

Salmon Farming: It's all about Location, Location, Location

The Kenepuru and Central Sounds Residents' Association (KCSRA) has been interested in different aspects of salmon farming in the Marlborough Sounds for some time. KCSRA's interest sharpened in 2012 as a result of New Zealand King Salmon (NZKS) wanting to place a large number of new salmon farms in the Sounds in areas then prohibited for marine farming. To achieve this NZKS initiated a Board of Inquiry process under the Resource Management Act (RMA). Coincidentally in 2012, a mass salmon mortality event happened at the NZKS Waihinau farm in the Pelorus.

Understandably, KCSRA was concerned at the reputational risk to the Sounds in terms of it being associated with large fish mortality events and this risk being enhanced as a result of the ramped up NZKS proposals. We were also nervous about the disease risk spilling over into other areas or other species.

Questioning NZKS experts as to their knowledge of this event at the Board of Inquiry proved largely fruitless. So, contemporaneously, KCSRA also sought answers as to the cause and extent of the mortality spike from the bio-security regulator – the Ministry for Primary Industries (MPI) via the Official Information Act (OIA). Answers to a number of our requests were declined by MPI. A complaint was made to the Ombudsman who initiated an inquiry. In due course (well over a year later) our complaint was largely upheld.

In 2015 another mass mortality event was reported by the media again at the NZKS Waihinau farm in the Pelorus. Again very little concrete information/analysis was supplied to the general public by MPI. Again the Association sent OIA requests to MPI, trying to find out what was going on, and if this was going to become the new norm. Again, “commercial sensitivity” was cited as a reason to withhold information.

Given this background and the interest shown by some members, KCSRA formed a small working group to carry out our own research and analysis to get an understanding of the root causes of NZKS salmon dying en masse in the Marlborough Sounds on a regular basis. The efforts of this group have led to this paper.

This paper collates data and evidence together from many sources, to explain to members and the general public what we have been able to garner about why, what and how these mortality events are happening and why in our view it is likely to continue to happen.

Introduction

Salmon Farming: Location, Location, Location

This slogan taken from the real estate business is also very apt for salmon farming.

In short, farming salmon (Chinook, also known as King, Salmon, in particular) is not easy being high maintenance and requiring very specific particular conditions in order to be able to be farmed efficiently.

To date, as far as we can ascertain, NZKS believes the prime location for salmon farming in New Zealand is the Marlborough Sounds. As noted, in 2012 NZKS initiated a very controversial bid to obtain, via a fast track Board of Inquiry (BOI) process, the water and sea bed space for nine new salmon farms in the Marlborough Sounds.

For the BOI process, NZKS presented a large number of documents, some dealing with the technical aspects of successfully farming Chinook or King Salmon.¹

The excerpt below is from NZKS's Mark Gillard's Site Selection and Consultation Document.²

"Key matters for consideration in selecting possible salmon farm sites

20. *Based on my experience, there are two overarching critical matters to consider in determining whether it is feasible to farm salmon productively:*

- a. *The **first critical matters** are the key appraisals of the physical characteristic required for salmon to successfully grow (rather than perform poorly or possibly die). These are primarily:*
 - i. **Water temperature** - salmon prefer cooler waters and usually grow best in water temperatures between approximately 12 to 17 °C;
 - ii. **Water depth** - which preferably should be at least 30 metres and ideally 40 metres or more;
 - iii. **High current** - it is generally preferable to grow salmon in areas of high current.

*Water depth and current can impact on temperature, but are also important in terms of "flushing" by-products from the farm area. It is not an exact science. For example, some warm sites that are at the marginal temperature of 17 °C (or even just over in the summer), can be managed if they are for example stocked at times to avoid warm temperatures especially with smolt during their first year in seawater. **Our existing site at Waihinou Bay falls into this category. Although we have farmed this site for over 20 years, we do still experience difficulties with our autumn mortality event.**"³*

¹ Details of the Board of Inquiry, including written evidence and transcripts of the hearings, may be accessed at:

<http://www.epa.govt.nz/Resource-management/previous/king-salmon/Pages/default.aspx>

² <http://www.epa.govt.nz/Resource-management/previous/king-salmon/evidence/Pages/Corporate-and-consultation-evidence.aspx>

