Attachments - Environment Committee Agenda

1 May 2014 Meeting

Item 3 - New Zealand King Salmon
Monitoring Reports 2013

Attachment 1

New Zealand King Salmon

13 March 2014

Marlborough District Council
PO Box 443
BLENHEIM 7240

Attention: Steve Urlich
Copy to: Catriona MacLeod

2013 Annual Monitoring Reports

I attach a copy of the 2013 annual monitoring reports for all farms. Overall, the results are good. This letter sets out our interim decisions on farm management resulting from the reports. We look forward to receiving your comments before the reports are formally submitted for compliance purposes.

As discussed you will also be aware we propose to have the reports reviewed by Catriona MacLeod. She has been copied this letter.

Interpretation of Results - Benthic

The below table gives a summary of compliance with seabed monitoring conditions. An outline of how results should be interpreted was set out in a letter from Gascoigne Wicks to Andrew Besley on October 30th 2013. A further copy of that letter is attached.

It is critical for each report to be read as a whole. The approach taken to monitoring the seabed looks at a series of environmental indicators, and weighs them according to their importance. The same weighting has been applied as in 2012. Cawthron have cautioned against looking at single indicators, which can fail to consistently represent the degree of impact at any monitoring point.

Farm	Pen	Middle Zone	Outer Zone
Otanerau	Compliant	Compliant	Compliant
Ruakaka	Compliant	Compliant	Compliant
Waihinau	Compliant	Compliant	Compliant
Te Pangu	Compliant*	Compliant	Compliant (within margins of error).
Forsyth	Compliant	Compliant	Compliant
MFL048	Compliant	Compliant	Compliant
MFL032	Compliant	Compliant	Compliant
Clay Point	Compliant	Compliant at 90mW boundary Issues at 90mE boundary	Compliant

The New Zealand King Salmon Co. Ltd. 93 Beatty Street, PO Box 1180, Nelson, New Zealand. T +64 3 548 5714 F +64 3 548 6993
E contact@kingsalmon.co.nz **www.kingsalmon.co.nz**

The results overall suggest the seabed is in good health. NZKS proposes the following management strategies throughout the rest of 2014 to maintain the position beneath the farms:

1. Hold feed levels at Ruakaka and Otanerau at the approximate levels set out in Gascoigne Wicks letter to Andrew Besley of 20 October. [1]

2. Reduce feed input at Te Pangu to approximately 4,400mt (consented to 5,500mt). This represents a 290mt reduction in feed from 2013.

An issue has been identified at the 90mE boundary at Clay Point. In 2013 NZKS was granted consent to discharge an additional 500mt of feed at this site, bringing the total allowable discharge to 4,500mt (refer consent U130466). 4,315mt was ultimately discharged. The changes to the consent also formalised ES levels into the conditions, and set ES levels for each monitoring site. Unlike other farms, results cannot be averaged across monitoring points.

As a result of the issues identified at the 90mE boundary, in 2014 we intend to:

3. Reduce feed discharge at Clay Point substantially, to less than 4,000mt this year. This represents at least a 300mt reduction in discharge from 2013.

4. Place on hold the pending application to increase feed discharge to 4,500mt for the 2014 and 2015 monitoring years.

In addition to the above, Cawthron has recently obtained consent to conduct experiments into various seabed remediation techniques beneath the fallowed Forsyth farm. These experiments will commence shortly and may provide options for improving seabed remediation time at existing farms.

We also intend to introduce a high energy diet at all farms for part of the 2014 rearing cycle, where this can be done under existing consent conditions. This diet is more easily digested and will result in lower environmental effects for a similar amount of feed discharged.

Interpretation **of Results – Water Column**

The water column results at all farms suggest there are no compliance issues.

Interpretation of Results – Copper and Zinc

We continue to monitor copper and zinc concentrations beneath all farms, however consents do not set a maximum level of impact. The 2013 results suggest copper and zinc levels remain low at most sites.

Although levels are good on most farm, raised levels of copper and zinc were identified at Ruakaka and Otanerau, consistent with previous years. We asked Cawthron to undertake additional analyses of the results at these sites. That analysis suggests the bioavailable fraction of Zinc at Otanerau is above ISQG-High trigger levels. We intend to take a sample of netting from our Otanerau farm to determine if residual levels on the netting could be contributing to these levels.

In terms of a response, we intend to use no copper based antifouling in 2014 (as was the case in 2013). Over time, this should cause levels of residual copper to reduce.

---

[1] All feed levels are projections. They may go up or down but illustrate the figures we are aiming for.

NZKS switched to the use of organic zinc in its feed at all farms in 2012, which should reduce zinc inputs into the environment long term. NZKS will monitor zinc levels at Otanerau and other farms again in November 2014. If levels remain high the possibility of a non-farm derived enrichment source may need to be considered.

We are unsure what has caused the high zinc levels but in order to get some comfort regarding levels in the feed we have implemented a testing regime for zinc in feed used on the Otanerau farm during 2013.

Going Forward

We look forward to receiving your comments on the monitoring reports. Please contact me with any queries.

Mark Gillard

Private Bag 49 Hobart
Tasmania 7001 Australia
Phone +61 3 6227 7277
Fax: +61 3 6227 8035
www.imas.utas.edu.au

REVIEW OF NEW ZEALAND KING SALMON ANNUAL ENVIRONMENTAL MONITORING REPORTS 2013 (2nd April 2014)

- DR CATRIONA MACLEOD
Deputy Director - Fisheries, Aquaculture & Coasts Centre
Institute for Marine & Antarctic Studies (IMAS-FAC)
University of Tasmania

Having reviewed all of the environmental monitoring reports for 2013 I would for the most part agree with Cawthron's overall assessment of site conditions. I have included below a summary of the key elements that I felt relevant to each site, in particular noting those points which appear most important for management (regulatory and farm-based). I have also provided some general comments on the findings and assessment process, and data interpretation that I hope you will find useful in discussions with the regulatory authorities. The deposition of copper and zinc are also discussed separately at the end of this summary.

REPORT NO. 2464 - ENVIRONMENTAL IMPACTS OF THE TE PANGU BAY SALMON FARM: ANNUAL MONITORING 2013

This site is considered high-flow (~ 15 cm/s). In current year feed input was 4,690 tonnes, a relatively small (190 tonne) increase in feed use since 2012. I understand that this lease is one of the high flow sites where there is currently discussion about boundary effects and the potential for a broader footprint (based on re-suspension issues) than the modelling might suggest, consequently I have included some discussion of the results on that basis.

Organic loading data indicate a major impact under cages but there is no evidence of significant elevation of organic material at sites outside of the farm itself. However, redox levels are reduced and sulphide levels have increased within the broader consent area (zones 2 and 3) relative to levels at selected controls. Sediments were quite coarse (sand based) suggesting that there is not a lot of natural organic enrichment at this location. Interestingly there was a clear spatial distribution gradient within the farm with impacts being greatest towards the NE, which would appear to be consistent with the prevailing current direction. It is worth noting that a greater proportion of shell material was noted in the video on the NE transect, shell material in the sediments can create areas of reduced water exchange, which may in turn result in greater variability (anoxic patchiness) in the sediment geochemistry.
It is interesting that the video for both transects notes marked changes in the sediment type along the transects, this is important as marked changes in sediment type can confound interpretation of changes in the ecological and biogeochemical measures, as the response to enrichment may as a result not be linear. It is interesting that in the “inner zone”/ zone 2 (i.e. under pens) a number of opportunistic benthic foragers were observed in the videos, this suggests that these species were taking advantage of the supplemented food supply but were not limited by anoxia/ hypoxia – this is encouraging as such communities will help to ensure the dispersal/ breakdown of farm derived material.

