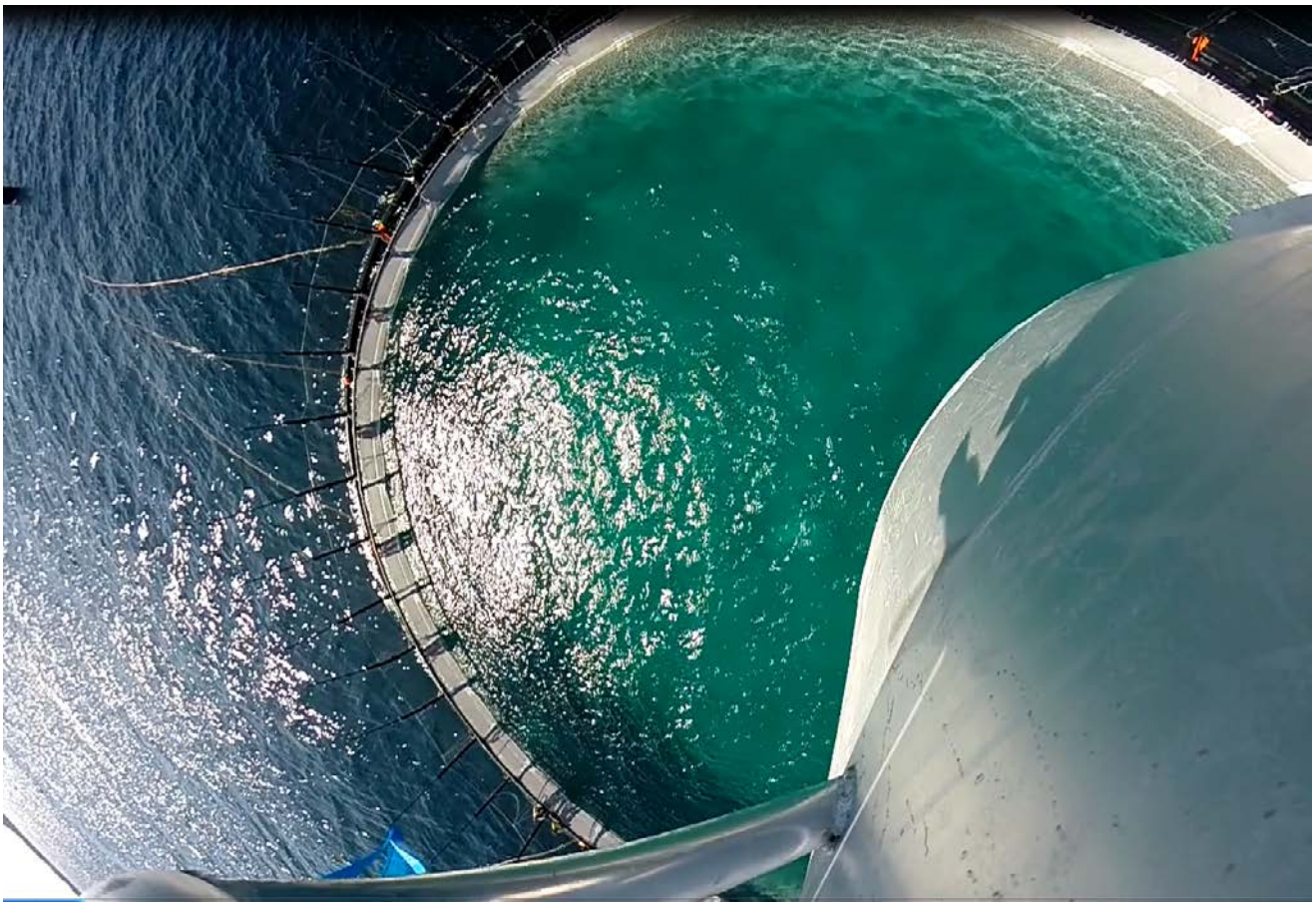
Department of Primary Industries

Marine Aquaculture Research Lease

Annual Environmental Management Report

October 2018



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Marine Aquaculture Research Lease – Annual Environmental Management Report

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More information

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Executive Summary

This report details the performance of the NSW Marine Aquaculture Research Lease (MARL) during the second year (September 2017 to September 2018) of an aquaculture research trial undertaken by NSW Department of Primary Industries (NSW DPI) and research partner Huon Aquaculture Group Limited (Huon). The report complies with State Significant Infrastructure Approval SS1 – 5118 MOD1 that an Annual Environmental Management Report be submitted to the NSW Department of Planning and Environment, the NSW Office of Environment and Heritage and the Commonwealth Department of Environment and Energy.

The report covers a range of activities including: construction and deployment; operation and maintenance; environmental monitoring and biosecurity; research; transport of fingerlings; marine fauna interactions; navigational interactions; compliance with standards and performance measures and community engagement.

The report highlights compliance with consent conditions and provides examples of where and when standards were exceeded. The report also identifies one non-compliance issue during this review period relating to sea pen maintenance which led to a fish escapement incident in January 2018.

Independent environmental sampling undertaken in the second year of operation found no significant impact on seafloor ecology or water column chemistry. Samples were taken from under sea pens and within the research lease, at compliance sites on the edge of the research lease and at the three control sites located at a distance from the research lease in Providence Bay. Monitoring will continue throughout the life of the MARL project to measure potential impacts on the environment as production biomass of Yellowtail Kingfish increases over time.

During the second year of operation there was:

- successful harvest of fish from two sea pens utilising a state of the art on-board harvest unit;
- rapid transfer of more than 11,000 fingerlings to the lease by helicopter;
- removal of five sea pens from the MARL to allow for lease maintenance and refurbishment of sea pens;
- no significant unexplained mortality or illness of fish;
- no new introduced pest/species identified on the lease;
- tagged shark monitoring, which indicated that during routine operations sharks have not been attracted to the lease area;
- no aquatic fauna entanglement incidents;
- there were 42 whales and 101 dolphins recorded within and around the lease;
- there were 87 whales and 612 dolphins recorded while travelling to and from the lease; and
- an increase in number of wild caught broodstock Yellowtail Kingfish held at the Port Stephens Fisheries Institute.

During the second year of operation there has been:

- attendance of NSW DPI/ Huon Research Team staff at community information forums;
- seven stakeholder updates released;
- updates placed on the NSW DPI and Huon websites;
- numerous research trials undertaken (e.g. genetics, hatchery, broodstock and nutrition);

- one water quality, benthic and video monitoring study conducted with an independent contractor and the University of Newcastle;
- results of one environmental monitoring event and video footage of this event placed on the NSW DPI and Huon websites;
- additional environmental monitoring undertaken to identify seasonal variations within Providence Bay;
- operational training of staff;
- review of operational and emergency management plans; and
- employment of ten full-time staff at NSW DPI and eight full-time staff by Huon Aquaculture.

This report also outlines a number of incidents related to operational matters that occurred on the MARL during the reporting period including:

- seven infrastructure malfunctions;
- one significant fish escapement incident;
- one health management issue that required the use of hydrogen peroxide to treat gill and skin flukes;
- marine fauna monitoring with zero entanglements but two entrapments within the lease area;
- six complaints registered and addressed; and
- one fine issued to Huon Aquaculture by the Department of Planning and Environment for failure to maintain lease infrastructure which led to a fish escapement incident.

The MARL is providing a sound research platform to investigate the viability and sustainability of sea pen aquaculture in NSW waters, and has had some key learning from its first two years of operation.

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List of Abbreviations

AMD	Aquaculture, Management and Development Pty Ltd
ANZECC	Australian and New Zealand Environment Conservation Council
APVMA	Australian Pesticides and Veterinary Medicines Authority
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
DO	Dissolved Oxygen
DRF	Dissolved Reactive Phosphorus
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979 (NSW)*
FM Act	*Fisheries Management Act 1994 (NSW)*
IALA	International Association of Lighthouse Authorities
MARL	Marine Aquaculture Research Lease
MSDS	Material Safety Data Sheets
NPWS	National Parks and Wildlife Service
NSW DPE	New South Wales Department of Planning and Environment
NSW DPI	New South Wales Department of Primary Industries
NSW OEH	New South Wales Office of Environment and Heritage
NSW RMS	New South Wales Roads and Maritime Services
PSFI	Port Stephens Fisheries Institute
ROV	Remotely Operated Vehicle
YTK	Yellowtail Kingfish

1. Introduction

NSW DPI and research partners Huon Aquaculture are undertaking a five-year offshore sea pen research trial to: validate the commercial potential of Yellowtail Kingfish aquaculture; trial the latest sea pen technologies; and undertake environmental monitoring associated with marine fish farming in the coastal waters of NSW.

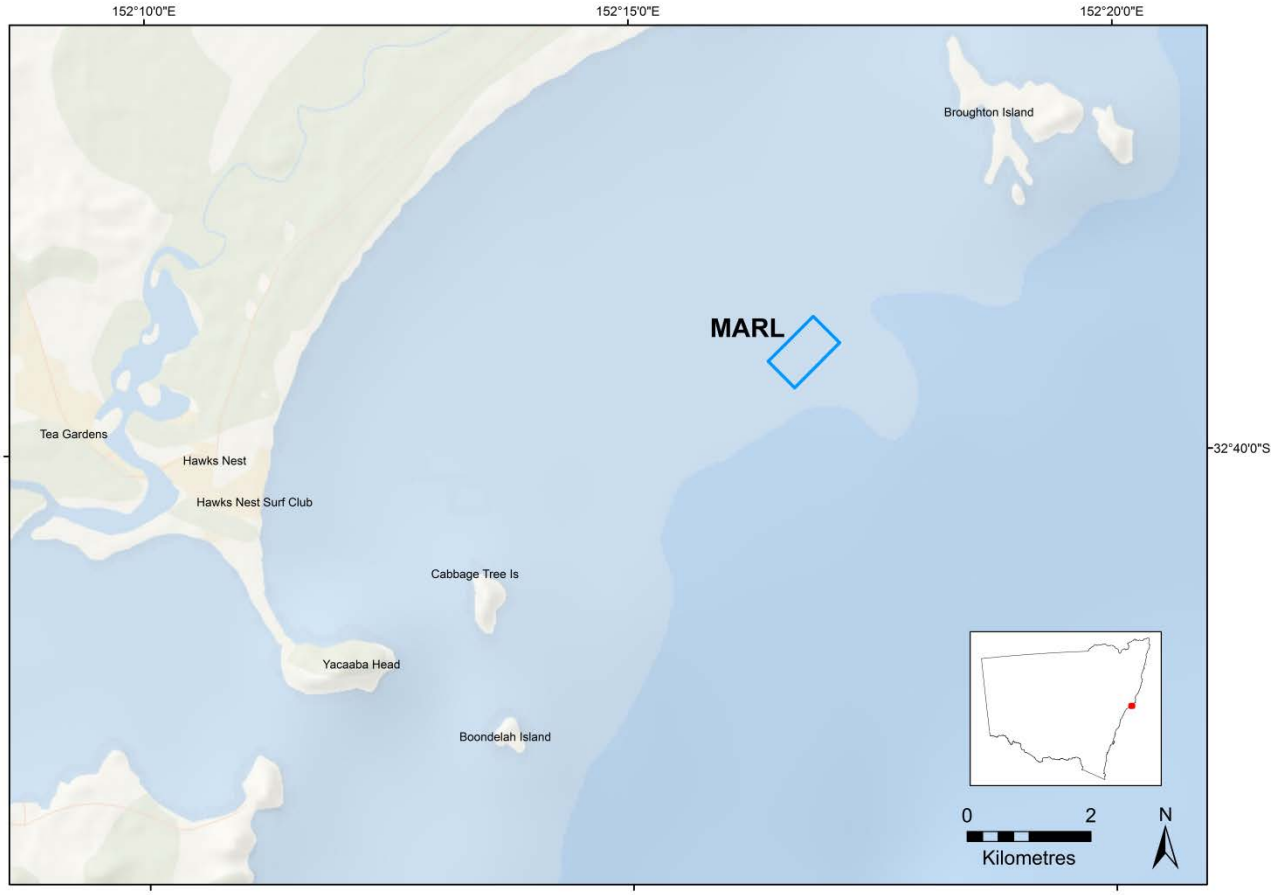


Figure 1: Location of the Marine Aquaculture Research Lease (MARL) (Source: NSW DPI, 2018).

The Marine Aquaculture Research Lease (MARL) is enabling NSW DPI to extend the successful Yellowtail Kingfish hatchery research at Port Stephens Fisheries Institute (PSFI) to an offshore sea pen trial. The principal objective of the MARL is to contribute to the development of sustainable marine aquaculture in NSW.

Two leases are approved for sea pen finfish aquaculture in Providence Bay, Port Stephens. A Modification Application was approved by NSW Department of Planning and Environment (NSW DPE) on 4th August 2016 to relocate the MARL and the Huon Aquaculture lease (former Pisces Marine Aquaculture Pty Ltd lease) further offshore into deeper water and adopt the latest aquaculture technologies.

In compliance with consent condition E7 of the MARL State Significant Infrastructure Approval SS1-5118, the Annual Environmental Management Report details the following:

(a) identifies the standards and performance measures that apply to the development;

(b) describes the operations that have been carried out during the reporting period;

(c) describes the research that has been carried out in the last 12 months;

(d) includes a summary of the complaints received during the reporting period;

(e) includes records of maintenance activities;

(f) provides details of monitoring results with commentary on any effects of the farm compared to relevant guidelines, pre-lease sampling or control sites and an analysis of any trends or key findings, including:

(i) incidents involving threatened species and/or marine mammals;

(ii) impacts on marine habitats - water quality, nutrient concentrations and sediments;

(iii) impacts on behavioural changes and predatory interactions;

(iv) marine fauna entanglement;

(v) benthic fauna assemblages;

(g) identifies any non-compliance including where the environmental performance goals for the development have not been achieved during the previous reporting period, indicating the reason for failure and the action taken to rectify and prevent any reoccurrence;

(h) includes details of any navigational incident related to the operation of the development;

(i) includes details on chemical use, disease and/or introduced pests;

(j) describes what actions were, or are being, taken to ensure compliance; and

(k) environmental management targets and strategies for the following reporting period taking into account identified trends in monitoring results.

2. Construction and Deployment Activities

2.1 Construction

Construction activities for the MARL continued in 2017/2018 with three new sea pens of 38 m diameter manufactured in the Kooragang Industrial Precinct Newcastle Harbour.

Figure 2: Five pens on the MARL (Source: HUON, 2018).

2.2 Deployment

Huon vessel *Delilah* undertook mooring grid maintenance in preparation for installation of the three sea pens. They were installed on the MARL on 20th September 2017.

Following two severe storm events in Providence Bay three sea pens were returned to Newcastle for maintenance (April 2018) and to allow refurbishment of the mooring grid. Two sea pens with fish remained on the MARL until the fish were harvested and subsequently those two pens were also removed to Newcastle Harbour in September 2018 for maintenance.

Figure 3: Removal of three sea pens to Newcastle Harbour for maintenance (Source: HUON, 2018).

3 Operations and Maintenance

3.1 Stock Management

A health certification for the Yellowtail Kingfish fingerlings from PSFI fish hatchery was issued by veterinary staff at the NSW DPI Elizabeth Macarthur Agriculture Institute for all stock prior to stocking the sea pens.

The first three fish stockings on the MARL took place in October and December 2016 and September 2017, respectively.

Fourth Stocking

The third sea pen on the MARL was stocked with approximately 11,000 150g Yellowtail Kingfish fingerlings on 9th–10th December 2017. The fingerlings were air lifted by helicopter in new purpose-built lift buckets from PSFI.

The health status and growth rates of the stock were routinely monitored. This data is being used to compile data to validate growth models. Overall, the first, second and third batches of Yellowtail Kingfish stocked in October and December 2016 and September 2017 displayed excellent health, survival and growth rates during the MARL's second year of operation.

3.2 Harvest

The first sea pen stocked with Yellowtail Kingfish from PSFI in October 2016 was harvested during March and April 2018. Whole fish averaging 5kg were marketed through the Sydney Fish Market with fish appearing on menus locally and in the Hunter wine region. The second harvest was undertaken June 2018

At harvest, the fish are corralled to a small area in the sea pen by net from where they are lifted into a self-contained harvesting unit on the deck of the work vessel *Bulldog*. The harvesting unit was specifically designed to meet a condition of the consent approval to retain all waste water associated with the harvest. The fish were quickly and humanely harvested and loaded into ice slurry in 1,000 litre insulated containers.

Figure 4: Harvest operation on vessel Bulldog (Source: HUON, 2018).

3.3 Feed Management

Fingerlings are initially fed daily by hand after transfer to the sea pens to enable monitoring for any relocation stress. Hand feeding was replaced by the use of a mechanical device in December

2016. Modifications to the mechanical device are being further developed. A Feed Register has been maintained for the MARL which has recorded feed input details e.g. feed type, size and quantity.

Only commercially prepared pellet feed that has been produced under a quality control program is used on the MARL. This prevents the introduction of a potential disease, parasite or pest.

Feeding regimes have aimed to feed fish to an observed level of satiation (fullness) without any feed waste. Appropriate feeding ensures all fish within populations have access to adequate nutrition while also minimising competition and social hierarchies within populations. Avoiding feed wastage also minimises the impact of feeding and stock on water quality and the benthic environment.

The main method of assessing satiation in the fish has been by surface observation during feeding events. The behaviour of fish (aggressive and high in the water column) has minimised the risks of feed waste. NSW DPI/Huon Research Team will continue to investigate alternative feeding methods, and will utilise underwater video streams and pellet detection algorithms to further improve feed access for the fish, especially in rough weather.

Effective feed inventory management and storage has been critical in ensuring that the freshness of feed has been maintained. Aquaculture feeds are stored in Huon Aquaculture's land-based facility at Shearwater Estate, Taylors Beach.

Figure 5: Mechanical feeding device (Huon 2017/18)

To assist in the prevention and preparation of a potential feed spill event at land-based sites, the following monthly maintenance actions have been undertaken:

- Inspection of feed storage areas to ensure they are clean and tidy;
- Ensuring storage containers are not damaged;
- Ensuring entry points to feed storage areas are secure;
- Ensuring all pest management facilities are in place and maintained;
- Ensuring non compatible products are not stored in feed storage areas; and
- Checking all spill response equipment (e.g. brooms and shovels) is in place.

To assist in the prevention and preparation of a potential feed spill event at sea, the following monthly maintenance actions have been undertaken on the MARL vessels:

- Inspection of feed storage areas on-board vessels to ensure they are clean and tidy;
- Ensuring transport storage containers and feed hoppers are not damaged;
- Ensuring feed transfer equipment is in good working order;
- Ensuring all pest management facilities on vessels are in place and maintained;
- Ensuring non compatible products are not stored in feed storage areas; and
- Checking all spill response equipment is in place.

3.4 Sea Pen Infrastructure

The MARL sea pen infrastructure has been inspected regularly since its deployment in September 2016. Visual inspections are undertaken by Huon staff on arrival at the MARL each work day for any infrastructure issues that may require maintenance. Routine inspections and any required maintenance have been undertaken at least every three months and have covered components of the infrastructure including nets, buoys, anchors, floating collars, ropes, chains, and connectors, as well as the cardinal markers. Subsurface components have been inspected *in situ* by divers and Remote Operated Vehicles (ROV). Inspections have also been conducted after net cleaning and severe weather to ensure the structural integrity has not been compromised.

A failure to adequately monitor a component of structural integrity of the MARL was highlighted during a severe weather event in January 2018. This has led to a review on monitoring priorities and development of a Structural Integrity and Maintenance Management Plan.

An inspection checklist has been developed which includes a list of components that must be inspected, issues detected, and any actions undertaken to rectify the structural integrity issues identified. Table 1 provides a summary of the inspection and maintenance activities for sea pen infrastructure during the first year of operation. Table 2 provides an overview of issues identified during the inspection and maintenance activities and the actions undertaken to rectify the issue.

The sea pen infrastructure has also been regularly cleaned of biofouling to ensure all components remain structurally sound and stable (see Section 3.5 – Biofouling Removal). The use of a submersible net cleaning robot to remove biofouling commenced in November 2016.

Monitoring sea pen structural integrity and stability is assisting the evaluation of effectiveness and suitability of design, including its ability to withstand the high energy environment of Providence Bay; how frequently repairs are required; whether line tautness is being maintained; the effectiveness of predator and bird exclusion nets; and whether escapements are being prevented (Table 2).

A net change occurred on the 9th of January 2018 to an improved and modified 35mm net design. The third sea pen changed nets from 12mm to 35mm mesh size on the 4th of April 2018. This provides the growing fish with better water flow across the sea pen.

Table 1: Inspection checklist for the structural integrity and stability of sea pen infrastructure.

Component	Inspection	Date	Issue	Action
Mooring grid components	Sub surface	Monthly by ROV	Wear and condition	Report and replace as required
Mooring grid components	Surface	By farm staff when present	Condition and alignment	Report

Component	Inspection	Date	Issue	Action
Pen integrity	Sub surface	Twice weeky by diver	Net integrity, inner and predator nets	Report and repair
Pen integrity	Surface	By farm staff when present	Pen structure, components, nets	Report and repair

Table 2: Issues encountered - structural integrity and stability of sea pen infrastructure.

Component	Inspection	Date	Issue	Action
Mooring grid components	Monthly by ROV	December 2017	Hardware malfunction	Reduce hardware components
Mooring grid components	Monthly by ROV	January 2018	Loss of buoyancy on grid	Repaired February 2018, Removed July 2018
Mooring grid components	Monthly by ROV	July 2018	Wear on rope rings	Removed July 2018

During the MARL's second year of operation, there have been seven structural malfunctions with sea pen infrastructure associated with severe weather conditions.

Malfunction One

One grid buoy broke free early in December 2017. The buoy was located by Water Police washed up near Fingal Spit and Huon Aquaculture recovered the buoy the following morning.

NSW Roads and Maritime Services (NSW RMS) and Marine Parks were promptly notified of this incident.

Malfunction Two

One grid buoy broke free late in December 2017. The buoy was located by Department of Lands washed up at The Entrance and Huon Aquaculture recovered the buoy.

NSW RMS and NSW DPI were promptly notified of this incident.

Figure 6: Buoy washed up at The Entrance (Central Coast Gosford Express Advocate, December 2017)

Malfunction Three

Between 14 and 18 January 2018 the weather experienced at the site of MARL was severe, with strong southerly winds and large south to south east swells. This event resulted in damage to the MARL infrastructure.

Equipment design was not identified as the lead cause of equipment failure rather, findings indicate the nets detached from the sea pens as a result of biofouling growth. The barnacles, caused damage to a number of ropes, which led to remaining ropes holding the nets becoming overloaded. Excessive weight due to biofouling growth put strain on the net rigging once the initial compromised ropes had been severed. The combination of load transfer resulted in leading to other structural damage including failure of components (snake ropes, water line ties, endless ropes, handrail “T”s and cotton reels) on two sea pens.

In addition, one empty sea pen collar was damaged as a result of the storm. Excessive wear from the mooring ropes attached to the cage, put extra pressure on the collar resulting in the rope wearing through the sea pen collar.

Figure 7: Post storm damage to sea pen 1602 (Huon 2018)

Malfunction Four

During bad weather in mid-March a piece of high density polyethylene tubing used for harvest crowding broke free of the lease and washed ashore at Bennetts Beach. Huon recovered the equipment after advice from National Parks and Wildlife Service (NPWS).

NSW RMS was promptly notified of this incident.

Malfunction Five

One grid buoy broke free in May 2018 after extreme weather conditions. The buoy and a length of chain washed up at Mungo Brush were located by local residents. The buoy was subsequently destroyed against rocks during storm action.

Figure 8: Buoy washed up at Mungo Brush (Local resident: May 2018)

Malfunction Six

Another grid buoy became loose on the 20th of June 2018. Farm personnel were onsite when it broke free and was able to retrieve it within the boundaries of the MARL.

Malfunction Seven

Two grid buoys have been retrieved from Queensland in July 2018. Huon received information from Queensland authorities regarding buoys washed up on the beaches. Huon recovered the buoys.

Corrective Actions

The corrective actions being investigated to manage this future risk include:

- Investigate the malfunction/s with the product manufacturer, use of alternative manufacturers and replaced shackles;
- The ability to fit grid buoys with GPS transponders;
- Alternative harvest methods to avoid the need for the tubing;
- Refurbishment of sea pen mooring infrastructure based on new wave data;
- Reduce hardware components associated with the current mooring arrangement where possible to prevent re-occurrence;
- Next mooring installation will have a further reduction of hardware components;
- The sea pens are undergoing repairs and refurbishment; and
- New technology-based systems relating to net cleaning, moorings inspection and maintenance schedules.

The MARL activities have highlighted the extreme nature of offshore conditions and the need to refine equipment to address these conditions.

3.4.1 Navigation Markers

The original spar cardinal marker buoys were replaced with Sealite Poseidon buoys on 5th October 2017. Poseidon buoys are larger in size and have enhanced visibility compared with the spar buoys. They maintain their vertical profile above sea level in large waves and strong currents. They do tend to exhibit more lateral movement around their installed position, but the improved visibility is more desirable following feedback from the community and RMS.

3.5 Escapements / Stock Losses

Stock numbers have been visually checked including weekly routine checks, after severe weather conditions, net changes and bathing treatments. If any significant predatory interactions had occurred, stock would have also been checked. Stock numbers have been regularly reviewed. This ensures prompt recapture attempts if an escapement occurs.

During the second year of MARL operation, the following escapement event occurred:

Date: January 2018

Numbers escaped: 20,000

Classification: Significant (>5%)

Numbers recaptured: > 5,000

Details of recapture method: Feed inducement to recapture fish, netting and trapping options. Pole and line with barbless hooks.

Reason for escapement: Barnacles appear to have caused damage to a number of ropes. There was also a delay in maintenance of the predator net to remove a build-up of biofouling. This led to the remaining ropes holding the nets becoming overloaded. The excessive weight due to biofouling growth put extra strain on the net rigging once the initial compromised ropes had been severed. There was also a delay in maintenance of the predator net to remove a build-up of biofouling.

Management actions: Secured damaged lease infrastructure. An incident investigation was undertaken by an Independent Investigation Facilitator in conjunction with the NSW DPI/Huon Research Team. An investigation team was assembled to conduct site visits, review the incident background and the processes leading up to and following the incident.

Incident reporting: DPE were provided with an interim and a final incident report. The community were provided with a summary document. See Incident Investigation Summary

Comments: Between 14th and 18th January 2018 the weather experienced at the MARL was severe, with strong southerly winds and large south to south east swells. This event was caused by two low pressure systems off the east coast of NSW. The maximum wave height recorded at the Crowdy Head wave buoy on the 16th of January was 11.27m, with significant wave heights peaking at 5.35m from SSE.

At the time of the incident there were five sea pens on site, three stocked with Yellowtail Kingfish, totalling 60,000 farmed fish on site.

It was agreed that the Emergency Protocol would be enacted at that time. In order to enact the Emergency Protocol safely, a temporary Section 8 Fishing Closure under the *Fisheries Management Act 1994* was put in place on the lease.

Key recommendations arising from the incident investigation relate to improving the existing management plans for structural integrity monitoring and emergency response/recapture procedures.

Huon will implement new technology-based systems relating to net cleaning, moorings inspection and maintenance schedules.

Review of Escapee Recapture Protocol: The Escapee Recapture Protocol outlines procedures to attempt the recapture of stock in the event that significant numbers escape into the wild. A significant escapement is defined as any loss of the cultured species to the marine environment in excess of 5% of individuals at any one time.

The Escapee Recapture Protocol will be reviewed again by the NSW DPI/Huon Research Team as part of the ongoing review process for the Operational Environmental Management Plan.

NSW DPE engaged an independent consultant to review the potential environmental impact of the January storm incident, in particular the escape of Yellowtail Kingfish. The consultant concluded that the loss of Yellowtail Kingfish from the MARL does not represent a serious or irreversible environmental impact. The conclusion was premised on the following:

- a large number of the Yellowtail Kingfish were caught by recreational and commercial fishers, and the NSW DPI / Huon Research Team;
- the quantity of escaped Yellowtail Kingfish is well within the bounds of natural variation of the commercial take of this species on the Australian east coast;
- Yellowtail Kingfish are not a species that are permanent residents of a particular location; they are a ranging species with a broad geographic distribution. Any remaining escaped fish would be expected to disperse throughout the species large range; and
- the health of the farmed Yellowtail Kingfish caused no cause for concern in terms of disease risk to wild stocks of kingfish and the environment in general.

