BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

BIOSECURITY MANAGEMENT PLAN

Bass Strait Blue Economy Zone (BEZ),
Aquaculture Research Trial in
Commonwealth Waters

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Australian Government
Department of Industry, Science and Resources

Cooperative Research Centres Program

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1 INTRODUCTION

1.1 Background

The Blue Economy CRC is committed to a high standard of fish health and biosecurity control. The Blue Economy CRC has partnered with industry to deliver and manage operational aspects of the Bass Strait Blue Economy Zone (BEZ) Aquaculture Research Trial in Commonwealth Waters (the Research Trial) and the Research Trial will be conducted in accordance with industry standard best practice environmental management systems and associated procedures.

This Biosecurity Management Plan is written to support operations at the Research Trial Site.

Best practice husbandry is central to fish culture and helps ensure that all staff understand biosecurity, the health and welfare of stock and the wildlife that co-exists within the farming environment. This allows staff to be able to better support fish welfare policy and comply with expectations in this document, ensuring optimal fish health and welfare.

1.2 Objectives

The foremost objectives of this Biosecurity Management Plan are to:

- Provide good health conditions for cultured animals used in the trial
- Minimise the transmission of existing or exotic pathogens, and
- Provide specific direction/guidance to achieve good health conditions.

This plan seeks to fulfil the basic intent of the OIE Aquatic Animal Health Code. The plan has been written in consideration of the requirements of the Australian Aquatic Veterinary Emergency Plan (AQUAVETPLAN), State Biosecurity Plan and follows HACCP protocols. In this respect this document covers:

- Regulatory requirements
- Surveillance for disease
- Prevention and control of disease in stock
- Use of therapeutants, and
- Welfare considerations.

1.2.1 Legislative requirements

Tasmanian legislation relevant to managing fish health includes:

- Animal Health Act 1995
- Animal Welfare Act 1995
- Environmental Management and Pollution Control Act 1994
- Finfish Farming Environmental Regulation Act 2017
- Living Marine Resources Management Act 1995
- Natural Resource Management Act 2002, and
- Biosecurity Act 2015.

Relevant regulatory agencies include:

- Environmental Protection Authority (EPA)
- Department of Natural Resources and Environment (NRE)
- Australian Maritime Safety Authority – Marine Board (MB), and
- Department of Agriculture and Water Resources.

2 FISH HEALTH

2.1 Keeping fish healthy

Keeping fish healthy is critical in reducing disease incidence on site, predisposing adjacent populations to disease risk and reducing losses during handling events. Fish must be routinely monitored for signs of health and disease. All personnel should be familiar with "normal" fish behaviour and appearance to be able to escalate/notify when there are abnormal observations, including:

- **Physical changes:** skin darkening; scale loss; fin erosion; ulcerative skin lesions; increased respiratory rate (gill plate movements); protruding eyes; predator strikes; external parasites e.g. amoeba.
- **Behavioural changes:** loss of schooling behaviour; loss of normal swimming (lethargy, breaking away from school, whirling); flashing; unresponsive to capture; reduced feed response; gasping at the surface or base of the net; regurgitation.

2.1.1 The immune system of a fish

A fish's immunity can be broken down into adaptive and innate immunity. It is important that both of these systems are optimised in a farming situation. Optimising the immune capacity of the fish will improve health and performance.

The innate immune system is the first barrier of response and is essential to combatting pathogens. The most important is the epithelial/skin/mucous barrier- this includes the mucosal barrier of the skin, gills and gut. These are the most important because they are the areas that will be first exposed to a pathogen.

Skin, mucus, scales and gills act as the first barrier for infection. The cuticle of fish consists of mucus and anti-microbial agents such as lectins, lysozymes, complement proteins, antibacterial peptides and immunoglobulin, which play a crucial role in inhibiting pathogens. The skin layer is also able to react to different attacks on the body by modifying what is excreted by the mucus cells. The integrity of the skin is extremely important to maintain osmotic balance (i.e. salt and water balance in all cells).

When handling fish, it is important to be conscious about the cuticle that may be disrupted. Soft materials are used for netting and gloves, equipment items are checked for areas that could cause mucus stripping and abrasion. It is imperative to maintain the cuticle coating on fish.

Scales are very deeply embedded in the skin (Figure 1). When dislodged, it can create a tract for bacteria to colonise and embed themselves into the deeper layers of skin e.g. lesions in fish could begin with just a small area of descaling. Superficial bacterial infections may progress to full thickness penetration i.e. an ulcer.

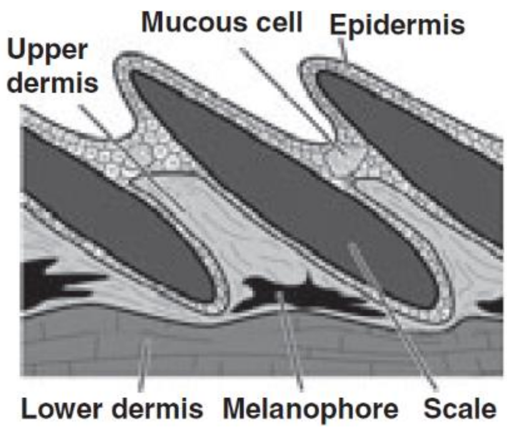


Figure 1 Fish skin structure

The adaptive immune system consists of a network of specialised cells, proteins, genes and biochemical messages in the body. The adaptive immune system is the basis for vaccination programs. It relies on the body to recognise proteins from foreign bacteria, viruses, parasites and then launch an immune reaction when subsequently presented with the same proteins.

Fish are vaccinated at the hatchery to prime their adaptive immune system, so when they reach marine sites, and are challenged with the same pathogens, their immune response is greater and faster.

The immune system can be impacted negatively by stress. Cortisol is a potent stress hormone that can interfere with the immune system.

2.1.2 Host-pathogen-environment interaction

Health management is holistic, and optimising performance relies on stock being in good health. The host-pathogen-environment (HPE) relationship is displayed in Figure 2. Essentially, if any of the factors are unbalanced, the risk of disease is increased. Therefore, it is important to understand these to ensure that the HPE relationship is not put off balance.

Decision-making should consider whether or not the planned activity will disrupt this relationship and how these disruptions can be minimised.

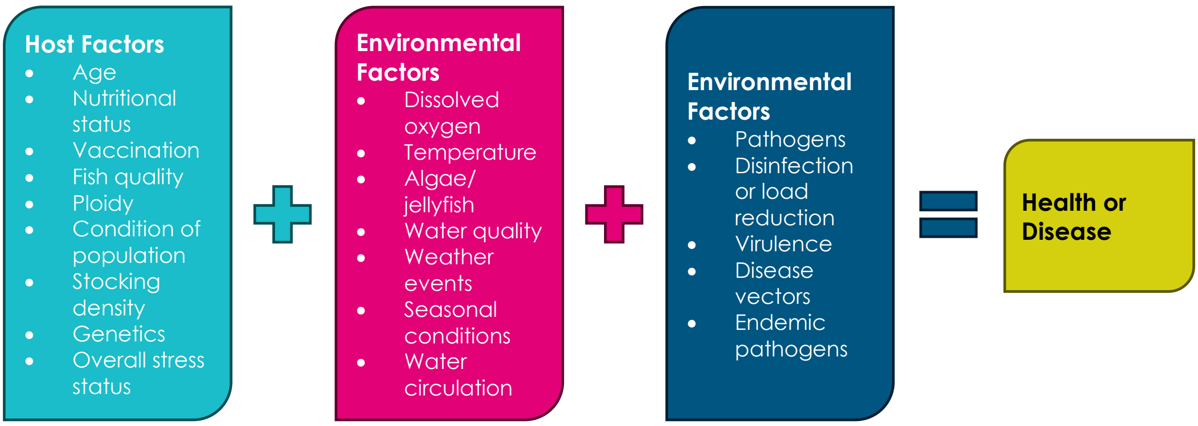


Figure 2 Factors that affect fish health and the development of disease

2.1.3 Maintaining a suitable environment

2.1.3.1 Rearing environment

A suitable rearing environment is required for each life stage. This includes stocking density (and schooling density), dissolved oxygen levels, water flow, mooring grid orientation, mooring grid configuration, ensuring that the systems in which fish are farmed optimise health and welfare of stock.

2.1.3.2 Predator exclusion

Predators will be excluded from the site as best as possible. Predation is a cause of fish stress and loss. The main predators are sea birds and seals. Protocols that ensure the welfare of wildlife need to be maintained, and staff need to ensure that they are still treating these animals humanely. If there are human safety risks associated with the individual animal, notification to the Trial Site Manager is required.

2.1.4 Feed and nutrition

Procedures are maintained for the healthy feeding of fish. Feed should be of suitable nutritional quality to meet the needs of the animal and life stage. Feed is stored in secure buildings where wildlife can be excluded, and spillage can be prevented. Feed needs to be protected from extremes in temperature, light and humidity to prevent it becoming rancid. If feed rates are low, an investigation must be launched to understand the cause.

2.1.4.1 Onsite feed quality monitoring

Feed is delivered into the silos on the barges by boat. During this process, there is the chance to make observations on the appearance of the feed. If the following is noted by staff members attending the feed, a complaint record is to be completed:

- Rancid smell
- Oil content too high
- Brittle feed
- Poor colour e.g. too dark could mean feed is burnt
- Whole grains appearing in the feed, or
- Fungal growth on feed.

2.1.4.2 Traceability

Traceability of feed is necessary to trace back and trace forward if there are toxicities or nutritional deficiencies associated with feed. Sometimes no clinical signs of nutritional deficiencies will be observed until an entire feed batch has been fed out, as it takes approximately 4-6 weeks for it to manifest itself. Record keeping is necessary at every site for this reason. All batch numbers of feed should be recorded.

2.1.5 Water quality

Maintaining good water quality is vital to good fish health. The zone must maintain a regular program of monitoring and recording water quality as described in Section 6.1.

