Petuna and Tassal Joint Venture Stocking Plan for Macquarie Harbour (MF 266) - 2018
Introduction

In 2012, expansion of finfish aquaculture and reconfiguration of leases within Macquarie harbour was approved subject to a range of State and Federal environmental requirements. Total allowable lease space increased from 564 ha to 926 ha.

A considerable body of social, economic and environmental information was consolidated into an Environmental Impact Statement that supported the proposed increased production in Macquarie Harbour.

The maximum sustainable biomass determined for the harbour was initially modelled at 29,500 tonnes. Salmonid production in the harbour reached a level of 19,200 tonnes in late 2014.

In April 2016, the company wide biomass cap was decreased to 21,500 tonnes for the 2016/2017 production year. However, subsequent biomass determinations from the Tasmanian EPA resulted in lower regulated production amounts for specific periods (i.e. 14,000 tonnes from 14 February to 30 April 2017, 12,000 tonnes for the period 31 May 2017 to 31 May 2018 and 9,500 tonnes per annum between 1 June 2018 to 31 May 2020).

The reduction in maximum allowable biomass in Macquarie Harbour has been the result of unanticipated environmental changes compared to what would normally be expected from farm related impacts at other regions within Tasmania.

In addition, harbour-wide changes to environmental conditions occurred rapidly in 2016, despite the high frequency of broadscale monitoring and visual surveys that are undertaken on a regular basis. Since late 2016 it became obvious that environmental conditions in the harbour had deteriorated and reduced dissolved oxygen (DO) levels had impacted upon benthic condition across the system.

Environmental Standards

Marine farming licence conditions relating to environmental management of finfish farms in Macquarie Harbour include a range of environmental standards which must be met by the licence holder.

The following licence conditions relating to benthic condition are included in all marine farming licences for operations in Macquarie Harbour.

There must be no significant visual, physico-chemical or biological impacts at or extending beyond 35 metres from the boundary of the lease area. The following impacts may be regarded as significant:

Visual:

- Presence of fish feed pellets
- Presence of bacterial mats (e.g. Beggiatoa spp.)
- Presence of gas bubbling arising from sediment, either with or without disturbance of the sediment
- Presence of numerous opportunistic polychaetes (e.g. Capitellla spp., Dorvelleid spp.) on the sediment surface.

In the event that a significant visual impact is detected at any point 35 metres or more from the lease boundary, the licence holder may be required to undertake a triggered environmental survey or other remedial activity determined by the regulatory authority.

Physico-chemical:

- Redox: A corrected redox value which differs significantly from the reference site(s) or is <0 mV at a depth of 3 cm within a core sample.
- Sulphide: A corrected sulphide level which differs significantly from the reference site(s) or is >250 uM at a depth of 3 cm within a core sample.

Biological:

- A 20 times increase in the total abundance of any individual taxonomic family relative to reference sites
- An increase at any compliance site of greater than 50 times the total Annelid abundance at reference sites
- A reduction in the number of Families by 50 per cent or more relative to the reference sites or a complete absence of fauna.

There must be no significant impacts within the lease area. The following impacts may be regarded as significant:

Visual impacts within lease area:

- Excessive feed dumping
- Extensive bacterial mats (e.g. Beggiatoa spp.) on the sediment surface prior to re-stocking
- Spontaneous gas bubbling from the sediment.

If a significant impact (as defined in the licence conditions outlined above) is detected within or outside the lease areas from annual compliance monitoring surveys, targeted management responses may be required, in addition to possible further investigation and depositional modelling.

Targeted management responses are implemented under the MFPA by way of management controls outlined in the Macquarie Harbour MFDP at the discretion of the regulatory authority and may involve one or more of the following actions:

- Reduction in total allowable biomass
- Reduction in nitrogen output, or
- Redistribution of biomass.
Regulatory Context

The management of benthic impacts using the regulatory approach described above has been in place for all marine farming regions in Tasmania for over 20 years.