In addition to the above known escapements there are other events that may have resulted in stock losses such as:

- Yellowtail Kingfish are a carnivorous species and will consume smaller cohorts and potentially dead or moribund fish;
- During stocking of the pens and prior to being able to install bird netting; losses due to bird predation can occur. It was noted during the first stocking event that there was heavy predation from sea birds prior to installing bird exclusion netting. Stocking procedures have been employed to reduce the predation but can still result in some stock losses;
- Large waves travelling through the sea pens, particularly when stock are small, may permit some of these smaller fish to escape through the bird netting;
- Marine scavenger species (small fish and crustacean species) present on the MARL are likely to consume some Yellowtail Kingfish mortalities, particularly when stock is small and when weather conditions prevent visitation to the MARL by staff. This can result in unknown stock losses;
- Routine removal of stock to enable sampling of fish for health checks, veterinary investigations and for research purposes; and
- Fingerlings are counted by the total weight of all fingerlings with the mean individual weight, an approximation of the total number of fish can be obtained. The approximation of the count could increase or decrease the total population.

The above matters outline why it is not expected that the harvest numbers of fish would match those of the fingerlings stocked.

3.6 Biofouling Removal

The sea pen infrastructure and nets are naturally colonised by a range of marine biofouling organisms, including algae, ascidians, molluscs and barnacles. The removal of this biofouling is important to reduce resistance to currents and wave action which may jeopardise the integrity of the infrastructure e.g. stress moorings and deform nets.

The culture nets have been regularly cleaned *in situ* using submersible net cleaning robots. Table 3 provides a summary of the biofouling removal activities undertaken during the MARL's second year of operation. The pen walkways have also been cleaned twice with the high-pressure gun to remove algae and biofouling.

The submersible cleaning robots are in the process of being upgraded to more powerful models to enable routine cleaning of the predator and culture nets (Figure 8 and 9). These new net cleaners only recently became available and have been trialled extensively at Huon's operations in Tasmania. Huon is confident that they will allow for more efficient cleaning of the nets, particularly the predator nets at the MARL.

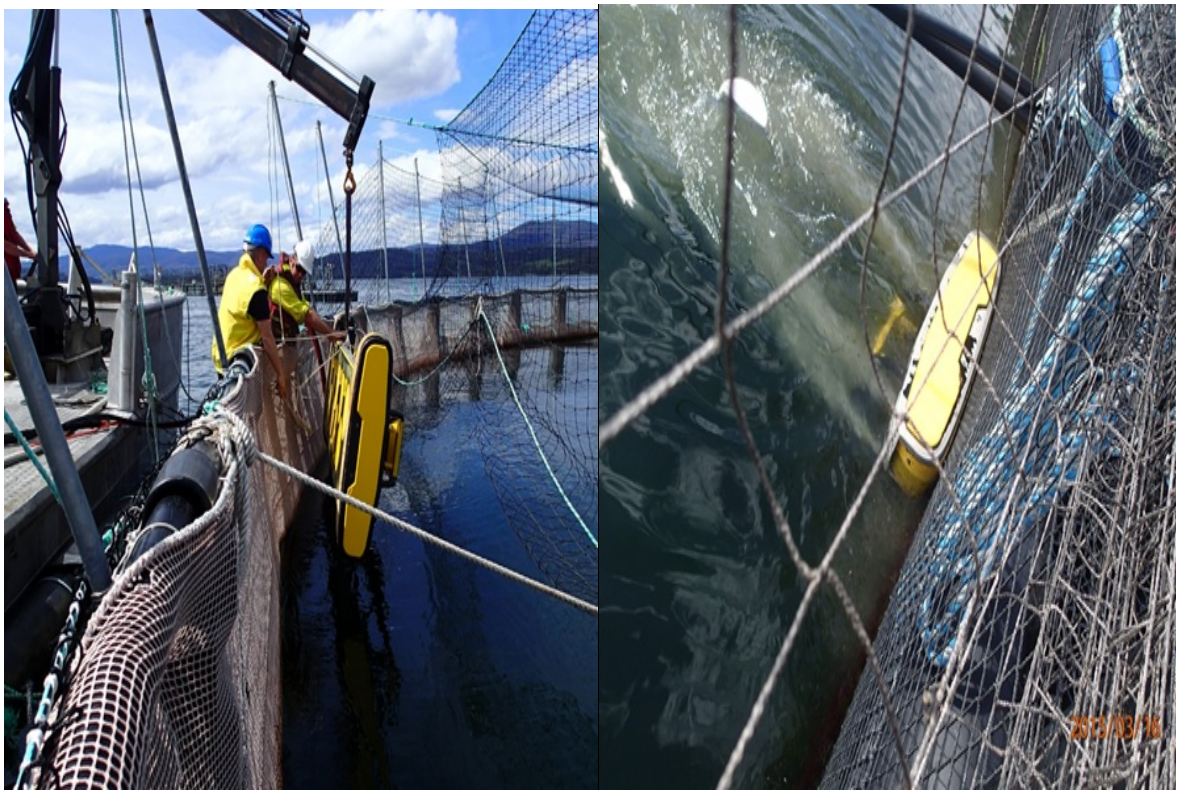


Figure 9: Picture showing deployment of the current robotic cleaner - remote operator net cleaner (Source: Huon, 2015).

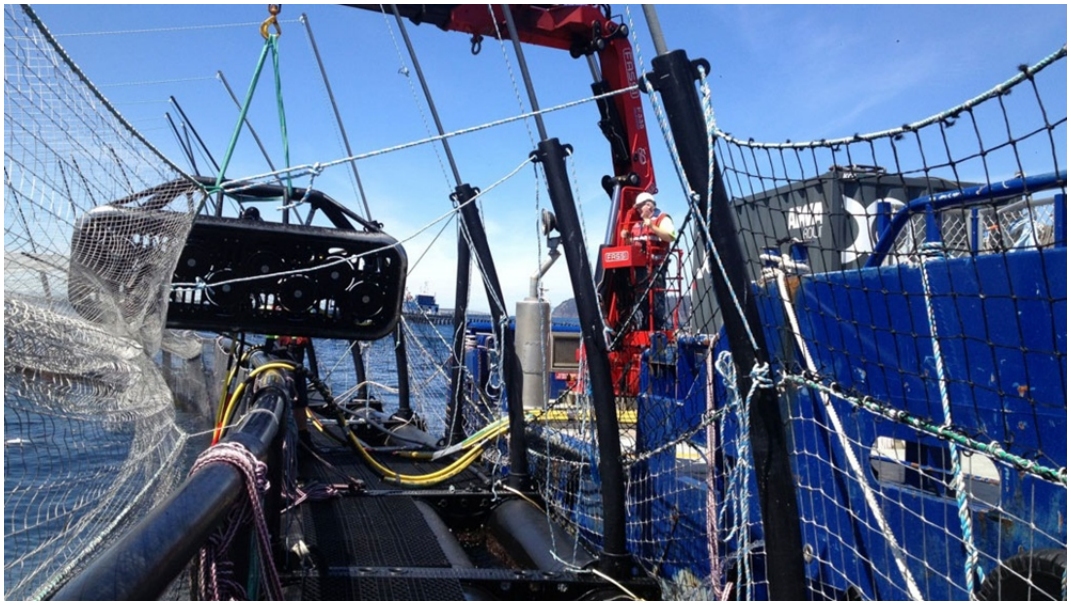


Figure 10: The new AKVA FNCR8 net cleaner being deployed into a sea pen. (Source: Salmonbussines.com, 2018)

Table 3: Biofouling removal records (September 2017 to August 2018).

Date	Method	Comments
September 2017	Submersible net cleaning Terminator	1 Clean, 3 week cycle
September 2017	5 Head RONC (remote opertor net cleaner)	1 Clean - trial
October 2017	Submersible net cleaning Terminator	2 Clean, Fortnightly interval

Date	Method	Comments
November 2017	Submersible net cleaning Terminator	2 Clean, Fortnightly interval
December 2017	Submersible net cleaning Terminator	2 Clean, Fortnightly interval
January 2018	Submersible net cleaning Terminator	2 Clean, Fortnightly interval
9th January 2018	Net change	1601 35mm to 35mm inner net
25th January 2018	Net removal	1602 inner net remove post storm damage
February 2018	Submersible net cleaning Terminator	2 Clean Fortnightly cycle
March 2018	Submersible net cleaning Terminator	2 Clean, Fotnightly cycle
4th April 2018	Netchange	Upsized 1603 – 12mm to 35mm Inner Net
May 2018	Submersible net cleaning Terminator	2 Clean, Fotnightly cycle
30th May 2018	Net Removal	Remove 1601 inner net
June 2018	Submersible net cleaning Terminator	2 Clean, Fotnightly cycle
5th July 2018	Net removal	Remove 1603 inner Net
17th July 2018	Net Removal	Remove outer net 1603
18th July 2018	Net Removal	Remove outer net 1601

3.7 Waste Management

The quantity and types of wastes generated by the MARL operations during the first year of operation have been summarised in Table 4. All waste storage containers have been inspected weekly to ensure that they are maintained in a condition appropriate for their use and containment of the specific waste.

Skips and bins have been monitored regularly to ensure that cross contamination doesn't occur. All waste removed from the site including products for reuse, have also been monitored to ensure there is no cross contamination. The NSW DPI/Huon Research Team will continue to review the type of surplus materials produced and where possible change the site design and operation to minimise products that go to landfill. Recycling or reuse of waste is a priority.

No wastewater was released into the environment during the harvest of Yellowtail Kingfish.

Mortalities removed from the lease represented approximately 4% of the stocked fish which comprised of 3,012 fish totalling 4.2 tonnes. This is within the normal range for aquaculture operations. Table 5 provides the monthly totals of fish removed and the putative cause of mortality.

Huon is investigating options for recycling feed bags and donating mortalities for agricultural fertiliser.

Table 4: Summary of waste generated by the MARL operations – September 2017 to August 2018.

Waste Type	Quantity	Date	Method/Place of Disposal
Feed Bags Small 25kg and 500kg bags	Total to end of August 2018 = 6,932	Every feeding day	Landfill
Pallet Packaging	334 pallets	As feed is consumed	Pallets returned to Chep
Cardboard	300kg (estimate)	As per deliveries	Recycled
Fish Mortality	4.2 tonnes	31/08/17 to 30/06/18	Landfill
Old Rope	8 tonnes (estimate)	31/08/17 to 01/08/18	Retained for recycling
Black Water	1000 litres (estimate)	31/08/17 to 01/08/18	Marina Black Water facilities Nelson Bay
Old Engine Oil	400 litres	31/08/17 to 01/08/18	Recycled at Waste Transfer Station
Harvest waste water	7 tonnes	14/03/18 to 30/06/18	Treated by environmental services

3.8 Land Based Operations

The hatchery/nursery and experimental feed trials are carried out in the existing footprint of PSFI at Taylors Beach.

Huon Aquaculture initially used a small facility in the Shearwater Industrial Estate at Taylors Beach before moving to an expanded facility in the same estate in May 2017. This provides offices and storage space for lease infrastructure components, gear and feed.

Huon Aquaculture has temporary access to a block of waterfront land in Newcastle Harbour. This land is being used for pen maintenance.

4 Chemical Use, Disease and Introduced Pests

Disease and pest control in intensive aquaculture production requires a holistic approach. Good site management, animal husbandry and rigorous biosecurity measures are central to reducing the risk of disease outbreaks and controlling the spread of infectious diseases and pests.

4.1 Port Stephens Fisheries Institute

Chemical use at PSFI associated with the MARL has been minimal during the second year of operation.

All Yellowtail Kingfish eggs were initially treated with ozone for disinfection (1.5 ppm for 30 seconds). No other chemicals have been subsequently used directly on the fingerlings.

The new broodstock brought into the hatchery were treated with hydrogen peroxide (a 75 ppm bath, three days in a row).

The only other chemicals used are general cleaning chemicals on the tanks, associated infrastructure and inlet water. Ozone is used to disinfect the incoming seawater in the hatchery and tanks are cleaned with liquid chlorine and a cleaning agent (Pyroneg). Personnel entering any of the PSFI production facilities are required to use alcohol and povidone iodine hand sprays and sodium hydroxide (caustic soda) footbaths to prevent the spread of pathogens.

4.2 Marine Aquaculture Research Lease

The sea pen infrastructure and the stock cultured within the sea pens can potentially be exposed to a range of endemic diseases, parasites and pests. The risk of endemic diseases and parasites from wild populations of fish surrounding the sea pens is identified as the greatest risk to the cultured stock. A number of preventative measures have been employed to mitigate the potential impact of endemic diseases, parasites and pests on cultured stock including the following:

- Stocking only certified disease free fish;
- Maintaining the sea pen infrastructure including predator nets;
- Water quality monitoring;
- Biofouling management;
- Maintaining appropriate stocking densities;
- Inspecting fish health and behaviour;
- Treatment procedures;
- Collecting samples for laboratory examination; and
- Maintenance of personnel and farm equipment hygiene.

Inspections of stock and infrastructure for disease, parasites and pests has provided the NSW DPI/Huon Research Team with an opportunity to compile a list of pathogens which are a potential threat to cultured fish in NSW waters, as well as contribute to the database on native pathogens of wild fish populations.

Daily and weekly inspections have been undertaken to assess the health of stock and quantify mortalities.

4.2.1 Disease and Parasites

The health status of the stock has been regularly inspected, including the potential occurrence of disease and parasites. The incidences of disease and parasites on the MARL during the second year of operation is listed in Appendix 1 and summarised below:

- September, October, November, December, (2017)
- February, March, April, May, June, (2018)
    - External skin and gill flukes were detected on stock.

- Treatment: hydrogen peroxide (see Section 4.2.3).

The prevalence of skin and gill flukes on the fish was expected, given the similar experience during the first year of operation. The flukes are commonly found on local wild stocks of Yellowtail Kingfish and other fish species.

Section 4.2.3 provides details about the treatment process and its effectiveness, including what chemicals were used (if any).

4.2.2 Stock – Mortality, Injury and Sickness

Daily or whenever practicable (and subject to weather conditions), sea pens have been inspected to remove mortalities. Seriously injured and/or moribund stock have also been removed wherever practicable. Records have been kept on the probable causes of death, sickness or injury, and the number of dead and moribund fish (see Table 5).

Marine scavenger species (small fish and crustacean species) present on the MARL are likely to consume some Yellowtail Kingfish mortalities, particularly when stock is small and when weather conditions prevent visitation to the MARL by staff. This can result in unknown stock losses.

If a significant unexplained mortality or health issue arises, samples of affected fish are sent to an approved veterinary laboratory for diagnosis. No significant unexplained mortalities or health issues occurred during the MARL's second year of operation. Veterinary investigations are also being undertaken into the cause of the minor numbers of moribund fish.

All collected mortalities and/or euthanised fish have been disposed of in accordance with the Waste Management Plan for the MARL. Staff involved in the removal of mortalities and/or euthanised fish followed strict hygiene procedures for personnel, their clothes and operational equipment utilised in the removal operations. Some individual fish were humanely killed by a sharp blow to the head. However, humane destruction was routinely undertaken with an overdose of anaesthetic. No fish have been left to asphyxiate in the air.

Table 5: Occurrences of stock mortalities, injuries and sickness during the MARL's second year of operation.

Year	Month	Bent	Deformed	Eye Damage	Floater	Good	Handling	Moribund	Old	Other	Runt	Sample	Total Mortality
2017	Sept	0	0	0	30	25	0	0	70	69	2	25	221
	Oct	0	1	0	74	56	0	2	90	97	10	6	336
	Nov	0	0	0	61	57	0	0	48	0	0	0	166
	Dec	0	0	0	22	55	388	0	228	30	0	2	725
2018	Jan	0	0	0	59	433	0	0	361	2	0	0	855
	Feb	0	0	0	11	104	0	0	47	3	0	190	355
	Mar	0	0	0	9	128	0	0	115	33	0	0	285
	Apr	0	0	0	0	38	0	0	4	0	3	0	45
	May	0	0	0	3	0	0	0	6	0	0	3	12
	Jun	0	0	0	0	0	0	0	12	0	0	0	12
Total		**0**	**1**	**0**	**269**	**896**	**388**	**2**	**981**	**108**	**15**	**226**	**3012**

4.2.3 Chemical Use

The types of chemicals available for use and the associated treatment protocols are tightly regulated. Chemical use associated with the operation of the MARL has been in accordance with the Australian Pesticides and Veterinary Medicines Authority (APVMA). The chemicals used on the MARL during the first year of operation consist of the following:

Hydrogen peroxide

Date used:

Dates	Dates
• 4th and 12th September 2017	• 19th March 2018
• 4th October 2017	• 6th April 2018
• 29th and 30th November 2017	• 2nd May 2018
• 19th and 20th December 2017	• 8th June 2018
• 28th February 2018	

Quantity and concentration:

Concentrations vary from treatment to treatment due to linear volume, biomass of sea pen and water temperature. To date concentrations have ranged from 180-260 ppm. Full details of the quantity used with each treatment are provided in Appendix 1.

Approval:

The APVMA has issued a minor use permit (PER83276) for hydrogen peroxide (see Appendix 2). The permit authorises its use in the treatment of metazoan and protozoan ecto-parasitic infestations and the control of fungal infections, in freshwater and saltwater finfish, and finfish eggs under the supervision of a registered veterinary surgeon. The administration and dosage used was carried out under veterinary direction.

Properties: Breaks down quickly into water and oxygen in the presence of light leaving no residue.

Purpose: Treat skin and gill flukes.

Effectiveness: Flukes were killed within 20-30 minutes.

Method: The fish were routinely monitored with regular health inspections and when the number of flukes reached a level of concern, the fish were treated. The inner net was lifted to reduce the total volume of water the fish were retained in. A specially shaped tarpaulin was placed around the inner net to form a fully enclosed 'bag'. A low concentration solution of hydrogen peroxide pre-mixed in seawater was added to the 'bag'. The tarpaulin 'bag' was removed once the flukes were killed.

4.2.4 Transfer of Fingerlings

A health check was undertaken by veterinary staff of the NSW DPI Elizabeth Macarthur Agriculture Institute on each batch of fingerlings prior to being transferred to the grow-out site.

As newly transferred juvenile fish are potentially exposed to a range of new pathogens and stressors, every attempt was made to minimise unnecessary handling, physical damage and exposure to other stressors during transfer procedures.

To assist in reducing the potential of pathogens being transferred to fingerlings the following procedures were undertaken:

- Disinfection of transport containers before and after they were used;
- Disinfection of transport water used to transfer fingerlings;
- Monitoring of water quality (particularly dissolved oxygen) during transfer;
- Rapid transfer of fingerlings from PSFI to the MARL (15 minutes air time)
- Ensuring that pen integrity (culture and predator nets especially) was maintained so that physical damage to transferred fingerlings was minimised;
- Minimise the number of fish movements and handling events;

- Ensuring that all fish have ready access to feed and feeding opportunity; and
- Monitoring fish health closely such that early mitigation could be implemented if necessary.

4.2.5 Broodstock

To increase the number of Yellowtail Kingfish broodstock and provide additional broodstock for nutrition research being done by the national Yellowtail Kingfish Research Project (K4P) held at PSFI, an additional 32 farmed fish were collected from the MARL by NSW DPI. Yellowtail Kingfish were collected from the first batch of fish transferred to a sea pen in March 2018. Producing fingerlings from broodstock sourced from the same genetic population mitigates the risk of introducing non-endemic diseases, parasites and pests into the current population of broodstock at PSFI and or transferring them to the grow-out sites.

The new broodstock were transferred to quarantine tanks in PSFI before introduction to the broodstock program. Their health status was assessed, and inspections were conducted to identify any potential disease risks that may require treatment during quarantine. During the quarantine period, broodstock were inspected daily for any signs of disease and were examined for causative agents. All 32 new broodstock have settled in to the systems at the PSFI.

4.2.6 Introduced Pests

Marine pests can potentially be spread by ballast water, and vessel hull biofouling (Commonwealth of Australia, 2009).

Service vessels and infrastructure for the MARL sourced from outside NSW could represent a marine pest risk for the region, so movement of service vessels and infrastructure has complied with the *National Biofouling Management Guidelines for Commercial Fishing Vessels* (Commonwealth of Australia, 2009). If the origin port of the vessel is known to have significant marine pest issues, a risk assessment is required, and mitigation measures must be undertaken to prevent translocation of pests. Huon Aquaculture utilised its established “Positive Release” protocols to ensure that this risk was managed.

During the MARL’s second year of operation, two vessels were brought from Tasmania and one from Queensland including:

- *Catalina* IV– fast vessel, set up for feeding and net cleaning.
    - *Specifications:* 17.4 m, displacement hull.
    - *Preparation:* Subjected to manual hull cleaning, replacement of ropes, drying of bilges and sprayed with Virkon solution.
    - *Transfer:* Deployed to NSW from Tasmania in November 2017
- *Bambra* - large landing craft vessel.
    - *Preparation*: Vessel was slipped, hull was cleaned, ropes were replaced and sprayed with Virkon solution.
    - *Transfer*: Temporarily deployed to NSW from Queensland in October 2017. Deployed to Tasmania from NSW in February 2018
- *Bulldog 13* – a large landing craft vessel.
    - *Preparation:* Vessel was slipped, hull was cleaned, ropes were replaced and sprayed with Virkon solution.
    - *Transfer:* Deployed to NSW from Tasmania in August and September 2017.
- *Huon Envy* - a specially built, fast-crew-transfer and technical projects vessel.
    - *Specifications*: 11.9 m, aluminium plaining hull.
    - *Preparation:* Subjected to manual hull cleaning, replacement of ropes, drying of bilges and sprayed with Virkon solution.
    - Transfer: Deployed to Tasmania from NSW via truck August 2018.

Positive release forms were completed for all of these transfers (see Appendix 3).

The sea pen infrastructure has been colonised naturally by a range of marine biofouling organisms, including algae, ascidians, molluscs and barnacles. Inspections of the MARL infrastructure and biofouling organisms have been regularly undertaken to ensure early detection of potential pest species. No new pest species were observed in the last year.

4.2.7 Training

The ability of NSW DPI/Huon Research Team staff to recognise pests and abnormal or unusual signs and behaviour in fish is fundamental to early detection of fish health and pest issues. To assist in the rapid response to these issues staff have been trained and/or have expertise in the identification of potential diseases and pests that may occur in the Providence Bay region. Ongoing regular training in fish health and biosecurity will continue through in-house and external training.

During the second year of operation of the MARL, the following disease, pest and biosecurity training was undertaken by staff:

- Attendance at presentations, seminars, workshops and conferences to stay informed about the latest industry research, practices and technologies relating to fish health or aquatic pests; and
- Regular and ongoing on-the-job training, as well as specific training was undertaken to promote the objectives and aspirations of the Health Management Plan, including:
    - Fish welfare training;
    - Chemical handler training;
    - Training against all standard operating procedures;
    - Disinfection training;
    - Use and handling of veterinary chemicals;
    - Presentations on key fish health and welfare topics;
    - Information sheets on key disease and fish health topics;
    - Cultural awareness training; and
    - Two-day workshop and training session held at Roseworthy Campus Adelaide University, conducted by the K4P Research Project.

5 Research

The research objectives for the MARL include but are not limited to the following:

- Evaluating and adapting husbandry practices for sustainable sea pen aquaculture;
- Evaluating the use of different protein and energy (fish food) sources (Section 5.4);
- Evaluating and developing dietary research to a commercial level including testing feeding efficiency and growth performance (Section 5);
- Determining the water temperature growth models for species to determine if there are any impacts on growth related to seasonal water changes (Section 5.4);
- Investigating the potential environmental impacts of a marine aquaculture farm (see Section 6);
- Evaluating a range of mitigation measures such as anti-predator netting, controlled feeding strategies and entanglement avoidance strategies (see Section 6.2);
- Investigating the structural integrity and stability of the proposed sea pen infrastructure (inherent in the farming procedure) (see Section 3.4); and
- Economic viability, including cost of fingerlings, feed, equipment, services and sale of product (will be evaluated at the end of the research period).

This chapter details the genetic, hatchery and nutritional research that has occurred during the first year of operation of the MARL.

5.1 Hatchery Research

The hatchery research being undertaken at PSFI is part of the FRDC Project Number: 2015-213 - *Enabling Land-based Production of Juvenile Yellowtail Kingfish in NSW*.

Hatchery, indoor nursery and preliminary outdoor nursery experiments undertaken at PSFI were completed. A range of options for the on-growing of advanced juvenile Yellowtail Kingfish including utilising flowthrough and recirculating aquaculture systems (RAS) tanks were trialled.

Project progress against FRDC project objectives

Good progress was made towards achieving the FRDC project's objectives:

1. *To validate the feasibility of the PSFI hatchery to produce commercial quantities of* Yellowtail Kingfish *fingerlings*"; and
2. T*o determine the feasibility and logistics of large-scale, land-based systems for production of advanced juvenile* Yellowtail Kingfish".

In the second year of the Yellowtail Kingfish (YTK) research project, PSFI undertook four replicated hatchery production runs and produced 22,800 (Batch 3a, 3b) and 34,500 (Batch 4a, 4b) fully weaned fingerlings. Three of the four production runs experienced lower survival than in last year's Batch 1 and Batch 2 with losses being experienced at 7-12 days post hatch. The final batch 4b resulted in much improved survival similar to that of the highest survival in Batch 1.

Fish fry were cultured at high density in a range of flowthrough systems (5-10,000L tanks) and RAS (22,000-24,100 L tanks) which incorporated either high-energy biofilters for control of dissolved ammonia/nitrite.

The final standing biomass for Batch 3 was 1305kg (120g/fish = 10902 fish) and for Batch 4 was 2697kg (159g/fish = 16964 fish). All fingerlings were successfully transferred to the MARL using helicopter transfer. Maximum stocking density of 500kg fish/m^3 was transported in specialised transport containers with 100% survival demonstrating that large numbers of advanced juvenile YTK can be transported at extreme stocking density for approximately 30mins.

Polyhouse-covered outdoor ponds for culture of advanced YTK

During the second year of the research project the suitability of polyhouse-covered outdoor ponds for culture of advanced YTK was evaluated.

These experiments investigated alternatives for greenwater culture, including the use of kaolin clay reduce incident light and investigated performance and suitability of outdoor ponds contained within a polyhouse for winter production of juvenile YTK. The intensive nursery experiments collected data on optimal stocking density, husbandry for production of high-quality juvenile YTK and supply chain costs in the production of juvenile YTK.

Evaluation of the suitability of polyhouse-covered 250m^2 ponds for culture of advanced juvenile YTK was done during the winter of 2017. Two ponds were each stocked with 50, advanced juvenile YTK and managed following standard culture practices similar to those used in nursery tanks (Table 1). Filtered seawater was supplied to each pond at approximately 25% exchange each day. In addition water was pumped from each pond via a submerged vacuum and through a sand filter to remove particulate waste and biological filter before being returned to the pond at an exchange rate of approximately 50%/day. An uncovered pond was run in concert with filtered estuarine seawater to provide comparative data on water quality, in particular temperature. Water quality measurements were taken once each day in the morning.

Results

Water temperature of the polyhouse covered ponds (range 14.2 – 19.5 ^{o}C) and was on average 2.0 + 0.8 ^{o}C warmer than the uncovered pond (range 11.3 – 17.1 ^{o}C) over the 114 day culture period (Figure 10). Growth of YTK was high with Food Conversion Ratio (FCR) of approximately 2.0:1 (Table 6; Unexplained mortality of all fish in pond 3 occurred after 77 days of culture. A phytoplankton bloom had increased in density several days leading up to the mortality event, and although there was no obvious deleterious water quality parameters measured, the increased turbidity may have been the causative factor. In future experiments the pumping capacity of filtered seawater to the ponds will be increased to potentially avoid any issues with poor water quality.