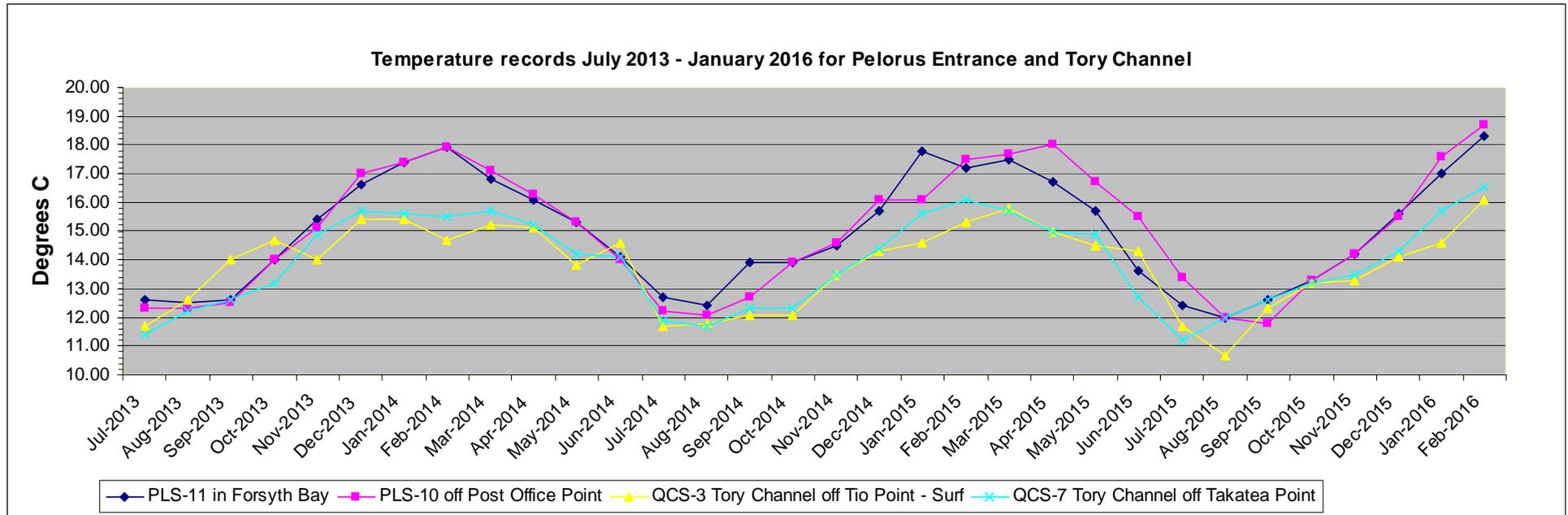
³ Emphasis added

Water Temperature

Clearly water temperature is a critical factor. So how does the Marlborough Sounds perform against this factor?

Figure 1 below shows recent temperature measurements collected by the Marlborough District Council (MDC).⁴

Figure 1 2014 and 2015 Average Monthly Temperatures in Outer Pelorus Sound and Tory Channel



The Pelorus is significantly warmer than Tory Channel and the average monthly temperatures in the summer are above the ideal temperature range of 12 – 17 °C for king salmon. In the Marlborough Sounds, Tory Channel, from a temperature point of view, provides the best growing conditions for salmon, exhibiting the correct water temperature, good depth and high current flow.

The question that remains to be answered is whether the environment of the Pelorus Sound is good enough to grow salmon successfully.

⁴ http://www.marlborough.govt.nz/Environment/Coastal/Monitoring-Research/-/media/Files/MDC/Home/Environment/Coastal/MDC_Monthly_Monitoring_Locations_Marlborough.pdf

Salmon Environmental Requirements

There is more to what makes up the ideal mix of growing and living conditions for farmed Salmon. The web site “The Fish Site”⁵ provides fish farming guides for a long list of farmed fish species.

For salmon, seafarm locations are selected on the basis of season water temperature profile, dissolved oxygen content, salinity, depth and current velocity; exposure to storms; presence of harmful algae and diatoms; proximity to other farms; and in compliance with local regulations. What follows is a snapshot of the various salmon species requirements.

Chinook (King) Salmon farming (the species favored by NZKS) is < 1% of total salmon farming in the world, Unfortunately this means there is not much data available on the web about the specific requirements of Chinook. Coho Salmon come closest.

