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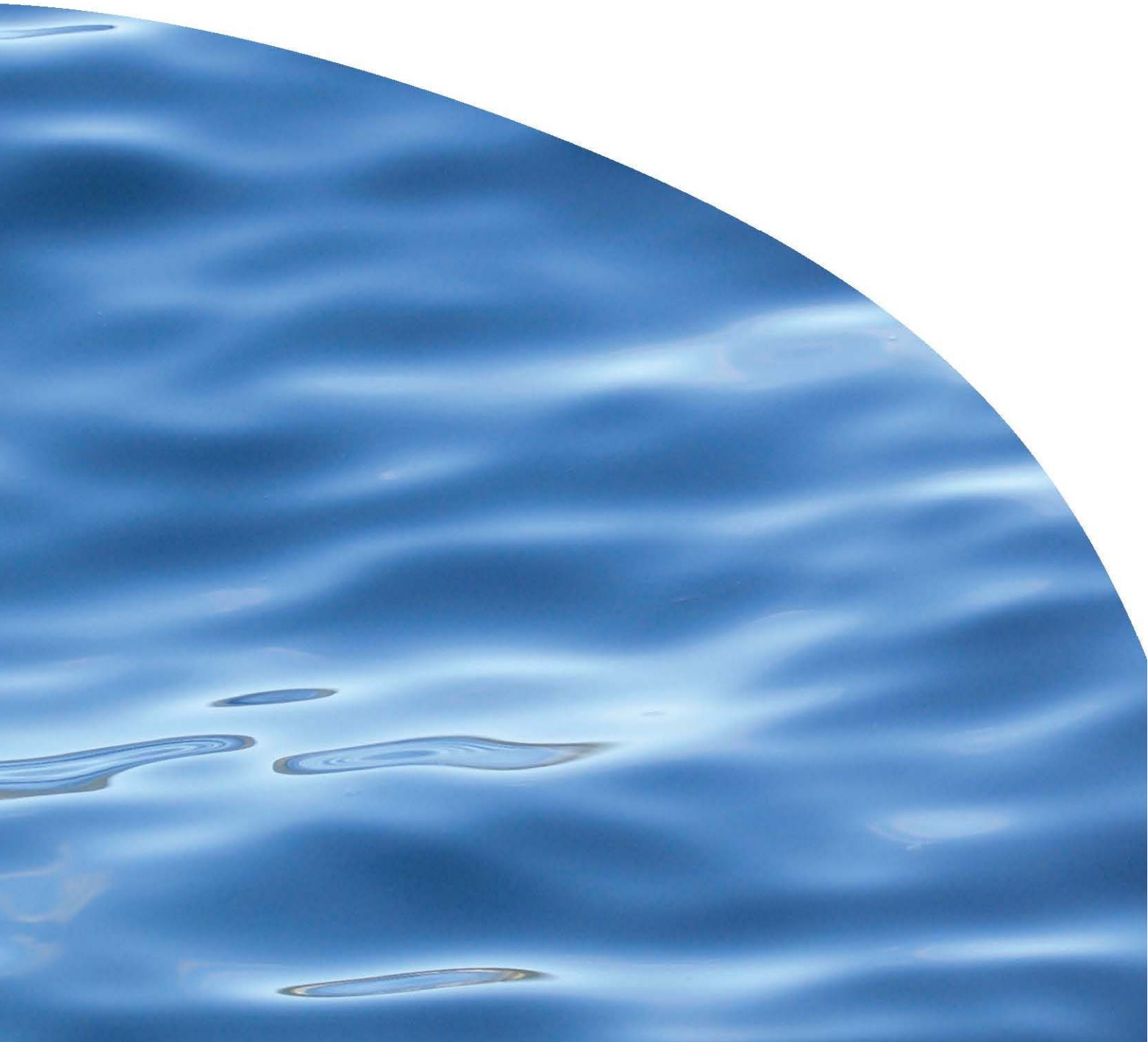

ENVIRONMENTAL IMPACTS OF THE MFL-48 SALMON FARM: ANNUAL MONITORING REPORT 2013

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1. INTRODUCTION

New Zealand King Salmon Company Limited (NZ King Salmon) is the largest finfish farming company in New Zealand and has a long history in the Marlborough Sounds. NZ King Salmon has eight consented farms in the region (Figure 1): Te Pangu Bay (TEP), Ruakaka Bay (RUA), Otanerau Bay (OTA), Waihinau Bay (WAI), Forsyth Bay (FOR), Clay Point (CLA), Marine Farm Licence 48 (MFL-48) and Marine Farm Licence 32 (MFL-32).