Table 6: Growth and feed consumption of YTK cultured in 250m2 polyhouse covered ponds at PSFI (Source NSW DPI 2018)

Pond 3	Stocked 11/07/17		Harvested 25/9/17		Total mortality					
	77 days		n=50fish							
	FL(mm)	**Wt(g)**	**Condition Score (K)**	**Biomass k(g)**	**FL gain (mm)**	**Wt gain (g)**	**AGR (mm/d)**	**AGR (g/d)**	**Total feed (kg)**	**FCR**
Initial	274.5	280.9	1.4	14						
Final	unknown	579.8		29		298.9		3.9	31.6	2.1
						`				
Pond 4	Stocked 11/07/17		Harvested 2/11/17							
	114 Days		n=50fish							
	FL(mm)	**Wt(g)**	**Condition Score (K)**	**Biomass k(g)**	**FL gain (mm)**	**Wt gain (g)**	**AGR (mm/d)**	**AGR (g/d)**	**Total feed (kg)**	**FCR**
Initial	273.9	286.4	1.4	14						
Final	419.1	1094.1	1.5	53	145.3	807.7	1.3	7.1	76.4	2.0

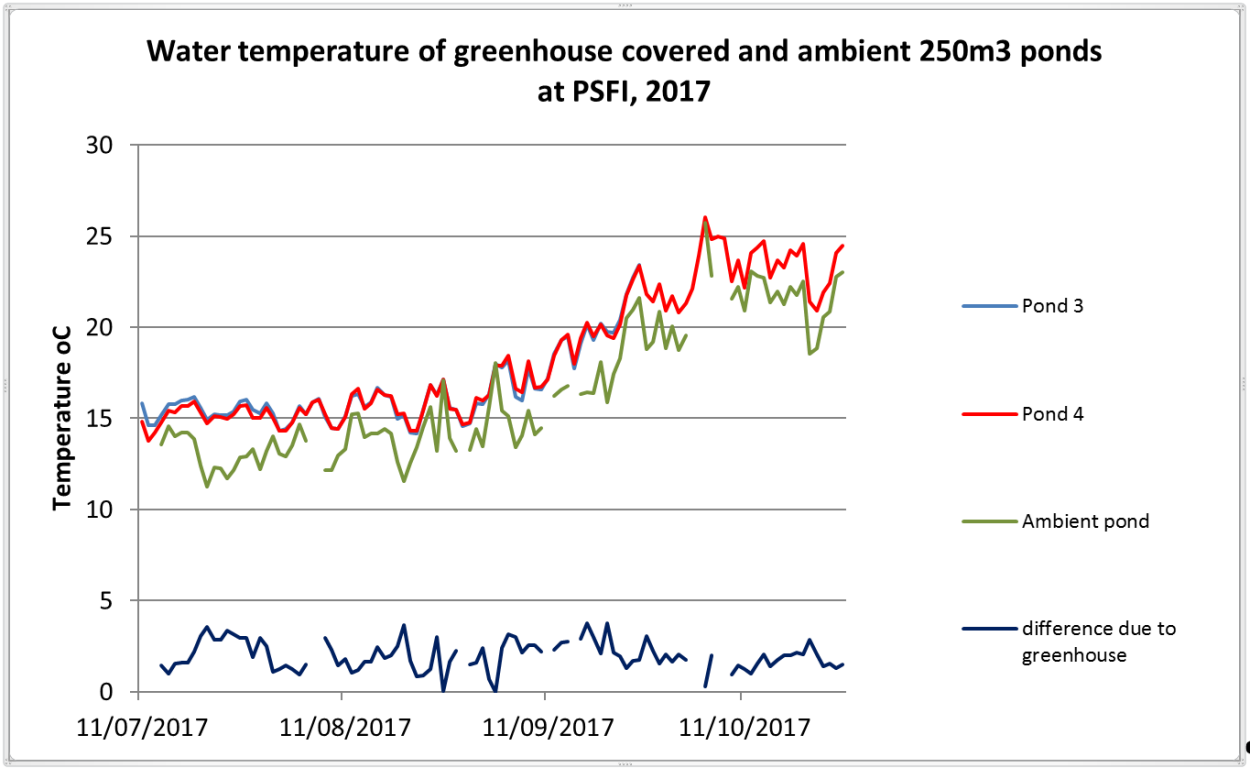


Figure 11: Graph showing water temperature of greenhouse covered and ambient PSFI ponds (Source NSW DPI 2018)

Figure 12: YTK harvested after 114days (July-November 2017) of culture in polyhouse-covered, plastic-lined ponds at PSFI. Fish were 1.0 kg.

Hatchery tank experiments.

Following the results of the first year's experiments which showed that standard black-sided tanks at PSFI hatchery were optimal for YTK larval production, the following experiments using six black sided hatchery tanks were undertaken.

Four commercial-scale hatchery tank experiments were undertaken to evaluate the PSFI intensive hatchery for reliable production of 25,000 YTK fingerlings at 25g each at three monthly intervals.

LED floodlights

The first experiment (Batch 3a) was initiated to determine the suitability of LED floodlights compared with the standard halogen floodlights used in the PSFI hatchery. LED lights use less power and produce less heat than Halogen lights and any new hatchery development would consider new technology if they were suitable. Significant mortality occurred in all tanks between 7-9 days post hatch, however there was a trend for higher mortality in the LED treatment tanks and thus the LED lights were removed.

A further hatchery run (Batch 3b) was started as soon as the hatchery was emptied in an attempt to produce target numbers of fingerlings for stocking to the MARL sea pens. Management of water temperature with room airconditioning was a significant challenge during extreme heatwaves and water temperature occasionally exceeded the target temperature of 24°C by 2°C. Compared with previous hatchery batches, survival of larvae to metamorphosis appeared to be compromised by the higher temperature and ranged from 1.9% to 6.6%. A total of 17,500 juvenile YTK were produced (Figures 12 and 13).

Both Batch 3a and 3b juvenile YTK were on-grown separately but growth was managed to allow amalgamation of similar size fingerlings for stocking to the MARL sea pens.

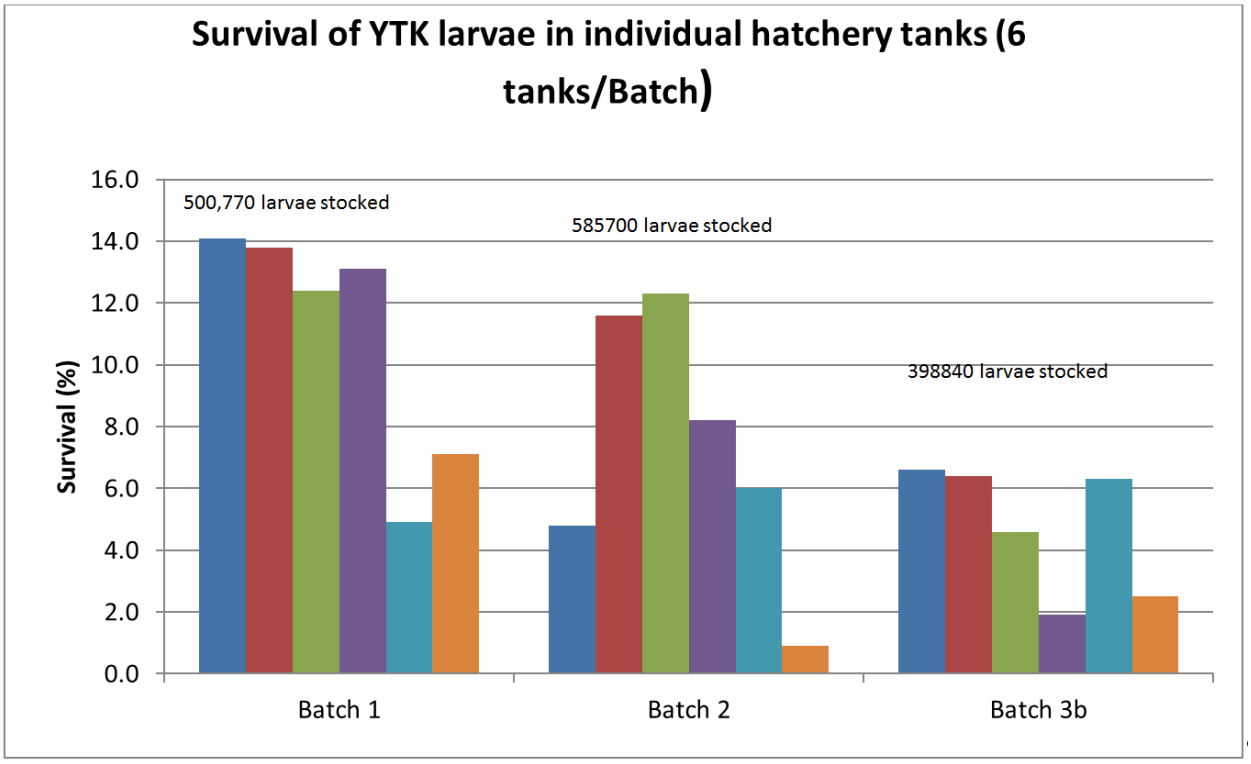


Figure 13: Graph, Survival of YTK larvae in individual hatchery tanks (six tanks/Batch)

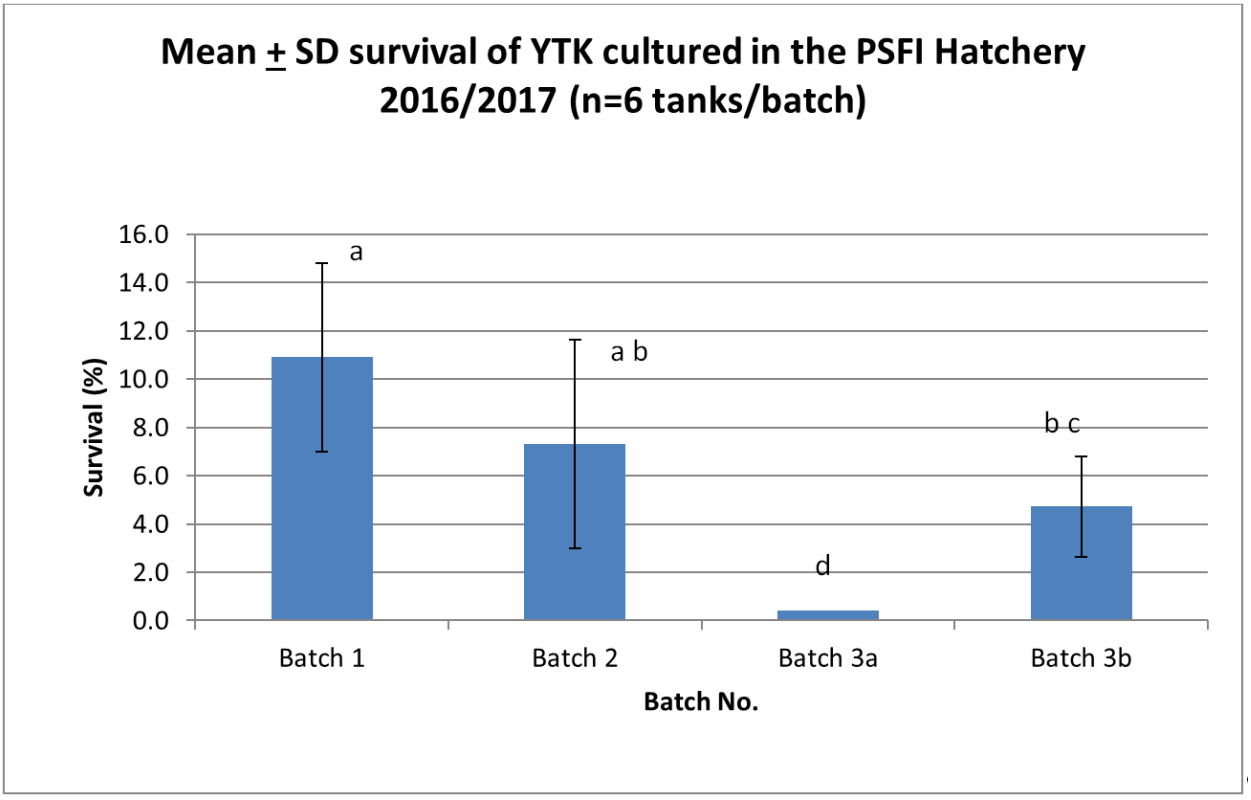


Figure 14: Graph, Mean survival of YTK 2016/2017 (Source: NSW DPI, 2016/2017)

Salinity and day length

The second experiment was initiated as the result of an event impacting on influent water quality.

The hatchery production of Batch 4 consisted of two hatchery runs, Batch 4a and Batch 4b. Unfortunately Batch 4a suffered significant larval loss in all tanks at approximately 7-12 days post hatch, and this was coincidental with an extreme rainfall event which resulted in deterioration of estuarine water quality, and especially a decrease in salinity from 35ppt to 29ppt (Figures 14 and 15). Survival was low (2.0%) resulting in production of 12,000 YTK fully-weaned fry.

The main observation made was that 9-12 days post hatch larvae were sinking out of the water column during the night when they became inactive and stopped swimming. Pre-dawn observations of larvae in hatchery tanks showed that larvae which had sunk to the bottom were alive and healthy and also showed a strong positive phototactic response. Larvae left the bottom and swam into the water column when illuminated with a torch light or when normal tank lights were turned on. The larvae were feeding extremely well on rotifers which had been maintained at high densities during daylight hours and were fully satiated (and continuing to feed) before the lights were turned off.

However, if larvae sink to the tank bottom, contact with tank surfaces can expose them to pathogenic surface bacteria including Vibrio spp. and also suboptimal microclimates of low DO. Larvae can then succumb to secondary bacterial infections.

Although the larval rearing tanks at PSFI are designed to provide upwelling to potentially avoid the larval sinking phenomenon which is greatest when YTK larvae have the greatest body density at 9-12 days post hatch, we hypothesise that a rapid decrease in salinity from 35 to 29ppt, exacerbated the sinking problem and resulted in high larval mortality.

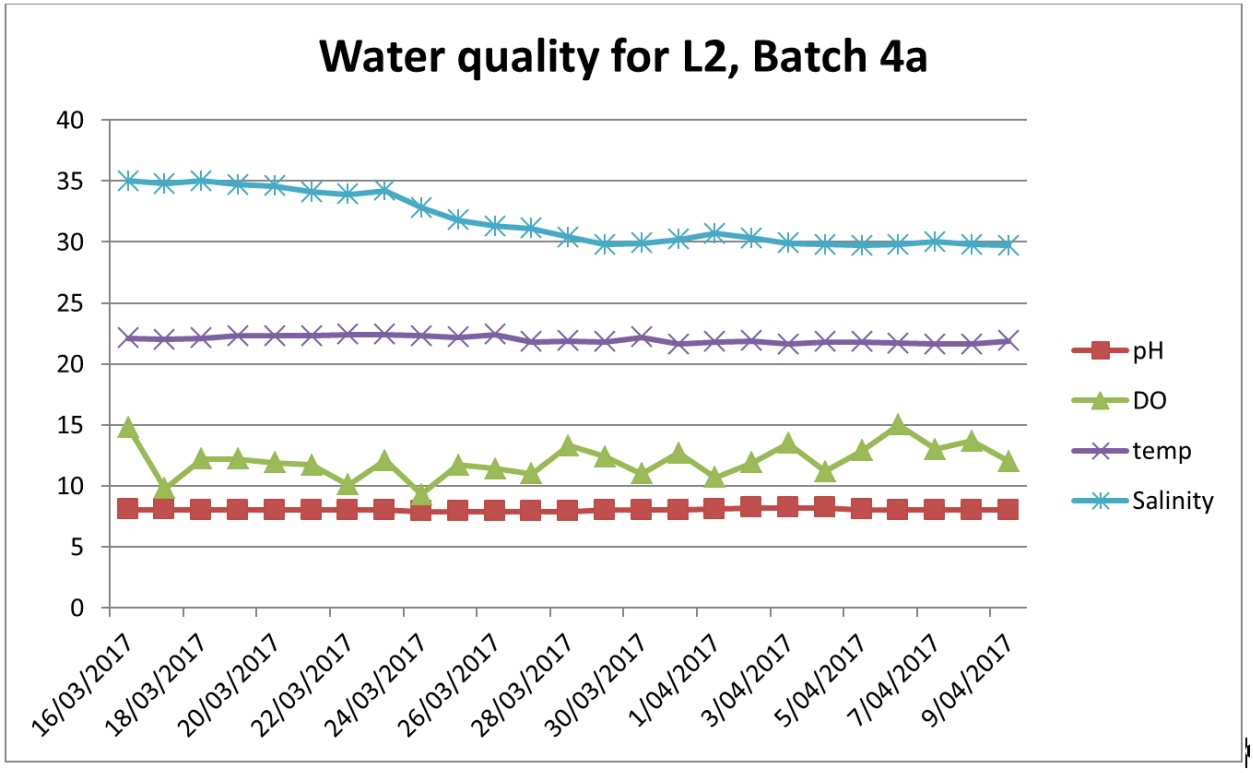


Figure 15: Representative larval rearing tank water quality Batch 4a

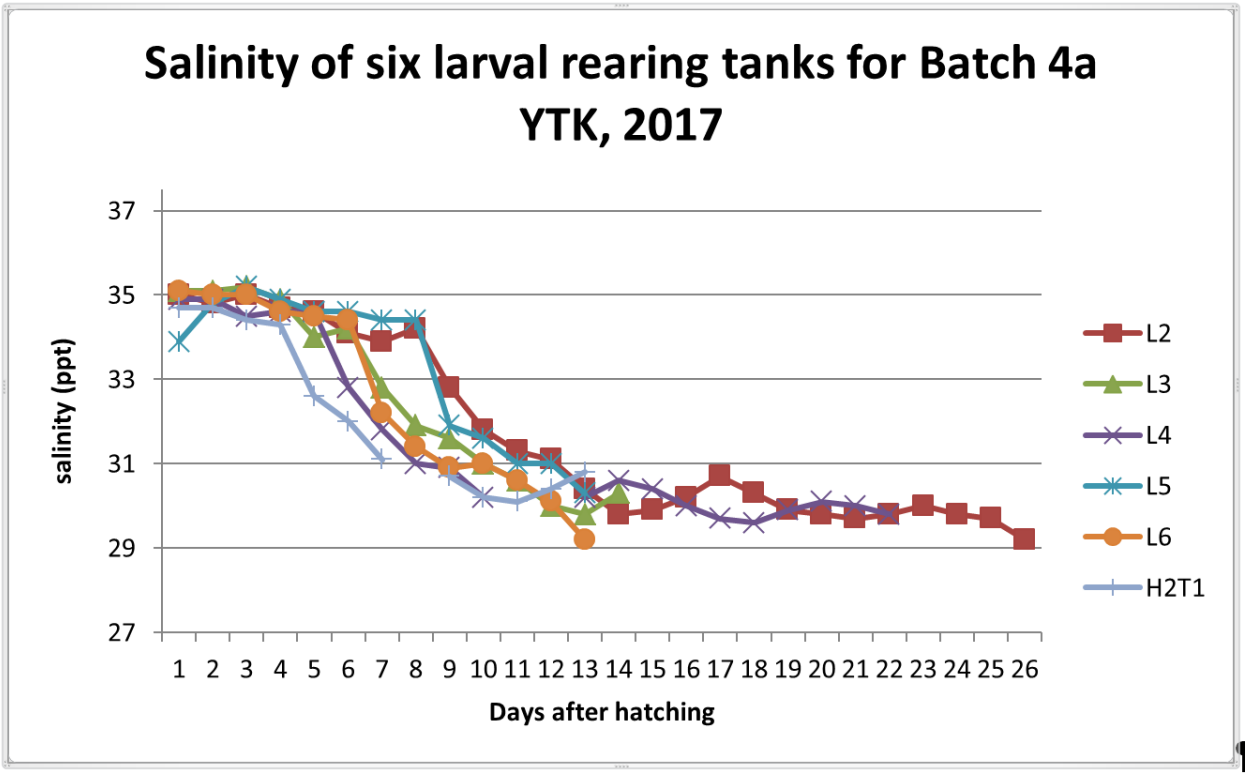


Figure 16: Salinity for all hatchery tanks Batch 4a.

A further hatchery production run, Batch 4b, was done as soon as the hatchery was cleaned and prepared for stocking. Particular attention was made to the salinity of the influent seawater and it was adjusted to 35 ppt by addition of artificial sea salt if it was lower than 35 ppt (see Figure 16). In addition, once larvae had finished swim bladder inflation at 6-7 days post hatch, the photoperiod was increased from 12:12 L:D to 24:0 L:D to promote continued swimming and to potentially avoid night-time larval sinking. This hatchery run progressed without incident and survival of 9.1% was equivalent to the previous best Batch 1 (Figure 17). Further experimentation is required to confirm the interaction of salinity and photoperiod on the effect of early-stage larval YTK sinking. A factorial experiment has been designed to compare the combined effect of salinity and photoperiod on

survival and growth of post-swim bladder inflation of YTK larvae and will be done in 32x100L experiment tanks at PSFI.

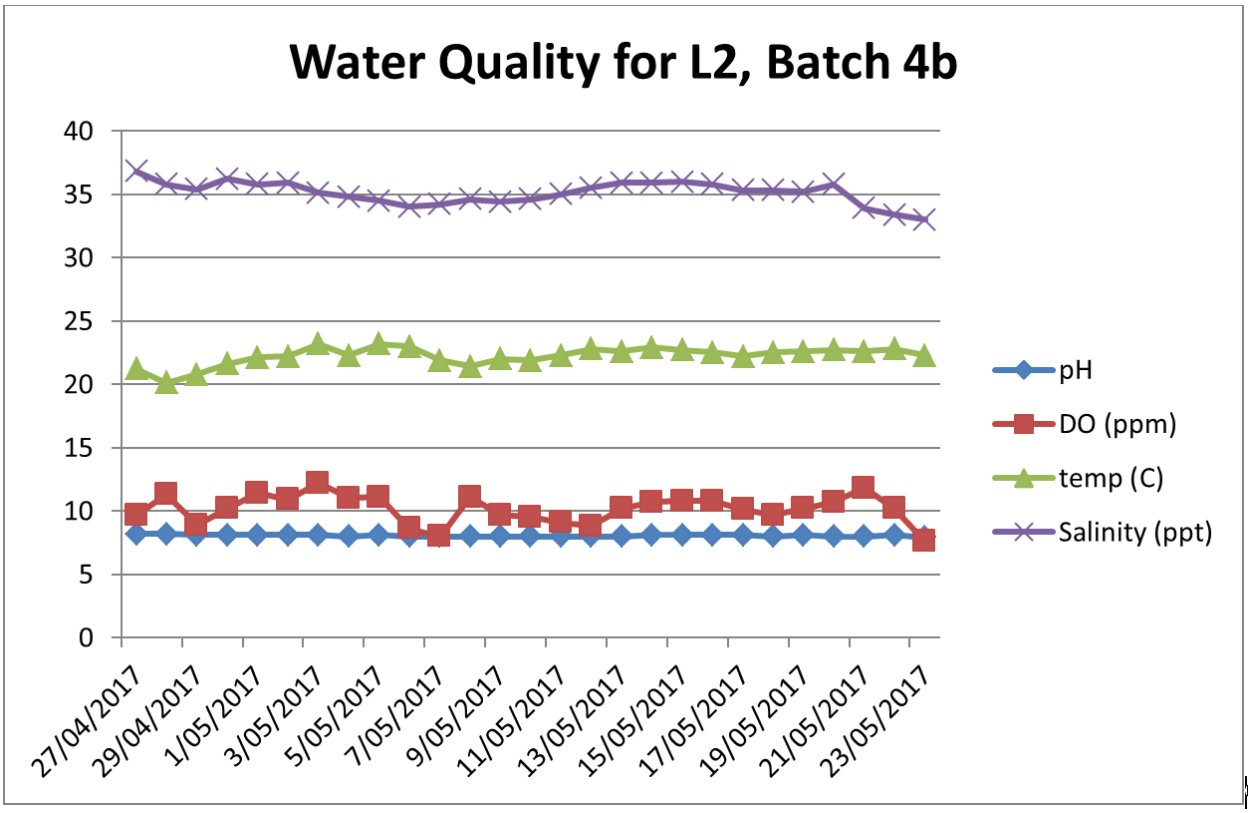


Figure 17: Water quality of a representative larval rearing tank, Batch 4b

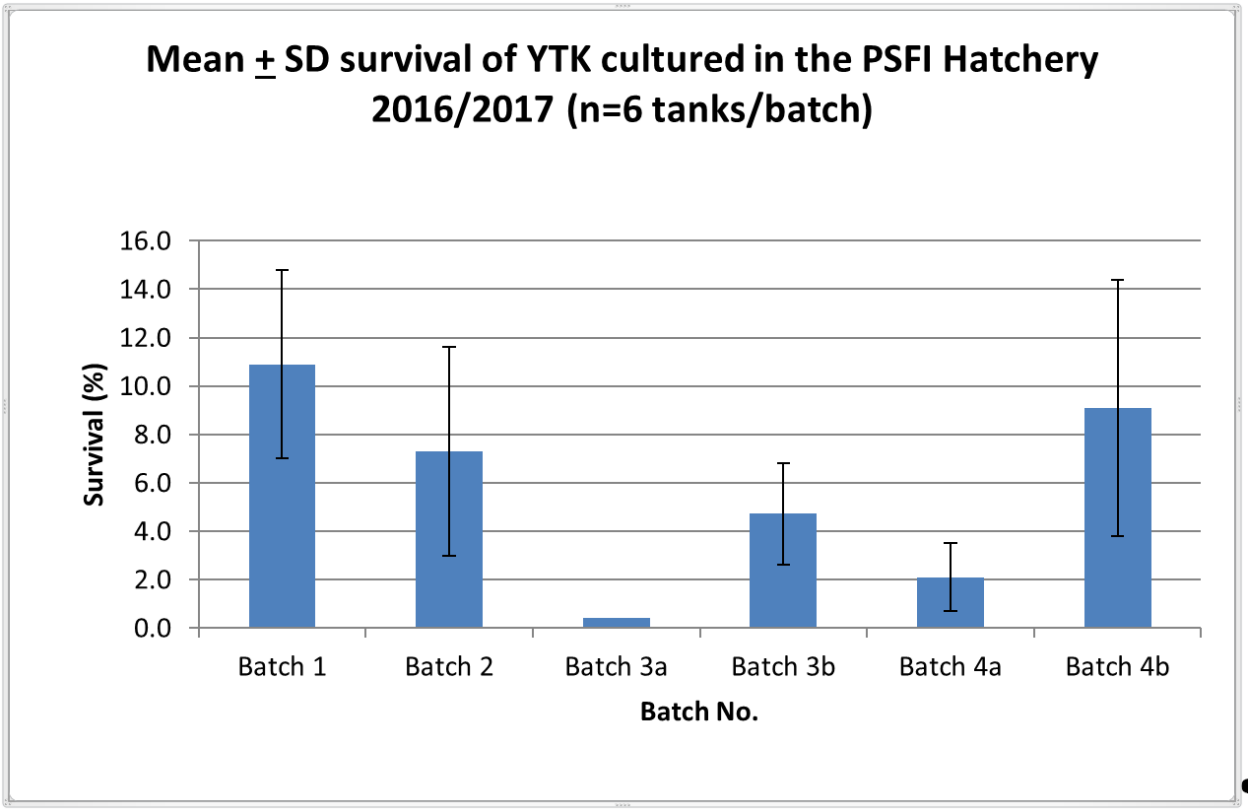


Figure 18: Survival of YTK larvae in all larval batches completed at PSFI

Nursery experiments

Evaluation of the suitability of RAS and flow-through systems at PSFI for intensive culture of advanced juvenile YTK continued and two experiments were completed for the on-growing of Batch 3 and Batch 4 fingerlings.

Experiment three was done in two, purpose-built RAS which each consisted of the following components: 24.1m^3 production tank, 1m^3 sump, rapid sand filter, foam fractionator, heater/chiller unit, UV filter and a biofilter and oxygen saturation systems. Influent water was filtered through sand and cartridge filters (10µm nominal), a UV filter and then heater/chiller to manage water temperature.

The aim of the experiment was to compare the performance of two standard filtration units and to determine any operational and logistical issues that could preclude the use of RAS for production of advanced YTK fingerlings in land-based systems. Both units had active biological activity for nitrification having been successfully used to culture the previous Batch 2 YTK.

In general, approximately 40-70% of new, influent seawater was exchanged and approximately 700% of the tank water was recirculated through the filtration system for both RAS each day. Batch 3a fingerlings were approximately 30 days older and significantly larger than Batch 3b. In order to amalgamate the batches as one stocking to MARL sea pens, the growth rate of Batch 3 was managed by manipulation of water temperature and feeding.

Each tank was stocked with juvenile YTK (3660 fingerlings at 11.4g, Batch 3a, RAS 2; 13325 fingerlings at 5.8g, Batch 3b, RAS 1) and cultured for 68 days using standard procedures including feeding with Ridley Pelagica diet (1.5 and 3mm) twice/day at approximately 2.5% biomass/d. Water quality (pH, salinity, temperature and DO) was monitored daily in the morning. It should be noted that it was not the intention to maximise growth of YTK but rather to maintain feeding and growth within manageable limits and to obtain production data and to reduce potential for stock loss. This was done by maintaining water temperature at target 15-16°C in RAS 2 and to restrict feed ration as opposed to satiation feeding. RAS 1 was operated at a target temperature of 22°C to optimise growth of YTK.

After 70 days, all fingerlings were harvested and divided evenly between both RAS tanks (8200 fish/RAS tank) and on-grown for a further 150 days. After approximately 45 days, the biomass in each RAS was reduced by removing fingerlings for on-growing in Flowthrough tanks to provide data for management of the two different systems.

Results

Growth of Batch 3a (0.23 g/d AGR) was lower than Batch 3b (0.28 g/d AGR) over a 68 day period which resulted in both batch's reaching the same mean target weight of ~26g/fish (Figure 18). This demonstrated that growth of an older batch of juvenile YTK can be successfully arrested by maintenance of water temperature at 15-16°C (Figure 19) and feeding restricted rations without compromising the fingerling condition or health.

