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:

Room 801
Federal Courthouse
701 West Georgia Street
Vancouver, B.C.

Tuesday, May 10, 2011

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701, rue West Georgia
Vancouver (C.-B.)

le mardi 10 mai 2011

APPEARANCES / COMPARUTIONS

Wendy Baker, Q.C. Lara Tessaro	Senior Commission Counsel Junior Commission Counsel
Mark East Charles Fugere	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")
No appearance	B.C. Salmon Farmers Association ("BCSFA")
No appearance	Seafood Producers Association of B.C. ("SPABC")
No appearance	Aquaculture Coalition: Alexandra Morton; Raincoast Research Society; Pacific Coast Wild Salmon Society ("AQUA")
Tim Leadem, Q.C.	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")
No appearance	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")
Anja Brown	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")
No appearance	Laich-kwil-tach Treaty Society Chief Harold Sewid, Aboriginal Aquaculture Association ("LJHAH")
No appearance	Musgamagw Tsawataineuk Tribal Council ("MTTC")
No appearance	Heiltsuk Tribal Council ("HTC")

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THE REGISTRAR: Order. The hearing is now resumed.

DONALD DOUGLAS MacDONALD,
recalled.

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. I expect my examination will be 60 minutes.

CROSS-EXAMINATION BY MS. CALLAN:

Q Mr. MacDonald, you would agree that water quality conditions in freshwater habitat are likely not the primary factor influencing sockeye salmon productivity in the study area?
A Yes, that's correct.
Q Okay. You would also agree that you did not find a dramatic change in the water quality or levels of a particular contaminant on the outmigration in 2007 or on the in-migration in 2009 that would explain the low number of sockeye in 2009?
A That's correct.
Q It would have been a useful exercise, though, to conduct this research. Oh, sorry. And specifically, when you looked at all of the concentrations, all of the contaminants of concern identified in Table 5.13 to 5.17, you observed that all of them have the same concentrations or lower levels than they did in 1990. And specifically if you could turn to page 66 of your report, and it would be the second paragraph midway through, where it says:

> However, comparison of the results for the entire watershed for the two time periods revealed that the frequency of exceedance of the toxicity reference values either remained the same or decreased for all contaminants of concern (Table 51.13 to 5.17). Such patterns of decreasing or constant frequency of toxicity reference value exceedance over time

were also generally evident across all of the areas of interest.

A There was a lot of information in that question, and maybe we need to break it up a little bit so that we don't provide incomplete information.
Q Okay. Would you agree that all of the contaminants generally had the same or lower levels than they did in 1990?
A So you referenced Tables 5.13 to 5.17, those don't provide information on concentrations specifically. What they identify is the frequency of exceedance of the toxicity thresholds. So they don't provide comparisons of pre-1990 to post-1990 concentrations.
Q Okay, However, the frequency, then, of exceedance was generally lower after 1990 than before 1990?
A I'm just looking at tables -- why don't we go through the tables one at a time. Do you want to start with Table 5.13, which is T-126?
Q Well, I guess, rather than do it on a graph-by-graph basis, because I do have limited time, do you agree with the statement that you made at page 66?
A And sorry, once again, could you re-state that portion of page 66 that you're referring to?
Q Okay. It's the second paragraph of page 55:

> However, comparison of the results for the entire watershed for the two time periods revealed that the frequency of exceedance of the toxicity reference values either remained the same or decreased for all contaminants of concern (Table 51.13 to 5.17). Such patterns of decreasing or constant frequency of toxicity reference value exceedance over time were also generally evident across all of the areas of interest.

A Yeah, and that's a general statement. When you look at the details, you'll find exceptions to the general statement. So, for example, if you look at, oh, total iron, for example, on the South Thompson region, you'll see the incidence or the frequency of exceedance of the toxicity threshold is higher in the post-1990 period. There's a variety of exceptions to that general statement,

but overall that was the conclusion, yes.
Q What is a "toxicity screening value"?
A A toxicity screening value for the purposes of our report is a conservative toxicity threshold. It's a concentration below which we expect to see a very low probability of observing adverse biological effects, and above which there is some increasing probability of observing effects as the concentrations increase.
Q And what is "toxic concentration low"?
A I'm sorry?
Q Do you know what the toxicological term "toxic concentration low" means?
A I think maybe you need to point me to some reference for that. I don't know specifically what you're referring to.
Q Okay. Do you know what is meant by "lowest observable toxicity concentration"?
A Generally in toxicological studies, the term we use is "lowest observed effect concentration", or "lowest observed effect level". It's a more common term than I think the terms that you're using right now.
Q Okay. How does "toxicity screening value" compare with "lowest observed effects of toxicity"?
A So "lowest observed effect level" is the term that I used previously; sorry to have gone quickly over that. Typically in a toxicological study, an experiment will be done on, for example, sockeye salmon, where you'll expose a fish to various concentrations of the contaminant in water, and you will, and typically if you can sort of picture beakers with water in each one of them, and different concentrations of the contaminant in each one of those beakers, you'll be able to look at the effects that you're trying to observe in each of the beakers.

And your first beaker is typically your control, and then your next beaker is a relatively low concentration, and concentrations increase as you go through the progression. What you often do in a toxicity study is you report the concentration at which there was no adverse effects on the organism, that's the no observed adverse effect level, and then the next concentration tested above that is the lowest adverse effect concentration or level.

So typically that is reported for individual studies or individual experiments, rather than what we've tried to do is take information that integrates information from a wide variety of experiments into something that we call a toxicity screening value. So we consider variables or reported results like lowest observed effect levels or no observed effect levels in the literature, integrate those across a variety of toxicity tests and species, life stages, et cetera, that have been tested, and then that gets us to a point where we can select a toxicity screening value which we believe is very protective of aquatic organisms. And that's the ones that we've selected in this case for the purposes of doing the assessment in Chapter 4.

Q Okay. So generally which one of the two values has a lower contaminant concentration?

A Again, a lowest observed effect level is from an individual study. And so you might have in the literature lowest observed effect levels reported for sockeye salmon eggs, or sockeye salmon alevins or fry. You would also have lowest observed effect level reported for other fish species, invertebrates, et cetera. So when you describe which is lower, a lower observed effect level, you need to keep in mind that what is reported in the literature is hundreds and hundreds of, for example, lowest observed effect levels for a substance like copper or cadmium, which is very well studied.

And then how does that compare to our toxicity screening values? We would expect, if the Canadian water quality guidelines were designed and developed in the way that they're intended to be, that the toxicity screening value would be lower than most, most or all of the lowest observed effect levels reported in the literature.

Q Do you have any idea of the magnitude of the difference between the two numbers?

A And again, there's no such thing as a single lowest observed effect level, so there's not two numbers that are compared, there's multiple numbers that are compared to a toxicity screening value. So it's important to keep that in mind.

Q Okay. For my purposes, when we're talking of the

lowest observed effect concentration, I'm speaking specifically with respect to sockeye salmon. Can you then outline the order of magnitude or the multiplication factor between the toxicity screening level and the lowest observed toxicological effect?

A What you're describing is, I think, possible conceptually, and that's the way I will answer your question. But again, practicality is important, as well. Because again we're talking about hundreds of contaminants, and there is no single ratio between the toxicity screening value and the lowest observed effect level for sockeye salmon. It's because there's, you know, so many different chemicals that have been tested. And in many cases there may not be an LOEL for -- sorry, lowest observed effect level for sockeye salmon.

And so what it sounds like you're looking for is a very specific number, which I can help you with, if you want to get very specific about individual chemicals, and if we want to look at the underlying data, we can certainly do that. But I don't think that's really what you're looking for, and I think what you're looking for is a more conceptual answer.

And so to get to a conceptual answer, you look at the protocol that is used to develop things like the water quality guidelines. And typically what is in that protocol is that rather than a lowest observed effect level, there's several techniques for developing these concentrations that are protective of aquatic organisms. One of which is looking at the median lethal concentration, that's the concentration of a contaminant that is toxic to half of the animals that were exposed, and multiplying that concentration by a factor of .1. So it's a tenfold safety factor for a median lethal concentration. But that's not an LOEL though, that's not a lowest observed effect level. There's a different protocol for developing from a -- a guideline from an LOEL.

Q Okay.

A Is that what you were looking for? Is that kind of a conceptual answer?

Q No.

A Okay.

Q What I'll ask you, then, is you're saying then that the lethal concentration, 50, is ten times the lowest observed effect level, is that how you're --
A No.
Q -- evaluating that?
A That's not what I'm trying to say, and I'm sorry if I'm not being clear. The Canadian Council of Ministers of Environment, they're the organization that is largely responsible for developing water quality guidelines in Canada, with support from the various provincial agencies, as well, and they work as a team in this process. And to guide that process, they've developed a protocol for developing water quality guidelines that will be protective of all species, and all of their life history stages over indefinite periods of exposure.

And so this protocol then provides a basis for calculating a water quality guideline, not a lowest observed effect level, but a water quality guideline from a median lethal concentration, that's an LC_{50} concentration that is typically reported in the literature, or from a lowest observed effect level. There's also a basis for calculating the guideline from that tool, as well.

And so I may or may not be helping you here, but I'm trying to make sure that we use the language clearly enough so that we know what we're talking about.

Q So it's fair to say, then, for all of your screening values, they are the toxicity screening values, they are not the lowest observed effect concentration or level.
A Yes. The protocol calls for using a -- for developing a guideline that is lower than the lowest value that is reported in the literature. That's not 100 percent true of all the water quality guidelines. Some of them were developed prior to when the protocol was in place, and so there's more recent data that demonstrates effects at concentrations lower than the guidelines in some cases, but, generally speaking, that statement is correct.
Q So all of your numbers then, that you've had for measuring contaminants, if you look at the numbers and there's an exceedance of the toxicity

screening value, it doesn't mean that necessarily that the sockeye salmon have observed or have experienced any toxicological effect?

A Yeah. And I hope, as I described this yesterday when we talked about Chapter 4, the use of the toxicity screening value was intended to provide a basis for identifying the contaminants that do not pose risk to sockeye salmon. And when those values are exceeded, then we have a situation where we have chemicals that pose a potential risk to aquatic organisms, is the way I think we phrased it in Chapter 4.

Q But when you do go into Chapter 4, as well, and do the enhanced screening, you still aren't comparing the effects of the lowest observed effect concentration, as well, you're looking at the 95 percentile number instead and the toxicity screening value.

A Could you ask that question again, please?

Q When you're doing your enhanced screening, once you identified the contaminants that were potentially of concern because they exceeded the toxicity threshold at some point in the province when you looked at the highest number anywhere, you still didn't look at the lowest observed effect concentration. You looked at the toxicity screening value again in the 95th percentile.

A No, that's not correct.

Q What did you do, then?

A So and I think now you're referring to the work that was done in Chapter 5.

Q That's right.

A Okay. So the two main differences between what happened in Chapter 4 and what happened in Chapter 5 is, you know, we use that analogy of the sieve where we had a very tight screen in Chapter 4 and only the substances where we had a very high level of confidence that they would not pose adverse risk to aquatic organisms were the ones that dropped away through that screen. Everything else was retained on top of our sieve.

So in Chapter 5 what we've done is we widened the mesh, if you like, on that screen in two ways. So one you appropriately identified was rather than using a maximum concentration of each of the chemical of potential concern, we looked at the 95th percentile concentrations of the chemicals of

potential concern.

But then in addition to that, rather than using a toxicity screening value, as was done in Chapter 4, we've used something called a toxicity reference value. And this is where we've tried to identify toxicity thresholds for sockeye salmon specifically, and where that wasn't possible, we developed those for salmonids. And the idea was to identify the concentrations of each of the individual contaminants of potential concern below which there was unlikely to be adverse effects on sockeye salmon or other salmonids that have similar sensitivities, and above which there is a likelihood of observing adverse effects. So it was a very different tool that was used to evaluate the concentration data in Chapter 5 than what was used in Chapter 4.

Q And how does that compare to the lowest observed effect concentration?

A It would be more or less equivalent to a lowest observed effect concentration, the toxicity reference value.

Q For your report you measured approximately 200 contaminants of concern?

A Yes, that's correct.

Q Okay. How did you measure them? Specifically did you take samples of water and analyze them, or did you measure effluents from the surrounding areas?

A I think as I described yesterday, we relied on pre-existing data that had been collected and compiled, in the case of the water quality -- water chemistry data, that had been compiled in the provincial EMS database.

Q And there are some chemicals that you didn't have data for and you used pesticide sales data?

A Could you ask that question another way, please?

Q Were there any chemicals that you've purported to measure concentration levels on that weren't from actual measurements that were observed through water samples?

A Yes, not -- well, not in the way that you've just characterized it, but, yes. And the one example of that was some estimates of tetrachlorodibenzodioxin toxic equivalents for sockeye salmon roe for three stocks, upriver stocks. And what we used was the estimate to the predictions in the deBruyn et al paper 2004.

Q Okay. We can get to that.
A So those were the predicted concentrations. But I don't believe that for either water or sediments we predicted concentrations of anything.
Q Did you at any point do a comparison of contaminant concentrations in 2007 or 2009 in comparison to other years when sockeye salmon returns were good?
A In 2007, 2009, yeah, we looked at those data, absolutely, to see if there was any patterns that we could discern. We also looked for spills that potentially had been reported in the river.
Q And what were your findings?
A We did not see anomalous results, meaning -- "anomalous" meaning well outside the general population for the post-1990 data for either of those two years.
Q If you could turn to Table A3.1, which is at page 26 of the Appendix, would you agree that many of these samples are very old?
A As I review the information in this table, what I see is that the period of record ranges from 1965 to 2010, and I think that's what I testified to yesterday, as well.
Q And you would agree that in many of the areas of interest you did not have data that went to 2009 or 2010?
A Yes, I would agree that in, I don't know what percentage is off hand, we could calculate that if you would like. But there were numerous areas of interest where the period of record either ended in 2008, or before that. Yes, that's correct.
Q And certainly the Chilko River area of interest, the latest date that you would have had for that sample was June 2004, and that would be somewhat representative of some of the areas.
A That's correct for Chilko, yes, but representative of other areas, can you be more specific about that?
Q For instance, the Pitt River area of interest.
A Yes, I see that for Pitt.
Q Okay.
A Did you want to go through this list? I just don't want to mischaracterize 2004 being the latest date for most of the areas of interest, because I'm not sure that that correctly characterizes that.

