Big Glory Bay Salmon Farms - Change of Conditions Application by Sanford Ltd

Technical Review

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Contents

1 Introduction

The application for a change in conditions to the existing salmon farming sites owned or operated by Sanford Ltd in Big Glory Bay was presented to Environment Southland in November 2017. The application included an outline of the changes sought and an assessment of environmental effects. The application is complicated by the number of farms (7 in total with a further 2 that may be used in the future), the history of the sites (some have been mussel farms, some used for smolt, some for broodstock, some for on-growing, and some fallowed), and the intention to use some farms for some of those activities in the future, along with a fallowing routine to allow the sea bed to recover after a period of farming. The history of the sites and their intended use is summarised in the application (Sanford 2017) and Aquatic Environmental Sciences (2018) and is not repeated here.

Upon receipt of the change of conditions application, Environment Southland commissioned NIWA to complete a technical review of the application as background to the resource consent evaluation process. NIWA was invited by Sanford to attend a site visit and a workshop in February 2018. Following a subsequent debrief meeting with Environment Southland, NIWA requested further clarification around the actual and potential effects of the proposal. Consequently, Sanford commissioned Aquatic Environmental Sciences to provide further information around the predicted effects of the proposal based on the AEE by Aquadynamic Solutions (ADS 2017a-e).

This report briefly summarises the information supplied with the application, with comment on technical aspects that may be useful for Environment Southland leading up to public notification and any hearing. This report does not repeat the technical information or methodology used to assess the potential environmental effects, but concentrates on issues that may require further clarification or discussion. It does not offer solutions to those issues.

2 The application in a nut shell

Sanford wish to farm the sites more intensively. They do not intend to increase their consented space, but by increasing stocking densities (numbers of pens per site) with rotation of pens among sites. To achieve this will require increased feed volumes, defined in the application by increased nitrogen input bay-wide. The total amount of nitrogen being applied for is based on the results of modelling undertaken for 3 of the possible 9 sites. The modelling indicates that the increased nitrogen will lead to increased Chl *a*, nutrients, and benthic deposition, and lower surface 0_2. The application argues that these effects will be within the assimilative capacity of Big Glory Bay.

3 Modelling

The model used predominantly in the application was DELFT3D, which was run by Aquadynamic Solutions (ADS) and calibrated against current speed and direction at two locations within Big Glory Bay. After comparing the measured data with the model results, ADS report the model is fit for purpose. We have no reason to believe the model used was inappropriate, and similar models have been used in the assessment of other salmon farms in the Marlborough Sounds. That is not to say there are not perhaps better models available that include more parameters than a total ammonium approach. Dr Hartstein, one of the authors of the ADS reports, has previously developed a full NPZD (nutrient-phytoplankton-zooplankton-detritus) model for Big Glory Bay, which may have provided a more comprehensive assessment, and we wonder why that was not used in the present assessment. We do believe, however, that the DELFT3D model probably provides a “worse case” scenario in terms of Chl *a* enhancement.

3.1 Water quality

3.1.1 Chlorophyll *a*

The monitoring data suggest that algal blooms have been rare to date and at present the usual Chl *a* level is <2 mg/m^3. The modelling suggests that the additional nitrogen being applied for over all farms will increase that level to around 6 mg/m^3, or an increase of around 4 mg/m^3, a 2-4 fold increase relative to the present. This is predicted not to cause a significant decrease in water quality, and Sanford have offered a condition that keeps the average bay-wide additional surface Chl *a* levels to < 4 mg/m^3. A 2-4 fold increase is a significant increase. For comparison, the present conditions for NZ King Salmon in the Marlborough Sounds aim to ensure that Chl *a* is not persistently greater than 5 mg/m^3, with a trigger level for further investigation of 3.5 mg/m^3.

Further thought needs to be given to the spatial and temporal frequency of sampling to monitor that condition, how many replicates are required, and what is the response if some of those replicates exceed the limit. The conditions also refer to the limits as "at the surface". This is ambiguous, and should follow what is normally considered best practice and refer to an integrated sample taken over the top 5 m of the water column.