However, there seems little disagreement that Chinook Salmon grow best when temperatures are in the range of 12–17 °C, while water currents have to be sufficient to disperse wastes and provide a continuous supply of well-oxygenated water. Chinook (King) Salmon remain in seawater for 15–18 months and are harvested after reaching 3.5–4.0 kg.

Coho Salmon tolerate a wide array of oceanic conditions but grow best when temperatures are in the range of 9–15 °C, and water currents are sufficient to disperse wastes and provide a continuous supply of well-oxygenated water. Our research suggests that stocking densities at harvest should not exceed 8–12 kg/m³.

Coho Salmon remain in seawater for 10–12 months and are harvested after reaching 2.5–3.5 kg. Best management practices dictate that a seafarm should contain only a single year class of fish. This practice reduces the risk of disease transmission to arriving smolts.

Atlantic Salmon seem to grow best in sites where water temperature extremes are in the range 6–16 °C, and salinities are close to oceanic levels (33–34 per cent). Water flows need to be sufficient to eliminate waste and to supply well oxygenated water (approximately 8 ppm).

Maximum stocking densities of up to 20 kg/m³ are usual. Atlantic Salmon are ongrown in seasites for up to 2 years with harvesting of fish from 2 kg upward. Seasites normally contain a single generation of fish. It seems good practice is to fallow seasites for a period of 6 weeks or more prior to the introduction of a new generation of fish.

Salmon Health

Salmon Health and Water Temperature

Our research shows that: ⁶Because water temperature affects the health of individual fish, it also affects entire populations and species assemblages. Temperature may directly affect salmonids in

⁵ <http://www.thefishsite.com/> - news, features, articles and disease information for the fish industry.

⁶ www.nwfsc.noaa.gov/trt/wlc/viabrpt/appendix_l.pdf - APPENDIX L

MAXIMUM TEMPERATURE: UPPER OPTIMAL TEMPERATURE LIMITS FOR SALMONIDS IN THE WILLAMETTE AND LOWER COLUMBIA RIVERS

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obvious ways, or indirectly through interaction with other important variables. (Dunham et al. 2001).

For example:

- Given sufficient magnitude and time, high temperatures can cause weight loss, disease, competitive displacement by species better adapted to the prevailing temperature, or death (Sullivan et al. 2000).
- When fish are stressed by any one process, they are less able to deal with other stressors. Salmonids already stressed by high water temperature will be less able to deal with a second stressor (e.g., **toxic pollutant, pathogen**). **Warmer temperatures often increase the infection rate or virulence of fish pathogens and lessen the ability of a fish to withstand disease** (Materna 2001) (Emphasis added).

Salmon Health and Water Flow

With salmon farming, high flow seems desirable, as it flushes away the excess nutrients (uneaten food pellets, fish faeces, etc.) from the farm and deposits it elsewhere. The seabed under a farm gets less quickly impacted than in low flow locations. Deeper water is also advantageous, as there is more time for the particles to be flushed away and the salmon are further removed from the ill effects of sulphide outgassing, low dissolved oxygen, etc. caused by a heavily impacted seabed. However we note that it seems that low flow sites can still be farmed effectively if best management practices are followed.

Salmon Health / Mortality and NZKS

So how do these factors play out in NZ in terms of mortality over the growing cycle? How does NZKS perform against its peers on a global basis?

Well, that sort of information is very hard to source from either NZKS or the Government agency responsible for monitoring disease outbreaks and animal health welfare – MPI, commercial sensitivity again. Nevertheless we hunted around the web and came up with some very interesting figures from an Industry group called the Global Salmon Initiative (GSI) of which NZKS seems proud to be a member.

From a Global Salmon Initiative Sustainability report⁷:

Fish mortality is a key measure used to evaluate fish health during production. We have chosen to measure mortality using a 12-month rolling mortality rate. This measure calculates mortality for the last 12 months (January – December) as a proportion of the estimated number of fish in the sea in the last month of the year (adjusted for harvest and mortalities).

From the GSI data we compiled Figure 2 below, which, as we understand it, shows the recorded mortality figures for all the salmon farms operated by GSI members worldwide.