The nutrient loadings in the water column do not indicate any major concerns; the slight elevation in ammonia concentration observed proximate to the cages is not surprising so close to fish pens, or likely to be any cause for concern. There is no evidence of any direct impact on chlorophyll levels. However, for future reference it might be useful to note the tide situation at the point at which the water samples are collected, and perhaps seek to measure nutrient loads at a consistent stage in the tidal cycle in order to avoid any possibility of misinterpreting tidal differences as temporal/ production issues.
If I am interpreting the zonation correctly, the derived ES scores suggest that for 2013 zone 2 (pen1/2) – 5.0 and zone 3 – 3.6 are compliant based on the current consent conditions. However, the average ES score for sites in zone 4 was 2.7, which is greater than the level of 2.5 proposed for this location and more than 0.5 higher than the average of the associated reference sites, with the standard deviation of 0.2 identifying it as borderline.
Examination of the data underpinning the ES classification suggests that the cause of this potential infringement are the conditions at the NE 300m sample site, with both the sediment geochemistry and the macrofauna suggesting a level of impact greater than might be expected in this zone, although the number of taxa at this site were consistent with that found at the control locations both the abundance and sulphide levels were elevated. Unfortunately the data for each replicate from the NE 300m site are not included in the report so it is not possible to determine whether this was due to a single anomalous result or whether all replicates were consistently impacted. The standard error cited suggests that at least some of the samples were at or below the recommended levels. However, given the video comments note coarser sediments and shell hash at 300m on the NE transect it may be that the changing sediment type and presence of larger shell particles is also influencing these results. It is worth noting that the equivalent 300m position on the NW transect was within guideline levels.
The embayment sample site is also interesting, based on distance from the farming operations this site sits in spatial zone 3 and the ES criteria for that zone would indicate that the results are well within defined levels. However, it is important to note that these samples were collected from only 7m depth whilst the rest of the monitoring samples were from much deeper sites (23-41m). At this depth this site may be within the photic zone and consequently the underpinning conditions and ecological processes may be quite different from that of the other sampling sites. Whilst the results so far do not suggest any particular concern at this site, this difference should be taken into account when evaluating the results from this location in the future.
The borderline result at the outer zone appears to be localised and is not excessive. That is not to say that it should be dismissed. But determining whether the result is real and how it might have happened will enable meaningful actions to be taken to address the situation. Consequently a step-wise investigation of the data may help to identify the actual level of risk posed. Although the ES in the outer zone is close to the recommended level the standard error associated with the infaunal measures is relatively high, consequently, I'd suggest you need to examine the data to ascertain whether there is any potential that an outlier (i.e. a single measure) is artificially elevating the mean. Assuming the levels are realistic then the next step would be to dismiss the possibility that localised differences in sediment conditions are affecting the results (this can be done by examining what previous sampling/ video data tell us about the sediments at this location - although I note that this particular sampling position has moved since the last sampling). Is there any difference in the depth profile across the sampling area that might indicate the NE 300m site is in a deeper area or potential "sink" zone? Given that the sites closer to the pens (zone 3) were still compliant, and that there is no evidence of any clear temporal trend towards non-compliance, in fact over time the impacts at zones 3 and 4 would appear to be relatively stable or for the most part to be trending downwards, it seems unlikely that this result indicates a major increase or more generalised spread of farm impact over a broader area. However, based on the assessment of existing data (i.e. if there are no particular risk factors evident in that evaluation) you may want to consider some additional emphasis in this area for the next survey.

Copper and zinc levels appear consistent with reporting from previous years and not a cause for concern.

REPORT NO. 2465 - ENVIRONMENTAL IMPACTS OF THE OTANERAU BAY SALMON FARM: ANNUAL MONITORING 2013

This site is considered a low / moderate-flow site (~ 6 cm/s), with feed inputs ranging from 1,501 to 2,568 tonnes per annum, and over the previous production cycle (i.e. December 2012 to November 2013) a total of 1,045 tonnes of feed was used.

In 2013 all zones sampled were compliant based on the Cawthron interpretation of the proposed ES stage under current consent conditions. Conditions beneath the pens were highly organically enriched with the impacts being very localised. Sites outside the direct influence of the cages showed a marked improvement in ecological condition and by 150m conditions were indistinguishable from reference sites.
There was no evidence of any issues water column impacts; variability in chlorophyll levels in/ around pens most likely reflecting the physical interference of the pen structures and fish. Historical comparisons suggest that both the controls and transitional zone assessments have been broadly consistent over the last few years (perhaps with a very marginal deterioration at the 50 & 150m sites), but that there may have been a slight improvement in farm based performance.

Very high levels of copper and zinc under the cages.

REPORT NO. 2466 - ENVIRONMENTAL IMPACTS OF THE RUAKAKA BAY SALMON FARM: ANNUAL MONITORING 2013

This site has been in operation for many years (since 1985). Average current speeds at this site are low (~3.7 cm/s). However, feed inputs have been relatively high ranging from 1,705 to 3,255 tonnes per annum. In the 12-month period leading up to this year's monitoring (i.e. December 2012 to end November 2013) a total of 1,661 tonnes of feed was used (356 tonnes less than the previous year), with the majority used during the six months prior to assessment (June to November).

In 2013 all sites sampled were compliant with ES stages consistently lower than proposed limits. For the most part impacts were highly localised impacts although there was some evidence of increased sulphide S, reduced redox and slight faunal impacts at 60m.
Water column effects apparent at the pen sites, with ammonia , DRP and TP levels elevated and chlorophyll levels and DO slightly decreased, although the latter is most likely due to water disturbance/ mixing by the fish..
The Cawthron report suggests that conditions have worsened at 150m position over time, whilst this may be true in comparison with previous year it is possibly premature to suggest this over the longer term.

Cu and Zn high at both pens

REPORT NO. 2467 - ENVIRONMENTAL IMPACTS OF THE FORSYTH SALMON FARM: ANNUAL MONITORING 2013

Average current speed at this site is ~ 3 cm/s, consequently it is considered a low-flow site. This site is subject to rotational fallowing and was vacant for 8 years prior to 2009. Since 2001 feed input when stocked has ranged from 1,987 - 3,261t per annum. Site was stocked from Dec 2009 to Nov 2011 then fallowed prior to restocking again from Oct 2012- Oct 2103, with 1,914t feed used, but was vacant at the time of the survey.

All sites were compliant, with ES stages well within guideline levels.
Although both biogeochemical and faunal conditions were highly impacted under cages these impacts were very localised. There is still evidence of an effect at 150m with sediment redox reduced, sulphide elevated and some faunal changes, however for the most part the organic enrichment effects were highly localised, suggesting that the organic matter is staying within the site. There were no water column effects observed.
The temporal comparison for this site is probably not meaningful as the conditions operating at each sampling time are not consistent. However, although technically the results suggest the site is still compliant it is very clear (and recognised by environmental managers in both industry and council) that this is not a great site for farming. The results suggesting that the conditions are quickly returning to previous levels.

