Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River

Commission d'enquête sur le déclin des populations de saumon rouge du fleuve Fraser

Public Hearings

Audience publique

Commissioner

L'Honorable juge /
The Honourable Justice
Bruce Cohen

Commissaire

Held at:

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Federal Courthouse
701 West Georgia Street
Vancouver, B.C.

Tuesday, September 6, 2011

Tenue à :

Salle 801
Cour fédérale
701, rue West Georgia
Vancouver (C.-B.)

le mardi 6 septembre 2011

APPEARANCES / COMPARUTIONS

Brock Martland Kathy L. Grant	Associate Commission Counsel Junior Commission Counsel
Mitchell Taylor, Q.C. Jonah Spiegelman	Government of Canada ("CAN")
Clifton Prowse, Q.C. Tara Callan	Province of British Columbia ("BCPROV")
No appearance	Pacific Salmon Commission ("PSC")
No appearance	B.C. Public Service Alliance of Canada Union of Environment Workers B.C. ("BCPSAC")
No appearance	Rio Tinto Alcan Inc. ("RTAI")
Alan Blair Shane Hopkins-Utter	B.C. Salmon Farmers Association ("BCSFA")
No appearance	Seafood Producers Association of B.C. ("SPABC")
Gregory McDade, Q.C.	Aquaculture Coalition: Alexandra Morton; Raincoast Research Society; Pacific Coast Wild Salmon Society ("AQUA")
Tim Leadem, Q.C. Judah Harrison	Conservation Coalition: Coastal Alliance for Aquaculture Reform Fraser Riverkeeper Society; Georgia Strait Alliance; Raincoast Conservation Foundation; Watershed Watch Salmon Society; Mr. Otto Langer; David Suzuki Foundation ("CONSERV")
Katrina Pacey	Area D Salmon Gillnet Association; Area B Harvest Committee (Seine) ("GILLFSC")

APPEARANCES / COMPARUTIONS, cont'd.

No appearance	Southern Area E Gillnetters Assn. B.C. Fisheries Survival Coalition ("SGAHC")
No appearance	West Coast Trollers Area G Association; United Fishermen and Allied Workers' Union ("TWCTUFA")
No appearance	B.C. Wildlife Federation; B.C. Federation of Drift Fishers ("WFFDF")
No appearance	Maa-nulth Treaty Society; Tsawwassen First Nation; Musqueam First Nation ("MTM")
No appearance	Western Central Coast Salish First Nations: Cowichan Tribes and Chemainus First Nation Hwlitsum First Nation and Penelakut Tribe Te'mexw Treaty Association ("WCCSFN")
Brenda Gaertner Crystal Reeves	First Nations Coalition: First Nations Fisheries Council; Aboriginal Caucus of the Fraser River; Aboriginal Fisheries Secretariat; Fraser Valley Aboriginal Fisheries Society; Northern Shuswap Tribal Council; Chehalis Indian Band; Secwepemc Fisheries Commission of the Shuswap Nation Tribal Council; Upper Fraser Fisheries Conservation Alliance; Other Douglas Treaty First Nations who applied together (the Snuneymuxw, Tsartlip and Tsawout); Adams Lake Indian Band; Carrier Sekani Tribal Council; Council of Haida Nation ("FNC")
No appearance	Métis Nation British Columbia ("MNBC")

APPEARANCES / COMPARUTIONS, cont'd.

No appearance	Sto:lo Tribal Council Cheam Indian Band ("STCCIB")
Steven Kelliher	Laich-kwil-tach Treaty Society Chief Harold Sewid, Aboriginal Aquaculture Association ("LJHAH")
Krista Robertson	Musgamagw Tsawataineuk Tribal Council ("MTTC")
Lisa Fong Benjamin Ralston	Heiltsuk Tribal Council ("HTC")

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Vancouver, B.C. /Vancouver
(C.-B.)
September 6, 2011/le 6
septembre 2011

THE REGISTRAR: The hearing is now resumed.
MS. GRANT: Mr. Commissioner, it's Grant, initials K.L. appearing on behalf of Commission Counsel, and with me is Mr. Martland. Today, we have a panel of witnesses on the topic of Fraser River sockeye and sea lice. We intend to qualify all four witnesses as experts in a moment.

Mr. Registrar, could I please have the witnesses affirmed.

THE REGISTRAR: Would you turn your microphones on, please?

SONJA SAKSIDA, affirmed.

MICHAEL PRICE, affirmed.

CRAIG ORR, affirmed.

SIMON JONES, affirmed.

THE REGISTRAR: State your name, please.
DR. SAKSIDA: Sonja Saksida.
MR. PRICE: Michael Price.
DR. ORR: Craig Orr.
DR. JONES: Simon Jones.
THE REGISTRAR: You'll have to speak right into the microphone as we proceed, okay? Thank you. Counsel?
MS. GRANT: Mr. Commissioner, Commission Counsel has circulated biographies of these witnesses, their CVs and our proposed expert qualifications to all the participants. We asked for objections and we received none, though we did receive some wording suggestions from Canada in respect of Mr. Jones, which we've incorporated.

So I plan to follow Mr. Martland's example from the fish health panel last week, file the witnesses' CVs and rely on that background to qualify them as experts.

Mr. Lunn, could I please have Tab 1 of the Commission's list on the screen.

EXAMINATION IN CHIEF ON QUALIFICATIONS BY MS. GRANT:

Q Dr. Jones, do you recognize this as your CV?
DR. JONES: I do.
MS. GRANT: Can we please mark that as the next exhibit.
THE REGISTRAR: Exhibit 1759.

EXHIBIT 1759: *Curriculum vitae* of Simon Richard Macrae Jones

MS. GRANT: Mr. Commissioner, could Dr. Jones please be qualified as an expert in parasitology and immunology with a specialty in sea lice and diseases of salmon, including as this relates to farmed and wild salmon?
THE COMMISSIONER: Yes, thank you.
MS. GRANT: Mr. Lunn, could I please have Tab 2 on the screen.
Q And Dr. Orr, do you recognize this as your CV?
DR. ORR: I do.
MS. GRANT: Can we please have that marked as the next exhibit?
THE REGISTRAR: Exhibit 1760.

EXHIBIT 1760: *Curriculum vitae* of Dr. Craig Orr

MS. GRANT: Mr. Commissioner, could Dr. Orr please be qualified as an expert in ecological sciences with a research focus on sea lice, affecting farmed and wild salmon?
THE COMMISSIONER: Yes, thank you.
MS. GRANT: Mr. Lunn, could I please have Tab 3 on the screen.
Q Mr. Price, do you recognize this as your CV?
MR. PRICE: Yes, it is.
MS. GRANT: Could we please mark that as the next exhibit?
THE REGISTRAR: 1761.

EXHIBIT 1761: *Curriculum vitae* OF Michael H.H. Price, MSc

MS. GRANT: Mr. Commissioner, could Mr. Price please be qualified as an expert in juvenile salmon ecology in relation to sea lice infestation?

THE COMMISSIONER: Yes, thank you.
MS. GRANT: And Mr. Lunn, could I please have Tab 4 on the screen.
Q Dr. Saksida, do you recognize this as your CV?
DR. SAKSIDA: I do.
MS. GRANT: Could we please have that marked?
THE REGISTRAR: 1762.

EXHIBIT 1762: Redacted *Curriculum vitae* of Sonja Saksida, BSc, DVM, MSc

MS. GRANT: Mr. Commissioner, could Dr. Saksida please be qualified as an expert in veterinary medicine and veterinary epidemiology with a specialty in fish health?
THE COMMISSIONER: Yes, thank you.

EXAMINATION IN CHIEF BY MS. GRANT:

Q All right, I'm going to begin with some questions about the genetic differences in sea lice, and Dr. Jones, I'm going to start by directing my questions to you.

The Commission has heard some evidence about genetic differences between Pacific sea lice and Atlantic sea lice. We've also heard mention of a paper by Yazawa, et al, on which you're one of the co-authors. Can you please assist the Commission by explaining how differences between Pacific and Atlantic sea lice might affect their virulence to Atlantic or Pacific salmon, their treatment when present on fish farms, and the applicability to the west coast of research on sea lice in the Atlantic ocean?

DR. JONES: We undertook an examination of the genetics of a particular species of sea lice, *Lepeophtheirus salmonis*, the salmon louse, with colleagues at the University of Victoria. We did this work as part of a larger study on the genetics of sea lice, and also we did this work with the awareness that other people, in Scotland, for example, had undertaken studies that examined genetic attributes of sea lice in the Atlantic ocean and had made comparisons with the Pacific ocean salmon lice.

What we found was that when we looked at the genomic DNA and also DNA associated with

mitochondria, was that there was very consistent and significant differences in salmon lice when they were collected, regardless of location, on the Pacific ocean, in contrast to the same genetic information that was present in sea lice collected from the Atlantic ocean, and we made a conclusion that this was a consistent difference and it was peculiar to the Pacific ocean salmon lice, probably, we speculated, because of a long-term divergence from Atlantic -- salmon lice in the Atlantic ocean with the resulting gradual change in the genetic information.

The question related to what the implications of these differences were in terms of virulence or treatment. We do have evidence that based on the -- on published work on disease of salmon lice in the Pacific ocean on salmon farming that there's -- it's been documented a lower instance of pathology and disease on farmed Atlantic salmon in the Pacific ocean when infected with Pacific lice, compared with the instance of disease on farmed Atlantic salmon in the Atlantic ocean, and it's possible, we speculate, that some of this difference may be related to the genetics of the salmon lice, recognizing that there are many considerations that need to be examined when we study virulence.

Very similar observations relate to treatment. It's been documented in the scientific literature that the frequency of treatment of salmon lice in British Columbia is much lower than has been documented in Norway or in Scotland, and again, we speculate that this reduced need to treat may be related to reduced virulence and may have its basis in the genetic difference of the Pacific salmon louse compared with the Atlantic salmon louse.

What it does mean, what this information does mean, is that we have a solid basis on which to approach the research that we do in British Columbia based on the unique attributes of the salmon louse. We may not understand all of the significance of the genetic differences between the lice, but we do recognize that this difference requires that we undertake research in British Columbia that is distinct and separate from research that's undertaken in Europe.

Q And do you know if -- do any of the differences within salmon lice, do they have a differential effect on Pacific or Atlantic salmon within the Pacific ocean, so either the farmed Atlantic salmon or the Pacific salmon, wild Pacific salmon?

DR. JONES: We have undertaken some experiments where we've compared the infections of Pacific salmon lice on species of Pacific salmon and compared that with Atlantic salmon in the laboratory and we do see evidence that the Pacific salmon louse behaves quite differently on different species of Pacific salmon and on Atlantic salmon.

Q And what sort of differences are you seeing?

DR. JONES: Well, one of the concerns that led us to do this research in the first place was a concern that on pink salmon, particularly on juvenile pink salmon, that infections with salmon lice were particularly virulent and can lead to mortality or other adverse consequences, and we undertook a series of laboratory infections where we tested the effects of salmon lice infections on juveniles of pink salmon and of chum salmon and documented that.

In fact, despite the very superficial, as it turns out, similarities between small pink and chum salmon, they're both very small salmon when they enter the marine environment, the salmon louse survived to a much greater extent on chum salmon and, in fact, we saw evidence of harm on the chum salmon, whereas on the juvenile pink salmon we saw very little, if any, evidence of harm on juvenile pink salmon. So this gives an example of how different species of Pacific salmon can respond quite differently to a uniform laboratory infection with the salmon louse.

Q All right. Mr. Lunn, could I please have Tab 9 of the Commission's list. This is a document entitled, EST and Mitochondrial DNA Sequences Support a Distinct Pacific Form of Salmon Louse, *Lepeophtheirus salmonis*. Dr. Jones, do you recognize this paper as the one you were just speaking about and which you're a co-author?

DR. JONES: Yes, I do.

MS. GRANT: Can we have this marked as the next exhibit, please?

THE REGISTRAR: 1763.

EXHIBIT 1763: EST and Mitochondrial DNA Sequences Support a Distinct Pacific Form of Salmon Louse, *Lepeophtheirus salmonis*, by Yazawa, et al

MS. GRANT:
Q And this study, it only had to do with *Leps.*, not *Caligus;* is that right?
DR. JONES: That's correct.
Q Do you know if there's similar genetic differences in the *Caligus*?
DR. JONES: The species of *Caligus* that infects salmon and a wide variety of other fish on the coast of British Columbia only occurs, to our knowledge, in the northeast Pacific ocean. In the north Atlantic there are other species of *Caligus*, and there are many species of *Caligus* that occur around the world.
Q All right. I'm just going to open it up to any of the other panellists who would like to make any sort of comments on genetic differences. Dr. Orr?
DR. ORR: Thank you. I read this paper again yesterday and I found it's a very interesting paper, and I think it's fairly solid on the genetics. But I read it three times and I'm trying to find if there's more than speculation on the pathogenicity differences in these lice, and I refer, you know, the Commissioner to Dr. Dill's report in which he said the only way to really tell is to do a common garden experiment in which you take species of Pacific salmon and Atlantic salmon and also lice from the Atlantic and Pacific and put them in a common environment to actually test the pathogenicity. And, you know, I just, I looked at this paper and I couldn't tell whether the literature that was cited was more about resistance to chemical therapeutants in the farmed salmon or whether it was actually the pathogenicity of the lice, and I think that that experiment would be a very useful one to carry out if we really wanted to talk about more than speculation on the pathogenicity of lice, different species of lice.
Q Thank you. Dr. Saksida?
DR. SAKSIDA: I've been working as a veterinarian since 1994, and I was working with the aquaculture industry. I've been involved in a lot of sea lice

research on the farms. I've seen the sea lice in the east coast and the effects -- the damage that it causes to Atlantic salmon on the east coast. I've seen the damage that sea lice actually caused to salmon in Norway, and I've seen the damage that the *Caligus* species in Chile is causing to the Atlantic salmon in Chile, and I can say that we did not and we have not seen the same kind of damage. We tend to see settlement increasing in the fall and we would sometimes see settlement higher in fish that are already compromised. So maybe if they're already sick, we tend to see higher loads, but we just rarely treat it. So I would say that it may be speculation, but it's based on observation.

Q Mr. Price, do you have anything to add on this point?

MR. PRICE: Just in terms of juvenile sockeye, which is what I study, and perhaps context and just to point out that it is *Caligus clemensi* that's the dominant louse species infecting juvenile sockeye, not *Lepeophtheirus salmonis*, but that's all.

Q Thank you. I'm going to move onto some questions about the occurrence and sources of sea lice in Fraser River sockeye. Mr. Price, I'm going to start by directing these questions to you.

Mr. Lunn, could I please have Exhibit 1476. This is also found at Tab 10 of the Commission's binder.

Mr. Price, this paper was published earlier this year and you were the lead author and Dr. Orr is one of your co-authors; is that correct?

MR. PRICE: Yes, it is.

Q Okay. I'm going to summarize what I understand you did, in layman's terms, and then I'm going to ask you if I've got it right. In the spring of both 2007 and 2008, you sampled Fraser River sockeye juveniles before and after they migrated past fish farms in the Discovery Islands and you compared the levels of sea lice, both *Caligus* and *Leps.* on the fish upstream and downstream of the fish farms. You also sampled juvenile sockeye in the north post, which do not migrate past fish farms, and compared the lice levels on those fish to the levels you found on the juveniles in the Discovery Islands. And finally, you also looked at the sea lice data that was available at the

time from fish farms in the Discovery Islands, which was from six marine harvest farms, and you compared that data with the lice levels you saw on juvenile sockeye.

Do I have that generally correct?

MR. PRICE: Yes, you do.

Q All right. Can you explain what you found in making those comparisons I just described? And if it's helpful, Mr. Lunn, perhaps you could turn to page 6, Figures 2 and 3, if you want to refer to those.

MR. PRICE: Do we want to --

Q The page before that. You don't have to refer to the figures. I just generally want to know what you found by those comparisons that I just described.

MR. PRICE: Sure. So on the north coast where you mentioned that we did only sample sockeye during the 2007 year, we found lice levels were quite low and, in fact, on fish downstream of salmon farms they were in an order of magnitude higher than sockeye of the north coast in that same year. And within the Discovery Islands region we noticed significantly higher lice levels on juveniles after they passed farms, so those downstream of farms, compared to upstream of farms. And in 2008, we noticed similar trends, although the differences between upstream and downstream were not as clear.

We did also notice, and if we refer to Figure 4, I believe, which was the first figure you put up, that inter-annual variations, these being lice levels on farmed fish at the time within the Discovery Islands, inter-annual variation between the lice levels of *Caligus clemensi*, which is at the top of the figure, and *Lepeophtheirus salmonis*, which is at the bottom of the figure, matched the inter-annual variation we saw on juvenile sockeye. So in 2007, they were -- lice levels were quite high for *Caligus clemensi*, particularly on juvenile sockeye within the Discovery Islands but specifically downstream of salmon farms. And in 2008 we saw an increase in *Lepeophtheirus salmonis* on those juvenile sockeye.

Q All right. And fish farms are not the only source of sea lice that infect sockeye; is that correct?

MR. PRICE: Well, there's no information, *per se*, to

show that other fish have specifically infected juvenile sockeye.

Q All right. Is it possible that the wild sockeye had more lice on them downstream of the farms just because they're bigger and they'd been at sea longer than the fish that you sampled upstream of the farms?

MR. PRICE: So if you're referring to weight, weight is a factor, those fish being larger downstream of farms compared to upstream of farms.

Q And length of time in the ocean as well.

MR. PRICE: So what we see, in 2007, if we break the years down, the weights of the fish were similar across all regions, north coast, upstream of farms and downstream of farms, those -- the weights of the fish were quite similar, yet we found that pattern of significantly higher lice levels on fish after they passed farms compared to upstream of farms, but also an order of magnitude higher than what we see in an area without salmon farms.

In 2008, yes, there was a weight difference between -- there were larger fish downstream of farms compared to upstream of farms on average, but looking at the data specifically, we see that two specific collection sites accounted for the difference in weight, and yet it didn't account for the -- a proportional difference in lice levels. So at these two sites, if we remove the fish downstream of farms, the average weight of fish downstream of farms is reduced to what is similar to upstream of farms, and yet the proportion of lice infecting those sockeye remain the same. So no, we don't think that weight was a factor, nor is increased exposure time to farms a factor.

Q All right. And did you account for other environmental factors in your studies, thinking of things like salinity or temperature?

MR. PRICE: Absolutely, yes. We ran those specific factors that we thought were responsible or partly responsible for lice levels, salinity, temperature, but also the year of migration, along with position relative to salmon farms in the model, and position relative to farms was the best predictor of lice levels on juvenile sockeye.

Q All right. Perhaps I can move, now, to Dr. Jones and Dr. Saksida. Perhaps the two of you could

comment on sources of sea lice infection on sockeye and some of the criticisms that you may have of this paper, and then I'll turn to Dr. Orr for comments and reply.

DR. JONES: Yeah, I read this paper and I was very interested to see just how common sea lice infections were on juvenile sockeye salmon, and it was -- the surveillance of juvenile salmon for sea lice is a very young science. We've only been at this systematically for eight or nine years on the coast of British Columbia, so there's a lot we still have to learn, and I think this kind of information is very helpful.

What I did notice, though, in this paper, was that there were one or two inconsistencies that I wasn't able to explain and I felt that the conclusions that farms were the only source of the infections that we saw were not always supported by the observations that I saw presented in the paper. So we have Figure 4 on the monitor, and if you notice on the left side of Part A and B, which is the upper and lower, there's a grey bar and the grey bar coincides with the time of the year when the sockeye samples were collected. And you'll notice on the fish farms that *Caligus* is present on two of the six farms that are -- that they have data for, and also *Leps.* are located on -- are present on three; two higher levels and one lower level of farm. But overall, in my opinion, somewhat similar levels of *Caligus* and *Leps.* on the farms between these two species.

Now, if we could please move to the table that shows the information on the sea lice upstream and downstream, I don't recall which table that is, it might be table 2?

Q It's on page 5.

DR. JONES: Yeah, the table at the bottom. Now, if we look on the left side of that table, you see the region Discovery Islands, and then we have upstream and downstream in 2007. So this corresponds to the time I just pointed out, which is 2007, the left-hand bar, if we move across to the column which is *Caligus clemensi*, we see that downstream of the fish farms, 4.83 is the abundance of *Caligus* and 1.14, and this is a difference about four -- four times of an increase with *Caligus*.

If we move across to *Lepeophtheirus* we see that the increase is much smaller, less than two times, a much lower level of louse infestation. If you look at the level of abundance, which is the average number of lice on the fish, there's very low levels of *Lepeophtheirus* and a much smaller increase, and yet the farm salmon population appeared to be similar for *Caligus* and *Leps.*, so I wondered, in this case, whether or not an alternative explanation may have been more appropriate for explaining why the downstream fish may have had a higher abundance of both species of lice.

Now, if I could please ask you to go back to Figure 4 that we previously looked at, and focus your attention, this time, on the right-hand grey bar of 4A and 4B, and this is the time of the year, in 2008, when the sockeye were sampled. And if you just focus your attention on Part A, which is *Caligus clemensi*, you see that on fish farms on the bar, the grey bar, were virtually free, a far as I can see, very, very low levels of *Caligus*, if any, on fish farms that were reported in this paper during that time. So very little *Caligus* on the farms in 2008.

And I'm sorry, I have to go back, now, to Table 2. Okay. And if we again look at Discovery Islands, this time upstream/downstream 2008 and then go across to *Caligus clemensi*, we see that *Caligus* increased from .95 of abundance to 1.61, which is about 1.7, I think I worked out, of an increase, despite the fact there was no evidence of a significant *Caligus* infection on the farms at the time. So this is another example of where I thought perhaps it would have been more appropriate to look for an alternative source or explanation for the increase and the abundance of *Caligus* on the sockeye.

Q Do you know of any alternative explanations?

DR. JONES: Well, *Caligus*, is a -- when it was first described in the early 1970s, it was pointed out that *Caligus* is very abundant on herring and on sticklebacks, and Bob Kabata and Leo Margolis, when they described the species, made it very clear this is a very common parasite occurring on a wide range of species.

We've done some survey reach in the - meaning

DFO - in the Strait of Georgia, from the Gulf Islands in the south and more recently throughout the Strait of Georgia, and we've seen evidence of *Caligus* on juvenile sockeye salmon in all of these studies throughout the Strait of Georgia. So although some of this information wasn't available to the office when this paper was written, I think, in my opinion, it's quite likely that the sources of *Caligus* that the sockeye salmon are infected with in the Strait of Georgia occur in the Strait of Georgia long before these salmon reach the salmon farms.

Q All right. Dr. Saksida, did you have anything to add?

DR. SAKSIDA: Just a couple of comments. I was quite interested in the outlier. If you go to the figure -- well, you can actually look at this graph right here. In 2008, there was an outlier where they captured 50 fish. In their materials and methods they said they actually sampled between -- they actually captured between one and 50 or 60 fish per seine. They didn't provide an average, so I'm making the assumption that that outlier is one sample of large number of sockeye.