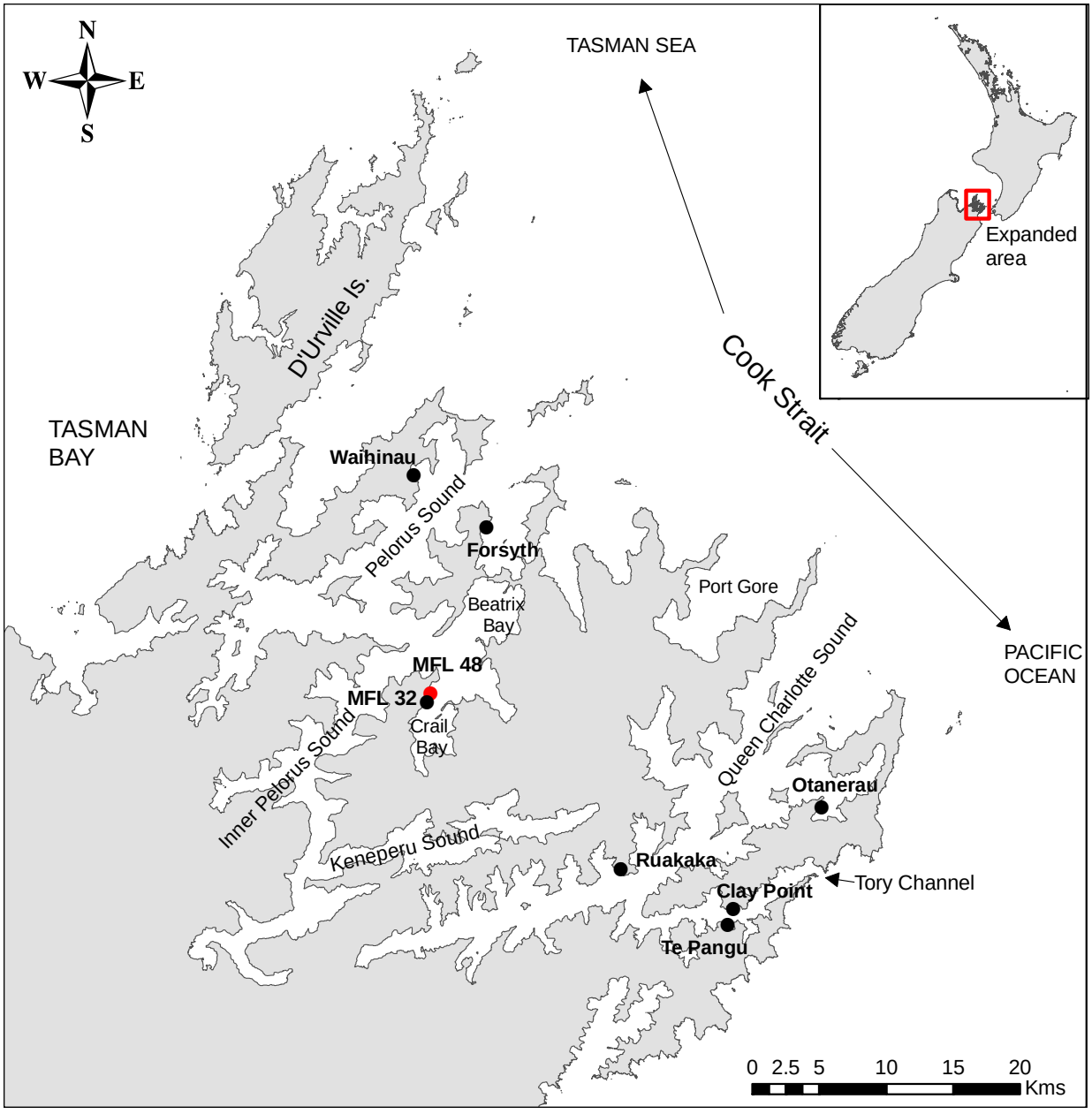

Figure 1. Map of the Marlborough Sounds area showing the location of the Marine Farm Licence 48 (MFL-48) salmon farm (red dot) along with NZ King Salmon's seven other farm sites (black dots).

NZ King Salmon is required to undertake environmental monitoring and reporting in accordance with its marine farm consents. The monitoring programme is conducted under an environmental monitoring plan (EMP) that is prepared by Cawthron Institute (Cawthron) on behalf of NZ King Salmon, and approved by Marlborough District Council (MDC) prior to implementation (Keeley 2013).

Consent conditions for all of the farms (with the exception of Waihinau) broadly require monitoring of the effects of deposition on the seabed, with particular regard to the benthic community composition and abundance, dissolved oxygen (DO) and water quality. The environmental monitoring results are used to determine whether the farms are compliant with the Environmental Quality Standards (EQS) specified in the consent conditions for each farm. These are based on a seabed impact 'zones concept'; a model, which provides an upper limit to the spatial extent and magnitude of seabed impacts (see Keeley 2012). In addition, water column monitoring (measuring nutrients and chlorophyll-*a*) has historically been undertaken each year at one low-flow and one high-flow farm. In 2013 water column monitoring was undertaken at all NZ King Salmon farm sites with a submersible sensor array used to measure *in situ* water column characteristics, and nutrient levels sampled at pen edge and down-current stations. Both TEP and CLA have adjacent rocky reef communities that are also monitored. This report presents the 2013 annual monitoring results for the MFL-48 salmon farm.

Reduced monitoring was undertaken at both Crail Bay farms (*i.e*. MFL-32 and MFL-48) in 2013 because the sites are not currently in use, and have been easily compliant with the farm-specific EQS for the last two years.

1.1. Site details and history of feed usage