Q Which areas did you feel that you had significant and updated information from, then? We'll go at it that way.
A Could you state that question another way, please?
Q Which ones of the areas of interest were you comfortable with the updated nature of the water samples?
A So just to -- I'm going to back up just a little bit here, and say we're talking about the temporal coverage of the data right now, and I think that's a very relevant discussion, as well.

Even more relevant than this, than the temporal coverage, is the spatial coverage of the data. And I think I talked about that at some length yesterday, where I indicated that I was relatively dissatisfied with our ability to characterize particularly conditions in incubation areas throughout the Fraser River Basin, and in early rearing areas throughout the Fraser River Basin. So those are two key data gaps that I think we, as we talk about data in more detail, we need to keep sort of that big picture in mind.

And now, getting back to the temporal coverage, would we have liked to have had data for the whole period of record for each of these locations that we did have data for? Absolutely, we would have wanted to have that. And are there some of these areas of interest where there is incomplete coverage in the most recent years? Yes, I would agree that that is the case.

Q And the province did have paper data that was available, but it was excluded for the purposes of your report due to time constraints.
A I don't remember that specifically. I believe that to be true, but I don't specifically remember exactly what was available in paper copies that we were not able to access because they were not available electronically.
Q Can you define "bioavailability"?
A Bioavailability is a measure of how accessible, in the context of contaminants, how accessible a contaminant like, for example, cadmium is to an organism that it is exposed to. So how likely that animal is actually going to experience that exposure of that contaminant in the form that it's in, in the environment.
Q Now, for the purposes of your report, you assumed

all of the chemicals were bioavailable for sockeye salmon to consume.

A That's not exactly correct, no.

Q Okay. If we could turn to page 57 of your report, and in particular it's the first paragraph under 5.1 and it's the last sentence:

> Furthermore, it was assumed that 100% of the measured concentrations of the chemicals of potential concern were biologically available, which is unlikely for total metals in surface water that carry substantial suspended sediment loads.

Do you disagree with that statement?

A No, I agree with that statement. Your question was bioavailable to consume, and that is what threw me for a loop. I didn't understand what you meant by that.

So again, bioavailability is a measure of how accessible the contaminant is to an organism in its environment. In this particular discussion that we're talking about, contaminants that are associated with the water column, the sockeye salmon aren't going to consume those contaminants, they're going to take those out via their gills or via contact with their epidermis or their skin, essentially. Those will be the two main mechanisms by which they'll access contaminants in the water column.

When we talk about bioaccumulative contaminants, then we talk about consumption of contaminated prey items, and then we can talk about, you know, 100 percent bioavailable to consume in that case, you know, that becomes more relevant. But in the context in which you asked the question, that's why I sort of -- I want to make sure that we're talking about the same things when we're having this discussion.

Q Okay. Well, if you assume that I do not use the word "consume" and that I use the word "consume or absorb through water", would that statement that I made earlier be correct?

A Yes.

Q Now, this is an unrealistic assumption, do you agree?

A Well, as you see in the last part of this

sentence, it says:

> ...which is unlikely for total metals...

So it may be for things like phenols, for example, which are largely going to be dissolved in the water, it's a very realistic assumption. But for certain things like metals, which can be either dissolved in the water column or associated with the particulates, like the suspended sediments in the water column, it's unlikely that 100 percent of the metal load is going to be biologically available.

Q So with respect to metals, it would overestimate the results?

A It would either estimate the results correctly or it would overestimate. It would be one or the other. In some situations, for example, in the rearing lakes where you have very clear waters, an estimate of 100 percent bioavailability of metals may be very reasonable. In the main stem Fraser where you have hundreds of parts per million of suspended sediments, it's unlikely to be correct. So it's, you know, you can't -- it's not one or the other, there's a variety of different conditions that exist within the Fraser River Basin, and we need to consider that range of conditions when we make generalities about...

Q Are you aware of any scientific studies which evaluate the amount of bioavailability of metals?

A Yes, I am.

Q Did they estimate a percentage that were bioavailable compared to the concentration?

A Well, I've done a number of studies in a variety of different places across North America that have been directed explicitly at answering that topic about metals, yes.

Q Were any in the Fraser River Basin?

A No, none of them were in the Fraser River Basin.

Q Where were they?

A Places like the Tri-State Mining District in Oklahoma, places like the Calcasieu Estuary in Louisiana, places like Newark Bay, New Jersey, those kinds of places around the U.S., Superfund sites, typically.

Q In those sites, what percentage did you find that were actually bioavailable?

A There is no single answer to that question. There is a range of answers. And I look primarily at metals in sediments and their bioavailability, that's one of my focus areas. And we find that we use an estimate of about 70 percent bioavailable for metals in sediments across North America, just looking at averages for a variety of different sites that we've actually done this work at.
Q Now, did you do any that were water-specific as opposed to sediment-specific?
A Yeah, and for water-specific, the range would be even greater than for sediments, because of the issue we just brought up. In clear waters with low levels of suspended material, up to 100 percent of those metals are either present in a dissolved form, or as in fine colloids, which are highly available, both of those forms are available to the organisms. So in those kinds of situations, you would see 100 percent or close to 100 percent bioavailability.

In other situations where you have high levels of metals that are associated with suspended solids, as well, the percent bioavailability would be much lower. And I can't give you a specific answer for that, for what that might be.
Q Could you estimate the range of the lower end?
A It would -- the range is from, at the lower end probably -- you know, I don't think that I could.
Q For the purposes of your report, did you assume that salmon were swimming and eating in the top 15 metres of water in the ocean?
A My report was focused on freshwater habitats in the Fraser River, so I didn't look at ocean habitats at all.
Q Okay. Would you agree with the following definition for "bioaccumulation": The key elements of bioaccumulation are that a fat soluble or lyophilise chemical is ingested by a species at the bottom of the chain, the food chain. Many of the bottom trophic level specimens are eaten by another animal at the middle trophic level, and then a predator eats a number of the middle trophic level and the lyophilise substance is magnified through consumption. Do you agree with that definition of bioaccumulation?
A I would use it -- the definition that you gave is

one of biomagnification, rather than bioaccumulation, and biomagnification is a type of bioaccumulation as well. But bioaccumulation is just simply the process whereby contaminants in the environment find their way into organisms and accumulate in their bodies.

Q Would you agree that sockeye salmon are in the middle of the food chain, and specifically when they're smolts?

A In the middle of the food chain. I think what you're asking is, or what you're trying to get at is are they at the highest trophic level, are they top level consumers? And the answer is no, they're not. They're typically planktonic feeders, and so they're somewhere below the top level of the food chain.

The term "middle of the food chain" is not a very specific term. There are ways of identifying where various organisms are within a food web, and I guess one could use the term "middle" if you choose to.

Q Because the smolts are in the middle of the food chain, or are planktonic feeders, bioaccumulation is not really an issue for sockeye salmon the same way that it would be for killer whales or harbour seals?

A Those animals at the top of the food web are the ones that are going to accumulate the highest concentration of those bioaccumulative substances, that's absolutely certain. One shouldn't say that because they don't accumulate contaminants to the same level as seals or killer whales, that bioaccumulation is not an issue for sockeye salmon. I think that would be an incorrect inference. But, yes, you're right, they would not accumulate to the same level.

Q And the fact that sockeye salmon only live for four years would also be a mitigating factor against them being highly affected by bioaccumulation?

A No, that's incorrect.

Q Are you saying --

A Would you like to know why?

Q Sure.

A Well, typically bioaccumulation is evaluated using something called bioaccumulation tests. That's how we do it in the laboratory. And for most of

the substances that we look at, things like PCBs, things like DDTs, things like dioxins and furans, these bioaccumulation tests are typically run -- and I'll refer to sediment bioaccumulation tests, because those are the ones that I run most frequently or have run for me most frequently, we run those for 28 days. And with those 28 days, we'll often run something called a 56-day time to equilibrium test, as well. And that's to determine how close to equilibrium we've come within that 28-day exposure period. And what we find is for most contaminants we see them coming to a steady state in the tissues of the organisms that we're exposing within about 80 percent of steady state within 28 days. And typically by 42 days, you hit maximum concentrations in those organisms. And so an organism that lives four years, you know, when you put it in perspective of coming to steady state, and largely into steady state, 80 percent of the way to steady state in 28 days, four years is a very long time in comparison.

Q Now, for your report, you would agree that you didn't have access to any sockeye-specific, sockeye salmon-specific, salmonid-specific or fish-specific sediment quality guidelines in the academic literature?

A Could you restate that whole -- I'm sorry, I was expecting that question to go a different way. Could you restate it, please.

Q Would you agree that you did not have available to you any sockeye salmon-specific, salmonid-specific, or fish-specific sediment quality guidelines?

A I don't think I would agree with that statement, and in the interests of time I'll explain quickly why that is. We relied upon the Consensus-Based Sediment Quality Guidelines that our group developed with the U.S. Geological Survey back in 2000, the year 2000, and they were based on the effects on sediment-dwelling organisms.

But we have also evaluated how effectively those sediment quality guidelines predict adverse effects on fish, as well, exposed to sediments. And what we -- what we find is that they do a very good job of predicting effects on fish. And the fish that we used here were not sockeye salmon.

We used fathead minnows in that evaluation. But they were good predictors of toxicity. And so although they were not developed specifically using data on sockeye salmon or fish, we find that they work very effectively for predicting effects on fish, as well.

Q Okay. So then you would disagree with the statement in paragraph 1 of page 61 that says:

> Sockeye salmon-specific, salmonid-specific, or fish-specific sediment quality guidelines were not located in the literature to support the detailed evaluation of sediment chemistry data for the Fraser River Basin.

A No, I'm not disagreeing with that statement. What I'm saying is that although we didn't have guidelines that were specifically developed using data on toxicity to fish, we have subsequently evaluated those sediment quality guidelines and find that they are predictive of toxicity in fish. So the statement is correct as presented on this page of the report, but I wanted to provide you with that supplemental information so that you would understand that these tools, although we haven't evaluated them with any of the salmonids or sockeye salmon, we've evaluated them with fish species and we find that they are predictive of toxicity.

Q So if we could turn to page 3 of your report, or page iii. In your report you wrote:

> Nevertheless the concentrations of selenium and [2,3,7,8-tetrachlorodibenzodioxin] toxic equivalents, occurred or are likely to have occurred in salmon eggs at concentrations sufficient to adversely affect sockeye salmon reproduction.

I put it to you that you do not have adequate data to support that statement. Do you agree or disagree?

A "Occurred or likely to have occurred", and I think what you're -- where you're getting at here is the deBruyn predictions of 2,3,7,8-TCDD toxic equivalent concentrations in the eggs of fish, using the model that he developed -- I see I'm

getting ahead of myself. I will wait until you get there.

Q You are. So when you're saying 2,3,7,8-tetrachlorodibenzodioxin (sic), you don't actually mean specifically 2,3,7,8-tetrachlorodibenzodioxin (sic), that's correct, right?

A Well, I believe the whole statement is:

> ...2,3,7,8-tetrachlorodibenzo-*p*-dioxin toxic equivalents...

Q So the answer is yes, then, you don't actually just mean that one particular compound.

A Yeah, and so the toxic equivalents, I think we talked about those a little bit yesterday, as well, and what the toxic equivalents allow us to do, because there are up to 209 individual congeners for -- 210 individual congeners for the dioxins and the furans, the chlorinated dioxins and furans, and they have similar modes of toxicity, and because there are a number of PCBs that exist, exhibit the same types of effects as the dixoins, there's 209 of those, PCBs, a subset of those, the coplanar PCBs are the ones that exhibit dioxin-like effects, this tool of toxic equivalents allows us to evaluate the additive toxicity of all of those different compounds together. So it provides a mechanism for looking at the additive toxicity of multiple dioxins, furans and PCBs that have the same or very similar modes of toxicity.

Q Okay. So it's a cocktail as opposed to one particular compound.

A Correct.

Q And that would be because 2,3,7,8-tetrachlorodibenzo-*p*-dioxin has never been commercially available in Canada?

A I'm sorry, I didn't understand your question.

Q The question is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin has never been commercially available in Canada?

A Do you mean available for purchase in Canada?

Q That's right.

A I doubt that that's correct. But I think what you mean in quantities that could be used in industry and then released into the environment, rather than purchased for the purposes of doing studies

on that particular substance; is that what you mean?
Q Okay. Well, what I mean is commercially available as in not available for scientists only for specific experiments, but available to the general public for use in pesticides.
A Yes, I believe that's correct.
Q And specifically 2,3,7,8-tetrachlorodibenzo-*p*-dioxin is the most toxic of all PCDDs?
A Yes, that's correct.
Q Okay. Now, would you agree that it's likely that the 210 congeners that you mentioned have different modes of action in the body and that could affect and create toxicological effects in different manners?
A Do you mean individual congeners act in different ways, or do you mean that as a group dioxins can exhibit a number of different types of effects in the body?
Q Both.
A The latter is certainly true. I don't know if the former is true.
Q Now, when you came to this statement, you looked at the roe data that we talked about in the deBruyn article, and we'll talk about a bit later, and you also looked at spawning and sediment data, so spawning sediment data as well as water quality data, or are you making it solely on the basis of the roe studies?
A This is entirely based on the concentrations that were predicted to be in roe, that's correct.
Q Okay. And you would agree, then, that on page (sic) 4.16 there is no entry for PCDDs. So if we turn to Table 4.16. It wasn't actually measured in the sediment chemistry data for the Fraser Basin, and specifically the PCDDs.
A We have not reported the results --
Q Okay.
A -- of measurements of 2,3,7,8-TCDD in sediments in the Fraser River Basin --
Q Okay.
A -- in this table, that's correct.
Q All right. And you'd also agree that dioxin-type chemicals have been decreasing in the environment since the 1970s?
A Since the 1970s, no, I don't think I would agree with that. Since the 1990s, I would agree with