And it's quite interesting that in 2008 it actually had some of the highest basically prevalence and intensity. So prevalence being -- is the number of fish infected, and intensity is the number of lice per infected fish. So I'm looking at the herring louse, the *Caligus clemensi*, and in the paper they actually pointed potentially to a processing plant as a source.

Now, if we go to the figure that shows the map -- I'm not sure which one that is.

Q Page 3.

DR. SAKSIDA: So the outlier is in Figure B and it's the furthest south point - I don't have a pointer - but it's the south tip of Quadra Island is considered the outlier. Where do I point? Okay, I don't want to blind anybody. Okay, so that's the outlier right there. My hand's shaky, I'm so sorry. And they presume that -- they hypothesize that it's because of the processing plant right there, which is probably about eight kilometres away.

Now, they maintain this site as being unexposed, so they weren't exposed to any fish

farms or fish farm sources. So I would say that if there was going to be an effect from the processing plant, it would have an effect on this location rather than this location. This is fairly tidal, but it has a net north flow. It has a bit of an estuarine flow, so you would presume that most planktonic stages would actually be going north and not south.

The other point I think is interesting in this paper is the fact that they did see more *Caligus,* or herring louse, on the sockeye salmon than the salmon louse. That, to me, suggests, and they did put this in the paper, that sockeye salmon are probably more resistant to the salmon louse than even other species of -- other species of salmon.

Now, that's not very different than some of the work that was done by a Japanese investigator, Nagasawa, who went into the high seas and actually sampled salmon in the high ocean and found that sockeye salmon tend to have less salmon lice. So that's a supportive piece to say, yes, sockeye salmon are probably fairly resistant to the salmon louse and possibly have a bit -- are more associated with herring lice. That's it.

Q All right. Dr. Orr?

DR. ORR: Mike Price designed this study. I'm going to actually let him answer the question about the tidal issue, if that's okay.

Q Certainly.

DR. ORR: But I'll just make a couple of general observations. I wrote down Dr. Jones' questions, and I'm struggling to understand exactly what he asked. I'm not sure if he cares to clarify that. He talked about a couple of figures where there were differences in lice and, you know, I think the figure in terms of louse abundance on the farms match the trends in louse abundance on the sockeye, which is what we discuss in the paper, so when *Caligus* were more abundant on the farms they're more abundant on sockeye, and vice versa.

The source of lice issue is one that's being going on for years in British Columbia and, you know, it's one that should be resolved by recent papers, one on which I was a co-author on, where we looked at louse production from a farm in the Broughton Archipelago and it was fairly clear that

the lice arise from the farm and not from the surrounding fish. And there's also lots of press releases from the past, in particular suggesting that lice are coming from herring and they're coming from sub-advective currents and they're coming from sticklebacks, but there's no evidence, really, that those sources of lice are anywhere near the magnitude of the source of lice from the farms, and I think there's a fairly large weight of evidence to suggest that lice are coming from farms by and large in British Columbia. But I'll leave the other questions for Mike Price to answer.

Q All right. Mr. Price, do you have any further comments or replies to what you've heard?

MR. PRICE: Yes. I could begin, perhaps, with the outlier, specifically, and it states right in our paper that we ran the analyses with and without the outlier excluded, and regardless of whether the outlier was excluded in our analysis or not, the results remained the same. So lice levels or, sorry, position relative to farms, so that exposure to farms was the best predictor of lice levels on juvenile sockeye without or with outliers.

Another important point in that outliers is that it is a hypothesis and it has pointed us to the potential of this processing site releasing pathogens, and that's a subsequent paper we have in review and it may be raised today. So it is an important point to consider when we do categorize a site as an outlier.

My other comments would be in terms of herring and if herring or other fish are -- were the potential source of lice for these sockeye, they would need to assume a similar spatial distribution as the salmon farms in this region. We see no evidence for that.

And in terms of resistance to sockeye to the salmon louse, we also pose the idea, yes, it could be that sockeye may be more resistant to *Lepeophtheirus salmonis*, but they also could be more susceptible to *Caligus clemensi* or *Caligus clemensi* has a preference for juvenile sockeye, or *Lepeophtheirus salmonis* don't have a preference for sockeye, as opposed to pink and chum.

Another, sorry, final point I just want to

raise, in terms of the farm data and the farm data that we included in Figure 4 is from Marine Harvest Canada. They do provide a select number of farms and sea lice data from their farms, and so what we showed in this paper were six farms, they show their data online, aggregated data, but numerous other farms were operating in this region at the same time. And if you refer to the Korman report, he states in there, since 2004 farms within or along the migration route of juvenile sockeye host an average of six *Caligus* per fish, times 30 million fish annually. And so that's a significant source of sea lice for these juvenile sockeye.

Q All right. I'm going to have to move onto my next topic, and that's the possible effects of sea lice on Fraser River sockeye. And Dr. Jones, I'm going to start with you. You spoke, earlier, about pink and chum salmon and I'm wondering if you could tell us, are the levels of lice loads that have been seen on Fraser River sockeye, for example, the loads that Mr. Price reported in this paper, are they detrimental to sockeye at an individual or population level, or is that known?

DR. JONES: I think it's really important, at this point, to recognize just how different the sea lice infections that have been reported on the juvenile sockeye that we've seen from the Strait of Georgia are in comparison to what we've seen on juvenile pink and chum salmon, where we've studied those in the Broughton Archipelago, which is an ecosystem a little further north. In the Broughton Archipelago, in almost all years from 2004 to 2008, when we did this work, the infections on juvenile pink and chum salmon were dominated by *Lepeophtheirus salmonis*, the salmon louse. We did see *Caligus*, and in those years *Caligus* was always -- had a level of infection much lower than were the *Leps.*

What we've seen in the Strait of Georgia, from the observations of the two Price papers and also our own observations, is that consistently *Caligus* is the most abundant parasite. So this is very different.

Our laboratory infections of pink and chum salmon with *Lepeophtheirus salmonis* have allowed us to explore how this parasite effects the health

of the juvenile pink and chum salmon, and we made some observations that have been published in the scientific literature that suggest that the pink salmon above a certain critical threshold size is remarkably resilient to the effects of the salmon louse - this is quite an unexpected finding - and we did this work always in comparison with other species, for example, with chum salmon, so this resilience was a relative measure under the conditions of our laboratory study that allowed us to characterize a type of resistance that the pink salmon had, the sea lice that we hadn't previously recognized.

We did some further analysis that included genetic testing of pink salmon and we found that the threshold was less than a gram, so pink salmon less than a gram already are developing this resistance to sea lice.

This information we do not have for sockeye salmon, yet. We don't have the laboratory data to allow us to properly understand what are the thresholds of effect on juvenile sockeye salmon, so at the individual level nor at the population level do we yet have an understanding of what levels of infection the salmon lice might be harmful.

Q All right. Is DFO doing anything to address that lack of information?

DR. JONES: Yes, we are. There's a series of experiments that -- the research is two-fold. It involves both a field surveillance effort, which has been underway since 2010. It also involves a laboratory component that allows us to determine in a laboratory, in a controlled environmental setting, conditions that might give us reason to believe salmon lice are harmful to juvenile sockeye salmon.

Q And has DFO been working in collaboration with any other groups, for example, with Mr. Price, who has begun some work on sockeye?

DR. JONES: To my knowledge, no, there's been no collaboration.

Q All right. Mr. Lunn, could I please have Tab 15. This is a paper entitled, Sea lice, either naturally occurring or passed from fish farms, are an important contributor to the Fraser sockeye situation. Dr. Jones, do you recognize this as a

paper that you prepared?
DR. JONES: Yes, I do.
Q And can you tell us the context for preparing this paper and the date of the paper?
DR. JONES: I believe this was a paper written in support of a PowerPoint presentation that I made at a Pacific Salmon Commission workshop in Nanaimo in 2010, and this document was a summary of that PowerPoint presentation.
MS. GRANT: All right. Can we have this marked as the next exhibit, please?
THE REGISTRAR: Exhibit 1764.

EXHIBIT 1764: Sea lice, either naturally occurring or passed from fish farms, are an important contributor to the Fraser sockeye situation, by Simon Jones

MS. GRANT:
Q All right. And despite the title, saying that sea lice is an important contributor, if you turn to the conclusions section of this, my reading of it is that basically you say what you just told us, that:

> There is insufficient evidence to conclude that sea lice, whether from natural or farmed sources, are an important contributor to the Fraser sockeye situation.

DR. JONES: I would like to point out that the title was actually given to me by the Salmon Commission, and all of the presentations that were made that day were framed in the context of a hypothesis, and so I think it's important to recognize that this -- the title of this document is actually a hypothetical statement that we then pursued the evidence and the literature to determine its -- the strength of that statement.
Q Fair enough. I wanted to turn to Dr. Saksida, and we've heard some evidence that sea lice may play a role as a vector in transferring disease, and I wanted to know if you could comment about that or explain how that might work?
DR. SAKSIDA: I can do that, but can I make a correction, please?
Q Sure.

DR. SAKSIDA: The Korman paper that Michael referenced as having *Caligus* -- motile *Caligus* levels at six was incorrect, and I believe it was actually corrected in the proceedings. What happened is that the levels are actually 20 times less, so the *Leps. Salmonis* -- the *Caligus clemensi* levels are actually 20 times less than what he has in his document and --

Q Yes.

DR. SAKSIDA: -- therefore the conclusions made are incorrect.

Q That was corrected on the record. I believe it was -- he used the farm averages rather than individual fish --

DR. SAKSIDA: Fish averages.

Q -- averages.

DR. SAKSIDA: Yes.

Q Did you want to still --

DR. SAKSIDA: I do want to address the transmission. There's been a lot of lab work that's suggesting that there may be some evidence of -- well, looking for evidence of transmission. Most of the work is nicely summarized in a paper prepared by Don Noakes, who was the Provincial veterinarian. And basically what they've done is they showed that sea lice are potentially a mechanical vector. It doesn't look like any bacteria or viruses actually replicate in the animal; they actually just sit on the animal or actually go through the digestive tract.

And most of the diseases they looked at are actually transmitted through water. So when fish are infected, the actual pathogens can transmit through water from one fish to another fish. Now, if there is transmission through the water, so there is enough pathogen in the water, I would say that the sea louse would be playing a minor role. So if the fish are close enough to have a sea louse jump between one fish and another fish, if they're motile sea lice, then there would be water-borne exposure. So I would say that the water-borne exposure is far more significant than any effect that a sea louse would have.

Q And you just referred to Dr. Noakes' report. Which --

DR. SAKSIDA: There's a report, it's called -- it's a -- I don't understand this, but AAA for

Identification, does that mean anything? It's a report that he prepared for the salmon farmers where he actually asked the question, "Could sea lice act as vectors?"

Q Was that Dr. Noakes, or was it a Dr. --

DR. SAKSIDA: Oh, sorry, sorry, Ron Lewis. I'm sorry. Dr. Ron Lewis, who was the Provincial vet.

Q I'm just going to turn to the other panellists, Dr. Orr and Mr. Price; do you have any comments that you'd like to make on the effects of sea lice on Fraser River sockeye?

DR. ORR: I think we'd be more concerned if we saw higher numbers of *Leps.* I mean, there are larger species of louse and they cause more mechanical damage, but I don't think that we can discount the issue of *Caligus*. We did see up to 28 individual *Caligus* per sockeye in, you know, as an extreme in these studies, and there was evidence of fin damage, no question about it.

But we have to consider, again, Dr. Dill's report. Table 1, he provides a fair bit of evidence that lice to serve as vectors, and there's quite a few studies listed in there, so I would refer to that study. And I would also look at some of the research that's being going on, on the behavioural influences of lice. A lot of that's been SFU research, some of Larry Dill's students have reported on it. And it shows one louse per fish can cause, you know, significant behavioural changes in juvenile fish, it can cause those fish to be on the outside of schools, where they're more vulnerable to predators, and the back of schools, again, where they're more vulnerable to predators, it can cause flashing behaviour, which makes them more visible to predators.

In fact, we had a workshop, the Marine Harvest and Coast Alliance for Aquaculture Reform in 2009, where we looked at all these influences and we looked at Dr. Jones' laboratory study, which had a very short exposure time and, in fact, in the wild it's about two to three orders magnitude higher exposure time for sea lice, so we'd expect, you know, more effects of lice on fish when you get into the real world.

So I think what we're looking at, here, is a need for some studies that really look at the effects of *Caligus* and whether they're vectors and

they cause mechanical problems on sockeye, and to look at the entire picture, but we haven't yet done that research in British Columbia.

Q Thank you. Mr. Price? All right, I'm going to move onto my next set of questions, which has to do with monitoring and management options. I'm going to start with you, Dr. Orr. I understand you've been involved with the Broughton Archipelago Monitoring Program, or BAMP, that looks at sea lice on farm salmon and wild pink and chum in that area; is that correct?

DR. ORR: That's correct. And before that it was the Coordinated Area Management Plan with Marine Harvest Canada.

Q Okay. Can you explain a little bit about what BAMP is; when it started; who's involved? And then I want you to think about whether there's anything that can be learned from that sort of a monitoring approach that could be applicable to sockeye migration routes through the Discovery Island.

DR. ORR: Sure. I think, you know, it was a good experiment and it's an ongoing experiment. Watershed Watch is not participating, at this time, for various reasons, but we helped set it up and design it, and working with DFO, Greig, Marine Harvest, Mainstream Canada, Crawford Revie, from the University of PEI is the project manager, and Dr. Marty Krkosek, University of Otago, is doing an audit of the analyses. And what it basically does is it looks at how many lice are on juvenile fish in the Broughton area, how many lice are coming from the farms. It casts back 10 years. We spent a fair bit of time negotiating data-sharing agreements, where DFO would put in their data and the farms would put in their data, and Marty Krkosek would put in his data, and it's looking at historical trends and it's looking at -- also looking at management options, when farms are treated, what does that mean in terms of lice loads on fish, can we actually minimize those lice loads. There's a hundred sampling sites that are sampling.

This has been going on for two years now, so this second year has just been completed where there were four sampling periods during the migration/outmigration period of juvenile fish and

these hundred sites would be sampled over a period of eight days four times a year.

So there's a wealth of data, and CAAR, the Coast Alliance for Aquaculture Reform, and Marine Harvest had previously negotiated collaborative research objectives around management options on whether these reduce lice to levels that were getting down to an area where they wouldn't harm the fish nearly as much, and those research objectives are actually being carried forward in scientific papers that the science team of the Brought Archipelago Monitoring Program Science Team are actually putting together.

Q Is there anything that could be learned from that experience that would translate to --

DR. ORR: To sockeye?

Q Yes.

DR. ORR: Well, there's no question that we went into this with a lot of concerns that we weren't getting updated from the farms. It was easier to sample wild fish, you could put together wild fish sampling programs and figure out how many lice are on those, but to relate it back to the farms was a difficult thing, and I think that would be something that would be, you know, a standing contribution to understanding the role of salmon farms in sockeye sea lice infections in other areas when they have the farm data available.

There certainly, you know, were some high points around collaboration, when we got the agencies together and the salmon farmers trying to share data and trying to come up with data-sharing agreements. But transparency in the data, being out there, and eyes on the situation, figuring out whether you had -- when you have high loads of lice on farms you're having high loads of lice on wild fish and whether management actions, such as fallowing farms, emptying farms, or coordinating management or use of SLICE actually have beneficial or negative effects on the wild fish.

Q All right. Do you think that DFO's plan to release sea lice data to put it on their website for all the farms, was that going to hep with some of this or provide some of that data and transparency that you were talking about?

DR. ORR: The BC Salmon Farmers, are you referring to?

Q No, I think DFO is planning on doing this.

DR. ORR: Releasing --
Q We heard evidence, earlier --
DR. ORR: On releasing farm data? Well, anybody that releases accurate farm data, that's not -- you know, specific data and fine-detail data would be very useful for the researchers. It's very hard if those data are averaged, say, over farms or over a month, and it makes statistical comparisons much more difficult. But, you know, the issue of transparency has been a big one in British Columbia for as long as I've been working on this subject, which is about 10 years now, and there's far more transparency in Europe, as we've heard in this court, and we need to get up to those international standards so we have a level of comfort that we really understand what's going on.
Q Okay. I wanted to move to a question to Dr. Saksida about treatment of farmed fish. I understand there's not really much we can do to treat wild fish if they get sea lice, but we can treat farmed fish. Is SLICE the only option that's available for sea lice in B.C., and is that a problem in terms of resistance?
DR. SAKSIDA: Right now SLICE, which is an in-feed therapeutant, is the only thing that's being used to treat for sea lice. We've been using it to treat lice on farm fish since 2000. It became registered -- it was originally under an EDR, which is an Emergency Drug Release, which is something that the bureau that drugs -- or Health Canada provides to give us the access to this therapeutant. It became registered as a full therapeutant I believe it was two years ago.

As for resistance, I've been involved in a couple of studies, well, one study that we published, and it was with Crawford Revie. We looked at Marine Harvest data collected from 2003 to 2008, and we did the same analysis that Dr. Revie had done in his Scottish work, and we found no evidence of resistance. We actually found that the lice levels were maintained at a much lower level than they were finding in Scotland for a much longer period. So there was no evidence of resistance.

We, at the B.C. Centre for Aquatic Health Sciences, we've also been involved in doing bioassays, which is another method of evaluating

resistance, and that means exposing lice collected off fish and to the actual chemical and seeing if they die. And again, our level of susceptibility for these lice is to -- to this drug is actually quite high. So they are still very susceptible to SLICE.

Q All right. I'm almost at my time here, but I want to offer if Dr. Jones or Mr. Price, if either of you have any follow-up comments that you'd like to make on monitoring or management?

DR. JONES: As I mentioned earlier, we had conducted, over a period of several years, in the Broughton Archipelago, an intensive survey of pink and chum salmon. We did not have access to farm data at the time, but the data that we collected from pink and chum salmon showed that there was a tremendous decline in the levels of lice over that period of time.

Retrospectively, we've associated that with a developing, you know, with the development of a more strategic and intensive sampling -- or treatment process on farm fish in the Broughton Archipelago. So this appears to be an indication that the appropriate treatment of farm salmon in the Brought Archipelago is coincident in time with the declining numbers of lice on the wild, pink and chum salmon, and to me this suggests that among all of the variables that we need to consider, that appropriate treatment of farm salmon does play a valuable role in effecting numbers of lice on wild salmon.

Q Okay.

MR. PRICE: Yeah, I just wanted to mention in terms of *Caligus*, which again, at least I can see for juvenile sockeye is potentially more problematic than *Leps.*, but SLICE does not appear to be very effective at reducing *Caligus*, which is arguably a different species in Europe, but SLICE is seen to not be very effective in Europe. And preliminary evidence also suggests that SLICE is not very effective at reducing *Caligus* levels here as well. But fallowing has been shown to be fairly effective at reducing lice levels, and we've seen that specifically on the juvenile sockeye migration route.

Q I'm just going to move to one last question for all the panellists, and I want you to think,

looking forward, how would you characterize the level of risk for Fraser River sockeye from sea lice, and is there a need for further regulatory or management measures to protect Fraser River sockeye from sea lice? Perhaps we can start with Dr. Jones and just move through the panel.

DR. JONES: This is obviously an area that does require an awful lot of research, still. My estimate, based on what we know today, is that there is low risk to moderate risk to sockeye salmon associated with all species of sea lice. My opinion is that *Caligus* probably does not pose a particularly high risk to sockeye salmon from the Fraser or any other river, but that *Lepeophtheirus salmonis* has a greater potential to cause harm, and that every effort to manage *Leps. salmonis* on salmon farms would be appropriate in terms of minimizing that risk.

Q Dr. Orr?

DR. ORR: I would suggest that the mechanical damage issue, again, I would probably be in agreement with Dr. Jones; there's probably a low to moderate risk of mechanical damage. I would hearken back to my comments before about the need to look at the full suite of issues around sea lice, all the behavioural influences, effect on the growth of juvenile fish, things like that.

But I might differ a little bit in terms of all the testimony I've heard about disease over the past few weeks in this court, or the last few days, and suggest that lice, as a vector for disease transfer, is something that would cause me to consider that salmon farms present a fairly high risk if we really don't control disease on the salmon farms.

Q All right. Mr. Price?

MR. PRICE: I'd say fairly high when conditions are not favourable for juvenile sockeye, and when combined with other factors, you know, in -- with predictions of climate change and future warming of the oceans, you know, these predictions suggest that ocean conditions will likely not be favourable for salmon in the future. And so, combined with that, whether there are food limitations or, as Dr. Orr suggested, these other possible stressors, whether that's increasing predation risk, I don't think a pathogen such as

sea lice are really going to be beneficial for these fish, and from what I've seen, lice levels are increasing on these fish over the years, and I believe the risk to be quite high.

Q Dr. Saksida?

DR. SAKSIDA: I think it's apparent that we need to do some more work with sockeye. I would agree with Simon that I believe *Caligus* is probably a low to moderate. I think we do have to do research on figuring out the distribution of *Caligus*. You know, it is called a herring louse. There is lots of herring out there. I've seen high prevalence of sea -- you know, *Caligus clemensi*, or this herring louse, on young of the year herring that are .3 grams, away from fish farms. So I think I few did a nice, systematic study, I think that would answer a lot of these questions. Right now, we're doing a lot of speculation an innuendos.

As for treatment of *Caligus* on salmon farms, it's a rare occurrence, but we do treat, and I'm not sure where you got your information from, but it is an effective treatment for *Caligus*. We just don't get -- we have even less damage associated with *Caligus*.

MS. GRANT: All right, thank you. Those are my questions. Counsel for Canada is up next, with 30 minutes.

THE COMMISSIONER: Thank you.

MR. TAYLOR: Thank you. In the time available, I'm going to ask most of my questions, or direct most of my questions to Dr. Jones, but I have some questions for other panellists as well.

CROSS-EXAMINATION BY MR. TAYLOR:

Q Dr. Saksida, I'm going to just start with you on SLICE, and you responded a moment ago to what Mr. Price said about SLICE and *Caligus*. Can you just expand on what you were saying there when you said *Caligus* is an effective treatment? This is an issue that's come up in this panel, and so I think we should see if we can afford some clarity with support for it.

DR. SAKSIDA: So in my experience, there seems to be a lot of variation in the *Caligus*, or the herring louse, abundance among the different farming regions. The *Caligus* tends to, in my experience,

be more predominant in the Port Hardy area and in the Discovery Island area. You don't see a lot of *Caligus* in the Sunshine Coast or on the west coast of Vancouver Island, at least on the farm fish.

We sometimes get increased infestations of the juvenile stages of *Caligus* in the summer, and probably June, and all of a sudden you have this sudden increase of these small motile stages, and at that point in time is when you treat, when they're still at the attached stages, and it's quite effective.

Q All right. And when you say that, is that as a result of work you have been involved in, that you've come to that conclusion?

DR. SAKSIDA: It's work as a veterinarian, having to look at the pre-treatment numbers and post-treatment, yes.

Q All right, thank you. Next, Dr. Orr -- Michael Price spoke of lice as a vector - I think it was Mr. Price. Dr. Saksida, do you have a comment about lice as a vector of pathogens?