The MFL-48 farm site was established as a salmon farm in 2010. It is situated at a depth of ~ 32 m, and with average water current speeds of ~ 2.5-3.0 cm/s, it is considered a low-flow site. It is located approximately 430 m from MFL-32. The MFL-48 and MFL-32 sites are relatively unique in that finfish net pen culture has been conducted alongside long line mussel culture, within the same lease. Historical feed inputs at MFL-48 farm were ~ 15 tonnes in 2010, and ~ 287 tonnes from December 2010 to the end of November 2011[1]. NZ King Salmon purchased the site in 2011 and has since destocked the site (December 2011). It currently lies fallow.

[1] Feed input data provided by NZ King Salmon.

2. METHODS

Sampling at MFL-48 was undertaken on 26 November 2013. Detailed methods and rationale describing the sampling protocol for all of NZ King Salmon's farms can be found in the most recent Annual Monitoring Programme and Methods (Keeley 2013). Copies are held by MDC and NZ King Salmon. This plan is updated and modified routinely to accommodate the most relevant and effective sampling methods. A condensed summary of the techniques that were used in the present survey is provided below.

2.1. Soft sediment habitat

2.1.1. Sampling locations

The MFL-48 salmon farm was monitored at the following locations:

- two pen stations (at the edge of Zone 1)
- two stations along a transect aligned perpendicular to the shore (away from the pens) at distances that correspond to the Zone 2-3 and Zone 3-4 boundaries, specified under the 'zones concept' (*i.e.* stations '50 m' and '150 m' respectively)
- one comparable reference or 'control' (*i.e.* 'CB-Ctl-1') station (Figure 2).

For a full explanation of the zones concept, please refer to Keeley (2011).

The Zone 2–3 and Zone 3–4 stations could not be positioned in line with the predominant direction of flow, due to the presence of mussel farms immediately to the north and south of the pens. This is considered acceptable as MFL-48 is a low-flow site and therefore will have minimal footprint deformity (*i.e*. skewing of the footprint) and the depth and substrates remain constant in the chosen direction.