that, when we put the regulations on operating pulp mills in British Columbia. And I assume you're talking about not just environment in general, but in British Columbia specifically.
Q Specifically.
A Since those regulations have been put in place, the releases of dioxins to the environment have decreased. The extent to which those concentrations have been reduced in sediments, I don't know that offhand. Again, these are highly persistent substances. We would expect that as the mass that is released into the environment decreases, we would also expect over time to see decreases in concentrations in sediments. But I don't know that for a fact. I haven't done that trend assessment.
Q Now, you used the deBruyn, the Kelly and the Siska papers, you evaluated them in your statement that you came to the conclusion on, on page iii, with respect to TCDDs?
A Yes, that's correct.
Q Okay. And the Kelly paper in 2007 found that the PCDD toxic equivalents were at a level within the guidelines?
A That should be Table 5.20; is that correct?
Q The reference that I'm looking at is page 70 of your report, second paragraph.
A Sorry, Table 5.23, for those who are following along. Yes, so once again, the deBruyn, we've adopted a toxicity threshold for TCDD toxic equivalents in salmon eggs that came out of a study conducted by John Giesy and his co-authors, I think it was at Michigan State University at the time, and reported in deBruyn, and that is the level of three picograms per gram lipid in salmon roe. And I think what you're referring to is the data presented in Table 5.23 which show results for Early Stuart collected at various locations, that range from .14 to .49 of pg/g lipid, and data for Weaver Creek stock that range between .29 and .89 pg/g lipid; is that correct?
Q No. Actually, what I'm talking about is the Kelly paper and the reference is on page 70.
A Yes. And the Kelly data are reported in this Table 5.23.
Q Okay.
A It's consistent with the information that you're

pointing to on this particular page.
Q Okay. So then we have one study where the TCDDs were within guidelines; is that correct?
A They were lower than the toxicity thresholds, that's correct. That's not a formal guideline. That's simply a toxicity threshold reported in the literature. Those are different things. A guideline is promulgated by a level of government, and is adopted as such and used in regulations and things like that. This is a toxicity threshold that came out of an individual study.
Q Now, the deBruyn paper didn't actually sample Fraser River sockeye; is that correct?
A They relied upon sockeye salmon that they collected in Alberni Inlet and in the rivers leading up to and beyond Great Central Lake.
Q Which is in Vancouver Island?
A That's correct.
Q And no samples of any fish were from the Fraser River stocks?
A I will double-check that.
Yes, I believe that to be true.
Q Now, deBruyn tried to use mathematical modelling to prove that the TCDD toxic equivalents would be -- could be used. So he would use his samples from the Vancouver Island and try to extrapolate them to other stocks of fish, based on the migration distance?
A That's in part true. More the model is based on mobilization of lipids during migration, and how those lipids then get transferred to gonads of the organisms. And as that's happening, then how the contaminants concentrate, that are already in the organism, but they concentrate in the salmon eggs, and in the -- somewhat in the muscle tissues also of the fish.
Q So basically, to summarize, deBruyn took some samples pre-migration and post-migration and then compared the relative TCDD toxic equivalents and came up with a magnification factor, and then he tried to extrapolate it to other stocks?
A Yeah. The way that he extrapolated it to other stocks was he actually looked at changes in lipid content in those stocks through the migration pattern. So he didn't just simply say, you know, here's my magnification pattern for the stocks on Vancouver Island. They developed a model that

utilized their understanding of what had happened on Vancouver Island, but then relied upon data, actual measured data on lipid levels in actual salmon from three different stocks in the Fraser River.

Q Okay.

A So it wasn't a direct extrapolation in the way that I think you're characterizing it, direct extrapolation of that magnification factor. It's actually using information on the lipid levels in those fish that are doing those migrations. And those were measured in those Fraser River stocks.

Q And the sample sizes were incredibly small; would you agree with that?

A What do you mean by "incredibly small"?

Q Six females on the pre period and two females on the post-migration that were compared, so six and two animals in total.

A Yeah, I believe those were the numbers.

Q And certainly that would not be enough to be statistically significant?

A One would like to have more information, if one was looking for statistical significance. But once again, this study wasn't conducted to demonstrate that levels of TCDD toxic equivalents were elevated in the roe of Fraser River sockeye salmon. What it was done was to illustrate that they could be elevated and that this is something that we need to look at more carefully to determine if this is a problem or not. So you need to keep in mind that the purpose of this was not to demonstrate statistical reliability of the results, or statistical applicability of the results to the Fraser River. That wasn't the purpose. It was to demonstrate that there was a potential problem that needs to be investigated.

Q But certainly it couldn't be formed to create the conclusion, then, that there was a problem with TCDDs.

A I believe the way that I've characterized and used that information in our report is to indicate that the concentrations in roe were at concentrations that either exceeded - how did I put it exactly - either occurred or were likely to occur at concentrations in excess of that toxicity threshold.

And so for me the work that was done by

deBruyn et al is convincing. It was a well-designed study and it provides me with information that I need to be able to say, gee, you know, those predictions look pretty good to me, and this is a potential problem. And if we choose to ignore problems like this that are addressed, at our own peril. We can say it's not statistically significant, and I would agree that it's probably not statistically significant, but what it is, is important, and that's why we focused on it in our report.

Q Now, in deBruyn's results on the Great Central Lake, it showed, if you look at the lipid normalized values in the roe, it was lower than 3 pg/g, and specifically I'm looking to figure 6, and that would be the two bars. We've got the level of 3 picograms, and we've got "Coastal" and "GCL".

A Yes, that's correct.

Q Okay. Now, if we turn to the other paper that you're looking at, the Siska analysis, this is a document that my friends from the First Nations Coalition intend on relying upon. And you'd agree if you look at page 52 and the bottom chart, all of the samples with the exception of Weaver sockeye fall below the three picogram per gram of lipid.

A Yes, that's correct.

Q And the Weaver sockeye, the error bar is such, or the error rate is such that the amount that it's over by three wouldn't actually be statistically significant?

A I don't believe there is any evaluation of statistical significance at all here.

Q Okay.

A All that shows you is what the error bar is.

Q And you'd agree that it falls within the error rate.

A I don't know what you mean by that, I'm sorry.

Q Well, would you agree that when you have an error bar, it means that the value above and below it signifies the error of the measurements that are being taken?

A Yes, I do. And what it also shows is that the mean concentration exceeded the toxicity threshold. So whether there was -- and what it shows is that there's variability in the results.

That's what the error bar is showing, is that there's some concentrations were lower, some concentrations were higher, but on average, the concentrations exceeded the toxicity threshold we're talking about.

Q On page 30 of your report you cite a 1998 study by Sylvestre.

A Sorry, page 30?

Q That's right, in paragraph 2.

A Yes.

Q He measured some effluents downstream of Annacis Island.

A I'm sorry, could you say that again?

Q Sylvestre, have you got that?

A Yes, just sort of I didn't hear the first part of your question.

Q Okay.

A I'm a little hard of hearing, so I sometimes miss things.

Q Oh, I understand. I usually talk very softly, too, so I'm sure I'm not helping.

Would you agree that Sylvestre measured some effluents downstream of Annacis Island?

A Upstream and downstream.

Q Okay.

A Not the effluents, what they measured was contaminants in the Fraser River, upstream and downstream of Annacis Island.

Q And this was in 1998.

A That's correct. Well, the sampling wasn't in 1998, may not have been in 1998. The report was published in 1998. I've forgotten exactly what year they collected that data. I expect it was like a couple of years before that.

Q Okay. And chromium, copper, iron and zinc, and PCB levels exceeded water quality guidelines in Sylvestre's report.

A That's my recollection, yes.

Q But you would agree that based on Table 4.3 of your report at page T-95, the 1998 findings are not consistent with your water table charts?

A Sorry, which table?

Q It's page T-93, and it's Table 4.3. Okay, well, actually 4.3, so it's T-95.

A Okay, And, sorry, your specific comment was what?

Q You would agree that the Sylvestre findings were not consistent with your findings on your water

table...
A Can you be more specific about not consistent in what way do you mean?
Q Okay. And specifically iron, cobalt and chromium were within the guidelines on page 93 of your report. So that would be Table 4.2.
A Yes. So I think the point that you're getting at is that the data that were evaluated in Table 4.3 did not include the results from Sylvestre, and that's true. We did not have the data electronically, and so that's why I described them in the text, rather than trying to incorporate them into the table specifically.
Q And you would agree, though, that the measurements in the table fall within the guidelines.
A For, sorry, for...?
Q Specifically for iron, cobalt and chromium.
A Iron, cobalt and chromium, well, I see a max level here of chromium of 44 picogram per litre. The Canadian water quality guideline for -- there's two Canadian water quality guidelines for chromium, one is for hexavalent chromium, one is for trivalent chromium. The trivalent chromium water quality guideline is 1 -- sorry, is 8, and the hexavalent is 1, and so this concentration would exceed both of those levels. I've forgotten exactly what the water quality guideline is for iron, and I think if we probably look back, we can figure that out. Iron is 21,200, maximum is lower than that, so that's correct. And then cobalt, there was no water quality guideline for cobalt identified here, in our study.
Q Okay. When I'm looking at your chromium total, I have number 4.48 as a median and the "Selected TSV" on page 93 is 43.4. Is that...
A Ah, that is correct. So what we've done there is -- sorry, page -- I was looking at the wrong page, I'm sorry.
Q Okay. So you'd agree, then, with my question?
A Well, I can't agree with you yet, because I have to go to the right page and then look at the results. So you're looking at table...
Q And you should be looking at the errata version, as well, since this one of the pages that you had changed. But I think it was -- the numbers were changed to micro from milligrams.
A Okay. So just let's go back a step. So we're

looking at Table 4.3; is that correct?
Q That's right.
A Okay. So that's surface-water chemistry data, correct?
Q Right.
A And then so what we need to compare that to is the data in Table 4.1, which is the toxicity screening values for surface water, correct?
Q Okay.
A So cobalt, on this page -- let's just make sure we go to that page first, shall we, that's T-90. So from this page what you'll see is a chromium level of 1.0, is that correct, it's also on the screen now.
Q Okay. All right. So you're right at the level. Okay. All right, so we'll move on.
THE COMMISSIONER: How much longer are you going to be, counsel?
MS. CALLAN: I've still got two pages, because he was a lot longer than I thought, but I can maybe speed it up and cut most of it out.
THE COMMISSIONER: Well, why don't we take the break and then we'll see if you can do that. Thank you.

(PROCEEDINGS ADJOURNED FOR MORNING RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: Hearing is now resumed.
MS. CALLAN: And I would like to mark the DeBruyn article as the next exhibit.
THE REGISTRAR: Exhibit number 835.

EXHIBIT 835: DeBruyn et al, Magnification and Toxicity of PCBs, PCDDs, and PCDFs in Upriver-Migrating Pacific Salmon - 2004

CROSS-EXAMINATION BY MS. CALLAN, continuing:

Q You would agree that there have been numerous improvements in waste water treatment since 1998?
A Is there a reason you selected the year 1998?
Q Perhaps because of the 1998 study by Sylvestre.
A In -- you've asked a question about waste water treatment. Can you be a little bit more specific about what you mean?
Q Waste water treatment from municipal waste water plants.

A Thank you. I appreciate that. And now can you tell me what specific changes you're referring to in treatment processes that have improved since 1998?
Q The question is meant to be general. Do you agree or no?
A I'm not aware of any specific changes in waste water treatment, municipal waste water treatment processes since 1998. Can -- if you're able to direct me at something that you're referring to, I would be delighted to look at it, but I don't know specifically what you're referring to.
Q If we could turn to page 63 of your report, you've mentioned that there's an improvement in water quality after 2003; however, you discounted the measured improvements. Can you say why you discount these improvements?
A Yes, I can. What we found when we looked at the data for the Lower Fraser River basin was that -- 1993 was the year, as we understand it, was the year that responsibility for collection and collation of effluent quality data and surface water chemical monitoring around municipal waste water treatment plants devolved to those -- to the GVRD and other regulated authorities within the province.

And what we understood and what we observed when we looked in the EMS database is that after that time, the data that typically would have been collected and collated in that database by ministry officials was no longer in that database after that date for certain locations within the Lower Fraser River basin. And so that's why we, although we observed certain changes in water quality index particularly since 2003 we didn't believe that was real, because we -- there was -- it appeared that there was data missing for some key sites that would have incorporated discharges from waste water treatment plants.

Q Now, yesterday you gave evidence that waste was increasing and specifically waste water because the population increased. I put it to you that that is incorrect based on Maps 9A and 9B of Dr. Johannes' report and that solid and liquid waste volume is not increasing. So this would be Technical Report 12.
A Could you refer me to a page, please?

Q It's Exhibit 735 and it is in the appendix and it's Map 9-A which is page M-21 and M-22. If Mr. Lunn could direct his attention to the table at the bottom of the page.
A I see the results for solid waste. I assume that that's solid waste -- we talked about several things yesterday, one of which was biosolids. I don't believe this is what we're referring to here. I believe this is essentially trash that is headed for landfills; is that correct, what is in this particular graph?
Q That's my understanding.
A Yes.
Q Do you agree based on this chart that solid waste is not increasing?
A What I see based on this chart is over the period we have data it looks like between 1990 and 2006 and it looks like the solid waste as measured in tonnes for six regional districts out of ten within our study -- it's very hard for me to interpret this graph. Let me tell you why. It's -- what it's -- as I look at the title it says, and this is all I have to go on here:

> Six regional districts out of 10 within our study area had available solid waste data which were included in these results. Less populated regional districts do not routinely monitor or have available data time series for solid waste disposal including: Nanaimo, Comox Valley, Powell River, and Sunshine Coast. Data from these regional districts were not included in the results presented.

What this doesn't tell me is what is included. I don't know what this data is. I'm sorry. If you can -- I haven't read this report. This is not one of the ones that I've looked at, not only not in detail, not at all and so if you were able to tell me what the source of this information is and what it represents, I think we could have a discussion about it.
Q Okay. Well, in the interests of time, I'll move to the next page then. And there are a number of charts which outline the liquid waste and it also, in my submission, shows that liquid waste is not increasing. Can you comment on that?

MR. LEADEM: Mr. Commissioner, I'm going to object to this line of questioning. The witness has already said that he has not read the report. We can spend a long time trying to discern what is meant -- what the witness may discern from this report, but at the same time, at the end of the day I'm going to suggest it's a useless exercise to go through, particularly given the fact that he's not read this report in depth and he doesn't understand how the data was derived.

MS. CALLAN: In my submission I have to put these to him, because there's a disagreement between experts and it would be unfair for me not to specifically put them. And if he says he hasn't read it, that's fine with me, but I wanted to be fair to the witness.

THE COMMISSIONER: Well, what I would suggest then, Counsel, in the interest of time, as you've said, I don't know if you're coming to the end of your examination or not.

MS. CALLAN: I am.