2.1.5.1 In pen venturation and oxygenation

Dissolved oxygen levels are affected by various factors including tidal flow, phytoplankton/jellyfish concentrations and pen biomass. Dissolved oxygen will be monitored at least daily by the remote feed centre. If dissolved oxygen is consistently low, in-pen venturation or oxygenation will be installed at the Trial Site.

2.2 Fish movement

2.2.1 Marine input

Tasmanian Atlantic salmon are transferred to sea between January and November.

All fish that are moved from hatchery to sea sites need to have:

- Been approved in the stocking plan
- Have an in date pre-transfer examination report that contains (valid for 30 days):
  - Average weight/length/condition factor and CV
  - Deformity measures
  - Health checked by fresh gill preparations, histopathology, microbiology, and
  - In date biosecurity certificate for the stock.

In addition, marine sites must be suitably prepared for smolt inputs with regards to containment infrastructure and environmental conditions at the time of input.

2.2.2 Movement between leases

Fish will not be moved from other marine leases to the Research Trial Site. Similarly, fish from the Trial Site will not be transferred to other marine leases.

2.3 Fish handling

2.3.1 Transport

During transport, the following should be monitored: dissolved oxygen saturation and concentration; temperature; carbon dioxide, pH and ammonia.

2.3.2 Crowding/bathing/splitting

Crowding of fish is a crucial part of operations. Procedures need to be followed when setting a transaction net and the crowd needs to be carefully observed. At all times, oxygenation needs to be provided to the crowd. Oxygenation should be as even throughout the crowd as possible.

Standard operating procedures are to be followed and crew must be trained in fish behaviour before commencing.

If there are other risks that are foreseeable e.g. adverse weather or high current; conduct a risk assessment to determine if there are mitigation measures to better fish safety.

Bathing is an important operation, being the primary method of managing amoebic gill disease (AGD). There are several considerations for a bath:

- Behaviour of the fish prior to the bath: If abnormal, contact the Trial Site Manager to determine if operation is to go ahead
- Environmental water quality: algae, ambient dissolved oxygen and temperature
- Freshwater quality (as above)
- How long the transaction net has been in the water and if any fish have been caught behind the transaction net,.

These factors need to be considered before commencement of a bath. Fish that are caught behind a transaction net will act as future seed populations for amoeba. They increase the total amoeba loading in the pen, which can cause more rapid onset of disease.

2.4 Photoperiod

Whilst several factors have been demonstrated to influence the timing of sexual maturation, the principal cue is reducing photoperiod as it stimulates endogenous rhythms and reproductive development. Depending on time of input, some fish types will be exposed to two consecutive winters (reducing photoperiod) at sea. To prevent early maturation in these fish types, pens will be placed under a photoperiod of 24 h light using artificial underwater LED lights from Jul to Nov during their first winter at sea.

2.5 Fish health monitoring

Throughout the entire marine production phase, from time of input to harvest, regular gill health and quality assessments will be conducted under the direction and advice of the Trial Site Veterinarian and by site staff during routine operations.

Operational staff will receive in situ training and refreshers conducted by the Trial Site Veterinarian where required.

Trial Site Veterinarian and Trial Site Manager will closely follow mortality trends and fish performance. Various stages of surveillance will be conducted as required.

Samples will be sent to the appropriate department for analysis (e.g. Fish Health Unit, Analytical Services Tasmania). Results will be reviewed by the Trial Site Veterinarian.

Notifiable disease outbreaks will be reported to the appropriate authorities by the Trial Site Veterinarian.

2.6 Algae and jellyfish

Phytoplankton and jellyfish can have detrimental impacts on fish health, including mechanical damage to the gill tissue, mortality from toxin exposure, and depleted in-pen dissolved oxygen levels. Concentrations should be monitored as frequently as possible by site.

2.7 Net cleaning

Nets will be cleaned on a rotational basis, approximately every ten days to two-weeks, or as required. Net cleaning operations will be directed by the Trial Site Manager.

Biofouling reduces water flow and hence oxygen availability in a cage. Biofouling consists of seaweed growth as well as hydrozoan growth which can have detrimental effects on fish gill health, additionally, the plumes from net cleaning can cause irritation to the gills. Guidelines for net cleaning include:

- Starve fish prior to net cleaning i.e. if net cleaning will occur in the afternoon, then starve from first feeding session
- Net clean with the out-going tide
- Net clean at low levels of biofouling, and
- Understand what is growing on the nets as hydrozoans can be harmful to fish.

2.8 Fish containment

Predators have the potential to spread disease and damage stock. Measures are in place to reduce predator interaction (refer Wildlife Management Plan).

Fish will be contained in fit for purpose nets that account for energy flow, depth, fish size and predation pressure. Net assessments ae conducted regularly to help prevent predator breach and/or fish escapes. Currently, predator breaches (seals) pose the highest risk for stock loss; consequently, there is a strong emphasis on exclusion technology. Refer to the Wildlife Management Plan for further details.

2.9 Escape prevention and response

Escapes can have negative implications on fish welfare, resulting in mortality from predation or the inability to feed in the wild environment. Mortality as a result from predation holds the highest likelihood.

Escape prevention is achieved through education, training, standard operating procedures, inventory management, and continual improvement of infrastructure and technology.

Any significant or suspected significant escape will be reported through the Trial Site Manager and where necessary to meet legal and licence requirements will be reported to the appropriate authorities as soon as is reasonably practicable.

2.9.1 Escape prevention

Through the implementation of the various management plans and procedures established for the Research Trial, escapes will be minimised through education, training, standard operating procedures, inventory management, ad-hoc community feedback, and continual improvement in areas of control.

In the event of a notifiable escapement of fish the following procedure will be followed:

- Standard operating procedures will be followed to prevent further fish escapes and inventory loss from the Trial Site. Any losses of stock will be reported in relation to approvals requirements.
- In the event of escape of fish which are being treated with antibiotics or during their withholding period (the time taken to ensure that residues of antibiotics are either not detectable or at such low levels that they do not represent any hazard to humans), the Principal Investigator BECRC will communicate with local community organisations e.g. boat clubs to indicate that any Atlantic salmon caught should not be consumed as antibiotic levels could be in excess of the maximum residue level permitted in Australian regulations.

2.9.1.1 Daily checks

- **Nets:** Informal surface net inspections are conducted on a daily basis by farm staff, feed staff and night security personnel.
- **Bird Nets:** The maintenance of bird netting within marine farms prevents marine birds from entering farming systems and consuming stock. The prevention of holes within bird netting maintains the enclosure for stock and prevents leakage.
- **Vessel Operation:** The weighting systems, net tension, and net designs do not allow for areas of net to be exposed to boats. A spotter is used to visually monitor and prevent damage to pens, nets, and mooring systems. This is only conducted by large vessels such as harvest or tow vessels that are close to pens.
- **Fish Feeding:** Feeding of fish occurs from a remote feed centre. This is carried out using an automatic feed system controlled by the feeder. Feed volumes can fluctuate from day to day; if a dramatic drop in feeding occurs or suppressed feeding continues for more than 2 days, this may indicate fish escapes, and divers will carry out full net inspection to affected cages.
- **Fish Handling:** Fish handling on marine farms is a frequent occurrence, it is conducted in such a way as to mitigate the chance of stock loss; this includes pipe protection netting, catch netting (for returning weight/gill checked fish to their donor pen), net inspections prior to crowding fish, and the accounting of culls on the daily mortality sheet (to balance inventory). The same approach is applied in the rare occurrence of a dive harvest.
- **Mortality Recovery:** Divers are in each net 1 – 2 times per week for collection of mortalities. Any holes sighted are repaired immediately and noted on the mortality report. Thorough net inspections are completed for post bath dives.
- **Smolt and Juvenile Deliveries:** A designated employee discharges fish at the transport tank and another designated employee observes other end of discharge hose in pen and ensures smolt capture nets are in place. All receiving nets are inspected for holes before fish are delivered.

2.9.1.2 Inventory management

As part of inventory management, all pens are counted at planned points during the production cycle, usually during a bath, cage split or a grade. This counting typically occurs 3-4 times during a production cycle.

After a pen of fish is counted, count accuracy is reviewed and any variance will be reviewed by the Trial Site Manager.

2.9.2 Escape response

The overall fish escape response procedure is illustrated in Figure 3.

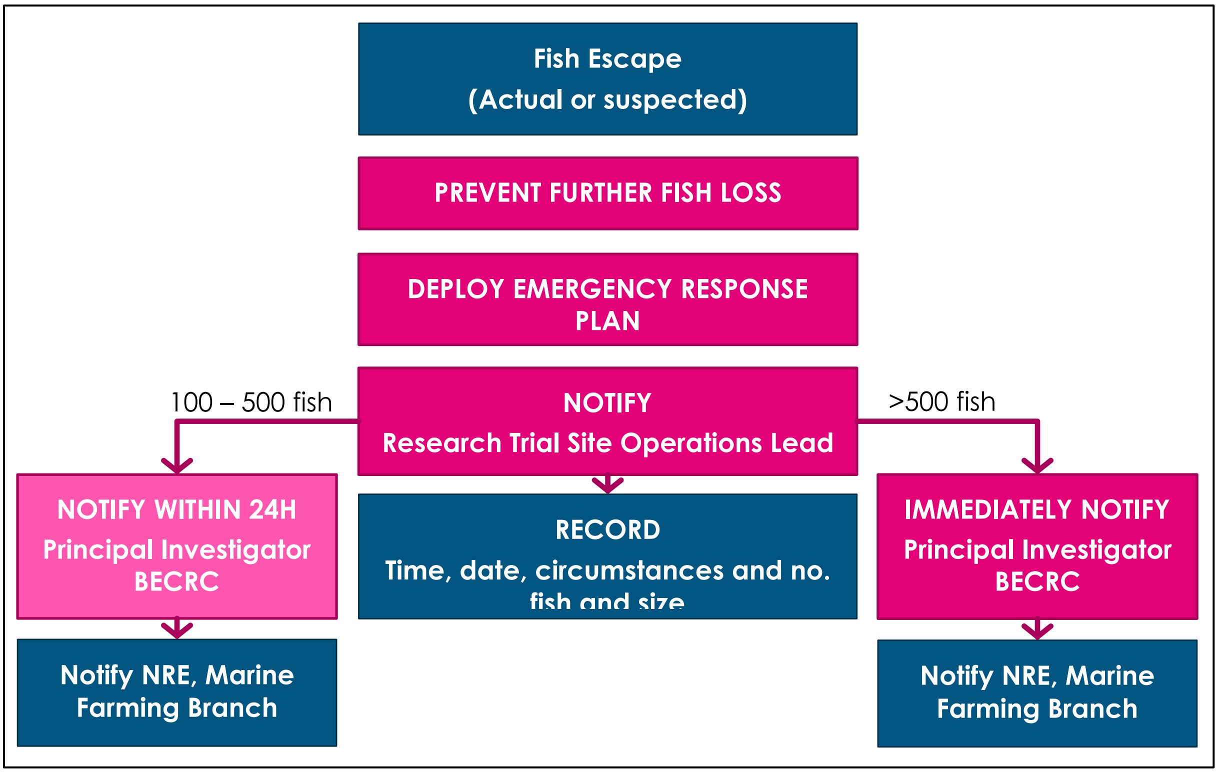


Figure 3 Escape response protocol

2.9.2.1 Equipment

An escape kit is to be located on every feed and bathing barge. The kit includes equipment that allows for a temporary repair of a hole in netting.