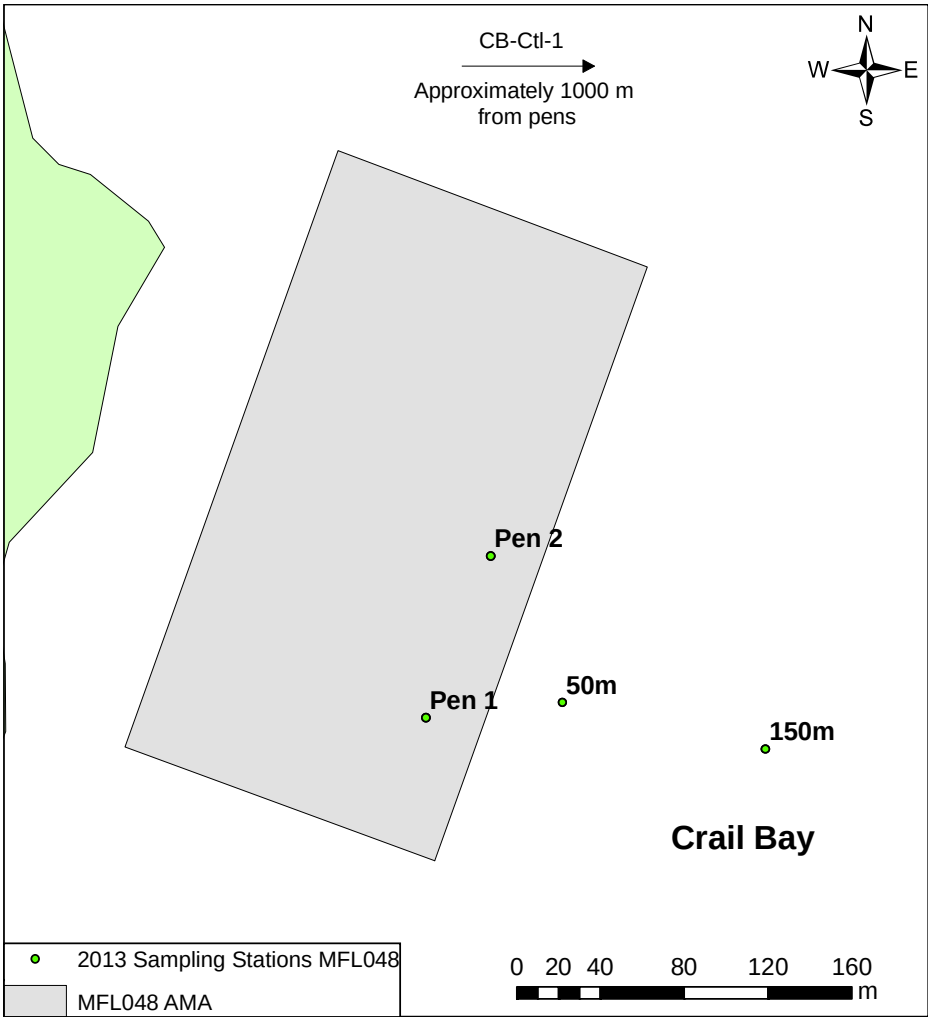

Figure 2. Soft sediment sampling locations for Marine Farm Licence 48 (MFL-48) in 2013. 'CB-Ctl-1' was located in the centre of Crail Bay (CB), approximately 1 km northeast of MFL-48. Station depths: Pen 1 = 33 m, Pen 2 = 33 m, 50 m station = 36 m, 150 m station = 33 m, CB-Ctl-1 = 32 m. Position accuracy ± 5 m.

2.1.2. Environmental variables

Three replicate sediment grab samples were collected at each sampling station using a modified van Veen grab. The top 3 cm of one sediment core (63 mm diameter) was analysed for redox potential (Eh_{NHE}, mV), and total free sulphides (µM). Organic matter in the sediments was not measured in 2013. Pen samples were analysed for copper and zinc concentrations. The sea surface was scanned for visible sediment out-gassing as this could provide further evidence of particularly enriched conditions.