THE COMMISSIONER: I was going to suggest that perhaps over the lunch break he could look at this and then right after lunch, he could just address this question once he's had an opportunity at least to look at the report, familiarize himself. And he may still have some queries for you about his ability to answer, but I think that might be a fair way to deal with it.

MS. CALLAN: Okay. So we'll move on from this.

THE COMMISSIONER: I'm not suggesting you have to continue questioning until after the lunch break, just that he would have that opportunity.

MS. CALLAN: I promise I won't.

Q So Harrison River sockeye rear in the backwater areas and sloughs within the Harrison -- within the Lower Fraser River for a period of time before migrating to the Georgia Strait; do you agree with that?

A I have had a discussion with Mark Johannes about this topic explicitly and he mentioned that to me. I don't know that first-hand and I don't specifically know where within the Lower Fraser they're rearing and how those rearing areas overlap with exposure areas within the Lower Fraser. So I'm uncertain about that.

I have never seen a map that shows me

specifically where the Harrison sockeye are rearing and for what period of time.

Q Well, that will shorten up my number of questions for you on the subject then.

A Okay. Very good.

Q And onto one of the last two questions, would you agree that the majority of current use pesticides registered for use in B.C. currently tend to have shorter half-lives, are generally not bioaccumulative and are for the most part less toxic than their predecessors?

A No, I wouldn't agree with that. And, you know, one of the things we talked about yesterday, I described that study that we've been working with United States Geological Survey on, looking at small streams within the large urban centres within the United States and specifically identified pesticide -- pyrethroid pesticides, as some of the most important pesticides -- most important compounds in the environment that we're explaining the toxicity that we're seeing in those small streams. So I know that's an assumption is that they are less bioaccumulative, less short-lived, less toxic. What we're finding in actual studies in the field is that those assumptions are not necessarily correct.

Q So then specifically you would be in disagreement with Mr. Verrin in Tab 834 at page 6 where he says:

> The majority of current use pesticides (CUP) registered for use in B.C. tend to have shorter half-lives, are generally non bioaccumulative and are for the most part less toxic than the predecessors.

So this would be page 6 and vi specifically.

A I don't disagree with that entire statement, no. I give you a caveat indicated that what we're finding with current studies is that some of these pesticides that we are assuming are less toxic than some of the legacy pesticides are still very important in the environment. The earlier portion of that quote is something that is that true.

Q Okay. And then my final question is if you could turn to page 53 of your report, in the middle of the page, so right after the bulleted note it

says:

> Although the maximum hazard quotients for cadmium, chromium, and mercury were almost certainly influenced by sample contamination issues...

And then it goes on to say that there were some results that showed exceedances, my question is can you describe why the samples were contaminated and how many of them were contaminated?

A I'll try. I can't attest to how many were contaminated, but in days gone by, mercury-based thermometers were one of the things that get carried around in the same vehicles that were used to carry around sampling equipment and sampling bottles and those thermometers sometimes broke. There was other sources of mercury, as well, and so in some cases we expect, although we cannot confirm, that elevated levels of mercury were due to that kind of contamination. The exact number of samples I can't tell you off the top of my head.

MS. CALLAN: Okay. And those are my questions. Thank you very much.

THE COMMISSIONER: Thank you. Mr. Leadem?

MR. LEADEM: Leadem, initial T., appearing for the Conservation Coalition.

CROSS-EXAMINATION BY MR. LEADEM:

Q I have a number of questions to ask you, Mr. MacDonald, and I just wanted to outline where I'm going to go. I want to go firstly to aspects of your report and focus on what was not said rather than what was said in some instances. Then I want to go with you to the conclusions that you draw from your report. I also will take you to some of the comments that some of the reviewers made, particularly the comments from Dr. Ken Ashley. And then finally, I will end up with going to the recommendations.

And I will -- my clients like your recommendations. I want to disabuse you of the notion that we're going to take issue with the recommendations, but I want to see if we can expand on them in the way that I'm going to work

with you on that.
A I appreciate understanding the direction. Thank you.
Q So what was not in the report, as I understand it, is any mention of synergistic effects between some of the contaminants that you measured; am I correct in that?
A Yes. That's generally correct. We've tried to use a number of tools to evaluate additive effects and the assumption is that we've used throughout this report is where we've used tools where we look at multiple contaminants together, we've assumed additivity, rather than synergistic effects. So that's absolutely correct.
Q And just so the commissioner is aware of synergistic effects, my understanding is that if you have two or more chemicals that function together, the result that they produce is not necessarily additive but may be independently attainable. It may not be independently obtainable. In other words, if you were to add one and one, often we think well, you'll get two. But if you factor in then synergy into that, one and one doesn't always equal two. It may equal 2.5 or it may equal 10 or something to that nature. Do I have that correct?
A Yeah. And it's just to sort of put a finer point on that illustration, is there's an excellent study done by Dr. Rick Schwartz (phonetic), who is with EPA down in -- sorry, down in Oregon, and what he looked at was the toxicity of PAHs, cadmium and mercury in sediments and identified concentrations that would be associated with a 50 percent mortality to the exposed population in each of those cases. And then when he put those contaminants together into the same material and then exposed the same animals, the effects were much higher than what would be predicted based on the results that were observed for any of the contaminants or the two chemicals together. So that's an example of what synergistic effects could look like in the environment.
Q And not just synergistic effects as they apply between two chemicals, but also there might be synergistic effects that are being brought about due to rising water temperatures. You may, for example, see that - and we've heard some evidence

from other scientists who have preceded you to this -- to that particular podium, that water temperatures are on the rise in the Fraser, so you would expect that the chemical effect of some of those contaminants or the effect of some of the contaminants that you've described might be elevated with elevated temperature; is that true?

A Yes. And there's a fair body of information that suggests that was water temperatures increase into the ranges where you stress the exposed organisms, they exhibit higher sensitivity to those contaminants, so that theory is borne out by quite a bit of data in the literature, as well.

Q And actually when you try to factor in the stressors upon the fish itself, upon the sockeye salmon, contaminants are just one level of stressor and if you add that stressor to something else such as temperature or any of the other things that we've been talking about, that may have an additive effect or even a synergistic effect; is that correct?

A That's correct.

Q Now, one of the other things that was not in your report is that geographically, you limit the report to the freshwater environment, to the Fraser estuary and up the Fraser to the headwaters of the Fraser; is that correct?

A That's correct.

Q And so missing entirely from the report are any contaminants from the marine environment; is that fair to say?

A Yes, that's correct.

Q And we know that there are many sources of marine contaminants through the area through which the sockeye migration pathway runs; is that not fair to say?

A Yes, that's correct.

Q There's municipal waste water. You've studied, for example, the Macaulay Point waste water facility outside of Victoria that runs into the Strait of Juan de Fuca, correct?

A That's correct.

Q And that's along the migration pathway, as you understand it to be of some of the sockeye migrating back?

A Yes. Some of the sockeye either going out or coming back in, yes.

Q There's also fish farms can be a source of contamination, correct?
A That's correct.
Q And you've studied that contamination from fish farms in some of the technical reports that you've done; isn't that fair to say?
A I would not characterize my work in exactly that way.
Q Okay.
A Or if I have, I've maybe forgotten that I've done that work.
Q I'm thinking about I came across a reference to Quathiaski Cove. I'm not sure what you were studying at Quathiaski Cove.
A That was a contaminated site that was affected by the presence of an old canning facility there and boatworks.
Q Now, the other thing that maybe not missing but you've referenced point sources, things such as pulp mills, municipal waste water sources and things of that nature. Do you take into account in your analysis the cumulative effect of point sources? So, in other words, if you have two or three pulp mills emptying into the Fraser River, do you take into effect the cumulative effect of each one of those point sources so that they're all adding to the load?
A Only to the extent that the data for, for example, the water chemistry data might have been collected downstream of all three of those and might have provided information on what the contributions of all three would be. That said, I think your point is a good one, is that that kind of information on the kinds of contaminants that are discharged by pulp mills or in some cases by other point sources aren't adequately characterized within the monitoring that we're doing anyway, and so if we don't have the data, we can't very well account for the multiple effects of discharges from three or four or five different pulp mills in the upper reaches of the Fraser, for example.
Q And from the work that you've done with respect to looking at how industries are regulated in terms of the effluent that they discharge into the environment and we're specifically speaking about the aquatic environment here, are you aware of how regulatory agencies approach point sources and

whether they take that cumulative effect into account in issuing permits and licenses to discharge?

A It's difficult for me to explicitly answer that question, but I'll tell you what I think. And I don't believe that cumulative effects are considered in most cases. One -- one exception might be in the Northwest Territories, where I do a lot of regulatory type work, as well, there is starting to be an interest in looking at regional cumulative effects assessment in considering that during the permitting of individual projects.

But that's only in its infancy in that part of the world and I believe that they're a leader in that area within Canada. So I don't believe that that's happening here in British Columbia.

Q Now, a lot of times in your report you talk about data not being available or you went looking but you couldn't find the source for data for some of the contaminants that you described. Why is it that we don't have that data? Is it just lack of resources and monitoring ability?

A Well, I think there's a number of reasons why that's the case. Again, there's -- spatially I've identified a number of challenges in terms of accessibility of the data and so one of the problems is that the data that we needed to do this evaluation really wasn't anticipated when designers of monitoring programs did their work. So they had other purposes for their data. Two, not -- even for the data that is being collected -- so that's number one, is the spatial context.

Two is sort of the range of contaminants that we're talking about and typically the monitoring that is being done is for a very limited suite of contaminants, so it's conventional variables. It's for nutrients. It's for metals. And then once you get beyond that list of three, then the list of variables gets pretty short. And so that's problematic, when you're looking to evaluate the effects of the inventory of 200-plus contaminants that we identified in this study.

And then data are being collected by a variety of different agencies and organizations around British Columbia and around the Fraser River basin. One of the challenges is that right now I don't believe we have a systematic way of

bringing all that information together in one place where it can be accessed to do these kinds of evaluations. So it's a combination of those factors is sort of what leads us to the place where we're at and also, of course, one last thing of course, is that even where very good data have been collected in the past, I'm not convinced that in all cases that data has been translated into a form that can now be used in contemporary assessments.

So, for example, and we may get to this later, there was a lot of very good data generated out of the Fraser River Action Plan. Not all of that is electronically available easily, or at all in case of we've asked for it and didn't get it. And that's problematic.

Where we have historical data, having this temporal context in these evaluations is very important where we're trying to look for factors that are influencing declines over an extended period of time. If all we have available to us is data for the last ten years, it's very difficult then to evaluate what the potential impacts of contaminants are over a protracted period of time where we have healthy populations and the declining populations, if all you have for many, many contaminants is just for the most recent time period. So together these challenges create a situation where we don't have the information that we need to do a comprehensive assessment in the kind that we tried to do in Chapters 4 and 5 of this report.

Q My understanding is is that specifically you limited your data usage to digitized electronic data sets that were available to you and that you eschewed the paper records and the Fraser River Action Plan records, for example, that Canada produced some ten years ago. You basically were told not to use those data sets?

A Nobody told us not to use anything.

Q Okay.

A In -- as structured, our investigation temporally in the time that we had available, we identified what we could do and what we couldn't do effectively and so we relied primarily on data that were electronically available. In some cases, we also used some hard copy data, but that

was a relatively small proportion of the overall information that we used in our assessment. So your statement is generally correct, yes.

Q Okay. I want to now move on from what the report is lacking in and I'm not faulting you for one moment. I mean, you had terms of reference and you could only work with the data that you had available to you and I want to now focus upon some of the conclusions contained in your report. And I want to begin by asking you to turn to pages 71 and 72 of your report where you, under Chapter 5, you have a summary of the evaluation of the potential effects of contaminants of concern on Fraser River sockeye salmon.

And I'm going to begin by looking at page 71, about oh, I think six or seven lines down from the top, I find this sentence:

> The results of this assessment indicate that exposure to contaminated surface water and sediment or accumulation of contaminants in fish tissues pose potential hazards to sockeye salmon utilizing spawning, rearing, or migration habitats within the Fraser River Basin.

And then you go on from there and you say:

> More specifically, these results indicate numerous contaminants of concern occur in one or more habitats at concentrations sufficient to adversely affect the survival, growth, or reproduction of Fraser River sockeye salmon.

And then you itemize them:

> TSS --

Which I think is total suspendable solids?

A Yes, total suspended solids, that's correct.

Q

> -- six metals --

And then you talk about them,

> -- (aluminum, chromium, copper, iron, mercury

and silver), and phenols.

So that was one of the -- that was the -- I draw that -- or I found that and I thought well, that's one conclusion that you draw from your report, that there are some contaminants which are of concern, specifically to Fraser River sockeye salmon; is that fair to say, based upon those two sentences I just read to you?

A Could you say that again? I just -- I didn't quite hear you over the siren.

Q You have the same hearing disability I had.

A There's a certain range that --

Q I only hear out of one ear and so --

A -- is very difficult.

Q -- when there's ambient noise, I sometimes don't always hear the question or the answer.

All right. So I read to you two sentences specifically from your report and the question was obviously the focus of this inquiry is Fraser River sockeye. And so I take it from those two sentences that there are contaminants and you've itemized them there, that are of concern specifically to Fraser River sockeye that we should take note of that we should say that that's important to recognize that those contaminants can affect Fraser River sockeye at some stage in their lifecycle.

A Yes, that's correct.

Q Then you go on at the bottom of page 71 to say:

> Exposure to contaminated sediments also has the potential to adversely affect sockeye salmon in the Fraser River basin.

So you're saying that not only are there problems with some of the surface water and the contaminants that are found in the water itself, but also the contaminate sediments pose a potential hazard to Fraser River sockeye.

A Yes, that's correct.

Q Right. At the end of the day though you say that this is a contributing factor to the overall decline in sockeye that we've been hearing evidence of but it's not necessarily the primary factor; do I have that right?

A Yes, that's correct.

Q And then the last paragraph, if I look now at page 72 and this is the same -- I'm going to show you the same sentence that counsel for the province took you to, as well, but in your executive summary, you say:

> Accumulation of contaminants in fish tissues...

So now you're specifically focusing upon what you will find if you dissect the fish out and actually do a sample analysis of what's contained in the fish tissue itself. So you say:

> Accumulation of contaminants in fish tissues represents a potentially important factor influencing the status of sockeye salmon populations in the Fraser River Basin.

And you go on to say:

> The results of this evaluation showed that selenium and 2,3,7,8-TCDD toxic equivalents --

I'm going to stress that "toxic equivalents" because I'm going to come back to that.