2.9.2.2 Procedure

If fish are sighted outside pen, cease routine operations and initiate fish escape response plan:

1. Inspect pens from surface to identify any breaches e.g. nets down, holes visible, seals in nets, equipment failure
2. If possible, correct breach immediately, then notify Trial Site Manager and dive team
3. If no surface holes or equipment failures are apparent, notify dive team for in water inspection of pens
4. Record time and circumstances of incident and number, size and condition of fish observed
5. If numbers are greater than 100 fish, notify the Trial Coordinator ASAP

If a tear in a net occurs, equipment fails, or a hole is observed:

1. Prevent further fish loss: deploy emergency containment net(s), deploy divers to repair hole or repair equipment
2. Notify the Trial Site Managers
3. If numbers lost are estimated to be more than 100 fish, notify the Trial Coordinator ASAP
4. If numbers are greater than 500, this is an official escape incident and procedures must be followed, the Trial Coordinator will notify NRE
5. Record time and circumstances of incident and identify number of pen and size of fish
6. Alert feeding staff of possible inventory loss and track feed response of pen

7. If a suspected fish loss of greater than 500 fish, a fish count will be conducted at the very next opportunity, if suspected fish loss is less than 500 fish, a count will be conducted at the next routine fish handling transaction, and
8. A event will be reviewed and documented, along with suggested improvements in mitigation and response.

2.9.2.3 Incidental Losses

Incidental losses are classified as one or two fish lost to the open water during routine transactions (e.g. gill/weight checks, bouncing out of transport pipes).

If an incidental loss occurs

- One person to stop activity and use available dip net to recover fish
- Return live fish to the pen from which they came, record the incident including pen number, fish size, number of fish assumed to have escaped and how many were recovered, and date and time of the incident, and
- If unable to recapture the fish, record the incident including pen number, fish size, number of fish assumed to have escaped, and date and time of the incident.

2.10 Feed operations

Feeding frequency and amount will be adjusted according to fish size, environmental parameters and input period.

Feed amounts are monitored for each pen and recorded daily. Remote feed centre staff and artificial intelligence systems are used during all feeding operations to maximise feed usage. Weight checks are conducted as required to monitor growth and feed performance.

2.11 Bathing operations

Freshwater bathing for the treatment of AGD will occur using conventional tarpaulins. Bathing will occur rotationally and/or will be conducted based on the AGD loading determined by routine fish health and quality assessments.

A soft net is a secondary net placed within a fish net that allows the fish to be crowded. The duration the soft net is in the pen must be kept to a minimum to reduce the risk of physical damage to the fish and/or unfavourable environmental conditions within the pen due to reduced flow.

Water quality must be monitored frequently during the bathing process and recorded by operational staff. Fish behaviour will be monitored, and all crowds supplemented with oxygen.

2.12 Mortality collection

Daily mortality counts should be estimated and reported to site by the remote feed centre using in-pen cameras. This data will be used to direct mortality collections.

Fish mortalities will be collected by the respective staff member, counted, and classified accordingly to indicate the likely cause of death. If there are >20 fish, a portion of the fish will be classified and extrapolated to the total mortality count. Classifications will be monitored regularly by the Trial Site Veterinarian.

Disposal of mortalities will occur in accordance with the Waste Management Plan.

2.13 Dive operations

During dive operations, fish behaviour is assessed, mortalities collected and classified, and fish nets assessed and repaired as required.

2.14 Significant mortality event response

In the case of a significant mortality event:

- Harvest vessels may be redirected to conduct an emergency harvest if appropriate
- Fish may be treated if applicable, and
- If all other options have been exhausted, and it is the best option for animal welfare, fish may be culled at the advice of the Trial Site Veterinarian in discussion with the broader project team and taking into consideration the requirements of applicable legislation.

In the event that a mass mortality event occurs, mortalities would be collected and disposed of in accordance with the Waste Management Plan.

2.15 Vaccinations

Vaccines are an important tool for the control and management of infectious disease. Vaccines that may be used and the respective pathogens they protect against are outlined in Table 1.

Table 1 Vaccines available for use.

SPECIES PERMITTED	VACCINE	PATHOGEN(S)	ADMINISTRATION
Salmon	Certovac	Pilchard Orthomyxovirus (POMV)	IP
Salmon	Tegovac + EC	*Yersinia ruckeri*, *Vibrio anguillarum*, *Aeromonas salmonicida*, T-RLO (East coast serotype)	IP
Fish	TBV Custom	*Tenacibaculum* spp., *Streptococcus* spp., *Vibrio* spp. & *Photobacterium* spp.	IP

All fish will be vaccinated according to veterinary direction at the time of sourcing, taking into consideration the best available information at that time and balancing the risk/benefit to the fish. At this time it is planned that salmon smolt would receive Certovac and Tegovac-EC. Yellowtail may receive a custom TBV vaccine with some or all of the pathogens covered at the discretion of the Trial Site Veterinarian.

2.16 Treatments

Potential treatments that may be used during the marine phase of production are outlined in Table 2. All antibiotic treatments are to be prescribed by the Trial Site Veterinarian and are not to be used prophylactically.

Table 2 Potential treatments used during the marine phase of production.

NAME	TARGET	ADMINISTRATION METHOD	DOSAGE	WITHDRAWAL PERIOD
Oxytetracycline	Bacterial infections	Feed	As per prescription	1,000 degree days
Trimethoprim	Bacterial infections	Feed	As per prescription	1,000 degree days
Freshwater	AGD	Bath	NA	NA

NAME	TARGET	ADMINISTRATION METHOD	DOSAGE	WITHDRAWAL PERIOD
Hydrogen peroxide	Skin or gill fluke	Bath	As per prescription	NA
Praziquantel	Skin or gill fluke	Bath/feed	As per prescription	150 degree days

No compounds, chemicals or antibiotics will be used that are:

- Banned in primary salmon producing or importing countries
- Antibiotics listed as critically important for human medicine by the WHO, or
- Banned under the FAO/WHO Codex Alimentarius CS/MRL2-2021.

2.17 Anaesthesia

A variety of fish health procedures require that fish be anaesthetized. Anaesthetics will be obtained from the Trial Site Veterinarian. AQUI-S or SED-8 is used as an anaesthetic for procedures that require sedation.

2.18 Euthanasia

If it is necessary to cull fish, a suitable humane method must be used. When euthanizing individual animals, the following methods are used:

- Ike Jimmi method with a spike to the head if animal is big enough, or
- Overdose with effective anaesthetic agent e.g. Aqui-S and then a percussive blow to the head.

2.19 Harvest

Fish are starved prior to harvest. Fish behaviour is monitored whilst crowded, and all crowds supplemented with oxygen.

Fish are seined and pumped onto the harvest vessel, where they are stunned and bled, placed in an ice slurry, for transfer to a processing facility. All blood water is contained on the vessel and disposed of at an on-shore facility to limit environmental contamination.

Harvested fish may be sent to any current wet processor.

3 BIOSECURITY MANAGEMENT

A clean and safe work environment will be maintained to reduce the risk for spread and exposure of fish to infectious disease. Broadly, biosecurity should:

1. Keep fish stocks healthy
2. Prevent disease incursion by creating a barrier, and
3. Control the spread of disease transmission between pens, leases and zones.

Pathogens may be spread by:

- Fish stock:
  - General population: Fish do not need to display 'active disease' to spread it, as individuals may be 'carriers' – when an animal does not present with clinical signs of disease, it is classified as "subclinical". The risk of spread is increased when stock are stressed.
  - Diseased mortalities: are highly infectious and should be removed frequently during active disease.
  - Year classes should be kept separate – the Research Trial will host a single year class.
  - Live fish should never be exposed to processing waste (including blood water).
- Staff and visitors:
  - Movement of staff between sites, contractors, and visitors from other farming regions (national or international) pose a risk for disease transfer. This risk is best counteracted by signage and disinfection stations to clean gear between sites within a Control Region. Gumboots, wet weathers and PPE should not be transferred between Control Regions.
  - Site induction will include a biosecurity clause and visitors will be taken through the expectations for basic hygiene status
  - If people need to go to multiple leases e.g. divers:
    - Travel from cleanest to dirtiest site i.e. younger year class to older year class and that diseased pens are isolated
- Equipment, vehicles and transportation: nets, pallets and bins, vessels, handling equipment, etc. Risk is managed through disinfection processes.
- Pests and predators: other aquatic life can be implicated in disease spread e.g. birds and pilchards/baitfish. It is best practice to exclude or remove wild animals from pens. Predators may damage or stress stock, predisposing them to disease.
- The aquatic environment (water and sediments):
  - Transmission through water is best combated by distance between farming areas; no marine farming is located close to the Trial Site.
  - Infectious agents can survive for long periods in wet or damp conditions that exist on equipment, vehicles and personal equipment.

