BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

Australian Government
Department of Industry, Science, Energy and Resources

AusIndustry
Cooperative Research Centres Program

SHORT SUMMARY

2.20.001 Seaweed Aquaculture Scoping Study

INTRODUCTION

The Australian seaweed industry is in its infancy, but a recent Seaweed Industry Blueprint has identified a strategy that could result in an AU$1.5 billion GVP industry supporting 9000 jobs by 2040. Offshore aquaculture is increasing globally and can be a significant part of this strategy. This scoping study aimed to determine the opportunities and priorities for developing offshore seaweed aquaculture within the Blue Economy CRC. There is currently a high level of interest from Australian funding sources, State Government, Universities and research organisations to support research and development. This suggests opportunity for unique BE CRC as well as collaborative projects.

Specifically we: i) engaged with stakeholders to determine priority seaweed species of commercial interest; ii) identified knowledge gaps for the cultivation of these priority seaweed in offshore environments and; iii) assessed the effects of seaweeds on hydrodynamics and the implications of these effects for offshore aquaculture. We ran two workshops and completed two literature reviews to achieve these aims.

Stakeholders identified three main seaweed groups of commercial interest: Asparagopsis, kelps (several species), and Durvillaea (bull kelp). These groups reflect two broad strategies of seaweed aquaculture: i) smaller seaweeds of high value per-unit biomass (e.g. Asparagopsis) and ii) larger species of lower value per-unit-biomass (e.g. kelps, bull kelp). For all these groups there is currently insufficient production to meet market demand.

KEY POINTS

- This project has identified three seaweed groups of commercial interest for offshore seaweed aquaculture within the Blue Economy CRC – Asparagopsis, kelps, and Durvillaea (bull kelp).
- For all these seaweed groups there is currently insufficient production to meet market demand.
- Key knowledge gaps exist for these groups, and we recommend a research program of two stages to develop offshore seaweed aquaculture.
- Phase 1 (2021-2025):
  - Develop knowledge and capability in basic biology, hatchery and grow-out methods for offshore cultivation (designed for offshore cultivation but developed using inshore sites), and
  - Understand how these seaweeds attenuate hydrodynamic forces around offshore structures.
- Phase 2 (2026-2030):
  - Transfer knowledge to offshore arrays with a view to optimising grow-out methods, spatial array designs, infrastructure requirements and hydrodynamic attenuation.

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THE CHALLENGE

The Australian seaweed industry is in its infancy, but a recent Seaweed Industry Blueprint has identified a large opportunity for a thriving seaweed industry in Australia. Offshore aquaculture can be a significant part of this strategy but there are large knowledge gaps for seaweed aquaculture in Australia – especially offshore aquaculture. Moreover, the technological challenges in cultivating seaweed offshore in high-energy wave-exposed environments including the strength, deployment, and functioning of infrastructure as well as the viability of the seaweed themselves are not insignificant.

Critically, those challenges must be overcome in a cost-effective manner to support the commercial viability of offshore operations. This scoping study aimed to determine the opportunities and priorities for developing offshore seaweed aquaculture within the Blue Economy CRC.

THE OPPORTUNITY

The Australian Seaweed Industry Blueprint (Kelly 2020) identifies the potential for an industry of AU$100 million GVP and 1200 direct jobs by 2025, and provides a strategy towards achieving an AU$1.5 billion GVP industry supporting 9000 jobs by 2040. There is currently insufficient production of seaweed in Australia to meet demand for the diverse markets that exist for seaweed products (e.g. human food, animal feed, fertiliser, nutraceuticals, pharmaceuticals, novel polymers). Seaweed aquaculture is well-established worldwide and there is a AU$10 billion industry globally with ~ 97% of this coming from aquaculture, highlighting the large opportunity in Australia. Seaweed also provide significant environmental benefits (nutrient mitigation, carbon sequestration, habitat provision).

OUR RESEARCH

Project Aims

This project aimed to identify and prioritise opportunities for seaweed aquaculture projects within the Blue Economy CRC. We sought to achieve that by i) engaging with stakeholders via two workshops to determine the needs, opportunities, and potential for seaweed aquaculture, including the identification of priority species of interest); ii) reviewing current cultivation knowledge and how that might align with offshore potential for priority seaweed species and, iii) considering the effects of seaweeds on hydrodynamics and the implications for offshore aquaculture.

These workshops and reviews generated several key questions and/or projects of immediate importance across 4 broad themes. Key linkages with BE CRC Research Programs are noted, whilst more general projects and those of specific relevance cultivation knowledge are presented elsewhere.