The initial emphasis of environmental monitoring of salmonid farming was on localised benthic impacts around the lease (i.e. indications of nutrient enrichment from uneaten feed and faeces on the sea floor near the lease boundary). This included the requirements for monitoring physical/chemical indicators (redox potential, sulphides, stable isotopes, sediment particle size, percentage organic matter), visual assessments (still photographs, video recordings, sediment profile imaging) and detailed benthic invertebrate assessments to species level (Crawford 1997, Crawford et al 2001, Crawford et al 2002, Macleod et al 2002, McGhie et al 2000, Macleod et al 2004a, Macleod et al 2004b).

A variety of indicators of organic enrichment have traditionally been used to assess the rate of deterioration and rate of recovery of benthic habitats within and around salmon farms in different locations (e.g. sheltered estuarine conditions and open, exposed sites) and at different stocking densities and farm rotational periods. Full infaunal community assessments to species level were initially used as the benchmark against which all other evaluations of sediment deterioration and recovery were judged. This assessment was based on overseas studies which showed that benthic infaunal community composition was one of the most sensitive approaches for evaluation of sediment condition.

In Tasmania, a vast amount of data have been generated from a range of collaborative research programs since the mid-1990’s. In particular, research programs were undertaken to characterise the impact/recovery stages of organic enrichment from salmon farms based on a variety of indicators. Additionally, a range of techniques were assessed for their suitability for industry based management of sediment condition, including the use of ROVs to undertake visual assessments of benthic condition.

It was found that a first order visual assessment of sediment condition which was relatively time-efficient and effective was the most useful approach for farm-based monitoring in south east Tasmania. Indices based on easily identifiable visual criteria, including key faunal indicators, which relate to specific stages of impact in both mud and sand environments were developed. Environmental monitoring methodologies tailored for the Tasmanian salmonid industry were described according to the “Guide to the assessment of sediment condition at marine finfish farms in Tasmania” by Macleod and Forbes (2004).

This visual assessment was successfully used by farm managers and subsequently adopted by the regulatory authority (DPIPWE) for routine monitoring of impacts of organic enrichment from salmon farms as part of their mandatory monitoring program. Video assessments are generally conducted annually, following on from the initial baseline surveys which include more comprehensive environmental assessments (i.e. sediment chemistry and biology, total organic carbon, particle size and heavy metal analyses).
The regulatory authority developed and documented detailed requirements for video assessments including methods to be used, equipment that is acceptable, quality assurance procedures and reporting requirements. For each lease area the regulatory authority specifies the number and location of visual assessments to be conducted at 35 m out-of-lease survey sites, at sites within the farm and at reference sites. If the video survey reveals unacceptable or significant environmental impacts, a triggered environmental survey or other remedial activity may be required.

Following approval of the Macquarie Harbour salmonid expansion in 2012, and the completion of environmental baseline surveys of new lease areas, visual assessments were used to satisfy the annual out-of-lease surveys. In 2015, the regulatory authority increased the frequency of these surveys to four monthly events as observations of Beggiatoa were recorded at out-of-lease survey positions (i.e. 35 m out of lease) at a number of leases within the harbour.

**MF266 Stocking History**

Environmental baseline assessments of MF 266 were undertaken in April/May 2012. This survey highlighted the naturally low abundance of infauna present in and around the lease, results which were consistent with surveys undertaken elsewhere in the harbour. This low level of abundance was also observed more broadly within the expanded production area and was attributed to the unique conditions experienced in Macquarie Harbour – due to a range of natural and anthropogenic activities. Previous studies have also shown that the biological communities within the harbour are relatively impoverished in comparison with coastal embayments elsewhere in south-eastern Australia (Koehnken, 1996).