Biological communities were not monitored under MFL-32 and MFL-48 in 2013.

2.2. Water column

Discrete samples were collected from mid-water using a van Dorn sampler. These were analysed in the laboratory for total nitrogen (TN), nitrate-N (NO_3-N), nitrite-N (NO_2-N), ammoniacal-N (NH_4-N), dissolved reactive phosphorous (DRP) and total phosphorus (TP).

In situ water column profiles of dissolved oxygen, turbidity, temperature, salinity, and chlorophyll-*a*[2] were recorded at each MFL-48 sampling station by slowly raising a data-logging sensor array from the seabed to the surface.

3. RESULTS

3.1. Soft sediment habitats

3.1.1. Physico-chemical characteristics

Redox potentials were lower at the two pen stations than the down-current and control stations (Figure 3), nonetheless all stations had average redox potentials >100 Eh_{NHE}, mV. Similarly, total free sulphides were elevated at the pen stations, and to a lesser extent at the 50 m station, compared to the down-current and control stations. Control levels of sulphides were near the lower limit of detection for the analysis.

[2] In 2013 use of the data-logging sensor array allowed for *in situ* measurement of chlorophyll-*a* throughout the water column, laboratory analysis of chlorophyll-*a* from discrete water samples was therefore not necessary.

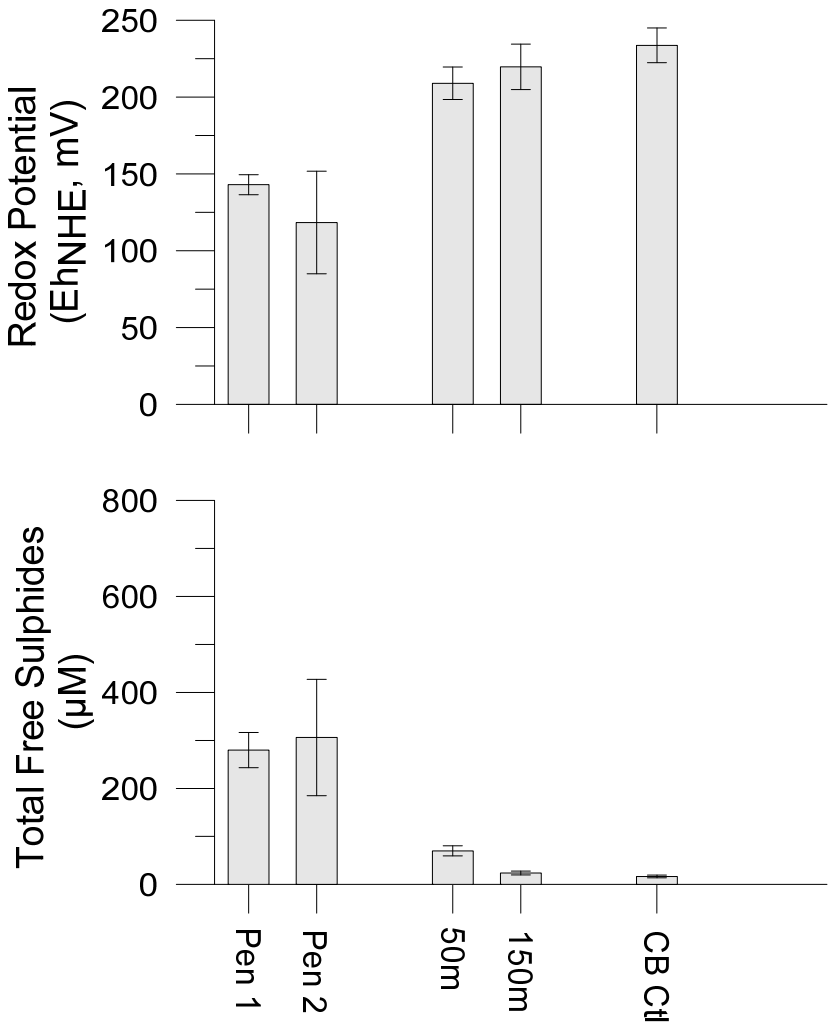

Figure 3. Redox potential (Eh_{NHE}, mV) and total free sulphide concentrations (µM). Error bars = standard error (SE), n = 2 at Pen 2, n = 3 for all other stations.