DR. SAKSIDA: Again, most of the research that has been done has been lab-driven research. I think Simon Jones has actually been involved in some of those with VIU, so he can probably speak to that point better than I could. He's more familiar with the research. But from my understanding, that sea lice are more of a mechanical vector than an actual, true vector for transmission of disease. It looks like they may, when a motile stage, a larger louse is attached to a fish, if there's another -- and they're diseased. If they're heavily diseased, this louse may actually pick up the virus or the bacteria, swim to the next host, and there is potentially a transmission.

However, I did state earlier that most of the diseases that they've investigated are water-borne transmission, so again, if the fish are close enough to be -- have a louse swim between them, they're probably more likely to get exposed from water-borne exposure than sea lice.

Q And turning to you, Dr. Jones, and having heard what's been said, what's our comment? What do you have to add to this, in terms of lice as a vector of pathogens and/or water, itself, as a means whereby pathogens are transferred?

DR. JONES: The list that was referred to in Professor

Dill's report was actually a list of references to the scientific literature where researchers had associated a particular fish pathogen with salmon lice. In other words, they had conducted diagnostic tests on the salmon louse to look for the presence of a virus or a bacteria or a pathogen that would normally be a pathogen of salmon, and in many cases they've found evidence for this. For example, with IHN virus or with ISA virus, or with *Aeromonas salmonicida* bacterial pathogen in salmon, there is evidence that these pathogens have been associated with the salmon louse.

But that's a very different piece of information than saying that the salmon louse, because of its biology and behaviour, is a competent vector of those pathogens. In other words, that the salmon louse will effectively transmit those pathogens from one fish to another fish and cause an infection in the second fish. And you might compare this to, for example, the mosquito which transmits malaria. It feeds on an infected animal, flies away, feeds on a second animal and transmits the infection to that animal. The salmon louse's behaviour is not like the mosquito; it tends to stay attached, for the most part, to a fish.

Caligus is a little different, but most of the research that we've had where pathogens have been associated with lice have been focused on *Leps. salmonis*, and my opinion is that there's very little evidence to support the idea that *Leps.* are vectors. They are capable of supporting the pathogen, but as was previously mentioned, most of these pathogens transmit very effectively through the water column, and it's questionable whether the salmon louse is actually increasing the effectiveness of that transmission process.

Q All right. Now, Dr. Jones, I'm going to ask you to back up for a moment and explain, briefly, for the Commissioner more about the state of science knowledge to do with lice. In this Commission there's a lot of papers and a lot of talk about sea lice, and you've spoken to some of this already in your testimony this morning, but can you just explain very briefly for the Commissioner, what is the state of science

knowledge about sea lice? How much is known, and how old or new is this?

DR. JONES: Well, I think, quickly, I would characterize the science of sea lice in British Columbia relative to the science of sea lice globally is still in its infancy. For a variety of reasons, we began systematic surveillance of juvenile salmon in the Broughton Archipelago in 2003. In 2002 some work was done, but the systematic surveillance of juvenile salmon for sea lice began in 2002, which means that we've had eight years to begin to understand how -- what is, in fact, a very complex ecosystem. We need to understand not just about salmon farms and sea lice, nor about lice on wild salmon; we need to understand about the conditions in the environment, the currents, the salinity and the temperature that the fish and the parasites live in, in order to understand how sea lice disseminate from one source to another source and how they survive in the environment.

So we've been doing this for eight years and my sense is that there's still an awful lot that we have to learn. One of the reasons I say this is that because during the eight years we've been conducting this work, we have, in fact, uncovered a number of completely unexpected observations that lead us to believe that our assessment of coastal ecosystems in B.C. as they relate to sea lice are, in fact, quite complex. For example, the work that we did on sticklebacks was novel and unexpected. We found that sticklebacks, which live in the marine environment, they cohabit with juvenile pink and chum salmon, are extremely highly infected with sea lice. Sticklebacks can carry five to 10 times higher levels of the same species of sea lice that are found on the juvenile salmon. We hadn't anticipated that, so that's an example of how complex and unexpected the research is.

We hadn't anticipated that pink salmon developed its resistance to salmon lice as early as a fraction of a gram and, in fact, this work has been supported by a number of papers that we've published in the scientific literature. And this leads us to believe that, from the salmon perspective, that there's still more we need to

understand about how different species of salmon differ in their susceptibility or resistance to sea lice or to salmon lice, *Leps. salmonis* infection. Not all salmon are created equally. Some salmon appear, for a variety of reasons, to be particularly susceptible. Other species of salmon seem to be quite resistant to infection, and a large part of our research is trying to understand exactly what makes the species resistant and what makes them susceptible. So it's very -- it's important to know you can't treat all salmon equally. And it also means that it's hard to predict whether a particular species of salmon is resistant or susceptible until you've done this sort of work.

Q All right. Sorry, go on.

DR. JONES: It was pointed out earlier our discovery of just how genetically distinct the Pacific salmon *Leps. salmonis* is in the Pacific ocean was important to help us design ongoing experiments to explore relationships between sea lice and salmon.

I think that the point I'm trying to make is because of the relative shortness of our experience conducting sea lice research in British Columbia, I anticipate we will discover an awful lot of new information, as we have done to date, and that this new information will be important, and how we understand the interactions between lice on farm salmon and on wild salmon.

Q All right. You mentioned, in your evidence just now, stickleback, and I'm going to ask that three papers be brought up, and if you identify them we'll mark them as exhibits, that bear on stickleback. The first is Tab 5, Mr. Lunn, of Canada's book of documents.

Do you recognize that paper? Maybe we can see the next page, if it helps.

DR. JONES: Yes, I recognize it.

Q And that's a paper that you produced and it bears on stickleback and sea lice?

DR. JONES: That's correct.

MR. TAYLOR: May that be the next exhibit, please.

THE REGISTRAR: Exhibit 1765.

EXHIBIT 1765: *The Journal of Parasitology*, The Diversity of Sea Lice (Copepoda: Caligidae) Parasitic on Threespine Stickleback (*Gasterosteus Aculeatus*) in Coastal British Columbia, by Simon Jones and Gina Prosperi-Porta

MR. TAYLOR: And then we have, if we may, Mr. Lunn, Tab 15 of Canada's book.
Q And is that another paper that you and others wrote, to do with stickleback and sea lice, Dr. Jones?
DR. JONES: Yes, it is.
MR. TAYLOR: May that be the next exhibit, please.
THE REGISTRAR: 1766.

EXHIBIT 1766: The Occurrence of *Lepeophtheirus Salmonis* and *Caligus Clemensi* (Copepoda: Caligidae) on Three-spine Stickleback *Gasterosteus Aculeatus* in Coastal British Columbia, by Simon Jones, et al

MR. TAYLOR: And the next, Tab 16, the next one, Mr. Lunn.
Q Again, is that a paper that you and other wrote to do with stickleback and lice, Dr. Jones?
DR. JONES: Yes, it is.
MR. TAYLOR: May that be the next exhibit, please.
THE REGISTRAR: 1767.

EXHIBIT 1767: Experimental infections with *Lepeophtheirus Salmonis* (Kroyer) on threespine sticklebacks, *Gasterosteus aculeatus* L., and juvenile Pacific salmon, *Oncorhynchus* spp., by S. Jones, E. Kim and S. Dawe

MR. TAYLOR:
Q Now, you mentioned pink salmon in your evidence a moment ago as well, and you mentioned as small as - I forget exactly what you said - but quite small in terms of a fraction of a gram and they were still showing that they could stand up to sea lice, is I understand what you said. What does that tell you, if anything?
DR. JONES: Well, the most obvious thing it tells me is that the pink salmon, once it passes that size

threshold is particularly resistant to the direct effects of sea lice infestation. The mechanisms that the sea lice employs to control sea lice cause a rapid reduction in the level of infection on the fish and that this rapid reduction effectively removes the harmful consequences of the infection to the pink salmon.

Q All right. And can you draw any conclusions from that about sockeye?

DR. JONES: The work on pink salmon was -- one of the most important features of that work was that it told us how important size is as the fish passes the size threshold, which in the case of pink salmon is a fraction of a gram. In the case of pink salmon, it coincides with the maturation of the skin, the tissue to which the sea lice attaches, and specifically to the development of the scales and to the thickening of the outer layer of the skin. The pink salmon is more resistant when it has these attributes.

The only connection, directly, that we can make to sockeye salmon is that when they enter the marine environment they're, in most cases, already a year older, they've been in freshwater over winter, and they're a larger fish with a more mature scaled skin, and I would expect that that would confer to the sockeye salmon some level of resistance. I would be hesitant to extrapolate further because, as I've already mentioned, chum salmon also have similar characteristics to pink salmon, and yet they display a lower level of resistance to the salmon louse, and we need to understand what this relationship is for sockeye salmon.

Q All right. In regard to size in pinks, I'm going to put three papers to you and see if you can identify them, and then, if so, we'll mark them as an exhibit. Tab 4, Mr. Lunn, of Canada's book. You may need to see the next page. Do you recognize that as one of your papers, and specifically on pinks and size dependence?

DR. JONES: Yes, I do.

MR. TAYLOR: May that be the next exhibit, please.

THE REGISTRAR: 1768.

EXHIBIT 1768: *Elsevier*, Volume 60, Number 2, June 2011, Comparative Biochemistry and Physiology, CBP, Genomics and Proteomics

MR. TAYLOR: Tab 6, please, Mr. Lunn.
Q Same question: Do you recognize that?
DR. JONES: Yes, I do.
Q And just finally in this series, Tab 11.
MS. GRANT: Did you want to mark that last paper?
MR. TAYLOR: Yes, thank you.
THE REGISTRAR: It's already marked as Exhibit 1473.
MR. TAYLOR: Thank you.
Q And so we're now at Tab 11. Do you recognize that paper, Dr. Jones?
DR. JONES: Yes, I do.
MR. TAYLOR: And may that be the next exhibit, please.
THE REGISTRAR: That's also marked; it's 1472.
MR. TAYLOR: Thank you. Mr. Commissioner, I note the time. I'm happy to keep going or take a break, as you wish.
THE COMMISSIONER: I think for the staff purposes, it might be useful to have a break now, Mr. Taylor, so let's take the break.
MR. TAYLOR: All right, thank you.
THE REGISTRAR: The hearing will now recess for 15 minutes.

(PROCEEDINGS ADJOURNED FOR MORNING RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: Hearing is resumed.

CROSS-EXAMINATION BY MR. TAYLOR, continuing:

MR. TAYLOR: I'm going to start this after-the-break portion of my next 15 minutes with putting in some exhibits. I'm just going to say the tab number and put the exhibit in unless there's any issue taken. They're all documents that Dr. Jones co-authored and all have been put on our list of documents for this panel. Tab 3, I ask be Exhibit 1769.
THE REGISTRAR: So marked.

EXHIBIT 1769: The Winter Infection of Sea Lice on Salmon in Farms in a Coastal Inlet in British Columbia and Possible Causes - Beamish et al

MR. TAYLOR: Tab 7 --
THE COMMISSIONER: I'm sorry. I apologize. I had 1769 as Tab 11. Did I make an error in that regard?
THE REGISTRAR: That was already marked as 1472.
THE COMMISSIONER: 1472?
THE REGISTRAR: That's correct.
THE COMMISSIONER: Thank you.
MR. TAYLOR: Yes. I tried to mark it, Mr. Commissioner and Mr. Giles corrected me as it having been marked, so 3 would be 1769.
Tab 7, Exhibit 1770.
THE REGISTRAR: So marked.

EXHIBIT 1770: Controlling salmon lice on farmed salmon and implications for wild salmon - Jones

MR. TAYLOR: Tab 8 Exhibit 1771.
THE REGISTRAR: So marked.

EXHIBIT 1771: A large, natural infection of sea lice on juvenile Pacific salmon in the Gulf Islands area of British Columbia, Canada - Beamish et al

MR. TAYLOR: Tab 10, Exhibit 1772.
THE REGISTRAR: So marked.

EXHIBIT 1772: Perspectives on Pink Salmon and Sea Lice: Scientific Evidence Fails to Support the Extinction Hypothesis - Brooks and Jones

MR. TAYLOR: Tab 12 Exhibit 1773.
THE REGISTRAR: So marked.

EXHIBIT 1773: The Abundance and Distribution of *Lepeophtheirus salmonis* (Copepoda: Caligadae) on Pink (*Oncorhynchus gorbuscha*) and Chum (*O. keta*) Salmon in Coastal British Columbia - Jones and Hargreaves

MR. TAYLOR: Tab 13 Exhibit 1774.
THE REGISTRAR: So marked.
MR. TAYLOR: Tab 14 Exhibit 1775.
THE REGISTRAR: So marked.
MR. LUNN: One moment, please.
THE REGISTRAR: We just found out that Tab 13 is already marked as 1340, so that will throw your numbers off a bit.
MR. TAYLOR: That's fine. So Tab 13 is already marked. Thank you. Tab 14 then, may it be Exhibit 1774?
THE REGISTRAR: That's correct.

EXHIBIT 1774: The salmon louse *Lepeophtheirus salmonis* on salmonid and non-salmonid fishes in British Columbia - Jones et al

MR. TAYLOR: Tab 17, Exhibit 1775, please.
THE REGISTRAR: So marked.

EXHIBIT 1775: Exceptional marine survival of pink salmon that entered the marine environment in 2003 suggests that farmed Atlantic salmon and Pacific salmon can coexist successfully in a marine ecosystem on the Pacific coast of Canada - Beamish et al

MR. TAYLOR: And Tab 18 Exhibit 1776, please.
THE REGISTRAR: So marked.

EXHIBIT 1776: Pink Salmon Action Plan: Sea Lice on Juvenile Salmon and on Some Non-Salmonid Species in the Broughton Archipelago in 2003 - Jones and Nemec

MR. TAYLOR:
Q Dr. Jones, you said in your evidence or referred in your evidence to some work that you are doing in the Strait of Georgia to do with lice; is that recent work? Who is it with? What is it and what are you finding, if you could briefly tell the commissioner, please?
DR. JONES: It is recent work. This was a project that began in 2010, last year, in which we began a series of surveys in the Strait of Georgia specifically to identify or to collect juvenile salmon, including sockeye salmon. One of our

objectives was to determine levels and identities or species of sea lice on the juvenile salmon and the other objective of the work was to conduct a more broad health assessment of these fish in the Strait of Georgia.

The work was valuable, in addition, because we were also able to collect specimens of juvenile sockeye salmon from their rearing areas in the Fraser River and also in the Lower Arm or the Lower Mainstem of the Fraser River prior to their entry into the Strait of Georgia. We began in 2010 and the work has continued this year and we've begun to analyze the data from that work. One of the -- and I guess to backtrack, the survey of sockeye salmon and of all juvenile species was throughout the Strait of Georgia from the estuary of the Fraser River up to the area known as the Discovery Passage area, the area that was identified in our earlier discussion of the Price papers where salmon farms occur, and throughout the Strait of Georgia to the south of that area. Samples were collected throughout the Strait of Georgia south of and in the area in which there are salmon farms and in 2010 we observed that in our first sample which was in May over 300 sockeye were identified and about 70 percent of these sockeye throughout the Strait of Georgia were infected with *Caligus* and approximately three percent of these fish were infected with *Lepeophtheirus salmonis*.

In June we sent boats out again and conducted a similar survey and we -- the data were almost identical, a little over 70 percent infected with *Caligus* and three or four percent with *Lepeophtheirus salmonis.* We are continuing to analyze the data and it does suggest that for *Caligus* that there is a strong relationship between the level of lice on the sockeye and the distance that they've migrated from the Fraser River. In other words, the time spent in the ocean seems to be a strong determinant of the level of infection with *Caligus clemensi* but as I say, this work is still -- the analysis of these data is still underway and I've not seen any data yet for the collections we've made in 2011.

Q All right. And in that regard, if we go to Tab 2, please, of Canada's book, this is a PARR project

proposal that is Program for Aquaculture Regulatory Research. You're familiar with this document, are you?

DR. JONES: Yes, I am.

Q Is that your proposal, along with Dr. Johnson for some research into sea lice?

DR. JONES: Correct. Yes, it is.

Q And that works on -- that was funded and it's ongoing, is it?

DR. JONES: This is the work I was just describing, yes, it is.

MR. TAYLOR: Thank you. Yes. Exactly. May that be Exhibit -- the next exhibit, please?

THE REGISTRAR: 1777.

EXHIBIT 1777: PARR Project Proposal 2010/11

MR. TAYLOR:

Q And are there other funding sources that went into this work besides the PARR funding?

DR. JONES: When I look at this document it says:

> The effects of single and repeat *Lepeophtheirus salmonis* infections...

As you recall, earlier I mentioned that the work was twofold: it was a field surveillance effort and the marine -- the marine surveillance effort and the laboratory component. This document actually refers to the -- it is a PAAR document. This refers to the laboratory infections that were conducting on sockeye salmon.

Q All right.

DR. JONES: So we were funded through the same process to conduct the field surveillance of sockeye.

Q That you just talked about?

DR. JONES: That I just talked about.

Q Dr. Noakes and Dr. Dill, who will be familiar to the panellists, gave evidence earlier and opined that sea lice is unlikely to be the cause of the decline in productivity of Fraser sockeye although Dr. Dill wasn't as certain as Dr. Noakes and wouldn't rule it out, but he hadn't found any evidence in that regard.

Mr. Price, do you agree that sea lice is not going to be found to be the cause of the decline in productivity of Fraser sockeye?

MR. PRICE: If you're asking whether sea lice acting in isolation are responsible or not responsible, is that your question, sorry?
Q Let's take that as the question and have you answer it.
MR. PRICE: So sea lice acting in isolation, would the or are they responsible for the -- or, sorry, sockeye productivity in general?
Q Yes.
MR. PRICE: So, no, I don't believe sea lice acting in isolation are responsible for the decline in sockeye productivity.
Q Same question as to the 2009 non-return, we'll call it. Would sea lice be the cause of that?
MR. PRICE: Again, I don't believe, you know, sockeye (sic) acting in isolation was responsible for that but nor do I believe a factor such as sea lice do act in isolation.
Q All right. Dr. Orr, taking sea lice in isolation and as well in concert with as a major contributor along with other things, do you agree that what Dr. Noakes and Dr. Dill, although not as strong as Dr. Noakes, do you agree that sea lice is unlikely to be found to be the cause of decline in productivity of Fraser sockeye?
DR. ORR: Well, it's a little difficult to take it in isolation. I know you want to go there, but I think Dr. Dill did suggest that he was concerned about it being a vector for disease. Is that not correct in terms of how he characterized it?
Q He has concerns about vectoring, yes.
DR. ORR: Yes. And I would agree with Dr. Dill in that case, that that is something that does need to be examined in this commission, whether lice vectoring disease had a major contributing factor or a major contributing factor to the decline in productivity. And in terms of isolation, I think I've already touched on that somewhat. Mechanical damage of *Caligus* is something that's -- something we're probably not quite as concerned about as mechanical damage of *Leps* but there are many behavioural influences that lice do and also transmitting up to the food chain, trophic transmission of lice, which has been shown to cause higher infections on coho salmon in the Broughton Archipelago, these are all factors that need more study and probably have a much greater

impact than just the pure mechanical damage of the lice themselves.

Q All right. Dr. Saksida, without meaning to cut you off but as much as you can give me a yes or no answer in the interests of time, that's fine. Sea lice, is it -- is it unlikely to be found as a major contributor to decline in productivity and, as well, the 2009 event?

DR. SAKSIDA: In my opinion it's unlikely.

Q Dr. Jones?

DR. JONES: In my opinion it's unlikely.

Q Now, Dr. Jones, you're familiar with two papers that Mr. -- at least two papers that Mr. Price has written, one in 2010 and one in 2011. The 2011 paper is Exhibit 1476 in these proceedings. I suspect the 2010 paper is, as well, although I don't have it to hand. You're familiar with those papers, I understand. Do you have comment on one or both of those papers?

DR. JONES: I commented earlier this morning in response to commission counsel regarding the 2011 paper.

Q Yes.

DR. JONES: But I would like to comment on the paper from 2010.

Q Okay.

DR. JONES: As I recall the paper published by Bryce et al in 2010 examined the relationship between salmon farms, specifically the productivity of salmon farms, also on levels of infection with sea lice on pink and chum salmon in a variety of areas of coastal British Columbia in the Discovery Passage area, in the Broughton Archipelago and, I believe, in two other areas on the coast of British Columbia. Perhaps the map here would show exactly where those areas are.

MR. MARTLAND: Just by way of assistance, Mr. Commissioner, I think what's on screen may be Exhibit 1481, the 2010 paper.

DR. JONES: Yes. Thank you. So there were three areas, "A" on the central coast, "B" in the Broughton Archipelago and "C" being the area known as Discovery Passage, which was the area of focus for the paper published in 2011.

One of the conclusions that the authors drew in this paper was that there was a relationship between the productivity of farmed salmon, meaning

the annual biomass produced in an area, and the levels of lice, *Leps. salmonis* and *Caligus clemensi*, on juvenile pink and chum salmon. And they demonstrated this relationship in Figure -- and I don't recall which figure it is, but it's one of the later figures in this paper that show this relationship. Perhaps it's Figure -- I'm not sure, 2 or 3. Up a bit. Yeah. Okay.

So on the Figure 3, the bottom figure, regional farmed salmon production and it illustrates that there are a number of different levels of production, depending on which area you're in and it ranges from zero on the left to over 17,000 metric tonnes on the right of farmed salmon production and the mean combined sea louse abundance, and the inference here is that there's a relationship between farmed salmon production and louse abundance.

What -- although the authors did collect salinity data, it was apparent that there are some differences in the salinity of the waters in which they collected these data, so that salinity was rather low in areas such as where there's zero farmed salmon production, and higher where there are areas where salmon farms are being -- salmon are being produced in farms, and we know from a number of studies that salinity, for example, is a very important environmental determinate for the survival of the larval stages of sea lice which live in the plankton. If the salinity is too low, these -- the larval stages do not survive or they develop poorly.

What -- and we felt that this explanation may be an alternative reason why mean combined sea louse abundance differed. And we conducted an alternative or we posed an alternative hypothesis which was that given our published data from the Broughton Archipelago over five years, where we can measure sea lice levels on wild, pink and chum salmon and have evidence from the farmed salmon industry which tells us what their annual production is, in a particular area of the Broughton Archipelago we could test the relationship between farmed salmon production and levels of lice on wild, pink and chum salmon. And when we did this analysis we found that - and this is based on published information - that the

levels of sea lice in this area of the Broughton Archipelago declined very significantly between 2004 and 2008, both on pink salmon and on chum salmon and we saw declines with *Leps. Salmonis* most notably, but also declines with *Caligus clemensi* over this period of time.

When we did an analysis that related this decline with the production of farmed salmon similar to this Figure 3 in this paper, there was no evidence of a relationship. Farmed salmon production did vary somewhat across these same years in the Broughton Archipelago and the number of lice declined significantly, but there was no statistically significant relationship between these two factors, farmed salmon production and numbers of lice. So what we suggested was that it's not the farmed salmon production that's most important. It's the management of sea lice on fish farms which is a more important determinate as to whether lice levels occur on wild salmon in the vicinity and to what extent they occur on those, which is a conclusion also reached by a paper published last year by Marty et al.

Q All right.

DR. JONES: So this was probably one of our most important concerns with this paper.