Zn levels elevated at pens

REPORT NO. 2468 - ENVIRONMENTAL IMPACTS OF THE CLAY POINT SALMON FARM: ANNUAL MONITORING 2013

Since 2007 feed input at this site has been slowly ramping up with feed inputs ranging from 3,152-4,304 t/yr, and is currently 4,315t. The site is considered high flow (~19.6 cm/sec up to ~109 cm/sec).
All pen positions sites were compliant with ES stages within guideline levels. There was a clear impact under the pens, which was evident in both the biogeochemistry and the faunal ecology. Although the biogeochemistry effects are largely restricted to beneath the pens there was evidence of effects on the biology at other sites, consistent with an easterly drift of impact which may be a response to the greater potential for dispersal of organic material at this site (see general conclusions for further discussion of this). As a consequence the ES level at the 90m E position (4.3 +/- s.e. 0.1), when placed within zone 2 in the historical comparison was above the recommended level of 4. However, the EQS for this site listed in the new consent U130466 proposes that the ES beneath the cages and out to 90m should be <5, and that the level between 90m to 300m should be <4; samples collected at 90m therefore fall between these two levels and this particular site may or may not be within guidelines depending on which side of the line you choose to place it. This highlights one problem with setting categorical limits to defined areas, and identifies the need to not just rely on a single number in making a decision but to also look at the details of the conditions at the site – trigger levels are most useful in identifying circumstances which need further examination. In this case whilst there was clearly evidence of organic enrichment extending out to the 90m site the sediment biogeochemistry (i.e. redox and sulphide levels) was not dissimilar to that of the equivalent station on the W transect. It is the infaunal community structure at the 90m E site which sets it apart from others and in particular the greatly increased abundances recorded at this location, one replicate having over 13,000 individuals.

The water column nutrients were only monitored on the western transect but showed some particularly unusual response, with elevated levels of nitrates at all sampling sites relative to the control. It is also interesting that ammonia, total nitrate and total phosphorus levels at the 300m site were higher than at any other sampling position. It is hard to understand how farming could contribute to increases in nutrients at the 300m position but not in the intervening waters. Single event sampling in the water column is very hard to attribute to any particular cause, as it is difficult to establish whether any given result may just be a transient localised pulse or whether it is a sustained input response. However, what is probably most important is the scale of the change and whether it persists. In this case the levels of nitrate observed were considerably higher than that experienced at any other site in the current survey, even those sites where current flows were low and significant localised impacts observed, so it seems perhaps inconsistent with the normal expectations of farming effects. I'm not sure I'd entirely agree with Cawthron observation that there is an increasing temporal trend of impact and deterioration in condition at this site; given the changes that have occurred in the locations of the sampling sites and the overall variability shown by the standard error levels, such an assessment might be a little premature.

I think the results for this site show quite clearly some of the difficulties that are being faced in setting appropriate environmental management levels for "high flow" sites, and particularly in defining both suitable "trigger" criteria and boundaries for monitoring and management. Unlike the more depositional sites where zones and levels of impact are well described and easier to model/ predict, I'd suggest the process for assessment still needs some refinement in these more dynamic areas. On that basis these results should be considered as useful in improving the process as they might be for identifying and managing current impacts.

REPORT NO. 2469 - ENVIRONMENTAL IMPACTS OF THE WAIHINAU SALMON FARM: ANNUAL MONITORING 2013

This site has been in operation since 1989 and has low to moderate current flow (~ 8.4 cm/s). It operates in rotation with the Forsyth site, and has had an annual feed input ranging from 1,014-3,790 tonnes per year. In the last cycle cages were in place from May-Nov 13 with a total feed input of 602 tonnes.

All sites reported ES stages consistently lower than the limits proposed by Cawthron.
There was no evidence of any impact on biogeochemistry at pens or 60m, but the under pens the faunal community was clearly impacted, with Pen 2 more impacted than Pen 1.
Samples collected at 180m were comparable to the Controls in all respects.
Nutrient levels are only shown for a single cage (Pen 1), and at that site there was evidence of some O2 draw down at pen level in water column and a slight elevation of both ammonia and TN. What is not clear is the timing for the water column sampling and whether this was consistent for all sites and locations. As previously noted a single water column sample is difficult to make sense of, it could reflect the normal conditions or it could relate to a single transitory event. The timing of sampling is also important as sampling at slack water may enhance localised oxygen depletion and nutrient accumulation effects around cages, and if sampling timing not consistent this might result in a false assessment of quite large changes.
No problems with Cawthron interpretation overall; but need to be mindful that changes at control may be background or just transitory effects from other sources, and are not necessarily due to farm impacts.

Cu & Zn levels elevated at P1: very high zinc in one replicate but overall lower than in previous year.

REPORT NO. 2470 - ENVIRONMENTAL IMPACTS OF THE MFL-32 (Crail Bay) SALMON FARM: ANNUAL MONITORING 2013

Average currents at this site were low (2.5 - 3 cm/s). Site was destocked in December 2011 and was fallow at the time of the survey.
No evidence of impact on faunal communities; redox levels at the cages were up a little, sulphide concentration was very low but still greater than control. There was no elevation of water column nutrients relative to the control location, in fact TN at the pen sites was actually lower that at the control – interestingly if this observation was reversed this it would elicit comment.

No issues with Cu and Zn.

REPORT NO. 2471 - ENVIRONMENTAL IMPACTS OF THE MFL-48 (Crail Bay) SALMON FARM: ANNUAL MONITORING 2013

This site was fallow at the time of the survey and there is no evidence of any impact or sediment changes as a result of previous pen placements.

No issues with Cu and Zn.

GENERAL COMMENTS:

Report Formatting/ Interpretation
I note that the reports do not employ any formal comparative statistics to assess differences between means when making temporal comparisons, as a consequence these comparisons where present are largely subjective. It is really important to take into account standard error (standard deviation) levels when making such comparisons, and not to just compare means directly. It is also important not be selective about the time periods employed when proposing/ interpreting trends. There is quite a lot of literature about interpreting long-term datasets. Ecosystems change at a range of spatial and temporal scales, and it is important to ensure that any trends or patterns inferred are relevant to the ecological scales that apply. It would be good if the graphical representation of the in situ sensor array outputs (i.e. dissolved oxygen, turbidity (optical backscatter), chlorophyll-a, temperature, and salinity data) could be orientated so that the depth is shown on the y-axis running from surface to seabed (as per MFL-48 plots). It may also be useful to view each variable together for all sites, rather than all variables for each site. The reports also need to be consistent in the levels to which the variables are reported (e.g. one/ two decimal places).

It is noted that there are inconsistencies in the monitoring requirements between farms/ locations, whilst I recognise that this is a legacy of the differing regulatory frameworks that have been implemented over time, it is important to understand and acknowledge how these differences make certain generalisations about performance particularly difficult.

As pointed out in the reports biological response variables assimilate the effects of changes in the biogeochemistry over time, rather than simply reflecting the conditions at a single sampling point, and therefore can provide a more integrated assessment of the overall sediment condition. A key rationale for the ES was the fact that it integrated both biogeochemical and ecological metrics to give a more holistic understanding of the environmental condition, consequently when proposing any trends in environmental performance it seems logical that all of the data for a site should be considered and not just individual measures.

Finally where there are clearly defined spatial gradients within the farm, for instance where impacts are clearly influenced by the prevailing current, then it is not necessarily meaningful to compare equivalent distance points, as there will always be a greater impact in one direction.