3.1 Biosecurity risk assessment for multiple species

Having multiple finfish species within an aquaculture research zone (Atlantic salmon and kingfish) may require specific biosecurity mitigation. In addition, both seaweed and mussels may be cultured within a geographically local area.

This section highlights biosecurity considerations for a multiple species area.

3.1.1 Source of stock

Atlantic salmon smolt and other marine finfish juveniles will be sourced from a landbased hatchery, where the health status of the animals can be assessed before movement to the marine farming zone.

3.1.2 Biosecurity assumptions associated with the zone

It is assumed that seaweed and mussels will be exposed to endemic pathogenic organisms in equivalent species in the zone.

Atlantic salmon are unlikely to be exposed to wild conspecifics; however, other farmed marine finfish species are likely to be exposed to wild conspecifics, for example wild *Seriola lalandi* will occur in the Bass Strait and thus are likely to come into contact with farmed fish in the zone.

3.1.3 Spread of biosecurity risk agents

Biosecurity risk agents may propagate between wild and farmed animals and plants; therefore, the following risks must be considered:

- Between finfish and seaweeds and mussels
- Between salmon and marine finfish, and
- Between farmed fish and wild fish.

The exposure of farmed salmonids to wild fish already occurs in Tasmanian waters, therefore this scenario does not represent an increased risk. Biosecurity measures consistent with those in the Biosecurity (Salmonid Biosecurity Zones) Regulations 2022 would be followed to manage the biosecurity risks to and from farmed salmonids in the zone.

However, other risk pathways must be considered (between salmon and kingfish, between wild and farmed kingfish and thus potentially also representing a pathway to salmon, and between fish and other species) and determine what mitigation measures would be appropriate in those cases.

3.1.4 Specific pathway considerations

3.1.4.1 Salmon and kingfish culture in the same zone

Biosecurity risks associated with kingfish

Having reviewed the pathogens associated with kingfish in Australia, the likely hazards that kingfish in the zone could be exposed to would be:

- Nodavirus
- Epitheliocystis
- *Vibrio harveyi, V. alginolyticus, V. anguillarum*
- *Photobacterium damselae subsp. damselae*
- *Tenacibaculum maritimum*
- *Lactococcus garviae*
- *Streptococcus iniae*
- *Aeromonas salmonicida* atypical *subsp.*
- Scuticociliates
- *Caligus spinosus, C. aesopus, C. lalandei*
- *Lernanthropus sp.*
- *Benedenia seriolae*
- *Zeuxapta seriolae*
- *Paramicrocotyloides reticularis*
- *Neobenedenia girellae*
- *Paradeontacylix sp.*

Risks shared with Atlantic salmon

The main hazards that could move between Atlantic salmon and kingfish are expected to be:

- Epitheliocystis
- *Vibrio harveyi, V. alginolyticus, V. anguillarum*
- *Photobacterium damselae subsp. damselae*
- *Tenacibaculum maritimum*
- *Aeromonas salmonicida* atypical *subsp.*

These all represent endemic pathogens and are not specifically due to the presence of a second finfish species in the water. Any incremental risk comes simply from the presence of a larger number of animals in the zone. In a trial condition, it is unlikely that numbers of animals would reach threshold population size for any of these pathogens to achieve an epidemic potential.

Therefore, risk mitigation involves routine record keeping, health monitoring of finfish stocks and best-practice husbandry to reduce potential for stress or physical injury.

3.1.4.2 Biosecurity risks associated with seaweeds

The study of the pathogens of seaweeds is less advanced than those of teleost fish, but the development of such knowledge will almost certainly happen alongside the development of these species as aquaculture candidates, as this provides the best opportunity to study them further.

With seaweed aquaculture developing, there is limited data; however, what is available is consistent in that the pathogens of macroalgae identified to date are fungi and bacteria. Fungal pathogens were identified as oomycetes (Cunningham, et al., 2020; Gachon, et al., 2010), common fungal constituents of the aquatic environment. Both *Olpidiopsis* spp. and *Pythium* spp. are expected to be present in Australian waters normally.

Bacterial pathogens of macroalgae cover a range of genera including *Aeromonas* spp., *Alteromonas* spp., *Cytophaga* spp., *Flavobacterium* spp., *Halomonas* spp., *Moraxella* spp., *Pseudomonas* spp., *Pseudoalteromonas* spp., *Vibrio* spp., *Agarivorans* spp. and *Cyanobactera* (Cunningham, et al., 2020; Kumar, et al., 2016; Egan, et al., 2014; Gachon, et al., 2010).

All these bacterial and fungal species are ubiquitous, being commonly found in the aquatic environment. The introduction of seaweed species does not increase the risk of their presence. These species are not recognised as primary pathogens as they rely on secondary factors rendering the hosts susceptible to infection.

Cunningham et al. (2020) in their review also identified copepod parasites, amphipods and endophytes that may have adverse pathological effects on seaweed.

Effectively, it is most likely to be the cultured trial stock that suffers any losses. This can be minimised by good husbandry, maintaining a conservative stocking density of plants and ensuring that juveniles are introduced only if they show no clinical signs of disease, and preferably from a hatchery with a health surveillance programme for the seaweed being reproduced on the hatchery site. In addition, any risk to the environment may be minimised by a program of active health monitoring of seaweed stocks, with appropriate diagnostic investigation of abnormalities enabling a response to occur, and by ensuring that there is separation from cultured and wild seaweeds. The site of culture should be in water over 15 m depth, with a sandy or mobile benthos such that wild populations of macroalgae are at some distance; the Trial Site has these characteristics.

3.1.4.3 Biosecurity risks associated with mussels and finfish in association

The risk to shellfish health from fish pathogens is negligible. Integrated multitrophic aquaculture systems, whereby fish and shellfish are raised alongside each other, show that fish and molluscs can co-exist. Where there is risk, it is actually to the fish, from the molluscs which can act as parasite hosts or short-term reservoirs of viruses. Suitable mitigation measures are to maintain the mollusc stocks at some distance from the farmed finfish. While an exact distance cannot be specified, greater separation distances would further reduce the risk.

In Australian waters, the greatest risk to shellfish health comes from enzootic bacteria e.g. Vibrio species or mollusc parasites.

Viruses affecting shellfish (i.e. causing pathology) are generally different to those causing disease in fish. For example, iridoviruses of shellfish lie in a different taxonomic group to iridoviruses of fish (King et al., 2012). The closest relationship lies in the marine aquabirnavirus (MABV) group of the aquabirnavirus genus, which may have some weak pathogenicity under conditions of stress for the shellfish; however, the MABV strains tend to be more risk to fish than molluscs in general (Renault, 2008). In Tasmania, aquabirnaviruses are restricted in distribution to Macquarie Harbour waters and are therefore not a biosecurity risk to molluscs or fish for the trial.

In summary, most finfish farms have resident populations of molluscs growing on nets and the incremental risk is not high; however, it is recommended that mussel lines are inspected at regular intervals and any unusual presentation be investigated appropriately.

3.1.5 Recommended standard finfish biosecurity measures

Accepted biosecurity measures for finfish include:

1. Records of stock movement to be kept so that fish can be traced from origin, through the farms and to destination. These records to detail batches of fish, where they have come from, which pens they are held in, how many mortalities have come from each pen, where fish have moved to and when they were harvested.
2. Training of site personnel so that they have an understanding of the importance of biosecurity, normal and abnormal appearance of the fish held on the farms and the reporting requirements and actions needed in response to abnormal findings.
3. There should be no uncontrolled movement of fish (i.e. without risk assessment and mitigation or without specific measures being established to manage any biosecurity risks e.g. health inspection) between pen sites within the zone.
4. Harvest of stock occurs in such a way that bloodwater is contained and taken ashore for disposal.
5. Mortalities are removed from the pens as frequently as possible.
6. Once removed from the pens, mortalities are held in leakproof containers and secured to prevent spillage or access by predators or seabirds.
7. Fish are fed only using feed that has been subject to heat treatment to recognised commercial standards.
8. Equipment entering, leaving or moving about the farms must be subject to cleaning and disinfection protocols.
9. Vessel hygiene standards and measures must be implemented and operated.
10. Divers, being a particular pathogen risk, must be subject to specific biosecurity measures to minimise the risk of movement of pathogens between grids and pens.
11. Procedures must be instituted to manage risk from site staff, visitors and contractors.
12. Pens may be fitted with bird nets and predator nets to mitigate against bird and predator entry to the pens. In addition, there must be measures to ensure that nets are checked for holes and weakness on a regular basis and that there are procedures and contingencies ready to implement in the event of a fish escape.

13. Stock to be sourced from a hatchery with appropriate biosecurity measures and health surveillance in place.
14. The fish species held on the farms are managed in a way that minimises stress.
15. The fish are provided with feed that is adequate in both volume and nutritional requirements for the species and lifestage being farmed and delivered in a way that minimises waste so that attraction to wild conspecifics is minimised.
16. The fish are monitored for health status in such a way that pathogens are detected and identified as rapidly as possible i.e. that observations on fish behaviour and performance are carried out, mortalities are classified by cause of death and health sampling is carried out routinely, diagnostic tests are submitted to recognised laboratories and the Trial Site Veterinarian is routinely involved in assessment of the health status of the fish.
17. Age classes of fish are separated to different blocks.
18. Farming blocks within the zone, once emptied of grow-out fish, are fallowed for a period of 6 to 8 weeks.

3.1.6 Specific kingfish considerations

Biosecurity and health measures have been identified and implemented in other kingfish cultivation to address the following risks:

- *Scuticociliates*
- *Benedenia seriolae*
- *Zeuxapta seriolae*
- *Paramicrocotyloides reticularis*
- *Neobenedenia girellae*, and
- *Paradeontacylix* sp.