The fingerlings were destined to be transported to a sea pen on the MARL continued to grow well in the RAS tanks at target temperature of ~18°C (Figures 19 and 20) and flowthrough tanks and the fingerlings attained a mean weight of 120g by 30 September 2017 (0.63 g/d AGR). Total biomass of fish held in tanks ranged from 9.9 to 16.8 kg/m^3 (Figure 21).

A total of 10,902 (1,308kg) fish were successfully transported by helicopter from PSFI hatchery to the MARL in a 500L, specially designed transport container at a maximum stocking density of 300 kg fish/m^3 (Figure 22).

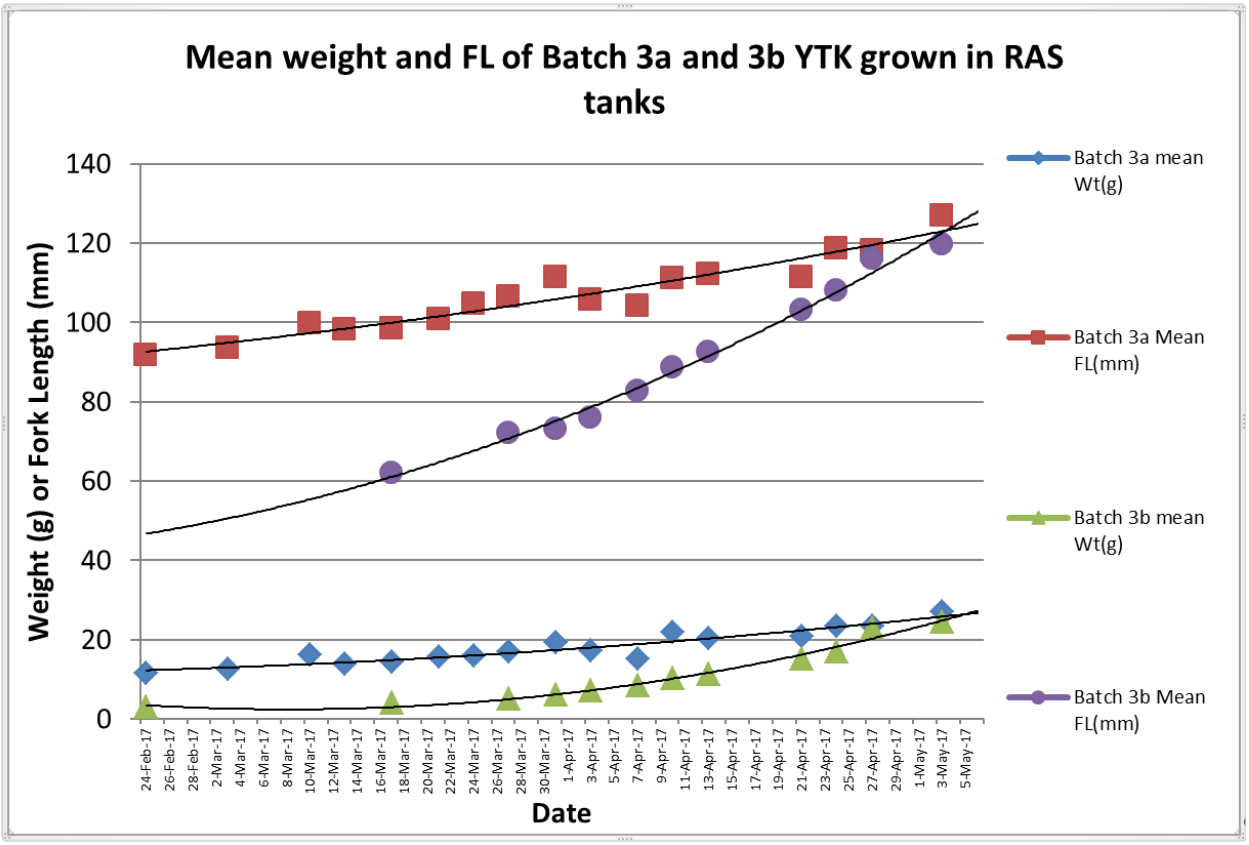


Figure 19: Mean weight and FL of Batch 3a and 3b YTK (Source: NSW DPI 2017)

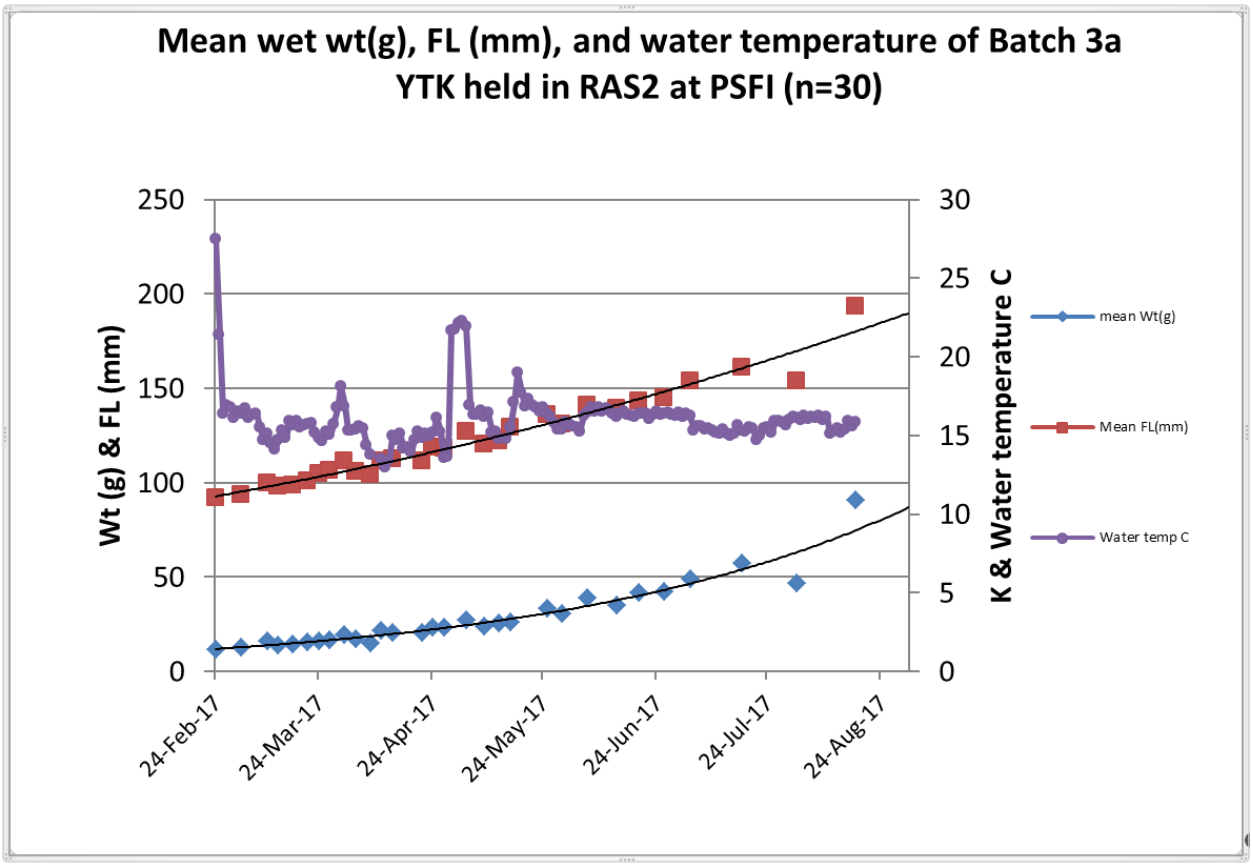


Figure 20: Mean wet weight, Fork length and water temperature of Batch 3a YTK (Source: NSW DPI, 2017)

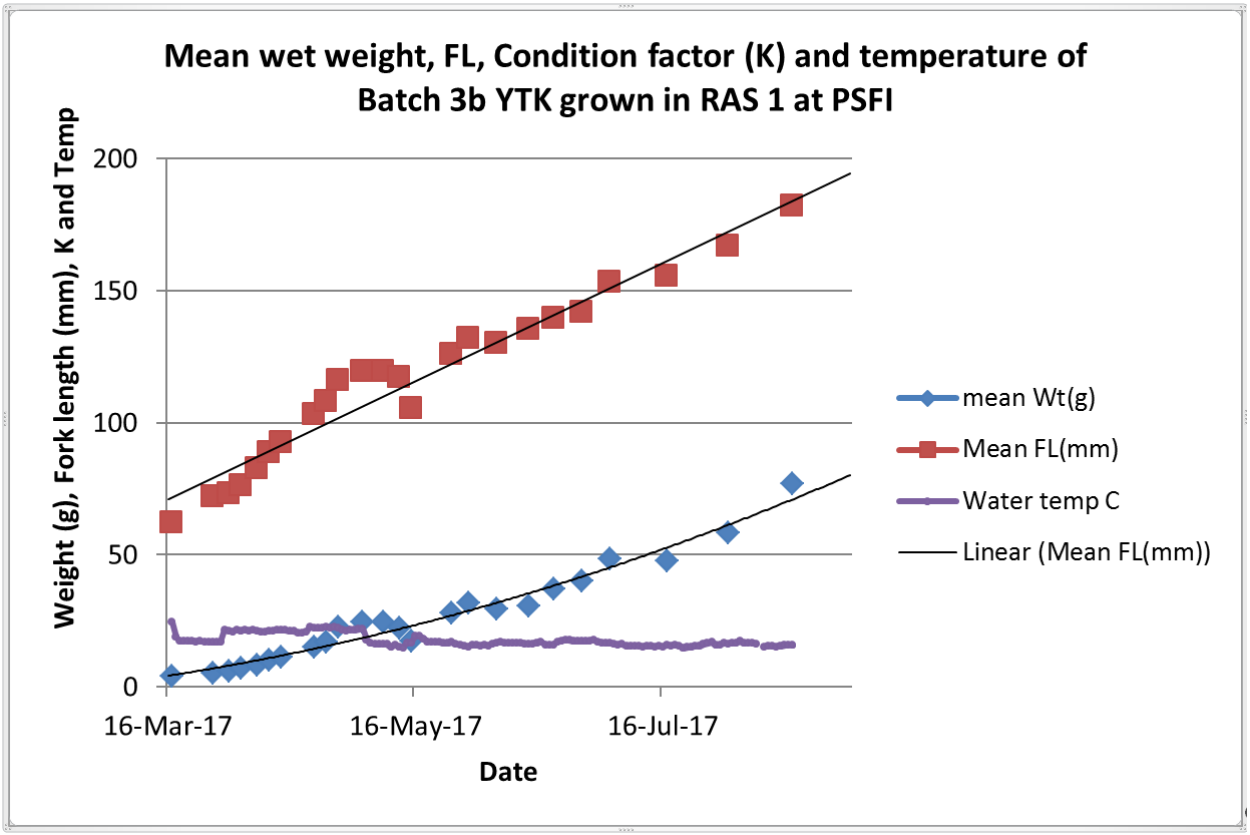


Figure 21: Mean wet weight, Fork length, condition factor and water temperature of Batch 3a YTK (Source: NSW DPI, 2017)

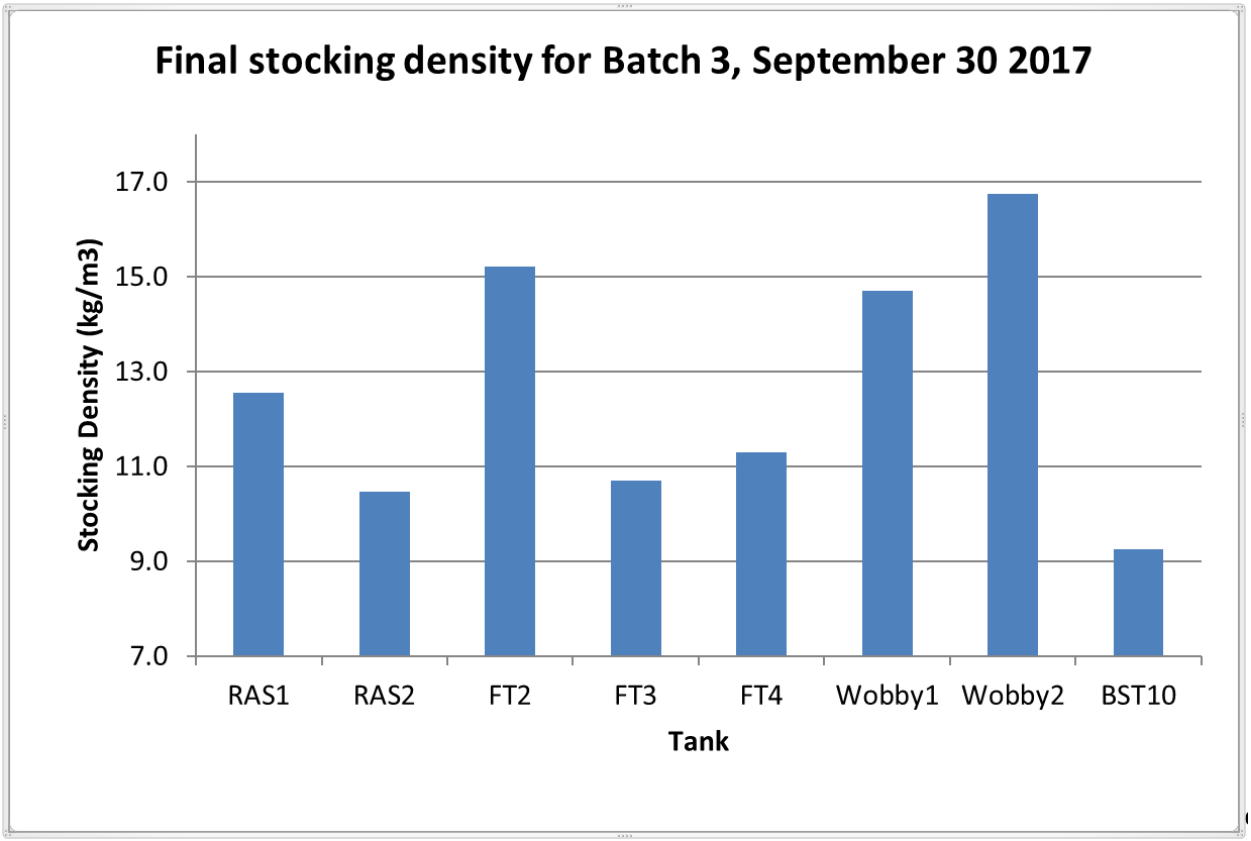


Figure 22: Final stocking density for Batch 3 (Source: NSW DPI, 2017)

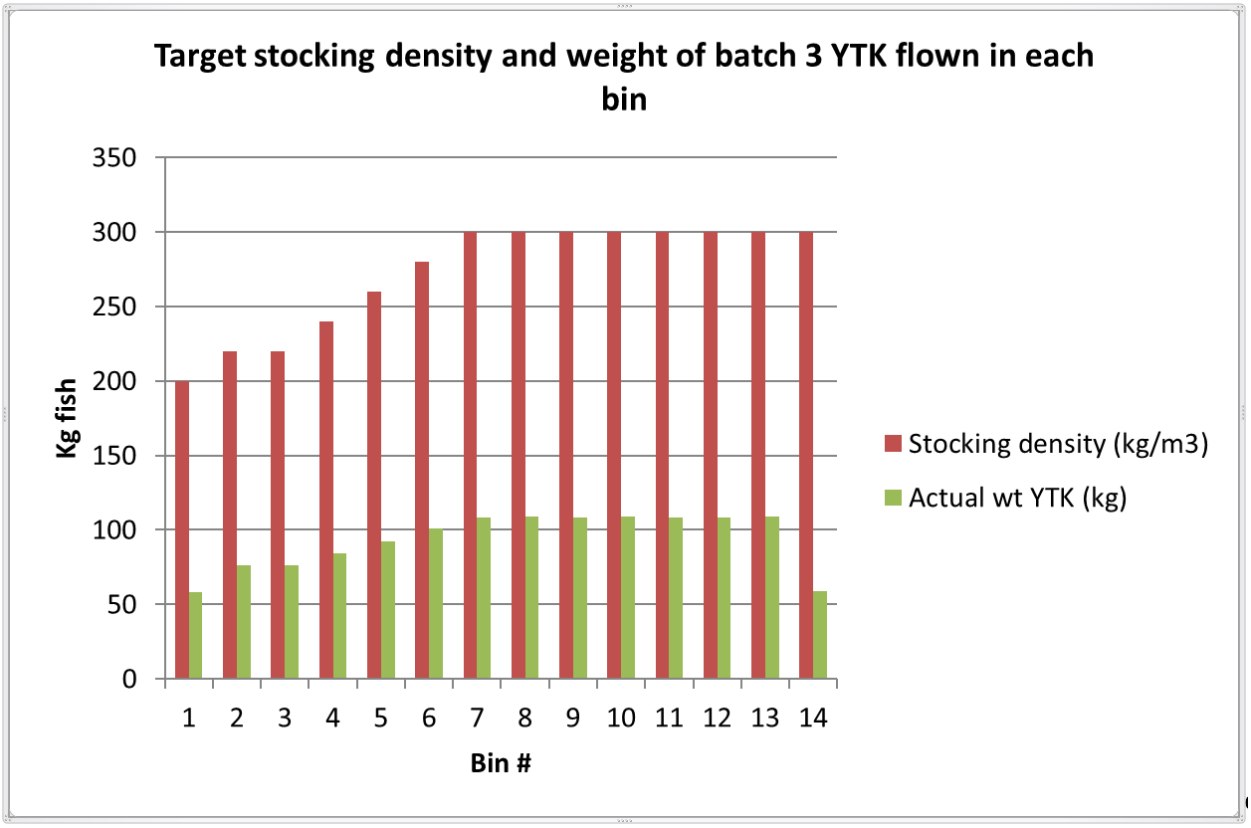


Figure 23: Target stocking and actual density and weight of batch 3 YTK (Source: NSW DPI, 2017)

The aim of experiment four was to continue to evaluate the suitability of a range of RAS and flowthrough tanks for on-growing of advanced juvenile YTK. All of Batch 4 fingerlings were on-grown at PSFI in 15 land-based tanks of varying sizes and consisted of RAS or simple flowthrough design (Figure 23). All tanks were provided with compressed oxygen either delivered via an oxygen saturation cone (RAS 1 and 2) or ceramic diffusers (all other tanks). General husbandry of the fingerlings followed standard operating protocols. Fingerlings were transferred from the hatchery at 32 days post hatch (~0.1g) and then size graded to prevent cannibalism every 2-3 days until fingerlings were 1-2 g. Fingerlings were then allocated to various tanks and the tank biomass reduced by dividing fish as they grew into other empty tanks on an ad hoc basis when water quality (Dissolved oxygen, suspended solids) was deemed to be suboptimal. The fingerlings were held in the nursery tanks for a further 192 days.

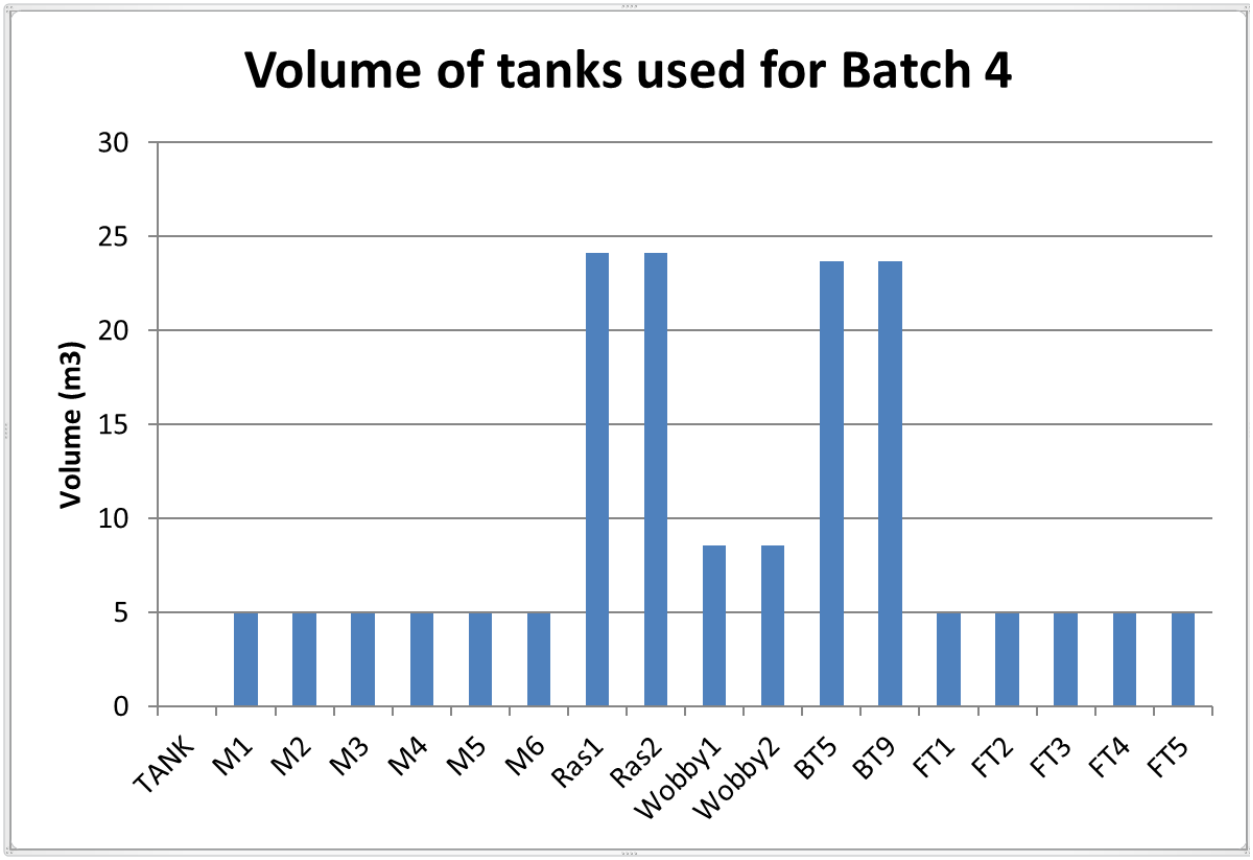


Figure 24: Volume of tanks used for Batch 4 (Source: NSW DPI, 2017)

Results

YTK grew well in all tanks during the 192 day period and reached a final mean weight of 166g/fish representing an AGR of 0.87g/d. As fingerlings increased in size, some fish randomly jumped out of the 4.9m^3 tanks mostly at night. This was stopped with the installation of mesh fence around the top of each tank.

Final stocking density of fingerlings stocked in the tanks ranged from 7.5 kg/m^3 to 25 kg/m^3 and daily feed rates ranged from 0.3 to 0.5 kg feed/m^3/day (Figure 24). Maintenance of high water quality was possible at these stocking densities and feed rates and fingerlings were in excellent condition at harvest from the tanks. Data has been collected on the operating costs of all systems and will be built upon with subsequent trials.

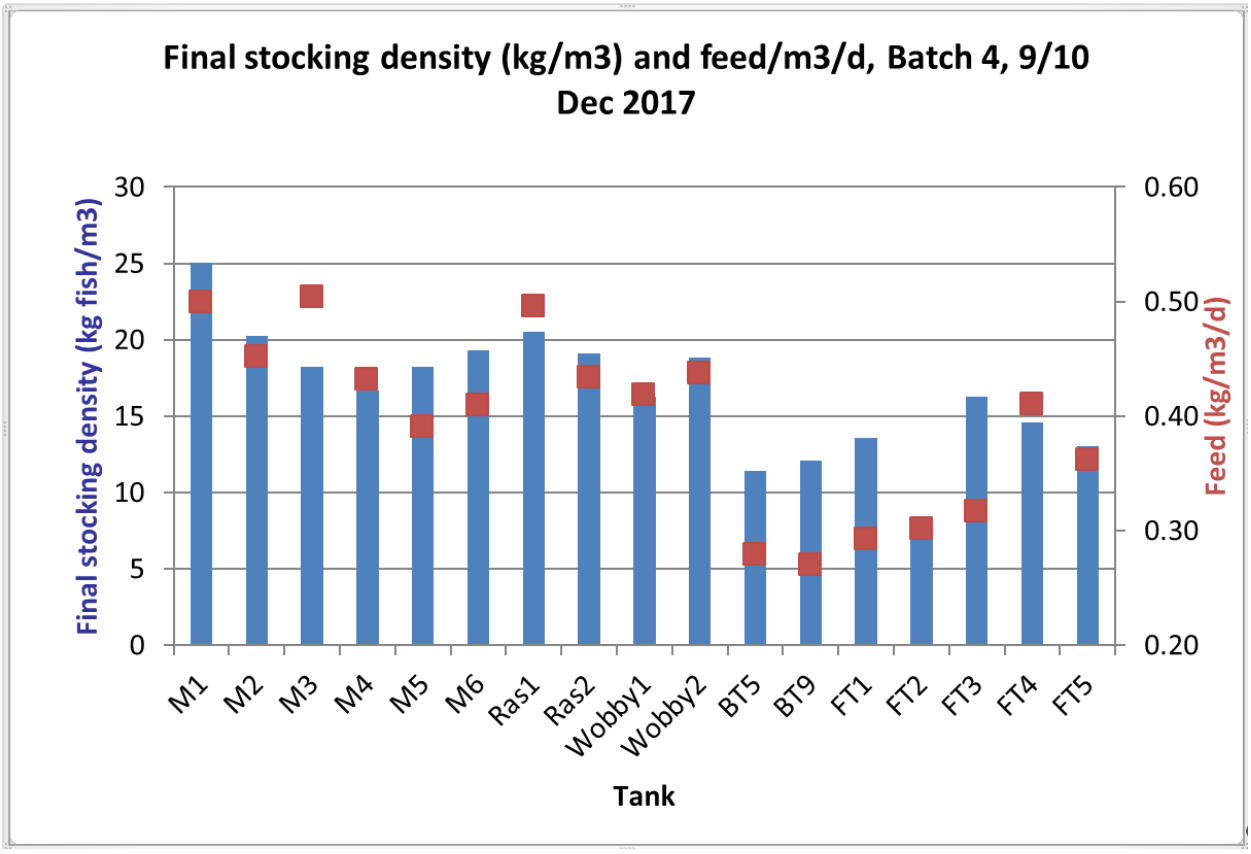


Figure 25: Final stocking density and feed of batch 4 (Source: NSW DPI, 2017)

5.4 Nutritional Research

Determine optimum feed types and feeding strategies that boost reproductive health and outputs from NSW Yellowtail Kingfish brood-stock

Two long-term brood-stock feeding trials have now been completed at PSFI. The first trial lasted over 12 months and determined that the fecundity and egg quality of Yellowtail Kingfish brood-stock was better in fish fed natural marine based foods such as pilchards (sardine) and high quality squid compared to fish fed specialised commercial feed preparations. The second trial lasted over four months and compared the fecundity and health (gut microbiome) of wild and first generation (FI) brood-stock fed either natural food sources (squid and pilchards) or commercial feed pellets. This trial indicated 1) F1 fish sourced from the MARL could be successfully repatriated to the PSFI hatchery and 2) repatriated F1 brood-stock could be successfully maintained on pelletized feeds. The results from these experiments will benefit both industry partners (i.e. Huon Aquaculture and Clean Seas Seafood) in terms of providing new data on better ways to manage their brood-stock and hatcheries. The results will also be used to plan the third and final brood-stock experiment at PSFI.

Effect of diet and feeding regimes on growth and feed utilisation of sub-adult Yellowtail Kingfish

NSW DPI/Huon Research Team has previously reported on the results of two feeding trials with juvenile Yellowtail Kingfish. The first experiment examined the performance of juvenile Yellowtail Kingfish fed a single commercial aquafeed under different feeding strategies at 24°C. The second experiment examined the performance of juvenile Yellowtail Kingfish fed a single commercial aquafeed under different feeding strategies at 16°C. These experiments were complementary in the sense that they used the same diets, the same feeding regimes and similar sized fish. The data collected from the earlier PSFI experiments also complimented research done by SARDI and CSS to optimise feeding frequency in larger YTK (>+1kg) at different water temperatures.

The trials demonstrated that sub-adult fish (150-500g) were comfortable consuming either 6mm or 9mm commercial pellets and that the size of pellet has little impact on growth rate or food conversion ratio (FCR). The studies also indicated that one daily meal, fed to apparent satiation, is sufficient to sustain optimum growth while at the same time subtly improving FCR. These results

have been provided to industry and currently represent best feeding practice for sub-adult Yellowtail Kingfish in controlled conditions such as indoor tank facilities.