⁷ <http://globalsalmoninitiative.org/sustainability-report/sustainability-indicators/>

Figure 2 Worldwide mortality figures for farmed salmon

Mortality Figures (% of total farmed fish averaged over a year) for different types of Salmon							
~ 70% of total farmed salmon http://www.globalsalmoninitiative.org/sustainability-report		2013	2013	2013	2014	2014	2014
		Atlantic Salmon	Chinook Salmon	Coho Salmon	Atlantic Salmon	Chinook Salmon	Coho Salmon
Country	Company						
New Zealand	NZKS		13.61			16.32	
Australia	Huon	6.38			7.71		
Chile	AquaChile	7.00		5.60	8.80		4.30
	Blumar	5.85			4.18		
	Camanchaca	4.70			3.10		
	Cermaq	8.98		6.55	9.73		6.55
	Los Fiordos	13.90		4.40	9.80		3.80
	Marine Harvest	3.33			2.15		
	Multiexport						
	Foods	9.55			3.48		2.97
Scotland	Ventisqueros	6.20		8.21	5.13		3.37
	Grieg Seafood	9.80			11.60		
Canada	Marine Harvest	6.40			14.40		
	Cermaq	5.56			7.06		
Faroes	Grieg Seafood	6.80			5.20		
	Marine Harvest	6.61			6.88		
	Bakkafrost	4.96			4.86		
Iceland	Marine Harvest	2.10			2.84		
	Fjardalax	4.40			13.40		
Ireland	Marine Harvest	38.56			18.15		
Norway	Cermaq	4.25			4.09		
	Grieg Seafood	9.00			10.90		
	Marine Harvest	4.72			4.76		
Average mortality per type		8.05	13.61	6.19	7.53	16.32	4.20
Average normal mortality (Excludes mortality > 10%)		6.36			6.20		

Discussion of Figure 2

As can be seen from the GSI data, the global figures show an average normal mortality rate of 6-6.5% per year. Mortality rates > 10% are seen to be, as we understand it, caused by an abnormal event, like disease or infestation or high water temperature or a combination of all three.

In respect of the unusual high mortalities shaded above in Figure 1 we uncovered the following incidence reports/commentary:

- 2013 Ireland Marine harvest mortality due to Amoebic Gill disease (AGD) and in 2014 due to abundance of jellyfish at exceptionally high seawater temp.
www.thefishsite.com/fishnews/category/13/salmon/vars/country/cl/.../45
- 10 December 2013 ... CHILE - An outbreak of Infectious Salmon Anaemia (ISA) has been detected on a fish farm in Chile. ... New Research Can Help Predict Fish Mortality in ISA

Outbreaks CHILE ... Anemia (ISA) has been detected by Chile's National Fishery and Aquaculture service (Sernapesca) on a Los Fiordos salmon.

<http://aquaculturedirectory.co.uk/the-health-status-impacts-chilean-salmon-firm-results/>

- October 9, 2015 - Aquaculture News, News-Europe: Sea temperature rise proves costly for Scottish fish farmer
Rising sea temperatures have been blamed for a huge increase in annual costs, including the loss of fish worth £7.75million, at salmon farms operated by Marine Harvest (Scotland). The firm, part of Norwegian fish farming giant Marine Harvest, said “fish health challenges” and treatment losses during 2014 were impacted by a slight increase in water temperature. The health issues related mainly to sea-lice, algae and amoebic gill disease – all of which can be exacerbated by the smallest changes in temperature and be ruinous for salmon production.
<http://aquaculturedirectory.co.uk/sea-temperature-rise-proves-costly-for-scottish-fish-farmer/>
- And for the NZKS high mortality percentages: No report, **nothing at all** on the web about the 2013 and 2014 NZKS salmon mortality rates, although it seems to be up to triple the world average.

Questions we are interested in include: What causes these high NZKS mortality rates? Is it high at every Sounds NZKS farm or are there “hot spots”, specific farms where it happens every year? Is the salmon mortality spread out through the year or is there a large peak during the summer for instance? Is this mortality linked to changes in the marine environment or to other management practices such as feed or excessive stocking rates?

To try and answer these questions we decided to focus on the information we could garner for the NZKS “hot spot” – their farm at Waihinau Bay in the Pelorus Sound.

Salmon Farming at Waihinau

We believe the NZKS Waihinau Bay salmon farm has been in operation since 1989.