Defining Non-Compliance And Appropriate Management Responses

I am conscious that there is currently no assessment made as to the significance of any non-compliance event. I think it is important as part of the monitoring assessment to try to make some judgement as to the nature and scale/ importance of the breach when any non-compliance is recorded. It should be possible based on the location, severity and relationship to other measures nearby to make an assessment as to the significance of a breach, and thus inform the management (industry and regulator) response. Firstly it would be important to establish whether the breach can be considered real (i.e. how reliable is the data) and then to evaluate how significant the suggested impact might be. Perhaps there needs to be a scale of response such that multiple breaches, either within the one location or at a single sampling site over several times, might necessitate a greater requirement for further investigation or action. It is important that any response initiated as a result of a non-compliance event actually results in actions to improve environmental conditions. Consequently actions need to be based on a considered understanding of all the facts surrounding the non-compliance event (i.e. including both monitoring data, the broader environmental understanding and production information). This assessment also needs to be farm-based with the end result being a better understanding of the causal factors (farm based and otherwise) and a meaningful plan to avoid future non-compliance events – an adaptive management response.

Ecological Context – Key Points to Note

Where is the best place to locate a fish farm – in a low flow environment where the impacts are highly localised or in a higher flow region where the effects can be more broadly dispersed? There are two equally reasonable and compelling arguments as to which is the best receiving environment for the organic material associated with fish farming. The first argument suggests that the ecology at highly depositional sites may be better suited to the assimilation of organic material as the natural fauna are pre-disposed to organic inputs. Consequently, so long as the fauna is not overwhelmed then low flow assimilative sites that are well adapted to breakdown of organic material may be the best solution. As a consequence the ecological status can more easily and more rapidly return to background levels. However, on the down side management of such sites can be quite tricky, if the assimilative capacity of the site is exceeded the system can tip rapidly into a dysfunctional hypoxic/ anoxic state. The second contention is that a more dynamic site will “spread the load”, resulting in a low level impact across a greater area (dispersal range). Whilst this may mean a greater ecological area is affected this may not necessarily be a bad thing if the faunal community is able to cope (i.e. can utilise/ break down the extra organic material effectively). However, the organic material associated with fish farming does fundamentally change the biology and functional nature of these environments. It is not possible to say that one is necessarily better or worse than the other, however, they do need to be managed/ reviewed in different ways.

Unfortunately it is not possible to apply the same set of management responses/ criteria to both (except maybe in extremes). From a farming perspective there will be less risk with sites where the organic material is widely dispersed and impacts at a low level compared with higher level localised impacts (as this is where there is more likely to be a tipping point). Interestingly, the monitoring undertaken to date has shown that different pen positions at given locations can have quite different performance results, which clearly shows that there is potential to manage sediment condition through changes in farm management practices. It would be good to build on this data to identify some clear farm based strategies for impact reduction/ remediation, providing farms with the necessary tools to be able to respond effectively to the environmental monitoring results.

In making judgements on environmental impacts it is important to be careful not to assume that all environmental changes are farm related. Whilst some correlations may be quite clear, it is important not to over-interpret change and assume an impact where in reality there might be none. Need to take into account i) the inherent variability of the system – is any

suggested change in mean levels effectively just noise associated with the sampling/ site/ environmental variation and within the spread of the standard deviation, and ii) the actual levels observed – although there might be a “statistical” difference in the mean values there may be no biological significance to that difference and therefore the suggestion of change is just maths (need to put the numbers into context and consider the reality). Key questions following on from this would be:
- Is that change problematic for the ecosystem as a whole?
- Is the change reversible?
Also need to consider the effects of impact from both an environmental and a farming perspective – taking both into account will help to identify realistic management responses to ensure the most effective outcomes into the future.

A final point worth considering is whether the ecological response to feed inputs is parametric and linear, which may not necessarily be the case. Report 2465 suggests that farm inputs have reduced progressively since 2010 but that the associated cage ES stages have not responded in a similar manner. This assumes that the ecological response is directly (linearly) correlated with impact, but it may be that the response is more consistent with a connected series of successional states based on different biological and biogeochemical processing states and interactions. Consequently whether something is 5.1, 5.2 or 5.5 may be ecologically irrelevant, and perhaps it is better not to get too concerned about the numbers per se and focus on the underlying trends. It is perhaps the changes between ecological and functional stages that really need to be managed, rather than the variability within stages.

Copper and Zinc Assessment – Key Points to Note

The copper and zinc levels in the reports were highly variable, however, it does seem as though it is the more depositional (low-flow) sites and those which have been farmed for a long time which appear to have the highest levels (e.g. Ruakaka, Otanerau and Waihinau).

Both copper and zinc residues can accumulate in sediments as a result of copper based antifoulant use on salmon net-pens, with zinc being a lesser component of the paint formulation. Zinc is also included as a nutritional supplement in fish feed. Antifoulant usage is likely to be the primary source of elevated copper levels within farms, local environmental conditions and certain farming practices can have a significant effect on copper accumulation and impact levels throughout the system. Where levels are high it may be prudent to review farm-based activities, as adjusting the type of antifoulant used, the level of net handling required, the level of biofouling encountered and the net-cleaning approach employed can make a difference to the overall impacts.

The major risk with significant build-up of copper and zinc in the sediments is the potential for associated ecological impacts. Highest levels are typically associated with organically rich sediments, with a higher capacity to bind and accumulate such metals. For accumulated metals to have an effect on local ecology or sediment processes they must be “bioavailable”, which is in turn reliant on the form (speciation) of the metal. Metal speciation in sediments is complex and strongly related to the geochemical status of the sediments (i.e. redox status of surficial sediments, pH, degree of organic enrichment, presence of geochemical phases) and on the extent of processes such as bioturbation and resuspension. In anoxic sediments, metals are generally thought to be less bioavailable, being tightly bound as insoluble sulphides.

Recent results from a study in Tasmania have shown that bioavailability is quite low with copper from antifoulant based paints and that the risk of serious adverse impacts on sediment processes from current copper contamination levels is also relatively low; largely because most of the copper occurs as paint flakes and can't be easily taken up by benthic organisms. This study indicated that in Tasmania the major source of the zinc in the sediments is likely to have been from fish feed, rather than from the paint. Zinc is an essential element for many marine organisms and, as such, is readily bioaccumulated. Although zinc was not a key focus of the Tasmanian study some assessments were undertaken to evaluate whether zinc may be contributing to the overall toxicity, with the findings suggesting that there was no evidence of specific toxicity or particular ecological concerns at the levels observed. However, levels of any metals well in excess of ANZECC guidelines still pose a potential toxicity risk and should be avoided and/ or appropriately managed. The simplest solution would be to transition from antifouled to non-antifouled nets in these situations.

Metals such as copper are conservative in the environment and simply removing the source does not necessarily mean that the levels will reduce. In highly depositional environments the main mechanism for reduction of copper is dilution/ burial by non-contaminated sediments, whilst in more dynamic systems resuspension and intermittent scouring may transfer/ spread the copper more broadly within the environment and thus reduce localised loads. Note the Tasmanian report will be publicly available in April 2014.

Disclaimer

Enquires should be directed to:

Dr Catriona Macleod
Institute for Marine and Antarctic Studies
University of Tasmania
Private Bag 49, Hobart, Tasmania 7001, Australia
Catriona.Macleod@utas.edu.au
Ph: (03) 62 277 277 Fax: (03) 62 278 035

Attachment 3

Questions for peer-review of Council's preliminary analysis of consent compliance

Introduction

New Zealand King Salmon (NZKS) currently operate eight marine farms under separate resource consents ("consents") in the Marlborough Sounds. These consents individually require annual monitoring reports of benthic and water column conditions. Monitoring reports for the 2013 consent year (December 2012-November 2013) were submitted to Council in March 2014.