Q Okay. Thanks. I'm going to have to leave it there on that because of time and I am out of time, so I'm just going to quickly put in three more exhibits, Tab 19 of Canada's book, a paper by Brooks. You're not the author, any of you panellists. Do panel members recognize this paper and recognize it as a valid scientific article? Anyone?

DR. JONES: I recognize the paper.

MR. TAYLOR: All right. I'm going to ask that this be the next exhibit, please.

THE REGISTRAR: 1778.

EXHIBIT 1778: The Effects of Water Temperature, Salinity, and Currents on the Survival and Distribution of the Infective Copepodid Stage of Sea Lice Originating on Atlantic Salmon Farms in the Broughton Archipelago of British Columbia, Canada - Brooks

MR. TAYLOR: And the same with Tab 20, another paper by Brooks on water temperature and salinity and currents, may this be the next exhibit, please?
THE REGISTRAR: 1779.

EXHIBIT 1779: The Effects of Water Temperature, Salinity, and Currents on the Survival and Distribution of the Infective Copepodid Stage of Sea Lice Originating on Atlantic Salmon Farms in the Broughton Archipelago of British Columbia, Canada - Brooks - A Response to the Rebuttal of Krkosek et al

MR. TAYLOR:
Q Finally, there is an additional document that we provided this morning. It's Dr. Jones' presentation at the April 14/15 DFO Science meeting that we've heard about in these proceedings. Do you recall that, Dr. Jones?
DR. JONES: Yes, I do.
Q And that's what you presented on April 15th or so to the -- your colleagues in DFO Science?
DR. JONES: That's correct.
MR. TAYLOR: I'm going to ask that be the next exhibit, please.
THE REGISTRAR: 1780.

EXHIBIT 1780: Hypothesis: sea lice, either naturally occurring or passed from fish farms, are an important contributor to the Fraser sockeye situation - Jones

MR. TAYLOR: That is my time and those are my questions, Mr. Commissioner.
THE COMMISSIONER: Thank you, Mr. Taylor.
MR. MARTLAND: I think it's also a speed record on exhibits. Mr. Commissioner, I have next counsel for the Conservation Coalition at 30 minutes.
MR. LEADEM: For the record, Leadem, initial T., appearing as counsel for the Conservation Coalition.

CROSS-EXAMINATION BY MR. LEADEM:

Q I want to begin with you, Dr. Jones. My understanding of the threshold that you found for

the pink salmon was actually derived from -- as a result of studies that you conducted in a laboratory; is that not correct?

DR. JONES: That is correct.

Q And that caution must be exercised in applying that threshold to what I will call real life or real conditions as they exist in nature; is that not fair?

DR. JONES: That is true, as we pointed out in the paper.

Q Right. And I'm going to turn to you, Dr. Orr. Is there a distinction that you can draw between experiments that are conducted in the field where you actually are in nature and in the ecosystem as opposed to laboratory conditions?

DR. ORR: Certainly. And I think Dr. Jones has admitted that. There is a paper that examine the paper, his seven-tenths of a gram threshold paper and it showed that in the field, the exposure times between sea lice and wild salmon was two to three orders of magnitude greater than in laboratory studies, so that has to be accounted for. There's a lot more passing of lice between fish during those longer exposure periods.

Q And one of the documents -- I wonder if we can have Mr. Price's 2010 paper that was put to Dr. Jones, 'cause I want to see if Mr. Price has any rebuttal to what he heard from... This is an exhibit. I -- and I failed to mark the actual number of this.

MR. MARTLAND: 1481, I think.

MR. LEADEM: Thank you, Mr. Martland.

MR. MARTLAND: Oh, I'm sorry, 1476.

MR. LEADEM:

Q Mr. Price, you heard Dr. Jones criticize your paper. Do you have any responses to his critiques?

MR. PRICE: Well, it was an interesting response in terms of acknowledging that management actions are responsible for reducing lice levels on wild juvenile salmon. I think that's an important acknowledgement to make. In terms of, you know, testing this hypothesis of productivity as you'll see in the paper we do not test this hypothesis that productivity leads to higher lice levels on juveniles.

What we tested was the exposure of these fish

to salmon farms, whether fish that are more exposed to salmon farms are more infected by sea lice, and that's exactly what we found and that's exactly what we state in this paper. In regards to if we want to come back to salinity, and whether some lower salinity values recorded in Bella Bella, which is our control region, whether that was responsible for the lower lice levels that we say overall, well, I point out that within the Broughton Archipelago, and it's in this paper, that low exposure sites, those juveniles that were collected at lower exposure sites in the Broughton Archipelago showed higher salinity levels that high exposure sites within the Broughton Archipelago and, in fact, in the Broughton Archipelago at high exposure sites we saw similar salinity levels than we did in Bella Bella. Yet, significantly higher lice levels were recorded on the juveniles.

Those are my two primary comments at the moment.

Q Thank you. I want to now turn to Dr. Saksida. If I can have Conservation document number 1, please? When it comes up, I'm hoping that you would recognize this, Dr. Saksida. It should be an email chain. Is this an email that you sent?

DR. SAKSIDA: Yes, it is.

MR. LEADEM: Could we have that marked as the next exhibit please?

THE REGISTRAR: 1781.

EXHIBIT 1781: Email chain between Sonja Saksida and Mark Saunders and others - Sockeye salmon health program

MR. LEADEM:

Q You're writing in this email to a proposal, as I understand it, in which you write directly to Dr. Brent Hargreaves and Dr. Jones, both of -- and Dr. Beamish from DFO; is that not correct?

DR. SAKSIDA: The email actually was directed to Mark Saunders, who is the department chair and then Laura Brown, who's also department chair, as well as every -- well, all the other people in that list, yes.

MR. LEADEM: Could we have Conservation document number 2, please?

Q This should be a paper that you authored for CERMAQ; is that correct?
DR. SAKSIDA: Yes, it is.
MR. LEADEM: Could we have that marked as the next exhibit, please?
THE REGISTRAR: 1782.

EXHIBIT 1782: Overview of Sea Lice Issues and Risks for Farmed and Wild Salmon in British Columbia - Saksida et al

MR. LEADEM: Could we have Conservation document number 3, please?
Q This is a letter directed to you from the managing director of the B.C. Pacific Salmon Forum Science Advisory Committee; did you receive a copy of this letter?
DR. SAKSIDA: I did.
MR. LEADEM: Could we have that marked as the next exhibit, please?
THE REGISTRAR: 1783.

EXHIBIT 1783: Letter from Pamela Parker to Dr. Sonja Saksida dated October 16, 2006

MR. LEADEM:
Q A reference in the first paragraph suggests that:

> ...based upon the feedback received from three external statistical reviews and their own discussion, they cannot, under current circumstances, recommend approval for funding of Stage 2.

DR. SAKSIDA: Can I comment on this?
Q Certainly.
DR. SAKSIDA: This project was a project that I worked with Simon Jones, Brent Hargreaves, Dario Stucchi and what we were trying to do at this point in time is finally bring salmon farming data with the wild fish data and the oceanography data together. Because of the group, there was another group of people that did not -- were not part of our team and they did not want this project -- I felt they did not want this project to go ahead. This project was the only project that actually went through peer review at the Pacific Salmon Forum.

As a result of the peer review, we went and re-evaluated the -- our methodology. We actually came back with a new proposal and we did receive funding.

MR. LEADEM: Could we have Conservation Tab number 9, please?

Q This appears to be an email exchange between you, Dr. Johnson at the beginning and then if you scroll down to the second email, there seems to be also Dr. Jones is now included. If you can scroll, keep on scrolling, please, Mr. Lunn. You'll see that the initial email is from you to Dr. Johnson concerning a rebuttal for the Price paper. Is that the 2011 study or the 2010 study; do you recollect?

DR. SAKSIDA: It was a 2011 study.

MR. LEADEM: Could we have that marked as the next exhibit, please?

THE REGISTRAR: 1784.

EXHIBIT 1784: Email chain between Dr. Johnson, Dr. Saksida and others - Re: Rebuttal for Price Paper

MR. LEADEM:

Q Did you ever then collaborate with either Dr. Jones or Dr. Johnson in terms of a rebuttal to the Price paper?

DR. SAKSIDA: We started to work on a rebuttal. Science is an iterative process. Preparing rebuttals can take a long time. Sometimes it's best just to leave research, to move forward and not spend time doing the rebuttal. I don't think we've made a decision if we are going to put in a formal rebuttal or just leave it.

Q I want to turn to now Dr. Jones. I want to talk to you about SLICE and potential resistance to SLICE. My understanding that the chemical name for SLICE is emamectin benzoate; is that right?

DR. JONES: That is correct. That's the active ingredient.

MR. LEADEM: Could we have Canada number 7, which I believe has now been marked as Exhibit 1770, please?

Q If we can look at, I think it's page 8 of that document, probably PDF number 8, and the top left-hand, if you can just -- thank you. You say in

this paper this sentence that I picked out and I'm going to ask you to comment on it in a moment. You say:

> However, the development of resistance to the widely-used therapeutant EB --

And I'm going to suggest that's emamectin benzoate or SLICE, is that right?

DR. JONES: That's correct.

Q

> -- is an obvious consequence to the increased frequency of treatments in these areas, particularly since the implementation of stringent treatment triggers.

And then you go on to say:

> With a growing emphasis on IPM --

Which I understand is an acronym for Integrated Pest Management; is that right?

DR. JONES: That's also correct.

Q

> -- there is an ongoing need to better understand coastal ecosystems to provide a more rational approach to the co-management of aquaculture and wild salmon fisheries.

And I'm just going to stop there because I think that's an important concept that you hit upon, that really you need to focus on the ecosystems and what effect, if any, salmon farms are having upon the ecosystems. Is that a fair statement?

DR. JONES: Well, I think by definition the concept of ecosystem research is holistic and requires that attention be made to all aspects of that ecosystem and if that includes salmon aquaculture, if that includes the biology and the ecology of juvenile wild salmon, then I think that that would be the intent that I was making in this statement.

Q And in terms of the SLICE resistance and as a biologist, you're familiar with the fact that as you treat for a pathogen, whether it be a parasite, an ectoparasite such as *Leps. Salmonis* or whether it's a pathogen and something that's internal, that there's a tendency on the part of

that parasite or that pathogen to develop resistance to the treatment that you bring to bear. That's common occurrence amongst biological processes, is it not?

DR. JONES: That -- yes, that is common, for example, in the application of antibiotics for the treatment of bacterial infections. I think -- I want to make it very clear here where I've said the development of resistance to the widely-used therapeutic EB is an obvious consequence, it was obvious to me.

So that's my opinion and it's -- and it seems to be the case, when you look at what is happening in other parts of the world, for example, in Chile or in Norway where there have been documented cases of resistance to emamectin benzoate, particularly in Norway, where stringent triggers or thresholds for the application of the SLICE have been applied and as a result of these management thresholds, lice -- SLICE has been used more frequently than perhaps it would have been used otherwise. But, yes, to answer your question it is a phenomena that is not uncommon in biology, that under selective pressure that you can see the rise of resistant strains.

Q Dr. Orr, do you have any comments with respect to what I've -- that discussion that we just had?

DR. ORR: On resistance? Sorry. On resistance?

Q Yes.

DR. ORR: Yeah. And Dr. Jones would be well aware of this, he was one of the organizers for a workshop called Sea Lice 2010 that was held in Victoria in May of 2010 where we heard research from around the world on growing resistance to SLICE as a treatment to sea lice. And there were some fairly sobering discussions there on how quickly lice can develop resistance to SLICE, as well. And I will say that in a couple of papers that I've authored or co-authored, I've looked at the effects of SLICE on lice, as well. It's very effective for lice on this coast. There's no question about it. But we do put some precautions in those papers on its use as a continual treatment for lice because of the experience from Europe, in particular, and the East Coast of Canada and how quickly lice can develop resistance to SLICE.

MR. LEADEM: I wonder if we can have Conservation

document number 75. It should be the last one in our list, Mr. Lunn.

MR. LUNN: Sorry, I don't have anything after document 62 for you but I do show your list ending at 75. I can try to get those. It'll take a couple of minutes, if you can... Sorry about that.

MR. LEADEM:

Q Did you attend a workshop sponsored in part by CAAR and Marine -- I believe it's MHC or -- I'm not sure of the acronym. I believe counsel has now handed you a copy of that.

DR. ORR: Are you asking Simon or me? I'm not --

Q I'm asking you, Dr. Orr. Sorry.

DR. ORR: Yes. I was -- helped to organize that workshop. It was November 2009.

Q All right. And if you can just read into the record the title of that workshop.

DR. ORR: Yeah. It was a workshop -- there were lots of things being said about the effects of lice on juvenile fish and, you know, about thresholds and about whether, you know, fish got above a certain size, it was immune, and we had a working relationship with Marine Harvest to look at morbidity and mortality impacts, morbidity meaning sublethal impacts of lice on fish and we decided to host a workshop with some international scientists there and a bunch of DFO scientists and Sonja and Simon were there, as well. And we discussed this issue of thresholds and we put this workshop together so we could come out with some common language on what we could say about how lice affect juvenile salmon.

I'm not sure if we actually succeeded, but we just actually got the proceedings done this year and what we did discuss at that workshop was that there, you know, are all kinds of effects of lice that we don't normally consider here, one Bengt Finstad found was that when lice swim through -- or, sorry, juvenile fish swim through polluted water, they're more susceptible to lice once they get out into the ocean. But we looked at this issue of thresholds and we looked at this issue that we discussed already of exposure time and behavioural effects.

Larry Dill did a presentation showing again that we have to consider trophic transmission of lice when we're looking at the holistic effects of

lice in wild fish and we also looked at this issue -- we didn't talk about sockeye so much. We were told that the DFO folks couldn't talk about sockeye at this workshop, but we did talk about fish the size of sockeye at this workshop, which are about eight grams, compared to about one gram for chum and pink salmon. And we also compared those to -- with the European experience for Atlantic salmon and sea trout, which are in the order of 15 to 25 grams. So those larger fish, in particular, are totally susceptible to lice. It's all about, you know, how many lice they get on them and the stage of the lice, whether they're motile or not.

And the Europeans there don't dispute and didn't dispute at this workshop any more that these larger fish, much larger than sockeye, are susceptible to lice. So we got a few common agreements out of this workshop, although we've never issued any public statements from it.

Q Can you recollect or can you take me to some of the common agreements that you may have reached?

DR. ORR: One that we did reach was that we have to be very cautious when we suggest that pink salmon are immune to lice once they get past seven-tenths of a gram.

MR. LEADEM: Could we -- I see that it's now on the screen, Mr. Commissioner. Could we have this Morbidity/Mortality Effects of Sea Lice on Juvenile Salmon Workshop marked as the next exhibit, please?

THE REGISTRAR: Exhibit 1785.

EXHIBIT 1785: Morbidity/Mortality Effects of Sea Lice on Juvenile Salmon Workshop

MR. LEADEM: I wonder if we could have Exhibit 11 pulled up.

Q This question is to you, Dr. Orr, once again. Do you recognize this statement from a think tank of scientists?

DR. ORR: I do.

Q And were you present at this SFU think tank?

DR. ORR: Yes, I was.

Q Do you support any of the conclusions or all of the conclusions reached by this group of scientists?

DR. ORR: It was a consensus statement and I support those conclusions, especially the part about removing salmon from the migration route, farmed salmon from the migration route of juvenile sockeye as an experiment.
Q When you say that -- this was attended by a group of scientists, was it?
DR. ORR: That's correct.
Q And to your knowledge did anyone from Department of Fisheries and Oceans attend that?
DR. ORR: No. That was unfortunate, too.
Q Were they invited?
DR. ORR: They were.
MR. LEADEM: Could we have Conservation document number 37, please?
Q You recognize this paper, do you, Dr. Orr?
DR. ORR: I do.
MR. LEADEM: Can we have that marked as the next exhibit, please?
THE REGISTRAR: 1786.

EXHIBIT 1786: Estimated Sea Louse Egg Production from Marine Harvest Canada Farmed Atlantic Salmon in the Broughton Archipelago, British Columbia 2003-2004 - Orr

MR. LEADEM:
Q Now, I should have said this at the beginning but I'll do it now, Mr. Commissioner, by questions. I understand, Dr. Orr, that you're a member of Watershed Watch?
DR. ORR: Yes, I'm the executive director.
Q And Mr. Price, you're a member of Raincoast Conservation?
MR. PRICE: Yes, that's right.
MR. LEADEM: Both of those, Mr. Commissioner, are my clients.
Q Now, Mr. Taylor asked you a general question about the decline of Fraser River sockeye production and whether or not there can be some connection or attribution to sea lice to both -- to all members of the panel and we've sat through lots of evidence from scientists like yourselves who have come and talked about factors that might have been giving rise to the decline of the Fraser River sockeye. And most of them, with one or two rare exceptions, have not been able to say that there

is a cause or the cause. Most of them have been able to say well, there's a combination of factors that have probably contributed to the decline and do I have it right when you gave your evidence, Dr. Jones and Dr. Orr and Mr. Price that you also would put lice in that category as a potential contributing factor, rather than the factor?

I'll start with you, Dr. Jones.

DR. JONES: As I conveyed earlier, there's a lot of uncertainty in terms of our understanding of what influences the survival of juvenile salmon in our local ecosystems and so it would be very difficult for me to say that anything could not be a possible contributing factor. Certainly the fact that 70 percent of juvenile sockeye salmon that we've seen in our surveys have *Caligus* infestations to me tells me that there will be a cost associated with those infestations and I think on balance I would not elevate the risk beyond low to medium that I suggested earlier based on what we've seen so far.

But I agree that there would be some circumstances that under which salmon lice or other species of sea lice could cause harm to juvenile sockeye salmon.

Q And I'll turn to you in a moment, Dr. Orr, but I just want to stay with you, Dr. Jones. You certainly recognize that the concept of sublethal effects and behavioural effects.

Would you agree with me that those kinds of effects are very difficult to measure in conjunction with something like an infestation of a sea louse? Is that fair?

DR. JONES: It is more difficult to measure sublethal effects because it's not such an obvious thing as mortality is, but there is certainly laboratory protocols that have been developed and have very well-demonstrated sublethal effects associated with *Leps. salmonis*, for example, swim performance or changing in the balance of different salts in the plasma of the blood of these fish, could be considered as sublethal effects and there's no question there are methods in order to make these measurements.

Q Dr. Orr, turning to you to answer the general question that I posited earlier.

DR. ORR: The general question on sea lice impacts, I

mean, if we were talking mainly infections of *Leps* it would be easier to come to a conclusion that we have concerns. Certainly there's been a lot of work done by Brendan Connors and others in the Broughton Archipelago showing lower productivity of coho salmon and other salmon, in particular coho, you know, larger than the sockeye, because of *Leps* and infections from *Leps* they're getting from their prey. So again, the behavioural effect and trophic transmission of lice with *Leps* is causing population declines.

There's certainly evidence from Europe, Costello I think his paper was entered in in evidence in the past, shows as few as five to ten lice are pathogenic to Atlantic salmon smolts. So there's quite a bit of evidence for *Leps*. It does come down to a lot of the behavioural influences when you're talking *Leps* and *Caligus* and whether there's interaction between *Leps* and *Caligus*, we don't know that. We do have to look in terms of these behavioural influences. And what we're trying to measure is very difficult to measure, and that's risk of predation in many cases.

We know, for instance, that a sparrow that feeds five metres from a brush pile is probably going to be more likely picked off by a hawk than one that feeds right next to the brush pile. But it's very hard to quantify that kind of a risk and the same is true for, you know, fish that are flashing, that because they have one louse on them are swimming at the outside of the school, they're swimming further away from uninfected juveniles and they're swimming at the backs of schools. We know that that likely increases their risk of being picked off by predators such as coho and cutthroat trout, but is very hard to quantify that risk, although it is something that is probably important research to do in the future.

Q And lastly, in the last minute that I have, Mr. Price, do you have a comment with respect to the question I posited earlier with regard to the general query about *Leps. salmonis* or *Caligus* and sea lice infestation and contributing factors as compared to the factor?

MR. PRICE: Well, I suppose a comment I want to make is that factors rarely act in isolation on the population dynamics of species, and so yes, I

believe these parasites acting with other factors, may be stressing these juveniles at the time, may be a contributing factor to not only productivity declines but also during that 2009 return or the low return.

MR. LEADEM: Could we have Conservation document number 29, I believe?

Q Do you recognize this document, Dr. Orr?

DR. ORR: I do.

MR. LEADEM: Could we have that marked as the next exhibit, please?

THE REGISTRAR: 1782 -- I'm sorry, 87.

EXHIBIT 1787: Dynamics of outbreak and control of salmon lice on two salmon farms in the Broughton Archipelago, British Columbia - Krkosek et al

MR. LEADEM:

Q The last line in the abstract, I just want to draw your quick attention to. You say:

> If parasiticides do not have adverse environmental effects and lice do not evolve resistance --

And I think you're referencing SLICE there; is that right?

DR. ORR: That's correct. SLICE specifically, but other -- you know, other chemical therapeutants have been used, as well.

Q And you say then:

> -- optimized parasiticide use on salmon farms may help reduce the spread of lice to wild salmon populations.

So I take it then as a consequence of this study that you would be in favour of controlled application of SLICE on salmon farms in order to help the populations of wild salmon?

DR. ORR: I wouldn't quite characterize it like that. In fact, this is part of an emergency interim measure that CAAR agreed to with Marine Harvest Canada is to use fouling -- trying to create migration corridors. We looked at Krkosek's 2007 Science paper where he showed very clear negative

trends in productivity of pink salmon with the impacts of salmon farming, and we felt we had to do something and we agreed with Marine Harvest to do alternating migration corridors at the time where there was removal of fish and also use of chemical therapeutants as an emergency interim measure, and I keep using that phrase, but we know that, you know, there is resistance after awhile and this is not a sustainable treatment into the future. To continue just to treat lice you have to probably be removing these salmon farms from the migration routes of these juvenile fish if you want to have sustainable long-lasting benefits.

MR. LEADEM: Thank you. Those are my questions.

MR. MARTLAND: Thank you. Mr. Commissioner, next I have counsel for the B.C. Salmon Farmers Association also with 30 minutes.

MR. BLAIR: Thank you, Mr. Commissioner. Alan Blair appearing for the B.C. Salmon Farmers Association and with me is my associate, Shane Hopkins-Utter.

CROSS-EXAMINATION BY MR. BLAIR:

Q Now, my first question will be for you, Dr. Saksida, and it relates to the B.C. Centre for Aquatic Health Sciences. If you could just take a moment to describe what that centre is, where it's located?

DR. SAKSIDA: B.C. Centre for Aquatic Health Science is a not-for-profit research facility located in Campbell River. We study fish health. We're looking both at wild and farmed fish. As a not-for-profit, we are basically controlled by a Board of Directors. We have ten members. They are a very diverse group. We have equal representation from different stakeholders. We have academics, we have people that are involved in enhancement. We have people involved in closed containment. We have two representatives from the salmon farms, one from Mainstream and Marine Harvest, and another two that are representative from ENGOs. One is the Ritchie Foundation and one is the Pacific Salmon Foundation.

Q And the funding for the various projects that you undertake come from a variety of sources, do they?