If a decision is made to stock kingfish in the Zone, measures will be put in place to ensure routine surveillance and response, where necessary, to escalation in numbers of the above parasites.

These measures will be developed and approved by the Trial Site Veterinarian in association with the Trial Site Manager.

With ongoing culture of kingfish in the zone the following should be considered for at least surveillance measures to identify any trends in incidence:

- *Caligus spinosus, C. aesopus, C. lalandei*, and
- *Lernanthropus* sp.

3.2 Site induction/training

All personnel, contractors, visitors, must receive awareness and training relevant to their responsibilities. Training topics include:

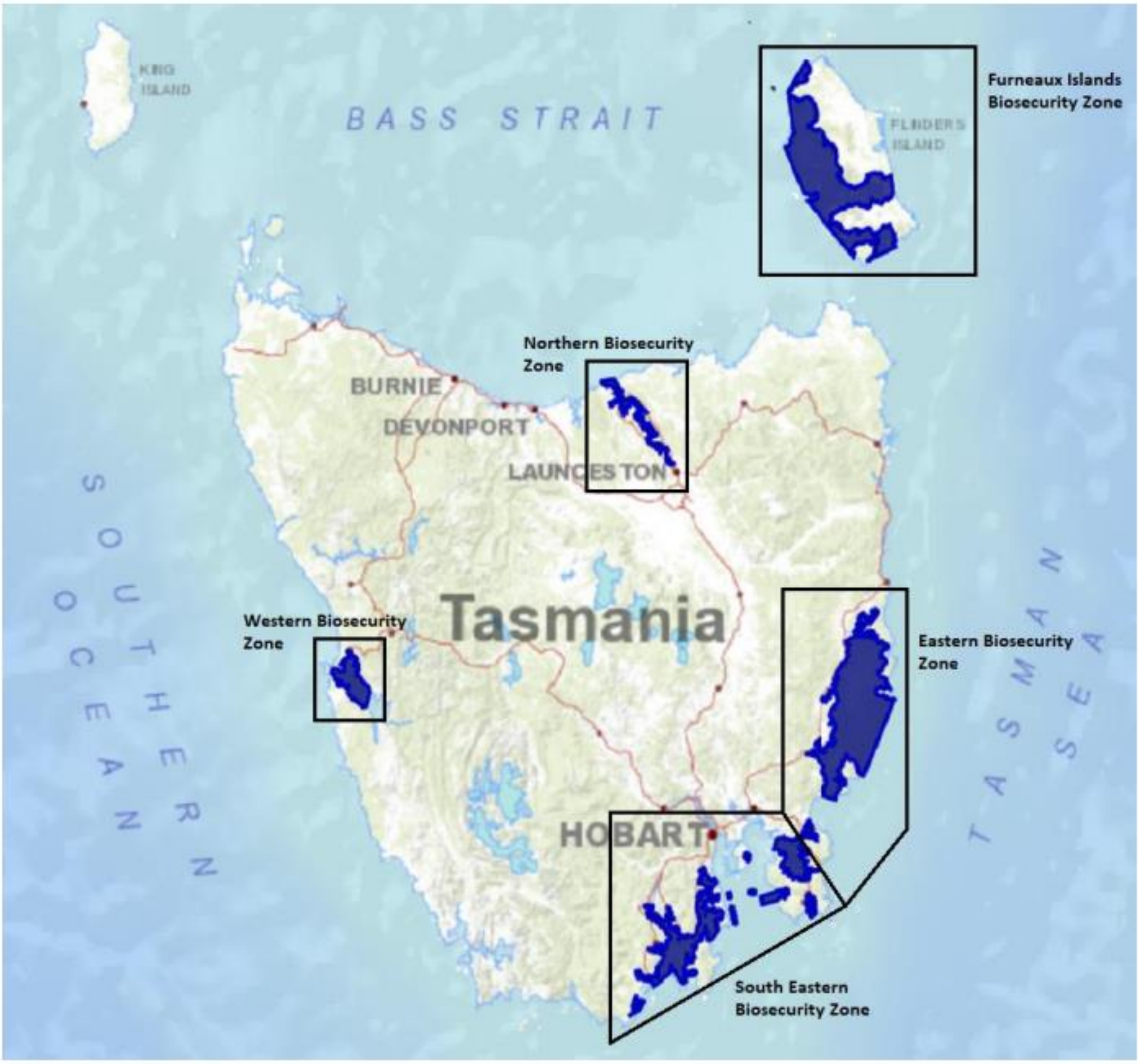
- Specific decontamination and disinfection procedures for personnel, equipment, transport vehicles, marine vessels and avoiding practices that could spread disease
- Recognising signs of infection of potentially diseases fish and taking appropriate action to escalate and place control measures
- Recognise risk of equipment contamination
- Recognised modes of disease transmission
- Collection of tissue and water quality samples for laboratory testing
- Handling and storage of mortalities

3.3 Preventing transmission between biosecurity zones

3.3.1 Biosecurity Zones

Biosecurity Zones are defined regions that are geographically separated.

Map of Marine Salmonid Biosecurity Zones around Tasmania[5]:



Note: This map provides a visual representation of the boundaries of each marine farm development plan and does not represent the total water space occupied by active farms.

Figure 4 Biosecurity zones – Tasmania (salmonids)

Biosecurity Zones are separated because they have different disease profiles and are in separate water bodies. The biosecurity zones are:

- South Eastern Biosecurity Zone
- Western Biosecurity Zone
- Northern Biosecurity Zone
- Eastern Biosecurity Zone, and
- Furneaux Islands Biosecurity Zone (unused).

Equipment or vessels may move between Marine Zones and the Trial Site.

No fish may be moved between Marine Biosecurity Zones.

3.3.2 Vessel movement between biosecurity zones

3.3.2.1 Harvest and Feed Delivery Vessels

Some vessels will move to the Research Trial Site from other biosecurity zones, including the harvest vessel and some sub-contractor vessels. The following biosecurity requirements apply:

- Vessels must be slipped in dry-dock for hull cleaning and disinfection including internal seawater pipework (where slipping is not possible due to unexpected urgency of movement, size of vessel or availability of slip facilities, alternative biosecurity measures may exceptionally be taken as agreed by the Trial Site Manager and Trial Site Veterinarian)
- All mooring ropes or other equipment which cannot be effectively disinfected, be removed and replaced
- Non-essential equipment must not be transferred between zones
- Bilge water must be disposed of and bilges decontaminated, and
- Other aquaculture companies must be notified of vessel movements between biosecurity zones.

3.3.2.2 Medium and large works vessels

Works vessels will be required during establishment, decommissioning and potentially for maintenance of the Trial Site infrastructure. The following biosecurity requirements apply:

- Assess the risk of the vessel
  - Has the vessel handled any fish or is frequently involved in fish handling operations e.g. AGD checks or mortality retrieval?
  - When was the vessel last involved in fish handling operations?
  - Does the current farming zone have any known disease and has the vessel been exposed?
  - Does the farming zone that the vessel is going to have naïve fish that could be exposed?
- All porous material on the vessel needs to be removed and left behind if traveling between biosecurity zones.

3.4 Decontamination

3.4.1 Principles

Decontaminating equipment is necessary for hygiene. Decontamination is the combination of cleaning and disinfection. Cleaning to remove all grossly apparent organic debris is critical before the use of disinfectants. Disinfectants should be chosen based on the task and the following should be taken into account:

- Pathogens of concern
- Material needing disinfection, and
- Human safety precautions.

Safety data sheets are kept with the disinfectant. Disinfectants can be deactivated by organic material, therefore, when disinfecting a piece of equipment, all organic material is removed before using the disinfectant. This can be done by using a foaming/detergent wash, high pressure cleaning, brush (anything that can lift the organic material mechanically). Once organics are removed, then disinfection of the piece of equipment can occur with the correct dosage and duration.

3.4.2 Disinfectants

Disinfectants that may be used during operations include:

- Hypochlorite solutions (calcium hypochlorite or sodium hypochlorite)
- Chloramine-T
- Peracetic acid
- Monosulfate compounds
- Chlorine dioxide
- Iodophors
- Sodium hydroxide
- Calcium hydroxide
- Glutaraldehyde
- Formalin solution, and
- Quaternary ammonium compounds.

These disinfectants are used as appropriate for varying situations (e.g. disinfecting surfaces or footbaths) and at suitable concentrations.

3.5 Medication and chemical treatments

The Trial Site Veterinarian will retain a veterinarian-client-patient relationship with the Research Trial Site Operations Lead that is the basis for disease diagnoses and prescribing treatments. Where antibiotic treatments are advised in the case of bacterial infections, then therapy may only occur under the direction of the Trial Site Veterinarian, following good prescribing standards.

3.5.1 Medicated feed storage, inventory and administration

Medicated feed is stored in clearly marked bags separate from non-medicated feed. The storage area shall be clean, dry and free of predators. The label on the medicated feedbag states details about the feed, medication included, feed rate, name of the veterinarian, prescription number and date it was milled. Medicated feed is inventoried separately from regular feed.

Daily inventory records are kept as the feed is fed to the fish per the prescription. If there is excess medicated feed after completion of the treatment, it is disposed of in accordance with the manufacturer's recommendations.

Medication mixed into feed has a Safety Data Sheet (SDS), which specifies handling and safety precautions. An SDS for all medications used is kept on site in a readily accessible binder. All trained staff must handle all chemicals safely, e.g. by wearing appropriate protective gear and taking suitable precautions when handling the medicated feed.

Medicated feedbags, including bulk bags, are handled carefully in transit from storage to automated feeding equipment. All inadvertent spillage is cleaned up immediately, and feed is protected from bird predation. Medicated feed is fed out in accordance with the Trial Site Veterinarian's instructions. The appropriate pen must receive the prescribed amount of medicated feed for the duration of treatment.

3.5.2 Treatment records

Records of treatments must be held for 5 years. These are to include the pen treated and amount of therapeutant used.

