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BLUE ECONOMY RESEARCH ZONE

REGULATED MONITORING PROGRAM

prepared for

Blue Economy CRC

August 2024

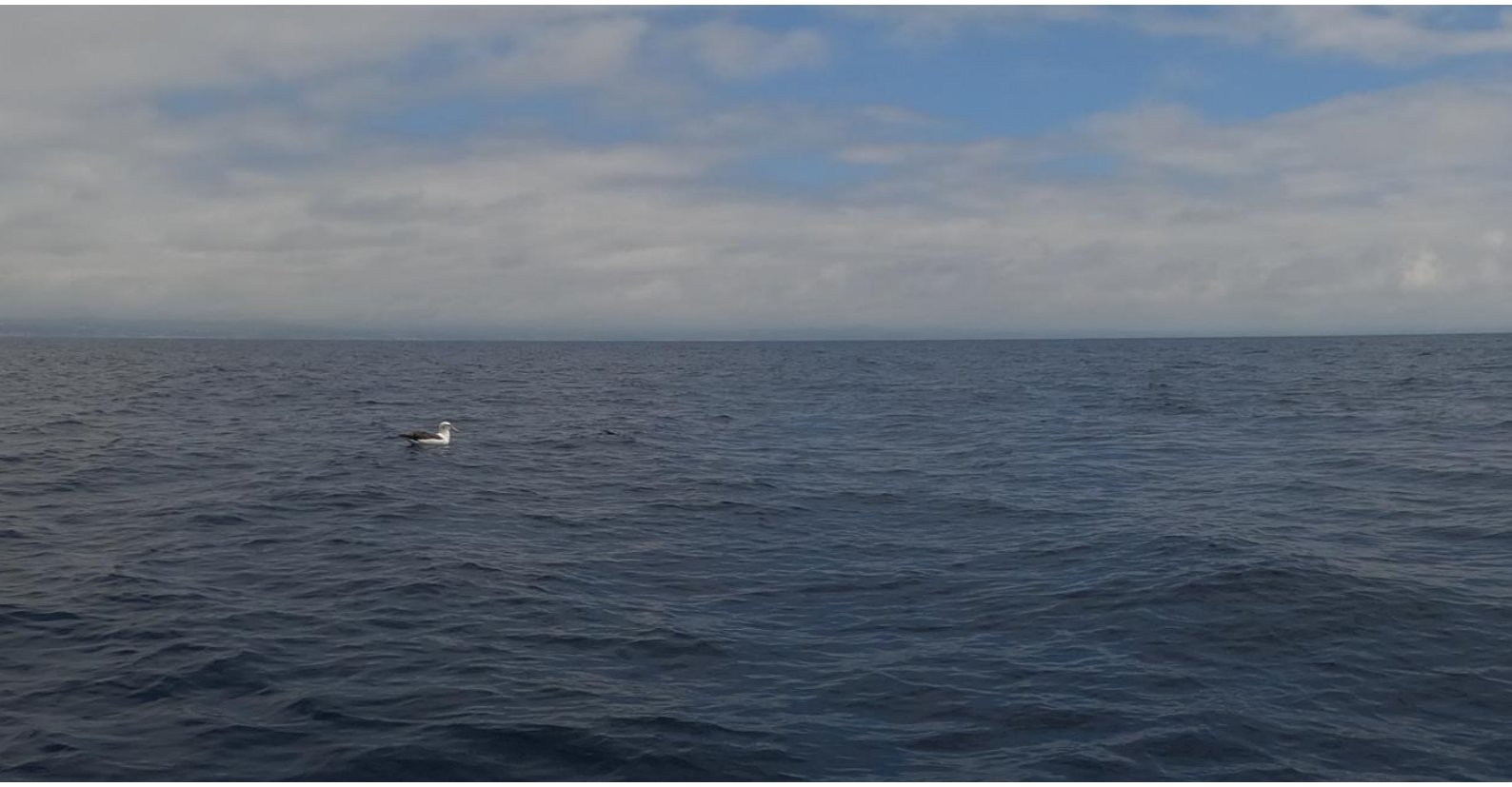

Table of Contents

Cover photo: Shy albatross (*Thalassarche cauta*), Blue Economy Zone, Bass Strait (Marine Solutions 2023).

Proposal Summary

The Blue Economy CRC have proposed a multi-species aquaculture research trial in the Bass Strait Blue Economy Zone (BEZ). The project is a three-year research scale Atlantic salmon (*Salmo salar*) and yellowtail kingfish (*Seriola lalandi*) farming operation, testing infrastructure that has been designed and commissioned for offshore aquaculture whilst monitoring social and environmental values.

The purpose of this document is to outline a monitoring program that will adequately capture any environmental impacts of the proposed BEZ high-energy environment trials. The objectives of the monitoring program are:

- To adequately capture any environmental impacts of the proposed BEZ trial.
- To provide a program that is scalable (for future expansions, reductions or removal of the proposed infrastructure/activities in the zone, or changes in conditions).