> -- occurred in salmon eggs at concentrations sufficient to adversely affect sockeye salmon reproduction.

So that was also a conclusion that you reached; is that correct?

A That's correct.

Q All right. Well, let's go back in your report to determine what are toxic equivalents, just so we understand that. And if you flip back to page 70 of your report in the paragraph beginning at 2001, the reference to Kelly, you'll see that second or third sentence in that paragraph you say:

> The concentrations of PCBs --

Polychlorinated biphenyls.

> -- PCDDs --

Polychlorinated dibenzo paradyoxins.

-- and --

Polychlorinated dibenzofurans.

-- were measured in each tissue sample collected, with the results expressed as 2,3,7,8-TCDD toxic equivalents.

So when you're using toxic equivalents, you're also referring to PCBs, PCDDs and PCDFs; is that fair to say?

A That's correct. Yes.

Q Now, PCBs, polychlorinated biphenyls, have been with us a long time. They're the substance that are found in electrical transformers; is that right?

A That's correct, among other things, yes.

Q Right. And so they were present in the environment. They're also something that's very persistent, aren't they?

A Yes, they are.

Q In fact, they have a half-life of centuries, I think we talked about those kinds of things having half-lives of centuries, so that they degrade in the environment, but at very, very slow rate; is that right?

A That's correct.

Q So once they're present, they're pretty well present for a very long time?

A Yeah. Yeah. In some of our PCB-contaminated sites, you know, it's 2011 now. Discharges there probably ended around 1977 or so. We're still detecting very highly-elevated levels of PCBs at places like the Hudson River, down in Choccolocco Creek in Alabama, as well. These are places where in some cases remediation is just now starting to get going on -- to remove those PCB concentrations, elevated PCB concentrations.

Q So --

A Because they're not going anywhere by themselves.

Q Right. So even -- even though B.C. has banned PCBs and using PCBs, nonetheless they are of environmental concern because of their persistence and the fact that they were used and they stick around; is that right?

A That's right. They're slowly degraded in the environment.
Q So back now to 72, so basically you draw the conclusion that the fish tissue samples show that selenium, and we haven't talked too much about selenium. Is this a metal?
A Yes, they're a metalloid, depending on how you look at it, yes, that's correct.
Q Is this a naturally occurring substance or is it found in waste water discharges? How does selenium come to be in the water?
A It's -- well, it's a naturally occurring substance and it can -- where we see particular elevations of selenium is in the vicinity of coal mining facilities. That's a very common place to have elevated selenium levels. But other places where you're processing ore or other mining or processing ore, that's another possible source of selenium beyond coal mines, hard-rock mining potentially, as well.
Q All right. So selenium and the 2,3,7,8-TCDD toxic equivalents are occurring at concentrations sufficient to adversely affect sockeye salmon reproduction. And then you go on to say:

> In addition, 2,3,7,8 --

Tetrachlorodibenzodioxin.

> -- toxic equivalents are predicted to reach levels associated with egg mortality in up-river sockeye salmon stocks.

And the prediction there, where does that come from? Does that come from the DeBruyn paper?
A That's correct.
Q And then you say:

> While the magnitude and extent of such effects could not be determined with the available data, bioaccumulation mediated effects could be important contributing factors to the decline of sockeye salmon in the Fraser River Basin over the past two decades.

And then you finish off by saying:

> In particular, the interactive effects of elevated water temperatures, infection by various disease agents, and bioaccumulation of toxic substances warrants further evaluation.

A Yes, that's correct.
Q Those are still your conclusions today?
A Yes.
Q So then if we then look to Chapter 6, page 118 under the heading "6.4 Summary" that's where you summarize your findings with respect to the potential effects of the endocrine disrupting chemicals and contaminants of emerging concern; is that right?
A I'm just catching up to you. Sorry.
Q Page 118, "6.4 Summary".
A Yes, that's correct.
Q And you begin by referring to the fact that:

> We have insufficient data available to evaluate the relationships between exposure and response for any of the endocrine disrupting compounds and contaminants of emerging concern that were identified in the Fraser River Basin.

Would one of the reasons be that -- for insufficient data is because these are relatively new chemicals, so there have yet to be sufficient studies to determine how they are interacting with fish?
A Yes, that's one of the reasons. Yeah.
Q What are some of the other reasons?
A That we may not have targeted -- so some of the endocrine disruptors aren't new to the scene. They've been around for quite a long time, things like the PCBs, for example.
Q Yes.
A And I think we just simply haven't targeted our research in that area to be able to generate the required data, even though we've known that there are potential problems, we haven't targeted our research to determine what the magnitude of those problems are.
Q As a consequence to the insufficient data you say:

> Therefore, it is not possible to conclude that exposure to these contaminants caused the declines in the abundance of Fraser River sockeye salmon over the past two decades or the low returns of Fraser River sockeye salmon in 2009.

So you say you can't conclude that, but you can't rule it out, right?

A That's correct.

Q And you go on at the bottom of the page, you say -- you talk about Harrison River and saying well, if you focus upon the Harrison River, that's one SOC or one conservation unit that seems to be doing relatively well. So if they're -- and I guess by -- the argument goes like this, if they're doing well and they're exposed to the same sort of contaminant array that other fish are -- that the other conservation units are exposed to, then maybe it's not the contamination that is causing the decline. Is that sort of how the argument goes?

A Yeah. That's the logic. But again, we don't know what the exposure is for the complex of sockeye salmon is as a whole within the Fraser or for individual stocks. And so that is -- that's the logic that was used to develop that argument, but that -- if, for example, the Harrison River stocks had differential exposure compared to other stocks, then that would be how -- we may draw a different conclusion as a result of that. And so the lack of exposure information is really a key factor that is preventing us from making conclusive statements about what the potential effects of these EDCs and other contaminants are.

Q At the bottom of page 118 you say:

> Nevertheless, traditional knowledge compiled by the Siska Traditions Society (2009) on physiological indicators reveals that the length, weight, and girth of sockeye salmon have changed over the last couple of decades.

So we don't know if it's contamination that's causing this observation or not, do we?

A That's right, we don't know.

Q But we do know that that observation is a valid

observation, that traditional knowledge and the First Nations observance of the fish that they're eating is a valid observation and something obviously is causing this.

A Yes. It's very important information.

Q But we don't know what it is.

A Correct.

Q Now, over the page at 119, you talk about some of the observations in Siska and then you say in the first full paragraph on that page you say:

> Overall, the results of this evaluation also demonstrate that the contaminant exposures cannot be discounted as a potential contributing factor for responses of Fraser River sockeye salmon over the past two decades and/or for the low returns of sockeye salmon to the river in 2009.

So once again, we relegate this to a possible contributing factor not necessarily the sole cause but we can't rule out how this has affected the sockeye, how the contaminants have affected the sockeye; is that fair to say?

A That's correct, yes.

Q Now, I want to now move to some of the comments that were made by the reviewers to your report and you can find those in your report beginning at pages A-3 and I want to begin with the first reviewer is Dr. Routledge from Simon Fraser University; you're familiar with him, are you?

A Yes, I am.

Q At page A-4 item number 4, under the -- the question was asked of him of Dr. Routledge:

> Are the recommendations provided in this report supportable? Do you have any further recommendations to add?

He says:

> I believe that the recommendations are well supported, and have no further ones to add. The issue of cost will inevitably arise though.

And that's what I want to focus on. And when we

get to the recommendations, I'm going to flesh this out a little bit.

Some of the things that you're recommending are going to be costly. I mean, every time you take a sample, it's going to be costly, right?

A Every time you do something, yes, it costs some money.

Q So Dr. Routledge is concerned about cost. Are you concerned about some of the costs associated with the recommendations that you're making?

A Well, I'm personally not going to be paying. If it was coming out of my pocket, I would be probably even more concerned. Clearly there is a limited number of resources that are available for doing environmental monitoring.

Q Right. And that's simply the point I'm trying to make, as well. And he goes on to say:

> Much as they are all desirable, someone will likely have to identify priority items.

And I find that suggestion eminently sensible, that somebody has to start to identify well, if you only have a limited source of money, where are you going to be spending this money? Do you agree with that, that someone should be there making those kinds of decisions?

A Someone will always be there making those decisions, yes.

Q And it's usually the person that is forking out the money that makes those decisions.

A Typically that's correct.

Q That's not necessarily the best of all possible worlds, is it, though, if the person paying the money is always the person making the decisions of where the money gets spent.

A There are situations where that could work very well and there are other situations where that might not work quite as well.

Q Now, I want to move on to another reviewer. The second reviewer was Dr. Sonja Saksida. Are you familiar with her background at all?

A I am not, no.

Q At page A-8 she has this comment, about the middle of the page. She says:

> The authors focused primarily on contaminants

in the --

Freshwater.

-- phase --

She uses "FW", I take that to mean freshwater phase.

A Yes, that's correct.

Q -- are there any concerns in the marine environments that should be considered?

And your response is:

Yes, the potential effects of exposure to contaminants in the marine environment needs to be considered, particularly in the Strait of Georgia where there are discharges from various municipal wastewater treatment plants and industrial facilities. Such an evaluation was beyond the scope of this investigation, however.

Your response is still valid today, is it?

A Yes.

Q And we talked about that earlier. I won't go through it again.

And then the third reviewer was Dr. Ken Ashley. Are you familiar with Dr. Ken Ashley's background?

A Yes, I am.

Q And he was a fisheries biologist and was an employee of the Ministry of the Environment for many years; was he not?

A That's correct.

Q That's the Provincial Ministry of the Environment. Now, under the first item:

Identify the strengths and weaknesses of this report.

He says:

The weakness of the report --

I'm now reading under the first response, "no

response required". He says:

> The weakness of the report is that it could only report on available data, and many of the potential contaminants in the Fraser river drainage have incomplete data, hence it was not possible to assess the magnitude of their potential effects on various life history stages of sockeye salmon.

And he says:

> For example, no data was available on the volume of effluent discharges from wood preservative, seafood processing and most major mining operations.

Is he correct in that?

A Yes.

Q Skipping now to page A-13 under the heading number 5:

> What information, if any, should be collected in the future to improve our understanding of the subject area?

He says:

> 1. Obtain the information to fill in missing effluent discharge data gaps on industries that were not available for this report --

And he goes through those same three that we just looked at:

> -- wood preservative, seafood processing and most major mining operations, and determine if the type and volume of effluents discharged could contribute to the 20 year decline in stock productivity of Fraser River sockeye;

And you thought that suggestion was a good one; did you not?

A I did.

Q And when we get to the recommendations, we'll see how you've incorporated his suggestion into your

recommendations. Then he talks about a new field of toxicogenomics and gives a couple of slides there. Are you familiar at all with this emerging field? Would you be able to give some evidence to us about toxicogenomics?

A I would not consider this to be one of the areas that I would comment on.

Q All right. But certainly to the extent that this sounds like an interesting area, you thought that it would be worthwhile to pursue in terms of a further -- further studies and further research; is that right?

A Yes. And it's something that with our partners at the Army Corps of Engineers were starting to bring into some of the other studies that we're doing at our contaminated sites in the United States. But it's very much at the preliminary stages right now and so it's hard for me to comment very much on it. It's hard for me to, more specifically, identify how the results of this kind of work compare with the results that we get from more traditional types of toxicity-based studies.

MR. LEADEM: Well, given that answer, I'll have to just file that for hopefully another researcher or someone. I know Dr. Miller is coming to talk to us about genomics and this is an interesting way to approach the whole field of toxicology, Mr. Commissioner, that I may wait and see if I can take it up with her when she comes to testify.

Q So now I want to turn to your recommendations section and that's where I'll spend the rest of my time with you. And I find those if I turn to page 140 of your report. And I've numbered these. I know you've got them in bullets, but I numbered them in -- as 1 through 9 corresponding to the bullets.

So the first one you talk about:

> Effluent monitoring programs for all industrial sectors should be reviewed and evaluated to determine if they provide the necessary and sufficient data to characterize effluents and evaluate effects on aquatic ecosystems.

So why specifically are you saying that? Is there a problem with how monitoring programs are now

being conducted by the industrial sector?
A Well, as we talked about yesterday, fairly briefly, we talked about, and I think we used the mining industry as an example of where we identified the number of variables that were included in their monitoring required under their permits. And when we -- we looked at those requirements and then compared them to the list of contaminants that were likely to be released into the environment from in that case the mining sector, what we found was that the -- what was required in the monitoring program was only a subset of what potentially was -- could be released into the environment.

And so when I say we need to review those kinds of monitoring programs, we need to look carefully to make sure we're monitoring the right things, we're getting the right data on the right variables and the right, you know, frequency and locations to be able to evaluate what the potential effects of those discharges are when they are released into the environment.
Q And the single database, why is that so important?
A It's to provide accessibility to the data. It's so the data can be broadly accessible to anyone who needs to be doing these kinds of evaluations.
Q So not just to scientists but to members of the public who may take an active interest in this.
A It would -- I can't think of a reason why we would not want to make data available to everyone.
Q Your second recommendation is routine monitoring programs and I'm going to suggest to you that one way that we can actually make this happen is to get the various ENGOs, the streamkeepers, and the First Nations who are actually present at the headwaters and who are available to -- you know, whose traditional lands may actually overlap some of these spawning areas, to take control of some of these monitoring programs or to allow them to do the monitoring programs, would you think that to be a good suggestion?
A Well, what's interesting about that suggestion is it's similar very much to what we've been -- we're just developing sort of that capability in the Northwest Territories right now. We just had a traditional knowledge workshop where we brought together representatives of aboriginal

organizations from throughout in that case the Slave River basin and identified what needs to be monitored to evaluate in this case the cumulative effects of things like oil and gas development, tar sands development, sorry, oil sands development, hydropower operation in the Peace, system and other industrial discharges to the Peace-Athabasca system.

And one of the strong recommendations that came out of that workshop was that this type of monitoring should be conducted by the people who are living in that area and who are most likely to be affected by the adverse -- those adverse effects of the discharges into that system. Those are the resources that they're using every day and they're familiar with them every day. They're watching those resources every day. So it's a very reasonable suggestion to indicate that that kind of a model could be used in the Fraser River basin to provide the kind of cost savings.

And I think there's two real advantages: one is there's a cost savings; but more importantly, I think that the quality and timeliness of the data is also likely to be enhanced by being able to have that data collected by the people who are right there observing the resource every day.