3.6 Summary of biosecurity guidelines

Awareness of biosecure area

Aim To ensure that personnel, visitors and contractors are aware of a biosecure area

Method
- Inductions include a visitor survey to determine the risk of the individual(s) and include expectations on hygiene practices.
- Signage and other significant items such as footbaths and handwash stations.
- Ensure that people walk through footbaths.
- Ensure that crew know the context behind good biosecurity culture, and mention regularly in in toolbox meetings.

Stock movement

Aim To ensure that disease is not able to be transferred between farming zones

Method
- All stock from hatcheries comes with a health certificate and known disease status.

Diving

Aim To minimise risk of disease transfer to stock while gathering information on mortality trends, symptoms and behaviour.

Method
- Dives at the Trial Site to be conducted as separate dives from other farming sites.
- Separate dive bags should be used for the Trial Site.
- Morts removed from pen should go into a mort bin immediately.
- Fish that are experiencing high/irregular pathogen loads or disease associated mortalities must be dived last during normal diving duties or as a separate dive by a separate diver.
- If diving a pen that is experiencing high/irregular mortalities, thorough clean down and disinfection of dive vessel, dive gear and diver is to occur on the lease immediately post-dive.
- Dive bags should be disinfected and cleaned between pens and soaked at the end of the day in a chosen disinfectant.
- Personal dive gear should be disinfected between each lease; and at the end of the day should be soaked in a chosen disinfectant and hung to dry.
- Wash down and disinfection of dive vessel, equipment and diver must occur between farming zones if within the same Biosecurity control zone.
- Personal dive gear should not transfer between farming zones.

Mortality investigation

Aim To improve detection of disease

Method
- Investigations are conducted if a pen has elevated levels of mortality for consecutive days or if there are reported fish incidents.
- Fresh mortalities are to be checked for signs of disease regularly i.e. external and internal observations for abnormalities.
- Fresh mortalities should be dissected where possible and observations made on the dive sheet.
- All dive boats should contain a dissection kit for this purpose.

Mortality handling

Aim	To minimise risk of disease transfer to naïve stock between or within farming zones.
Method	• Mortalities are stored in a plastic liner in non-leaking bins with sealable lids. • Mortality cartage contractors are to clean and disinfect bins before returning to farm sites. • Mortality bins are inspected prior to use. • Mortality bags are cleaned of physical debris and disinfected in fresh solution before hanging out to dry at the end of every day. • The dive vessel is fully cleaned and disinfected once mortalities have been off loaded at the end of every day. • Crane, hooks and jetty area are to be cleaned and disinfected after mortalities have been unloaded.

Nets and rigging

Aim	To minimise risk of disease transfer
Method	• Dirty nets/rigging removed from one operational base are not placed on a vessel/truck carrying clean nets/rigging for another operational base. The reverse should also not occur. • Clean nets/rigging are only put onto a vessel/truck that has been carrying dirty nets/rigging if the vessel/truck has been first washed down and disinfected. • During wharf transactions and storage, clean nets/rigging should be maintained in clearly identified areas which are consistently separate from dirty nets/rigging. Deviation from this can only occur after appropriate cleaning and disinfection has been undertaken. • All net strops should be disinfected before being used on clean nets. • Before receiving stock, all empty pens are net-cleaned to an acceptable score.

Transaction nets

Aim	To minimise the risk of disease transfer between pens
Method	• Transaction nets should be segregated where possible. • If moving transaction nets from another lease ensure it is disinfected properly using the disinfection requirements for porous materials

Fish cleaning and dive harvests

Aim	To reduce the risk of blood borne pathogen transfer through water column to other fish on the site.
Method	• Fish are not bled and gutted directly into the water column. • All equipment used is cleaned and sterilised prior to reuse to minimise contamination to future harvest fish and stock.

Weight and gill checking

Aim	To minimise risk of disease transfer to naïve stock through weight check procedures and gear between and within control zones.
Method	• Weight check gear should not be moved between control zones. • Naïve/later year class stock are gill checked before previous year class stock on any given day. • Weight check gear is cleaned and disinfected after use in pens suspected of active disease mortality.

Bathing operations

Aim	To minimise transfer of disease between leases and pens
Method	• Ensure that equipment is washed down appropriately at the end of the transaction. • In a disease situation, all equipment is to be fully disinfected before being relocated.

Visitors/contractors/staff from other sites

Aim	To minimise transfer of disease from farming zones and hatcheries
Method	• All personnel receive an induction that includes expectations regarding biosecurity. • All biosecurity protocols are to be followed. • Staff and sub-contractors shower and change clothing before going onto another marine zone.

Equipment movement

Aim	To minimise transfer of disease via equipment
Method	• Movement of fish handling equipment from one farming zone to another is minimised. • If a piece of equipment needs to be moved, a risk assessment is conducted and appropriate protocols followed for disinfection. • No pens or fish nets are moved between biosecurity zones unless they are cleaned and disinfected to a satisfactory standard. • Where equipment needs to be packed away e.g. lights, ensure that all organic material is taken off the equipment, that the equipment is clean and disinfected.

Vessels

Aim	To minimise transfer of disease between leases and biosecurity zones
Method	• Decks and equipment are hosed off and sprayed with disinfectant when the vessel is leaving a lease area to travel to a different lease area or when returning to an operational shore base.

Communication

Aim	Early detection of disease
Method	• When there is an abnormal mortality, the Trial Site Veterinarian is contacted. • An incident report submitted with adequate detail within 48 hours. • Technical officers are used as first responders to disease events.

Technical equipment

Aim	Early detection of disease
Method	• Sampling kits are always stocked with equipment and stocktake performed every month. • Tech teams have a sample kit with them to allow for rapid response. • Kits include: water sampling kit, algal and jellyfish sampling equipment, fish sampling equipment along with formalin/RNA later/charcoal Amies swabs and/or agar for sample preservation.

4 POTENTIAL DISEASES AND RISKS

4.1 Thermal stress

The thermal stress period is seen throughout January to end of March seasonally, where fish are subjected to temperatures that test their thermal limits. It is important to prepare for periods of thermal stress to reduce the effects of summer temperatures on stock.

Table 3 Thermal stress reduction measures

ITEM	ACTION	BENEFITS
Diet	Ensure that a high temperature diet is fed to the stock prior to onset of high temperatures – this should contain higher levels of antioxidants.	Reduced oxidation in fish tissue and lower depletion of antioxidant stores.
Risk assessment	Prior to all handling events during summer period, a quick risk assessment should be performed to know that all redundancies are adequately covered.	The risk assessment framework allows pre-assessment and communication prior to the operation to limit operational mistakes.
Oxygenation in crowds	Ensure all crowds have adequate dissolved oxygen in summer when required to handle fish.	Reduce crowding stress and reduce mortality associated with handling events.
Multiple crowds for high biomass pens and large fish	Ensure that when crowding larger fish crowds are limited to 1-1.5 hours.	Reduce crowding stress, stress hormone release and improve performance post-handling.

ITEM	ACTION	BENEFITS
Adequate starve periods	Ensure all animals being handled receive at least 48 h starve; this is international best practice standards and will relieve.	Reduce crowding stress by ensuring complete gut evacuation.
Gill pathology (see Section 4.2)	Ensure that all sites are monitoring gill necrosis and AGD.	Gill necrosis and AGD scores are an indicator of total functioning surface area of the gills, they therefore need to be considered together in gill health management.

4.2 Amoebic gill disease and complex gill health issues (gill necrosis)

Amoebic Gill Disease (AGD) is a parasitic disease caused by *Neoparamoeba perurans*. It presents clinically as white mucoid colonies on the gill tissue. Unmanaged, it results in loss of functional gill surface area and hypoxia in the fish. AGD will be scored on the 0-5 scale via physical examination of 40+ fish in the pen at suitable intervals to be determined by the Trial Site Veterinarian. Treatment will be via freshwater bath.

Gills are also subject to a variety of environmental insults which can result in physical damage to the functional area and capacity of the organ. These include phytoplankton and zooplankton related damage, which can result in excessive mucus production, haemorrhage (acute and chronic, ecchymotic [large bleeds] and petechial[pin point]) and loss of gill tissue caused by toxic damage from jellyfish stings directly and subsequent bacterial infection and erosion (e.g. from *Tenacibaculum* spp. infection). Gill damage will be assessed at the same time as AGD is scored, and will be subject to a categorical scoring system designed to identify to prevalence of different gill pathologies on the site at each assessment.

4.3 Pilchard orthomyxovirus

Pilchard Orthomyxovirus (POMV) is the most important infectious disease for Tasmanian salmonid aquaculture. This disease causes sporadic outbreaks in naïve stock and is considered endemic. After transfer from the hatchery, fish are susceptible to disease for up to 70 days post transfer or post-500 g in weight. This disease is known to be transferred by pilchards/baitfish, which makes it very difficult to control.

At the Trial Site, baitfish are considered to be the sole vector of the disease, given the absence of other aquaculture farms in the area.

Once the disease has been transmitted to a naïve population, it is likely that a susceptible sub-population contract the disease. However, a stress event usually precedes a disease outbreak. This is important, as farm management practices can significantly reduce the likelihood of an outbreak occurring. Known stress factors preceding disease include:

- Algal blooms in smolt sites
- Predation issues
- High levels of baitfish (which is likely to increase the background level of exposure to the virus)
- Chronic exposure to poor environmental conditions
- Splitting events in larger fish, and
- Transfer stress (seen as slow feed responses and higher mortalities from lesions).

It is likely that a stress event incites the outbreak, by increasing the presence of stress hormones (cortisol) and reducing the immune capacity of the fish.

All fish being transferred to sea are vaccinated against POMV. Whilst this is designed to protect the fish against infection in the event they are challenged, vigilance around risk periods is necessary.

Table 4 presents measure that are taken to prevent POMV outbreaks.