The environmental monitoring plan will include:

- Baseline conditions (pre-trial and ongoing reference site monitoring).
- Trial duration.
- Adjustments/investigations needed for scalability.
- Decommissioning.

This document covers monitoring proposed for regulatory purposes and is intended to outline the requirements under regulatory bodies.

1 Introduction

1.1 Proposal Background

The Blue Economy CRC have proposed a multi-species aquaculture research Trial (hereon the Trial) in the Bass Strait Blue Economy Zone (BEZ) (See Section 1.2). The Trial proposes a three-year long research scale Atlantic salmon (*Salmo salar*) and yellowtail kingfish (*Seriola lalandi*) farming operation, testing infrastructure that has been designed and commissioned for offshore aquaculture whilst monitoring social and environmental values.

The Trial proposes to commission a six-bay grid, with two pens active for fin-fish production with 15,000 fish in each.

1.2 Site Information

The BEZ is located within the established MOU area in the Commonwealth Fisheries Arrangement Area, approximately 12 km to the north of Burnie, Tasmania (MOU, Figure 1). The location was identified in 2020 as an area of interest for the conduction of research trials. Since then, numerous field surveys have been conducted in the vicinity of the MOU and the BEZ site has been well characterised (Cossu and Frid 2022, Marine Solutions 2023, Marine Solutions 2024a, Marine Solutions 2024b).

Depths vary from approximately 54.5 m to 60.7 m depth across the BEZ with the deepest locations on the northeastern side of the study area. Benthic habitat throughout has been identified as unconsolidated, bioturbated sandy sediment interspersed with sparse sponges (Figure 2). Refer to Section 1.3 and 2.5 for further details of collected data.

The site is deeper and current flows are greater when compared to existing near-shore aquaculture.

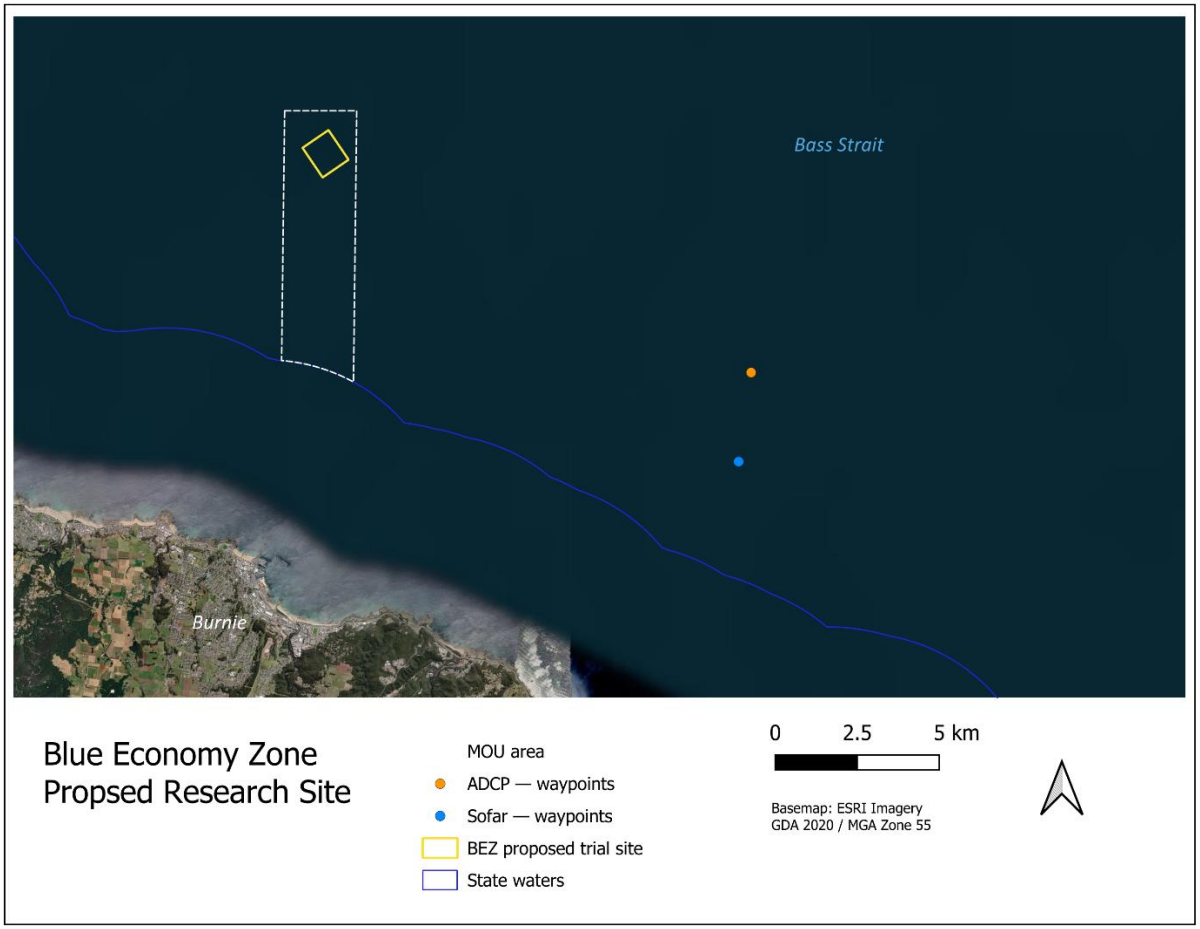

Figure 1. Map showing Blue Economy proposed trial zone (yellow) in the context of the broader Fisheries Arrangement Area (MOU, in white). Position of ADCP and Sofar Spotter buoy deployment are denoted by orange and blue waypoints.