Theme 1: Hydrodynamic Fundamentals

1. Fundamental hydrodynamics of the priority seaweed species, and of potential farm arrays proposed for offshore cultivation (RP1).
   Species-specific applications, such as Macrocystis for current attenuation, and Durvillaea for waves.
2. Seaweed biomechanics (ability of the seaweeds to withstand the hydrodynamic forces) (RP1, RP2)
   e.g. ‘fatigue impacts’ and repetitive stresses
3. Species-level risk-opportunity matrix (RP2)
4. This theme will generate critical data and parameters for work under the following themes.

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Theme 2: Improved scenario-testing and capacity to conduct trials

1. Modelling/simulations:
   a. Flow redirection/channelling (RP1)
   E.g. for energy production (RP3)
   b. Testing different aquaculture growing configurations (RP1) and seaweed densities (RP2)
   c. Testing different site and environmental conditions (e.g. depths, storms, etc) (RP1)
   d. Biogeochemical (RP4)
2. Tank/flume experiments:
   a. Testing in wave/flow tanks and model test basins, especially any with variable and asynchronous wind and current conditions (RP1)
3. Small-scale field measurements (RP1, RP2, RP4):
   a. To calibrate and validate modelling and tank experiments
   b. Take advantage of existing seaweed farms and offshore infrastructure (i.e. what is currently available that we can learn from?)

Theme 3: Trade-offs and values

1. Understanding the economics:
   a. Valuation of specific hydrodynamic applications of seaweed
   E.g. What is the value of increasing 'operational windows' for other offshore aquaculture (RP2)?
   a. Improved benefit-cost analyses and technoeconomic analysis by incorporation of hydrodynamic knowledge (RP5)
2. Examine infrastructure benefits of attenuation by seaweed (RP1)
3. Are hydrodynamics/ renewables the key co-benefits? (RP1, RP3, RP5)

Theme 4: Infrastructure

1. Cultivation infrastructure will be driven largely by the species' biology (RP1, RP2)
   a. What will/won't the particular seaweed grow on?
   b. Especially relevant for Durvillaea (bull kelp), where cultivation is poorly understood and specialised methods may be required
2. Associated biodiversity of seaweed arrays
   a. Positives (e.g. provision of habitat) (RP4)
   b. Negatives (e.g. biofouling) (RP1)
3. Engineering solutions – align with existing engineering options for wave breaks/ renewables (RP1)
4. Cost effective substrates
5. Recyclability and repurposing (RP1, RP5)

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OUTCOMES

Seaweed of Commercial Interest

Stakeholders identified three main seaweed groups of commercial interest: Asparagopsis, kelps (several species), and Durvillaea (bull kelp). Key knowledge gaps for these groups, and thus potential projects that would allow for offshore seaweed production, include:

- Development of hatchery and grow-out methods for Asparagopsis;
- Optimisation of grow-out and harvest methods (including infrastructure requirements) for offshore cultivation of kelps; and
- Basic biological information on reproduction and growth, development of hatchery methods and grow-out requirements (including infrastructure) for offshore cultivation of Durvillaea.

Effects of Seaweed on Hydrodynamics

The cultivation of large seaweed such as kelps and bull kelp will likely affect hydrodynamics around offshore structures, but will depend on the density and morphology of the species being grown and the hydrodynamic conditions they are grown in. Key knowledge gaps for the effects of seaweed on hydrodynamics and potential projects were identified in four broad areas:

- A greater understanding of the effects of priority seaweed on hydrodynamics;
- Scenario-testing using modelling, tank/flume tests and small-scale field measurements and experiments;
- A greater understanding of the trade-offs and value-add (including economics) of attenuation of hydrodynamic forces; and
- Infrastructure needs and possible alignment with existing engineering options for wave breaks/ renewables.

NEXT STEPS

This scoping study highlights a strong opportunity for offshore seaweed aquaculture within the Blue Economy CRC to contribute to the development of the Australian seaweed industry. We propose a research program of two phases, where Phase 1 (2021-2025) focuses on developing knowledge and capability in the cultivation of priority seaweed species and effects on hydrodynamics, and Phase 2 (2026-2030) focuses on transferring knowledge gained from Phase 1 to offshore arrays.

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PROJECT REPORTS/PUBLICATIONS

Wright, J. et al. (2020). Seaweed Aquaculture Scoping Study, 2.20.001 – Final Project Report. Blue Economy Cooperative Research Centre.

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