Our research suggests that it is a low- to moderate-flow site, with mid-water average flows of 8.4 cm/sec, and maximum water velocities up to 33.7 cm/sec. Water depth at the farm site is on average 26 m, with the net pens extending from the surface to a depth of about 20 m.

As can be seen from the MDC data in *Figure 1 2014 and 2015 Average Monthly Temperatures in Outer Pelorus Sound and Tory Channel*, the Waihinau farm is operating at or above the desired water temperature limit (17°C) for King Salmon for several months of the year (Post Office Point is closest to Waihinau Bay).

As part of its resource consents, NZKS needs to supply annual reports to the MDC. Unfortunately, for various legacy reasons these reports focus only on what is happening to the seabed (benthic) and not on farming operations or mortality events. However, we searched around.

2014 Mortality Event

NZKS reported for 2014 in the Global Salmon Initiative report (see Figure 2 Worldwide mortality figures for farmed salmon) a 16.3% overall mortality rate, for its farmed salmon. Against an average salmon mortality of 6.2% across the industry, we believe this is a fair indication that a significant mortality event has happened that year.

Our hypothesis was that the mass mortality happened at the Waihinau farm and we have found data supporting our hypothesis. Moreover, we estimate that half of the fish in this farm died in 2014. In a Stuff interview in March 2015, Mr. Rosewarne of NZKS also mentions a high mortality rate at the Waihinau farm in 2014.⁸ Accordingly it seems possible that there was an unusual mortality event in 2014, but, as yet, we have been unable to have this independently confirmed.

2015 Mortality Event

It does not seem rocket science to arrive at the conclusion that the Waihinau Salmon Farm is at best poorly located and at worst a disaster waiting to happen year after year. On that note we now turn to the latest reported unusual mortality incident involving NZKS operations in the Marlborough Sounds.

The following is taken from an interview reported on Stuff on 13 March 2015, with NZKS CEO Mr. Rosewarne:

*“NZ King Salmon chief executive Grant Rosewarne said **warm sea temperatures**⁹ at the company's Waihinau Bay farm, in Pelorus Sound, had contributed to the deaths. Rosewarne would not say for commercial reasons how many salmon had died, or how many fish were at the farm, but said the mortality rate was a "multimillion-dollar problem to solve".*

Water temperatures at the Waihinau Bay farm had stayed above 18 degrees Celsius for three months, Rosewarne said. "I don't think we've ever had it quite as bad as this year."

The increased salmon death rate in the Pelorus Sounds started in mid-February, Rosewarne said.

*The Waihinau Bay farm is the only NZ King Salmon farm affected by higher than normal mortality rates. No "**primary pathogen**" was pinpointed during investigations into what was causing the fish deaths, and there was no risk to human health, Rosewarne said.*

Rosewarne said staff were unable to move the fish to another site because it would put further stress on them, and there were no suitable alternative sites for the fish.

Wanting to know more about the scale and seriousness and response to this unusual salmon mortality event in the Marlborough Sounds, KCSRA sent several OIA requests to MPI.

We wanted to know what (and when) they had found out about the 2015 mortality event.

It is interesting to compare what we asked and what MPI was prepared or able to divulge bearing in mind the latter's concerns about breaching commercial sensitivity. As our last Ombudsmen noted in the title of her final report, regrettably OIA requests are increasingly a "game of hide and seek".

⁸ <https://www.google.com/url?q=http://www.stuff.co.nz/marlborough-express/news/67314620/Millions-lost-after-warm-seas-kill-salmon>

⁹ Emphasis added

The interview with Mr. Rosewarne is dated March 2015. The most informative MPI response to our OIA requests after a set of reasonably cordial exchanges was dated December 2015.

It is clear from Mr. Rosewarne's reported remarks that in March 2015 there was a significant and unusual mortality event in full swing in at least the NZKS Waihinau farm.

However, MPI confirmed that NZKS did not see fit to notify MPI until some time in May 2015.

We asked MPI to confirm the name or names of the NZKS farms involved. MPI declined citing various parts of section 9 of the OIA (prejudice the commercial position of the person (NZKS) disclosing the information and that the information was supplied under an obligation of confidentiality).

