture, marine renewable energy, and maritime engineering.

Connecting the capability, capacity and interests of industry and research partners, the Blue Economy CRC performs world class, collaborative, industry focused research and training to underpin the growth of the Blue Economy through increased offshore sustainable aquaculture and renewable energy production.

The Blue Economy CRC's research portfolio is structured into five integrated programs: *Offshore Engineering and Technology, Seafood and Marine Products, Offshore Renewable Energy Systems, Environment and Ecosystems, and Sustainable Offshore Developments.*

Combined, these programs will deliver the knowledge to enable current and new industries increase offshore seafood and renewable energy production. This includes developing technologies and production systems that can withstand both regular and extreme weather events, while being safely and economically managed. These programs also aim to deliver the knowledge to underpin new planning, regulatory and monitoring systems that encourage and support sustainable capital-intensive operations while giving community confidence that the operations are environmentally sustainable and socially responsible.

The emerging Blue Economy industries will require a new highly skilled workforce and the Blue Economy CRC has an active postgraduate education program helping to develop the workforce of the future.

4. Australian Aquaculture: Current Status

Australia's offshore domain is significant – 6 048 681 square kilometres (excluding offshore island territories) – slightly less than the continental land mass, and a coastline of 36,000 kilometres. Australia's marine domain supports a range of activities and uses, including a aquaculture sector, with considerable potential for development.

Australian aquaculture value and production are dominated by Atlantic salmon farming in Tasmania (approximately 60% of value and production tonnes). This is undertaken in predominately coastal waters, albeit in some highly energetic and exposed locations. The remainder of value is mainly for Southern bluefin tuna (9%), edible oysters (7%), pearls (4%), prawns (6%) and barramundi (4%). The success of salmon can be attributed to several key factors including how well suited Atlantic salmon are to being farmed, global technology and its exceptional product and culinary characteristics that underpin an expanding domestic market. The establishment and current expansion can be attributable foremost to individuals and industry leadership as well as an environment of supportive State governments and excellent multi-disciplinary research organisations.

Around Australia other aquaculture has been less successful: species have appeared and many have disappeared and in ways that reflect a global issue of focusing on new aquaculture species and technology before, rather than after, suitable market research. Some sectors appear stable or relatively well placed for expansion and include tropical prawns and tropical marine white-fleshed fish. In contrast, there appears to be no large market opportunity for freshwater based aquaculture although regional niche markets may do well locally (e.g. silver perch). An emerging aquaculture sector with great current interest and potential for Australia is seaweed aquaculture. Although there is no established commercial seaweed aquaculture industry in Australia, there are some promising developments.

Australian aquaculture has a relatively low production in global terms but this mask a long history of innovative and entrepreneurial approaches to existing and new aquaculture as well as considerable research capability and capacity. Around Australia, State Governments have taken different approaches but for the majority of time there has been support by all States and NT for aquaculture through affiliated research organisations, such as the SARDI in SA and SMRAC in Tasmania. At a Federal level, CSIRO has an active and multidiscipline approach to aquaculture that, along with several other research organisations, provides world leading capability. Along with this the combination of experienced commercial operators and aligned service industries provides a strong base for expansion of aquaculture production. The FRDC, through coordinated government and industry investment plays a significant role in funding research to assist the management of sustainable aquaculture.

The underlying challenge is to maintain and expand existing domestic markets and to identify new markets to support expansion. The Blue Economy CRC is building on existing knowledge to support offshore aquaculture. These opportunities link to workforce needs and training in highly technical areas. At the same time societal concerns need to be recognised and addressed, and that both opportunities and barriers exist in terms of future expansion of Australian aquaculture.

5. **Australian Aquaculture: Opportunities and Barriers to Expansion**

Australian aquaculture has displayed considerable innovation as it has developed and expanded. At the same time the sector faces a number of challenges that provide both opportunities and barriers to expansion. These include species selection, biosecurity risks, site selection and operational issues (environmental impacts, use of energy), environmental change and the efficacy of the current regulatory and management framework.

While current aquaculture is centred on estuarine and coastal areas, this provides considerable barriers to expansion; both in terms of the amount of physical space that is available and limits deriving from cumulative pressures put on coastal ecosystems by multiple inshore uses (such as fishing, shipping, recreational and other uses) as well as from increasing warming of inshore waters. There appear to considerable opportunities to expand operation in waters further offshore, yet this option has a number of challenges and potential barriers. These challenges and some potential opportunities are outlined briefly below. The Blue Economy CRC is leading work in a number of these areas.