Smolt were first introduced to MF 266 in January 2014. The lease was operational for 39 consecutive months between January 2014 and March 2017 (see Figure 1 below).
The presence of *Beggiatoa* at one out-of-lease survey point during the January 2015 annual video survey led to the first management directions for fallowing pen bays within the lease area. In this instance, the closest two pen bays to the lease boundary at either end of the grid systems were fallowed. In addition, the frequency of video surveys throughout the entire Macquarie Harbour waterway was increased from annually to four-monthly.

The four-monthly out-of-lease surveys at MF 266 continued to show the presence of *Beggiatoa* both within the lease area, and at a small number of out-of-lease survey positions. In September 2016, a significant number of out-of-lease survey positions (14) showed the presence of *Beggiatoa*, including significantly increased density of cover at many sites (i.e. thick and thin mats versus small patches). The EPA subsequently requested the leaseholder to undertake significant management action to remediate the sediment condition within the lease area. This involved the development of a de-stocking plan and preparation of an extensive environmental monitoring plan in consultation with the EPA and IMAS to better understand how benthic infauna and sediments recover during lease fallowing. MF lease 266 was de-stocked in April 2017.

Figure 2 (a-g) show the results of out-of-lease surveys at MF lease 266 between September 2016 to May 2018. Despite the lease being fallow from April 2017, the observed presence of patchy *Beggiatoa* was variable and does not show a pattern of recovery or sediment condition which would be indicative of farm related impacts at the fine spatial scale (i.e. lease specific).

However the significant reduction in *Beggiatoa* extent between Jan 2017 – May 2017 did correspond with de-stocking, suggesting this impact and subsequent recovery was related to farm inputs.

Subsequent to de-stocking, the “low level” isolated out of lease *Beggiatoa* patches have shown spatial and temporal variability at the harbourwide level – factors influencing its presence are not clearly understood (i.e. water column dissolved oxygen levels, harbour water retention times, hydrodynamics, and nutrient inputs from nearby river systems or fish farms). Isolated patches of
*Beggiatoa* spp. (including of undetermined cause) still suggest a receiving environment that is sensitive to organic input.
MF 266 Post-Harvest and Recovery Surveys

Post-harvest and recovery surveys were undertaken in May 2017, January 2018 and April 2018. These surveys followed the specifications provided by the EPA and included current measurement, ROV video surveys, sediment chemistry, organic content, particle size analysis and benthic faunal analysis. Survey sites included those sampled in the May 2017 post-harvest survey, along with 13 additional internal sites surveyed in January and April 2018. The additional internal sites were included to determine pre-stocking suitability at
proposed new grid locations. “Old grid’ sites were selected based on previous pen bay feed inputs and locations relative to other sampling sites. “New grid” sites were based on the proposed location of new grids.

Figure 2 below shows the out-of-lease survey positions (CP1.2-CP12.2), internal monitoring sites (I2, I5, I7, I10), new grid sites (NG 1.1-NG2.4) and old grid sites (OGW PB23A, OGW PB35, OGW PB39 OGE PB20).

Figure 2 – Sampling locations for post-harvest and recovery surveys for the MF 266 in 2017 and 2018.

Key results for each sampling methodology are shown below in Table 1. Whilst there was evidence of improved sediment condition based on measurements from key benthic condition indicators (i.e. benthic fauna, sulphide and redox measurements), over the same time-period there was an increase in the frequency *Beggiatoa*, a pattern considered to represent a decline in benthic condition.

Isolated *Beggiatoa* patches were recorded at five out-of-lease survey positions in April 2018 and were more widespread than recorded in January 2018. These contrasting patterns highlight the complexity of benthic condition assessment in Macquarie Harbour, even though the site has not been stocked for 14 months.