Table 4 Measures to prevent POMV outbreaks at the Trial Site

DISEASE TRANSMISSION ROUTE	ACTION	POTENTIAL FOR CONTROL
Vaccination	All fish are vaccinated against POMV	Current practise
Water	Structure site to maximise distance between pens and avoid water flow between pens	Good during outbreak to minimise viral exposure of adjacent cages
Equipment (fish handling)	Segregate fish handling equipment so that naïve fish are not exposed to same equipment as older year classes Good biosecurity/hygiene procedures after operation Hygiene of technical equipment important	Prevents transmission of disease from lease to lease
Mortality extraction	Dive daily or as often as reasonably practical for first 14 days and at least every 2 days to 65-70 days post smolt transfer	Frequent mortality extraction reduces viral loading if fish are infected
Nutrition	Feed smolt a diet that helps transition to the marine environment.	Unknown efficacy
Early detection	Risk factor analysis shows that animals that are poorer performing from input are more susceptible to POMV	Early detection essential for investigation Divers to dissect animals and send photos if anything abnormal is detected
Rigging- minimising stress	Minimising stress on fish by signing-off pens ahead of stocking.	Best practice husbandry reduces stress and maintains immunity levels
Net cleaning (biofouling)	Minimising stress on fish with better water better flow and lower exposure to biofouling Disinfect net cleaner head between each lease	Best practice husbandry reduces stress and maintains immunity levels
Transports	Minimise stress during transport to give animals good start in the marine environment	Best practice husbandry reduces stress and maintains immunity levels
Smolt quality	Minimise deformities in smolt transferred to site as these are more likely to be susceptible to disease	Healthier fish are less likely to be susceptible to disease

DISEASE TRANSMISSION ROUTE	ACTION	POTENTIAL FOR CONTROL
Personnel and contractors and visitors	No visitors to during the smolt stage if they have been on other fish farms. All sub-contractors abide by hygiene and biosecurity protocols	Equipment and vessels from sub-contractors are high risk if they handle fish/ fish handling equipment/ nets
Predators/pests	Implement predator exclusion (particularly birds) to minimise stress	Best practice husbandry reduces stress and maintains immunity levels
Dealing with an infected pen	There may be consideration to cull the primary affected pen when POMV PCR tests are confirmatory and the pen shows signs of low feed rate and very high mortality	Culling a severely infected pen limits the potential vectors of disease and viral infective load

5 INCIDENT AND EMERGENCY RESPONSE

In a disease control situation, each farming zone is a "control zone", as it has its own designated staff and equipment. If there is a disease outbreak, refer to disease outbreak and emergency response, but protocols should always be put in place in consultation with the Trial Site Veterinarian.

A fish health emergency is any situation where the health of a fish population is suddenly at risk. This may be from significant pathogens (such as POMV), water quality changes (e.g. plankton blooms/acute low dissolved oxygen) or from husbandry related causes. Emergencies are considered serious problems with severe or critical consequences.

When a fish health emergency is identified, the Research Trial Site Operations Lead will immediately be notified. The Trial Site Veterinarian will coordinate an investigation into the emergency to determine the characteristics, cause and develop a pathway to resolve.

BECRC will communicate incidents of disease that are significant to other industry associations so that unaffected sites in the region can be alert to the concern.

5.1 Investigation

An outbreak is defined as an unexpected occurrence of mortality or disease. The initial investigation is very important in determining the likely cause. With this step, the goal is to identify if it is an infectious disease outbreak or if the cause of the mortality event/disease event is non-infectious. Site managers/animal health team should be notified immediately so they can attend.

Fresh mortalities and moribund animals should be collected for inspection and diagnostic sampling.

A detailed history of the pen(s) in question should be taken- this needs to encompass a course of events leading up to the notification. All stressors are important to document as they may cause the host to become more susceptible to infectious disease.

Data on mortality rate should be gathered to understand what the mortality trends have historically been, and how they had travelled leading up to the outbreak.

5.2 Infectious disease emergencies

An infectious disease outbreak is one caused by an infectious pathogen that can spread. In Tasmania, the pathogen of greatest significance is POMV. When dealing with an infectious disease, the main objective is to keep the pathogen loading as low as possible to reduce the likelihood or rate of disease transmission.

When there is a disease outbreak of an infectious exotic nature, then the Trial Site Veterinarian response will be directed by the relevant Competent Authority.

5.3 Isolation and quarantine

At the Trial Site Veterinarian's discretion, the site may be officially quarantined based on initial findings and differential diagnoses. Quarantine will remain in effect until such time that the problem has been diagnosed and/or managed and the order rescinded by the veterinarian. In the first instance:

- Isolate the disease to the pen
- Minimise lease to lease transfer by restricting works (crew and equipment) to the Trial Site (i.e. equipment and vessels not to move to other farming areas during quarantine)
- Reduce pathogen loading through mortality extraction and culling if necessary
- Reduce movement of unnecessary vessels and personnel at the Trial Site, and
- Isolate the Trial Site if necessary.

5.4 Stop fish movement or handling

At the advice of the Trial Site Veterinarian, the movement of fish on and off and within the site may cease depending on results. Fish will not be further handled, equipment and personnel will not move on or off the site unless there are special arrangements.

5.5 Disinfection and hygiene

All biosecurity protocols will be followed during a disease outbreak; however, alternative protocols may be stipulated by the Trial Site Veterinarian if required as a response to the outbreak.

5.6 Cause of the outbreak

It is critical to determine the cause of the outbreak. An investigation will be conducted under the guidance of the Trial Site Veterinarian.

5.7 Suppliers

Suppliers and sub-contractors will be informed if there is a disease outbreak to ensure that they are compliant with any enhanced biosecurity protocols for the status of the site.

5.8 Mortality extraction

If mortalities can be extracted without the use of divers, this is the preferred extraction method during an outbreak.

5.9 Reporting

Notification: Under sections 27 & 28 of the *Tasmanian Animal Health Act 1995*, any person who knows or has reason to believe that an incidence of a list A or List B (i.e. diseases notifiable under the act) disease has occurred in Tasmania must notify an inspector of that incidence as soon as possible.

List A diseases are generally exotic disease agents, whilst list B diseases include atypical aeromonads such as MAS, Tasmanian RLO, Tasmanian birnavirus and *Lactococcus gravieae*. Significant unexplained mortalities would also be considered to require notification.

Section 30 of the Act also states that: If an owner of a group of animals knows or has reason to believe that an unknown disease is causing unusual level or manifestation of disease or number of deaths in the group of animals, they must engage a veterinary surgeon to investigate or notify an inspector.

The Tasmanian Chief Veterinary Officer (CVO) and NRE's Biosecurity branch has access to all fish health unit laboratory reports, which is to be supported through a phone call explaining the extent of the mortalities when there is a potential outbreak. They are must also be informed of the progression of disease.

If there is a disease of significance suspected or confirmed positive which could have detrimental effects on neighbouring sites/farms, then these companies are to be notified.

If mortalities are above 0.25% for 3 consecutive days, Tasmania's Marine Farming Branch, CVO office and EPA are to be notified.

5.10 Incident reporting

The industry partner's incident report system will be used for the Trial.

When fish mortalities reach above 0.2% per day, it is reported through the fish incident and hazard reporting group. This is necessary, as smaller scale incidents assist to identify potential shortcomings in existing processes. This aims to harness a continual improvement culture.

6 MONITORING AND AUDITS

6.1 Water quality

6.1.1 In-pen water quality

Daily water quality monitoring is required to understand the environment outside of the pen that may affect fish health, and includes as a minimum temperature, dissolved oxygen concentration, salinity and phytoplankton readings prior to feeding. Staff members in the remote feed centre are responsible for the recording and escalation of any potential issues that may arise from monitoring.

- Ambient and in-pen water quality monitoring includes:
  - Temperature taken at surface, 5 m and 10 m
  - Dissolved oxygen concentration taken at 0 m, 1 m, 5 m, 10 m and 15 m
  - Plankton trawl taken on the lease, away from the feed barge as a 15 m tow at 1 m/second at the very fastest rate. Submissions of samples to the Trial Site Veterinarian may be required if the phytoplankton cannot be identified:
    - Each site should have access to a digital camera which can be placed onto the eye-piece to take high resolution photos of any algae that cannot be identified by personnel. Please send these to: fishhealth@tassal.com.au for assistance.

6.1.2 Freshwater water quality monitoring

Freshwater is used for AGD treatment. Monthly water quality monitoring is undertaken for the fresh water supply. Testing includes: pH, alkalinity, conductivity, hardness, total suspended solids, sulphide, sulphide as H_2S, ammonia, nitrate and nitrite, total nitrogen, total phosphorous, total calcium, total magnesium and biochemical oxygen demand (BOD).

Testing is required to ensure that water quality is suitable for bathing animals, i.e. it does not contain any toxic compounds and total hardness/calcium and magnesium levels are optimal. Softer water is preferred to optimise the kill rate of amoeba in baths. The recommended water quality limits for bathing are shown in Table 5.

Table 5 Recommended freshwater quality limits for bathing

PARAMETER	RANGE
CO_2 saturation	<10 mg/L
O_2 saturation %	90-120%
Calcium	<10 mg/L
Sodium	<10 mg/L
pH	6.0-6.8
Salinity	<2 ppt
Total organic carbon (TOC)/dissolved organic carbon (DOC)	<3 mg/L

6.2 Algae and jellyfish

Algal monitoring is performed every day before the first feed event. Jellyfish sampling is performed as directed by the Trial Site Veterinarian. Algal counts are entered daily via an App.

Algal trawl nets are 20 micron in mesh size. For jellyfish 40 micron and 100 micron nets are used. Potential issues relate to hydrozoans; these microscopic jellyfish can sting and potentially produce toxins that can affect the gill architecture and cause necrosis and inflammation.

6.3 Passive surveillance program

The passive surveillance program is designed to specifically target moribund fish for early detection of emerging diseases and diseases of significance. The Research Trial Site Operations Lead and Trial Site Veterinarian are responsible for carrying out this program, including sampling and reporting their findings.