There is growing interest in land-based farms for salmon aquaculture using large scale Recirculation Aquaculture Systems (RAS). There are significant limitations to land-based aquaculture for large scale grow out to market size for Atlantic salmon including: significant water and power demand, large areas of coastal land required for the RAS operations, disposal of saline organic waste, fish quality, biosecurity, and animal welfare. Future innovations in RAS will improve the sustainability of land-based operations but they will inevitably remain high resource input, high-cost production systems that will require efficient market access to make them relatively financially viable. While land-based RAS operations will remain an important part of the Australian salmon industry for producing smolts, in the Australian context the ocean will remain the most sustainable place to grow salmon from smolts to market size.

Technological

There are logistical and technical challenges in operating in exposed and offshore waters – for example in creating structures that can withstand the physical conditions, access to the site for any human-dependent operations, servicing the site safely and in a timely fashion (e.g., if a breach of some kind occurs). These technical requirements are further complicated by the current reliance on diesel electricity generation offshore, expansion would see barriers around storage, contamination risk, transport and associated costs; not to mention changing public sentiment regarding fuel types. All of these operational challenges provide opportunities for technical innovation which can then be sold back into the globally rapidly expanding industry. For example, integrating renewable energy systems with supply vessels or production platforms.

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An emerging trend overseas is towards installation of large structures that support the co-location (integration) of seafood and renewable energy production systems. Whether this is the route taken in Australia remains an open question – so far Australia has not simply adopted pen designs from overseas due to requirements and high energy levels specific to the Australian context. There are significant questions still to address about financial feasibility, level of environmental footprint and interactions between production systems, which are at different levels of maturity. However, significant opportunities exist in finding solutions to these issues – beginning with looking at what can be adapted from overseas, or from other offshore industries already active in Australia waters, such as the offshore oil and gas industry (which may provide insights around design engineering standards, expected rates of wear and pre-competitive sharing of baseline information to lower entry costs while still protecting against cumulative effects).

A further technical challenge is around monitoring of offshore systems – both for operational aspects (such as feeding, tracking fish health, infrastructure integrity etc.), but also to meet regulatory requirements. To do this safely and cost effectively in high energy offshore sites, where there is also the chance of encountering large marine predators will require a radical shift in the level of adoption of autonomous technologies (e.g. drones, robotics, smart sensors etc) that can undertake monitoring and maintenance of offshore facilities and production. Some of the issues are to do with the challenges of working in a constantly moving environment but many are to do with the simple capacity to filter and deliver the appropriate information at the scales and frequency required. While there have been rapid advances in the capacity of sensors and their battery and computing power there are still constraints in terms of the availability of commercial products that are fit for purpose in offshore conditions. Moreover, the operating capacity of onshore information delivery (i.e. the adequacy of NBN services in more remote locations) further complicates the issue (as even when information can be delivered to shore based receivers it can be hard to ensure quality of connection to centralised onshore feed control or monitoring hubs).

Cultured Species

While offshore production is beginning using currently widely cultured species (such as salmon) the route to offshore production is not clear for many species - such as bottom dwelling invertebrates (e.g., bêche-de-mer, sea cucumbers, or filter feeding bivalves). This is not to say they cannot be cultured, just that research and innovation will be required. A BECRC scoping report identified that even for salmon and other well understood fish there is significant learning yet about whether specific bloodlines (genetic strains) are more suited to offshore environments, how the more energetic conditions will influence product quality and whether typical production practices for each life history stage will require modification to maximise productivity and minimise any risks of adverse outcomes. There is also plenty of opportunity to explore the promise provided by other species, potentially in combination, though at present there is no rapid means of assessing which show the greatest potential.

The nascent state of the production of all but a small number of species in Australia means there are significant gaps around production (and associated technological challenges), even inshore let alone offshore. Identification of suitable sub-tropcial and tropical white-fleshed fish from current aquaculture species for offshore aquaculture would accelerate progress. Notable species already in commercial aquaculture are barramundi, cobia, mulloway and yellowtail kingfish. Similar consideration is required for other animals and plant species. In particular the development of seaweed aquaculture is emerging as a large new aquaculture opportunity and the BE CRC has prepared a study on elements related to advancing offshore seaweed aquaculture. The selection of appropriate species is challenging and can be considered in relation to key factors related to their biology, their roles in a multispecies group and their market. To this end the BECRC will explore a “Species Selection Tool” that will model how to select species.

Environmental Interactions

One of the motivations for moving aquaculture operations offshore is to reduce the risk of undesirable environmental impacts due to the dispersion of waste and nutrient loads, which can be exacerbated in shallower waters – as shown by the more intensive monitoring requirements in shallower waters in countries such as Chile and Canada. The Blue Economy CRC is undertaking research to verify the assumption that the depositional footprint in offshore waters is lower than in near shore waters.