The recognised features used to characterise impact and recovery stages for sheltered/fine silt/muddy sites as described in Macleod and Forbes (2004) appear to conflict with the patterns observed in Macquarie Harbour. This reflects the more complex biophysical characteristics and environmental responses specific to Macquarie Harbour that would otherwise be expected from typical farming in other regions within Tasmania.
Table 1 – Summary of post-harvest and recovery surveys undertaken at MF 266 between May 2017 and April 2018.

| ROV Video Survey | Seabed condition between the May 2017 and January/April 2018 surveys were broadly comparable. ROV observations from out-of-lease survey positions in 2017 and 2018 showed some differences when compared with the previous 2012 baseline survey. The main difference was the presence of dorvilleid worms, which were absent in 2012, but present at all out-of-lease survey positions in 2017 and 2018. Faunal groups recorded at most sites in the April 2018 survey included heart urchins (*Echinocardium cordatum*), dorvilleids and *Nebalia* crustaceans. Sabellid fan worms, terebellids, cerianthid anemones, polynoid worms and gobies were also observed at most out-of-lease, internal and new grid sites. Faunal diversity tended to be lower at old grid sites and dominated by dorvilleids and *Nebalia*. *Schistomeringos loveni* was the most commonly recorded dorvilleid species. Overall, there was an improvement in abundance and diversity of mobile fauna between the January and April 2018 surveys. There was some evidence of improvement in seabed condition – with increased faunal diversity and darker black sediments becoming less prominent in the April 2018 survey. Despite this improved faunal condition, continued presence of *Beggiatoa* remained both within and outside of the lease boundary. The distribution of patchy *Beggiatoa* also appeared to increase in the April 2018 survey compared to January 2018. At the out-of-lease survey positions in January 2018, *Beggiatoa* was recorded from one site, while in April 2018, patchy *Beggiatoa* was recorded at 5 of the 14 out-of-lease survey positions surveyed. *Beggiatoa* patches were also evident at distances of 50 m from the out-of-lease survey positions. |
| Visual Assessment of Sediment Cores | Visual assessment of cores from out-of-lease survey positions in 2017 and 2018 were generally comparable with observations recorded during the previous 2012 baseline survey, when dark brown/black mud was recorded in all cores. Whilst there was some evidence of hydrogen sulphide odour in some of the samples collected from the May 2017 and January 2018 surveys, *no hydrogen sulphide odour* was detected from any sediment cores in April 2018. |
| Sediment Chemistry - Redox | Redox potential during the April 2018 survey was higher than measured during January 2018, with all sites returning a positive redox value. Values measured during the April 2018 survey were higher than those measured in recent studies, but comparable to levels measured in 2012. |
| Sediment Chemistry – Sulphide Concentration | Sulphide concentration at most sites in April 2018 was lower than measured during January 2018. Across out-of-lease, internal and new grid sites, sulphide concentration was low and averaged 4.8 μM in April 2018, compared to 23.9 μM in January 2018. |
At the old grid locations, sulphide concentration averaged 34.8 μM in April 2018, compared to 121.0 μM in January 2018. The highest sulphide concentration during the April 2018 survey was measured at OGW PB35 (89 μM). It is notable that at internal site I7 there was a considerable decline in sulphide concentration since January 2018, with levels indicative of organic enrichment averaging 206.2 μM in January 2018, declining to 6.4 μM in April 2018.

| **Organic Content** | Results from the April 2018 survey are yet to be received from AST. Results from the January 2018 survey are summarised below. Across all sites, organic content levels were relatively consistent between the May 2017 (average 28.1% across 20 samples) and January 2018 (average 27.0% across 36 samples) surveys. Organic content levels measured in 2012 were slightly lower (average 22.2% across 36 samples) than those measured in 2017 and 2018. Whilst there was some variability in organic content levels within out-of-lease and internal site locations, there was a tendency for slightly higher organic content levels at the internal sites based on the January 2018 survey. Average organic content levels measured in January 2018 at out-of-lease survey positions measured 24.3 %, compared to 28.3 % for internal sites. |
| **Benthic Infauna** | Comparison between 2018, 2017 and 2012 faunal samples showed considerable differences. Diversity and abundance was higher in April 2018 (1272 individuals from 20 families; 54 samples) compared to January 2018 (423 animals from 11 families; 54 samples). Although sample numbers varied between surveys, diversity and abundance in April 2018 was comparable to May 2017, but considerably higher than recorded in 2012 (79 individuals from 12 families; 32 samples). |
Joint Venture Arrangement between Petuna Aquaculture and Tassal