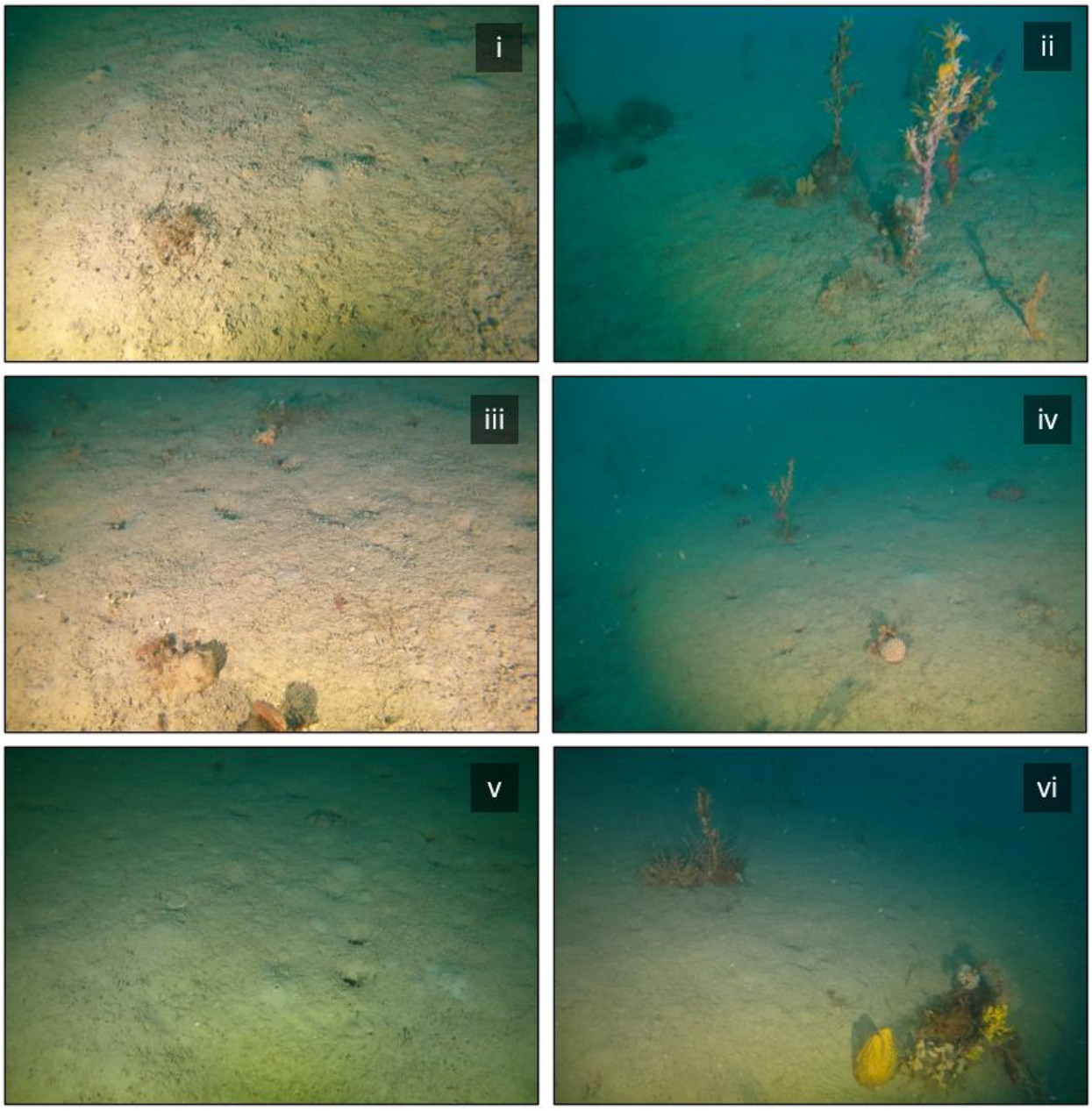

Figure 2. Example images of dominant benthic habitat in the BEZ; bioturbated soft sediments interspersed with sparse sponges (Marine Solutions 2024a).

1.3 Existing Data

The Blue Economy Zone was identified in 2020 as an area of interest for the conduction of research trials. Since then, the site has been well characterised, with collected data summarised in Table 1.