Biofouling, the growth of unwanted organisms on infrastructure, is also a significant issue offshore, as it threatens the operational performance of the infrastructure (increasing weight and changing hydrodynamic properties) and any monitoring equipment (via overgrowth blocking inputs etc) and techniques used in inshore sites to clean nets are not as easy or indeed even viable offshore.

New robotic cleaning drones are becoming commercially viable, but significant opportunities remain in finding cost effective cleaning methods, use of the waste materials to create new products and potentially also designing infrastructure in such a way that it either discourages fouling (as is being attempted in some port infrastructure by varying the orientation and materials used for some of the engineering components) or conversely encourages the establishment of desirable communities (which could benefit the establishment of artificial reef systems, depending on the geographic placement of the production centres this could also incidentally benefit from current and eddy patterns that are shifting with large scale climate change, delivering larvae offshore that historically were returned to inshore settling sites).

Offshore production also presents biosecurity issues. The presence of large predators – which can penetrate pens or pose a threat to anyone working in the water on site – may be the first to come to mind, but the infrastructure also provides a potential entry point for dispersal of invading species. Moreover, exposure of cultured species to new fish communities (with their own pathogens) and new biofouling communities may negatively impact fish health (through toxins, stings or pathogen transfer). This threat is currently poorly understood as the influence of such interactions on fish health is currently largely unassessed. Closed systems (to protect against such interactions and to retain control over any waste) are one proposed solution, however they are technologically very challenging offshore due to the mechanical action of sloshing and sympathetic wave formation – which risks structural integrity of the structures, but can also adversely affect fish health.

While moving offshore has been proposed as one means of dealing with warming inshore waters, it will not be a complete panacea as offshore conditions can also be affected – either in terms of acidification, oxygen profiles or thermal environment, but also in terms of the size of the sea state (waves and storm conditions), which could be much stronger as a result of climate change.

Regulation and Policy

Some of the greatest challenges and opportunities to come with a move offshore are to do with marine spatial planning and site selection. Offshore aquaculture production is one of many offshore and marine sectors showing considerable capacity for expansion in the near term. This creates the potential for the competition for space seen inshore to spread offshore without thoughtful marine spatial planning that is structured to minimise cumulative effects. This is not straightforward however, as individual sectors are still managed somewhat independently and with few specifically offshore frameworks or criteria.

Levels of knowledge about offshore environments are much lower than for nearshore or terrestrial locations. This and the greenfields nature of offshore developments has seen the demand for extensive baseline surveys in overseas developments, which can act to inhibit access by new entrants. A significant opportunity exists not only in terms of identifying appropriate criteria for use in offshore site selection, but also in supporting pre-competitive processes and information sharing platforms at scales relevant to production – so they can share information gathered during surveys, lightening the individual load, reducing duplication and greatly accelerating the capacity for greater knowledge generation and benefit from a deeper understanding of offshore waters.

Offshore production globally is a rapidly evolving sector, reflecting its early stage where growth potential and technological evolution is rapid. This means that industries everywhere, including in Australian are often acting in advance of, or at least along the margin of, policy and regulation. This creates frustration, timeline blow-outs and excess cost - as proponents must navigate uncertain and unclear permitting processes, especially if trying to combine operations such as aquaculture production and energy generation – but also puts guarantees of long-term sustainability at risk (creating the potential for large downstream costs for government and/or industry or insurers).

There are well developed regulatory and management systems in place in state waters, but with less certainty or competence over aquaculture activities outside state waters. As new species are considered there will be legal issues to considered with respect to current licensing and rights of aquaculture produced species with existing quota arrangements for wild capture operations such as lobsters and abalone. There is currently no coordinated pathway for planning and approval of key commercial and research and development Blue Economy activities related to aquaculture in Commonwealth waters. Consideration needs to be given to ways to provide complementary processes for activities that may be in Commonwealth waters or move between Commonwealth and State waters.

Coordination and regulation are not only needed in terms of planning and regulatory procedures surrounding production, but also supporting services. For example, overseas offshore aquaculture projects have been hampered in some cases by the long lag (in some cases spanning many years) in obtaining regulatory approvals for support vessels – which tend to fall between specifications for other classes of craft (as production personnel are not crew, but neither are they leisure passengers etc). Australia needs to learn from this and realise the importance of having clear regulatory systems in place for handling offshore aquaculture vessel and platform designs, building, acquisition, inspection and licencing processes.

6. Current Regulatory Framework – Directions for the Future

As noted above one opportunity for expanding Australian aquaculture is to look to offshore sites. While there are high energy sites within states waters (for example in Storm Bay in Tasmania) inshore or coastal sites have numerous constraints. In general, moving offshore beyond three nautical miles from low water mark (noting a small number of exceptions: for example, Storm Bay in Tasmania, Spencer Gulf and Gulf of St Vincent in South Australia etc.) will bring such operations into Commonwealth waters where there are no clear regulatory arrangements directed at aquaculture. This situation provides immediate challenges but can be addressed by utilising the framework provided under the Offshore Constitutional Settlement (OCS).