In May 2018, both Petuna Aquaculture and Tassal entered into a Joint Venture to support a new and more collaborative farming approach in Macquarie Harbour. Under the Joint Venture, both companies established a combined operational management committee, including senior representatives from both companies, to oversee operations, and to deliver better biosecurity and environmental outcomes in Macquarie Harbour.

The primary aims of the Joint Venture were to:

- Maximise spatial separation between year classes,
- Improve lease fallowing arrangements, and
- Improve animal welfare outcomes.

Proposed Stocking Plan for MF 266 (2018 YC)

The establishment of the Joint Venture between Petuna Aquaculture and Tassal acknowledges the complex and sensitive environmental conditions experienced in Macquarie Harbour from time to time. It also seeks to develop a longer-term production strategy that can be accommodated within these environmental constraints.

The Joint Venture is mindful that the complex biophysical and environmental characteristics of Macquarie Harbour have provided a range of management and research challenges in recent years, however this collaborative approach represents an important step for maintaining a sustainable and viable long-term industry for Macquarie Harbour and the west coast community.

The Joint Venture recognises that 2018 will be a key transitional year to achieve long-term, sustainable salmonid farming operations as both companies adjust their stocking and harvesting plans to reflect a more environmentally sustainable and biosecure stocking strategy for future year classes. In addition, this approach will provide a more robust platform for salmonid production within the assimilative capacity of Macquarie Harbour with a view to developing an objective-based production plan for the longer term.

Most of Petuna and Tassal’s current 2017 YC are located on northern leases within Macquarie Harbour (i.e. Table Head Central and Middle Harbour). Petuna’s southernmost lease (Bryans Bay) has recently been vacated and is now in fallow. Tassal’s southernmost lease (MF 266) has not been stocked since April 2017 and has been fallowed for 14 months. Re-stocking of the lease will require the approval of the regulatory authority subject to consideration of the extent to which the benthic condition of the lease area has recovered.

The Joint Venture considers that the benthic condition within MF 266 has recovered sufficiently to allow the 2018 YC of smolt to be placed within this lease for a 9-10 month period, prior to relocation of this stock to northern leases for growout.
Under this plan, new pen bay positions will be established over new grid positions within the lease area. Results from the post-harvest and recovery surveys undertaken in May 2017 and January/April 2018 suggest that the benthic condition across these new grid positions has recovered sufficiently for smolt to be placed on the lease between July 2018 and April 2019. The placement of smolt over a new grid system is preferable, since some survey sites within the existing grid, which was previously stocked with 2015 YC salmon, showed signs of organic enrichment.

![Figure 3 – Proposed new grid locations for MF 266 lease.](image)

The proposed stocking plan for the 2018 YC involves the placement of smolt within 40 pen bays over a new grid system for a 9-10 month duration. Smolt will be introduced to the lease in July 2018 and then relocated to marine farm leases held by the Joint Venture partners in the northern end of Macquarie Harbour for the remainder of their grow-out period.

The proposed stocking plan will be provided separately to in sufficient detail to include clear lease mapping, detailing proposed grid locations/layout, pen bay IDs, barge locations etc. Pen bays will be uniquely identified (e.g. including grid codes) so that they will not be confused with the other grids or with previous grid pen bay IDs for this lease.

Once these smolt have been removed from MF 266, the lease will remain fallow for a 15-month period, prior to introduction of the 2020 YC. In the same way, the 2019 YC will be introduced to MF 213 in 2019 for 9-10 months (whilst MF 266 is fallowed) and subsequently moved to the northern end of the harbour for grow out.
Figure 4 – Feed inputs for the 2018 YC relative to previous feed inputs between 2014-2017.