Following baseline site investigations carried out in 2021 and 2022 (Cossu and Frid 2022), site characterisation surveys were conducted in 2023 (Marine Solutions 2023).

A detailed site characterisation of the proposed BEZ site was conducted in 2023 and 2024 to determine its suitability for a BEZ trial site, based on marine environmental factors (Marine Solutions 2024a). Survey methods included MBES bathymetric mapping, sub-bottom profiling, flora and fauna survey, benthic habitat survey and sediment sampling. Refer to Appendix 1 for additional data captured.

Table 1. Summary of collected environmental data.

Survey/Data Collection Method	Data	Date Conducted	Adjacent in the Commonwealth Fisheries Arrangement Area	In the MOU Area (~700m south of BEZ)	Proposed Trial Site (BEZ)
ADCP (Figure 1)	Tidal range, current magnitude and current direction, significant wave height, mean and peak wave period, and mean and peak wave direction	Dec 2020- Mar 2021 Mar 2021- May 2021 May 2021- Aug 2021 Aug 2021- Nov 2021 Nov 2021- Apr 2022	✓		
Sofar Spotter buoy (Figure 1)	Significant wave height, mean wave period, peak wave period, wind speed and wind direction	Aug 2021 - Dec 2022 with some periods of data loss	✓		
Temperature logger	Water temperature profile	5/12/2022 to 30/04/2024 (with large period of data loss)	✓		
		2/11/2021 - 7/03/2022		✓	
		20/10/2022 - 20/04/2023		✓	

		19/12/2023 30/04/2024			✓
		Currently deployed, commenced 30/04/2024			✓
Sediment sampling	Particle size distribution	Date unknown (2021-2022)	✓		
		06/02/2024			✓
Sediment sampling	Benthic infauna assemblages	Date unknown (2021-2022)	✓		
		06/02/2024			✓
Multi beam mapping	Detailed bathymetric map	19/12/2023			✓
Sub bottom profiling	Sub bottom depth data	04/02/2024			✓
Threatened species search	Targeted sediment sampling for Gunn's screwshell (*Gazameda gunnii)*	06/02/2024			✓
Benthic video survey (Figure 2)	Habitat characterisation	09/11/2023		✓	
		30/01/2024			✓

2 Environmental Monitoring

2.1 Overview

The objective of environmental monitoring is to identify and mitigate against unacceptable environmental impacts of research activities in the BEZ.

The objective of the environmental monitoring plan is to provide clear guidelines for adaptive monitoring in the research zone, which can be scaled depending on intensity, duration, spatial extent of the activities being undertaken, and results of the monitoring. The adaptive plan include includes water quality monitoring, infauna, benthic habitat and sediment characterisation to capture three phases:

- Baseline,
- Trial duration, and
- Decommissioning.

Significant impacts are not expected, rather the plan has been designed to capture the signature of Trial activities to improve understanding of potential impacts of commercial scale aquaculture in offshore environments.

The parameters and sites selected for investigation are based on the existing understanding of the BEZ site and are informed by findings from the intensive research program conducted by the Institute for Marine and Antarctic Studies (IMAS) and partners in Storm Bay, Tasmania. Given the BEZ is situated in a deep, high-energy environment, detectable environmental impacts are expected to be minimal relative to what is currently measured at sites in Storm Bay. Furthermore, the low number of stocked pens (two) reduces the likelihood of detectable impacts. The scale of the monitoring program is deemed to be appropriate given the scale of expected environmental impacts.

The monitoring program is designed to be conservative and may also be adjusted based on results after the initial sampling period during the Trial.

Table 2 provides an overview of the proposed monitoring program which is further detailed in Section 2. Table 3 outlines an example monitoring schedule which may be extended based on the results of the monitoring program.

Table 2. Monitoring overview (water quality and benthic habitat) including frequency, trigger values and potential adaptations.

Sites	Phase and frequency	Indicators and trigger levels	Potential adaptations
Water quality (WQ) sampling (nutrients and physical parameters) - 35 m from the six-bay grid boundary (x 4) - 100 m from the six-bay grid boundary (x 4) - 35 m from the BEZ boundary (x 2) - 3 km reference site (x 1)	- Baseline: Monthly for 3[1] months - During production: Monthly - Decommissioning: Monthly for 3 months post-decommissioning.	- Nutrients: 80th percentile of baseline [2] - Chemistry: 20 – 80th percentile. - Chl a: 3 x the median baseline Chl a concentration.	- Outside BEZ and outside six-bay grid sites: If parameters are detected above triggers at existing furthest sites (i.e., 100 m), add sites at next distance interval (i.e., at 200 m distance from the pen). If no detectable changes in WQ parameters above guideline values for the full growth cycle (and full seasonal cycle, whichever is longer) for both species at 35 m sites AND 100 m sites, 100 m sites can be removed from the sampling design. These will only be re-introduced if triggers are then met at any time at 35 m sites (as above). - 100 m (N/S/E/W axis) sites outside six-bay grid, and 35 m (N/S axis) sites: If no detectable changes in WQ parameters after a full growth cycle (or full seasonal cycle, whichever is longer), these sites can be removed from the program.