3.1.2 Dissolved Oxygen

The levels of dissolved oxygen (DO) are reported to be well above 6 mg/L on average throughout the water of the Bay at all depths, with only slight differences between seasons at monitoring sites. DO depletion has only been observed in the immediate vicinity of farms, where levels within the pens have been observed to drop by up to 1.5 mg/L. Modelling results predict that levels will remain > 7mg/L overall and > 6 mg/L within the farms. These levels are high enough to not cause significant impacts to the fish and surrounding biota, but it is unclear whether these predictions are for surface waters or throughout the water column. The suggested conditions are that that DO will remain > 6mg/L in Big Glory Bay. If this is at the surface, then lower levels may become present in deeper water, especially beneath the pens.

It is in the best interests or the farm operators to ensure DO levels remain higher than 6 mg/L minimum to avoid stress on the fish themselves. The increased nutrient discharge being applied for will increase sea bed deposition and hence oxygen consumption. DO should be measured throughout the water column as part of the consent conditions. It is quite plausible that levels at the surface may remain high due to exchange with the atmosphere, but be lower near the sea bed or under/within the pens.

3.2 Benthic environment

There is uncertainty in the application about what the applicants consider to be acceptable benthic impacts. There will be considerable and significant deposition (with the associated impacts) within the consent boundaries even if the modelling shows acceptable limits 100 m from the consent boundaries. Much of the discussion in the application centres around the depositional footprint beyond the site boundaries, and the proposed conditions/assessments relate to minimising or mitigating effects beyond 100 m from the site boundaries (for those sites that have been modelled).

The benthic effects, based on modelling, indicate extremely high deposition within the sites. For instance, at Farm 246 the predicted total organic carbon is up to 16 kg/m^2/y (Fig 24A in AES 2018, Part 2) and the total faeces and waste is greater than 45 kg/m^2/y (Fig 24B in AES 2018, Part 2). The proposed thresholds that allow functioning benthic processes and faunal communities for those deposition estimates are 0.73 and 5 kg/m^2/y respectively. Clearly there will be significant impacts beneath the pens, possibly leading to anoxia and *Beggiatoa* mats within the entire site boundaries. The effects of this level of deposition on oxygen depletion and fish health are not addressed in the application.

AES (2018) have provided an assessment of the potential enrichment of the benthic habitats using the modelled deposition rates. They do this by adopting the Enrichment Scale (ES) methodology that has recently been used to set thresholds for salmon farms in the Marlborough Sounds. There is an empirical relationship between deposition and ES, and although that same relationship may not be entirely the same in Big Glory Bay as Marlborough Sounds, it can be assumed to be similar. The ES scale ranges from 1 (pristine, unimpacted) to 7 (extremely enriched and impacted, possibly anoxic). In recent decisions around salmon farms in the Marlborough Sounds, the criteria applied is that ES should be <5 immediately beside and beneath the pens. Using the relationship between deposition and ES, AES (2018) calculate the ES scores for the proposed farms that have been modelled. The results are presented in Figure 27 (AES 2018, Part 2) for Farms 339 and 246. Nowhere within the consent boundaries of those two farms is ES <5, and in the centre of the sites it is higher in both Farm 339 and Farm 246. The ecological and farming consequences of this impact is not addressed in the application or AEE.

There are two mitigation measures suggested in the application to reduce the impact of this deposition to acceptable levels, the use of a binding agent in the feed at Farm 246, and fallowing cycles, both of which are discussed below.

3.2.1 Binding agent in the feed

The addition of a binding agent to the feed increases the sinking rate and reduces the fragmentation of the pellets, both result in less spread in the deposition of waste food and faeces. The result is greater deposition in a smaller area. In most situations it is preferable to disperse the deposition as far as possible, but at a lower rate. This is the reasoning behind, for instance, the preference for dispersive farming sites (those in higher currents and deeper water). The addition of binding agents to the feed at Farm 246 reduces the deposition beyond the farm boundaries, but significantly increases it within the site. This may be one of the reasons for the extremely high deposition beneath the pens at that site, and the predicted severe ecological impacts (ES >>7). If that level of deposition and impact affects the health of the fish, then it may have consequences for the attempt to increase fish densities at that site. The balance between the size and area of dispersion is one that Environment Southland may have to decide.

