BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

Australian Government
Department of Industry, Science and Resources

AusIndustry
Cooperative Research Centres Program

SHORT SUMMARY

1.21.003 Robust Salmon Feed Delivery Systems

KEY POINTS

- Challenges for feed pipes systems in high energysites were examined.
- Methods to avoid or suppress potential types offailure in feed pipes were tested.
- Alternative methods to secure and restrain feedpipes were trialled.
- Global modelling of a proposed 16-pen array at ahigh-energy site was conducted.
- A team of eleven main researchers from fiveorganisations contributed to this project.

THE CHALLENGE

In salmon aquaculture, feed is conveyed from the feed barge to individual pens using High Density Polyethylene (HDPE) pipes, which float in a loose bundle. These pipes, and their connections to feed barges and pens, can become damaged and disordered in bad weather. Maintaining feed pipe systems in existing exposed sites is already challenging; maintenance and repair costs will increase in more exposed sites. Interruptions to feeding are expensive.

THE OPPORTUNITY

Being able to reliably and economically operate salmon farms in more exposed waters will be a considerable advantage for the Tasmanian salmon industry.

This project aimed to understand the dynamics of feed pipe systems, especially through computer simulation; to improve the robustness of feed pipe systems in the most energetic existing sites: and develop knowledge and simulation methods to help develop systems for future more-exposed sites.

OUR RESEARCH

This project aimed to better understand the dynamics of feed pipes systems, and to develop solutions to make the system more robust. It was organised into three work packages.

Work Package 1

In WP1, we aimed to understand the issues for operation of feed pipes systems in high energy environments. Current feed pipes systems were characterised. Feed pipe operations, potential types of failure or damage, maintenance requirements, and the challenges in operating in more energetic waters were summarised. Previous efforts to improve organisation of feed pipes were noted, and relevant experience from other industry sectors was sought. A multiscale modelling approach was agreed.

Work Package 2

In WP2, the main expected challenges for the feed pipes system were confirmed and detailed. The project concentrated on two issues: methods to secure and control groups of feed pipes in high-energy environments, and potential damage to individual pipes in such environments.

Types of potential damage were characterised in a laboratory environment, and potential methods and devices to reinforce pipes against damage at high energy sites were developed. These were tested in scale models, full-scale tests, and on-site trials.

New systems to secure feed pipes were brainstormed, and three systems, based on different principles, were selected for manufacture and trial. Trials revealed advantages and disadvantages, and two feed pipe organising systems have been recommended for different high-energy situations.

Work Package 3

In WP3, computer simulation was used in two ways.

Modelling of the dynamics of a potential fish pen array in a high-energy site was carried out using AquaSim.

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The model generated time-displacement predictions for individual fish pens and a feed barge under extreme wave and current loads.

Other simulations were used to support the work in WP2. Mesh-free FE methods were used to understand the dynamic behaviour of a bundle of pipes in typical waves. These allowed potential deformation mechanisms to be examined and potential reinforcement methods to be assessed.

A third area of simulation supported the work of WP2 by simulating potential pipe failure modes in high energy environments and by examining the mechanics of proposed pipe control methods.

OUTCOMES

The project developed a detailed understanding of the operating environment and operational challenges for feed pipe systems delivering pellets from a feed barge to the typical open, floating, flexible, circular, fish pens used by Tassal in energetic environments.

The project developed, tested under laboratory conditions, and trialled systems for holding and organising feed pipe bundles, and for reinforcing individual feed pipes. Computer simulation assisted in the understanding of problems addressed by these improved feed pipes systems.

The project developed a computer simulation to predict the movement of fish pens and a feed barge in a 16-pen layout at a Tassal site, subject to wave and current action.

NEXT STEPS

All parties involved will consider the findings and recommendations of the project. A follow-on project proposal, or a project extension to more thoroughly examine simulation predictions, or to trial feed system modifications, may be recommended.

PROJECT TEAM

The main members of the project team are listed below.

- Ryan Campbell, ACS Australia
- Rowan Paton, ACS Australia
- Rod Thomson, ACS Australia
- Hassan Karampour, Griffith University
- Bruce Cartwright, Pacific ESI
- Allen Chhor, Pacific ESI
- Matthew Brown, Tassal
- Peter Heard, Tassal,
- Ashley Dyson, University of Tasmania
- Gholamreza Kefayati, University of Tasmania
- Ali Tolooiyan, University of Tasmania

Other persons from each of these organisations assisted in various ways.