One criticism of feeding frequency trials run under controlled conditions is that they do not accurately reflect the practical and logistical problems often faced at the production scale. For example, fluctuations in water temperature and weather conditions often affect the feeding response of fish and the ability of farmers to feed their stock on a daily basis. Of these events, the inability to feed on a daily basis due to inclement weather and safety concerns has the greatest effect on production performance. In our final eight week feeding frequency experiment we test the hypothesis that the performance of Yellowtail Kingfish fed sporadically can be ameliorated by feeding a high specification diet. This was done by formulating a high specification diet (high protein and energy) and a lower specification diet (lower protein and energy) and feeding them to groups of sub-adult Yellowtail Kingfish once daily seven days per week (i.e. best practice regime), five days per week (i.e. economic regime) or randomly (i.e. mimic off-shore conditions at the MARL). The trial has only recently been finished, but it has demonstrated that Yellowtail Kingfish perform better on a higher specification feed, irrespective of feeding frequency. Growth rate and feed efficiency were found to decline in Yellowtail Kingfish that were fed less frequently, whether by design or circumstance. The results indicate that Yellowtail Kingfish are unable to consume enough feed to promote compensatory growth. This trial provides evidence that Yellowtail Kingfish should be fed at least once daily in order to maximise production outcomes.

Refining the growth and bioenergetic model for Yellowtail Kingfish

Bioenergetic models are useful for predicting growth and predicting feed rate at different water temperatures, thereby giving producers a tool by which to benchmark production performance or plan feeding. To date the NSW DPI/Huon Research Team has completed three major experiments with respect to the development of bioenergetic models for Yellowtail Kingfish; one experiment tested the effect of temperature on bioenergetic model coefficients; one tested the effect of oxygen saturation on bioenergetic model coefficients and another determined the critical oxygen threshold of Yellowtail Kingfish. Our final experiment is designed to validate the latest version of the bioenergetic model for Yellowtail Kingfish. The study is being done in research tanks. Ultimately the validation of the model will be extended to the farm environment; however it is critical to validate/adjust the model under controlled conditions before this occurs. The newest version of the model is being tested on sub-adult Yellowtail Kingfish being grown at PSFI in 1000L recirculating aquaculture systems (RAS). One system was operated at 16°C and the other system 23°C. The model is being validated by establishing a series of experimental treatments in which Yellowtail Kingfish are fed a ration predicted by the model (i.e. a prescribed or optimized ration) and compared to the performance of Yellowtail Kingfish fed to appetite. The model is based on optimal growth of Yellowtail Kingfish; therefore if it is reliable, the weight gain of Yellowtail Kingfish fed the optimal ration should be similar to the weight gain of Yellowtail Kingfish fed to appetite, irrespective of feed intake. Similarly, the food conversion of Yellowtail Kingfish fed the optimal ration should be more efficient than fish allowed to eat to appetite. If these hypotheses are grossly incorrect it will demonstrate that the model is unreliable in its present form. If these hypotheses are supported it will indicate the model has merit, albeit minor adjustment of some model parameters may be necessary.

The trial was run during the 2018 summer where extreme ambient air temperatures caused significant temperature fluctuations in the cold water system during the first stages of the trial; however, growth and feed conversion efficiencies of the prescribed ration group were similar to the satiated group, indicating that in cold water the model in its current form is reliable in predicting growth and feed requirements. At 23°C the model was accurate in predicting growth over the first three weeks of the trial; however, the model tended to overestimate growth by the end of the trial.

Further tissue compositional and diet digestibility analyses for this study are pending; however, based on growth and feed intake data the current bioenergetic model for Yellowtail Kingfish can predict growth and feed demand with reasonable accuracy in cool water but overestimates growth and feed demand in warm water. Further refinement of the growth model in warm water is therefore warranted. Data generated from these studies will be used to improve feed models for

Yellowtail Kingfish facilitating better feed management and feed formulation through a better understanding of nutrient requirements and therefore dietary specifications for Yellowtail Kingfish.

Determine taurine requirements of sub-adult Yellowtail Kingfish

Taurine is a conditionally essential nutrient which is added to commercial aquafeeds for Yellowtail Kingfish at a rate of about 10g kg^{-1} diet. No published study exists in Australia with respect to the quantitative taurine requirements of Yellowtail Kingfish, however several studies have emerged recently that attempt to define the requirement for taurine in feeds containing high levels of soy product. These types of feeds are generally not used in Australia. In addition, no study has been published that defines the sparing effect of supplemental methionine on the taurine requirement of Yellowtail Kingfish.

This experiment has successfully determined the taurine requirement of rapidly growing juvenile Yellowtail Kingfish reared at or near to their optimal water temperature (i.e. 23˚C). The results demonstrate that the growth rate of Yellowtail Kingfish is highly dependent on the dietary taurine level and that methionine is able to spare dietary taurine when it is provided in excess of current industry standards. Further PhD research is being done by Ms Caroline Candebat on samples generated from this experiment with the hope of gaining a greater knowledge of taurine metabolism in Yellowtail Kingfish and its relationship to precursor amino acids such as methionine and cysteine as well as investigations of liver health, bile and cholesterol production. The results of this experiment have provided the Yellowtail Kingfish industry with hitherto unknown data on the taurine requirement of Australian grown Yellowtail Kingfish.

Establishing the optimal dietary methionine requirement of juvenile Yellowtail Kingfish in the presence of low and high levels of cysteine.

The aim of this experiment is to identify the dietary methionine requirement of juvenile Yellowtail Kingfish in the presence of a low or higher level of dietary cysteine. The design of this trial is factorial in nature and based largely on the successful design used in the preceding taurine experiment. As for the taurine experiment we have used, as far as possible, commercially available raw materials to formulate the experimental feeds (at the request of industry partners and feed companies). This constraint makes it difficult to formulate diets with negligible amounts of methionine and cysteine desirable for use in requirement studies. However, most commercial feeds produced in Australia are generally based on a suite of raw materials that when combined provide a minimum amount of cysteine (e.g. approximately ≥ 0.6% of diet). As such the lowest dietary concentration for cysteine possible in this experiment was also 0.6% of the diet. The upper dietary level of cysteine was set at 1.80% of the diet to ensure there was enough cysteine to augment diets containing the lowest levels of methionine. This should allow the sparing effect of cysteine to be observed if it occurs. Dietary methionine concentration of test diets was reduced to a minimum of 0.88% of diet under our formulation constraints. This concentration is 20% lower than the lowest methionine concentration recorded in the preceding taurine experiment (i.e. ≈ 1.10%). Dietary methionine content of test diets in this experiment has been increased in five increments (i.e. 0.88, 1.41. 1.94, 2.47 & 3.00% of diet). The practical part of this experiment has been completed and samples have been submitted for chemical testing. The results, once available, will be used to recommend suitable levels of methionine and cysteine to Yellowtail Kingfish feed producers and farmers.

Use of prebiotic and probiotic supplements in diets for Yellowtail Kingfish; impacts on immune response, gut health and digestibility.

The interest in the use of prebiotics and probiotics in aquaculture is increasing. The nomenclature surrounding these terms varies somewhat, but generally prebiotics are considered to be indigestible fibres which enhance beneficial gut bacteria resulting in improved health of the host. The benefits from use of prebiotics stem from the by-products derived or produced from the fermentation of the prebiotic substrate by intestinal bacteria. The fermentation process can also enhance colonies of commensal probiotic bacteria. Generally, probiotics are considered to be living microorganisms that can be ingested orally which lead to health benefits. Probiotics are live bacteria that exist in sufficient numbers, either due to ingestion or subsequent proliferation, which

change the gut microflora of the host exerting beneficial health effects. The beneficial impacts on health manifest in a variety of ways including increases in growth, increased digestibility and upregulated immune response leading to increased resistance to stress and some diseases.

A recent study on Yellowtail Kingfish explored the nutraceutical effect of grape seed extract for its potential to reduce the symptoms of sub-acute enteritis induced by feeding Yellowtail Kingfish on diets containing 30% soybean meal at low water temperature. Unfortunately, inclusion of grape seed extract at 20 or 40mg kg^{-1} of the diet did not reduce the symptoms of sub-acute enteritis or positively affect growth or FCR. Nonetheless, sub-acute enteritis or similar gut-related conditions in farmed Yellowtail Kingfish fed commercial feeds containing plant proteins may be ameliorated by the use of other prebiotics or probiotics commonly used in many intensive animal production sectors. For this reason the aim of the present study was to screen several commercially available prebiotic and probiotic sources for use in commercial feeds for Yellowtail Kingfish in the expectation they may 1) increase feed intake, growth performance, feed efficiency and digestibility and 2) improve gut health and immune response, ultimately increasing the animals potential to combat stress and disease.

The commercially available prebiotic and probiotic products evaluated in this experiment are: brewer's yeast; inulin powder; Protexin® powder; Pro(N8)ure®-IFS powder. These products are also commonly used in other animal farming industries. This trial has been stocked and is due to be harvested at the end of October 2018.

Field evaluation of feeds, feeding models and feeding strategies for juvenile and sub-adult YTK.

The original objective of this experiment was to evaluate new state of the art feeds, feeding strategies and feeding models for Yellowtail Kingfish developed as a result of the research conducted by the NSW DPI/Huon Research Team during the project. The experiments were to be run under practical off-shore farming conditions at the MARL; however events beyond the control of the NSW DPI/Huon Research Team have prevented the experiments proceeding at this location. Consequently, the experiments have been translocated to PSFI where they will be conducted in a large scale, 0.5ML outdoor research pond. The 0.5ML pond has been fitted with a floating pontoon and 12 x 3.5m^3 rearing pens. Pens are aerated with dissolved oxygen and covered with nets to prevent the escape of fish or predation of fish by birds. Apart from oxygen other water quality variables fluctuate with ambient conditions. Yellowtail Kingfish were stocked into pens when they reached 70-90g body weight. The basic aims and design of each trial is presented below. The trials will be completed in early December 2018.

PSFI Pond experiment #1

This six pen field based experiment was stocked at the beginning of August and is tracking well. It is designed to evaluate performance of juvenile Yellowtail Kingfish fed a very low fishmeal diet (15%). The low fishmeal diet and a control (i.e. higher fishmeal level) were formulated based on new or confirmed values for taurine and methionine and data on the digestibility of common raw materials. Feeding strategies adopted in this experiment are based on the most successful strategies identified from earlier experiments at PSFI. The trial is planned to run for approximately 4 months and should conclude in December 2018. An adjunct experiment will be run during this period to determine the digestibility of the diets. In addition, the results will be compared theoretically to our improved bioenergetic model to assess its validity.

PSFI Pond experiment #2

This six pen field-based trial was stocked in the first week of September and will be run until early December 2018. The experiment is designed to evaluate the performance of juvenile Yellowtail Kingfish fed diets that completely replace prime quality, wild-captured fishmeal with reclaimed fishmeal. As for the first pond trial, we have incorporated new information on the nutrition of Yellowtail Kingfish into the formulations and have based the feeding regime on successful strategies identified from earlier experiments. We will also conduct an adjunct experiment to determine the digestibility of the diets in this study and the growth results will be compared theoretically to our improved bioenergetic model.

Figure 26: Yellowtail Kingfish nutrition research trials being conducted in outdoor ponds at PSFI (photos courtesy of Mark Booth; NSW DPI 2018).

Student engagement and outputs

The NSW DPI/Huon Research Team K4P project is supporting three PhD students. These students are Ms Angela Liu (UNSW), Ms Dam Thi My Chinh (USC) and Ms Caroline Candebat (JCU). Each student has been working closely with researchers at PSFI over the last two years and each will make significant contributions to the body of research generated by the project. Ms Liu is focusing on the choline requirements of Yellowtail Kingfish, Ms Chinh is focusing on the digestibility of alternative raw materials and their impact on gut health of Yellowtail Kingfish while Ms Candebat is focusing on taurine and methionine metabolism in Yellowtail Kingfish. Ms Liu and Ms Candebat recently travelled to the 2018 International Symposium on Fish Nutrition & Feeding which was held in Gran Canarias, Spain. Ms Liu presented a conference poster on choline and Ms Candebat was selected for an oral presentation for research on taurine. The travel was funded by the K4P project and formed part of the student's professional development activities. Ms Candebat was awarded a student prize for her presentation and interviewed by FRDC on her return to Australia. Each student is now finalising their practical work, developing their theses and working towards publishing their research in quality peer reviewed journals. Ms Chinh is planning to present her research papers at an international microbiome conference in America in 2019.

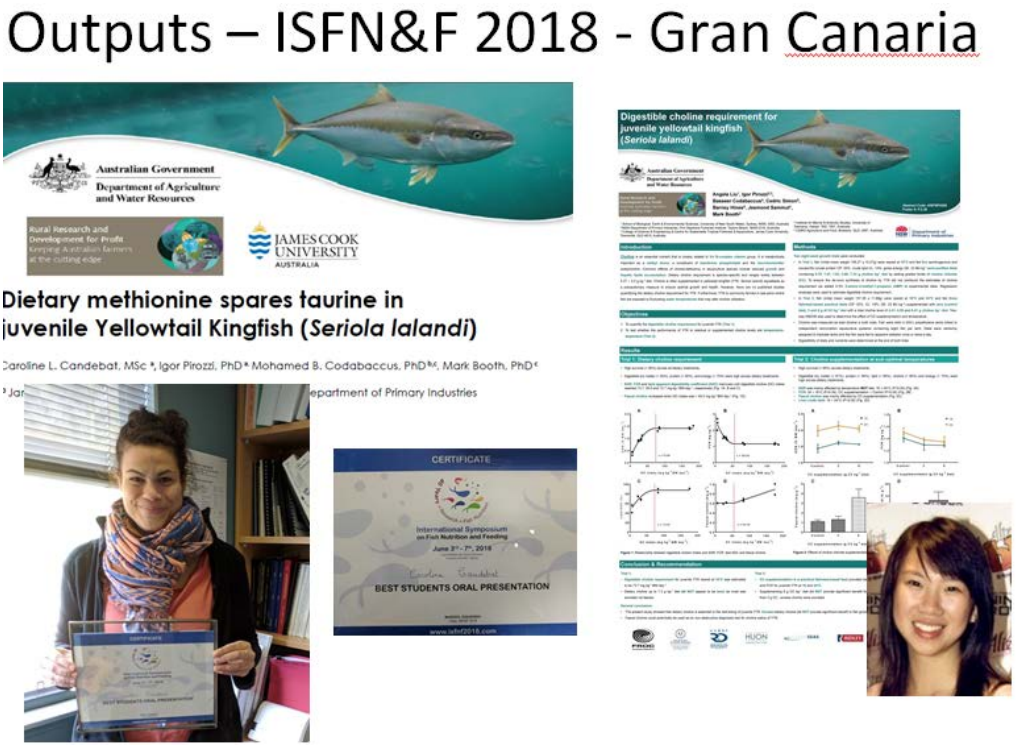


Figure 27: Students attending the 2018 ISFN&F, Gran Canarias, Spain. (Source: NSW DPI 2018)

Research partners

This project is supported by funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit Programme, the Fisheries Research and Development Corporation (FRDC), South Australian Research and Development Institute (SARDI), Clean Seas Seafood, Department of Primary Industries New South Wales (DPI NSW) and Huon Aquaculture. Ridley and Skretting Australia have also contributed actively to the project through the input of technical information and the manufacture of experimental feeds.

6 Monitoring

6.1 Water Quality and Benthic Monitoring Program

The Water Quality and Benthic Environment Monitoring Program has been implemented by NSW DPI/Huon Research Team to assess and mitigate potential impacts from the operation and is consistent with consent conditions issued under SSI-5518 MOD 1.

The Program includes monitoring of: water quality (temperature, salinity, oxygen, pH, Chlorophyll α and concentrations of nitrogen and phosphorus); biological changes (macrobenthic invertebrates, i.e. worms and crustaceans larger than 1 mm); chemical changes (the composition of elements in the seafloor); and physical changes (the particle size of sediment and video footage) (Figure 30).

Figure 28: Core Sample equipment used during the Water Quality and Benthic Environment Monitoring Program. (Source: Huon, 2017)

Samples and video footage are taken from under the sea pens, on the outside edge of the MARL (compliance sites) and at three locations away from the MARL in Providence Bay (control sites).

The first or Baseline survey event for the Water Quality and Benthic Environment Monitoring Program was conducted by Aquaculture, Management and Development Pty Ltd (AMD) and the University of Newcastle between the 1st and 7th September 2016.

The Baseline survey is intended to provide pre-farming measurements of the range of variables that have been approved in order to assess the environmental performance of the sea pens. The results from future sampling events within and around the MARL will be referenced against both this baseline data and the data collected concurrently at the control sites. The data collected will be subject to seasonal differences and therefore some of the ongoing monitoring has to be planned for the same time of year.

The second sampling event (Update 1) for the Water Quality and Benthic Environment Monitoring Program was conducted by AMD and the University of Newcastle between the 17th and 20th April 2017.

The third sampling event (update 2) for the Water Quality and Benthic Environment Monitoring Program was conducted by AMD and the University of Newcastle between the 13th and 24th September 2017.

The fourth sampling event (update 3) for the Water Quality and Benthic Environment Monitoring Program was conducted by AMD and the University of Newcastle between the 15th and 22nd September 2018.

Additional water samples were collected monthly by Huon to improve baseline data as fish grow and help build a stronger picture of the effects of the operation of the MARL. The number of monitoring samples taken and analysed to date is greater than consent condition requirements.

Quadruplicate samples have been collected from pen sites (S3 & S4), control sites (C1 & C2), and at 35 m deep compliance sites (S1, S2, S5 & S6) at which ROV spot dives have also been undertaken (Figure 30).

NSW DPI/Huon Research Team has positioned one grid on the lease which can carry up to six sea pens. The first sampling event occurred prior to fish farming activities while the second sampling event occurred following two pens being stocked with YTK with a standing biomass of 50 tonne. The third sampling event occurred prior to the third pen being stocked with YTK with a standing biomass of 130 tonnes. The fourth sampling event occurred while the lease was destocked with fish being harvested out by the end of June 2018.

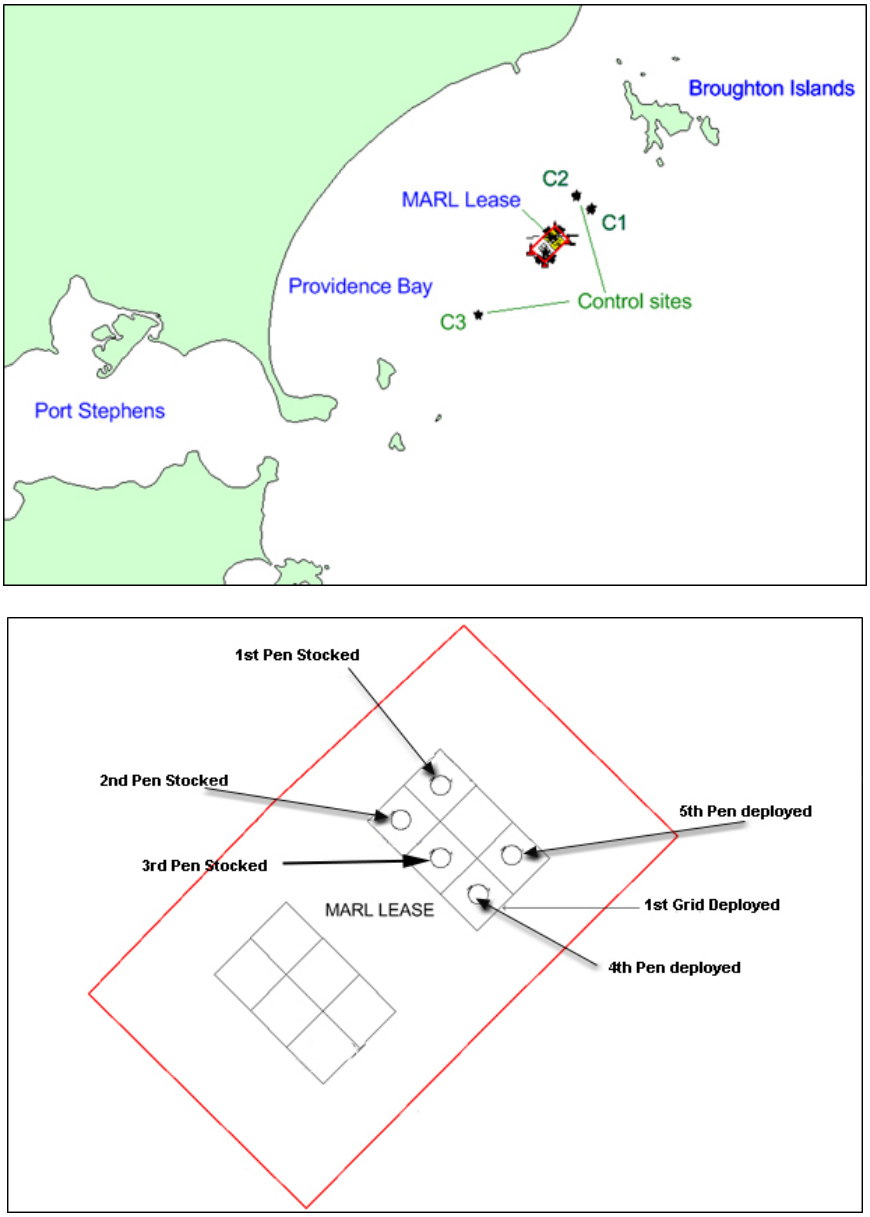


Figure 29: Location and survey sampling sites within Providence Bay and the MARL Note: Red rectangle – lease boundary (Source: AMD, 2016).

6.1.1 Water Quality Monitoring

Dissolved oxygen (DO), pH, salinity and temperature data in the water column were measured using an YSI 6820 model Sonde and a YSI Pro ODO Digital Optical Dissolved Oxygen Meter. The meters measured from the water's surface down to 1-2 m above the seafloor. Chlorophyll α and nutrient samples were collected by hand dipping the sample bottles into the surface water and using a Niskin bottle with graduated cord to collect samples just above the seafloor.

Update Survey 2

The Final Update 2 Survey Report is available on Huon website (https://www.huonaqua.com.au/about/portstephens/environmental-monitoring/), and the results are summarised below:

Results

DO (% saturation) ranged between 104-107% at the surface, decreasing down through the water column to 82-90% at the seafloor for most sites, except C1 (96%) and C3 this being the shallowest site at 98% saturation at 30m depth. These DO levels are more variable than those measured for the same sites in the Baseline survey with surface DO higher and seafloor DO lower than for Baseline.

Water temperatures were also more variable than for the Baseline survey with temperatures ranging from 19.5^{o}C to 19.9^{o}C at the surface for all sites to 17.2^{o}C to 18°C for most sites at close to the seafloor. Again C1 (18.5^{o}C) and C3 (18.8^{o}C) were slightly higher than the other sites at the seafloor. Salinity was also highly consistent and >35 parts per thousand for all depths at all sites.

Nitrate+nitrite (NOx) and dissolved reactive phosphorus (DRP) levels were consistently higher at the seafloor compared to the surface, all nitrate+nitrite readings being at or below the limit of reporting, i.e. 0.002mg/L at the surface, and <0.003-0.082mg/L at the seafloor. Dissolved reactive phosphorus ranged between 0.005-0.008mg/L at the surface and 0.005-0.017mg/L at the seafloor.

Kjeldahl Nitrogen, Total Nitrogen and Total Phosphorus readings generally showed little difference between the surface and the seafloor across sites, with Kjeldahl Nitrogen ranging from 0.29-0.37mg/L, Total Nitrogen ranging from 0.29-0.41mg/L and Total Phosphorus ranging from 0.03-0.05mg/L. Ammonia levels were also generally similar between the depths and across the sites (range of 0.004-0.013mg/L) except for the pen site (S3), where there was a spike in Ammonia of 0.024mg/L.

These results are higher than for the Baseline survey except for: Nitrate+nitrite at the surface, and, a small increase in ammonia (when compared to other sites) registered at the surface for the S3/PB01 site. But all lie within the broad scale environmental range for the region.

Huon Aquaculture is presently also undertaking in-house monthly samples for nutrient water quality across a reduced range of sites (C1, C3, S1, S2) in order to establish or develop suitable local guideline levels. When compared to the monthly results, surface ammonia levels for S3 are also slightly elevated above the range demonstrated by those control and compliance sites. Seafloor nitrate levels in the current survey are shown to be well within the range experienced through the monthly monitoring program.

Across all sites, Chlorophyll α levels ranged from <0.2-0.65µg/L. Mean levels did not differ greatly between surface (0.37 µg/L) and seafloor (0.40 µg/L) sites.

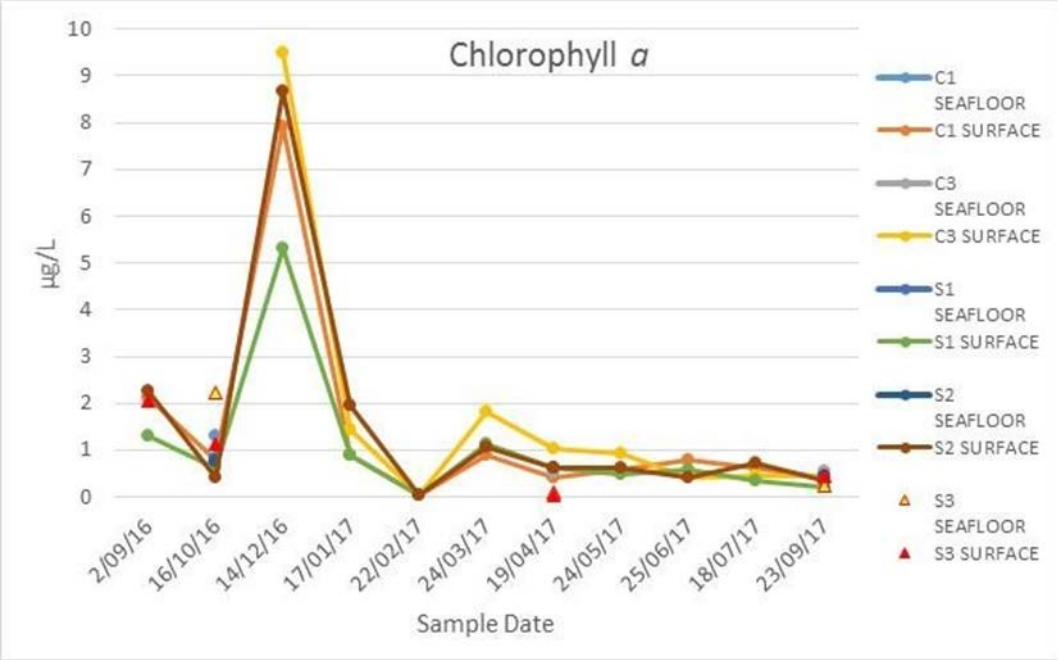


Figure 30: Monthly Chlorophyll α levels at sites C1, C3, S1 and S2 (Source: AMD, 2017)

Interpretation

Water Quality monitoring is included as part of the survey programme primarily in order to; define the baseline concentrations for these variables on a seasonal basis for Providence Bay, and to detect if there are any measurable changes/differences in these water quality variables around the fish farm, and if so at what distances from the farm these differences might be detected.

Baseline characteristics and Seasonality of the water quality variables is being addressed through the monthly sampling surveys (with 12 months of data available), and from the Baseline, Update 1 and Update 2 surveys. From the data presented above and Table six below, the following broad trends are suggested:

1. Oxygen saturation levels can decrease in this region by as much as 20% from the surface to seafloor at certain times of the year.
2. Dissolved nutrient levels Nitrate+nitrite and dissolved reactive phosphorus (FRP-Table 6) differ markedly between the seafloor and the surface samples. For the other nutrient categories there was a slight increase in levels at the seafloor compared to surface values.
3. At control and compliance sites both Nitrate+nitrite (seafloor) and Total Nitrogen (seafloor and surface) levels greatly exceed, and Total Phosphorus (seafloor and surface) and Chlorophyll α (surface) levels slightly exceed the ANZECC 2000 trigger levels, confirming a need to establish or develop suitable local guideline levels (as suggested by the Baseline survey results) for Providence Bay.
4. The monthly data suggests that there is an ingress of nitrate rich waters in Providence Bay during the summer months, which may be linked to higher productivity as evidenced by the Chlorophyll α levels in December 2016 (Figure 29). Results for the present survey suggest that this increase can start in early spring.

Update 2 survey occurred when MARL had a standing biomass of approximately 130 tonnes of YTK, with the additional expectation that this would happen approximately 12 months after the Baseline survey, thereby eliminating seasonal effects in any comparison between the Baseline and present Update 2 surveys.

Despite some seasonal variation suggested by the monthly data, the only observed increase at the pen site is the slight increase in surface ammonia level, noting that compliance sites remained at the same levels or lower than the control sites. All other nutrient, chlorophyll α and physical/chemical water data do not yet show any upwards trend at the pen site or elsewhere around the farm.

Of interest for the future management of the farm may be the observation that oxygen saturation levels can vary in the midwater depth between the southern and northern end of the lease.

Table 7: Nutrient and Chlorophyll α levels from control and compliance sites compared against ANZECC Trigger levels (2000) (Source: AMD, 2017).