DR. SAKSIDA: Right now we are -- most of our projects are -- or most of our diagnostics are actually

dedicated to doing screening, both for smoltification, which is trying to determine if a fish is ready to go to sea, and that is done for the salmon farms because they want to make sure that the fish are healthy when they go into the ocean or basically ready to go into the ocean. The other large chunk of money is actually done -- is again from the salmon farms and it is basically related to brood stock screening. So the point there is that we screen the brood stock for infectious diseases such as viruses and bacteria. Those brood stock are not used to avoid any kind of vertical transmission, which means transmission from the adult or the brood to the eggs.

And then we also have some wild fish research that we are conducting in conjunction with the Campbell River Salmon Foundation and DFO.

MR. BLAIR: Mr. Commissioner, I'm going to do -- follow the lead of some of my colleagues and ask Mr. Lunn to put up exhibits starting with -- these are all B.C. Salmon Farmer exhibits, starting with number 1 and in the case of the next few exhibits, they've all been authored or co-authored by Dr. Saksida.

Q I'd ask Dr. Saksida to have a look at the screen and confirm that this was prepared by you at the B.C. Centre for Aquatic Health Sciences.

DR. SAKSIDA: Yes, it was.

MR. BLAIR: Next exhibit, please?

THE REGISTRAR: 1788.

MR. BLAIR: Eighty-eight?

EXHIBIT 1788: Sea Lice Presence and Pathogenicity in the Campbell River and Sunshine Coast Salmon Farming Regions of British Columbia - October 2010

MR. BLAIR: And number 2, please, Mr. Lunn?

Q This is an addendum, Dr. Saksida, to the report just marked as 1788?

DR. SAKSIDA: Yes, it is.

MR. BLAIR: 1799 (sic), please?

THE REGISTRAR: Exhibit 1789.

EXHIBIT 1789: Sea Lice Presence and Farm Production on 120 Farms in British Columbia - March 2011

MR. BLAIR: Thank you. Number 5, please?
Q You're listed as a co-author actually with Simon Jones and Dick Beamish and others, correct?
DR. SAKSIDA: Yes, I am.
MR. BLAIR: Next exhibit, please?
THE REGISTRAR: 1790.

EXHIBIT 1790: Exceptional marine survival of pink salmon that entered the marine environment in 2003 suggests that farmed Atlantic salmon and Pacific salmon can coexist successfully in a marine ecosystem on the Pacific Coast of Canada - Beamish et al

MR. BLAIR: Number 36, please?
Q Do you recognize this document as well, Dr. Saksida?
DR. SAKSIDA: Yes, I do.
MR. BLAIR: Next number, please.
THE REGISTRAR: 1791.

EXHIBIT 1791: Discovery Passage Plankton Monitoring and Juvenile Salmon Assessment 2009 - Downey et al

MR. BLAIR: 37, please?
Q Listed as an author, Dr. Saksida?
DR. SAKSIDA: Yes, it is.
THE REGISTRAR: 1792.

EXHIBIT 1792: Evaluation of sea lice abundance levels on farmed Atlantic salmon located in the Broughton Archipelago of British Columbia from 2003 to 2005 - Saksida et al

MR. BLAIR: 38, please?
DR. SAKSIDA: This is one of mine, too.
MR. BLAIR: Thank you.
THE REGISTRAR: 1793.

EXHIBIT 1793: Evaluation of Sea Lice, *Lepeophtheirus salmonis*, abundance levels on farmed Salmon in British Columbia, Canada - Saksida et al

MR. BLAIR: And, lastly number 42 on our list, please.

DR. SAKSIDA: Yes, this is one of mine.
THE REGISTRAR: 1794.

EXHIBIT 1794: The efficacy of emamectin benzoate against infestations of sea lice, *Lepeophtheirus salmonis*, on farmed Atlantic salmon, *Salmo salar L.*, in British Columbia - Saksida et al

MR. BLAIR: Thank you.
Q Dr. Saksida, you've been studying the health and welfare of salmon virtually your entire career, some 15-plus years; is that correct?
DR. SAKSIDA: Yes, it is.
Q If we were to ask you what your priorities would be in terms of what needs to be investigated to understand the sockeye issue, where would you start, in a very few minutes.
DR. SAKSIDA: A very few minutes. I think there is this big black hole and we've all sort of talked about it here. We don't know what happens to the fish once they leave fresh water. We don't know what's going on in early marine survival. I think it's very important that we actually start looking at the wild fish holistically. We have to look and see what's going on with them, what's going on with their environment.

We always seem to speak about sea lice, but there are other conditions that we need to worry about and we need to have a baseline and we have no baseline. Until we have that, we really are just going to be speculative.

I would suggest that we have to look at the environment. Obviously there's huge variations in the environment that these animals go into. You know, Strait of Georgia has probably changed as the whole regime change. I think it's very important that we look at the changes in - and I think you brought it up - is temperatures, changes in temperatures, changes in salinity, and the most important environmental factor is food. There's been lots of research. There's -- pink and chum researchers are always talking about food quality.

We have been involved with the Quinsam Hatchery, which is an enhancement hatchery, working with the Quinsam Hatchery and the A-Tlegay First Nations Fisheries Society for the past four

years and we've been monitoring zooplankton in the Discovery Passage area and it's amazing how different the food is in that environment in the Springtime. 2007, if you wanted to go back to the plankton project, you can see that 2007 there was very little abundance of food in the Discovery Passage and the quality of that food was very low. You compare that to 2008 and you can actually -- 2008 the amount of food during the same period of time was extraordinary. So --

Q Let me just --

THE REGISTRAR: Your microphone, please?

MR. BLAIR:

Q If we could just go to Exhibit 1791, please. I believe this is the reference to the study you were referring to zooplankton; is that correct?

DR. SAKSIDA: Yes, it is.

Q And it's -- do you have the notation of the -- is there a particular graph in this that you'd like to refer to?

DR. SAKSIDA: If you go into the Table of Contents I can tell you.

Q Figure 4, I believe.

DR. SAKSIDA: Go into -- on page -- zooplankton, I think page 7. Now go to the next -- go back up to... There we go. So it's Figure 4. And you can actually see -- it works out better in colour.

Q Just lead us through this. This is the project you're referring to when you're studying the presence of zooplankton and just so we're clear, zooplankton is what sockeye salmon eat?

DR. SAKSIDA: Yes.

Q And so you're studying the presence or absence of zooplankton in and around the Campbell River area?

DR. SAKSIDA: The Discovery Passage area.

Q Carry on, please.

DR. SAKSIDA: The whole purpose of this study was the problem is with coho salmon the Quinsam Hatchery had extraordinary returns in the '80s and they were getting ten percent, which is extraordinary for coho. Now the returns are at less than one percent. And the big question that the manager has is are they releasing the fish at the wrong time so it's mismatched with what's in the area to eat.

So this is actually a coho project, not a sockeye project but they both eat the same thing.

So you can see in this figure what we've done is we've looked at the last 2007/2008, we've actually continued on the project. We have '09 and '10 and you can see right here on this low bar right here, that's 2007 compared to 2009. So there was large spikes of zooplankton in -- sorry, 2008 compared to what was going on in 2007. So our theory - and it actually seems to be coming through with the coho, is that if you mismatch or there isn't good food or abundant food, that you're not going to get the fish back. And that sort of falls into what Dick Beamish has touted, is that early marine survival and the growth rate that fish have to achieve.

It's really interesting work. It's been very difficult to fund. We've been doing this on a shoestring. Nobody seems to want to fund this kind of work. And that's what's really frustrating, is that we keep talking about sea lice, we keep talking about wild fish, but when it comes to doing actually long-term monitoring projects, nobody wants to fund it.

MR. BLAIR: I note the hour.

THE COMMISSIONER: Thank you very much, Mr. Blair.

THE REGISTRAR: Hearing is now adjourned till 2:00 p.m.

(PROCEEDINGS ADJOURNED FOR NOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: The hearing is now resumed.

MR. BLAIR: Good afternoon.

CROSS-EXAMINATION BY MR. BLAIR, continuing:

Q Mr. Lunn, could you please bring up our Tab number 33. This question is for you, Dr. Jones. Could you take a moment and tell me whether or not you're familiar with this particular paper?

DR. JONES: Yes, I've read this paper.

Q And PDF on page 1, just down at the bottom of the first -- I'm directing your attention to the bottom of the first paragraph in the abstract, so it's the top, Mr. Lunn. Yes. Do you see the last full sentence starting "Thus, a single *L. salmonis*"; do you see that?

DR. JONES: Yes, I do.

Q Could you read that into the record, please, and

I'll ask you for a comment.
DR. JONES:

> Thus, a single *L. salmonis* impacted swimming performance and postswim whole body ions of only the smallest pink salmon and with a sea louse stage of chalimus 3 or greater.

Q So in English, does that mean that -- well, what does it mean? What's the relationship between small fish and big fish, and small lice and big lice?
DR. JONES: Could you give me a minute to just absorb the rest of the abstract?
Q Thank you.
DR. JONES: My recollection of this paper is that the meaning of that last sentence is consistent with the work that we did on direct mortality of juvenile pink salmon, in that the lethal effects of sea lice on juvenile pink salmon were only observed when pink salmon were smaller than -- or approximately .3 of a gram. So this paper does seem to provide some support, using alternative analyses for that concept.
MR. BLAIR: Thank you. Could this be marked as the next exhibit.
THE REGISTRAR: Exhibit 1995 (sic).
MR. BLAIR: Is that 700?
THE REGISTRAR: One-seven-nine-five.

> EXHIBIT 1795: Nendick et al, Sea lice infection of juvenile pink salmon (*Oncorhynchus gorbuscha*): effects on swimming performance and postexercise ion balance, 2011

MR. BLAIR: Thank you.
Q Could we go to AAA for identification, Mr. Lunn. This question is for you, Dr. Saksida. This morning we stumbled over Dr. Lewis and Dr. Noakes, you recall that passage, and I think answering questions of Commission counsel. You're familiar with this particular document prepared by Dr. Lewis?
DR. SAKSIDA: I am.
Q And we've heard who Dr. Lewis is earlier, but -- and I believe you described him, but attributed to

Dr. Noakes, but Dr. Lewis was the former top provincial veterinarian for the Province of British Columbia?
DR. SAKSIDA: Yes, that's correct.
Q And you've had a chance to read this particular paper?
DR. SAKSIDA: Yes, I have.
MR. BLAIR: Mr. Commissioner, I'm going to use the same words and perhaps I'm going to get the same objections, but I would like to have a ruling on this.
Q You've read this paper of Dr. Lewis and you adopt its findings; is that correct?
DR. SAKSIDA: That's correct.
MR. BLAIR: And again for the record I'd seek to have it marked as an exhibit.
MR. BLAIR: Exhibit 1796.
THE COMMISSIONER: Just a minute, Mr. Giles, I'm sorry.
THE REGISTRAR: Okay.
MR. BLAIR: I'm pausing.
THE COMMISSIONER: That's not the paper on the screen, I take it.
DR. SAKSIDA: No, it's not. Yes, it is, sea lice could be a vector, yes, it is.
THE COMMISSIONER: Is that --
MR. BLAIR: I think that's triple "A" for identification, yes.
THE COMMISSIONER: Triple "A", that's what I was missing, the --
MR. BLAIR: Yes. So again, Mr. Commissioner, this is another one of those series of papers. It's much like the paper that Mr. McKenzie said that as an expert he'd also read and adopted. This is a different Dr. Lewis -- same Dr. Lewis, different Dr. Lewis paper, putting the same question to the expert witness and waiting for the ruling.
THE COMMISSIONER: I'm sorry, different than triple "A" for identification?
MR. BLAIR: No, this is triple "A" for identification.
THE COMMISSIONER: Right.
MR. BLAIR: There's -- Dr. Lewis also wrote a series of papers for this Commission, and Dr. McKenzie last week referred to a different Dr. Lewis paper, same Dr. Lewis, and said he'd read it and adopted it. And we had a debate about whether it could be identification or otherwise.
THE COMMISSIONER: I think the logistical difficulty

I'm having, Mr. Blair, is that there are a series of these exhibits that potentially fall into a similar category, where at different stages of our process we've had objections or not had objections, and I'm trying to reach an accord here to get all counsel, not all are here today, who are acting for participants, if they have points of view with respect to the marking of these particular documents. I don't know if Mr. Martland can help us or not.

MR. BLAIR: I don't want to take much of my time.

THE COMMISSIONER: No.

MR. BLAIR: I just wanted to be clear that while we had Dr. Saksida here we could have the record clear on our request and I'm perfectly happy to have the ruling, if it's still for identification, we'll move on, but --

THE COMMISSIONER: All right.

MR. BLAIR: -- I want to be on the record that we're seeking to have it marked as an exhibit.

THE COMMISSIONER: No, I understood that.

MR. BLAIR: Thank you.

MR. MARTLAND: So thank you. And I'll just very quickly indicate that we are working on a process with our colleagues among different Commission teams and all participants, if you will, to have an omnibus process to address some of these outstanding questions. Thank you.

THE COMMISSIONER: Thank you.

MR. BLAIR: Thanks for that clarification, Mr. Martland.

Q Dr. Saksida, you're familiar with the recent work described as the Kristi Miller work and the discussion about a new diagnostic tool or perhaps a parvovirus?

DR. SAKSIDA: Yes, I am.

Q And we've had some discussions about it, and I think it's fair to say that you'd see this as potentially an exciting new diagnostic tool?

DR. SAKSIDA: This is potentially a great diagnostic tool that could actually be used both for infectious and non-infectious diseases, but it really is still in developmental stages, it's -- we still have to verify. I've worked with Kristi on this signature for other projects, and we're looking at the potential of using it as a diagnostic tool. So, yes, it's very exciting. It

still has to be proven, though.
Q Do we know what it means yet?
DR. SAKSIDA: Well, that's the confusing part for me is that originally the paper suggested that it could be a signature for a retrovirus. No retrovirus was actually isolated. There was no disease associated with this signature. But now it -- and there's been a lot of emphasis put onto the whole, this could be plasmacytoid leukemia, because there has been that debate as to plasmacytoid leukemia, which is a fish disease, is it a retrovirus cause or is it parasitic.

Now it looks like the signature is most potentially resembling a parvovirus. Again there hasn't been the work done to show that it actually is a parvovirus, or that it actually is causing any disease. This work has to occur. But really a parvovirus and a retrovirus, one's a single strand DNA virus, which may mean nothing, one is a single strand RNA virus. It's like apples and oranges. They're very different viruses. So it's, you know, there's still a lot of work. It's definitely moving away from the whole plasmacytoid leukemia. It may or may not be a disease. It may or may not be a infectious virus.

Q In terms of new stage diagnostic tools, I think you have some personal experience on what can go wrong when one hypes a new diagnostic tool, and you encountered that yourself when you were preparing your Master's thesis. Can you take a moment to describe that?
DR. SAKSIDA: My Master's degree was to basically to validate a diagnostic tool for plasmacytoid leukemia. There was a lot of hype put onto this test. It's a fluorescent antibody test. It would have made it easier to diagnose. Right now the classical method of diagnosis is histology. And I went out and I tested it in the field and it didn't work. So it's always horrible as a grad student to have a thesis where it's negative findings, but basically that test was dropped and we moved on.

Q And there's been much discussions about viruses generally, and we've heard -- the Commissioner's heard that viruses are a very, very plentiful -- I can't call it an organism, a particle. It's essentially a carbon particle, is it, or is that

overstating my reach of my knowledge of this?
DR. SAKSIDA: Well, we're all carbon.
Q Okay.
DR. SAKSIDA: So...
Q Let me put it to you this way. I've heard it said that viruses in the ocean are very plentiful and there was a recent paper describing that viruses in the ocean by volume would be the same as 75 million blue whales if you could put them together.
DR. SAKSIDA: Dr. Curtis Suttle from UBC wrote a really, actually easy to read paper and I think it was published in *Nature*, and he talked about viruses being one of the most plentiful organisms in the ocean. There's millions and billions of viruses in the sediment. There's viruses that infect anything and everything in the ocean. So really to try to figure out what this virus is, to try to figure out if it's even something that infected what the fish was eating, or if it actually was a pathogen of the fish itself, all those questions have to be answered, and we're not there.
Q So in human terms we often go to our doctor when we think we either have a cold or a virus, and most of us aren't really aware of what that means when the doctor says we have one or the other. But we go because we're feeling ill, we have some form of a disease. In your world, in the marine virus world, does a virus necessarily equate to a cold, to a disease, to something, or is it something different?
DR. SAKSIDA: Well, according to the paper, the *Nature* paper, viruses intrinsically can cause disease to something. It may not cause a high level of disease. It may just be a cold. But basically by nature, viruses are minor pathogens or major pathogens. So they have the capacity to cause disease, as in dis-ease, as opposed to disease, if you can get my gist. But, yeah, I mean, they tend to be according to, you know, the work, they tend to be pathogens, but the level of pathogenicity, it can vary.
Q Mr. Lunn, could we have ID WW, please. On the screen, Dr. Saksida, you'll see this is a document prepared in July of this year by that's R. Beamish, he's Dr. Richard Beamish.

DR. SAKSIDA: Yes.
Q And you're familiar with this report; you've read it?
DR. SAKSIDA: I've read it, yes.
Q Indeed there's a reference to some of your work, and it requires a correction at page 7, please, Mr. Lunn. Near the top of the page you see three lines down, it says "Saksida *et al*. 2007". Do you see that, Dr. Saksida?
DR. SAKSIDA: Yeah, it should actually read *C. clemensi* was also found on farmed salmon, not juvenile pink salmon.
Q So in the middle of the second line, "juvenile pink" should be replaced by "farmed salmon", that's the work you did?
DR. SAKSIDA: My paper is referencing farmed salmon, not juvenile pink salmon.
Q Yes. So we'll note that correction for the record. Does that change the conclusion of the paper, or your view of the conclusion of the paper, having read it?
DR. SAKSIDA: No, basically this paper just speaks to the complexity of the whole ecosystem and fish biology, and how early mortality is normal, but it's also important to try to determine, and also very difficult to try to determine the factors associated with it.
Q And, Mr. Commissioner, this is yet another one of those papers, and again I'll ask the witness. Dr. Saksida, as an expert, have you read and do you adopt the conclusions of Dr. Beamish in this paper?
DR. SAKSIDA: Yes, I do.
MR. BLAIR: And once again for the record, I'd seek to have it marked as an exhibit, but I understand the Commissioner may wish to keep it as identification, if I'm speed reading ahead. I see a nod, and for the record...
THE COMMISSIONER: Yes, thank you. I'm sorry.
MR. BLAIR: Thank you.
Q Could we go to Exhibit 1788, please. Now, Dr. Saksida, we marked this Exhibit 1788 earlier this morning. This is your document prepared by your Centre, correct?
DR. SAKSIDA: That's correct.
Q If we could go to page 34, please. And I'm going to, while it's being brought up on the screen, you

reached certain conclusions which seem to run counter to assumptions about farmed salmon and negative effect; is that a fair summary?

DR. SAKSIDA: To a certain extent, yes.

Q Could you elaborate on that, please?

DR. SAKSIDA: Basically what we were just looking at the data from Sunshine coast and the Campbell river area. We weren't doing the 120 farms. And what we found is that production of salmon in both areas was higher in 2008 than 2007. The *Leps salmonis*, the salmon louse, was higher prevalence in 2008 than 2007, and *Caligus clemensi*, the herring louse, was basically higher in 2007, 2008. Basically, what that means is that the salmon louse being more of a salmon-specific issue was -- was basically higher in 2008 than 2007. so if there was an effect because of the *Leps salmonis*, you would have seen it more in 2008, which coincides with the record returns of sockeye. But if you look at 2007, even though there was -- no, 2008 actually also had higher production. It's very confusing.

Q Thank you. I'm just going to go back a little bit. I've been handed a note that I'm not sure that you accepted when I said on the Dr. Beamish WW that we just had on the screen, is this a paper that you read and adopted, Dr. Beamish's work?

DR. SAKSIDA: Yes, I read and adopted it.

Q Thank you. Could we, please, Mr. Lunn, go to B.C. Exhibit 1555. Dr. Saksida, you see your name on as the middle author there with Drs. Marty and Quinn?

DR. SAKSIDA: Yes, I do.

Q Can you describe this paper briefly?

DR. SAKSIDA: This is a paper that we did. Dr. Marty is actually a fish pathologist, and Dr. Terry Quinn is a biometric specialist, which is basically somebody that studies, statistically analyzes biological data. He works at the University of Alaska in the Fisheries Department.

What we did here is that we collected farm sea lice data from 2000 -- or as far back as we could, and we also looked at production data in the Broughton Archipelago - excuse me, this is all Broughton Archipelago - back to 2000. The questions we wanted to answer in this was whether production had -- salmon production had any

negative effects on pink salmon runs, and whether the first question being is sea lice from salmon farms affecting juvenile pink salmon, so are they correlated. And then the second question is are lice on salmon affecting production of population returns of pink salmon.

Q And then, Mr. Lunn, if you could highlight the bottom nine lines in bold in the first paragraph, starting "However", nine lines from the bottom. Thank you.

DR. SAKSIDA: Where are we?

Q You see the cursor at the side?

DR. SAKSIDA: Okay. Yes.

Q Can you just read into the record the balance of that paragraph, starting with "However".

DR. SAKSIDA:

> However, productivity of wild salmon is not negatively associated with either farm lice numbers or farm fish production, and all published field and laboratory data support the conclusion that something other than sea lice caused the population decline in 2002.

DR. SAKSIDA: Do you want...

Q Continuing.

DR. SAKSIDA: Okay.

> We conclude that separating farm salmon from wild salmon -- proposed through coordinated fallowing or closed containment -- will not increase...salmon productivity and that medical analysis can improve our understanding of complex issues related to aquaculture sustainability.

Q Is that still your opinion today?

DR. SAKSIDA: Yes, it is.

MR. BLAIR: Thank you. I have no further questions.

MR. MARTLAND: Mr. Commissioner, next I have counsel for the Province with 20 minutes. Thank you.

MS. CALLAN: Mr. Commissioner, Callan, C-a-l-l-a-n, initials T.E., appearing on behalf of Her Majesty the Queen in Right of the Province of British Columbia.

CROSS-EXAMINATION BY MS. CALLAN:

Q Would you agree that most of the research to date on wild Pacific salmon affected by sea lice from salmon farms involve an analysis of pink salmon? And Dr. Saksida can answer this, or anyone else.

DR. SAKSIDA: I would say that to date most of the data that we have looked at has been mostly pink salmon.

Q And as opposed to sockeye, of course.

DR. SAKSIDA: Yes.

Q Now, as I understand, there have been three papers that have found that the numbers of sea lice in the Broughton Archipelago are not correlated with pink salmon survival based, and those papers specifically are Dr. Beamish's paper at Provincial Tab 2, your paper with Dr. Marty's at Exhibit 1555, and Morton's 2010 paper, which is Exhibit 1553.

MR. LUNN: Would you like any of those documents brought up?

MS. CALLAN: Could you bring up Provincial Tab 2.

Q Do you agree with that statement?

DR. SAKSIDA: Yes, I do.