Q All right. So you can envisage that this monitoring program will be done by local communities, be they First Nation or otherwise, because they're mostly concerned about their individual streams. You probably are familiar with environmental groups or streamkeepers and people who walk along the streams looking to observe whether debris is being deposited and things of that nature. And so this is just simply adding an overlay to that of having them also take some water samples and send them off to a chemist for analysis.

A That's correct, yes.

Q Then you talk about the monitoring programs, these routine monitoring programs and your next recommendation saying what they should entail, water quality, sediment quality and fish tissue quality, are these things difficult to obtain as samples?

A No, they're not. And by that I mean that people can be trained to do these -- this kind of

sampling correctly in a relatively short period of time.

Q All right. Your fourth bullet also embellishes the monitoring programs that you've just been discussing or we've just been discussing and you single out that there's some contaminants of concern in each area of interest and you identify those in Table 8.1 and then you say:

> Near-term priorities should include --

Total suspended solids.

> -- and streambed substrate quality monitoring in incubation habitats, nutrient monitoring in rearing habitats, dissolved metal monitoring in all habitats...

And then selenium, polychlorinated biphenyls and PCDDs and PCDFs in all habitats. And then monitoring in fish tissues.

So when you say near-term priorities, does that mean in the immediate future? Is that what you're referring to there by near-term?

A Yeah. I think we have an immediate need for that kind of information on what environmental quality conditions are like within these habitats if we're to resolve this question about, you know, what are the factors that are causing or substantially contributing to the decline of Fraser River sockeye? If we're serious about answering that question, I think we need to get the data that are required to answer that question. So, yes, that's what I mean by near-term priorities.

Q And then if I have time for one more, Mr. Commissioner, your fifth item down is:

> Ambient monitoring programs should also include direct measures of effects on sockeye salmon, such as morphology, physiology, en-route mortality, pre-spawn mortality, and egg viability;

These are some of the things that we would expect First Nations to have available through their traditional knowledge base; is that fair to say?

A Yeah. It's -- for this bullet it's a combination

of traditional knowledge and contemporary Western science, bringing those together. It's hard to evaluate, for example, en-route mortality unless you have information on what you start with and what you end with. And so you need to have sort of that kind of monitoring integrated over the basin. But these other kinds of things related to morphology and physiology that can be determined in much the same way as has been done in some of the data that we've been able to use from the Siska Tradition Society. Those are the kinds of things that could be done by people in the field in the area where the fish are actually spawning.

MR. LEADEM: All right. Mr. Commissioner, I'm ahead of schedule and I expect that I'll be less than the time that I've allotted.

THE COMMISSIONER: Thank you very much.

THE REGISTRAR: We will now adjourn until 2:00 p.m.

(PROCEEDINGS ADJOURNED FOR NOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: Hearing is now resumed.

MS. CALLAN: And 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. Further to the Commissioner's leave to grant a couple extra questions on Project 12, I'm back for Round 2.

CROSS-EXAMINATION BY MS. CALLAN, continuing:

Q Mr. MacDonald, if you could turn to Map 9-A which is at M21 of Project 12 which is Exhibit 735, I believe.

A Yes.

Q Over the lunch hour you had a chance to review this map?

A Yes, I did.

Q Okay. Are you in a position now to agree with Dr. Johannes' conclusions based on what he's wrote on this map and the chart at the bottom of the page?

A Could you explicitly state what you believe his conclusions are, please?

Q Okay. My understanding of this is that total solid waste for the six of the ten regional districts has been remaining constant over the

last ten years; would you agree with that statement?
A Generally I would agree with that statement. Yes, it looks like 1990 was a little bit higher. I'm assuming that implementation of recycling programs is what has caused the reduction between 1990 and 2001 and then we have relatively consistent reported levels of -- I need to -- this is really hard on eyes at my age to be able to read this. But the units are total solid waste in tonnes per kilometre squared. So -- so that doesn't mean the total amount of solid waste is the same or consistent over that period. It just means on a density basis.

So if, for example, there was increases in the -- increases in the amount of developed area within the Lower Mainland or within these regional districts, we could have seen increases, net increases in the amount of solid waste that was being dealt with by each of the regional districts. But the units that he's used here is normalized to kilometre squared. And that's what is reported and assumed to be consistent over the last ten years.
Q Thank you. Now, if you could turn to Map 9-B.
A Yes.
Q Okay. And this is a measure of liquid waste from waste water treatment plants in the Lower Fraser River.
A That's not exactly correct, but yes, go on.
Q Okay. Can you provide me with your interpretation of what is being measured here?
A Well, inclusive of the plants that are in the Lower Fraser River we also have the Lion's Gate plant, which is outside the Lower Fraser River but within the Strait of Georgia.
Q And my interpretation of this data is that solid -- or, sorry, liquid waste is remaining relatively constant; would you be in a position to agree with that statement?
A So do you mean the volume of liquid waste?
Q Yes.
A Yes. So there's four graphs here that are shown explicitly. One is the average daily waste water flow in million litres per day and that would be the indicator of total volume. And then there's several other indicators, as well, that are

identified in these three other graphs that are shown and, yes, I would agree that the volume of waste water appears to be consistent throughout the time period of 1997 through 2009 in this case.

One thing I'd like to sort of highlight though is that although the volume may be consistent over this period, one thing to remember is that the number of people that live within the Lower Mainland, I think in Dr. Johannes' report he identifies increase over the last 20 years of roughly 150 percent in terms of population density within this area. People generally produce the same amount of -- I doubt that the amount of waste that people have created has been reduced over that period. People are people and if we had a -- for example a poop quotient as an indicator of what goes into the municipal waste water treatment plants, I think we'd find that on a per capita basis we would not have seen -- we wouldn't have seen any differences on a per capita basis, but because the number of people in the Lower Mainland has increased by 150 percent, the total mass of contaminants that went into those sewage treatment plants likely increased, probably by about the same percentage.

And that's particularly important for things like the water-soluble contaminants we talked about some of them yesterday, that didn't get associated with the particulate matter and would have been discharged. Now ten years later at higher concentrations, probably over the last 20 years, concentrations that have increased by 150 percent if it's a linear relationship.

So it's important not to draw the conclusion that just because volume has remained consistent that the concentrations have remained consistent in the waste water treatment or the total mass of contaminants that have been discharged is consistent.

Q But you have not measured that.

A That's correct, I have not.

Q Okay. So you're not in a position to say if that's likely or not. It's just a possibility or a hypothesis?

A No. I think it's likely. It's -- in fact, it's highly unlikely that the concentrations would have decreased as a result of -- we know that the

population has increased. We know that for a fact. And we know that the effluent volume has remained the same, so the mass must -- to the sewage treatment plants must have increased and therefore, if the volume is the same that's been discharged, then the concentrations must have been higher than they were previously.

Q Or the alternate hypothesis would be that the waste water treatment plants are more efficient at removing contaminants than they were previously and that the technology is improving?

A Well, there's contaminants. They don't disappear. So either they go out in the liquid effluent or they go out in the biosolids. If they go out in the liquid effluent, they go directly to the aquatic ecosystem. If they go out in the biosolids and they're -- and the biosolids are used in treatment -- in applications in uplands for agricultural purposes or for other purposes, then those contaminants are then available still for being washed into aquatic systems. So it's not like they've -- those contaminants have disappeared. They've just been treated potentially differently.

Q Or they could have been treated by oxidation or reduction or by another chemical process to make them into an inert compound?

A Well, things like metals, that doesn't work. Sewage treatment plants don't change metals. For example, they don't change dioxins and furans. They don't change PCBs. Those things are -- those kinds of contaminants are inert, relatively inert. Metals, particularly, don't change. They can change their form, but they don't go away and certain things like the persistent bioaccumulatives, sewage treatment has very little impact on those. So it's highly unlikely. There's certain things that may have been degraded, but it's highly unlikely that many of the things we're talking about would have undergone that.

Q But again, you haven't done actual research into the subject so you can't actually speak with certainty on that?

A No, not for these particular discharges. Once again, I talked yesterday about the work that we'd done for the U.S. Fish and Wildlife Service to

evaluate biosolids that were being released into the National Wildlife Refuge system and in those -- as we looked at the data for those biosolids, we saw relatively high concentrations of many of the contaminants that we're talking about here. And so like you say, I didn't look at this for the Lower Mainland sewage treatment facilities, but this type of technology is relatively consistent across North America and so I would not expect to see large differences.

MS. CALLAN: Those are my questions. Thank you.

MR. LEADEM: Leadem, initial T., appearing for the Conservation Coalition.

CROSS-EXAMINATION BY MR. LEADEM, continuing:

Q We have been examining the recommendations contained in your report, Mr. MacDonald, and I am about to draw your attention to page 141 of your report. The bullet at the top of the page which is your recommendation number 6 deals with a suggestion that there be coordination among government agencies to ensure that the requisite data are being collected. Let me make it -- my first question is is the requisite data, so where we see requisite data there, is that the data that is missing right now and you're saying ought to be collected?

A Yes, that's correct.

Q So in other words, all the time -- all the times that we saw in your report "not available" or where you have indicated in the confines of your report it would be nice to have this data, it would be important to have this data, that's the kind of data that you say should be collected and stored; is that right?

A That's right. And the kind of -- the preceding recommendations that we talked about before lunch outlined in a relatively specific way what kinds of data we're talking about. Yes, that's correct.

Q Would that also include data relative to spills, oil spills and contaminated spills and things of that nature?

A Yes, it would.

Q I noted that at page 28 of your report, if we could just go back there momentarily, you deal with spills under 3.1.1.10, at the bottom of the

page 28 you say:

> Accidental spills can also result in releases of contaminants to the Fraser River and/or its tributaries.

And then you say:

> According to records maintained by the Canadian Coast Guard and the B.C. Ministry of the Environment, spills of raw sewage, partly treated sewage, gasoline, oil, diesel, other fuels and other substances are common within the study area.

So the fact that you've got two databases, records maintained by the Canadian Coast Guard and the B.C. Ministry of the Environment, are you saying that they ought to be amalgamated so someone keeps track of all of these spills?

A Yes. And it would be very nice if that data were available electronically. My recollection is that most of the data that we got on spills were provided on hard copy on a spill-by-spill basis, so you can imagine a thick number of pages that provided information on individual spills, that would be very nice if that was compiled in an electronic database.

Q Instead of page-by-page where you have to sift through and take the number and then transfer it into an electronic format.

A Yeah, and then try to figure out where exactly that spill occurred within the basin and how that spill relates, the location of that spill relates to other spills that may have occurred or other releases that have occurred with in the basin.

Q So when you say that they're common, are you able to tell the commissioner -- quantify that in any way?

A Oh, we specifically looked at -- looked for data on spills for the year 2007 and particularly during the time when smolts were out-migrating through the system, so I think we looked very carefully at data for about three months in that Spring and it seemed to me that we had, oh, something in the order of 40 or 50 spills that had been reported in that time and that's intended to

be order of magnitude, rather than a specific number. It was a relatively large number for a short period of time. I was surprised by the number of spills that have been reported in that period of time.

Q You were surprised by the magnitude of them?

A By the number of them, yes.

Q And you go on to say, talking about spills there, you say:

> However, the information needed to specifically characterize the substances or volumes released is only infrequently available.

So that also would be something that you would like to see happen in terms of a record?

A That's correct, yes. Frequently that information on spills indicated that the spill was an oil-like substance or an oily substance, for example, and didn't really provide an indication if it was a specific type of diesel oil or some kind of a used motor oil or something like that. So having a clear idea of exactly what was released and what contaminants could be associated with the material that was spilled is frequently difficult to determine.

Q Mm-hmm.

A In other cases, you know, jet fuel B, for example, on the specific amount of litres would be reported, but it was a, you know, variable in terms of how that reporting had been done.

Q And it was during the course of your reviewing those spills that you came to the conclusion that there wasn't that large spill of a substance that would be responsible for wiping out the entire run.

A That's correct.

Q I suppose - and you may not be able to answer this, but I'm going to ask you anyhow. It's one thing knowing about these spills and knowing when they occur. It's another thing to know what, if anything, is done about the spills. Is that within your area of expertise about what gets done about spills and how that's handled, how it's reported?

A Most of my work on spills is done in the United

States.
Q All right. So you don't have any expertise in what occurs to spills once it happens in Canada or in the Fraser Basin?
A Not really. Most of my work is large oil spills and so what's being done on smaller spills of the kind that are reported sort of at the frequency we talked about is not something that I have intimate knowledge of.
Q You wouldn't be able to comment to, for example, to answer me this, that in your opinion is the Province of British Columbia and is Canada prepared for a large oil spill if one were to occur in the Fraser Basin?
A It's hard for me to comment on that level of preparedness.
Q Going back now to the recommendations, I just want to finish that Item 6. You're not the first scientist to -- has told us that you would like a single database or compatible multiple databases. What is the significance of having just one-stop shopping for a scientist?
A Well, it ensures access to information and if it's one-stop shopping, it's access to the most comprehensive data set that's available. And that's, for a scientist, that's very important. It allows you to understand what is known and also what is not known, what we have data for and what we don't. And so that can be very, very helpful in terms of determining whether or not we have the information that needed to answer a question and then also being able to determine what information needs to be collected to answer certain questions that may get posed.
Q Your next recommendation deals with research programs and you have something that you introduce there that's novel, so -- to some of the recommendations. You call for some international collaboration on research programs dealing with these contaminants of emerging concern and the endocrine disrupting compounds. What led you to make that suggestion that these should be studied on an international level?
A Well, these compounds have been identified as emerging contaminants not just here in Canada but in Europe, in the United States, and elsewhere. And we're all dealing -- everyone who's looking

into the potential effects of these contaminants are all dealing with the same limitations on the available information on the toxicity of these contaminants and on the levels in the environment. And so individual jurisdictions will certainly need to be responsible for understanding levels within their jurisdiction in the environment, but it would seem to me that it would be very efficient if governments worldwide or certainly development -- developed governments are able to work together to generate more comprehensive information about what the effects of these kinds of contaminants are. It provides for certain cost savings and it allows us to access that information in a more -- more efficiently from a temporal perspective, or have it available to us sooner.

Q As a toxicologist, you attend conferences from time to time where these substances and emerging contaminants are discussed?

A Yes.

Q And at those kinds of conferences, scientists share information and exchange studies and that furthers the nature of science; does it not?

A That's correct.

Q Your recommendation number 8 deals with more studies to deal with the interactive effects of contaminants. This is some of the discussion that we had earlier, the synergistic effects; is that right?