Six of the farms are at sites characterised as "low flow" (<10 cm/s mid-flow): Waihinau, Forsyth, Otanerau, Ruakaka, and Crail Bay (2 farms) which are in relatively sheltered bays or reaches; and two as "high flow" (>10 cm/s): Te Pangu and Clay Point which are in Tory Channel. The low- and high-flow distinction is important due to the differences in localised intensity and extent of organic material deposition under different flow regimes.

Each monitoring report follows the monitoring methodology developed by Nigel Keeley of Cawthron Institute[1] (hereinafter "Methods Paper") and updated in late 2013 ("Addendum to Methods")[2]. The narrative underpinning the benthic enrichment scale (ES) model in the Methods Paper explicitly recognises this flow distinction.

Council's preliminary analyses of the results have been assessed against current consent conditions, which set out the maximum level of enrichment permitted in different depositional zones. These zones commence under the pen out to 50m (or greater at high flow sites), then generally extend 50-150 m at low flow sites and 75-300m or greater at high flow sites.

Environmental standards and associated monitoring are not consistent between farms. This is because they were consented at different times over the last 15 years. Over that time, scientific understanding of seabed enrichment effects from fish farming in the Marlborough Sounds has evolved.

- The Waihinau Bay consent is the first generation consent (2000). As such, it does not have prescriptive enrichment stage standards beyond avoiding adverse effects.
- Ruakaka, Otanerau, and Ruakaka are second generation consents (2002-2006). They have a simple spatial enrichment effects model. This is accompanied by a descriptive set of permitted conditions.
- Te Pangu is the third generation consent (2009). It has a more sophisticated enrichment stage model, broken into six stages. It is a precursor for the current ES model used in the Methods Paper.
- Clay Point is the fourth generation consent (2006 varied in 2013). It employs the current seven stage ES model, and associated monitoring, as outlined in the Methods Paper.

The monitoring data collected by Cawthron is evaluated with the respect to the seven-stage ES model in the Methods Paper. Cawthron then translates the equivalent ES stage to the descriptive enrichment stage in the consent conditions, to provide an assessment of compliance with environmental quality standards.

The peer-review should focus on checking the preliminary assessment of compliance, and the explanatory comments, for robustness and plausibility of interpretation. A number of monitoring reports for individual farms prepared by Cawthron Institute are also provided. The peer-review report should clearly identify where it agrees with Council's preliminary findings, and where it departs and why. Additional comments are welcomed.

Note: there is a process currently underway to identify best practice standards and monitoring guidelines for salmon farm management in the Marlborough Sounds. The guidelines are likely to result in changes to consent conditions to make them more consistent and to provide clearer benchmarks for compliance.

Steve Urlich
Environmental Scientist
7 April 2014

---

[1] Keeley, N. 2012. Assessment of enrichment stage and compliance for salmon farm. Prepared for New Zealand King Salmon Company Limited. Cawthron Institute Report No. 2080. [Note: This is Enclosure 1].

[2] Keeley, N. 2012. Assessment of enrichment stage and compliance for salmon farm. Prepared for New Zealand King Salmon Company Limited. Cawthron Institute Report No. 2427. [Enclosure 2].

1. Monitoring Report for Te Pangu Bay salmon farm 2013 [Enclosure 3][3]

Consent U090841 (as modified by U130466): To increase the discharge from 4,000 tonnes (as authorised under previous consent U040813) to 5,500 tonnes of fish feed per year. Site No 8408. <u>Condition 22</u>. The environmental quality standards (EQS) that shall be applied for seabed effects follow the model as presented in the application i.e. seabed effects are 'zoned' around the cages to allow for a mixing or transition zone. Outside this zone no adverse effect on the seabed is allowed. Three 'zones' under and around the marine farm shall be established as follows: a) Referred to as 'Zone 2' - Beneath the cages and out to 50 metres from the cages. b) Referred to as 'Zone 3' - From 50 metres to 200 metres from the outside edge of the cages. c) Referred to as 'Zone 4' - Beyond 200 metres from the outside edge of the cages. <u>Condition 25</u>. The EQS in each zone will be managed with reference to permitted 'impact stages', as depicted and defined in Figure 1. In relation to Figure 1, the effects within the zones specified in condition 22 will not exceed (i.e. be higher than) the following permitted impact stages. Zone 2 shall not be more that the transition between stages IV and V. Zone 3 shall not be more than the transition between stages III and IV. Zone 4 shall not be more that the transition between stages I and II

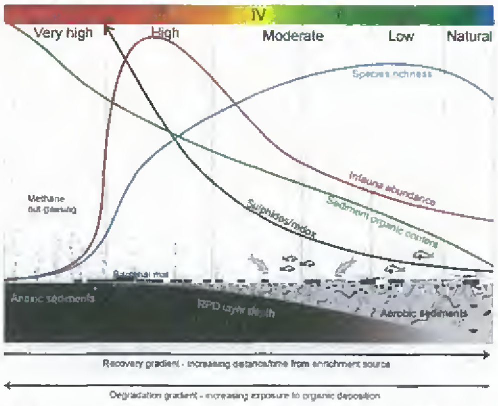


Figure 1. Stylised diagram indicating how environmental variables change over an enrichment gradient in relation to impact stages I-VI.

Preliminary Assessment: The monitoring results suggest the consent is in compliance.

Comment: Pen 1 had an ES of 5.3 ($\pm$ s.e. 0.1) which is above the permitted ES in Zone 2 according to Cawthron's interpretation of the transition between Stages IV and V (Table 3, pg 15, #2464). However, the results are averaged between Pen 1 and Pen 2 (ES 4.7 $\pm$ s.e. 0.1). The consent cannot be said to be in non-compliance, when considering the standard error associated with the results. Averaging of results between sample stations has occurred in past compliance monitoring reports, and has only recently been questioned.

Taking the average of sampling stations within a zone, as opposed to assessing compliance based on single-station values, is a matter for consideration in developing the best practice guidelines. This issue was traversed in the review of Council's preliminary assessment of compliance for the 2012 year (Black 2013)[4].

Another consideration is whether there is any detectable adverse effect from an ES which exceeds 5 at Pen 1. The Cawthron report assesses that there is still a functioning and assimilative benthos, suggesting there is no significant issue, although the low number of taxa "gives some cause for concern" (pg 18). NZKS intend to voluntarily reduce the tonnage discharge by 290mt in 2014[5]. Regular management monitoring of the seabed should probably occur at regular intervals to avoid the Pen sites exceeding the permitted ES. This is because it appears that the seabed appears currently close to its maximum assimilative capacity.

---

[3] Newcombe, R; Keeley, N; Forrest, R. 2013. Environmental Impacts of the Te Pangu Bay Salmon Farm: Annual Monitoring 2013. Prepared for New Zealand King Salmon Company Limited. Cawthron Institute Report No 2464. [Enclosure 3].

[4] Black, KD. 2013. Scientific peer-review of monitoring results from New Zealand King Salmon Farms. SAMS Research Services Ltd.

[5] New Zealand King Salmon letter to Marlborough District Council 13 March 2014 enclosing 2013 Annual Monitoring Reports. [Enclosure 7].

Management monitoring is also recommended to track the condition of the sample station at the Zone 3 NE 300m transect. This is because the ES score of 2.7 (± 0.2 s.e.) is on the borderline of exceeding the background reference levels of enrichment permitted in the consent. Dr Catriona Macleod, in her review of the Cawthron monitoring reports for NZKS, has suggested interrogating the data to assess the actual level of biological risk, and considering additional emphasis in the next monitoring survey.[6] I agree with this approach.