Q Now, Drs. Dill, Connors, Krkosek and Morton recently re-analyzed the data from your paper at Exhibit 1556. If you could answer yes or no.

DR. SAKSIDA: Yes, they did.

Q Now, I understand the major difference between the two papers involves assumptions made in order to run a mathematical model. In your paper you assume there were slightly higher lice levels before 2001 when SLICE became available, and the Connors, Dill, Krkosek and Morton PNAS paper excluded these years from the analysis. Do you have any thoughts on which assumption more accurately reflects biological reality at the Broughton Archipelago before 2001?

DR. SAKSIDA: Having been a veterinarian for several of the sites in the '90s, I would say that our assumption is more valid that there was sea lice on farmed salmon prior to 2000.

Q Now, are internal inconsistencies problematic in mathematical models?

DR. SAKSIDA: I'm not a modeller, so I really shouldn't be answering that question.

Q Does anybody else from the panel have any comments

on that?
DR. JONES: Could you specify what you mean by internal inconsistencies?
Q Okay. Well, I understand upon a review of Exhibit 1556, that there is some internal inconsistencies, and specifically two different measures are used for coho and pink salmon. The best of the four alternative models for coho salmon is considered to be the worst of the four models for pink salmon.
DR. SAKSIDA: If you move down to the -- I think it's Table 1 or Table 2, if you just scroll down. Yeah, that page. You can see -- actually, I think it's Table 2. I'm not a statistician, but I think what is being referred to that I think he used that "ΔAIC" to determine which is the best model.

And it looks like for pink salmon it's model number 2, which assumes that basically no lice prior to 2003, if there was no farm data. Whereas, in coho, the best model is model number 1, which indicated -- is using the same data or assumptions we made, which assumes large numbers of -- if you basically zoom out and go down, you can see model 1 has a high estimate of sea lice abundance, and that one is the one that seems to explain the coho salmon, whereas model 2, which has a very low estimate of sea lice abundance on farm fish appears to be the best model for the pink salmon.

However, there's some issues with even mortality estimates for the coho salmon, since most of the data that's been available to date has shown that coho salmon are actually highly resistant to sea lice infections. There is a paper from Stewart Johnson and Larry Albright that was published in 1992 that did an experimental, basically a lab study, and they found that coho were actually more resistant to sea lice infections than either Atlantic salmon or chinook salmon.

Then, and I know, I understand that Craig Orr has problems with lab-based studies. There was a study done in the field by Nagasawa, Ho and Nagasawa, in Japan where they actually exposed coho salmon and rainbow trout in farms. They put them in, in the fall, just as the chum were coming back and these fish basically became -- or the

fish became infected from the lice from the returning fish. The interesting fact is that it was rainbow trout that became infected and the coho only became infected several months later, and it was only the pre-adults -- oh, it was the adult motile stages.

So his conclusion in that paper was that in fact coho are highly resistant to sea lice, to *Leps salmonis*, the salmon louse, and the only way they actually became infected in this study was through cohabitation, through the motiles moving; he suggested it was the motiles moving from the rainbow trout to the coho. And as a veterinarian who has worked with coho, chinook and Atlantic salmon, I can tell you I have never had to write a prescription or had to treat either chinook or coho for the salmon louse.

Q Dr. Orr?

DR. ORR: I'll just point out for the record that Brendan Connors did a paper on ecological applications last year that showed that the coho salmon had more lice on them than the prey that they were eating, and that he did find a negative correlation in the coho salmon survival with louse infections. And so that that is a paper that I believe has been entered into evidence here before. So there is some good evidence that coho salmon are affected by lice.

But I just mainly wanted to put up my hand, and I'm just asking for clarification. What, who said that there are internal inconsistencies in the model? Is that -- can you just give me a reference for that? I'm not sure...

Q Well, I'm questioning the panel and finding out what your --

MR. ORR: So you're posing -- you're posing whether there are or not. I got it. Okay, thank you.

DR. SAKSIDA: There is one more inconsistency, and I think this is maybe -- I've talked to both, oh, Carl Walters, I think he's been here on a panel. He's a fisheries biologist from UBC, and I also spoke to our -- and again this is -- you should be talking to the statisticians directly. But I've also spoken with Terry Quinn, and I think the big problem with the model, and happens with -- is when you're comparing two different populations of pink salmon to two different populations of coho

salmon. There's so much variation in the environments they're living in that it's really hard to try to point to one factor and say that's the cause.

Pink salmon, according to Carl Walters, are notorious for having crashes, and I'm sure Dick Beamish has talked to you about that, having -- going up and then just crashing for some unknown reason. So to actually say that this crash is because of sea lice is counterintuitive.

Q So this question is generally for the panel. Are internal inconsistencies problematic or fatal in a mathematical model?

DR. ORR: I just wanted to remind everyone of the testimony that Brendan Connors gave when he was a witness. He did say that he didn't consider that there weren't sea lice. He just considered them as no data, as a way of analyzing the model so that it didn't provide the fatal inconsistencies that you're talking about. So I would urge you to go back to his testimony when he was an expert witness here.

Q Well, my question was actually general, is that in a general principle, not with respect to this case in particular, but generally are internal inconsistencies problematic, fatal, something to be avoided in mathematical modelling?

DR. SAKSIDA: You have to be very -- you have to be very aware of your assumptions, and you have to list them, and they have to make biological sense. And the issue we have with this paper is that statistically it looks great, but it really makes no biological sense to assume that to use the 1990 to 2000 data and say it's missing because -- and making the assumption that there was no lice back then, is again counterintuitive, but it's also ignoring the fact that many of these authors and many of the fish health people that have worked in the Broughton have talked, and we've actually, you know, we've discussed the fact that there were lice there. There were -- we just had different ways of treating, and we weren't treating lice because it still wasn't a problem.

And even at the trigger of three, we're not treating our fish at the trigger of three for any kind of health reasons. We're doing it because of the precautionary principle.

DR. ORR: Sorry, I didn't understand your question before. But it is common to vary model parameters, you know, in sensitivity analysis to see how the model performs with different parameters, but that's not the same as inconsistencies.

But I will say one of the things that this reanalysis did do differently from the first paper is it looked at a multi-stock framework of spawner recruit data at a river level, far finer spatial, you know, scale, and it also controlled for areas without salmon farms. So you know you build these models and you do an analysis, you build on what you do know from inconsistencies as you're talking about and you try to come up with, you know, the best way of portraying the data. And I think that the reanalysis did a finer spatial and temporal control, and that's I think why it arrived at different conclusions.

Q Dr. Saksida, and then Dr. Jones.

DR. SAKSIDA: And that's where one of the problems is, and again is the fact that you're looking at several rivers and you're assuming you actually know what's going on once they're in the seawater. We don't know, once the fish have left their natal -- their natal streams and they're in the pathways through the Broughton, no one's looked to see where those stocks are. So you can't assume that there's equal effect on all the stocks because of sea lice, and that is -- that is very problematic. And I think what happens is when -- if you're assuming you're able to keep each river separate, and the sea lice effect is separate on these, that you will at the end of it have a lot of parameters that aren't true. So basically you're adding -- you're making a bigger, more robust model on inaccurate assumptions.

DR. JONES: Well, I'll start by saying I'm not a modeller, either, but I have done a considerable amount of research on levels of lice infections that lead to mortality in experimental pink salmon and other species of salmon. And I was interested to note that under the various scenarios presented in this paper that mortality among pink salmon can range from well into the 90 percents and lower, depending on the year and depending on the scenario that's used, and in pink salmon, get also

very high in coho salmon, as well.

And I'll also note that the paper makes little or no reference to the experimental data that supports a level of resistance both in pink salmon and in coho salmon to the effects of *Leps salmonis*.

I'll also note, too, that the laboratory infections, they were criticized earlier because they were short duration, that they were single pulse infections. I think it's important to point out that in many cases these experimental infections are comparative. That although the fish are being exposed at a single time to a certain level of exposure, the experiments involve a comparison of how one species of fish responds under those conditions to how another species of fish responds.

And so when coho salmon were cited as being resistant, that was an experiment done in comparison with fish like Atlantic salmon, or chinook, or other species. So it's a relative level of exposure. And so the notion of an experiment being invalid because of its short exposure time is counterbalanced by the value that you get under the same conditions by showing that the resistance level is relative among salmon species.

So getting back to this paper, this, the link between the modelled predictions of mortality and -- and what has been documented experimentally, appears to be rather weak. And in fact they did identify a parameter that was sea-lice associated mortality, but I couldn't find anywhere in the paper where a definition of that parameter was provided. And so I would call that an inconsistency.

Q Thank you. Now, if we could turn to Exhibit 1557, that is Provincial Tab 18. On page 155, second column in the middle of the page, started at:

> Based on escapement data, there were no significant differences in survival that corresponded to sea-louse abundance in juvenile salmon mortality on the migration route containing active farms relative to unexposed populations north of the Broughton Archipelago.

And then if we could then look up to page 149 under the heading "Escapement and survival analysis" it says:

> Survival among rivers, based on escapement data, was highly variable, and there was no detectable difference in mean survival for the Broughton Archipelago relative to the central coast.

And then it goes on after a little bit:

> ...only the Embly (sic) River clearly corresponds to the fallow migration route. That population experienced very poor survival, with a 90% decline, although it was subject to fallow intervention.

Would you agree that this research indicate that fallowing or moving to closed containment specifically may not have any effect on wild salmon survival? This is actually anyone can answer this question, but I guess we'll start with Dr. Saksida.

DR. SAKSIDA: Okay. It's actually an interesting study because it does show that Embley, which went past fallow farms, actually had poorer returns than the Wakeman-Kingcome, which apparently, according to the theory in the paper, went through the area where there's farms. So it basically counters most of the other papers that have been written, saying that fallowing -- to me, that fallowing actually made a difference. It actually didn't make any difference in this paper.

Q Dr. Jones, do you want to add anything?

DR. JONES: Well, a little bit. I think to me what this result highlights is the uncertainty with which we can conclude at a population level that sea lice are having an effect, whether it's in chum salmon in this case, or in any other species. There's been a number, many studies that have identified that at the individual fish level, sea lice are -- have the potential to be harmful, and the factors that influence the harm at an individual fish level vary widely. They can be the size of the fish, the condition of the fish, the number of sea lice, on and on and on, many

factors.

But there's always been a gap in our understanding when it comes to translating those individual effects into population level effects, and we haven't been able to identify very clearly exactly what population effects as a result of salmon are -- or salmon lice are, nor have others who have tried. For example, the Norwegians have a multiyear study on the impacts of salmon lice on wild salmon, and they conclude that whether with sea trout or Arctic char or Atlantic salmon, that more work is still needed to understand population level effects. And I think that this document in front of us now highlights that uncertainty.

Q Now, Dr. Saksida, earlier on we learned about SLICE application. What is the difference on how SLICE is applied in British Columbia compared to other jurisdictions, and does this affect drug resistance?

DR. SAKSIDA: The application, basically how it's provided to the fish is no different. Pretty much everybody adds the medication to feed, and then feeds the fish. The difference that we experience in British Columbia is the frequency of treatments. In other jurisdictions, they treat far more frequently. In British Columbia, we can -- there's often farms that never have -- Atlantic salmon farms that actually never have to treat for sea lice because they never reach that trigger point. Most farms, if they have to treat, don't treat more than twice in a production season, so that's equivalent to once a year. And that hasn't changed. It's still only about between zero and two treatments for a generation of fish.

Whereas in Europe SLICE was overused, because it's a very easy medication to use because it is in feed. It's -- whereas a lot of the other medications that are used in other areas are baths, so you actually have to crowd the fish and then actually add a pesticide to the water to delouse. This is actually added to feed, so it's a very easy application. So people would use it because of its ease of use, and I think the frequency, so basically resulted in the resistance.

MS. CALLAN: And I'm out of time now and I thank you for your answers to my questions. Thank you.

THE COMMISSIONER: Ms. Callan, just before you sit down, I think Dr. Orr had his hand up and didn't get a chance to answer.

DR. ORR: I did want to say something about fallowing, and fallowing is used as sort of a loose term. You know, it has a specific meaning in taking the farm out of production for a certain time in terms of benthic impacts and lice. But we usually use combinations of chemical therapeutants and age class separations. Juvenile fish don't have as many lice. Obviously when they go in the water they have no lice, but they get them after a while.

But I think the best evidence that fallowing is effective is the work by Paddy Gargan in Ireland, where they've had terminus crashes of sea trout, and when they actually took farms out of production, those sea trout rebounded and they came back in those rivers. And he's published several papers, some of which Dr. Dill cited.

THE COMMISSIONER: Thank you. Mr. McDade.

MR. MARTLAND: Counsel for the Aquaculture Coalition at 20 minutes next. Thank you.

MR. McDADE: Thank you, Mr. Commissioner. Good afternoon, panel. My name is Gregory McDade. I'm counsel for Dr. Morton and the Aquaculture Coalition.

CROSS-EXAMINATION BY MR. McDADE:

Q Let me begin, Dr. Saksida, where Mr. Blair left off, with plasmacytoid leukemia. Mr. Lunn, document 47 from panel 2. This is a paper you wrote, Dr. Saksida?

DR. SAKSIDA: (Indiscernible - microphone off).

MR. McDADE: Could we have that marked as the next exhibit.

THE REGISTRAR: Exhibit 1796.

EXHIBIT 1796: Saksida et al, A Field Evaluation of an Indirect Immunofluorescent Antibody Test Developed to Diagnose Plasmacytoid Leukemia in Chinook Salmon (*Oncorhynchus tshawytscha*)

MR. McDADE:

Q You still stand by that paper?

DR. SAKSIDA: That the test doesn't work? Yes.
Q All right. And the plasmacytoid -- you still believe in plasmacytoid leukemia as a disease?
DR. SAKSIDA: Yes, and I do see right on the top of the third, it says:

> Both a retrovirus and a microsporidian...have been proposed as possible [etiologies]...

Yes.
Q Yes. And if we could just perhaps go down that column, and there's just one other reference I'd like to -- if we could, what's in the middle of the page now, starting with the word "histology". I gather that one of the points being made in this paper is that histology as a diagnostic method has been determined to be quite ineffective in diagnosing PL when fish have concurrent infections with -- with BKD; is that right?
DR. SAKSIDA: Yes, it is.
Q And BKD is often seen in association with plasmacytoid leukemia?
DR. SAKSIDA: I think you can see them separately and you can see them -- you can see BKD on its own, and you can see -- I think it's all three versions are possible.
Q All right, thank you. Now, let me determine what your level of experience is, Dr. Saksida. I gather you've basically since graduation worked your whole 15 years for industry, for the aquaculture industry?
DR. SAKSIDA: When I first started, I started with EWOS, which is a feed company producing feed and this feed is actually used by commercial farms, enhancement, so a variety of different user groups. So I've worked with both enhancement societies, both DFO and the private enhancement, or the community enhancement and industry.
Q And when you were in private practice as a veterinarian, your primary clients were the fish farms?
DR. SAKSIDA: When I was in private it would be -- yes, I worked for the Salmon Farmers and I also did projects.
Q So is it fair to say you're a supporter of the aquaculture industry?
DR. SAKSIDA: I believe in aquaculture. I believe that

we can't keep taking from the wild, so I believe that we eat -- everything we eat is farmed, and it just makes sense that we should be eating farmed fish. I've worked with closed containment, Mr. McDade, so I'm very familiar with all sorts of different types of aquaculture. I've worked with net pens and closed containment.

Q Well, that's kind of a long answer. Is the answer, yes, you are a supporter of the aquaculture industry?

DR. SAKSIDA: Yes.

Q All right. And your current job is Executive Director of the B.C. Centre for Aquatic Health Sciences, right?

DR. SAKSIDA: It is, yes.

Q And so that's a salaried position, a paid position?

DR. SAKSIDA: Until recently it was a contract position. It became salaried last year.

Q When you became the Executive Director?

DR. SAKSIDA: No, I was actually on contract as an Executive Director for the first year.

Q And the primary funding for that centre comes from the aquaculture industry?

DR. SAKSIDA: I was hoping you actually listened to my answer earlier this morning where I said that direction for -- for projects is based on our Board of Directors, and obviously we have to make money. Unfortunately, all our efforts to try to get wild fish research, fish health research, has been for naught. I've approached organizations like the David Suzuki Foundation, like the Moore Foundation, to try to see if they're interested in wild fish research, and been shut down. So, yes, our current funding, a large component is from the aquaculture, but really honestly it's not for the lack of trying to diversify.

Q You know, I only have 20 minutes here to cover a decade worth of sea lice research and four experts.

DR. SAKSIDA: Okay.

Q The answer is yes, the primary source of your funding comes from the industry, right?

DR. SAKSIDA: Currently, yes.

Q Thank you. And your Board of Directors includes Dr. Peter McKenzie, who testified here last week?

DR. SAKSIDA: It does.

Q From the industry.
DR. SAKSIDA: Yes, I've said that.
Q And your Board of Directors also include Clare Backman, who is going to testify tomorrow for the industry?
DR. SAKSIDA: And it also includes Terry Tebb from the Pacific Salmon Foundation, and --
Q Just wait for the questions, please. It includes Dr. Clare Backman?
DR. SAKSIDA: Yes.
Q It includes Dr. Larry Hammell, who my friend, Mr. Blair --
DR. SAKSIDA: Larry Hammell --
Q -- is asking to make a witness for the B.C. Salmon Farmers Association.
DR. SAKSIDA: Actually, no, Larry Hammell has resigned from the Board, and we have Ian Gardner replacing him.
Q And the only NGO that you claimed -- as I understand, you said you had NGO memberships, but the only one you referenced was the Ritchie Foundation?
DR. SAKSIDA: No, I also referenced the Pacific Salmon Foundation.
Q You call that an NGO?
DR. SAKSIDA: Where do they get their money from? They get them from the public. Yes.
Q The Ritchie Foundation is a private foundation that supports aquaculture, isn't it?
DR. SAKSIDA: No.
Q No.
DR. SAKSIDA: No, it's actually the Ritchie brothers does not support aquaculture. They're there for sustainable fishery. They're more interested in preserving the chinook and other salmon for fishing purposes, not aquaculture. They have nothing to do withy aquaculture.
Q So Dr. McKenzie and Dr. -- and Claire Backman are actually your bosses?
DR. SAKSIDA: They're two of ten of my bosses.
Q All right. And there are no NGOs on your Board who are opposed to aquaculture?
DR. SAKSIDA: I would say that both the Pacific Salmon Foundation and the Ritchie Foundation are hesitant about aquaculture. I would say they're not necessarily proponents. They are -- I understand that they are working with other -- with the

closed containment group to try to look at different options for aquaculture.

Q I took the chance today to look at the -- to look at your website, and your organization lists two global objectives as its reason for being, right? The first one is to increase the economic value of B.C. marine industries. Does that seem familiar?

DR. SAKSIDA: You do have to realize marine industries also includes fisheries.

Q And the other is to educate and train fish health professionals and to address the industry needs for an implied level of investigation. Right?

DR. SAKSIDA: Again, it can imply wild fisheries, as well.

Q But you don't have any wild fisheries funding. It's all aquaculture industry funding.

DR. SAKSIDA: That's not true. We do have wild fish. We are basically being funded by DFO. We're collaborating with some of their wild fishery research. We're also involved with the Quinsam Plankton Project, which is actually funded by the Campbell River Salmon Foundation. We have received funding from Pacific Salmon Foundation. So, yes, we do have funding outside of aquaculture.

Q And I took a look at your *c.v.* today, Dr. Saksida, and it seemed as I went down the list of projects that you're involved in, every single one was being funded by the industry; isn't that right?

DR. SAKSIDA: A large proportion is, yes.

Q Okay. So you wouldn't describe yourself as impartial, to be fair, would you?

DR. SAKSIDA: I think that based on my work and my history, I am impartial. I think it's very important that we have aquaculture. I think it's very important that it's done properly. And so I am critical of the industry when it is not done properly, and I will praise the industry when it is done properly.

Q Now, you also work very closely, it seems to me, with DFO. For instance, you published a number of times with Dr. Jones here, right?

DR. SAKSIDA: I think we have two papers.

Q Yes. And I think you have two or more papers with Dr. Beamish, who we've heard from.

DR. SAKSIDA: Yes, we worked on a project together through the Pacific Salmon Forum.

Q And Dr. Marty?
DR. SAKSIDA: Dr. Marty and I have worked on obviously that other project, yes.
Q And he's a friend of yours?
DR. SAKSIDA: He's a colleague.
Q Dr. Kent, you publish with?
DR. SAKSIDA: Michael Kent was my supervisor when I was doing my Master's.
Q Right. I see that you published with someone named Tiffany MacWilliams, that's someone -- that's a vet at Marine Harvest, a paper to the American Fisheries Society?
DR. SAKSIDA: Sorry, I'm not sure which -- Tiffany is not actually a veterinarian, and I'm not really sure what paper you're referring to.
Q Well, is she a relation to Christine MacWilliams, from DFO?
DR. SAKSIDA: No, she's not.
Q The -- you've never worked in collaboration with the -- with any of the organizations that are here as part of my coalition, or as part of the Conservation Coalition?
DR. SAKSIDA: When I was involved in the original CARR Marine harvest, Craig Orr and I did work together in trying to develop some terms of reference. So that's the extent there. I was on a conference call with Alexander Morton, and actually Kristi Miller, and I think Stewart Johnson was on it, and David Welch, and we were all trying to figure out a research project, a joint research project where we could look at sockeye salmon, that never really went.

So again, I have contacted, like I said, I spoke to David -- the David Suzuki Foundation and asked them if they were interested in doing a project on basically the effects of using lights on wild fish, the lights being used on farms, and the effects on the wild fish around them. There was an initial interest, and then for some reason, doors shut. So really it hasn't been for the lack of trying.

Q So let me -- let me ask you this. I'm interested in a number of studies that you've done around sea lice over the last five or six or seven years, quite a few, in effect, that's probably your primary publishing -- the primary subject matter that you've researched and published on in the

recent past, yes?
DR. SAKSIDA: Yes, because that's where all the funding was coming from. But really, Mr. McDade, I'm not -- my job isn't to publish. My job is fish health and fish welfare, and the publications just come out because there's the need to inform.
Q Well, I wouldn't suppose that you went to school to try and learn more about sea lice. Why are you doing so many studies on sea lice?
DR. SAKSIDA: Obviously because the Pacific Salmon Forum in its wisdom, when they were trying to determine the effects of on wild fish, concentrated on sea lice. When I was at the Pacific Salmon Forum, I pushed hard to try to expand it to a more holistic -- to start looking at fish health, because really we have no idea what's going on with the fish health in the wild fish. We seem to be learning a lot about sea lice, which is great, but the actual fish health, if there's secondary infections associated with sea lice, if there is a -- you know, obviously we've been talking about transmission, is there transmission issues. Those are things that I have wanted to do, and unfortunately every time I tried to get projects, they were shut down.
Q Could I see Exhibit 1782 up on the screen, page 2. This is a paper that you wrote for Cermaq, right?
DR. SAKSIDA: Yes.
Q Paid for by Cermaq?
DR. SAKSIDA: Yes.
Q AS were -- and a number of your sea lice studies were funded in part by industry, were they not?
DR. SAKSIDA: The original work was done through ACR -- the original work with Grace Karreman and Joanne Constantine were actually ACRDP, and the sea lice work that I did with Dr. Marty and Terry Quinn was actually unfunded. This was actually not a published report. This was an information report. Because when I went to Europe, I met with these -- with basically Cermaq, and they were asking what was going on in British Columbia. So they asked me to write a state of knowledge. So that is what it was. It was actually to inform them of what was going on in British Columbia, and it was an opinion piece.
Q Okay. It was paid for by them.
DR. SAKSIDA: Somebody has to pay for something.