[1] Baseline data collected for as long as possible

[2] Guideline limit levels derived using baseline data collected prior to commissioning at site, and ongoing reference data collection.

Benthic (sediments, biological, and visual assessment)	-	As above (WQ) Beneath each active pen (x1)	-	Baseline During production: Once per peak biomass (i.e. once at peak salmon biomass and once at peak kingfish biomass), and once approximately 3 months (standard fallow period) after the removal of all fish Decommissioning: not required if no impacts are observed during the trial, or annually following decommissioning until impacts have returned to an acceptable level.	-	Location dependent – different triggers depending on whether the site is under an active pen or outside six-bay grid sites.	- Outside BEZ and outside six-bay grid sites: add sites along axis if impacts detected at furthest sites (as above for WQ). - 100 m (N/S/E/W axis) sites outside six-bay grid, and 35 m (N/S axis) sites: If no detectable changes in parameters after a full growth cycle (or full seasonal cycle, whichever is longer), these sites can be removed from the program. - Beneath active pen sites: one benthic site per active pen (add or remove depending on adding or removing active pens).
Therapeutics monitoring	-	TBD, in consultation with the EPA	-	Baseline Monitoring decided per therapeutics event	-	TBD	- TBD, in consultation with the EPA. - Prior to any therapeutic use, the EPA should be notified, and a monitoring plan needs to be produced and monitoring conducted.

Table 3. Example monitoring schedule.

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Salmon Pen	Baseline						Active Pen												Harvest		DC*				
Kingfish Pen	Baseline									Active Pen										Harvest			DC*		
Sediment Sampling	X															X			X						X
Water Quality Sampling	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

*Decommissioning

2.2 Proposed Monitoring Sites

The number and location of monitoring sites have been selected in order to best capture and understand the scale and nature of any impacts.

To target the likely highest impact areas, sites to the east and west have been selected based on prevailing currents (approximately 90°, 300° (Cossu and Frid 2022)).

In addition to sites in and bordering the BEZ, we propose a reference site 3 km from the BEZ with comparable characteristics including depth, benthic habitat and sea state.

Initial proposed monitoring sites include (Figure 3):

- Water quality (Section 2.3) and benthic habitat (Section 2.4)
    - 35 m from the six-bay grid boundary (x 4)
    - 100 m from the six-bay grid boundary (x 4)
    - 35 m from the BEZ boundary edge (x 2)
    - 3 km reference site (x 1)
- Benthic habitat only (Section 2.4)
    - Beneath the active pen sites (x 2).

Certain site locations (sites within the active pens and sites based on distance from the six-bay grid) are adaptable depending on the location edge of the research pens to allow for flexibility in the Trial including the positioning, size and number of pens within the BEZ.

Other sites (reference site, sites based on distance from the BEZ boundary) are intended to be fixed to facilitate continuous data collection, regardless of the location of the research pens and activities within the BEZ (Figure 4).