Dr Macleod has also made a recommendation about collecting water quality samples at a consistent stage in the tidal cycle. I agree with this approach for all farms.

2. Monitoring Report for Clay Point salmon farm 2013 [Enclosure 4][7]

Consent U060926 ((as modified by U130466 allowing an additional salmon feed discharge of 500 metric tonnes for period 1 Dec 2012 – 30 Nov 2013): To establish up to 2 hectares of salmon farming structures (cages and barges), to install underwater lighting, to discharge up to 4000 tonnes (reduced from 6000 tonnes at hearing) of salmon feed per annum within marine farm licence 537 and associated discharge marine fouling from nets cages and other structures and from antifouled seal protection nets.

Condition 34. The environmental quality standards (EQS) that shall be applied for seabed effects follow the model as presented in the application i.e. seabed effects are 'zoned' around the cages to allow for a mixing or transition zone. Outside this zone no adverse effect on the seabed is allowed. Three 'zones' under and around the marine farm shall be established as follows:

a) Referred to as 'Zone 1' - Beneath the cages and out to 50 metres from the cages.
b) Referred to as 'Zone 2' - From 50 metres to 250 metres from the outside edge of the cages.
c) Referred to as 'Zone 3' - Beyond 250 metres from the outside edge of the cages.

Condition 35. EQS Compliance Zones shall be defined for the farm, in accordance with Figure 1 and the dimensions and area contained in Table 1.

Table 1: Maximum distances of EQS Compliance Zone 2/3 and Zone ¾ boundaries from the nearest edge of the salmon farm net pens; and the maximum total areas of Zones 1,2 and 3

EQS Compliance Zone Boundary Dimensions (maximum distances)		EQS Compliance Zone Area (Maximum area)
Distance from nearest net pen to Zone 2/3 boundary	Distance from nearest net pen to Zone 3/4 boundary	Total compliance zone area of Zones 1,2,3
Metres (m)	Metres (m)	Hectares (ha)
90	300	31

Condition 36: At all times, the seabed beneath and in the vicinity of the farm shall comply with the EQS specified in Table 2. Zone dimensions and area for compliance purposes shall be defined in accordance with condition 35. Enriched Stages (ES) shall be defined in accordance with Figure 2 (attached) and Table 3 (attached). For the avoidance of doubt, the ES shall be calculated for compliance with purposes as the mean of all sample replicates taken at a single sampling station (refer to Figure 1). Standard errors or confidence limits of the mean ES at each sampling station shall be reported in the monitoring report (refer to condition 41).

Table 2: Environmental Quality Standards (EQS)

Compliance Zone	Compliance Monitoring Location	EQS
Zones 1 & 2 – beside and beneath the net pens	Measured beneath the edge of the net pens	ES ≤5.0 • No more than on replicate core with no taxa (azoic) • No obvious spontaneous out- gassing (H2S/methane) • Bacteria mat (*Beggiatoa*) coverage not greater than localized/patchy in distribution.
Zone 3 – near to the net pens	Measured at the Zone 2/3 Boundary	ES ≤4.0 • Infauna abundance is not significantly higher than at corresponding "Pen" Station • Number of taxa >75% of number at relevant/appropriate reference Station(s)
Zone 4 – outside the compliance zone area of Zones 1, 2, and 3	Measured at the Zone 3/4 Boundary	ES ≤3.0. *

Note:
* For the avoidance of doubt, sediments may be slightly enriched at the furthest distances able to be effectively sampled (300m).
** Examples of sampling station locations are shown in Figure 1. For the avoidance of doubt, these are diagrammatic only.

---

6 Macleod, C. 2014. Review of New Zealand King Salmon Annual Environmental Monitoring Reports 2013. University of Tasmania. [Enclosure 8]

7 Newcombe, R; Keeley, N; Forrest, R. 2013.. Environmental Impacts of the Clay Point Salmon Farm: Annual Monitoring 2013. Prepared for New Zealand King Salmon Company Limited. Cawthron Institute Report No 2468. [Enclosure 4]

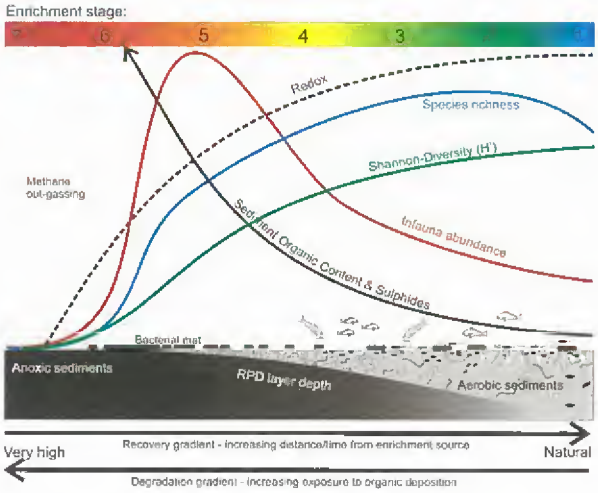


Figure 2 from consent U060926 (as modified by U130466)

Preliminary Assessment: The monitoring results suggest the consent is in compliance, with the exception of the 90m E sampling station.

Comment: Clay Point differs from the other consents, in that Environmental Quality Standards (EQS) align with the seven-stage ES model (Figure 2 above). Compliance is also assessed on single station samples.

The Pen sites were compliant with the ES threshold score of $\leq$5.0, despite negative redox measurements. Infauna abundance and diversity measures reflected that the benthos was functional.

The sample station at 90m E position exceeded the permitted ES of $\leq$4.0 (4.3 $\pm$ s.e. 0.1). The environmental effects of this exceedance do not appear to be significant. The seabed is still able to assimilate waste as the benthos is functional. Dr Macleod pointed out the sediment chemistry was broadly comparable with the 90m W sample station, but the infauna abundance was highly elevated, and exceeded levels recorded at Pen 2.

Although, the 2013 monitoring results at the 90m E sample station exceeded the consent conditions, they are an improvement over the 2012 monitoring results. In 2012, there were negative redox values (>-100 Eh_{NHE}, mV) compared to +100 Eh_{NHE}, mV in 2013, organic matter was more elevated (>7 % AFDW compared to ~5.5% in 2013) and there were higher levels of sulphides (<5000 μM versus <2000 μM in 2013).

Dr Macleod has suggested that the 90m E station results highlight the difficulties in setting appropriate management levels at high flow sites, and that further refinement is needed. She has recommended that the results be therefore considered as useful in improving the identification and management of impacts.

NZKS has signalled an intention to reduce feed discharge to <4000mt in 2014. In addition, they are introducing a high energy diet for the 2014 rearing cycle, which is apparently more easily digested by the fish, and NZKS hope that will result in lower environmental effects for a similar amount of feed discharge.

I agree with Dr Macleod and accept NZKS intended management approach, provided it is implemented.

3. Monitoring Report for Otanerau Bay salmon farm 2013 [Enclosure 5][8]

Consent U040217 To extend the existing salmon and snapper farming structures (currently occupying 1.289 ha) to a total area of 2 ha within the existing permit area (10.0 ha) within the coastal marine zone. To discharge up to 4000 metric tonnes of salmon feed per annum.