3.2.2 Fallowing

The success of the proposal is reliant on the use of a rotational fallowing programme to allow the sea bed to recover after a period of farming. Fallowing is the major mitigation strategy to allow the increased biomass of fish to be farmed. As such, it is important that the strategy is well researched and provides confidence to Environment Southland in its decision making.

The application proposes to use a fallowing programme with 2 years of farming, followed by 5 years of recovery. Pens will either be shifted within existing site boundaries where there is sufficient space, or to other consent sites within Big Glory Bay. As such, it relies on sufficient space within the Bay and that the time-frame for recovery is sustainable. There are three aspects that should be considered, and we believe are not well addressed in the application:

1. The definition of “recovery”. AES (2018) state that recovery is defined as “to a state that the area can be farmed again”. They also provide references to other studies that have either defined or reported on recovery (P 26, Part 2). However, the definition in AES (2018) is not explained further, and Environment Southland will need that definition to be expanded, with data that will show an area can be farmed again.

2. The time of recovery is based on some published references, but in many cases those studies did not follow the entire recovery process, and did not report against the above suggested definition of recovery. There has been minimal sampling undertaken at the presently fallowed Farm 249, and sampling continues at that site. The fallowing cycle of 2 years farming, followed by 5 years fallowing may be acceptable, but there is insufficient information at this stage to assess whether that is the optimal cycle.

3. Previous studies, and the monitoring currently underway at Farm 249 is based on the deposition and impact that was present after current farming practices. The application seeks to significantly increase the benthic deposition within the sites, to a level that is likely to result in anoxia and large impacts to the benthic communities. Fallowing may therefore begin from a much more impacted state and recovery may take longer than anticipated in the application. The application does not provide any information on what the operational response may be should “recovery” take longer than 5 years. Is the sufficient space to move pens among sites should those sites not be available?

4 Concluding remarks

Overall, the application is thorough and based on useful information and background data gathering. There are several aspects that Environment Southland may wish to clarify or consider in their deliberations.

- The application is difficult to follow in detail, due to the complicated history of the sites and the proposed conditions. The summaries of past changes and changes as depicted by monitoring results may have been influenced by changes in methodologies over the years and, as such, changes that may have occurred are not recognised. This is not likely to be a significant factor, but could have been addressed in the application.

- It is not clear operationally how more fish will be farmed in the same area, with rotation of cages, and what may happen when additional modelling is undertaken at other sites that have not yet been modelled. The ability to rotate within the predicted time-frame associated with fallowing is crucial to the application, but see comments above.

- “Recovery” needs to be better defined, so it is clear what will be monitored, where, and how often. The recovery cycle is also crucial to the success of the proposal.

- Benthic monitoring is required, but the details are not adequately spelt out in the application, instead leaving to some future environmental monitoring plan to be submitted to Environment Southland. Some details are provided, such as ‘no more than one replicate with no taxa’. What surface area for the core? What depth? How many replicates in total. Clearly, increasing surface area of an individual core reduces the chance of getting no taxa, but increasing the number of replicates increases the chances of finding one that contains no taxa 'purely by chance'. Similarly, at what spatial scale is *Beggiatoa* to be measured to define "patchy/localized"?

- Overall, the benthic standards being proposed are less stringent than those agreed to by NZ King Salmon. The deposition and resulting impact beneath the pens may affect the health of the fish, completely destroy the benthic communities, and take a long time to recover. The standards appear to protect the benthic environment beyond 100 m from the consent boundaries but almost ignore what happens within the consent boundaries. Is this acceptable to Environment Southland, and is it sustainable for farming?

- Water quality standards are based on Bay-wide sampling and while that may be sufficient to protect the wider Big Glory Bay, will they allow sustainable farming within each site? The Chl *a* values are predicted to have a 2-4 fold increase. While they may not trigger phytoplankton blooms, they may increase the frequency of naturally occurring ones.

5 Acknowledgements

We are grateful to Sanford Ltd for providing us access to their commissioned reports and for open discussions during the site visit and workshop.

6 References

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