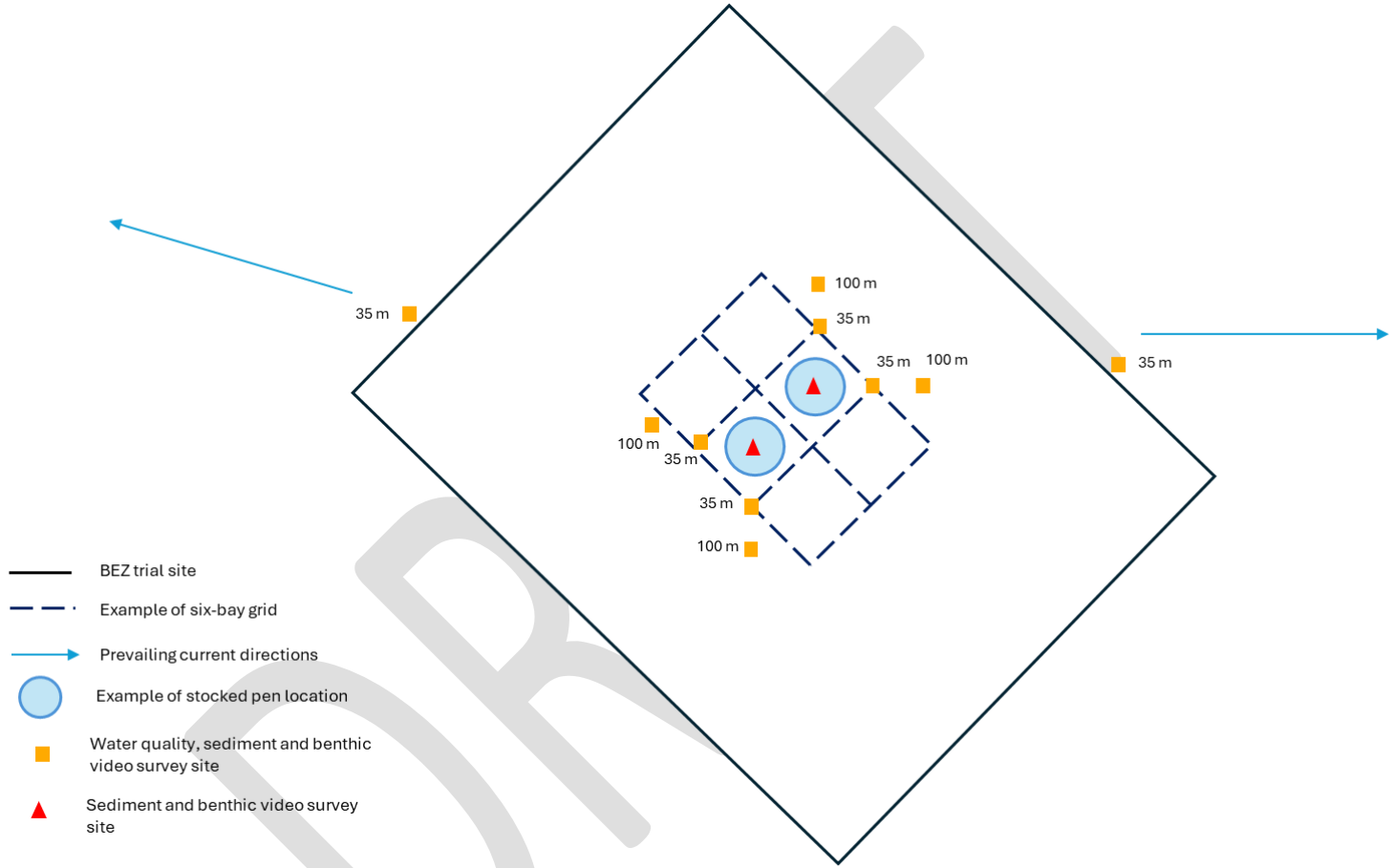

Figure 3. Proposed adaptive and fixed monitoring sites (does not show reference monitoring site 3 km from the BEZ trial site). Note that diagram is not to scale.