Condition 13. The environmental quality standards (ES) that shall be applied for seabed effects follow the model as presented in the application i.e. seabed effects are 'zoned' around the cages to allow for a mixing or transition zone. Outside this zone no adverse effect on the seabed is allowed. Three 'zones' under an around the marine farm shall be established as follows:

[8] Newcombe, R; Keeley, N; Forrest, R.. 2013. Environmental Impacts of the Otanerau Bay Salmon Farm: Annual Monitoring 2013. Prepared for New Zealand King Salmon Company Limited. Cawthron Institute Report No 2465. [Enclosure 5]

Referred to as 'Zone 1' – Beneath the cages and out to 50 m from the cages.

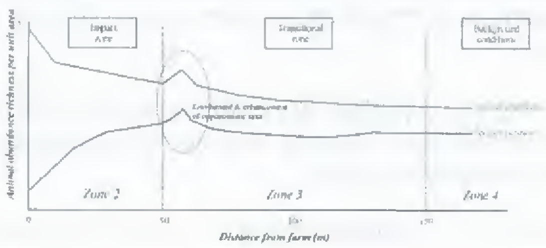
Referred to as 'Zone 2' – From 50 m to 150 m from the outside edge of the cages.

Referred to as 'Zone 3' – Beyond 150 m from the outside edges of the cages.

Existing Condition 14: The zones may be distorted to allow for the action of tidal currents such that the total area of each zone remains the same as if concentric zones were around the marine farm.

Existing Condition 16. The EQS in each zone is

Zone	Spatial Extent	Description and Bottom Line
1	Beneath the cages and out to 50 m from their outside edge	Sediments become highly impacted and contain low species diversity, dominated by opportunistic taxa (e.g. polychaetes, nematodes). It is expected that a gradient will exist within this zone, with higher impacts present directly beneath the cages.
2	From 50 m to 150 m from the outside edge of the cages	A transitional zone between zones 2 and 4. Within this zone, some enrichment and enhancement of opportunistic species may occur, however species diversity remains high with no displacement of functional groups. It is expected that a gradient will also exist within this zone.
3	Beyond 150 m from the outside edge of the cages	Normal conditions (i.e. background or control conditions).
All Zones	These conditions are not permitted beneath any NZKS farm	Sediments that are anoxic and azoic (i.e. no life present) will not be permitted.



Preliminary Assessment: The monitoring results suggest the consent is in compliance.

Comment: Seabed monitoring results under the pens in 2013 were highly enriched but showed an improvement over 2012 results (Table 4, pg 17, #2465), particularly under Pen 2.

However, a new pen site sampled for the first time in 2013 (Pen 3) had highly elevated %organic matter, redox below zero, very high sulphides, and infauna abundance at post-peak levels. This pen site needs to be monitored to prevent the development of azoic conditions. One replicate (A) had only 53 individuals of one species *Capitella capitata*, indicating near-azoic conditions.

Discharge rate and levels need to be carefully managed at this site, given the enriched state of the seabed.

Feed discharge was reduced in 2013 and is the lowest recorded at 1045 tonnes (Figure 3, pg 3, #2465). The site was also fallowed over the previous 2012/13 summer as well as the 2013/14 summer.

Dr Macleod observed that feed discharge at Otanerau has been reduced progressively since 2010 but the ES under the pens have not responded in a similar manner (pg 8, Enclosure 8). She pointed out that the trends in the ecological condition are the important point, rather than the variability in ES scores. It appears that the seabed beneath the pens at Otanerau has limited capacity to absorb sustained quantities of organic material, given the history of highly enriched conditions (Table 4, pg 17, #2465).

Dr Macleod also recommends individual farm strategies for seabed impact reduction and remediation. This is to manage sediment condition through changes in farm management practices, by "providing farms with the necessary tools to be able to respond effectively to the environmental monitoring results" (pg 7, Enclosure 8). Strategies would be based on analysis and modelling of the monitoring data collected over time from different pen positions.

The levels of copper and particularly zinc recorded underneath the pens exceeded the ANZECC ISQG-High threshold for 'probable biological effects'. These samples were reanalysed using weak acid extraction to determine the bioavailable fraction of these constituents. Results have been received in a separate report (#2491 – see Table excerpt below) which shows that the bioavailable fraction of total recoverable zinc exceeded the ISQG-High guideline trigger level of 410 mg/kg dry wt, and the ISQG-Low trigger level for Copper of 65 mg/kg dry wt.

MARCH 2014 REPORT NO. 2491 | CAWTHRON INSTITUTE

Table 2. Total recoverable (TR) and weak acid extractable (AE) copper and zinc (mg/kg dry wt, 1 SE in brackets) from sediments under NZ King Salmon farms at Ruakaka Bay and Otanerau. Grey boxes indicate levels above ISQG-Low; black boxes indicate levels above ISQG-High trigger levels.

	TR Cu	AE Cu	TR Zn	AE Zn
RUA Pen 1	138.3 (32.2)	39 (6.7)	633.3 (92.4)	306.7 (33.3)
RUA Pen 2	221.7 (145.5)	55.7 (6.5)	573.3 (278.3)	343.3 (78)
OTA Pen 1	250.7 (60.7)	55.7 (5.5)	1,506.7 (598.9)	740 (80.8)
OTA Pen 2	410 (80.2)	65.7 (5.5)	723.3 (115.7)	536.7 (17.6)
OTA Pen 3	204.3 (104.4)	46.7 (3.5)	773.3 (58.4)	543.3 (63.6)

The high levels of bioavailable zinc are of concern, as toxicity effects to benthic organisms and communities can occur when threshold concentrations are exceeded, which can result in negative ecosystem level effects (Sneddon 2012)[9].

NZKS changed from using zinc sulphate in feed to organic forms of zinc (methionine analogues or proteinated zinc) in September 2011. This was expected to favourably alter the rate and extent of zinc accumulation in sediments over the long-term.

Dr Macleod has provided some commentary around the source and consequences of metals in sediments. She recommends that "levels of any metals well in excess of ANZECC guidelines still pose a potential toxicity risk and should be avoided and/or appropriately managed" (pg 9).

NZKS have advised that they intend to take a sample from their netting at Otanerau to determine if residual levels of anti-fouling paints on the nets could be contributing to the high levels. NZKS have also advised that they are testing for zinc in feed used on Otanerau during 2013.

Provided these results are shared with Council, this is an acceptable approach towards managing this issue at this time. Monitoring the seabed in November 2014 will assist in determining whether the levels have peaked or are still accumulating over time at the low flow farms.

4. Monitoring Report for Forsyth Bay salmon farm 2013 [Enclosure 6][10]

Consent U040412 To extend the existing salmon and snapper farming structures (currently occupying 1.2 ha) to a total area of 2 ha within the existing permit area (6.0 ha) within the coastal marine zone. To discharge up to 4000 metric tonnes of salmon feed per annum.

Conditions 14, 15 and 17 are the same as for Otanerau (as set out above).

Preliminary Assessment: The monitoring results suggest the consent is in compliance.

Comment: Seabed monitoring results under the pens in 2013 were highly enriched, with overall ES scores between 5.5 and 5.6 for the three pen sites. Biogeochemical and infauna conditions were highly impacted.

[9] Sneddon, IR (2012) Statement of evidence of Ian Ross Sneddon in relation to effects of copper and zinc inputs for the New Zealand King Salmon Co. Limited. Board of Inquiry. http://www.epa.govt.nz/Publications/16%20Ian%20Ross%20Sneddon%20-%20Copper%20and%20Zinc%20Inputs%20-%20v1.pdf

[10] Newcombe, E; Keeley, N; Forrest, R. 2013. Environmental Impacts of the Forsyth Bay Salmon Farm: Annual Monitoring 2013. Prepared for New Zealand King Salmon Company Limited. Cawthron Institute Report No 2467. [Enclosure 6].