Q Yes, again I will ask you, given the length of time I have, if you'll answer directly.
DR. SAKSIDA: But I did already say yes.
MR. McDADE: All right. Can we go back a page. Yes, thank you. No, no, back another page, please. Can I go to page 2 of the document.
MR. LUNN: That's PDF page 2?
MR. McDADE: Yes. Yes, thank you.
Q If we could just highlight the second paragraph. Over the last few years, you say there, Dr. Saksida, that a large percentage of your time and research efforts are spent responding to this debate which has become a vocal and often reoccurring topic, and the negative news stories presented by NGOs make great headlines, and responses that call into question the motives of and provide a critical analysis do not.

> Responding to the same repeated messages and faulty science has become a source of frustration for me and many others throughout the BC salmon farming industry.

Is that correct, that this has become a source of frustration for you?
DR. SAKSIDA: I find it very -- very difficult to handle listening to information that I find incorrect, and most of the time I leave it, sometimes I respond, and, yes, I can find it quite frustrating.
Q So a large percentage of your time is going to responding to these NGO science on sea lice. That's why you keep getting dragged into this debate?
DR. SAKSIDA: It certainly seems like it.
Q Yes. Dr. Jones, you also have spent a great amount of time studying sea lice. Is that because it's the most important issue facing the health of the wild sockeye, or is it because of the amount of public attention that sea lice has gotten?
DR. JONES: Well, when we first started to study sea lice in 2003 we simply didn't know. There was so little information on the effects of sea lice on juvenile wild salmon populations, there was no way of knowing just how important or how trivial this issue was. And I think that was the driving force behind why we got into the research.

Q But we keep hearing that there's all this funding problem with getting funding to study the problems of wild sockeye, but you seem to have had no trouble getting lots of time and funding to study sea lice. Why is that, is it because it's the biggest problem around?

DR. JONES: Well, problems often seem to morph from one issue to another, and certainly it started with sea lice. And it started with sea lice on pink and chum salmon in the area of British Columbia, and now it's -- the focus has shifted to sea lice on sockeye salmon. And frankly we do find it easier to get funding where there is a focus of attention, and that focus does shift.

Q I see you've done three studies on sticklebacks, and clearly that's not DFO priorities, is it?

DR. JONES: Well, it wouldn't have been ten years ago. But when we started to find sticklebacks occurred in such large numbers where we were collecting juvenile pink and chum salmon, in addition where we found levels of sea lice on the sticklebacks were five to tenfold times higher than they were on those cohabiting pink and chum salmon, it became an issue. It became an issue because we needed to understand exactly what the significance of this finding was.

Q Dr. Saksida, I'm going to read you a sentence and ask you if you agree with it.

> When the premeditated outcome of science is the delivery of a marketing message, the methods and results of that research have to be questioned.

Do you agree with that statement?

DR. SAKSIDA: Yes, I do.

Q You wrote it, didn't you?

MR. MARTLAND: I'm going to suggest Mr. McDade save us the drama and take us to the document if he's got that to put before the witness.

MR. McDADE: Well, if I get the point for calling it drama. Page 55 of that document, the numbered page 55, Mr. Lunn, not the PDF number.

MR. LUNN: I understand. It will just take a moment.

MR. McDADE: Okay.

Q While we're waiting for that, Dr. Orr, I want to ask you a question because I'm running out of

time. Do we have that now?
MR. LUNN: Page 55.
MR. McDADE:
Q Yes. Okay. Could you just highlight the last sentence of the paragraph there, of the first paragraph. Yes. So that was in the conclusion of your paper. Right?
DR. SAKSIDA: Yes, it is.
Q Okay. Can we have Aqua 68 from Regulatory panel 2 up on the screen. Dr. Orr, because I'm running short of time, I want to go to a written summary. This is Dr. Morton's paper. Dr. Morton will be testifying tomorrow. But at page -- you've reviewed this paper, from page 41 to 50, in particular?
DR. ORR: I have read this paper.
Q Page 41 to 50 deals with sea lice issues on which you are being presented as an expert. Do you agree with the statements made from page 41 to 50 and adopt that as your evidence?
DR. ORR: I believe Alex has published quite a few more papers than I have, and I see that she's referenced these very carefully and also a lot of the references are from Ringtail, as well, so I have no problems adopting it.
Q Could I ask that that be made an exhibit, and I think consistent with the rest, for identification please.
MR. TAYLOR: I think it already is an exhibit for identification.
MR. MARTLAND: I don't know that it is, off the top of my head.
MR. McDADE: I don't think it is.
MR. MARTLAND: And I've paid some attention, so I think this -- but I'll suggest Mr. McDade's approach, I'm sure he would take the position it might become more than an exhibit for ID, but given the discussion that we're not having in the hearing room so much, I'll suggest it become an exhibit for ID, as well.
MR. McDADE: Yes, I'll tender it as evidence tomorrow.
THE REGISTRAR: That will be marked as DDD, triple "D".

DDD FOR IDENTIFICATION: Morton, What is happening to the Fraser sockeye? August 14, 2011

MR. McDADE:
Q And, Mr. Price, I don't want to leave without giving you at least a chance to say something. Can you just tell us what your experience is in trying to work with DFO in terms of cooperative studies? Has that been a positive experience for you, or have you made any such efforts?
MR. PRICE: I have made efforts. They have not panned out. So, no, we've never been able to collaborate on any projects. And, yes, to be honest, the largest frustration was that we had been doing the sockeye work since 2007, and without any discussion at all a project of their own had taken place, which I believe it's still going on today, and I think Stewart Johnson had mentioned that. So, yes, it's been a frustrating process.
Q Would you agree that most of DFO's research seems designed to simply counter that research that's coming from the NGO community?
MR. PRICE: I'm not sure. I don't know if I --
Q All right.
MR. PRICE: Yeah, I wouldn't want to say that.
Q My last question, Mr. Commissioner, if we could have Exhibit 1784 back on the screen. Dr. Saksida, this one's for you, as it's an email string involving you. We saw that email string earlier today. If we could go to the last page and highlight that. So there you are, asking Stewart Johnson of DFO, saying I'd like to be involved in this one. Why was that? Why would that be?
DR. SAKSIDA: I just think it needed to be a rebuttal, so and I have expertise on some of the Discovery Inlet area. So I thought it would be important that I could have some input. I also noticed some discrepancies between the two papers and I thought that maybe I would have some value -- provide some value to the rebuttal. Thank you.
Q But in answer -- in answer about this, I heard you say, I think, as to whether there had been a rebuttal, that we haven't decided yet whether we're going to do one. Who's "we"?
DR. SAKSIDA: Basically the co-authors for the rebuttal. So, yes, so it's not just myself. It would be everybody.
Q So DFO's intending to do a rebuttal, then you get involved and then they're not. Why would that be?

DR. SAKSIDA: I don't think they ever were necessarily intending on doing a rebuttal. I think that was something that we were considering on working on. So it's not that they stopped doing a rebuttal. It was just whether the decision is to make the effort to publish a rebuttal or just to leave it.
Q And this is how you get involved in DFO's studies, you send an email saying you'd like to be involved and it happens that easily?
DR. SAKSIDA: I wish it were that easy.
MR. McDADE: Thank you, panel, those are all my questions.
MR. MARTLAND: Thank you. Mr. Commissioner, I have next the counsel for Areas D and B for five minutes.
MS. PACEY: Thank you, Mr. Commissioner. Good afternoon, panel. My name is Pacey, P-a-c-e-y, first initial K., counsel for Area D Gillnet Association and Area B Seiners.

CROSS-EXAMINATION BY MS. PACEY:

Q My question is for you, Dr. Jones, just to begin. Could you confirm whether you were responsible for conducting an audit, or some form of evaluation of Dr. Saksida's lab at the Centre for Aquatic Health Sciences?
DR. JONES: Yes, I can confirm that.
Q And would you be able to produce the results of that audit to the Commission?
DR. JONES: Yes, I can, if they haven't been provided already.
MS. PACEY: Thank you. So, Mr. Commissioner, I'd ask that that be produced to the Commission.
MR. TAYLOR: I'm not sure what this is. I haven't heard about this before. We'll consider whether it's relevant. I don't know what Commission counsel's position is.
MR. MARTLAND: I was caught, not napping but timekeeping with my friend, Ms. Gaertner, Mr. Commissioner. I'm afraid I'm not up to speed on this.
MR. TAYLOR: The request is for Dr. Jones's audit of Dr. Saksida.
MR. MARTLAND: I'll have to double-check. Was this a document for which -- Ms. Pacey can advise if notice was given, and I don't know if the question

has been put. I apologize for this, Mr. Commissioner.
MS. PACEY: And I apologize, too, Mr. Commissioner. This was new information that came to my attention just recently, so I wasn't able to provide notice.
Q Mr. Lunn, if I could ask you to please -- I'm going to be referring to my friend's list of documents from the Conservation Coalition, and specifically document 49 from their list. And that is one of the Fish Health databases. It's the List of Lice Counts for 120 Fish Farms, dated January 2008, March 2010. And, Dr. Orr, I'm going to direct my questions to you. Do you recognize this database?
DR. ORR: I have opened it up and looked at it, but I don't know it in detail.
Q Are you able to confirm the information contained in this -- in this database?
DR. ORR: Yes.
Q And this contains essentially lice counts for the various fish farms during those dates that I listed; is that correct?
DR. ORR: That's correct.
MS. PACEY: Could I ask that this be marked as the next exhibit, please.
THE REGISTRAR: Exhibit 1797.
MS. PACEY: Thank you.
Q And, Dr. Orr, I'm going to ask you to please refer -- or, actually, Mr. Lunn, if I could get you to click on Tab 2 at the bottom, which says "Lice Farm Environmental Data". Thank you. And, Dr. --
MR. MARTLAND: I'll just raise, this may be housekeeping, but this has a BCP production number. It may fall under one of the subdocument categories, or at least one of these database exhibits that we already have. Perhaps what we can do at the break is simply to pick up on that, too, Mr. Lunn, and see if we can put on record if it is already in as an exhibit or a subdocument. Thank you.
MS. PACEY: Thank you.
Q Dr. Orr, if I could get you to refer to column "L", which you will see is the "Fish Inventory Count". And without taking you through all of the numbers, for the interest -- or in the interests of time, I'm going to suggest to you that the farms and the numbers contained there generally

indicate that the farms hold between 250,000 and 700,000 adult fish; is that consistent with your understanding?

DR. ORR: I haven't looked at this column in great detail, but my experience is going on farms and writing papers is that there is that kind of a variation. It's more in the order of maybe 500 to 750,000 is more the normal variation.

Q Thank you. And my question for you this afternoon is regarding the trigger level that's set in terms of the number of motile lice per fish. And I'm going to ask you whether you agree with me if I suggest that the trigger level, which is three motile lice per fish, does not actually take into account the number of fish on the farm itself. And the result does not actually take into account the number of lice that could be found on the fish farm; is that correct?

DR. ORR: I think that's accurate. I think the scientific explanation is that it's not sensitive to density dependence, which is the numbers of fish on the farms, and it's an arbitrary -- it's an arbitrary trigger at this time that several of us have been advising government to actually do some adaptive management around to see if it actually is meaningful in terms of protecting wild fish. At this point we don't know.

Q So in the interests of actually protecting both farmed and wild fish health, you would suggest that the number of lice per farm be the trigger level?

DR. ORR: That trigger level was for wild fish, and so that's what it was designed to protect during the outmigration.

Q Thank you. And I'm done, but I just would ask Mr. Lunn to please pull up document 49 on the Conservation Coalition's list, which is a similar database, although it is for a different range of dates. It's the Sea Lice Count for the 120 Fish Farms January 2004 to March 2008.

MR. LUNN: This is Tab 49.

Q Oh, I'm sorry. Sorry, could I say Tab 48. Thank you. If I could ask that that -- or perhaps I should ask you first, Dr. Orr, if you recognize this document.

DR. ORR: This is one of the suite of ones that were produced recently.

MS. PACEY: And if I could ask that this be marked as the next exhibit.
THE REGISTRAR: I'm informed that this could be the same list of documents.
MS. PACEY: Perhaps if I --
MR. MARTLAND: I don't hear people objecting to it going in, but perhaps if I can suggest this. If we take -- if we move to break now, Mr. Commissioner, and if I'm able to suggest perhaps a seven or so minute break, what we can do in that time is double-check and learn whether these documents, it may have been different sheets with the spreadsheet or something that were placed at those tab numbers, but we can pick up on that and address it on the record when we reconvene.
MS. PACEY: That's very well, thank you, Mr. Commissioner.
THE REGISTRAR: The hearing will now recess for ten minutes.

(PROCEEDINGS ADJOURNED FOR AFTERNOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: Hearing is now resumed.
MR. MARTLAND: Mr. Commissioner, I have some brief housekeeping matters I'll deal with now that we're resuming. The first - and Mr. Lunn may need to correct if I don't quite get this right. I think what we're going to suggest happened vis-à-vis the documents that Ms. Pacey went to most recently is to cancel or withdraw the last exhibit marking and put on record that the documents you are looking at, first of all Tab 49 of the Conservation Coalition's material, I believe it was, in fact is in the -- the production number is BCP2868 within Exhibit 1549, that is sub-document 221. And likewise, Tab 48 of the Conservation Coalition materials, which is BCP2867, it may have been mislabelled on the top of the sheet, the version we looked at in court. That indeed is Exhibit 1549 sub-document 220. That is the state of affairs vis-à-vis those exhibits.
The other quick housekeeping matter I'd like to deal with briefly is just to put on record stemming from evidence that was led I believe on December 16, 2010 and an issue that arose vis-à-vis two different exhibits, just to confirm on the

record that Exhibit 132 and Exhibit 121 are the identical, they're the same document. We had one of these situations where the same document was marked twice. You'll see one document, Exhibit, I think, 121 there's a redaction to remove personal contact information for a witness, so the redaction having been made, those two documents are now the same. All I'm doing is simply placing that fact on record.

I have next counsel for the First Nations Coalition with an allocation of 15 minutes.

THE COMMISSIONER: Thank you.

MS. REEVES: Good afternoon, Mr. Commissioner. Reeves, R-e-e-v-e-s, initial C., for the First Nations Coalition. I've been allotted 15 minutes of time.

CROSS-EXAMINATION BY MS. REEVES:

Q I'd like to pull up Exhibit 640 which is Tab 1 of our documents, Mr. Lunn. And these questions will be directed towards you, Dr. Jones. This memorandum for the minister was written in 2008 and if we could just scroll down to the third bullet point on the bottom of page 1 there, and it says:

> Since 2003, the Department and others (e.g. the Pacific Salmon Forum) have conducted extensive field and laboratory research into the potential origins of sea lice and their relationship to the health of wild salmon populations in the area.

Dr. Jones, would you agree that this statement is accurate and, in particular, as it relates to field and lab research and sea lice with the help of wild salmon, so since 2003?

DR. JONES: Yes, I would agree with that statement.

Q So there's been extensive research on the health of wild salmon and its interactions with sea lice populations?

DR. JONES: We've conducted or at that time we had conducted a number of studies that focused on sea lice and some of those studies had a more broad interest, where we did focus on health issues that went beyond sea lice.

Q And were any of those studies particular to Fraser

River sockeye salmon?
DR. JONES: No, they were not.
Q Thank you. I'd like to also go to page 3 of this same document, Mr. Lunn. On page 3 and starting on actually the page before, this sets out, I guess, a 2008 strategy on sea lice and you can see there is the bullet points and one of the bullet points that's at the top of page 3 says:

> Enhanced management actions to reduce sea lice numbers on salmon farms and reduce exposure of young wild salmon to sea lice associated with salmon farms.

What in your understanding would enhanced management actions mean, Dr. Jones?
DR. JONES: Well, trying to remember the context of this briefing note, but in my opinion, enhanced management actions as it relates to this document would include a combination of factors that include monitoring and surveillance of the farm population, appropriate siting and stocking activities and harvesting activities, in other words, being coordinated. It would include treatment where practical or harvest where appropriate, so it would take into consideration the results of monitoring the farm population and acting accordingly to minimize levels of lice on a farm.
Q Okay. And then if you look the next bullet -- or some bullets down it talks about:

> Enhanced engagement of industry, ENGOs and First Nations and government research in decision-making regarding aquaculture management.

Now, this is a 2008 memo. Do you feel that that strategy or engagement strategy has been accomplished or being done, particularly given sort of what we've heard earlier today about the lack of collaborative research perhaps?
DR. JONES: Insofar as we've engaged various sectors of industry, it's been successful. Now, to my knowledge and speaking from my own research programs, it has not been successful regarding engagement of ENGOs or First Nations in our

research, so I've not had active involvement or participation of either of those communities in my research programs.

Q And as to the rest of the engagement strategies, do you feel that those have been undertaken effectively?

DR. JONES: Could you please specify exactly what you mean by the rest of --

Q Well, has a rigorous international peer review of the current signs with respect to sea lice and salmon farms been created in British Columbia?

DR. JONES: I would suggest that whenever our work is published in the peer-reviewed literature, that it is subject to a rigorous review. Any work that we've published through our internal -- our internal DFO Science program or the CSAS program is subject to peer review, which can be international and it's certainly rigorous. So that, yes, our research is subject to this sort of review.

Q And is there room for improving any of these management options?

DR. JONES: Well, I think -- there's always room for improvement. I think one of the -- one of the directions that these recommendations was moving towards was a recognition of the need to be flexible enough to take into consideration new information so in an environment where there's a very active research activity underway, new information will be available on an ongoing basis, and that what are initial deficiencies are often accommodated by results of ongoing research. But I think it's clear there will always be deficiencies and the expectation is that as we learn more, we remedy that and try to fill the gaps.

Q Perhaps you, Dr. Orr, could very briefly comment on whether you feel these management strategies or engagement strategies have been met since 2008 in your opinion?

DR. ORR: Engagement with ENGOs in particular?

Q Yeah, perhaps you could comment on that.

DR. ORR: Well, we haven't worked with Dr. Jones too much, but we certainly have worked with some of the people in DFO in the field for the Broughton Archipelago monitoring program and that's been actually a very good collaboration in terms of

sharing data and setting up monitoring programs. It's sometimes a little frustrating that you have to go through government process. It took us well over a year to negotiate data sharing agreements between the ENGOs and the industry and DFO but we did get those done and so there's been a fair bit of collaboration with DFO on monitoring programs, but I will qualify that by saying that, you know, they're -- one of the reasons that's probably happened is because DFO doesn't have as much money and capacity to do those as they did in the past. So they're looking at making sure that industry and ENGOs take up a little bit of the slack on that.

Q Okay. Thank you. I'll move on from that piece. Dr. -- or -- oh, sorry. Can I get that marked as an -- oh, it was Exhibit 640. Sorry.

Can I get our Tab 17, please? And I'd like to ask the panel if any of you are familiar with this study done by Dr. Timothy McDaniels at the School of Regional Planning at UBC? Dr. Jones or Dr. Orr?

DR. JONES: No, I'm not familiar with this.

DR. ORR: I've read it and it's a fairly old paper, isn't it? I can't actually see the date. I've read it a few years ago, I believe.

Q Right. It's a 2006 paper and what Dr. McDaniels did was he surveyed a large group of scientists who were involved in aquaculture research in British Columbia during the period leading up to 2006 and what he was trying to measure was risks and uncertainties. And if we go to page 779 of the document, Mr. Lunn? And if you could just blow up that table, please?

So this was the -- obviously anonymously some of the groups or -- that were surveyed as part of his survey work and it includes DFO, provincial government scientists, consultants, industry, academics and students. And if we could go to page 785 and if you could just blow up the first paragraph. And based on their survey results, the 50 people that were surveyed, 50 scientists that were surveyed, the potential risk of disease in 2006 spread from confined salmon to wild salmon and other ecosystem species was one of the top four risks in all three contexts. And unfortunately, I don't have time here to go into

what the other questions or contexts was.

> The ranking of the riskiness index was the highest for effects on wild salmon health at both the local and regional scales.

Would you agree that that still would be a top risk as identified by scientists of this panel?

DR. ORR: I think you heard today that disease was rated as a top risk by two out of four members of the panel.

Q And then if we could just go down to the last paragraph on this page, and starting at the top of the paragraph. They did a correlation between calculated riskiness and uncertainty and what they found was:

> The spread of disease from confined fish to wild salmon was identified as an important risk for which experts believed uncertainty in the scientific knowledge was comparably high for both the local and regional contexts. Some events, such as extended periods of artificial lighting, were suggested to pose less risk to wild salmon...

And then they went on to say:

> Changes in local water quality were cited as important risks to both wild salmon and other ecosystem species...

Would those still be risks that you would calculate today as important?

DR. JONES: I'd just like to comment that I'm a little concerned that these conclusions are based on the opinion of 49 or 50 anonymous individuals who may or may not have expertise in disease or pathology or sea lice and that these are obviously issues of some contention that a number of panels have been weighing into in this process. My sense is that from what we've heard and what we've described today, that the spread of disease that's specifically due to sea lice is not a significant issue as it relates to the health of wild salmon populations.