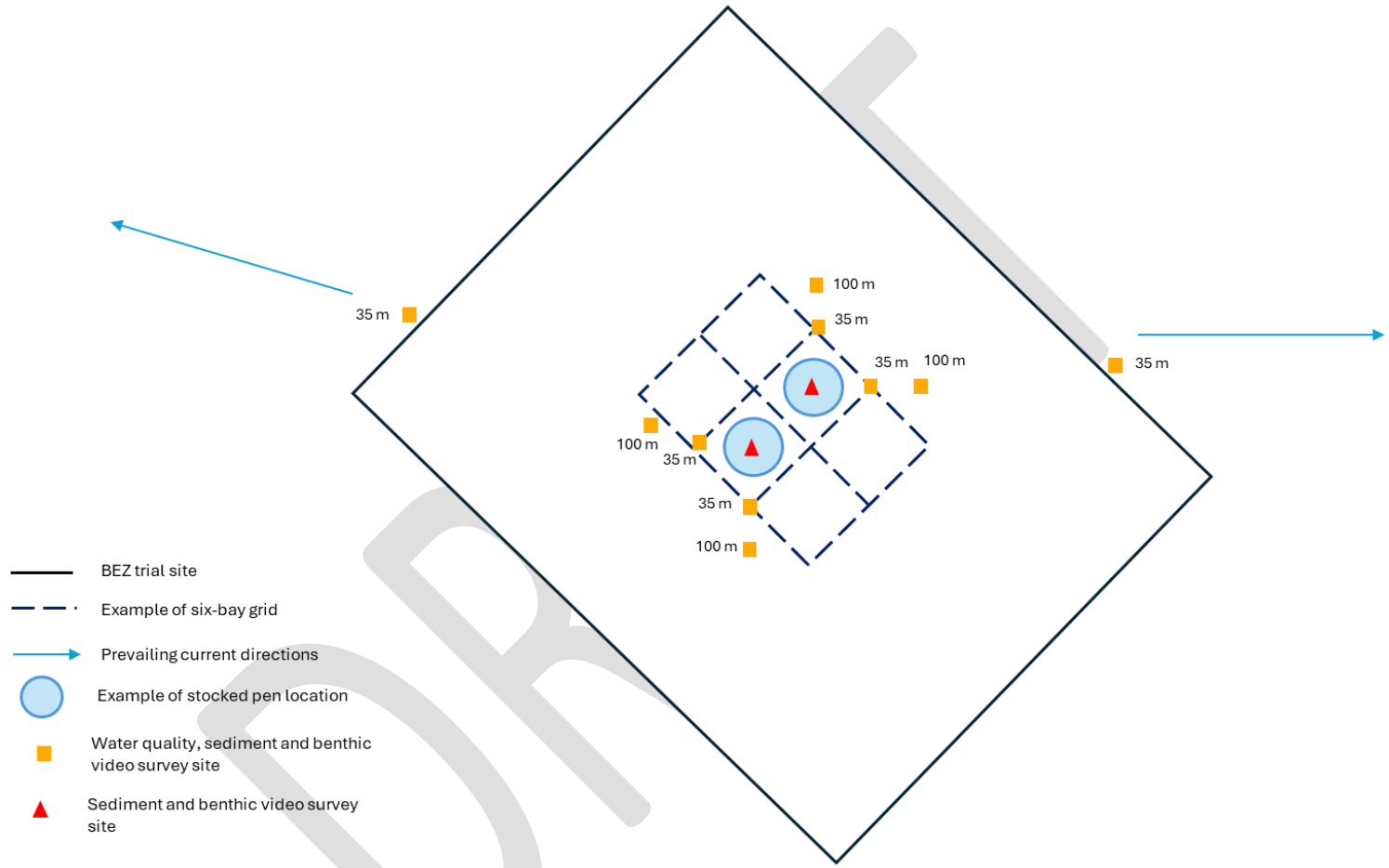

Figure 4. Proposed fixed monitoring sites (does not show fixed reference monitoring site 3 km from the BEZ trial site). Note that diagram is not to scale.

2.3 Water Quality Monitoring

Water quality parameters will be monitored *in situ* and collected samples will be analysed by a NATA accredited laboratory during all three phases of the Trial. Table 4 provides an overview of water quality monitoring parameters and methods.

Table 4. Water quality monitoring.

Sampling Type	Parameters	Method	Depth
Nutrients	Total Nitrogen Nitrogen Kjeldahl Phosphorus Dissolved Ammonia (TAN) Nitrate Nitrite Nitrate + Nitrite Phosphorus (DRP) Silicate (SMR) Dissolved Organic Carbon (DOC)	Niskin bottle + laboratory analysis (NATA accredited)	Sampling at surface and one metre above seabed. 10 m below surface sample will be taken at the reference site
Water chemistry	Dissolved oxygen (% saturation + mg/L), temperature (°C), salinity (PPT), turbidity (NTU), pH	Sonde profiler	Surface, every metre for first 10 metres, then every 5 metres thereafter and bottom.
Phytoplankton	Cell count, taxonomy, relative abundance, Chlorophyll a	12 m depth integrated sampler	Top 12 m of water column

Finfish aquaculture operations result in the release of waste products into the pelagic system which can elevate nutrient levels in the water column. This dissolved waste has the potential to increase ambient nitrogen levels that can stimulate phytoplankton production. Nutrients and phytoplankton will be regularly sampled to capture any impacts the Trial activities may have on the water column. Monitoring water quality parameters including DO, temperature, salinity, turbidity and pH will

capture potential environmental impacts of the Trial and provide valuable information for the research activities.

In order to establish baseline water quality parameters, baseline water quality monitoring will be conducted for a minimum of three months prior to the stocking of fish. To supplement the dataset, the reference site data will be used to inform acceptable levels of impact and trigger levels. EPA default guideline values (DGVs) for the Bass Strait Shelf Province (provincial scale), and the Boags and the Central Bass Strait (mesoscale) Bioregions[3], and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality[4] can also be used to inform acceptable levels of impact and trigger levels.

Water quality monitoring will be conducted for a minimum of three months after the removal of fish from the trial in order to capture any impacts of the Trial. If impacts are still detectable at the completion of the three months of decommissioning monitoring, additional monthly monitoring may be required.

If any parameter monitored is found to have an unacceptable level of impact on water quality, mitigation actions will be taken.

[3] https://epa.tas.gov.au/environment/water/water-quality-guideline-values-for-tasmanian-aquatic-ecosystems/coastal-and-marine-water-dgvs-for-aquatic-ecosystems
[4] https://www.waterquality.gov.au/guidelines/anz-fresh-marine

2.4 Benthic Monitoring

Sediment biological and physicochemical characteristics will be monitored in all three phases of the Trial. Table 5 provides an overview of benthic monitoring parameters and survey methods.

Table 5. Benthic monitoring.

Survey type	Component	Parameters monitored	Method
Sediment sampling	Biological	Infauna	Benthic grabs (van veen or similar, same volume captured throughout).
	Sediment characterisation	Sulphides	Benthic grabs or cores.
		Organic content	
		Particle size	
Underwater video	Visual assessment	Benthic habitat	ROV, drop camera or other suitable method.

2.4.1 Sediment Sampling

Sampling will be conducted to capture potential impacts of research activities on biological and physicochemical characteristics of sediments in the area. Inputs such as feed and faecal matter may impact sulphide levels, organic content, particle size, and the structure of benthic infauna communities.

The sampling schedule (peak biomass of salmon, peak biomass of kingfish, and three months after the removal of all fish from the system) is intended to capture the highest levels of potential impact and impacts after a typical fallow period. If impacts are detected in the fourth round of benthic sampling (decommissioning/fallow round), further monitoring may be required until the benthic environment has returned to an appropriate state.