6.4 Site visits

Regular site visits and health assessments on fish populations will be undertaken by fish health personnel. All population mortality and health assessment data will be reviewed weekly by the Trial Site Veterinarian and their associates.

6.5 Biosecurity audits

6.5.1 Annual

Annual audits will be performed the Trial Site Veterinarian to understand where there are potential gaps in fish health and biosecurity management, opportunities for improvement or efficiencies and alternative (better) methods to achieve the same outcome.

6.5.2 Incident

Audits will be performed by the Trial Site Veterinarian after a fish health or biosecurity incident to identify root cause and present recommendations for improved procedures or protocols.

7 REPORTING AND RECORD KEEPING

7.1 Incident reporting

Refer Section 5.9 for incident reporting.

All communications with external parties (regulators and other industry members) are to be coordinated through the Principal Investigator BECRC.

7.2 Fish health records

Fish health records must include but are not limited to:

- Inventory records (Includes source, number, location and lot of fish at the site)
- Fish movement records
- Daily feed consumption, growth rate and feeding behaviour
- Mortality records including mortality cause
- Signs of increased morbidity
- Laboratory work
- Diagnostic sampling records
- Water quality records
- Medicated feed records
- Therapeutant treatment records
- Records of mitigation actions (other than therapeutants) taken to prevent or mitigate disease, e.g. refused shipment of potentially infected eggs, and
- Records of reporting to authorities, in accordance with existing regulations.

7.3 Treatment records

Regulations require that treatment records for therapeutants include:

- Finfish farming license number and name of holder
- Location of aquaculture facility
- Species of fin fish
- Name of the prescribing Veterinarian, and
- A log naming the drugs (therapeutants). The log must include:
  - Name of the drug
  - Mode of administration
  - Treatment schedule including the date treatment commenced
  - Date of last treatment
  - Name of the person responsible for administering each treatment
  - Reason for medication
  - Identified pens and inventory of animals medicated, and
  - Withdrawal period.

Detailed records of medicated feed will be kept for the entire time the fish are on site.

8 ROLES AND RESPONSIBILITIES

BECRC and its industry partner are jointly responsible for implementing this Biosecurity Management Plan.

The Research Trial Site Operations Lead is responsible for ensuring operational activities associated with the BEZ Research Trial are conducted in a manner consistent with this Biosecurity Management Plan.

Table 6 Roles and responsibilities

ROLES	RESPONSIBILITIES
Chief Executive Officer (Blue Economy CRC)	• Ensure that this management plan is effectively implemented • Support subordinates and hold them accountable for their specific responsibilities relating to biosecurity and fish health management.
Principal Investigator (Blue Economy CRC)	• Coordinates all correspondence with third parties, including regulators and other industry members.
Research Trial Site Operations Lead	• Ensure the effective implementation of this management plan and associated procedures and task breakdowns. • Support subordinates with their specific responsibilities relating to biosecurity and fish health management. • Responsible for identifying and managing risk factors to minimise impacts on fish health.
Trial Site Veterinarian	• Responsible for overall fish health management for the Trial. • Licensed in Australia and retains a valid veterinarian-client-patient relationship with the operator. They are expected to exercise good professional judgement in fish health matters. • Responsible for disease diagnoses and prescribing.
Managers, supervisors & team leaders	• Each manager, supervisor and/or team leader is responsible for taking all practical measures to ensure the fish health and biosecurity management systems and procedures are complied with. • They are responsible for employee inductions, training and supervision to meet their requirements under this system.
Employees	• Site staff may be assigned to fish health duties depending on operations, and at the discretion of the Research Trial Site Operations Lead. • Site staff are expected to follow good hygiene measures and all fish health and biosecurity protocols/procedures, regulatory documents and approved standard operating procedures and task breakdowns. • Escalate to Research Trial Site Operations Lead and Trial Site Veterinarian any issues relating to fish health or biosecurity.
Contractors and visitors	• All contractors and visitors engaged to perform work or are observing Research Trial activities are required to comply with the hygiene, fish health and biosecurity protocols for the site and observe directions from the designated member of staff accompanying them.

APPENDIX A – DISEASES

Table 7 Endemic diseases

DISEASE	SIGNS/SYMPTOMS	CONFIRMATORY TESTS
Pilchard orthomyxovirus (POMV)	• Increased mortality • Lethargy • Darkened skin • Blood spots in the eye (rare) • Mucus in stomach • Pyloric caeca and spleen inflammation and congestion	• Molecular • Histology • Viral culture
Tasmanian Rickettsia-like organism (T-RLO)	• Increased mortality • Lethargy • Darkened skin • Nodular skin lesions (rare) • Nodular liver lesions (red or white) • Ascites • Congestion over internal viscera • Inflamed spleen and kidney	• Molecular • Histology • Viral culture
Tasmanian Salmon Aquareovirus (TSRV)	• Decreased fish performance (high level of infection) • Possible darkened skin (high level of infection) • Lethargy (high level of infection) • Internal pinpoint haemorrhaging and/or congestion across viscera	• Molecular • Histology • Viral culture
AGD – *Paramoeba perurans*	• White, raised lesions on gill tissue • Increased mortality • Reduced appetite	• External non-invasive gill assessment • Histology
Yersiniosis – *Yersinia ruckeri* serotype O1b	• Increased mortality • Reduced appetite • Exophthalmia • Haemorrhaging of the eye • Darkened skin	• Molecular • Histology • Bacteriology (blood agar)
Vibriosis – *Vibrio anguillarum*	• Skin lesions • Haemorrhaging on the base of pelvic and pectoral fins • Darkened skin • Blood spotting on internal organs • Inflamed kidney and spleen	• Bacteriology (Anacker Ordal)
Tenacibaculosis – *Tenacibaculum maritimum; T. dicentrarchi; T. soleae*	• Skin lesions • Gill lesions	• Bacteriology (Anacker Ordal)
Nocardiosis	• Nodules in spleen, kidney, and liver • Skin ulcers or nodules	• Bacteriology (Anacker Ordal) • Histology

DISEASE	SIGNS/SYMPTOMS	CONFIRMATORY TESTS
Nephrocalcinosis	• Increased mortality • Granular deposits in the kidney (calcium phosphate)	• Histology
Gas Bubble Disease	• Increased mortality • Gas bubbles in the eye, gills, and skin • Disorientation and loss of equilibrium • Darkened skin • Skin haemorrhaging • Embolism • Subcutaneous emphysema	• Histology

Table 8 Exotic diseases

DISEASE	SIGNS/SYMPTOMS	CONFIRMATORY TESTS
Enteric Red Mouth Disease (ERM) – *Yersinia ruckeri* – serotype O1a or Hagerman strain	• Exophthalmia • Haemorrhaging of the eye, liver, pyloric caeca, swim bladder, gills, corners of mouth, gums, palate, and tongue • Ascites • Enlarged spleen	• Molecular • Histology • Bacteriology (blood agar)
Bacterial Kidney Disease (BKD) – *Renibacterium salmoninarum*	• Darkened skin • Pale gills • Exophthalmia • Internal haemorrhaging • Ascites • White membrane-like layer covering one or more internal organs • Creamy, white nodules in/on kidney • Enlarged spleen	• Molecular • Histology • Viral culture • Bacteriology (blood agar)
Proliferative Kidney Disease (PKD)	• Pale gills • Inflamed, grey/mottled kidney • Inflamed spleen • Exophthalmia • Ascites • Anaemia	• Molecular • Viral culture • Kidney smear • Histology

DISEASE	SIGNS/SYMPTOMS	CONFIRMATORY TESTS
Furunculosis – *Aeromonas salmonicida* subsp. salmonicida	• Boils (furuncles) in the skin • Increased mortality • Darkened skin • Pale gills • Haemorrhages on the skin, mouth, fin bases, muscle, and internal organs • Bloody discharge from nares and/or vent • Exophthalmia • Enlarged spleen • Focal necrosis of the liver • Mucus filled stomach • Congestion of the intestine	• Bacteriology (blood agar) • Histology
Piscirickettsiosis – *Piscirickettsia salmonis*	• Skin lesions (including raised scales, white raised plaques, and shallow ulcers on flanks and heads) • Liver lesions • Congestion on viscera • Ascites • Inflamed or discoloured internal organs	• Molecular • Histology • Viral culture
Infectious Salmon Anaemia (ISA)	• Pale gills • Exophthalmia • Haemorrhaging of the eye, skin, internal organs, and adipose tissue • Fin rot • Swollen abdomen • Inflamed liver, kidney, and spleen • Ascites	• Molecular • Histology • Viral culture
Infectious Pancreatic Necrosis (IPN)	• Disorientation • Darkened skin • Exophthalmia • Distended abdomen • Petechial haemorrhages on pyloric caeca • Pale liver and spleen	• Molecular • Histology • Viral culture
Infectious Hematopoietic necrosis (IHN)	• Lethargy • Frenzied behaviour prior to death • Darkened skin • Exophthalmia • Haemorrhaging at fin bases • Petechial haemorrhages on adipose tissue and muscle surrounding organs	• Molecular • Histology • Viral culture

DISEASE	SIGNS/SYMPTOMS	CONFIRMATORY TESTS
Epizootic Hematopoietic necrosis (EHNV)	• Distended abdomen • Darkened skin • Petechial haemorrhaging on fin bases • Gill haemorrhaging • Enlarged kidney, liver, and spleen • Focal white to yellow liver lesions	• Molecular • Histology • Viral culture
Sea lice – *Lepeophtheirus salmonis; Caligus elongatus*	• Visible lice generally attached to the head, back and perianal regions • Reduced appetite, growth, and food conversion efficiency • Secondary infections from host attachment point	• Visual examination • Histology of lice
Whirling Disease (WD)	• Convulsive, erratic, nervous darting behaviour • Swimming in a 'whirling' motion • Increased respiratory rate • Darkened skin • Spinal curvature (in recovered fish) • Skull deformation (in recovered fish) • Shortened gill places (in recovered fish)	• Molecular • Histology (wedge or core samples of the hear, gill arches, and operculum)