3.1.2. Copper and zinc

Sediment copper and zinc concentrations in samples from beneath the pens were below the ISQG-low threshold of 65 mg/kg and 200 mg/kg respectively (ANZECC 2000). (Appendix 1, Figure A1.1). Levels of both metals were similar to the previous year.

Table 1. Copper and zinc concentrations in sediments (raw data).

Station	Replicate	Total recoverable copper (mg/kg dry wt)	Total recoverable zinc (mg/kg dry wt)
Pen 1	1	15	71
	2	11	61

3.2. Water column

Due to the MFL048 site being fallowed at the time of sampling, water column nutrient samples were only collected from the net-pen and control stations. Levels of ammonia were slightly higher at the pens than at the controls, all other nutrients were identical at pen and control stations, or lower at the pens (Table 2).

Table 2. Water column sampling results from the Marine Farm Licence 48 (MFL-48) pen station and the nearby Crail Bay (CB) Ctl-1 station. Values are averages in g/m^3, with 1 SE in brackets, n = 3 for all samples. Shaded boxes indicate that more than one replicate reading was below the analytical detection limits. Individual readings below the detection limit were assigned the detection limit value.

	Station	
	Pen 1	**CB-Ctl**
Nitrate-N (NO_3-N)	0.002 (0)	0.002 (0)
Nitrite-N (NO_2-N)	0.002 (0)	0.002 (0)
Ammonia (NH_4-N)	0.017 (0.003)	0.013 (0.003)
Total nitrogen (TN)	0.19 (0.005)	0.207 (0.007)
Dissolved reactive phosphorous (DRP)	0.006 (0)	0.006 (0)
Total phosphorus (TP)	0.011 (0.001)	0.013 (0.002)

At both MFL-32 and MFL-48, water column profiles indicated strong density stratification, with a large drop in temperature, and increase in salinity with depth (Figure 4). Sub-surface chlorophyll-*a* maxima occurred around 15–25 m, and indicated moderately productive conditions. These conditions were consistent with the observed turbidity increase at depths >20 m (probably due to the deposition of phytoplankton from above) and the decline in DO from a peak of ~8.5 mg/L at approximately 10 m, to ~6.5 mg/L at the seabed. There was no apparent effect of proximity to pens on the water column characteristics.