The proposed feed input for the 2018 YC at MF 266 represents 18% of the feed input delivered to stock at the lease for 39 consecutive months between Jan 2014 and April 2017, or 60% of the feed input for a comparative period between July 2016 and April 2017.

The proposed feed input for the 2018 YC at MF 266 also represents 37.5% of the feed input for the 2015 YC at the same lease.

The Joint Venture partners are aware of the need to minimise feed wastage at such environmentally sensitive sites and propose to establish a centralised feed system to minimise the benthic impact of feeding practices (particularly excess feed pellets on the seafloor) at MF 266.

Figure 5 shows the proposed Joint Venture stocking plan and alternate movements of salmon between leases in the southern and northern ends of the harbour. This approach achieves both year class separation and conservative falling of the more environmentally sensitive southern leases in the harbour through alternate stocking patterns.
Figure 5 – Schematic of stock movements (2018 and 2019 YCs) under the proposed Joint Venture arrangement.

Ongoing Assessment of MF 266 (subject to stocking approval from the EPA)

The Joint Venture partners are acutely aware of the need to ensure that any approval to restock MF 266 will require a level of assurance that benthic conditions will be monitored for environmental health across a range of spatial scales. The JV partners will liaise with the EPA and IMAS to develop a monitoring plan that supports this new approach to salmonid farming in Macquarie Harbour.

In addition to the traditional sediment monitoring (i.e. visual surveys, sediment chemistry and biology) which is undertaken within the lease and at out-of-lease survey points, the JV partners have supported a significant body of scientific work proposed for Macquarie Harbour. This will involve an extension to FRDC Project 2016-067 “Understanding oxygen dynamics and the importance for benthic recovery in Macquarie Harbour” comprising four additional discrete work packages investigating:

- Benthic responses to farm management and O2 dynamics
- Development of a real time dissolved oxygen observation network
- Biogeochemical model development to include oxygen transport modelling
- Nutrient and DO mapping in the harbour – including an assessment of freshwater inputs and microbial activity
The predictive capacity for hydrodynamic modelling, particularly in relation to dissolved oxygen dynamics within the water column throughout the harbour system, has significantly improved industry’s understanding of the relationships between marine recharge events, meteorological conditions, water column stratification, dissolved oxygen concentration, and deterioration in benthic condition across the harbour. Figure 6 shows a snapshot of the real-time CSIRO hydrodynamic model across Macquarie Harbour as opposing cross sections through the basin.

Figure 6 – Oxy Tracer Section from the CSIRO Near Real-Time Hydrodynamic Model of Macquarie Harbour

The CSIRO Model output includes a model animation with the capacity to predict conditions two days in advance of real-time conditions. This capability is particularly important when recent marine recharge events have been shown to dramatically alter the hydrological properties of the harbour within a timeframe of hours.

In addition, the CSIRO modelling capability also provides the capacity to observe declining water quality conditions (i.e. reduced bottom water DO) at fine spatial scales, and potentially predict the extent to which these conditions may lead to reduced benthic health across the system.

There does appear to be a relationship between reduced mid and bottom water DO levels throughout the harbour and the presence of *Beggiatoa*. Hence the use of multi-disciplinary scientific tools to assess the environmental condition of Macquarie Harbour, such as traditional sediment condition monitoring techniques
(i.e. visual and faunal) and real-time hydrodynamic models, will provide a much greater chance of linking water body movements with benthic condition at the harbour-wide level.

**Alternative Stocking Options**

The Joint Venture partners have carefully considered the range of options for developing a more structured and sustainable approach to improving biosecurity and environmental outcomes in the harbour. To this extent, the proposed stocking plan, which includes an important transition period where MF 266 is stocked with the 2018 YC for a 9-10 month duration, will ultimately lead to the most favourable long-term outcome for salmonid farming in Macquarie Harbour. Appendix 1. Outlines the JV Partners assessment of the various stocking options for the 2018 year class of "smolt".