			ALL SURVEYS (COMPLIANCE AND CONTROLS ONLY)			
Parameter	Unit	ANZECC Trigger level 2000	Control sites Surface Mean	Control sites Seafloor Mean	Compliance sites Surface Mean	Compliance sites Seafloor Mean
NH4-N	µg/L	20#	7	9	6	8
NOx-N	µg/L	25#	6	42	6	49
Tot N	µg/L	120	267	301	267	297
FRP	µg/L	10	5	10	5	11
Tot P	µg/L	25	28	30	27	35
Chl *a*	µg/L	1	1.58	0.62	1.31	0.61

- From ANZECC - NSW elevated levels due to frequent upwelling events

6.1.2 Seabed Remote Operating Surveys

Update Survey 2

The appearance of the seabed in the vicinity of the MARL was recorded by filming spot dives of the sea floor using a VideoRay Remote Observation Vehicle (ROV).

All sites shared the common features of medium to coarse rippled sand, some shell grit and old shells, with a depauperate fauna. There were very occasional Pennatulaceans (Cnidaria), juvenile Flathead and a Stingaree, brittle stars (ophiuroid), hermit crabs and ribbon worms; observed at only one or two sites. There was no further evidence for the dark grey rounded 'globules' present at S1.1 site in the Baseline survey. The present survey again shows that light coloured amorphous (possibly sand) accretions/globules are widely distributed with evidence for them at a number of sites (e.g., S4, S5, S6 & C3).

The pen sites (PB01 & PB04) showed some slight differences to the rest of the sites as might be expected. These differences were restricted to the presence of dislodged shell debris below the pen, e.g., dead *Megabalanus coccopoma* barnacles (shells only).

Drift algae was abundant at nearly all sites, except C3, where only a few sparse and old pieces of plant material were observed. There appeared to be a density gradient of drift algae in general from northern (most dense) to southern sites as observed during Baseline survey.

Update 2 Survey

Video footage of the ROV results is available on Huon Aquaculture's website. See MARL Benthic monitoring

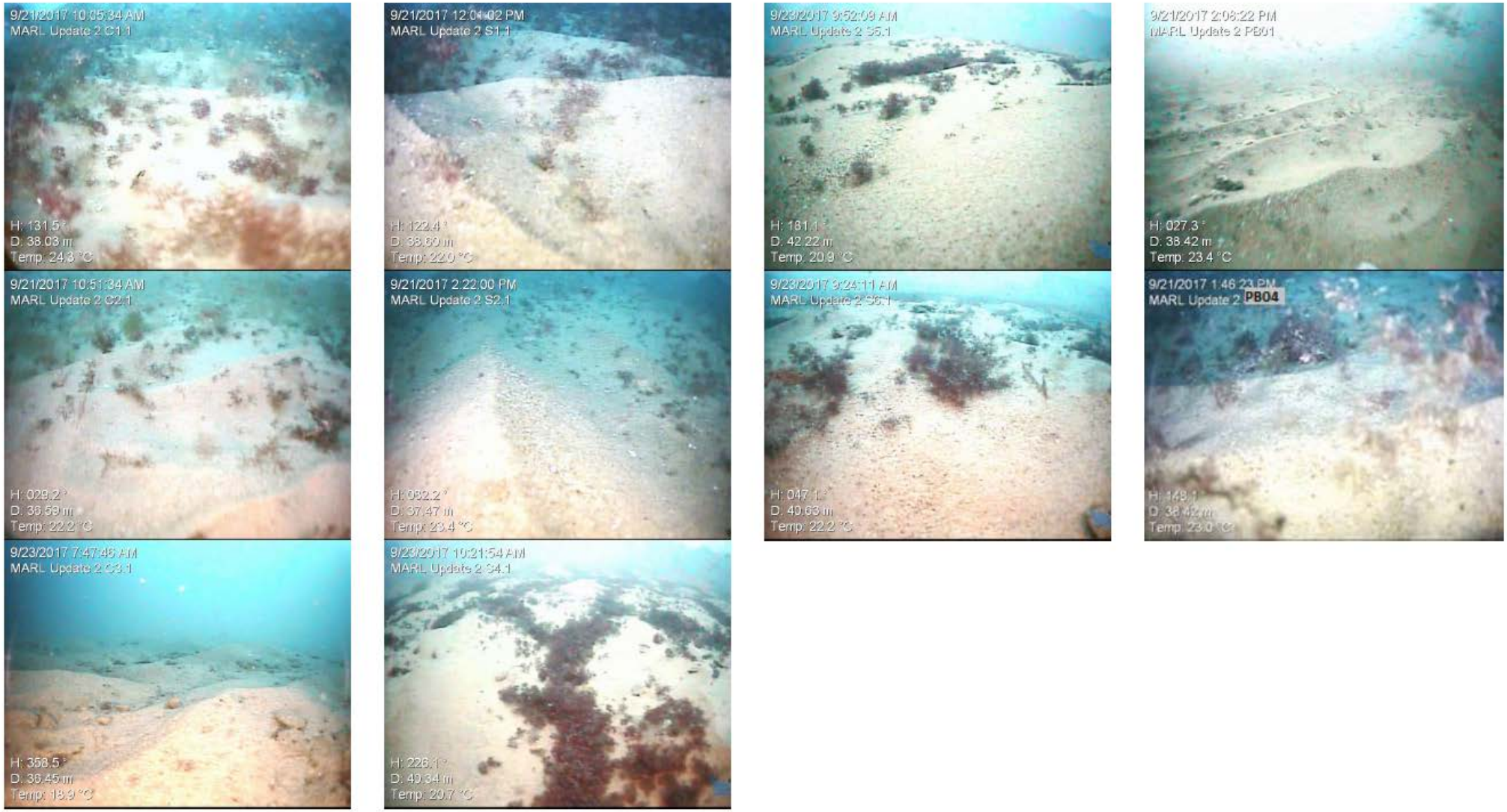


Figure 31: Screenshots of ROV footage from all sites during Update 2 Survey highlighting the presence of drift algae.

6.1.3. Macrobenthic Invertebrate Monitoring Program

Macroinvertebrates were collected at each of the eight sampling sites, using a Van Veen grab (see Figure 31) which sampled a 0.07 m^2 area of seabed. Four replicate grab samples were collected at each of the control (C1 and C2 and C3), pen (S3 and S4) and compliance (S1, S2, S5 and S6) sites, with a total of 36 grabs collected.

The number of benthic macroinvertebrates at the nine sites of Update 2 Survey were similar to that recorded in baseline and was far less than recorded in Update 1 Survey. This is most probably related to seasonal changes in small crustaceans.

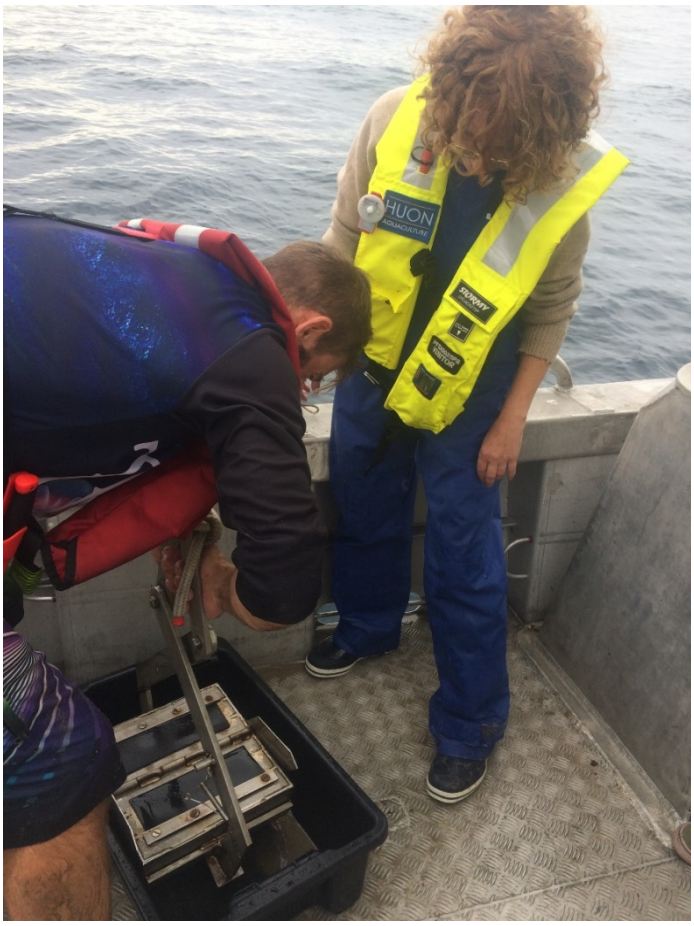


Figure 32: University of Newcastle collecting sediment samples using a Van Veen grab (Source: Huon, 2018).

Update 2 Survey

A total of 3210 benthic macroinvertebrates were recorded, representing a total of 32 broad-scale taxa (including 11 phyla) and, collectively within the polychaetes, molluscs and decapod crustacean over 20 families. Some of the families caught in previous surveys were not obtained, and these were typically represented in low numbers of individuals in other surveys (except for opheliid polychaetes). Of the newly-sampled families, these included single individuals of a polychaete (cf. Heterospionidae) and one crustacean (Penaeidae). Thirty-seven small dorvilleid polychaetes were recorded, with most of these being represented at C2, possibly due to unusual sediments present at that site during survey. For comparison, 19 dorvilleids were obtained over all sites in the Update 1 Survey, while just one was recorded in the Baseline Survey. As for Baseline, there were very few capitellid polychaetes. Caprellid amphipods were found again in low numbers, i.e. one or two at each of the sites, but which was greater than the total three found in Update 1 Survey. The Phylum Chordata was also represented, but not included in subsequent analyses, with three small teleosts being obtained at two sites, i.e. an ophichthyid (sand eel) at c2, and a pleuronectid (flounder) and platycephalid (flathead) at S3.

In terms of abundance, the benthic macroinvertebrate was again dominated by crustaceans (70%), especially amphipods (40%) and tanaids (14%), with polychaetes (13%, esp spionids) and molluscs (nearly 4%, esp. tellinid bivalves and marginellid gastropods) making smaller contributions to the overall numbers. It is noted that tanaids, and particularly the very small, tube-

dwellers were far less abundant than in the Update 1 Survey. Of the larger decapod crustacenas, diogenids (hermit crabs) and pasaipheids (shrimps) were the most abundant in Update 2.

Conclusion

Based on the above faunal patterns for Update 2 Survey, it is evident that S3, the pen site, does not show an obvious difference when compared to the northern control and compliance sites, when taking into account both broad-scale and family-level comparisons. This is similar to that in Baseline, i.e. before the fish were introduced into the pens (AMD, 2016), but contrasts with that found in Update 1, carried out in April of 2017 (AMD, 2017). In this latter survey, the benthic macroinvertebrate composition at S3 was showing differences, which reflected increased numbers overall and of particular taxa such as ostracods and gastropods (esp. buccinids) at the pen site. At the time, this difference was considered likely to reflect the increased organic input (fish food and faeces) from farm operations. However, given now that the pens have been stocked for a further five months, with these fish having being fed continually since that time, and presumably with more faecal and feed deposition, it is likely that some other factor is responsible for the present lack of obvious difference. It is also possible that the conclusion regarding Update 1 Survey in AMD (2017) may have been confounded with the Baseline and Update 1 surveys having occurred at contrasting times of year, i.e. spring vs autumn. It is worth noting that, when comparing the macroinvertebrate composition at the family level for the three surveys together, the centroid for S3 in Update 2 Survey does not fall within the large group of samples from other surveys and sites, implying that there is at least some level of change at this site in the Update 2 Survey.

From the results of Update 2 Survey, it is now considered likely that either the heavy wave action or recent net cleaning operations, which acted to remove fouling communities from the stocked sea pen to the seabed below and thus contributed to the difference between S3 and other sites in Update Survey 1, has not occurred in the present survey. Recall in Update 1 that large fragments of *M. coccopoma* colonies were observed, with one individual at least still being alive (AMD, 2017 and video footage from that survey) and anoxic sand, presumably from decomposition of those fragments, was also observed. In this Update 2 Survey, no anoxic sand and only small remnants of *M. coccopoma* colonies were obtained at S3 (also supported by results of ROV in the present study), and there were very small and weathered remnants at 2 of the sites at nearby C1. This conclusion that wave action/net cleaning resulting in fouling community deposition to the seafloor and thus influences the environment is consistent with work elsewhere, see e.g. Edgar et al. (2010). It is recommended that information around the extent of wave action/processes and timing of net cleaning operations be obtained and used to investigate further these apparent effects on the seabed. In the present survey, *M. coccopoma* fragments were detected for the first time in C1, which lies close to S3, and which indicates that dynamic processes are redistributing these fragments away from the stocked sea pen. These remnants were small and sparsely distributed, and the faunal composition of C1 did not show any notable differences. However, the dynamic processes that are present in the study area, which clearly involve sediment movement around the broader area, could also imply that effects from the stocked sea pens may be relatively diffuse and thus possibly underestimated using a straightforward sea pen versus compliance versus control site comparison.

The number of benthic macroinvertebrates at the nine sites of Update 2 Survey (3213) were similar to that recorded in the Baseline, which did not include sampling for C3 (2704) and was far less than the 7631 recorded five months previously in Update 1 Survey (AMD, 2017). This is most probably related to the seasonal increases in tanaids and other crustaceans during autumn 2017 (Update 1 Survey) in comparison to spring in 2016 and 2017 (Baseline and Update 2 Survey). These marked changes in overall numbers of invertebrates and their community compositions between time of year also raises the question as to the best timing for future comparisons of possible effects of the MARL.

Comparisons of the community composition of the benthic macroinvertebrates from the Update 2 survey with those of both Baseline and Update 1 surveys at both a broad and family scale, found overall significant differences between the three surveys. These differences were most marked

between Update 2 vs the other two surveys, but also emphasised the substantial variation between sites in each of the survey periods.

6.1.4 Substrate Monitoring Program

Sediment samples for substrate analysis were collected using a Core sample (Figure 27).

Update 2 Survey

All sites have mean sediment redox values above 240mV. The observed high redox values are indicative of well oxygenated, unimpacted sediments (Macleod & Forbes, 2004) and it would appear that whatever impacted S1 since the baseline survey and S3 in the previous survey has now dissipated or was highly localised.

Sulphide concentration in sediments was well below detection. The observed sulphide concentrations presently, suggest there to be no significant evidence of organic enrichment (Macleod & Forbes, 2004).

Surface sediments were taken from the grab samples provided for the faunal analysis

Apart from C2, all sediments sampled across the area were dominated by medium sand fractions with the great majority of sediments (>50% at each site) being in the 0.25 and 0.5mm size classes. The sediments were clean with a very low proportion of mud fractions (i.e. < 0.063mm). The mean grain size across all of these sites was within a narrow range with a trend of increasing mean grain size from north to south across the survey area as was also identified during the Baseline and Update 1 surveys, and there were no site specific differences identified since Baseline survey.

The patterns of particle size distribution for all sites were indicative of a sedimentary environment with moderate agitation of seabed sediments and associated low abundance of fine silt and clay fractions. These patterns are considered typical of sediments in deep (i.e. >20m) and exposed locations. The overall similarity in particle size distribution between the majority of sites implies similar depositional environments.

As for both previous surveys, the organic content was very low for all samples, ranging from <0.04% to 0.18% with an average of 0.07% across all samples. Total organic carbon (TOC) levels would appear to be slightly higher in the northern end of the survey area than the south as shown by higher levels at C1, C2 and S1. There would appear to be no significant increase in TOC levels at the pen site (S3) since Baseline. A comparison of the results from all three surveys (Figure 32) shows the relative decrease in organic content at sites C1 and S1 between this and the previous surveys.

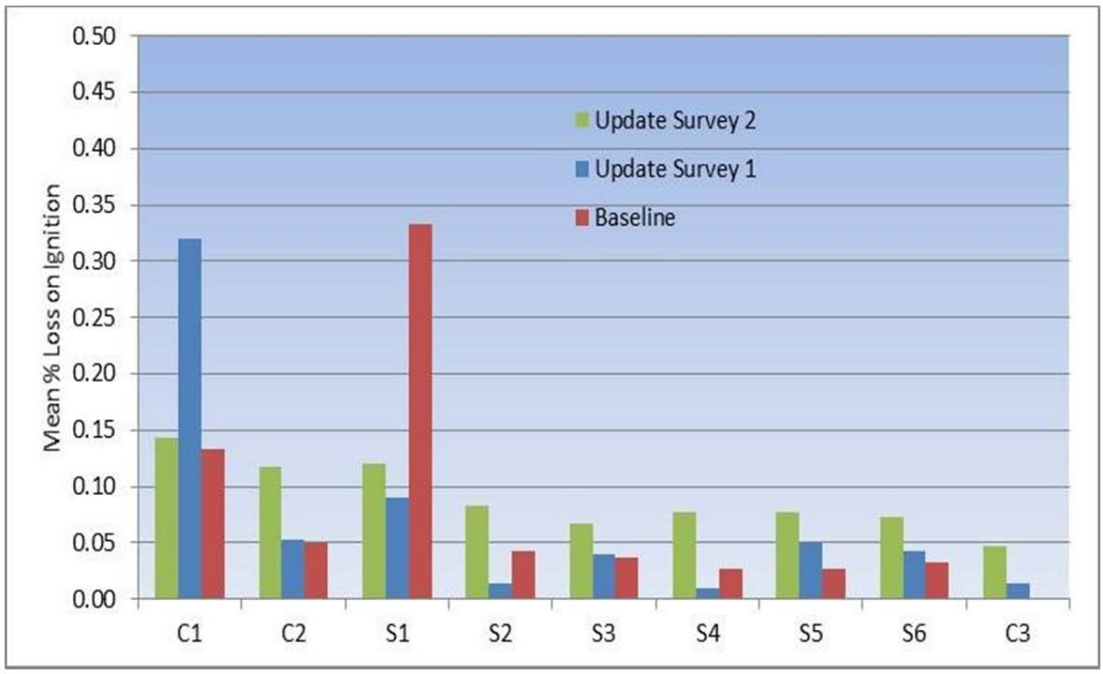


Figure 33: TOC comparison between Baseline survey (red) and Update 1 survey (blue) and Update Survey 2 (green) (Source: AMD, 2017).

6.2 Marine Fauna Interactions

The Marine Fauna Interaction Management Plan was developed to identify and mitigate potential impacts on marine fauna associated with the MARL. The Plan includes an Interaction Protocol; Monitoring Program; Light Spill Management Plan and Observer Protocol. It was developed by the Marine Fauna Interaction Committee consisting of representatives from NSW OEH, Macquarie University, Port Stephens-Great Lakes Marine Park, Huon Aquaculture and NSW DPI. Notably, Huon Aquaculture has extensive experience in managing interactions with marine wildlife around aquaculture operations. All members of the NSW DPI/Huon Research Team have been informed about the Marine Fauna Interaction Management Plan and received appropriate training.

All marine fauna interactions with the MARL, notably threatened species, have been monitored since the sea pen infrastructure was installed in September 2016. A NSW OEH approved observer was present during this stage of the project and during the installation of three additional pens in September 2017 to monitor any marine fauna interactions. Marine fauna monitoring has also been undertaken on all vessel trips when travelling to and from the MARL, as well as within and around the lease (see Table 8). Particular attention has been given to the movements of threatened and protected species, migratory species (e.g. Humpback whales, White Sharks, Grey Nurse Sharks, fur seals, Gould's Petrel and dolphins). Regular updates on marine fauna observations can be accessed on Huon Aquaculture's website (Web Reference 1).

The Huon sea pen design has proven effective in limiting marine fauna interactions on the MARL (Figure 33). The design seeks to prevent marine fauna from entering the pens, accessing stock and fish feed, as well as discourages marine fauna from resting on the infrastructure. The effective prevention of predatory interactions on the MARL has greatly minimised fish stress, injury and loss (Web Reference 2).

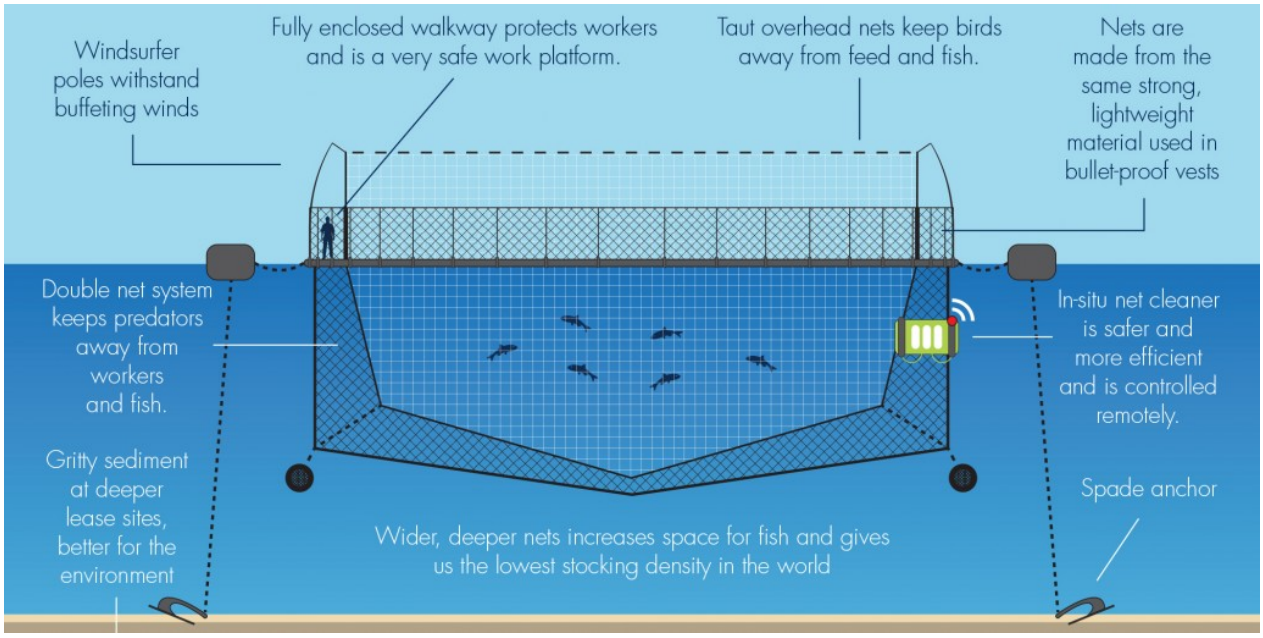


Figure 34: Huon sea pens (Source: Huon Aquaculture, 2017).

6.2.1 Seabirds

The potential risk of sea birds particularly shearwaters interacting with the sea pen infrastructure was raised in the first year of operation. It was proposed to investigate suitable visual aids for sea birds such as streamers.

However, during the second year of operation, there were no bird entanglement incidents on the MARL.

Table 8: Summary of marine fauna interactions with the MARL (Source: Huon Aquaculture, 2018).

Report Period	Observations (travelling to & from MARL)					Observations (in and around lease)							
Start - Finish	*Humpback Whale*	*Calf*	*Dolphin*	*Seal*	*Obs*	*Humpback Whale*	*Calf*	*Dolphin*	*Seal*	*Obs*	*Nature Of Interaction*	*Entangle*	*Comments & Actions*
9/10/2017 22/10/2017	22	2	13+2 pods	2		5		3				Nil	Feeding and Pen Maintenance
23/10/2017 5/11/2017	5	2	5			5						Nil	Feeding and Pen Maintenance
6/11/2017 19/11/2017												Nil	Feeding and Pen Maintenance
20/11/2017 3/12/2017												Nil	Feeding, Bathing and Pen Maintenance
4/12/2017 17/12/2017			pod									Nil	Feeding and Pen Maintenance
18/12/2017 31/12/2017												Nil	Feeding and Pen Maintenance
01/01/2018 14/01/2018								1	3	5x Grey Nurse Sharks	Seal on walkway. Sharks between nets	Nil	Feeding and Pen Maintenance
15/01/2018 28/01/2018								2	2	2x Whaler sharks	Seals feeding on fish. Sharks inside net	Nil	Pen repairs/feeding after storm
29/01/2018 11/02/2018			pod							1 x Great White Shark	Shark around Pen 1603	Nil	Feeding and Pen Maintenance
12/02/2018 25/02/2018			pod				10		2		Seal on walkway Pen 1603	Nil	Feeding and Pen Maintenance
26/02/2018 11/03/2018			pod							2 x Whaler Sharks	Removed from Pen 1601	Nil	Feeding and Pen Maintenance
12/03/2018 18/03/2018			26					15		1x Bull Shark	Diver observation on outside of pen	Nil	Feeding and Pen Maintenance
19/03/2018 25/03/2018				1	Seal on empty sea pen							Nil	Feeding, Bathing and Pen Maintenance
26/03/2018 08/04/2018			Pods of 50					60	4		1 seal around pen	Nil	Feeding and Pen Maintenance
09/04/2018 22/04/2018			29						1		1 seal around pen	Nil	Feeding, and Pen Maintenance
23/04/2018			235						8	1(observed on	1 seal around	Nil	Feeding, Pen Maintenance

Report Period	Observations (travelling to & from MARL)				Observations (in and around lease)							
06/05/2018									lease)	pen		and bathing
07/05/2018 20/05/2018	1			East of lease							Nil	Feeding, Pen maintenance and moorings
21/05/2018 03/06/2018	4	1	20	Whales breached east of lease	1			5		1 seal around pen	Nil	Feeding, Bathing and Pen Maintenance
04/06/2018 17/06/2018	9	1	150	East of lease	9	2	20	13	Whales 100m off pens	1 seal around pen	Nil	Feeding, Bathing and Pen Maintenance
18/06/2018 01/07/2018	22		40	East of lease travelling north				4	1 seal around pen		Nil	Harvest
02/07/2018 15/07/2018	15		40	East of lease travelling north				4	1 seal around pen		Nil	Pen Maintenance
16/07/18 30/07/18	3			Travel to lease								Pen Maintenance
31/07/18 12/08/18			2	In Providence Bay							Nil	

Light Pollution

No night work operations have been conducted on the MARL during the second year of operation so the potential for light pollution associated with vessel lights impacting on seabirds at night is considered to be negligible. Four low intensity navigation strobe lights were attached to buoys on the corners of the MARL in accordance with NSW RMS requirements. The requirements include a range of at least four nautical miles (7.4 km) in clear conditions (transmissivity of 0.74) which are within range of Cabbage Tree Island (5.6 km from lease) and Boondelbah Island (7 km from lease).

There are no records of direct interactions between the MARL and the light sensitive species of the Gould's petrel (*Pterodroma leucoptera leucoptera*), little penguin (*Eudyptula minor*) and white-faced storm petrel (*Pelagodroma marina*).

6.2.2 Whales

During the MARL's second year of operation, 30 Humpback whales (*Megaptera novaeangliae*), and 12 Humpback calves have been recorded within and around the lease (see Table 8). 81 Humpback whales, six Humpback calves were also recorded while travelling to and from the lease during the second year of operation. There were no direct interactions recorded between whales and the MARL.

Figure 35: Humpback Whale within the MARL (Source: DPI 2017)

6.2.3 Dolphins

Many dolphins have been recorded within the lease area (101) and while travelling (612) to and from the lease within the wider area of Providence Bay and Port Stephens but have not been observed directly interacting with the MARL infrastructure in any way or aggregating around the sea pens (Table 8). Similarly, there are no records of boat strikes or entanglements.

No acoustic deterrent devices are used on the MARL.

Figure 36: Dolphins seen while travelling to and from the MARL. (HUON 2017)

6.2.4 Seals

There have been 43 sightings of fur seals within the lease area; three siting's having been recorded while travelling to the lease. There are no records of fur seals attempting to prey on the stock, interacting with staff e.g. divers, entanglements or interactions with sharks during the second year of operation.

One fur seal has been recorded using the access way for one of the pens as a haul-out site during the month of January and March. This part of the infrastructure is the entry point outside of the sea pen – no seal has breached the enclosed walkway that surrounds each of the sea pens. This interaction will continue to be monitored and vigilance with maintaining the structural integrity of the predator exclusion nets and walkways has been reiterated to MARL staff. On one occasion a seal was observed between the predator and culture net and it promptly managed to exit the predator net unharmed through a hole which was subsequently repaired.

No acoustic deterrent devices are used on the MARL.

Figure 37: Fur Seals hauled out on Cabbage Tree Island (Source: NSW DPI, 2017)

6.2.5 Sharks

Shark research has been undertaken by NSW DPI in collaboration with CSIRO and other researchers for a number of years. This research has included the monitoring of shark movements within NSW waters through the use of acoustic tagging and acoustic listening stations. Acoustic tags are deployed in fish and sharks through a range of projects lead primarily by public sector agencies and universities. The receiver is located on a buoy or attached to the seafloor, and detects transmissions from tags when a tagged animal swims within a range of 500-800 m. The receiver logs the individual-specific tag code, the date and time, and any sensor telemetry from the tag, and allows the duration in which animals were in the vicinity to be determined.