The site was fallowed from October 2013 after the discharge of 1783mt from December 2012. Had the farm not been fallowed, the ES at all three pen stations may well have exceeded 6. Sulphide measurements were around ES4, which may reflect relatively rapid recovery of sediment chemistry following fallowing. Cawthron pointed out that the "macrofauna was still highly impacted and the large amount of residual organic matter indicated that the seabed will remain heavily impacted for several months to come".

Dr Macleod noted that: 'although technically the results suggest the site is still compliant it is very clear (and recognised by environmental managers in both industry and council) that this is not a great site for farming. The results suggesting that the conditions are quickly returning to previous levels".

This is a site which previous study by Cawthron has shown that recovery of seabed has taken several years. The reintroduction of the farm may therefore require careful consideration and management.

Zinc levels exceeded the ANZECC ISQG-High levels for probable biological effects, and copper levels were marginally below the level for possible biological effects (ISQG-Low). Similar comments apply here to the management of metals in the sediments, as with Otanerau.

It should be noted that Cawthron are undertaking seabed remediation trials at Forsyth under consent U130789. This will include monitoring benthic recovery and the fate of Copper and Zinc in sediments.

Attachment 4

Review of Councils Preliminary assessments of compliance for 2013 results for Te Pangu, Clay Point, Otanerau and Forsyth Bay, Marlborough Sounds, New Zealand

for

Marlborough District Council

provided by

Professor Kenneth D. Black
SAMS Research Services Ltd.
Scottish Marine Institute
Oban
Argyll
PA37 1QA
UK

April 2014

SRSL, Scottish Marine Institute, Oban, Argyll, PA37 1QA, tel 01631 559 470, www.samsrsl.co.uk

1. Context

The brief provided by Marlborough District Council (MDC) is as follows:

The peer-review should focus on checking the preliminary assessment of compliance, and the explanatory comments, for robustness and plausibility of interpretation. A number of monitoring reports for individual farms prepared by Cawthron Institute are also provided. The peer-review report should clearly identify where it agrees with Council's preliminary findings, and where it departs and why. Additional comments are welcomed.

In this response I will first make some comments on the results reports prepared by Cawthron before commenting on MDC's preliminary assessment of these results.

2. Comments on the Cawthron reports

2.1 Te Pangu (report 2464)

The results show reveal a large farm that is broadly stable over time with respect to annual feed inputs (Figure 2) and benthic impacts (Table 4) and the site appears to be complying with its consent conditions. The value given in the text for sulphide concentration at Pen 2 (6,865 µM) is not reflected in Figure 5 where it looks about 2250 µM. This is consistent with table A1.1 but in the table for section 4.2 the sulphides at pen 2 are described as "very high". This needs to be referred to the authors.

Minor issues

p4 Fig 3 legend and second Y-axis – these are not mega tonnes. They are metric tonnes and there is no need for the word metric when tonnes are so spelled. Also the abbreviation for tonne is t not T (temperature).
p6 second para – so = as.
p10 Azites – AZTI
p14 Figure 7 – units for chlorophyll a not given.
P16 Table, Pen2, is the word "only" appropriate here? I am impressed that there are so many species.

2.2 Clay Point (report 2468)

The large Clay Point farm seems to have responded to increases in feed use over the past 5 years (Figure 2) with slightly increased benthic impact (Table 4) taking into account movements of sampling positions. The station at 90E is slightly outside of its consented range (ES4.3 compared to the target of <4) and this is picked up correctly in the report.

Minor issues:

P9 Azites – AZTI
p13 Figure 7 – units for chlorophyll a not given.

2.3 Otanerau (report 2465)

This medium sized site has experienced reducing amounts of feed input over the last 4 years (Figure 3) and apparently some improvement in benthic impact. The site and stations have changed position slightly since the previous samples were taken (Figure 4) so it is not clear whether the analysis of temporal trends is as meaningful as it would have been had samples been taken from the same positions – but this is inevitable. I entirely agree with the authors that if the site had been made less intensive rather than just smaller, benthic impacts might have been much lower near the cages. However, the site appears compliant at all stations.

The copper and zinc results should certainly be followed up. It will be important to ensure that metal inputs are reduced and that metal concentrations continue to be monitored.

The discussion relating to the results at the control station seems to me to be the wrong way around. We should look at other stations with respect to the controls and not vice versa. There should be no doubt that controls are unaffected by the farm: if there is doubt, these are not controls. In any event it appears that control station 1 will need to be moved.

Minor issue
p13 Figure 7 – units for chlorophyll a not given.
P24 The biological data for station Pen 3C are missing from the table.

2.4 Forsyth (report 2467)
This medium sized site has had highly variable inputs over the past 12 years (figure 2). The site was restocked after a long fallow but the 2011 monitoring showed high impacts. The present study was made after a year of reduced feed input production and showed high impacts near the cages but less than those measured in 2011, probably because of the reduced feed input. The stations under the cages are clearly highly enriched but overall the site appears to be compliant, with the 150m station being close to control levels (ES 2.2 compared to 1.8 and 1.7).

Minor issue
p13 Figure 7 – units for chlorophyll a not given.

3. Peer-review of MDC Preliminary Compliance Assessment.
3.1 Te Pangu
The first paragraph considers the difference between the average values at each pen station and the average of the 2 pen stations. Under the existing consent, MDC allow averaging of results across stations within a zone and thus this zone is compliant. I agree that the benthos at Pen 1 is still functional but also that it appears close to its maximum assimilative capacity and am therefore encouraged that a modest reduction in input is proposed. I also agree that management monitoring is warranted at the 300NE station (ES 2.7) and efforts be made to bring this below the ES2.5 threshold that Cawthron interpret from the consent (Table 3, report 2464). For the purpose of protection of the wider environment, I would argue that it is more important to achieve consent compliance at the boundary of a site than within a site.

3.2 Clay Point
Although there is one station (90E) that is above the consent condition (ES4.3 vs 4.0), this station has improved compared to the previous year and future inputs will be reduced. Given that the 300m stations are consent compliant, I think that the risks to the benthic environment are constrained and

that there is a good prospect of the site becoming completely compliant in the near future given the management action proposed by NZKS.

3.3 Otanerau

Although compliant, the poor condition of the sediments at the pen stations under a regime of declining organic inputs may suggest that this site is still operating at too high a level of input. Regarding providing farmers with tools to better manage their impact, I wholeheartedly agree. Ideally consents have enough flexibility within them to allow farmers to make small adjustments (e.g. to the positioning or specification of cages) specifically for the purpose of reducing environmental impacts. The copper and zinc contamination of the sediments is potentially serious and warrants further monitoring and management action to reduce metal inputs.

3.4 Forsyth

Even more so that at Otanerau, this site seems to have very limited resilience to continued inputs of organic matter at present levels. Although compliant at the time of monitoring, I agree that this may well have become non-compliant had inputs continued. There appears to be general agreement that this site is far from ideal for production at the present level. I look forwards to the results of the benthic recovery and remediation studies proposed and the proposed work on sediment metals.

3.5 Summary of compliance peer review

The preliminary assessment of compliance by MDC for the 4 sites Te Pangu, Clay Point, Otanerau and Forsyth appears to me to be evidence-based, reasonable and provides a consistent approach despite the present differences in discharge consent. This approach offers protection of the benthic environment broadly comparable to that of other salmonid producing countries that I am aware of. However, I am very pleased that the very high levels of zinc and copper contamination at the low flow sites are being further investigated.