If any parameter monitored is found to have an unacceptable level of impact on sediments, mitigation actions may be required.

2.4.2 Video Survey

Video surveys can be employed to detect potential visual and biological impacts of the Trial. Parameters monitored by video survey may include, the presence of fish feed pellets, presence of bacterial mats e.g. *Beggiatoa* spp., outgassing from the sediments, species and community composition, and presence/absence of threatened, protected, and invasive species.

Video surveys are to take place at the same project phase as the sediment sampling in order to capture the highest level of impact and impacts after a typical fallow period. If impacts are detected in the decommissioning/fallow round, further monitoring may be required until the benthic environment has returned to an acceptable state.

If any parameter monitored is found to have an unacceptable level of impact on the benthic habitat, mitigation actions may be required.

2.5 Therapeutics Monitoring

Salmon and kingfish have differing requirements for therapeutic treatment. Regulations for the salmon aquaculture industry are well described for the Tasmanian regulatory framework, whereas kingfish aquaculture is a growing industry in Australia and is a new sector in Tasmania. To the knowledge of Marine Solutions, there are no guidelines under the Tasmanian regulatory context specific to kingfish aquaculture. Therefore, it will be necessary to work closely with the Environmental Protection Authority Tasmania (EPA) and maintain a highly conservative approach to monitoring for impacts of kingfish aquaculture and in particular, the use of therapeutics that may be different to what is described already for the salmon aquaculture industry.

2.5.1 Salmon - Oxytetracycline (OTC)

Salmon may require provision of medicated feed containing antibiotics (active ingredient: Oxytetracycline (OTC)). The EPA have guidelines for monitoring antibiotic residues originating from leases in seabed sediments and in wild fish, however, the final field design for monitoring will be dependent on the site characteristics and amount of medicated feed used during the treatment for

that event. Although the sampling program will be specific to the treatment event, the monitoring design for OTC residue will likely follow similar methods completed at other locations, whereby a field survey including sediment sampling and when needed, monitoring of wild fish populations was conducted (Petuna Aquaculture 2022 & Aquenal 2024). However, the final sampling program will be dependent on the treatment event(s) and will be designed in collaboration with the EPA and other relevant authorities.

2.5.2 Kingfish – PZQ

At the time of writing, Marine Solutions have been provided with the following information regarding farmed kingfish therapeutic requirements. Farmed kingfish require antibiotic treatment in the form of Praziquantel (PZQ), an anthelmintic used to treat a range of flatworm parasites and amoebic gill disease. At regular intervals, kingfish are placed into a saltwater bath with a PZQ treatment to treat amoebic gill disease and other parasites.

Like other therapeutics, there are environmental concerns pertaining to the release of PZQ into the environment (Norbury *et al*. 2022). Therefore, monitoring for PZQ - or any other used therapeutics - in the ambient environment in the vicinity of the active pens will be essential. Monitoring for therapeutics will be dependent on known characteristics of that product (chemistry, accumulation potential, degradation pathways etc.). Monitoring could include water quality, sediment and food web (i.e., wild fish) sampling across several sites and events. As above for salmon, the final sampling program will be dependent on the antibiotic used, the scale of the treatment event(s) and will be designed in collaboration with the EPA and other relevant authorities.

3 Conclusion

The monitoring plan has been designed to best capture any environmental impacts of research activities conducted in the BEZ. The plan is intended to be adaptive, responsive to the results of monitoring and scale, type and duration of the Trial.

Based on the results of previous monitoring including in Storm Bay and the Mercury Passage, it is expected that detectable impacts of the Trial will be negligible owing to the site depth, current flows, and the low number (two) of pens stocked.

Collecting baseline information and regularly monitoring environmental parameters will provide valuable data which can be used to inform future high-energy aquaculture projects.

4 References

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Norbury LJ, Shirakashi S, Power C, Nowak BF, and Bott NJ (2022). Praziquantel use in aquaculture - Current Status and Emerging Issues. *Int J Parasitol Drugs Drug Resist.* 2022 Apr;18:87-102. doi: 10.1016/j.ijpddr.2022.02.001.

Petuna Aquaculture (2022). Antibiotic Residue Survey Report MF178 Final Report July 2022 | Rowella - Van Diemen Aquaculture (Petuna Aquaculture Pty Ltd).

Appendix 1. Additional Blue Economy Zone Data

Table 6. Additional collected data pertaining to the BEZ.

Survey/Data Collection Method	Data	Date Conducted	Adjacent in the Commonwealth Fisheries Arrangement Area	Proposed Trial Site (BEZ)
Single beam bathymetry	Bathymetric map	Dec 14 - 15 2020, Mar 10 - 17 2021, May 11 - 13 2021	✓	
Sub-bottom profile	Sub-bottom profile map	Mar 10 - 17 2021	✓	
Fish trawl	Benthic fish species diversity	Nov 29 - 30 2021	✓	