PROJECT REPORTS/PUBLICATIONS

Confidential internal reports were produced covering:

- Work Package 1,
- Work Package 2,
- Work Packages 2A and 2B,
- Work Package 3A,
- Work Package 3B,
- Work Package 3C,
- as well as the Final Project Report.

No external publications were produced.

PROJECT REPORTS/PUBLICATIONS

Rowan Paton (ACS Australia)

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3.21.001 – OES Study on the Energy Requirements of Offshore Aquaculture as a Market for Ocean Energy

OUR RESEARCH

This report assessed the potential of aquaculture as a market for ocean renewable energy. While the primary focus was offshore aquaculture, this report also included information from projects related to onshore and nearshore aquaculture.

Firstly, the technical attributes for each renewable energy technology are described, the relative advantages and challenges for their application to the aquaculture sector are identified and the technology readiness levels are discussed.

This report then provides an overview of the current status of the aquaculture industry in a few key countries—mainly OES member nations, large aquaculture-producing nations, or those who are interested in offshore aquaculture—including examples of energy requirements for different aquaculture operations.

This report also highlights case studies from projects that are researching or have successfully implemented renewable energy, both ocean renewable energy and other renewable sources, to meet the energy demands of aquaculture operations. The case studies presented in this report include all major marine-based aquaculture types and a range of renewable energy technologies, with a focus on ocean renewable energy, to provide examples and lessons learned for co-locating ORE and offshore aquaculture.

This report then identifies the potential opportunities and challenges for co-location of ocean renewable energy and offshore aquaculture. In addition to the general opportunities and challenges for co-location, examples of opportunities and challenges in several countries (Australia, Chile, China, Indonesia, the Philippines, and the United States) were identified. Examples of offshore aquaculture and ORE are the main focus, but because these industries are emerging, opportunities and challenges also include nearshore aquaculture as well as other renewable energies because associated similarities and learnings may be applicable.

Finally, this report summarises the reviewed literature and offers recommendations for further research needs and for identifying potential pathways for the expansion of co-location opportunities based on the findings of this report.

OUTCOMES

This report summarises the available information on the energy demands of aquaculture operations in several countries. While energy data are limited at this time, this report provides a useful representation of how aquaculture energy demands vary by aquaculture type, farmed species, and/or country.

NEXT STEPS

Based on the information presented in this report, several recommendations to expand the potential for co-location and further understanding of powering offshore aquaculture with ORE have been identified.

- More information, including finer-resolution data, about energy demand and the associated energy demand profiles (e.g., daily, monthly, seasonally, for specific stages/processes) for offshore aquaculture operations is needed

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NEXT STEPS (cont.)

- Hybrid energy solutions (e.g., solar PV and tidal energy, solar PV and wave energy, diesel and wave energy, etc.) have the potential to increase the use of ORE technologies for aquaculture operations by offering more reliable and clean ways to supply power, replacing the current reliance on diesel.
- Further research on the environmental and social effects of co-locating ORE and offshore aquaculture is to facilitate consenting processes of projects and to support strategic marine spatial planning.
- Increase the uptake of ORE for aquaculture-relevant applications, there is a need to engage with and educate aquaculture stakeholders (e.g., owners, facility managers, vessel operators, technology providers of moorings/pens/feed barges, policy makers, regulatory agencies, financial organizations, communities, etc.) on sustainable energy transitions.
- Identify licensing of existing national or regional marine spatial plans to find countries or regions that require co-location or offer pathways to development can aid industry planning efforts.
- Increased support through government funding to make ocean renewable energy a viable and cost-competitive alternative to diesel or other renewable energies used in aquaculture production.

PROJECT TEAM

- Eloise Wilson, University of Tasmania
- Dr. Mark Hemer, CSIRO
- Mikaela Freeman, Pacific Northwest National Laboratory
- Dr. Lysel Garavelli, Pacific Northwest National Laboratory
- Dr. Michael L.S. Abundo, OceanPixel
- Dr. Gonzalo Tampier Brockhaus (Organisation)

PROJECT REPORTS/PUBLICATIONS

Freeman, M.C., Garavelli, L., Wilson, E., Hemer, M., Abundo, M.L., Travis, L.E. 2022. Offshore Aquaculture: A Market for Ocean Renewable Energy. Report for Ocean Energy Systems (OES). April 2022.

SHORT SUMMARY AUTHOR

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