A That's correct.

Q And not only can contaminants interact with one another, but disease can also play a role so that, for example, if a fish has been stressed by disease and encounters a contaminant either through the food chain or through the medium of the water, then it could have an additive or synergistic effect upon that animal; is that right?

A Yes. And what's been reported in the literature so far is actually the reverse of that, where the exposure is to the contaminant first, that then seems to have an effect where we see a suppression of the immune system and that predisposes the animal to infection by these pathogens. So, yes, this kind of interactive effect and potentially synergistic effects are certainly possible, for

sure.
Q Right. So that -- I think I get your point is that the contamination may actually work to allow the disease to spread more quickly or for the animal to encounter the disease; is that what you're saying?
A That's exactly what I'm saying.
Q Okay. Now, you also in that recommendation number 8, talk about tests to detect sublethal effects. What do you mean by sublethal effects and what kinds of tests are you contemplating there?
A So there's a variety of effects that don't result in mortality of the organism, so those are the kinds of effects that I'm referring to and they're sublethal effects and they could include such things as changes in growth, changes in reproduction, changes in things like immunocompetence, the ability of the animals to fight off disease, organisms, those kinds of things are what I mean by sublethal effects.
Q We've heard some evidence that there's something called mortality on the spawning grounds and I can't remember the exact word that we've been using for that. There's en-route mortality and then there's mortality so that the fish actually dies before it spawns, so it may arrive at the spawning grounds but it doesn't get to spawn. Is it your opinion that there could be some contamination that works or some disease that is at work that prevents that fish from being able to spawn?
A Yes. The term I think we've been using is pre-spawning mortality.
Q That's correct. That's it.
A And I think there's a fair bit of evidence to show that disease agents can be a factor in pre-spawning mortality. I don't know what we have available right now to demonstrate the contaminants contributes to that, but that's one of the areas of research that I think would be fruitful as we move forward.
Q And then finally under your recommendation number 8, you draw a reference to that toxicogenomic approaches that we discussed earlier and you see these as an emerging field that might help us understand the role of contaminants and how it's affecting the fish.

A Yes, I'm very interested to see how it relates to sort of our more traditional approaches to toxicity testing and how it may allow us to predict effects more efficiently than what we're doing right now with the tools that we've got available.
Q And your final recommendation, number 9, deals with fish processing plants and this emanated from a suggestion that Dr. Ken Ashley made to you, I understand; is that right?
A That's correct.
Q And so the thinking here is that there should be a screening survey upstream and downstream of these fish processing plants to determine the presence of disease organisms. And you would agree that that's something that would be valuable?
A I think it's a great idea, yes.
MR. LEADEM: Thank you. Those are my questions.
A Thank you.
MS. BROWN: Thank you, Mr. Commissioner. For the record, Anja Brown and with me is Kennedy Bear Robe, law student.

CROSS-EXAMINATION BY MS. BROWN:

Q Mr. MacDonald, we are here for the First Nations Coalition and the First Nations Coalition is made up of a number of groups, including First Nations located along the Fraser River, First Nations fishing organizations with interests along the Fraser River, also the Council of Haida Nation and the Douglas Treaty First Nations. And my questions today will really be focused around the Siska Report that you reference a number of times in your report.
And according to your bibliography, it was a report that was prepared in 2009 by the Siska Tradition Society and it's entitled "Siska Salmon and Indigenous Peoples' Life Work - Effects of Environmental Contaminants in Up-River Migration, Toxicity and Exposure Levels Assessment Report". Mr. MacDonald, did you have any involvement in the preparation or review of this particular report?
A I did not.
Q And how did it come to your attention in the work that you were doing to prepare your report?
A I believe it was mentioned to me, its availability

was mentioned to me by someone.
Q If we could turn up the acknowledgements page which is Roman numeral number xxiv. I'm actually referring to Mr. MacDonald's report.
MR. LUNN: Oh, thank you.
MS. BROWN:
Q Thank you. And at the bottom of the page there you make reference to Terry Raymond and Chief Fred Sampson of the Siska First Nation and Mr. Raymond of the Siska Tradition Society and acknowledge them, and you also acknowledge Nancy MacPherson from UBC and you indicate there in that sentence in terms of the acknowledgement that reports, data and information on contaminant concentrations in sockeye salmon and the health of the sockeye salmon were provided by these individuals. So can you advise how Nancy MacPherson assisted you in the preparation of your report?
A I think as I recollect she helped us to identify -- I don't think I can answer this question fully accurately. I had one of my staff pursue the acquisition of the underlying data and I've forgotten exactly the process that we went through and exactly how we contacted people and in what order --
Q All right.
A -- to obtain this information. I'm sorry, I can't remember that, but it's -- it was a little while ago and I just simply can't remember.
Q Do you know if Nancy MacPherson is a scientist at UBC?
A I don't know her qualifications specifically.
Q All right. And would your response be the same if I asked you about Terry Raymond or Chief Fred Sampson?
A I don't know specifically the background, no.
Q All right. Now, if we could turn to page 70 of Mr. MacDonald's report, please, and this is part of your Chapter 5 which is the evaluation of contaminants of concern. And you make reference there to the tissue sampling work that was done by the Siska Tradition Society and specifically there samples that were taken from eggs and muscle from Weaver Creak and Adams River sockeye salmon and you note there that those tissue samples were analyzed to determine concentration of certain metals and pesticides and then incorporated into

your Tables 5.21 and .22. And so this data, you go on to say, indicates, as did the data that you obtained from other studies that you referred to that sockeye accumulate a number of persistent contaminants.

Do you agree that the data that was collected and reported by Siska and which you refer to in your report and as reproduced in the tables, is that data that you consider to be reliable and scientifically sound?

A Yes.

Q And I suspect flowing from that is because you considered to be scientifically sound, it's one of the reasons why you felt that you could rely on it, some of the conclusions that you drew in your report; is that correct?

A Yes, that's correct.

Q Now, I'd like to take you now to the source of the data, which is the Siska Report, so if Mr. Lunn could please turn up our document. Do you recognize, first of all, this as the Siska Report that's referenced in your report?

A Yes. And just to be clear, what we utilized was information in this report, plus we requested additional information from the Siska sources, as well, which provided us with a specific -- the more specific data that we incorporated into the tables 5.21 and 5.22 that you referred to earlier.

Q Right. And that was actually going to be one of my questions, because in reviewing the Siska Report, there's a narrative with some graphs, but we don't really see the raw data that you incorporated into those tables. So my question was how you accessed that raw data.

A Yes, we requested that directly.

Q And do you recall who it was requested from?

A I'm sorry.

Q Conceivably one of the authors of the report.

A I believe we actually went...

Q If I can assist, the second page of the report indicates there who the report was funded by and that identifies some of the collaborators, so it identifies members of the Siska Indian Band which is actually located near Lytton and this Indian Band is part of the Nle'kepmx First Nation. So the project included a number of different participants, including the Siska Indian Band, the

Nicola Watershed Stewardship and Fishing Authority who we've heard about in some of the earlier hearings, as well as people from DFO and scientists from the University of British Columbia. And about mid-page there we have the research team identified which includes Chief Sampson, Terry Raymond and Nancy MacPherson, who we know from your acknowledgements is somebody associated with UBC.

When you look at the names of the research team, Mr. MacDonald, is there anyone there that you can identify as a scientist?

A By the term "scientist", I assume you mean --

Q A Western --

A -- contemporary Western scientist?

Q Thank you for clarifying that, yes. I do mean a Western-trained scientist and the reason I bring you there is simply to see if that assists you at all in answering the question as to who you might have obtained the raw data from.

A Right. And I don't know specifically the backgrounds of any one of these people on the research team.

Q All right. If we could have page 35 of the Siska Report, please? I'm just going to use the English words but for the benefit of everyone there's actually a glossary at page 62 that sets out the translation for the various words that we see herein the First Nations language. So the heading here is "Salmon Poisons" and there's reference made there to the Late Summer Adams River sockeye and Weaver Creek sockeye runs and the work that was done there measuring contaminants at three points in the upriver migration, so at the mouth of the river, mid-river and then at the spawning grounds. And there's a photograph there of a tool that's used called a fish wheel to monitor the salmon returns.

And then, if we could just go to page 50, also of the Siska Report, this -- these are two graphs which, if I'm reading them correctly, depict the results of the work that was done in terms of the tissue samples obtained from the Weaver Creek and the Adams sockeye muscles and roe, and my question is whether this work that's described here in brief on pages 35 and 50, if the results of this monitoring work and the resulting

data is what we see in your report, and in specifically the raw data that we see in Tables 5.21 and 5.22?

A Yes. I believe that it's consistent with the data that we've used. Again, we relied upon the data that was applied to us in spreadsheets, rather than interpolating from these graphs and so to the extent to which those spreadsheets agreed with the data that were on these graphs, then they will be the same information.

Q Now, if we could go back to Mr. MacDonald's report at page 118, and while that's being brought up, this is your summary from Chapter 6 which is the endocrine disruptors and contaminants of emerging concern summary, and I'm going to the bottom of the page and Mr. Leadem brought you to this earlier and it again makes reference to the Siska Traditions work and some of the physiological indicators there that reveal changes in length, weight and girth of the salmon, observe changes that had occurred over the last couple of years, also changes to the skin condition, and also feminization of one male sockeye. And what's indicated there in your report on the top of page 119 is that:

> Such changes in salmon physiology are not unlike those that could occur in response to endocrine disrupting compounds and/or other contaminants.

So in other words, does that mean that these compounds or contaminants could be what caused the changes in the salmon physiology?

A Caused or contributed.

Q Right.

A Yes.

Q Now, Mr. Lunn, if we could go back to the Siska Report at page 54, and this is the part of the Siska Report that summarizes endocrine disrupting compounds and the work that was done in that regard, so mid-page it says there that the Siska compared DNA and genetic makeup to the physical appearance of 80 sockeye and they also looked at 80 spring salmon, and they note there about the feminization of one of the fish and they also found several genetic markers that showed stress,

possibly from pollution. Are you able to provide some insight to us on what sort of a genetic marker would indicate stress?
A I don't know specifically what is being referred to here.
Q All right.
A Sorry.
Q And if we go over the page to page 55, this is a series of photos, in the top right-hand photo there's a picture there of somebody taking a sample of a kidney and it says that they're testing the kidney for health and stress caused by contaminants. Are you able to speak to what sorts of analysis would be done to determine that?
A Not specifically.
Q Now, if we could go back to Mr. MacDonald's report, this time to page 137, please? And in the middle of the page, about mid-paragraph, there's a sentence that starts:

> Furthermore --

But it says:

> -- traditional knowledge compiled by the Siska Traditions Society (2009) suggests that sockeye salmon morphology and/or physiology has changed in recent years, potentially in response to contaminant --

Issues. Do you also agree that one of the other factors that could cause change in physiology or sockeye morphology could also be increasing water temperature?
A Yes, I do.
Q So exposure to -- or possible exposure to contaminants is one of the possible factors that could cause that sort of an observation; is that correct?
A That's correct.
MS. BROWN: And now, Mr. Lunn, if I could ask you to once again go back to the Siska, please, and this time to page 31. Thank you.
Q And this page here shows excerpts of observations made by various individuals with respect to changes that have been observed in salmon quality, so an individual named Glen Michell refers to his

belief that the salmon are less healthy because environmental factors and he refers to pollution there and says:

> Who knows what's actually going into these rivers nowadays?

Mid-page there's an observation about a change in water temperature where this individual observes that the water has gotten warmer about five years ago and she observed about four years ago that the fish looked like they were cooked from the warm water. So there's reports here about changes observed in the salmon quality which appear to coincide with observed increases in water temperature.

And if I heard you correctly, but just to confirm, do you agree that there may, indeed, be a cause and effect correlation between those sorts of observations so increase in water temperature changes in quality and appearance of fish?

A Yes.

Q Are you able to comment at all about the Siska study from your point of view as a scientist?

A I was very impressed with what I saw.

Q And what impressed you with it?

A The breadth of the study and the care that was taken to generate the kind of data that were generated and importantly, that the data were generated here that have not been generated by others who have been looking into issues related to the salmon. So this was a relatively unique study and very helpful to us as we were doing our evaluation.

Q So it would be one of those pieces of work that helped fill one of the many gaps that you identified to us earlier?

A Yes, that's correct.

Q And would you agree that one of the strengths of the Siska study is because it represents a collaboration between First Nations traditional knowledge and expertise, particularly in terms of the continuity of the information and observations, some of which would have been gathered over perhaps decades of time, so what we have is a collaboration between the First Nations knowledge and expertise and Western scientific

training and expertise?
A My experience in other areas leads me to believe that that kind of a bringing of traditional knowledge together with contemporary science helps to improve our understanding of environmental issues, effects of anthropogenic activities and potentially how best to deal with those, as well. So that kind of a cooperative approach to looking at these kinds of issues is, in my perspective, very, very helpful.
Q Right. And to use a term that we've been using today but in a slightly different way, would you agree that combining forces in this way really results in a synergistic effect?
A Yes. Yeah, you typically have a better or more complete understanding of the problem and, of course, when you have a complete understanding of the problem, your potential for developing a solution that is going to be effective is that much greater.
Q Right. So you'd agree that more collaborative studies such as this would be of benefit to better understanding Fraser River sockeye salmon?
A Yes, I do.
MS. BROWN: Could the Siska study be entered as the next exhibit, please?
THE REGISTRAR: Exhibit 836.

EXHIBIT 836: Siska Salmon and Indigenous Peoples' Life Work - 2004

MS. BROWN:
Q Now, I'm not going to take you to it, but the Siska Report at the end makes a number of recommendations including that because of their knowledge and expertise they ought to be included in planning and stewardship and management of the salmon resource and I take it based on your earlier evidence that that's something that you would agree with; do you agree with that statement?
A Yeah. I believe that's actually recommendation number 6.
Q Well, yes, indeed. It's one of your recommendations. And interestingly, it's also one of the recommendations that's made in the Siska Report, so you're of one mind on that. If -- I

also heard in your evidence earlier today that one of the strong recommendations that came out of the work that you did with Northwest Territories First Nations was that fish monitoring should be conducted by those living in the area and by those who are most impacted. And then you went on to say that this same approach or model is one that should be applied on the Fraser River and I think you gave reasons of cost savings, timeliness of data and that it makes sense to have it collected by the people that are best placed to do so.