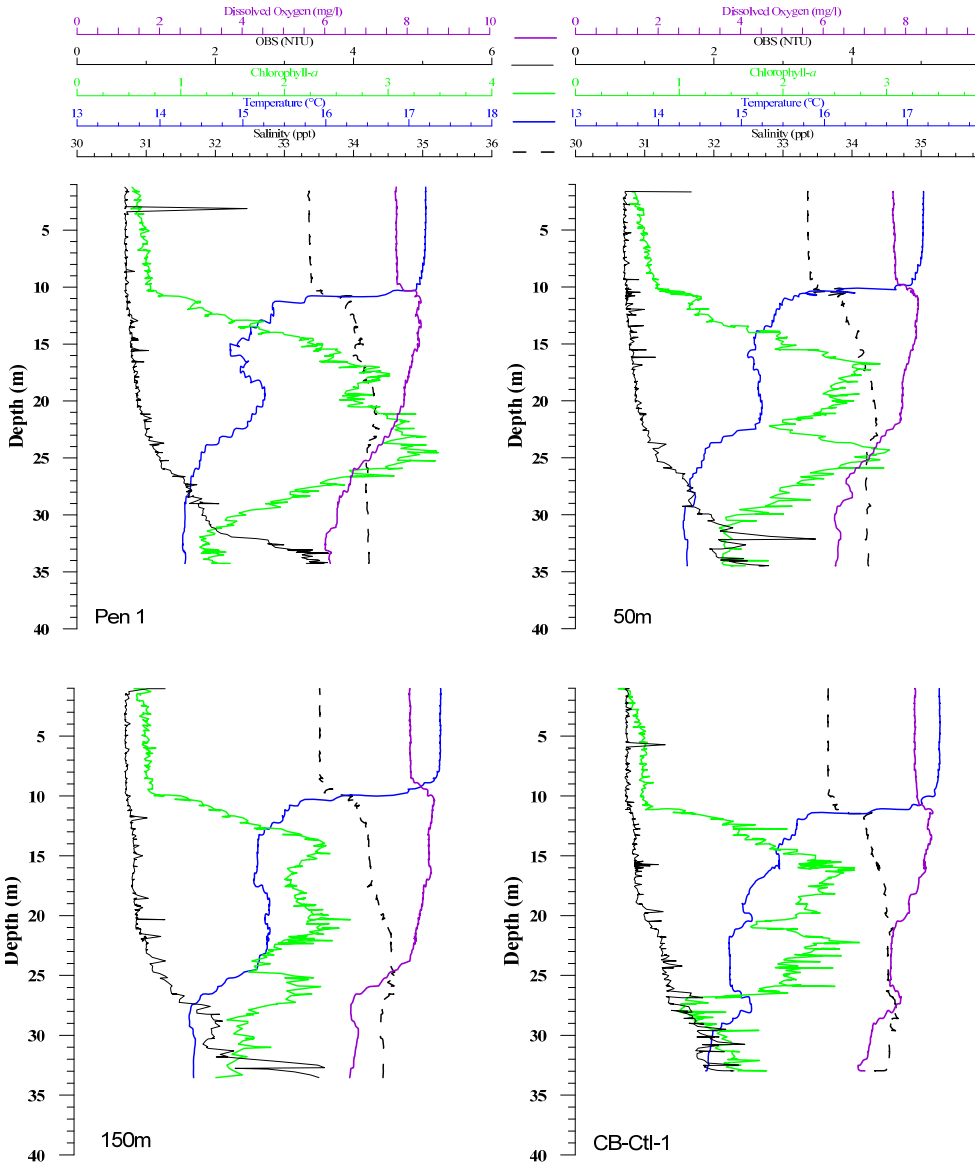

Figure 4. Dissolved oxygen, turbidity (optical backscatter), chlorophyll-*a*, temperature, and salinity as measured by an *in situ* sensor array raised through the water column.

4. ASSESSMENT OF SEABED ENRICHMENT

Redox potential and sulfide levels under the pens revealed slight impacts of farming. While still classified as normal, levels of these factors at the pen sites indicated mild enrichment, and minor impacts were still observable at the 50 m station.

5. SUMMARY AND CONCLUSIONS

In November 2013, the reduced monitoring programme undertaken at the MFL-48 salmon farm showed only minor impacts of farming.

5.1. Seabed enrichment

The selected subset of environmental variables investigated showed minor benthic impacts. The results are consistent with the farm undergoing recovery since being destocked two years prior to monitoring. The minor signs of enrichment observed could be at least partly attributed to the presence of the mussel farm. Full benthic monitoring should recommence once the farm is restocked.

5.2. Copper and zinc

Levels of metals remained low, and below ANZECC thresholds for possible biological effects.

5.3. Water column

The slight increase in ammonia observed at the pens was not ecologically significant. There was no evidence of farm-related effects on near-bottom DO levels and other water column measurements revealed no discernable impacts of farming.

6. REFERENCES

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Keeley N 2012 Assessment of Enrichment Stage and Compliance for Salmon Farms — 2011. Prepared for New Zealand King Salmon Company Limited. Report No. 2080. 15 p.

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7. APPENDIX

Appendix 1. Comparison of copper and zinc levels.