The OCS is supported by "complementary" commonwealth and state legislation – the Coastal Waters (State Powers) and Coastal Waters (State Title) Acts 1980 enacted by each state and the Commonwealth. The OCS's legislative design was such that Commonwealth and states Coastal Waters (State Powers/Titles) legislation complemented each other and established areas of state jurisdiction three nautical mile offshore from a baseline – in most cases the low water mark, but in some areas closing lines across bays moved the baseline many miles offshore, for example, Spencer Gulf, Gulf St Vincent and Kangaroo Island in South Australia, and in Storm Bay in south east Tasmania.

In effect these arrangements entrenched the State or territory jurisdiction over what became known as 'state waters' – waters within a line drawn three nautical miles offshore of the territorial sea baseline. The OCS includes "Agreed Arrangements" across a range of marine sectors, but as yet does not address aquaculture.

Future development should include work on an appropriate regulatory framework for offshore aquaculture. The Blue Economy CRC is leading work on the creation of an appropriate framework to establish what it has termed Blue Economy Zones in Australian waters within the framework established under the OCS.

Blue Economy Zones could provide 'investment ready' platforms with strategic environmental approvals and management policies already in place, allowing both commercial and R&D activities to be initiated more seamlessly and with less need for lengthy, complex and expensive approval processes.

7. Innovation, Commercialisation and Expansion of Aquaculture

Offshore research and development is in general resource intensive and aquaculture activities are similarly faced with high start-up costs and risks. Blue Economy CRC research to date has undertaken a review of fish pen designs and mooring systems and identified various potential improvements to current fish pen designs need to operate in offshore sites.

Blue Economy CRC research has highlighted the need for research focused on using multiple approaches to monitor the health and welfare of salmon and to combine these to provide mitigation responses and strategies. The ability to predict the risk of planktonic biological threats – such as bacterial and viral pathogens, harmful algal blooms (HABs), and jellyfish – is dependent on emerging capacity in visual image processing and existing knowledge around pest occurrence and remains highly challenging. To further advance aquaculture production the BECRC will develop innovative research platforms that focus on the translation of data and information in a two-way process between scaled-up experimental systems and commercial facilities. This this will build on the successful University of Tasmania Experimental Aquaculture Facility (EAF) that IMAS and commercial partners use to conduct applied research on large harvest size salmon under controlled environmental conditions and use the data to inform development of aquafeeds and feeding regimes. A particular focus is understanding growth and nutrition under environment change scenarios. Current developments will improve capability of the facility to address water current velocity as a key characteristic of offshore sites.

An in-depth understanding of the relationship between specific biological indicators and the monitoring technologies used to measure these variables will be critical for biological threat prediction. The monitoring of seals and other large predators poses different challenges as their presence or absence is more easily determined, but their movement is more independent of the physicochemical characteristics of water masses. As well as monitoring the threat it is also important to recognise the need to monitor the fish to assess their current and changing status as well as monitor environmental factors.

While the Australian salmonid industry is well established and globally competitive, further opportunities arise through other species. The Australian seaweed industry is very small, with production valued at AU $3 million, with the majority of this value from collection and processing of storm cast kelp in Tasmania. AgriFutures Australia (2020) recently released an Australian Seaweed Industry Blueprint that outlines plans for an AU $1.5 billion Australian seaweed industry that could employ 9,000 people, however Australia currently has no commercial scale seaweed ocean farms and growth will rely significantly on reformed policy and regulation to allow for ocean cultivation of native seaweeds in offshore zones, and the formation of a dedicated research and development plan.

Integrated Multi-Trophic Aquaculture (IMTA) based on artificial reefs populated by a range of interacting species looks to take offshore production beyond "deep water" versions of nearshore monospecific culture facilities to financially viable IMTA that lives up to the vision of a "self-cleaning" production system that reduces any environmental footprint to an absolute minimum. The BECRC will explore pathways to IMTA via multispecies groupings that consider how to enhance overall production through the use of additional associated species. To this end the BECRC will conduct a scoping project, in addition to research on artificial reefs. As a novel ecosystem services approach, artificial reefs have enormous potential, but ongoing research is needed to address the development of floating structures that can support benthic artificial systems to enhance productivity and ecosystem, while supporting offshore developments through wave attenuation, nutrient recycling, carbon sequestration and, where applicable, provision of marine products (potentially via an IMTA framework).

Yours sincerely,

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Reference

AgriFutures Australia. 2020. *Australian Seaweed Industry Blueprint–A Blueprint for Growth*, Publication No. 20-072, Project No. PRJ-012324.