Did I capture your evidence correctly --

A Yes.

Q -- in that regard?

A Yeah. I think that was a good summary. Thank you.

Q All right. And I believe I heard you to state, but just to close off by confirming this, would you agree that First Nations involvement would be an important and useful component of the recommendations that you made at pages 140 to 141 of your report?

A I would go a little further and say that it's essential.

MS. BROWN: Thank you. Those are my questions.

MS. BAKER: Thank you, Mr. Commissioner. I have a couple of re-examination questions and then I think we are complete for the day.

THE COMMISSIONER: I just have a couple.

MS. BAKER: Yes.

THE COMMISSIONER: Do you want me to do those now or wait until you are done, Ms. Baker? I'm sorry. I apologize. I have a couple of questions. I could do them after you're done or do them before?

MS. BAKER: Go ahead.

THE COMMISSIONER: Thank you.

QUESTIONS BY THE COMMISSIONER:

Q I just wanted to take you to pages 140 and 141 of your report, Mr. MacDonald and this is the recommendations section that Mr. Leadem spent some time with you on and I'm just asking these in terms of just for clarification and understanding. Do I understand that on page 139, I'm sorry, I meant to include that, on page 139, just at the top, there's -- in the middle of that -- what's

left of that paragraph, it says:

> However, it is a strong possibility that exposure to the contaminants...

Et cetera. And then you give the bullets below that. Do I read that in the context of your recommendations, in other words, in your recommendations you are setting out a long list of things that should be done, including the gathering of data, the type of data and how that data ought to be inclusive rather than exclusive and those kinds of things.

Do I read that statement in the context of what needs to be done with respect to reaching a conclusion around your study?

A Yes. Yes, that's correct. So to put just a little finer point on that, what I've tried to say here is that there's a very strong possibility that contaminants are a contributing factor. If we are to have the information that we need to be able to determine whether or not contaminants are a contributing factor and to what extent they are a contributing factor, then we need to work through these recommendations that are listed on pages 140 and 141.

Q Okay. And insofar as the players who might be involved, Ms. Brown just discussed with you the First Nations' involvement, but can you just enlighten me as to who the players in your view ought to be?

A Yes. So the federal government will be a player, the provincial government, the First Nations governments and organizations and I use this term regulated interests, and I've used that sort of carefully to be inclusive of affected parties, so those that have a legitimate interest in the resource and its management over the long term should be involved in the process of designing and implementing and interpreting the results of monitoring and research that is -- provides us with a basis for understanding these issues.

And what I didn't explicitly say there is academia, but clearly academia will be one of the key players in the process, as well.

Q From your experience is there someone in your view who ought to take the lead with regard to the

recommendations that you set forward on pages 140 and 141? I realize there are jurisdictional issues here, but in your view, is there some sensible entity that ought -- sensible in the sense that it would be the most effective entity to try and undertake what you're recommending?

A It's hard to give you a clear answer on that. In my mind I think that the federal government could take -- play a leadership role in terms of bringing together the organizations that need to be involved in that process. But it would need to be a very sincere commitment to making a process work for it to work.

Q Meaning?

A Meaning that -- that there needs to be a real interest in getting the data that are required to answer the questions. That needs to be the primary purpose of whatever leader takes on this process. There's a lot of other agendas, of course, that go with salmon management, environmental management. This has to be a very clear agenda for whoever takes this on, this agenda being the most important to them.

Q And I take it from some of your earlier answers that you would include both marine and freshwater data?

A It's clear that the animals start in fresh water, they work -- they spend two years, they spend two years generally in salt water, as well. If we look at one-half of the equation or the other half of the equation, we'll be left with data gaps. So looking at freshwater and marine environment together in integrated studies is going to be the most effective way of getting to the bottom line.

Q At the top of page 141 I think that was the bullet that you, Ms. Brown, were speaking about a moment ago unless I misunderstood. That's -- she talked about collaboration and those kinds of things. I wonder, Mr. Lunn, if you could bring up in the Siska report, which was now marked as 836, I believe, page 31. Can you just tell me if that kind of information that's set out there under "Salmon Quality" is the kind of information obviously not all of the information but the kind of information or an example of the information that ought to be collected along with other kinds of data that would be required to fulfil your

recommendation?
A Yes, that's the kind of information that is very important. And, for example, in the Northwest Territories, part of the information that we use to identify a problem related to we believe discharges from the oil sands was the observations of changes in fish flesh quality that were made by the users within the -- well, within the Slave River but also further upstream, as well, in Lake Athabasca. And without that kind of information it prevents you from understanding enough about what the potential mode of toxicity is to be able to design other studies that help to get more at the cause and effect relationships. So these kinds of observations are, in my view, critically important to be able to include in the basket of information that we use to try to solve this problem.
Q I'm not sure -- I haven't -- my eye didn't find it in your report but it may be covered there, do you include in your realm of data collection not just what's going into the water from facilities, for example, but also traffic on the water, in other words, the degree of traffic that is on the water, the type of traffic on the water, what might be coming from that traffic into the water source?
A Yes. So we've talked a little bit about non-point sources in the report and I think yesterday I referred to things like Bis(2-ethylhexyl) phthalate which is associated with outboard oil particularly. That's one of the things that is associated with a density of use or traffic within the water body. One of the other things I've brought up is tributyltins or organotins, generally as a group which are used as antifouling paint, so the bottom of ships, so those are the kinds of indicators that we can use to get to the sense of the density of traffic in the water, relative to contaminants. There are some other, of course, effects associated with traffic on the water in terms of how that might affect salmon migration or things like that or habitat use specifically, but my comments were primarily directed at contaminants.
Q And is there a table that addresses those contaminants broken out in terms of traffic on the water?

A No, not specifically, no.
Q I heard the term used "dead zone" in connection with marine water. Is that a phenomenon also associated with freshwater?
A Well, some of the sites that I go to, yes, it is.
Q I'm talking about the Fraser.
A In the Fraser, I would not characterize the Fraser in that way, based on the data that we've looked at. Many of the sites that I've gone to are in the United States are so contaminated that we see toxicity within 24 hours of exposing an organism to them. I don't expect to see, although I don't have specific data to demonstrate this, I don't expect to see based on the concentrations of the things that we have been able to look at, that kind of very high level effect that we would see in certain other areas that are much more highly-industrialized than what we see in the Lower Fraser.
Q Okay. I'm sorry, I'm taking a bit more time than I had thought I would. I just wanted to ask you the salmon are migrating out and they're coming back in, and we've had evidence before this commission about the fact that the salmon are passing through many different ecosystems, but in the sense of what you've been addressing in the last couple of days and the questions you've been answering, is there a distinction to be made between fish who spend a lot of time in a given body of water and fish who are simply passing through, in other words, to absorption rates, contamination levels and that kind of thing?
A Yes.
Q And do you make those distinctions in your report?
A Duration of exposure is important and, yes, as you'll see in Chapter 6, we've attempted to evaluate the level of risk posed to certain stocks based on how long they are potentially exposed to conditions in the Lower Fraser or how long they are exposed to conditions in the Upper Fraser where we have discharges from pulp mills. And so we have assigned different levels of risk to those stocks based on the duration of exposure that they may have to those kinds of contaminants.
Having completed the evaluation in that way, it's somewhat unsatisfactory to me because I feel like we have not been able to, on an individual

AOI, area of interest by area of interest basis really been able to evaluate what those exposures are and really evaluate what those risks are, and so we've had to interpolate what those risks are based on what we know about how long it takes certain stocks to migrate through various portions of the ecosystem. So we would have liked to have done it more specifically than we did, but we have taken that factor into account.

Q And finally, I just wanted to ask you - and you did mention this in your evidence, but from an ecosystem management basis, the data that you are recommending here be collected and the monitoring that you're recommending to be done would include far more than data with respect to salmon obviously, but how far beyond that do you go?

A I look at the data that we're -- that is specifically recommended for collection that would help us to answer this question related to be salmon to be very relevant for understanding the status of the Fraser River ecosystem as a whole. And for me, that's very important. The sockeye salmon are clearly in and of themselves are a very, very important receptor but they're also an indicator of potentially what's going on more broadly in the ecosystem. And so having the information available to evaluate what their exposure is and what potential effects are on them also helps us to understand what the status of the ecosystem is as a whole and I think that that's critically important to be able to do a good job of managing the ecosystem.

THE COMMISSIONER: Yes. Thank you for answering my questions. Counsel may have something arising from your answers and if they do, I invite them to let me know. If not, Ms. Baker, I turn it back to you.

MS. BAKER: Everybody's nodding or shaking, I guess, their heads, so I'll proceed with my re-examination. I only have a few short questions.

RE-EXAMINATION BY MS. BAKER:

Q When Mr. East was asking you questions yesterday about how the different guidance levels were developed, he asked you some questions about what species were used in developing those standards

and what kind of tests and experiments were done on different species, and he asked a question which I can actually bring up on the screen. Do you have yesterday's transcript available?

MR. LUNN: Yes, I do.

Q Okay. So if you turn to page 78, at the bottom, line -- there's a discussion that you can see typed out here about the different guideline documents and then at the bottom, page -- or line 45 the question is asked, he says:

> And also, often I think, as I understand it, the aquatic organisms used for the testing aren't necessarily salmonids. These are guidelines that are developed for other types of species. Is that rainbow trout, for example, or fathead minnows?

And then you describe how the guidelines were developed. You remember those questions?

A Yes, I do. And this is always the embarrassing part where you get to see your own words in type again.

Q Well, they look pretty good to me. I don't think you should be embarrassed. But I just wanted to ask is rainbow trout actually a salmonid species?

A It's *Oncorhyncus mykiss* is its actual name and so it's one of the salmon -- within the same genus that the rest of the salmon are, yes.

Q All right. And it's one of the species on which various evaluations have been done in developing the guidelines?

A Yes, that's correct.

Q Then Ms. Callan for the province asked you some questions today about a number of things, but one of the documents she took you to was Verrin, a paper by Verrin and Peter Ross in 2004, you remember that?

A Yes.

Q And then later on in her questions she put a sentence to you and asked if you agreed with it and then she -- it was taken from that document, but she didn't actually take you to the document when she asked the question, and I think the reference on the record might be to page 6, but I'm not sure that's the right page number. I think it should be Roman numeral xi and which is the CAN

number 11 so there's the document on the screen. It's Exhibit 834. You see that?
A I see it, yes.
Q Okay. So if we turn to CAN11, Roman numeral xi, you'll see just above a quarter of the way down the page you'll see the phrase:

> The majority of current use pesticides registered for use in B.C...

You see the marker is hovering on the margin right around that line?
A Yes, I do.
Q Okay. Now, Ms. Callan asked you if current use pesticides registered for use in B.C. tend to have shorter half-lives, are generally non-bioaccumulative and are for the most part less toxic than their predecessors. You remember being asked that?
A Yes, I do.
Q All right. First of all, she didn't ask you if -- she didn't put the qualifier of "the majority of" on that phrase when it went to you in the first, so that's my first point.
A Okay.
Q And you answered that you agreed generally with this phrase but you put some qualifiers on it and I just want to ask you, you would agree that the majority of current use pesticides have shorter half-lives and are generally non-bioaccumulative, I take it?
A So when I was answering that question, what I had in my mind was specifically organophosphate pesticides, which was one of the examples that she had provided previously, and so my answer was really related to the contaminants -- or the in-use pesticides within that class.
Q Okay. Now, this paper was written in 2004 so that's already seven years ago. Has the scientific knowledge changed as to the current use pesticides? Would you agree that they all -- we would all -- science would agree that they all now have shorter half-lives, are generally non-bioaccumulative and are, for the most part, less toxic than their predecessors?
A It would be nice to have a specific list of contaminants that we're talking about before we

draw those broad generalizations.
Q All right. And would you -- do you understand that the toxicity levels of current use pesticides is something that science is now starting to learn more about? You couldn't make such a broad generalization about current use pesticides being less toxic than their predecessors?
A Yeah. And that's exactly why I brought up the example of pyrethroid pesticides, is something which were considered to be lower toxicity than some of their predecessors, but what we're finding is that they're actually explaining much of the toxicity in some of these small urban streams. In fact, they're predicting toxicity better than anything else in these small urban streams among the very broad list of analytes that we're measuring. So, yeah, the last half of that statement I hope I said that I did not agree with.
Q All right. And that would -- we have to be very cautious in looking at that as a statement of the current state of science knowledge.
A It's a broad general statement, yes.
Q And then I don't know if I misheard a number or if you misspoke a number, so I just want to take you to some questions that were asked by Ms. Callan and unfortunately I don't have the reference page number, but you'll remember being asked questions about a statement in your report where water quality improvement since 2003 were -- you discounted the improvements in water quality since 2003; you remember that line of questions?
A Yes. I think what I said was that we were uncertain that those -- those apparent improvements in the water quality index that we observed were real improvements or ones that were artefact of the fact -- of the data that were available, where we believed that a certain portion of the data for some key sites were being housed in other places rather than in the EMS database.
Q Right. And I heard you say that it was in 1993, that was the year when collection and maintenance of that data moved to authorities like municipal authorities, and I don't know if that was what you said or if I heard it wrong or if that's the right date.
A Oh, it's very likely that I said it incorrectly,

but the correct date is 2003.
MS. BAKER: All right. Thank you. That was the only final question I had for you. Thank you.
A Thank you.
MS. BAKER: Mr. Commissioner, I believe we are complete for today.
THE COMMISSIONER: And tomorrow we have...?
MS. BAKER: Tomorrow is... A good question.
THE COMMISSIONER: Mr. Lunn would probably know.
MS. BAKER: Mr. Lunn would probably know better than anybody.
THE COMMISSIONER: If he doesn't, he'll find out and send us an email, I'm sure.
MR. LUNN: Yes.
THE COMMISSIONER: Mr. MacDonald, thank you very much for your attendance at the commission and for your report and for answering the questions of counsel and myself. Thank you very much.
A You're welcome.
THE COMMISSIONER: And we know we're adjourned until 10:00 tomorrow. We're not sure who's going to be here.
MR. LUNN: Fisheries monitoring enforcement, Patrick McGowan and Jennifer --
THE COMMISSIONER: Right. Perfect. Thank you very much.
THE REGISTRAR: Hearing is now adjourned for the day and will resume at ten o'clock tomorrow morning.

(PROCEEDINGS ADJOURNED TO MAY 11, 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.

_____
Pat Neumann

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