As always, the Joint Venture partners will play an active role in monitoring benthic condition across this period, in close consultation with IMAS and the EPA. Should there be decline in benthic health across the lease which is attributable to salmon farming, then alternative stocking or waste capture regimes may be examined as a first order response.
References


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<th>Lease Stocking Options</th>
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<th>Risk-based assessment for stocking with smolt (2018 YC)</th>
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<td>Restock MF 266 over old grid placements (NW/SE Grids)</td>
<td>The sediment condition of old grid sites is recovering from an organically enriched state (2015 YC). Recovery surveys May 2017/Jan/April 2018 showed reduced signs of off-gassing at old grid survey positions post-fallowing. Old grid sites continue to show signs of organic enrichment, evidenced either by a depauperate fauna or high densities of organic enrichment indicator species. Currently, most pen bay positions may not pass pre-stock assessment requirements.</td>
<td>The old grid positions would be better managed by maintaining in a fallow state for longer term recovery prior to placement of 2020 YC. Additional feed input over old grid may lead to a more rapid onset of degraded sediment condition than would otherwise occur at other positions within the lease area. MF 266 was stocked over the old grid system for 39 consecutive months between Jan 2014-Apr 2017. It has since been fallowed for 14 months and is in a state of recovery from an organically enriched state. Any move to consider placing stocked pens over the old grid positions should also consider installation of waste capture systems. Higher likelihood for observations of <em>Beggiatoa</em> to be present at lout-of-lease survey positions. Continued environmental monitoring would be required to monitor sediment condition.</td>
<td>This is not the preferred option for the JV Partners as it would compromise a range of environmental and fish health objectives. This option would require the use of waste capture systems as some pen bays on the old grids positions may be not be of adequate pre-stock assessment condition. Overall, this option may compromise future stock management planning – particularly for the 2020 YC (which is proposed to be placed over the “old grid” system area of the lease)</td>
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<td>Restock MF 266 over new grids (low stocking density) placements (NE/SW Grids)</td>
<td>The sediment condition of new grid sites is in a recovering state. Recovery surveys May 2017/Jan/April 2018 showed improved sediment condition for benthic infauna diversity, redox and sulphide concentrations. Internal survey work in this area of the lease has shown adequate sediment health in this previously unfarmed area of the lease. These positions meet benthic health criteria required under a pre-stocking survey.</td>
<td>The sediment condition at the proposed new grid positions is sufficiently recovered for temporary placement of smolt (2018 YC) for a 9-10 month period. There may be visible signs of enrichment over this period, however there will be 27 months fallow for this new grid area of the lease (next input over this new grid system area of the lease will be 2022 YC).</td>
<td>The proposed new grid system represents “new ground” – no stock has been placed over this grid system area of the lease. Sediments in this area of the lease are compliant with historic pre-stock requirements (pending final EPA signoff). If there are signs of significant adverse environmental impacts using this stocking plan, individual sea cages positioned over degraded sediments may be relocated to Bryans Bay (213). Continued environmental monitoring would be required to monitor sediment condition.</td>
<td>The temporary placement of smolt over the proposed new grid system at MF 266 represents the preferred option for the JV Partners. Results of the May 2017/Jan/April 2018 environmental surveys (and extensive internal observational work) characterise sediments within the new grid system as low organic enrichment. As highlighted in the latest IMAS report – there is Beggiatoa present at broadscale locations as well as in and around some leases within the system. This option is thought to present the lowest risk of this occurring at this lease considering the documented recovery gradient of the system. Risk of longer-term sediment degradation for new grid is lower than would be the case for old grid area of the lease. This stocking plan places smolt over “new ground”</td>
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| 3 Restock MF 266 over NE grid (high stocking density) | The sediment condition of new grid sites is in a recovering state. This NE grid is approximately 10m deeper than the SW new grid location and further away from historic out of lease issues. Recovery surveys May 2017/Jan/April 2018 showed improved sediment condition for benthic infauna diversity, redox and sulphide concentrations.  