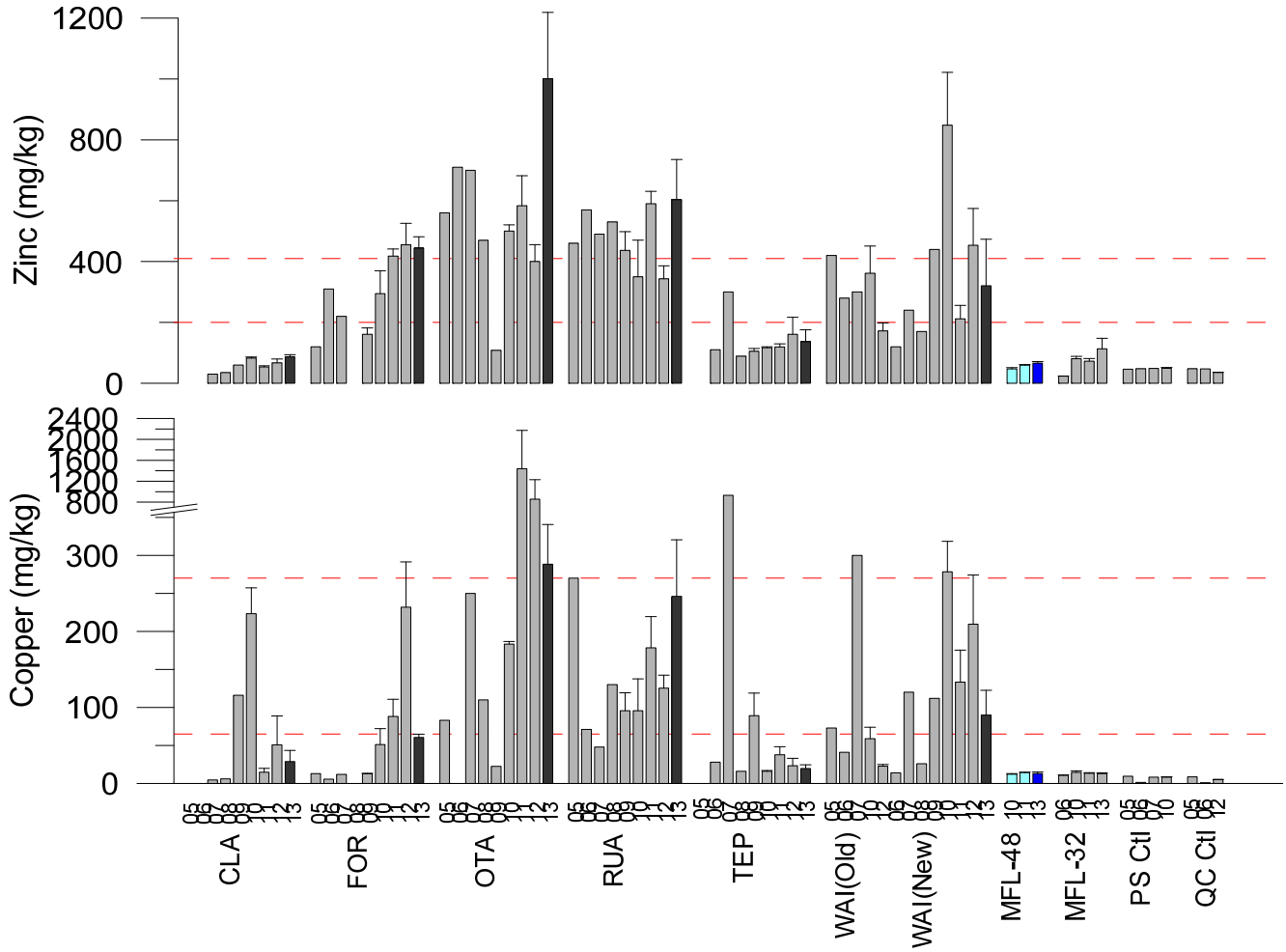

Figure A1.1. Comparison of the last nine years of annual monitoring data for sediment copper and zinc concentrations beneath all eight NZ King Salmon farms and two control stations (PS = Pelorus Sound, QC = Queen Charlotte). Red dotted lines indicate respective ANZECC ISQG-High and -Low trigger levels. Marine Farm Licence 48 (MFL-48) salmon farm site data are in blue. Error bars = +1 SE