Q And, Dr. Orr, would you agree with that assessment

of Dr. Jones?
DR. ORR: Probably not.
Q What about you, Dr. Price?
MR. PRICE: I'm not a doctor, so I should just clarify that, but I agree with Craig, so yes, I disagree with Dr. Jones.
Q And I guess I have to ask you, Dr. Saksida, obviously what your thoughts would be.
DR. SAKSIDA: I think we're on an even split here, and I agree with Dr. Jones.
Q Right. So given these uncertainties and I would say maybe our clients call it duelling scientific views regarding sea lice as a vector for disease or having other impacts and given the increased vulnerabilities to the life cycle of Fraser River sockeye we heard earlier this morning mentioned about climate change as a possible environmental impact, what would be the available management options robust enough to address uncertainties with -- from sea lice?
Maybe we'll start with you, Dr. Orr?
DR. ORR: I think we did cover that this morning when we put up the convenor's report from the SFU think tank from 2009. I'm still of the same consensus statement opinion that we should be experimentally removing farms to see if that helps sockeye.
Q Dr. Jones, what management options would you suggest given the uncertainty?
DR. JONES: Well, there's always uncertainty, but I would suggest that there's less uncertainty as it relates to sea lice and their interactions between wild and farmed fish now than there was in 2003. Our data that we discussed this morning from the Broughton Archipelago that showed a very significant reduction in the numbers of lice on wild juvenile pink and chum salmon despite the presence of an ongoing salmon aquaculture industry suggests that the practices that have been in place and have been developed and evolving in that industry over that time period have shown some measure of success, and that these would involve being more strategic in terms of treatment, for example, and that this sort of a practice could be built on, as it seems to show, some measure of success.
Q Dr. Price or Dr. Saksida? I'm sorry.
MR. PRICE: I'm not a doctor, but --

Q Sorry. Sorry.
MR. PRICE: It's all right. I believe there's more uncertainty than ever and I do agree with Dr. Orr that experimentally removing the farms would be certainly be a novel thing to do but also a practical thing to do at this time.
DR. SAKSIDA: I think what we need to do is really try to understand the uncertainty. I think there is a lot of data out there, even in the published literature, to show that there seems to be a lot of regional differences in sea lice - I think we can agree - sea lice, which ones are -- you know, which ones are the most abundant and in intensities and I think maybe, and I think Craig Orr actually brought it up, is the whole idea that maybe we need to look at area management concepts based on the ecosystem. I'm not sure if that's what you meant.
DR. ORR: Can I clarify?
Q Yes.
MR. MARTLAND: Mr. Commissioner, I don't believe this paper has yet been marked as an exhibit. Perhaps that might occur. And I do know we're also at time for this allocation.
MR. TAYLOR: I don't agree to it being marked. No one's identified it as anything that they will know about or agree with and it appears to be a paper about methodology and not about anything to do with the substance of sea lice. It's a paper about studying risk.
MS. REEVES: It's about calculating risks of sea lice and I believe Dr. Orr had said he had read the paper and recognized it.
MR. MARTLAND: I'll support the First Nation Coalition on this. Dr. Orr did, I believe, indicate that he'd read it. It was used as the premise for a series of questions. I think there's things to be said later on about its utility or its use perhaps, but I'll suggest given the standards we've used broadly speaking, this seems to be a published journal paper, that it may be received as an exhibit proper.
DR. ORR: And may I just finish my comment on the area management? Is that possible?
MS. REEVES:
Q Yes.
DR. ORR: I just wanted --

MR. MARTLAND: Well, perhaps we can, before we do that, simply deal with the question of the exhibit.
DR. ORR: Sure. Sorry.
THE COMMISSIONER: Yes, we'll mark it as the next exhibit, please.
THE REGISTRAR: It will be marked as Exhibit 1797.

EXHIBIT 1797: Expert Judgments Regarding Risks Associated with Salmon Aquaculture Practices in British Columbia - McDaniels et al

THE COMMISSIONER: Dr. Orr?
DR. ORR: Thank you, Commissioner. I've thought about it a lot and been involved in area management schemes with industry since 2009 and agree with Dr. Jones that by, you know, age class management, hold bay management, you know, coordinated treatments of farms, early treatment of farms, that's been the biggest benefit for the Broughton. All the farmers are treating in December which has been a real big benefit for the wild fish, you can reduce the numbers of lice. You can reduce the impacts and infestations on wild fish. But we don't yet know whether that's enough to counter-balance the population of impacts we've seen in those fish. Those studies haven't been done.

And as a reviewer for an area management paper that was recently published too and the aquaculture environment interactions, I can tell you that it's very easy to see cross-infections where you actually take farms out. You can see lice will travel several kilometres between farms and re-infect farms, so it's not the panacea that some people make it out to be and it can buy you some time, but it's, in my view, in working on it for a number of years, it's not a permanent solution.

MS. REEVES: Thank you. That's my time.
MR. MARTLAND: Thank you. Mr. Commissioner, we're in a position just by way of the timing, unfortunately we have three participants with ten minutes each in their allocations. I'll simply perhaps suggest we carry on and perhaps they can proceed with that in mind, anything they can do to compress their questions, and witnesses can do to assist us would be appreciated.

Counsel for the Aboriginal Aquaculture Association is next.

CROSS-EXAMINATION BY MR. KELLIHER:

Q Panel, my name is Steven Kelliher and I appear for the Aboriginal Aquaculture Association. And I'm going to ask you a question that I put to Drs. Korman, Connors, Noakes and Dill the other day. You'll understand that my clients have a significant interest in the efficacy of the industry in their traditional territories and the question that I put to the doctors that I've mentioned was that given best practices, is it possible that in-the-ocean aquaculture can coexist with the thriving of the wild stocks?

Can I ask you first, Dr. Saksida, your view on that?

DR. SAKSIDA: I think there's evidence to show that they can coexist. There has been a lot of changes in the last 20, 25 years in aquaculture. There has been better vaccine development, a lot more screening. We understand stress basically things that affect stress, like density, so those things have all been mitigated. We monitor -- the environment is actually monitored by the salmon farms on a regular basis and management practices are basically -- are made based on what the environmental conditions are. Bottom line is as a result of that, if you go into the BCMAL website in their fish health reports, you can actually see that there has been a decline in -- well, I believe a decline in mortality, but there certainly have been a decline in antibiotic use. So with proper preventative measures, you can actually reduce the use of antibiotics and reduce disease.

Q All right. Thank you. That's five out of eight. Dr. Jones, what do you say about that question?

DR. JONES: I believe that there is evidence that suggests that a thriving aquaculture industry can survive -- can coexist with a healthy wild salmon fishery or wild salmon populations. I think the uncertainty relates to parasites such as *Caligus* which we know are important on some species of juvenile salmon, but my opinion is that *Caligus* is a parasite whose management will relate more

towards the abundance of wild fish populations such as herring and possibly other fish, and therefore it makes it a more difficult target for management as opposed to *Leps. salmonis* where there's good evidence that that parasite could be managed through activities on farmed salmon among other host populations.

So yes, to answer your question, there is scope for me to believe they will coexist.

Q All right. That's six out of eight. Mr. Price?

MR. PRICE: I feel -- I have not studied a system that has shown best practices and as far as I can see, there is no evidence of sustainability of this industry so that wild salmon will not be influenced or harmed by pathogens that are being released from farms or processing plants, et cetera. So no, I guess I'll be the one so far out of seven to say no.

Q All right. Let's follow that up a little bit. Are you saying that aquaculture should not exist at all because it's inevitable to jeopardize the wild stocks?

MR. PRICE: No, I don't believe that at all. But I suppose when I took your question I was thinking of the way fish or salmon are raised currently, which is in open net pens.

Q All right.

MR. PRICE: And so in that context, I -- and I perhaps should have qualified that as such, raising fish in open net pens, no, I don't believe they can coexist. But sure, create a barrier, create a physical barrier between wild and farmed fish and then I think, yes, this industry has a potential to be sustainable in that respect.

Q All right. Your position is that you are unqualifiedly opposed to open net aquaculture; is that right?

MR. PRICE: No, that's not correct. But I will say that from what I've seen right now, if there's no barrier between wild and farmed fish, then there's potential impact for wild fish.

Q All right. Then are you saying that given the state of the industry today, that you are opposed to open net aquaculture?

MR. PRICE: I believe the way salmon farming is practiced today in open net pens, yes, is problematic for wild salmon.

Q Because it compromises wild stocks; is that correct?
MR. PRICE: It could do, yes.
Q It could do? Or it does?
MR. PRICE: I'm saying it could do.
Q And you're prepared to oppose aquaculture, open net aquaculture, on the basis that it could or it might compromise the wild stocks?
MR. PRICE: I suppose I could step back and say out of the regions that I've examined for sea lice in particular on wild fish, and this is in salmon farming regions, it appears as though the less farms that are operating, that the less lice infection levels there are and so perhaps if you were to have one farm operating, it may be considered sustainable and perhaps wild fish and farmed fish could coexist.
Q Is that a yes?
MR. PRICE: I'm not -- sorry, what's your question?
Q It's a qualified yes, is it?
MR. PRICE: Sorry? What's your question again?
Q Whether in-ocean aquaculture and thriving wild stocks can coexist.
MR. PRICE: In what context?
Q In the marine context.
MR. PRICE: I'm sorry, I'm not trying to be difficult but I'm -- could you elaborate a little? I mean, if --
Q Well, what part of the question poses the problem for you?
MR. PRICE: I don't feel I have the context of the question that you're asking. So you're asking me if a farmed fish, if it's a single farm fish, if it's a million farmed fish, can coexist with wild fish?
Q I'm asking you whether the aquaculture industry, open pen aquaculture industry, could co-exist with thriving wild stocks on the coast of British Columbia?
MR. PRICE: I suppose my answer would say I don't know. I don't have the expertise to say.
Q Because the science isn't at the level that allows someone to answer that question with certainty, is it?
MR. PRICE: I would say yes, you're correct on that. Yes, there --
Q All right.

MR. PRICE: -- there remains uncertainty.
Q You wouldn't condemn this industry to oblivion on the basis of the science that's known today, would you?
MR. PRICE: I don't believe I'm condemning the industry and I wouldn't condemn the industry.
Q Nor would you, no.
Dr. Orr, what do you say to that question?
DR. ORR: I would ask you for some clarification. You talked about -- one thing you're leaving out and you're sort of rephrasing is given best practices. Are you talking about full disclosure of disease information, sea lice information? Are you talking about full-on monitoring programs for wild fish along the entire coast? You know, research programs looking to replace SLICE as a resistance develops? Is that the kind of --
Q Yes. All of those things.
DR. ORR: All of those kind of things.
Q Yes. I think Dr. Dill was cautious to make -- underline the same points that you are.
DR. ORR: Well, and I think one of the things that my colleague, Mike, is struggling with here is that your question is sort of static. It's not one about density dependence. I mean, the industry is talking about expanding on this coast. So as we keep expanding the number of farms, the question becomes very, very different because this is mainly a question about density dependent effects on the coastal ecosystem, so we're not talking about just a static system, are we?
Q Right. Well, best practices would include density though, would they, in your mind?
DR. ORR: I don't know. I'm asking you.
Q Yeah, that's what I would think.
DR. ORR: Yeah.
Q Yeah.
DR. ORR: Well, then --
Q Bearing that in mind, what do you say?
DR. ORR: -- it means that you're going to have to cap the density of fish at some time. If you really want the treatments for lice and disease to be effective and the information to be valid, but I think my answer from what I said before stands, is I think it's possible through best practices to reduce impacts of farms on wild fish, but I have not seen evidence and, in fact, I've seen opposite

evidence in Europe, despite their best efforts to continue to reduce triggers and increase treatments and find new treatments for lice, they are not bringing our wild fish back. And the best evidence suggests that we're not there.

MR. KELLIHER: All right. Thank you very much.

MR. MARTLAND: Thank you. Mr. Commissioner, I have counsel for the MTTC followed by counsel for the Heiltsuk.

THE COMMISSIONER: We have until 4:00. How are you going to do that?

MR. MARTLAND: We do have until 4:00, Mr. Commissioner. I'm open to any direction you have. I'll be asking counsel to do their very best to work within that time constraint. I appreciate -- hit against the wall a little here.

MS. ROBERTSON: Krista Robertson for the Musgagmagw Tsawataineuk Tribal Council. So I'm feeling in a bit of a dilemma. Basically every minute I take for my exam here I'm taking away from my friend, so I guess I'll just start with one question. Mr. Lunn, if you could pull up Exhibit 1496, please?

CROSS-EXAMINATION BY MS. ROBERTSON:

Q Dr. Saksida, do you recognize this paper?

DR. SAKSIDA: Yes, I do.

Q So earlier today in your testimony you gave your opinion that it isn't so much sea lice in your view that's a risk for disease transmission, it's more about the water. It's more about transition through water; is that correct?

DR. SAKSIDA: Yes, it is.

Q So in this paper where you studied the IHN outbreak in 2001 to 2003 what in your finding was the greatest distance between farms that disease could be transmitted, just based on this study? What was the largest distance? And we can go to page 5, if that would assist you.

DR. SAKSIDA: It would, actually.

Q Can we please go to page 5, Mr. Lunn, the tables there? Maybe you could just highlight the Area 1.

DR. SAKSIDA: So those are basically just a description of the spread of the disease over time. The distances don't necessarily mean that they're actually waterborne. It could have been actually being carried by something so the 30 kilometres or

whatever or the hundred kilometres isn't actually straight waterborne transmission. Some of that had to do with just bad management.

Q So what about the three or the five or the six there, those top three?

DR. SAKSIDA: I would think that some of -- depending on the water flow, I would venture to say that the three and the five are probably fairly accurate, that you could, if you have a high enough concentration of virus in the water, it's possible that it could transmit that far.

Q Right. And the currents are favourable, et cetera.

DR. SAKSIDA: Yeah.

Q So what in your opinion then would be the furthest distance, the outer limit, let's say?

DR. SAKSIDA: I don't know.

Q In this scenario, what was your conclusion there, the outer --

DR. SAKSIDA: I don't think I actually made a conclusion on how far something can actually be from waterborne transmission.

Q So six then would be possible.

DR. SAKSIDA: It's -- it's possible, depending on the currents and the concentration of diseased fish, because it really does, it -- and Craig Orr has brought this up, density dependence. And if you have a lot of sick fish that are basically shedding virus, it's possible it could move, but the problem is that some of the -- my opinions have been sort of countered by other work that's being done by Kyle Garver and Garth Traxler, where they actually said that that may not be possible because of the virus seems to be deactivated fairly quickly in sea water and to the exposure of sunlight. So I thought it would be waterborne. Others are questioning that.

Q All right. Thank you. Just another question then, so as a veterinarian working for salmon farms, you would have prescribed SLICE many times, I gather?

DR. SAKSIDA: I don't know what many times means. I've prescribed SLICE, yes.

Q Well, let me -- would you agree that sea lice on fish is a stressor? Why do you prescribe SLICE for fish on salmon farms?

DR. SAKSIDA: Since 2003 it's because of the trigger

levels.
Q Really? So you don't prescribe, as a vet, you don't prescribe SLICE to treat lice on salmon farms because there's any belief on your part as a vet that the lice are causing stress on the fish in the pens?
DR. SAKSIDA: I've treated for -- if we speak on the *Leps. salmonis* I'm treating at far lower thresholds than I would believe that the fish are actually experiencing stress. The times I have actually treated for *Caligus* it is because I believe that the fish were actually -- that it might be a welfare issue, so that's why I treated them.
MS. ROBERTSON: All right. Thank you. Well, unfortunately, I'm just going to have to leave it there, so my friend has some time.
MR. RALSTON: Benjamin Ralston appearing on behalf of Heiltsuk Tribal Counsel and with me here today is Lisa Fong, my co-counsel.

CROSS-EXAMINATION BY MR. RALSTON:

Q Okay. I'm going to start with some questions for Dr. Jones, please. First of all, Dr. Jones, as a scientist knowledgeable about sea lice, would you agree that a First Nation that is considering whether to consent to a salmon farm being placed in their traditional waters should have access to the salmon farm fish health data to assess the risk of such a farm?
DR. JONES: I would agree to the extent that all competent and interested parties should have access to that information, that that's -- I do agree with that.
Q Okay. So if you were to give a list of potentially relevant salmon farm fish health data that a First Nation would or should have access to, what items would you include in that list?
DR. JONES: Well, I would include information on production data, information on the number of fish stocked, the time of stocking, information on treatment histories, information on lice counts, information on the species of lice, the stages of development on these fish, information on mortalities and mortalities from which clear health data may be obtained, so the fresh silver

category, I believe it's called. So, yeah, okay.
Q That's great. Would anyone else on the panel like to add or subtract from that list? Okay. Ms. Saksida?
DR. SAKSIDA: I think it's really important actually that some of the environmental data is also accessible. I think the data basically on temperature, salinity, DOs, that's really important because it informs if the fish are actually going to undergo stress or not.
Q Okay. Thank you. And Dr. Jones again, could you tell me would this information be readily available to DFO to provide to a First Nation?
DR. JONES: Well, I understand, although I can't say for sure, that with the new regulatory process that's being put in place, that DFO would have access to that information, and that my understanding is that much of this information will be available, although I guess I'm referring to health-related data. I'm not sure that all of the data that we've just described will be available on the website, but I'm really not competent to describe exactly what will or will not be planned to show.
Q Okay. But to date have you ever been asked to prepare such a package of information for a First Nation?
DR. JONES: No, I haven't.
Q Okay. But would you be capable of doing so given the new regulatory regime, as far as you understand it?
DR. JONES: Well, there's much I don't yet understand about the new regulatory regime, but that is a possibility.
Q Okay. Just another general question. What level of expertise do you think would be necessary to properly understand the information that you gave in that earlier list, as supplemented by Ms. Saksida, of course.
DR. JONES: I think it would be best understood by parties who have training in animal husbandry, specifically salmon husbandry. It would probably be useful to have some experience working with environmental or health data.
Q Okay. Would you have anything to add, Ms. Saksida?
DR. SAKSIDA: I agree with Simon, that you definitely

need to understand disease processes and understand infection versus disease, so I think you'd need probably a fish health expert to be able to interpret the data and understand what is actually a problem and what is just something that is a minor issue.

Q Okay. Thank you. My remaining questions will be for Mr. Price. Okay. So first of all, Mr. Price, your resume states that you act as a science advisor to the Heiltsuk Nation; is that correct?

MR. PRICE: Yes, I have been, yes.

Q Okay. In your view, what would you say is the value to Heiltsuk Nation of having a science advisor such as yourself, with particular reference to your expertise in juvenile salmon and sea lice interactions?

MR. PRICE: Well, probably within the -- what you have described, if the Heiltsuk were considering placing open net pens in their territory, what risk might they -- what risk might salmon farms play for juvenile salmonids. But also migration routes and species and as well as particular streams that they may be residing in.

Q Okay. Just to clarify that second part of your answer then, so for a First Nation such as Heiltsuk who are opposed to finfish aquaculture in their traditional territory, would you still think it would be useful to have access to scientific advice like your own?

MR. PRICE: I think so, yes, because I'm not certain if they're entirely opposed to this industry. It may be with the use of open net pens.

Q Thank you for that clarification.

MR. PRICE: Yes.

Q Okay. Could you also tell us just a bit about the types of work that you've done with Heiltsuk Nation through the Raincoast Conservation Foundation to date?

MR. PRICE: Well, a large portion of early work were identifying unknown salmon streams within their traditional territory, so that included spawning salmonids, but also juveniles that may rear in numerous streams that are not at least included in Fisheries and Oceans database.

Q Okay. And just to clarify, to date you've been working in partnership with Heiltsuk's integrated resource management department, that being their

fisheries management department?
MR. PRICE: I have worked with them, as well as hereditary chiefs, yes.
Q Okay. And could you tell us how the work that you've done with Heiltsuk Nation has been funded?
MR. PRICE: Well, part of it was funded with -- in terms of the sea lice work, if you're getting back to the small streams, I'm not sure --
Q We can focus on sea lice, that's fine.
MR. PRICE: Okay. All right. Well, the provincially funded B.C. Pacific Salmon Forum contributed nearly all of the funding to do the sea lice research that I -- that's been shown in the 2010 paper today.
MR. RALSTON: Okay. I just want to speak to the commissioner for a moment. I realize we're now at 4:00 p.m., so I guess I'm in your hands then. We could always deal with the remaining questions in writing or talk to commission counsel about that, but we're here at the hour.
MR. MARTLAND: Mr. Commissioner, just by way of the timing, we don't have additional questions in re-examination. Mr. Taylor, I think, had passed a note that he may be seeking to ask one or two questions. Frankly, from our point of view, we've avoided thus far through these hearings moving into the written process and I think conceptually many of us are not keen on starting into that, especially ahead of the next panel for the next two days. But we are in your hands with respect to whether there are further necessary questions that haven't been asked, in addition, with respect to Mr. Taylor's proposed further questions.
It may be that five more minutes does the trick here. I don't know.
THE COMMISSIONER: If we could be assured of that, Mr. Martland, I'd be content. I would allow this counsel one more question and then I think Mr. Taylor has one or two more questions. Is that correct?
MR. TAYLOR: I passed my note saying three and I'll make it two.
THE COMMISSIONER: All right. Then one more question from the HTC and then Mr. Taylor has two questions. Thank you.
MR. RALSTON: Okay. That's great. Thank you.
Q Maybe then Mr. Price, if you could just comment on

your sea lice project and just to identify that, that was your 2010 paper co-authored with Alexandra Morton and John Reynolds and that was done in conjunction with work that you did with Heiltsuk Nation, correct?

MR. PRICE: That's correct.

Q Could you just comment on the value of Heiltsuk's traditional knowledge to that paper and research?

MR. PRICE: Good question. I'm not sure how much went into it. Not a lot, to be honest. Yeah.

MR. RALSTON: Okay. Fair enough. Those are my questions. Thank you.

THE COMMISSIONER: Mr. Taylor?

CROSS-EXAMINATION BY MR. TAYLOR, continuing:

Q Dr. Jones, you were asked about an audit by one of the counsel, I think it was Ms. Reeves, an audit of Dr. -- I'm sorry, Dr. --

THE COMMISSIONER: Saksida.

MR. TAYLOR:

Q Saksida. Thank you. I don't know why I keep tripping over that. I apologize. What was the subject of that audit and why was it done?

DR. JONES: The subject of the audit was in the context of the Broughton Archipelago management plan or program, BAMP, as we've described earlier and in that, in the context of that surveillance work, sea lice were identified by two laboratories and our role was to conduct an audit of the identification of the sea lice by each of those two laboratories.

Q An audit of counting?

DR. JONES: An audit of the counting but more importantly, of the identification of the lice that were -- that was obtained in the original identification.

Q My next and final question is as to - and I'll mispronounce it - plasmacytoid leukemia: (a) can you clarify how it was diagnosed in the '90s versus today; and (b) is there a difference between plasmacytoid leukemia and marine anaemia?

DR. SAKSIDA: They're actually synonymous. Basically when we call it marine anaemia, it's just the common name for plasmacytoid leukemia.

Q All right.

DR. SAKSIDA: The way it was diagnosed in the '90s is

very -- is no different than it is diagnosed now. The gold standard is histology so you have to have an increase of blast cells in two organs. One is usually the kidney and it either is in the liver or the heart or the brain is usually the second. So you have to have interstitial hyperplasia in two organs, plus you have to have the clinical signs of the swollen kidney and enlarged spleen and pale gills.

MR. TAYLOR: All right. Thank you, Dr. Saksida and Dr. Jones.

MR. MARTLAND: Thank you, Mr. Commissioner. That concludes this panel's evidence and we'll resume again tomorrow morning. Thank you.

THE COMMISSIONER: I want to express the commissions appreciation, Dr. Saksida, Mr. Price, Dr. Orr and Dr. Jones. Thank you very much for coming here today and answering the questions of counsel. Much appreciated, thank you.

(PANEL NO. 61 EXCUSED)

THE REGISTRAR: The hearing is now adjourned till 10:00 a.m. tomorrow morning.

(PROCEEDINGS ADJOURNED TO SEPTEMBER 7, 2011 AT 10:00 A.M.)

I HEREBY CERTIFY the foregoing to be a true and accurate transcript of the evidence recorded on a sound recording apparatus, transcribed to the best of my skill and ability, and in accordance with applicable standards.

_____

Karen Hefferland

I HEREBY CERTIFY the foregoing to be a true and accurate transcript of the evidence recorded on a sound recording apparatus, transcribed to the best of my skill and ability, and in accordance with applicable standards.

_____

Susan Osborne

I HEREBY CERTIFY the foregoing to be a true and accurate transcript of the evidence recorded on a sound recording apparatus, transcribed to the best of my skill and ability, and in accordance with applicable standards.

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Pat Neumann