*New grid site characterisation – low organic enrichment.* | The sediment condition at the proposed new grid positions is sufficiently recovered for temporary placement of smolt (2018 YC) for a 9-10 month period.  
There may be visible signs of enrichment over this period, however there will be 27 months fallow for this new grid (next input over this new grid system will be 2022 YC). | The proposed new grid system represents “new ground” – no stock has been placed over this grid.  
Higher stocking density is an inferior biosecurity outcome.  
If there are signs of significant adverse environmental impacts using this stocking plan, individual sea cages positioned over degraded sediments may be relocated to SW grid or Bryans Bay (213). Continued environmental monitoring would be required to monitor sediment condition. | The temporary placement of smolt at higher density stocking (i.e. over one grid) at MF 266 is not the preferred option for the JV Partners.  
Higher density stocking represents increased biosecurity, dissolved oxygen and benthic health risks for stock.  
The proposed approach of JV Partners is for longer term improved biosecurity and environmental outcomes in Macquarie Harbour. |
<p>| 4 Restock MF 266 over new grid placements – relocate stock from SW Grid to Bryans Bay (213) after 4-5 months at MF 266 | The sediment condition within the Bryans lease is in a recovering state from recent stocking (2017 YC). Relocation of smolt from the MF 266 lease may compromise the recovery processes at MF 213 | The use of both MF 266 and MF 213 may be considered should the preferred approach above (2) show signs that some areas around the lease become degraded and limited numbers of sea... | This is not the preferred option for the JV Partners - but may be considered in the event that sediment conditions associated with Option 1 at some areas within the lease become degraded and limited numbers of sea... |</p>
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<td>Most pen bay positions have not been approved for re-stocking (through pre-stock assessment work).</td>
<td>lease may show signs of significant adverse environmental impacts. However, the JV Partners consider that single stocking of leases under the proposed plan (i.e. stock MF 266 with 2018 YC, MF 213 with 2019 YC) represents the most appropriate long-term strategy to deliver longer term environmental and biosecurity outcomes for the harbour.</td>
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<td>cages (i.e. &lt;10) could be moved across to Bryans Bay for temporary placement.</td>
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<tr>
<td>Restock Bryans Bay (213) over existing grid placements</td>
<td>The sediment condition within the Bryans lease is in a recovering state from recent stocking (2017 YC). The stocking of smolt at Bryans Bay (213) may compromise the recovery processes of the sediments within the lease. This lease has only recently been de-stocked and requires a fallow period.</td>
<td>Bryans Bay held stock in 2018 and requires a fallow period for sediments to recover – proposed stocking of smolt at this lease will commence in 2019. This option does not represent the preferred biosecurity outcome for the 2018 YC.</td>
<td>This is not the preferred option for the JV Partners – the use of MF 213 represents an inferior outcome in terms of longer term environmental and biosecurity outcomes for the harbour.</td>
<td></td>
</tr>
<tr>
<td>Lease Stocking Options</td>
<td>Environmental Condition</td>
<td>Consequence of Additional Feed Input/Stocking</td>
<td>Comment and Contingency</td>
<td>Risk-based assessment for stocking with smolt (2018 YC)</td>
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<tr>
<td>6</td>
<td>Restock MF 213 over new (northern) grid placements</td>
<td>As above (Option 5)</td>
<td>As above (Option 5)</td>
<td>MF 213 has held stock in 2018 and requires a fallow period to allow sediments to recover for potential stocking of smolt in 2019. <strong>This is not the preferred option for the JV Partners</strong> – the use of Bryans bay represents an inferior outcome in terms of longer term environmental and biosecurity outcomes for the harbour. The preferred Option 2 above is a logical sequence based on historic stocking and fallowing practices within the harbour, and as a Joint Venture approach within the one system.</td>
</tr>
</tbody>
</table>