Acoustic listening stations have been installed near Hawks Nest and on the MARL. These have provided information about the presence of tagged sharks (Bull, White and Tiger). Specifically, an acoustic listening station was deployed at a temporary mooring 3km northeast of Cabbage Tree Island in November 2015 to obtain data prior to sea pen installation. An acoustic listening station was also deployed on the MARL in October 2016 and removed in mid-August 2017

The receiver near Cabbage Tree Island was in position until mid-June 2016 where 11 tagged sharks were detected during that time (six Bull Sharks, four White Sharks and a Dusky Shark). The most common visitor was a Bull Shark that was detected on 40 separate days, while on average each shark visited the site for six separate days. The receiver on the Research Lease was in position until mid-August 2017.

A total of 19 tags were recorded and included fourteen White Sharks, two Bull Sharks and three Grey Nurse Sharks. The maximum time a tag was detected was nine days, with most individuals detected on only one day. Since August 2017, thirty-three sharks have been recorded over seven months. Up to December 2017, the majority of the detections were White Sharks, which were transiting past the lease. After Christmas the overall number of detections fell, with White Sharks becoming less common and Bull Shark numbers increasing. It was uncommon for sharks to remain on the lease; however, one Bull Shark remained for over a week following the escape incident in late January.

The patterns observed from acoustic tag monitoring suggest that sharks routinely visit the MARL and most detections are thought to be transient animals undertaking broader migrations.

There have been two short periods in which shark numbers have increased, however, including the end of 2017, which is consistent with records of migratory shark movements in the area over time, as well after the escape incident in January 2018.

Two direct interactions have occurred since the MARL commenced operation. The first interaction involved five Grey Nurse Sharks which were observed swimming between the predator net and inner net in January 2018 and self-released.

The second interaction involved two whaler sharks which became trapped in a sea pen and exited unharmed after the storm event in January 2018 and two small whaler sharks (not a protected species) that became entrapped and were subsequently euthanised and removed as attempts to release them were unsuccessful and had safety implications for staff. Any instance of euthanasia is regrettable, however, it is important to note that this shark species is commercially fished, and they were removed from the pen in accordance with the permit issued by the NSW Department of Primary Industries. The sharks were disposed of as per the aquaculture permit condition and the remains were given to a local college for use as organic fertiliser.

Acoustic tag monitoring results and observations from MARL staff, including underwater inspections and the implementation of the Observer Protocol, do not indicate that the MARL has induced behavioural change or attracted increased numbers of sharks to the lease area during normal operating conditions in the second year of operation.

6.2.6 Marine Turtles

During the second year of the operation of the MARL, there were no observations of marine turtles.

6.2.7 Marine Mammal Entanglement

There have been no reports of entanglements of marine mammals in MARL infrastructure during the second year of the operation between October 2017 and August 2018 (see Table 7).

7 Standards/Performance Measures and Environmental Targets/Strategies

In accordance with the SSI-5118 MOD 1 consent conditions the NSW DPI/Huon Research Team developed an Operational Environmental Management Plan (OEMP) which outlines the management practices and procedures to meet the standards and performance measures that apply to the MARL development. The OEMP contains a number of sub plans which provide further details on the respective standards and performance measures that apply to specific activities. Templates of these redacted management plans can be viewed on the NSW DPI aquaculture web page. See Environmental Management Plan Examples

The OEMP and associated sub plans were submitted and approved by NSW Department of Planning and Environment. The OEMP and associated sub plans have undergone a six monthly review to ensure that they are still relevant in meeting the conditions within the SSI-5118 consent and/or standards and conditions for operation of the MARL.

Independent environmental sampling that has been undertaken in the second year of MARL research program has found no significant impact on benthic invertebrate ecology or water column chemistry within the MARL, at the sea pen, compliance, or at the control sites. The monitoring is to continue throughout the life of the MARL project to assess any potential change as production biomass of fish increases through time. An additional control site has been added to the ongoing monitoring program to better inform the environmental monitoring.

8 Navigational Interactions

A range of mitigation measures have been implemented throughout the deployment and operation stages of the MARL to ensure navigational safety, including:

- The lease area was surveyed and is delineated by four cardinal and two special markers. The four cardinal markers were originally Spar buoys and were replaced with six Sealite Poseidon buoys. They exhibit more lateral movement around their installed position, but the improved visibility is more desirable from the feedback from the community and regulatory authority. NSW RMS used this information to update maps and issue a 'notice to mariners' to highlight the change in navigable conditions in Providence Bay;
- The cardinal markers have been fitted with auto-notification technology to advise NSW DPI/Huon Research Team staff and NSW RMS if any markers move off the lease site;
- The sea pens are to be fitted with GPS trackers once a suitable power source can be fitted, to monitor their performance within the mooring grid;
- Section 8 Fishing Closure under the *Fisheries Management Act 1994* was put in place on the lease. The temporary fishing ban was initially in place up until, and including, the 7 February 2018. Given ongoing recovery and fish recapture efforts the temporary closure was extended until 28 February 2018.
- RMS issued a navigational "Securite" for the high-density polyethylene tubing that broke free off the lease during bad weather. The equipment was washed ashore at Bennett's Beach where Huon recovered the equipment.
- NSW DPI/Huon Research Team has met and discussed navigational safety issues associated with infrastructure of the Marine Aquaculture Research Lease with RMS and Water Police in February and July 2018 and discussions are ongoing. Following the interaction with recreational boaters after the January fish escape, there are real concerns about boaters safety, transiting too close to lease infrastructure and for workers and divers on the sea pens who needed to contend with speeding vessels and vessel wake, activity within prescribed "keep clear" distances and the legacy of hooks and lures left in sea pen infrastructure. Discussions are ongoing with RMS to enhance navigational safety on the MARL.
- Nil complaints received by RMS over last 12 months.

There have been seven structural malfunctions with the sea pen infrastructure associated with severe weather conditions but none of the malfunctions resulted in a navigational interaction as the malfunctions were resolved. See Section 3.4 for the details on the seven structural malfunctions.

9 Compliance

A number of actions have been undertaken to ensure compliance with the consent conditions of the State Significant Infrastructure Approval SS1-5118 for the MARL.

9.1 Training

Personnel employed on the MARL including employees, contractors and subcontractors, have received appropriate induction training and have the required skills and qualifications to fulfil their respective roles in a competent manner. Only personnel that meet the required training and competency requirements of NSW DPI/Huon Research Team have been employed to work on the MARL.

Minimum environmental training has included:

- An induction onto the MARL and land based sites;
- A briefing on the importance of conformity with the environmental policy, procedures and requirements of the Operational Environmental Management Plan (OEMP), as well as their roles and responsibilities;
- Specialised environmental training and instruction required for undertaking allocated tasks, especially in regard to compliance with the environmental conditions of the SSI-5118 consent;
- Other specific training and instruction requirements including emergency response and operation of specific equipment; and
- Regular meetings which have included discussions on safety issues, risk assessments and controls.

9.1.1 Informing Consultants and Subcontractors

All consultants and/or subcontractors have been properly briefed and made aware of the requirements of the OEMP. The specific requirements of the OEMP have been incorporated into the induction process undertaken by all consultants and subcontractors working on site.

9.1.2 Site Meetings, Toolbox Meetings and Contractor Meetings

Any daily items or ongoing matters applicable to the environmental management of the MARL have been addressed by staff, consultants and subcontractors during site meetings, toolbox meetings and contractor meetings which have been conducted on an as needed basis. Fortnightly meetings have been held for all members of the NSW DPI/ Huon Research Team. Minutes have been kept for all meetings.

9.2 Environmental Monitoring

The number of monitoring samples taken and analysed to date is greater than consent condition requirements for the MARL, where consent condition D20 indicates compulsory annual water quality and benthic sampling. Three extensive sampling events have been undertaken since the start of the operation. Water quality, benthic fauna, sediment chemistry and particle size have been analysed which included ROV video surveys.

Supplementary water and benthic samples have been collected in addition to those collected during the Baseline survey and Update 1 survey. The supplementary samples aim to improve the baseline data available as fish grow which will help to build a stronger picture of the effects of the operation of the MARL. An additional control site was also added to the south of the MARL.

9.3 Review of Environmental Management Plans

A review of the Operational Environmental Management Plan (OEMP) was conducted by the NSW DPI/Huon Research Team six months after the MARL commenced operation. The OEMP was reviewed for usage, effectiveness and compliance issues. Revisions were proposed during this review, mostly to emergency contact details. The OEMP will continue to be reviewed by the NSW DPI/Huon Research Team every six months. The Emergency Response Protocol was updated

after the January 2018 fish escape incident and Huon has prepared a Structural Integrity and Maintenance Management Plan.

9.3.1 Non-Compliance

Non-compliance is defined as a non-fulfilment of a specified requirement (either legal, specified or policy) and a corrective action is defined as an action taken to eliminate the cause of a detected non-compliance and to mitigate any environmental impact.

The Department of Planning and Environment (NSW DPE) was notified of an incident at the MARL in which two sea pens were damaged during large seas from 13 January 2018 to 18 January 2018, resulting in the escape of farmed Yellowtail Kingfish. Poor maintenance of the sea pens and the attached predator nets, and a build-up of barnacles and algae on the sea pens were identified as significant contributors to the incident. Huon have since undertaken measures to reduce the likelihood of a similar event occurring in the future. Huon were issued a $15,000 penalty infringement notice for failure to maintain sea pen infrastructure.

9.4 Navigation Safety

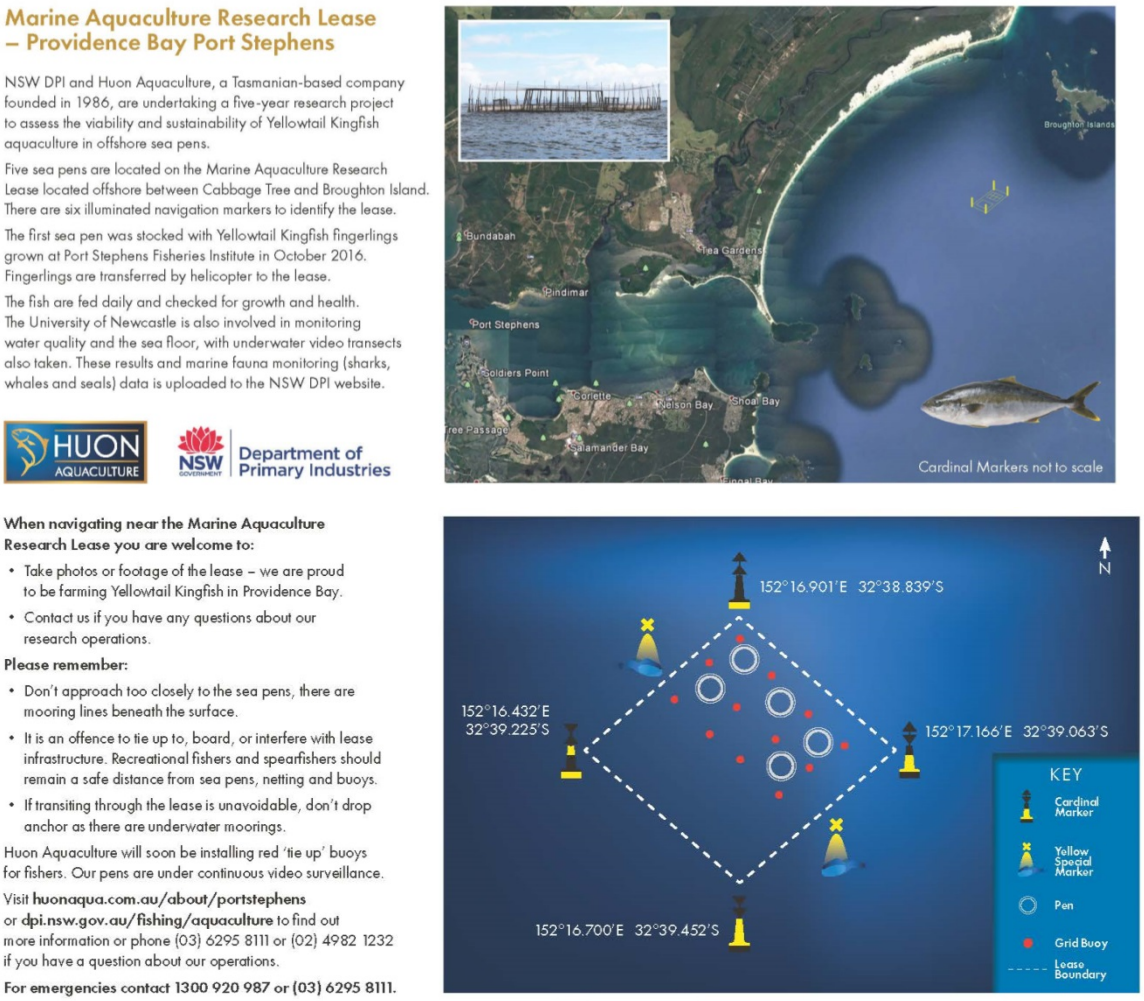
The MARL has six cardinal markers, the Sealite Poseidon buoys. Poseidon buoys are large in size and have enhanced visibility. They maintain their height above sea level in large waves and strong currents. They do tend to exhibit more lateral movement around their installed position, but the improved visibility is more desirable from the feedback from the community and regulatory authority. The cardinal markers are fitted with auto-notification technology and with GPS trackers.

9.5 Community Consultation

Community consultation during the MARL's second year of operation has consisted of the following:

- A regular stakeholder update newsletter which is available on NSW DPI's website;
- Stakeholder meetings including:
    - Port Stephens Estuary Management Committee;
    - NSW RMS Waterway Users Group:
    - Marine Rescue Port Stephens;
    - Tasmanian international aquaculture workshop; and
    - NSW Coastal Conference Shoal Bay- .
- 10 community/student group tours of the PSFI;
- ABC Landline story aired in April 2018
- Members of the Worimi Local Aboriginal Land Council visited the MARL in June 2018 to view operations. The tour included a description of operations, feeding the Yellowtail Kingfish and getting an update from Huon Aquaculture staff working on the lease; and-
- Signage and distribution of information sheets at boat ramps and recreational fishing outlets detailing changes in navigational condition in Providence Bay.

In addition to the above community consultation NSW DPI's research partner Huon, in April 2017, opened up its Helping Hand Community Grants program to states other than Tasmania. In September 2017 the Karuah Landcare Group which aims to maintain their past projects (Karuah Boardwalk and Karuah Wetlands) and regenerate bush in their local area were the first in NSW to successfully obtain a grant. At the time of writing the current 2018 grants were open for applications and advertised in local media.



Marine Aquaculture Research Lease – Providence Bay Port Stephens

NSW DPI and Huon Aquaculture, a Tasmanian-based company founded in 1986, are undertaking a five-year research project to assess the viability and sustainability of Yellowtail Kingfish aquaculture in offshore sea pens.

Five sea pens are located on the Marine Aquaculture Research Lease located offshore between Cabbage Tree and Broughton Island. There are six illuminated navigation markers to identify the lease.

The first sea pen was stocked with Yellowtail Kingfish fingerlings grown at Port Stephens Fisheries Institute in October 2016. Fingerlings are transferred by helicopter to the lease.

The fish are fed daily and checked for growth and health. The University of Newcastle is also involved in monitoring water quality and the sea floor, with underwater video transects also taken. These results and marine fauna monitoring (sharks, whales and seals) data is uploaded to the NSW DPI website.

HUON AQUACULTURE

NSW GOVERNMENT Department of Primary Industries

When navigating near the Marine Aquaculture Research Lease you are welcome to:

- Take photos or footage of the lease – we are proud to be farming Yellowtail Kingfish in Providence Bay.
- Contact us if you have any questions about our research operations.

Please remember:

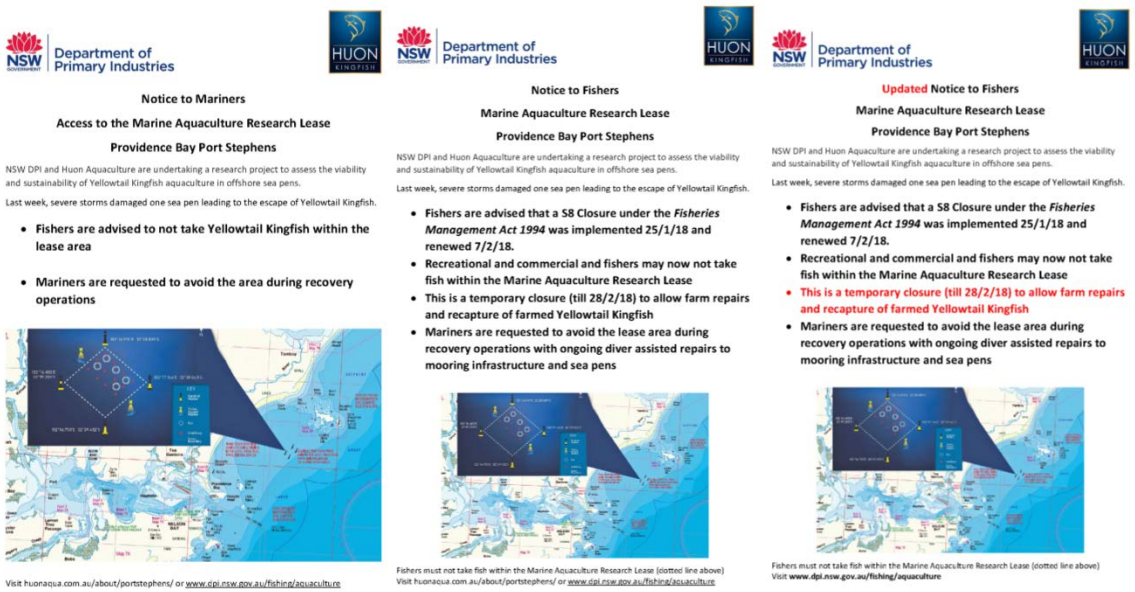
- Don't approach too closely to the sea pens, there are mooring lines beneath the surface.
- It is an offence to tie up to, board, or interfere with lease infrastructure. Recreational fishers and spearfishers should remain a safe distance from sea pens, netting and buoys.
- If transiting through the lease is unavoidable, don't drop anchor as there are underwater moorings.

Huon Aquaculture will soon be installing red 'tie up' buoys for fishers. Our pens are under continuous video surveillance.

Visit **huonaqua.com.au/about/portstephens** or **dpi.nsw.gov.au/fishing/aquaculture** to find out more information or phone (03) 6295 8111 or (02) 4982 1232 if you have a question about our operations.

For emergencies contact 1300 920 987 or (03) 6295 8111.

Figure 38: Christmas 2017 tourist information flyer (Source: Huon, 2017).



NSW GOVERNMENT Department of Primary Industries — HUON KINGFISH

Notice to Mariners

Access to the Marine Aquaculture Research Lease

Providence Bay Port Stephens

NSW DPI and Huon Aquaculture are undertaking a research project to assess the viability and sustainability of Yellowtail Kingfish aquaculture in offshore sea pens.

Last week, severe storms damaged one sea pen leading to the escape of Yellowtail Kingfish.

- **Fishers are advised to not take Yellowtail Kingfish within the lease area**
- **Mariners are requested to avoid the area during recovery operations**

Visit huonaqua.com.au/about/portstephens/ or www.dpi.nsw.gov.au/fishing/aquaculture

NSW GOVERNMENT Department of Primary Industries — HUON KINGFISH

Notice to Fishers

Marine Aquaculture Research Lease

Providence Bay Port Stephens

NSW DPI and Huon Aquaculture are undertaking a research project to assess the viability and sustainability of Yellowtail Kingfish aquaculture in offshore sea pens.

Last week, severe storms damaged one sea pen leading to the escape of Yellowtail Kingfish.

- **Fishers are advised that a S8 Closure under the *Fisheries Management Act 1994* was implemented 25/1/18 and renewed 7/2/18.**
- **Recreational and commercial and fishers may now not take fish within the Marine Aquaculture Research Lease**
- **This is a temporary closure (till 28/2/18) to allow farm repairs and recapture of farmed Yellowtail Kingfish**
- **Mariners are requested to avoid the lease area during recovery operations with ongoing diver assisted repairs to mooring infrastructure and sea pens**

Fishers must not take fish within the Marine Aquaculture Research Lease (dotted line above)
Visit huonaqua.com.au/about/portstephens/ or www.dpi.nsw.gov.au/fishing/aquaculture

NSW GOVERNMENT Department of Primary Industries — HUON KINGFISH

Updated Notice to Fishers

Marine Aquaculture Research Lease

Providence Bay Port Stephens

NSW DPI and Huon Aquaculture are undertaking a research project to assess the viability and sustainability of Yellowtail Kingfish aquaculture in offshore sea pens.

Last week, severe storms damaged one sea pen leading to the escape of Yellowtail Kingfish.

- **Fishers are advised that a S8 Closure under the *Fisheries Management Act 1994* was implemented 25/1/18 and renewed 7/2/18.**
- **Recreational and commercial and fishers may now not take fish within the Marine Aquaculture Research Lease**
- **This is a temporary closure (till 28/2/18) to allow farm repairs and recapture of farmed Yellowtail Kingfish**
- **Mariners are requested to avoid the lease area during recovery operations with ongoing diver assisted repairs to mooring infrastructure and sea pens**

Fishers must not take fish within the Marine Aquaculture Research Lease (dotted line above)
Visit **www.dpi.nsw.gov.au/fishing/aquaculture**

Figure 39: Notice to mariners regarding escape incident (Source: DPI, 2018).

Figure 40: Worimi visitors at the Research Lease (Source: NSW DPI, 2018).

Karuah Landcare Group

HUON AQUACULTURE

ROUND EIGHT

Huon's Helping Hand community grants is assisting Karuah Landcare Group's project 'Regenerating Karuah Wetlands Centre'. The project aims to improve public access to the wetland for people of all ages to enjoy.

Shelley Macorig, Karuah Landcare Group's Secretary and Treasurer said "we are in the process of regenerating the bush around the wetlands with a series of working bees and regeneration workshops. We hope that the local community will be able to enjoy the natural beauty of this area."

For more information, visit Port Stephen's Council website.

Figure 41: Karuah Landcare group recipients of Huon's Helping Hand community grant (Source: Huon, 2018).

10 Feedback and Complaints

In compliance with condition E5 of the State Significant Infrastructure Approval SS1-5118, the Community Stakeholder Communication Plan for the MARL details the following:

- Processes to receive and manage feedback and complaints; and
- Phone, email and mail contact details for the development including a 24-hour contact number.

Local councils have been informed of the procedures so that on receipt of any complaints they are able to redirect issues to the appropriate regulatory departments.

The Feedback and Complaints Handling Protocols include:

- A contact number and a site contact person who manages complaints;
- A feedback and complaints register (see Section 10.1);
- Proposed mitigation measures and follow up with the complainant;
- Contingency measures when repeated complaints are received including provisions for additional monitoring and amelioration measures;
- Compliance performance agreements with residents; and
- Reporting procedures to relevant government agencies or council.

Feedback and complaints about the MARL can be registered via the following options:

- *NSW DPI*
    - Mail: Locked Bag 1, Nelson Bay 2315

- Email: aquaculture.administration@dpi.nsw.gov.au
- Phone: 02 49821232 Aquaculture Management
- Emergency Hotline:- 1300 920 987
  - This contact number has been listed in local papers and on the NSW DPI website.

- *Huon Aquaculture*
  - Online: https://www.huonaqua.com.au/community/community-feedback/
  - Phone: 03 6295 8111

10.1 Feedback and Complaints Register

A feedback and complaints register has been maintained by NSW DPI/Huon Research Team staff at the Port Stephens Fisheries Institute, which has been regularly reviewed to determine the most appropriate response to feedback and complaints.

The register also records whether the complaint originated from normal operational procedures, an 'incident' or occasional procedure. For feedback or complaints associated with occasional procedures, discussions are held with complainants regarding whether it was the timing or nature of the impact and how the impacts can be better managed. In most cases it is believed that an agreement can be reached between parties regarding procedures, timetables, duration and intensity. If the feedback or complaint has resulted from normal operation procedures, these procedures are reviewed in discussion with the relevant approval authorities.

Table 9 provides a summary of the feedback and complaints register. Feedback and complaints received during the past year will be compared to those that are received in future years.

Table 9: Feedback and complaints register - September 2017 to August 2018.

No.	Date	Name	Contact details	Nature of feedback/complaint	Action taken
1	12/01/18	XX	Restaurant Owner	Foul smell from net on wharf at Nelson Bay	Huon apologised for mistakenly leaving the net on the wharf and removed the net as soon as possible. Huon subsequently updated its Standard Operating Procedures (SOP – YTK Net Change and Net Removal) to ensure a similar incident wouldn't reoccur
2	21/01/18	XX	Tourism Operator	Concerned about the impact of escaped kingfish on the environment. Particularly with regard to their potential predation on wild fish and concerns about disease transfer to wild stocks	NSW DPI/Huon Research Team met directly with the stakeholder to discuss the incident and explained that it was anticipated that there would be no significant impacts. This was the finding of an independent expert when a review of the incident was conducted by the Department of Planning and Environment.
3	25/01/18	XX	Local Resident	Unhappy about Section 8 closure of fishing in lease area. Concerns about recapture of fish and the capture of	NSW DPI responded and addressed all of the resident's questions and concerns. The majority of the kingfish were recaptured by pole and line which

No.	Date	Name	Contact details	Nature of feedback/complaint	Action taken
				bycatch if recapture is conducted with nets. Also under the impression that the government was protecting private industries profits	avoided any potential by-catch issues.
4	3/02/18	XX	Nelson Bay Resident	Accused Huon and DPI of telling lies and suggested that the marine parks had been destroyed. Blamed lower than normal marlin catches on the kingfish escape. Questioned why the farm was located in such a rough site. Also, brought up the false accusation of Huon staff starting fights in the local pub	Huon responded and provided the resident with extra information including the incident investigation summary.
5	6/03/18	XX	Hawks Nest Resident	Questions regarding: section 8 fishing closure; recovery of farmed fish; marine debris on Bennetts Beach. Concern that the community in Hawks Bay hadn't been adequately consulted	NSW DPI responded and addressed all of the resident's questions and concerns
6	10/04/18	XX	Tourism Operator	Advised that they had struck an object and believed that it was the mamba that was lost on 24 March 2018. No photos of the object were taken and the skipper didn't attempt to secure the object. The boat didn't sustain any damage and the passengers were uninjured. Marine Rescue was notified and the boat carried onto Broughton Island.	Two of Huon's vessels were sent to the coordinates of the incident and spent several hours looking for the object in the water. Given the mamba had been located but unreported two weeks prior on a beach in the Myall Lakes National Park, it was obviously another object that had been struck. Huon continued to look for the object that had been struck, however, nothing was found. Huon provided additional contact details to the Tourism Operator to ensure farm personnel could assist tourist vessels with any incidents in the future. The Tourism Operator was happy with this outcome.