From what MPI was prepared to confirm and in subsequent discussions it seems MPI has ruled out feed as a primary causative agent. MPI believed water temperature alone not to be the primary cause either. They preferred to point to a range of possible causative factors.

MPI confirmed that they had collected past and present mortality data as well as temperature and other environmental data for analysis, but they did not share this data with us due to commercial sensitivity issues.

No "pathogens" were found by NZKS during their investigations, but the MPI Animal Health Laboratory (AHL), confirmed that *Tenacibaculum maritimum* and a *Rickettsia*-like organism were detected in salmon samples. Further investigations are being carried out to determine if these pathogens are present in other salmon farms and other areas of the Marlborough Sounds.

Retesting fish from the 2012 Mortality Event at the Waihinau farm showed, using new and more sophisticated techniques, that these pathogens were also present then.

These pathogens are not seen by MPI as a threat to human health or warm blooded animals.

MPI has issued movement restrictions to the farms where the pathogens were detected, to mitigate the further spread of the pathogens while investigating the cause of the mortalities. Of course they could only do that, once they became aware of the unusual mortality event.

For the full details of the questions and answers see the KCSRA web site www.kcsra.org.nz.

So What Next?

As far as we know the Waihinau farm was not restocked with smolt in 2015.

In May 2015, we understand that smolts (very young salmon) were introduced into the Forsyth farm. MDC records state that early January 2016, the Forsyth farm structure was towed with the young salmon to the new Waitata farm location.

This is the first time that the Waitata farm location has been used. It is near the Waihinau farm.

To date MDC records show that the Sound water temperatures in this El Niño year are even higher than in 2015. We will endeavour to find out what is happening at Waitata Bay. Given their close proximity we believe the Waihinau, Forsyth and Waitata farms could well share the same pathogens.

Conclusion

In our view from the evidence we have collected, it seems clear that the Waihinau farm mass mortality events are not isolated events, but happen frequently, and may do so as long as NZKS keeps farming salmon in the Pelorus Sound and certainly at this site.

A likely consequence of high seawater temperatures during summer, combined with low to medium current flows, is to stress the salmon to the point of dying en masse from heat stress. It is possible that associated salmon pathogens are now endemic in the Pelorus.

Will we be seeing another interview in Stuff with Mr. Rosewarne explaining about yet another mass mortality event? Is the Waitata farm location actually good enough to successfully grow salmon? We note that NZKS are claiming a “cracker” production year at Waitata so we will monitor to see if it is a sustainable result repeatable in the coming years. We will also continue to support efforts to have NZKS adopt best management practices as soon as possible. The Sounds deserves nothing less.

MPI needs to investigate if in 2014 an unusual mass mortality event occurred at Waihinau Salmon farm. If yes, why was it not reported to them? In this regard we have been encouraged by the willingness of MPI to engage meaningfully with us and KCSRA now has a representative on the MPI Salmon Biosecurity Liaison Group.

Nevertheless, MPI needs to take immediate measures to ensure the well being of all the salmon farmed by NZKS, as the yearly mortality figures seem much too high in some of their farms. KCSRA believes there is a real and unacceptable reputational risk for the Sounds from these mortality events. In terms of the disease pool risk, notwithstanding that there is more than one member in the class of Rickettsia organisms, we **were alarmed** to realize that diseased Scallop shell fish in Ketu Bay (just across the channel) have shown signs of a Rickettsia-organism affecting them, according to an MPI report¹⁰.

By way of a postscript and breaking news, we note the issue by MPI of a Controlled Area Notice (CAN) under the Biosecurity Act 1993, effective 20 April. The CAN puts in place movement controls and procedures over the Outer Pelorus and Queen Charlotte Sounds. The CAN applies to live or dead farmed Chinook (King) Salmon and associated plant and equipment used in the farming of such salmon. The purpose of the controls is to prevent the spread of a Rickettsia- like organism and minimize the damage caused to farmed Chinook (King) Salmon populations in New Zealand by such organisms.

KCSRA intends to continue its dialogue with MPI into the triggers behind the issue of this CAN.

¹⁰ http://kcsra.org.nz/documents/scallops/151124%20KCSRA%20-%20MPI%20Final%20Report%20on%20Scallop%20Health_diseases%20in%20NZ%20to%20mid%202015.pdf

Marine Sub-Committee
Kenepuru and Central Sounds Residents' Association

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