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12. Appendices

Appendix 1 – Parasite surveillance and treatments for the MARL

Appendix 2 - APVMA Minor Use Permit (Per83276)

Appendix 3 – Positive release forms for vessels used for the MARL

Appendix 4 –Marine Aquaculture Research Lease – Update 2 Survey Environmental Assessment

Appendix 1 – Parasite surveillance and treatments

Sea Pen 1

		AVG GILL FLUKE			AVG SKIN FLUKE				DEFORMITIES total				
0	# FISH SAMPLE	Gravid Adults	sub Adults	Juvenile	Gravid Adults	sub Adult	Juvenile	Water Temp	Jaw	Head	Spine	Gill	Eyes
11/09/2017	6	0	0	0	0	0	0	19	0	0	0	0	0
26/9/2017	5	0	0	0	0	0	0.4	18.3	1	0	0	1	0
4/10/2017	BATH 1200 Litres Hydrogen Peroxide												
12/10/2017	5	0	0	0	0	0	0	18.8	0	1	0	0	0
24/10/2017	4	0	0	0.25	0	0	0	17.8	0	0	0	0	0
3/11/2017	5	0.6	1	0.6	0.2	0	0	19.2	0	0	1	0	0
9/11/2017	4	2	2	1.25	0	0	0.75	19.6	0	0	0	1	0
14/11/2017	4	0.75	1.75	1	0.25	0.75	0	19.6	0	0	1	0	1
22/11/2017	5	4.8	1.4	0.4	0.2	0	0	18.6	1	0	0	0	0
29/11/2017	BATH 1870 Litres of Hydrogen Peroxide												
7/12/2017	6	0	0	2.17	0	0	0	18.1	0	1	0	0	0
13/12/2017	6	0	0	12.2	0	0	1.4	19.6	1	0	0	0	0
19/12/2017	BATH 2300 Litres of Hydrogen Peroxide												
21/12/2017	4	0	0	0	0	0	0	18.8	0	0	1	0	0
28/12/2017	4	0	0	0	0	0	0	20.3	0	0	0	0	0
11/01/2018	6	0	0.3	0	0.3	0	0.3	21.5	0	0	0	0	0
20/01/2018	5	0.6	0.2	0.2	0.4	0	0	21.3	1	0	0	2	0
30/01/2018	5	2	0.6	1	0.8	0	0	22.1	0	1	1	0	0
7/02/2018	5	0.2	2.4	4.8	1	0.4	1.4	23.1	0	1	0	1	0
14/02/2018	5	10.2	11.4	21.4	4	5.4	8.2	24	0	0	0	0	0
22/02/2018	5	3	3.2	3.8	8.8	5	9.4	22.9	0	0	2	1	0
28/02/2018	BATH 1800 Litres of Hydrogen Peroxide												
8/03/2018	5	0	0	5.2	0	0	13	23.4	0	0	0	0	0
19/03/2018	BATH 1500 Litres of Hydrogen Peroxide												
28/03/2018	4	0	0	0	0	0	9.7	22.4	3	1	0	0	1

Sea Pen 2

		AVG GILL FLUKE			AVG SKIN FLUKE				DEFORMITIES total				
	# FISH SAMPLE	Gravid Adults	Sub Adults	Juvenile	Gravid Adults	Sub Adults	Juvenile	Water Temp	Jaw	Head	Spine	Gill	Eyes
11/09/2017	6	0	6.8	27.5	0	7.8	2.6	19	1	0	0	1	0
12/09/2017	BATH 1740 Litres Hydrogen Peroxide												
26/9/17	5	0	0	0	0	0	1.4	18.3	0	0	0	0	0
4/10/2017	BATH 2100 Litres Hydrogen peroxide												
12/10/2017	6	0	0	0	0	0	0	18.8	2	0	0	0	0
24/10/17	5	0	0	1	0	0	0	17.8	2	0	0	1	0
3/11/2017	6	0	0	0	0	1.3	0.5	19.2	0	0	0	1	0
9/11/2017	5	0.4	1.8	1	0	0	0.2	19.6	0	1	0	1	0
14/11/17	5	0.5	1.6	0.2	0.2	0	0	19.6	0	0	1	0	0
22/11/2017	5	1.8	0.4	0	0.4	0	0	18.6	0	0	1	0	0
30/11/2017	BATH 2300 Litres Hydrogen Peroxide												
7/12/2017	5	0	0	0	0	0	0	18.1	0	0	0	0	0
13/12/2017	6	0	0	18	0	0	3.83	19.6	0	0	0	0	0
20/12/2017	BATH 1850 Litres Hydrogen Peroxide												
21/12/2017	4	0	0	0	0	0	0	18.8	0	0	0	0	0
28/12/2017	5	0	0	0.2	0	0	0	20.3	1	0	0	0	0
2/01/2018	6	0	0	0	0	0	0	20.5	1	0	1	1	1
11/01/2018	5	0	0	0.2	0	0.2	0	21.5	0	0	0	0	0

Sea Pen 3

		AVG GILL FLUKE			AVG SKIN FLUKE				DEFORMITIES total				
	# FISH SAMPLE	Gravid Adults	Sub Adults	Juvenile	Gravid Adults	Sub Adults	Juvenile	Water Temp	Jaw	Head	Spine	Gill	Eyes
9/11/2017	11	0	0	0	0	0	0	19.6	2	0	5	3	0
14/11/2017	10	0.2	0.1	0	0	0	0	19.6	1	4	2	3	3
22/11/2017	12	0	0	0	0	0	0.08	18.6	1	1	6	2	4
29/11/2017	BATH 2200 Litres Hydrogen Peroxide												
7/12/2017	10	0	0	0	0	0	0	18.1	2	0	2	2	4
13/12/2017	9	0	0	0	0	0	0	19.6	3	1	0	0	4
19/12/2017	BATH 2150 Litres Hydrogen Peroxide												
21/12/2017	7	0	0	0	0	0	0	18.8	2	0	0	2	0
28/12/2017	12	0	0	0	0	0	0	20.3	5	0	2	1	5
2/01/2018	12	0	0	0	0	0	0	20.5	9	0	0	2	8
11/01/2018	15	0	0	0.06	0	0	0.13	21.5	5	0	2	4	3
20/01/2018	10	0	0.3	0	0.2	0	0	21.3	5	3	0	2	2
30/01/2018	10	0	0	0.3	0.4	0.1	0.2	22.1	6	1	0	4	3
14/02/2018	12	0.75	1.3	2.6	5.4	5.3	9.5	24	1	3	1	0	0
22/02/2018	10	0.8	0.8	4	12.5	10.3	17.7	22.9	1	1	1	3	2
28/02/2018	BATH 2060 Litres of Hydrogen Peroxide												
8/03/2018	10	0	0	0.7	0	0	51.6	23.4	3	1	1	1	0
12/03/2018	10	0	3.7	122.5	8.8	52.6	26.9	23.6	2	0	1	0	0
19/03/2018	BATH 1850 Litres of Hydrogen Peroxide												
28/03/2018	9	0	0	0	0	0	8	22.4	0	1	1	0	0
6/04/2018	BATH 820 Litres of Hydrogen Peroxide												
9/04/2018	11	0	0	0	0	0	0	21.7	4	2	2	1	5
20/04/2018	11	0	9.8	7.7	0.4	0.8	9.5	20.8	0	0	3	1	1
29/04/2018	10	12.2	6.1	11	7.5	9.6	6.8	20.6	1	0	0	2	1
2/05/2018	BATH 2725 Litres of Hydrogen Peroxide												
3/05/2018	10	0	0	0	0	0	0	21.1	0	1	1	1	3
10/05/2018	13	0	0	0.08	0	0	6.23	21.1	3	1	1	2	7
18/05/2018	10	0	0	26	0	4.3	16.6	20.7	2	1	2	2	3
24/05/2018	11	0	19	33.8	4.45	11.45	7	20.1	1	1	3	3	1
8/06/2018	BATH 2505 Litres Hydrogen Peroxide												
11/06/2018	7	0	0	0	0	0	0	18.2	2	0	1	1	1

Appendix 2 – APVMA Minor Use Permit (Per83276)

Australian Government
Australian Pesticides and Veterinary Medicines Authority

PERMIT TO ALLOW SUPPLY AND MINOR USE OF UNREGISTERED VETERINARY CHEMICAL PRODUCTS

PERMIT NUMBER – PER83276

This permit is issued to the Permit Holder under Section 112 of the Agricultural and Veterinary Chemicals Code, scheduled to the Agricultural and Veterinary Chemicals Code Act 1994 (the Agvet Code) of the jurisdictions set out below. This permit allows a Supplier (as indicated) to possess the Products for the purposes of supply and to supply The Products to a person who can use The Products under permit. If this permit were not issued, supply of the Products as specified below would constitute an offence under section 78 of the Agvet Code. This permit also allows a person, as stipulated below, to use The Products in the manner specified in this permit in the designated jurisdictions. This permit also allows the Permit Holder, the Supplier (if not one and the same) and any person stipulated below to claim that The Products can be used in the manner specified in this permit.

THIS PERMIT IS IN FORCE FROM 14 NOVEMBER 2016 TO 30 NOVEMBER 2019.

Permit Holder:
Parafarm Pty Ltd (trading as Allfarm Animal Health)
No 2 Glendale Avenue
HASTINGS VIC 3915

Suppliers authorised by this permit to supply The Products and make claims:
Redox Pty Ltd
4 Holmes Rd
MINTO NSW 2566

Solvay Interox Pty Ltd
20-22 McPherson Street
BANKSMEADOW NSW 2019

Persons authorised by this permit to use The Products and make claims:
Persons having completed the Parafarm Pty Ltd (trading as Allfarm Animal Health) accreditation process and are under the direction of a veterinary surgeon registered under the law of the relevant jurisdiction.

Product to be used under permit:
HYDROGEN PEROXIDE 60%
Containing: 742 g/L HYDROGEN PEROXIDE as its only active constituent.

Directions for Use:
To be used in the treatment of metazoan and protozoan ecto-parasitic infestations and the control of fungal infections, in freshwater and saltwater finfish, and finfish eggs under the supervision of a registered veterinary surgeon. The **Attachment** to this permit provides guidance on dose rates and treatment protocols.

Withholding Periods:
Meat (fish) – Nil.
Eggs (fish) – Nil.

Jurisdiction:
ALL States.

PER83276 Permit Version 1 Page 1 of 5

CONDITIONS

Supply

The Suppliers authorised by this permit to supply The Products and make claims must supply The Product in a container that must:

a. be impervious to, and incapable of chemical reaction with, its contents when under conditions of temperature and pressure that are likely to be encountered in normal service; and
b. have sufficient strength and impermeability to prevent leakage of its contents during handling, transport and storage under normal handling conditions; and
c. if it is intended to be opened more than once, be able to be securely and readily closed and reclosed; and
d. have sufficient excess capacity to prevent it from breaking if its contents expand during handling, transport or storage; and
e. enable all or any part of its contents to be removed or discharged in such a way that, with the exercise of no more than reasonable care, the contents cannot:
    (i) harm any person; or
    (ii) have an unintended effect that is harmful to the environment.

The Suppliers authorised by this permit to supply The Products and make claims can only make claims for use of the Products in farmed finfish.

Use

Persons who wish to prepare for use and/or use The Products for the purposes specified in this permit must read, or have read to them, the details and conditions of this permit.

THIS PERMIT provides for the use of two unregistered products in accordance with the instructions in the **Attachment** of this permit, and The Products' Safety Data Sheet.

Any adverse event arising from the use of The Products in fish must be reported to the APVMA's Coordinator, Adverse Experience Reporting Program (phone 02 6210 4792).

The Permit Holder is to monitor the use of hydrogen peroxide in aquaculture overseas and inform the APVMA of any change in status of that use, particularly any incidents of environmental contamination. Also, the Permit Holder is to inform the APVMA of any action taken by overseas regulatory authorities in regard to the use of hydrogen peroxide in aquaculture.

Claim

A person who is authorised by this permit and makes a claim about the use of The Products, can only make a claim consistent with the Directions for Use and the instructions in the **Attachment** of this permit.

Issued by Australian Pesticides and Veterinary Medicines Authority

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Attachment

POISON

KEEP OUT OF REACH OF CHILDREN
READ SAFETY DIRECTIONS BEFORE OPENING

HYDROGEN PEROXIDE 60%

ACTIVE CONSTITUENTS: 742*g/L* HYDROGEN PEROXIDE

Used for the treatment of metazoan and protozoan ecto-parasisitc infestations and the control of fungal infections, in farmed freshwater and saltwater finfish, and finfish eggs.

Net Contents 1200 kg

UN NUMBER 2014
PACKAGING GROUP II
HAZARD CLASS 5.1
SUBSIDIARY CLASS 8
HAZCHEM CODE 2W

DIRECTIONS FOR USE:

SALTWATER AND FRESHWATER FINFISH AND EGGS

FISH

The dosage and method of application of hydrogen peroxide necessary to control external protozoan parasites will depend on a number of factors including the species of fish. The dose and treatment regime should be advised by a veterinarian. As a guide, hydrogen peroxide can be used in the following methods:
Bath – Add 100 to 1500ppm of hydrogen peroxide to bath water depending on water temperature. Treat for up to 60 minutes. Treatment may be repeated if advised by the veterinarian. Follow the dose temperature guidelines advised by the veterinarian.
Temperature/dose ranges suggested for treatment trial with hydrogen peroxide on finfish.

Temperature (degrees C)	Dose (ppm)
<6	1500
6-10	1000-1250
10-15	600-1000
15-20	300-500
20-25	200-300
25-30	100-200
>30	<100

EGGS

As a guide, hydrogen peroxide can be used in the following methods:

1. BATH – Add 1 to 2 mL hydrogen peroxide/L (1000 to 2000 ppm) and treat eggs for up to 15 minutes. If prevailing conditions are favourable for fungal growth, repeat treatment daily or more frequently if needed. Excessive re-treatments may cause egg mortality, OR,
2. Add up to 0.25mL hydrogen peroxide/L (250ppm) and treat eggs for up to 60 minutes.

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NOT TO BE USED FOR ANY PURPOSE OR IN ANY MANNER, CONTRARY TO THIS LABEL UNLESS AUTHORISED UNDER APPROPRIATE LEGISLATION.

WITHHOLDING PERIOD: NOT REQUIRED

PROTECTION OF WILDLIFE, FISH, CRUSTACEA AND ENVIRONMENT:

DO NOT contaminate streams, rivers, waterways or surface waters with the undiluted chemical or used container.

STORAGE: Store in the closed, original vented container in a well-ventilated area, below 30°C, away from heat and combustibles. The storage area must be an approved segregated area where spills can be contained (eg by bunding). Do not store for prolonged periods in direct sunlight. Store away from other chemicals. Do not store on wooden pallets or on a wooden floor.

DISPOSAL:

1. Treated Water Management:
   a. Freshwater: Used solutions should be held on farm and/or treated to a concentration of 0.5ppm or less before releasing to receiving waters.
   b. Marine Water: Release of treated waters should only occur under conditions likely to lead to adequate dilution/dissipation.
2. Container: Triple rinse into treatment mix. Recycle container if possible otherwise crush dispose of in accordance with site and local regulatory requirements.
3. DO NOT remove by effluent disposal truck (not adequately vented nor of compatible materials).

SAFETY DIRECTIONS:

Hydrogen peroxide's primary risk is that it is a strong oxidizer, bleaching agent and disinfectant. Its subsidiary risk is its corrosive nature. It is poisonous if swallowed. The fumes are corrosive and act as an irritant. Do not inhale vapour. Protective clothing and eyewear must be worn at all times when applying this product. When opening the container and using the product, wear impervious PVC or rubber gloves, chemically resistant goggles or eye-shield, protective suit or apron and chemically resistant boots. If the product is on skin, immediately wash area with large volume of water. Observe good hygienic practices while using. Wash personal protective equipment with large volumes of water. Store product in cool well ventilated place. DO NOT replace used product in the original container. DO NOT expose product to grease, organic chemicals (e.g. Solvents, fuels) metals or strong solutions of metal ions. Use suitable equipment for pumping and ensure equipment is adequately maintained. DO NOT store product in a circuit, between closed valves or in a container without a vent.

FIRST AID: If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 131126; New Zealand 0800764766.

Inhalation:
- Remove to fresh air
- If symptoms persist, call physician.

Eye contact:
- Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
- In the case of difficulty of opening the lids, administer an analgesic eye wash (oxybuprocaine).
- Consult with an ophthalmologist immediately in all cases.

Skin contact:
- Remove and wash contaminated clothing before re-use.
- Wash off with plenty of water.
- Keep warm and in a quiet place
- Consult a physician

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Ingestion:
- The following actions are recommended:
- Call a physician immediately.
- Take victim immediately to hospital

If Victim is conscious:
- If swallowed, rinse mouth with water (only if the person is conscious)
- DO NOT induce vomiting.

If Victim is unconscious but breathing:
- Artificial respiration and/or oxygen may be necessary.

MSDS: Additional information is provided in the Material Safety Data Sheet.

Redox Pty Ltd

2 Swettenham Road,
Minto, NSW, 2566 Telephone: +61 2 9733 000

Shelf Life 12 months *(Active constituent will typically degrade less than 10g/L over 12 month period.)*
Date of Manufacture:

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Appendix 3 – Positive Release Forms for Vessels

HUON	DOCUMENT CODE :	AQF0105		
	EFFECTIVE DATE :	3 June 2015	VERSION 2	Page 1 of 1
	DOCUMENT TITLE :	**Positive Release Form – Cleaning and Disinfection Protocol for Transfer of Operational Equipment Between Sites**		

NOTE: It is essential to prevent the introduction and/or spread of disease between sites. Before operations equipment (eg. boats, feed, cage, net etc.) is transferred between sites this "Positive Release" Protocol and Form must be completed. This includes all secondhand equipment plus any new equipment with potential to be contaminated (if in doubt seek approval).

For the purpose of this protocol, sites include:

- South East Region, including: APM, Port Huon, Huon River, D'Entrecasteux Channel and Storm/ Trumpeter Bay
- Macquarie Harbour
- Each Huon Hatchery Site: Lonnavale, Millybrook, Springfield, Bridport, Meadowbank, Forest Home
- Any other site operated by another aquaculture company either in Tasmania or elsewhere
- Any other site where there is the possibility of disease contamination

Description of equipment to be transferred and current/intended use:
Delilah Vessel – returning to Tasmania after a few weeks at Port Stephens
Accommodation container
6 x Cardinal Markers lights (4x used, 2x new)
Van Veer Grab, Sediment corer
Huon Pride Vessel
Various Mooring Hardware

Proposed transfer date: 24/10/17	**Current location:** Port Stephens NSW

Proposed destination: Port Huon Tasmania

Proposed cleaning, disinfection and transfer process:
Remaining mooring hardware that was not used during works carried out in NSW remains brand new and uncontaminated.

Huon Pride

- Removed from the water in Newcastle and pressure cleaned at Custom Transportable Buildings compound at Kooragang Island
- Prior to loading onto Delilah, the hull, deck and externals of wheel house will have 1:200 Virkon applied to all surfaces and allowed to dry

Boat (Delilah) and Stowed/Deck cargo.

- Apply 1:200 Virkon to all surface (inside and out) and allow to airdry. (Responsible J Clark/S Stockford)
- Bilges to be pumped dry and virkoned prior to departure and again on the journey to Port Huon (Responsible J Clark prior to departure and Seb Stockford on the journey)
- Cardinal marks, grab and sediment corer to be cleaned of any dirt or mud and virkoned as per all other surfaces, at 1:200 dilution.
- All other equipment, including the boat to be virkoned prior to departure and again on the journey across with 1:200 Virkon solution (Responsible J Clark prior to departure and Seb Stockford on journey)
- All tie off ropes on Delilah will be replaced with new rope prior to departure (responsible Seb Stockford)
- Hull to be scrubbed by divers prior to departing Port Stephens (Responsible J Clark)
- Hull to be pressure washed and 1:200 Virkoned on arrival at Bridport, Tasmania (Responsible C Coulson and Seb Stockford)

Ballast Tanks

- Each ballast tank will be pumped out leaving approx. 200lts. Virkoned at 1:200. Each ballast Tank will be filled and drained out minimum 4 times (approx. every 100Nm) so long as to not compromise safety of vessel and crew. (Responsible Seb Stockford)

(*Detail pre-disinfection cleaning, type/concentration of disinfectant, application, contact time etc. For disinfection guidelines, refer to Section 3.5.3 of the Veterinary Health Plan)

Any modifications required to proposed cleaning, disinfection and transfer process: Nil

Notified (circle): Director of Fisheries / Chief Veterinary Officer / Marine Farming Branch

Authorised by: Jasmine Knowles **Signed:**

(*Must be General Manager Marine Ops/Fish Health & Environment Manager/General Manager Freshwater Ops/Company Veterinarian)

Disinfection procedure completed by: Jason Clark

Cleaning and disinfection has been completed as per requirements above: Yes

Release approved by: J. Clark **Signed:**

(*Must be the Operations Manager or higher management)

HUON	DOCUMENT CODE :	AQF0105		
	EFFECTIVE DATE :	3 June 2015	VERSION 2	Page 1 of 1
	DOCUMENT TITLE :	Positive Release Form – Cleaning and Disinfection Protocol for Transfer of Operational Equipment Between Sites		

NOTE: It is essential to prevent the introduction and/or spread of disease between sites. Before operations equipment (eg. boats, feed, cage, net etc.) is transferred between sites this "Positive Release" Protocol and Form must be completed. This includes all secondhand equipment plus any new equipment with potential to be contaminated (if in doubt seek approval).

For the purpose of this protocol, sites include:

- South East Region, including: APM, Port Huon, Huon River, D'Entrecasteux Channel and Storm/ Trumpeter Bay
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Description of equipment to be transferred and current/intended use:

Vessel Catalina

1T Feed Hopper (used)

Water Cannon including pump, hoses and nozzle (used)

2x pallets of Pallet boxes (new)

2x Fuel Cells

Proposed transfer date: 21/11/17 | **Current location:** Port Huon

Proposed destination: Nelson Bay – Port Stephens

Proposed cleaning, disinfection and transfer process:

Boat and Deck Cargo

- Hulled was Cleaned and repainted on 1/9/17 9 (has not been alongside a fish farm since returning to the water)
- Apply 1:200 Virkon to all surface and allow to air dry inc. deck all cargo, wheelhouse etc
- Bilges to be pumped dry and virkoned prior to departure to Port Stephens
- All vessel mooring ropes to be replaced with new rope prior to departure

Feed Equipment (used equipment)

- All surfaces pressure washed (inside and out) to remove feed remnants, dirt etc
- Any greasy Feed oils on the bin surface must be removed with a detergent and/or hot pressure wash
- Apply 1:200 Virkon to all surfaces (inside and out) and allowed to air dry

(*Detail pre-disinfection cleaning, type/concentration of disinfectant, application, contact time etc. For disinfection guidelines, refer to Section 3.5.3 of the Veterinary Health Plan)

Any modifications required to proposed cleaning, disinfection and transfer process:

Nil

Notified (circle): Director of Fisheries Chief Veterinary Officer Marine Farming Branch [illegible]

Authorised by: [illegible] **Signed:** [illegible]

(*Must be General Manager Marine Ops Fish Health & Environment Manager General Manager Freshwater Ops Company Veterinarian)

Disinfection procedure completed by:

Cleaning and disinfection has been completed as per requirements above:

Release approved by: [illegible] **Signed:** [illegible]

(*Must be the Operations Manager or higher management)

HUON	DOCUMENT CODE :	AQF0105	
	EFFECTIVE DATE : 3 June 2015	VERSION 2	Page 1 of 1
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- Any other site where there is the possibility of disease contamination

Description of equipment to be transferred and current/intended use:
Vessel – BULLDOG 13 (Works and YTK Harvest), YTK Harvest System and associated gear (Harvest), Lift up system (Mort Retrieval), DVP Gear , Harvest sweep net, Counter weights and bomb weights , Cage Components (MPW)

Proposed transfer date: 2/2/18 | **Current location:** Port Huon

Proposed destination: Nelson Bay – Port Stephens

Proposed cleaning, disinfection and transfer process:

Boat (Responsible C Butt and D Morrison during journey)

- Vessel Slipped December 2017, all fouling removed, virkoned at 1:200 and allowed to air dry (has not been alongside a fish farm since returning to the water)
- Deck area washed down and Virkon applied at 1:200 to all surfaces
- Apply 1:200 Virkon to all surface throughout wheelhouse and galley. All unfixed equipment to be removed
- Ballast tanks flushed to remove any remaining debris then pumped down as much as possible. If water remains, sufficient virkon is to be added to create a 1:200 concentration, left for 20 minutes contact time and then over the course of journey north, exchange ballast water 3 times completely
- Bilges to be flushed and pumped dry and virkoned at 1:200 prior to departure to Port Stephens
- All vessel mooring ropes to be replaced with new rope prior to departure

Deck Cargo

- YTK Harvest System and Harvest Gear – Virkon applied at 1:200 to all surfaces and components (Responsible A Cordwell)
- Lift Up System – Virkon applied at 1:200 to all surfaces and components and used components to be pressure cleaned and scrubbed prior to virkon (Responsible L Savage).
- DVP Gear – Virkon applied at 1:200 to all surfaces and components and used components to be pressure cleaned and scrubbed prior to virkon (Responsible W Van Den Broek)
- Harvest Sweep Net – Separate PRF (responsible J Ley)
- Counter and bomb weights – Separate PRF (Responsible J Ley/C Coulson)
- Cage Components (MPW – Virkon applied at 1:200 to all surfaces and components and used components to be pressure cleaned and scrubbed prior to virkon (Responsible B Mitchell (MPW and C Butt)

(*Detail pre-disinfection cleaning, type/concentration of disinfectant, application, contact time etc. For disinfection guidelines, refer to Section 3.5.3 of the Veterinary Health Plan)

Any modifications required to proposed cleaning, disinfection and transfer process: Nil

Notified (circle): Director of Fisheries Chief Veterinary Officer Marine Farming Branch

Authorised by: Jasmine Knowles **Signed:**

(*Must be General Manager Marine Ops/Fish Health & Environment Manager/General Manager Freshwater Ops/Company Veterinarian)

Disinfection procedure completed by: J. Ley, C. Coulson, L Savage, C Butt

Cleaning and disinfection has been completed as per requirements above: YES

Release approved by: ED RIVETT **Signed:** E. P. Rivett

(*Must be the Operations Manager or higher management)

HUON	DOCUMENT CODE :	AQF0105		
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- Any other site where there is the possibility of disease contamination

Description of equipment to be transferred and current/intended use:
Voyage of the vessel Bambra (16.4m vessel) from Newcastle in NSW to Port Huon in Tasmania.

Proposed transfer date: commencing 26th Feb to 4th of March 2018

Current location: Newcastle NSW

Proposed destination: Port Huon Tasmania

Proposed cleaning, disinfection and transfer process:

- Remove vessel from water, high pressure blast to remove all fouling and apply 1% Virkon to the vessel and leave to air dry
- Replace mooring ropes with new rope prior to departure
- Removed all tyre fenders (to be replaced when vessel arrives in Tasmania)
- Drained 2 x ballast tanks of freshwater and add Virkon to make a 1% concentration when refilling
- Hose down deck(s) and spray with 1% Virkon and leave to air dry
- Pump the bilges dry and flush through with 1% Virkon (can be done on the journey)
- Regularly fill and flush bilges on 4 occasions throughout the journey

(*Detail pre-disinfection cleaning, type/concentration of disinfectant, application, contact time etc. For disinfection guidelines, refer to Section 3.5.3 of the Veterinary Health Plan)

Any modifications required to proposed cleaning, disinfection and transfer process:
Nil

Notified (circle): Director of Fisheries Chief Veterinary Officer Marine Farming Branch

Authorised by: Jasmine Knowles **Signed:**

(*Must be General Manager Marine Ops/Fish Health & Environment Manager/General Manager Freshwater Ops/Company Veterinarian)

Disinfection procedure completed by: Charlie Coulson, Adam Morgan

Cleaning and disinfection has been completed as per requirements above: Yes

Release approved by: Jasmine Knowles **Signed:**

(*Must be the Operations Manager or higher management)

HUON	DOCUMENT CODE :	AQF0105	
	EFFECTIVE DATE : 3 June 2015	VERSION 2	Page 1 of 1
	DOCUMENT TITLE :	**Positive Release Form – Cleaning and Disinfection Protocol for Transfer of Operational Equipment Between Sites**	

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For the purpose of this protocol, sites include:

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- Any other site operated by another aquaculture company either in Tasmania or elsewhere
- Any other site where there is the possibility of disease contamination

Description of equipment to be transferred and current/intended use: Huon Envy, current travel and general farm use vessel

Proposed transfer date: ~~31/7/2018~~ 6/8/2018 | **Current location:** Port Stephens - NSW

Proposed destination: Port Huon - TAS

Proposed cleaning, disinfection and transfer process:

Remove vessel from water and pressure wash entire boat with fresh water. Pay particular attention to the hull and the roof of the boat, and remove all organic material, especially bird faeces and marine growth. Spray entire vessel with 1% Virkon solution and leave to air dry.

All unnecessary equipment (i.e. Tie-up ropes, rubber mats, fenders, anchor rope/chain) is to be removed from the boat and left in NSW. New gear can be fitted back in Tasmania.

Any upholstery (i.e. seats) needs to be cleaned and wiped with 1% Virkon solution.

Outboard motors need to have all organic material/marine growth removed from them and 1% Virkon solution applied and left to air dry. Flush the outboards with fresh water to remove any salt water from the cooling system.

Open any hatches and inspect for water. If water is visible, pump dry and apply 1% Virkon solution. A fresh water rinse can occur after 15 mins contact time.

Pump all bilges dry and disinfect with 1% Virkon solution. Virkon can be flushed with fresh water after 15 mins contact time.

(*Detail pre-disinfection cleaning, type/concentration of disinfectant, application, contact time etc. For disinfection guidelines, refer to Section 3.5.3 of the Veterinary Health Plan)

Any modifications required to proposed cleaning, disinfection and transfer process:

Nil

Notified (circle): Director of Fisheries Chief Veterinary Officer Marine Farming Branch

Authorised by: Andrew Bourke **Signed:** A Bourke

(*Must be General Manager Marine Ops/Fish Health & Environment Manager/General Manager Freshwater Ops/Company Veterinarian)

Disinfection procedure completed by:

Cleaning and disinfection has been completed as per requirements above: YES/NO

Release approved by: P. DAYTON **Signed:**

(*Must be the Operations Manager or higher management)

Appendix 4 – Marine Aquaculture Research Lease – Update 2 Survey - Environmental Assessment

Please refer to the MARL Environmental Monitoring webpage.