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

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

le mercredi 9 mars 2011

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No appearance	B.C. Public Service Alliance of Canada Union of Environment Workers B.C. ("BCPSAC")
David Bursey	Rio Tinto Alcan Inc. ("RTAI")
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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")
Don Rosenbloom	Area D Salmon Gillnet Association; Area B Harvest Committee (Seine) ("GILLFSC")

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Christopher Harvey, Q.C.	West Coast Trollers Area G Association; United Fishermen and Allied Workers' Union ("TWCTUFA")
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No appearance	Maa-nulth Treaty Society; Tsawwassen First Nation; Musqueam First Nation ("MTM")
No appearance	Western Central Coast Salish First Nations: Cowichan Tribes and Chemainus First Nation Hwlitsum First Nation and Penelakut Tribe Te'mexw Treaty Association ("WCCSFN")
Brenda Gaertner Leah Pence	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")

TABLE OF CONTENTS / TABLE DES MATIERES

	PAGE
PANEL NO. 25	
SCOTT HINCH (recalled)	
Cross-exam by Ms. Callan	1/2/3
Cross-exam by Mr. Blair	11/12/13/14/15/16/17
Cross-exam by Mr. Leadem	20
Cross-exam by Mr. Rosenbloom	33/36/40/41/43
Cross-exam by Mr. Harvey	48
Cross-exam by Mr. Eidsvik	59/62/63/73
Cross-exam by Ms. Gaertner	73/77/80
Re-exam by Mr. McGowan	96
EDUARDO MARTINS (recalled)	
Cross-exam by Ms. Callan	1/2
Cross-exam by Mr. Blair	11/12/13/14/15/16
Cross-exam by Mr. Rosenbloom	35/38/41/42
Cross-exam by Mr. Eidsvik	62/63/72
Cross-exam by Ms. Gaertner	75/80

EXHIBITS / PIECES

No.	Description	Page
561	Farrell, Hinch et al, "Pacific Salmon in Hot Water: Applying Aerobic Scope Models and Biotelemetry to Predict the Success of Spawning Migrations"	29

Vancouver, B.C. /Vancouver
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March 9, 2011/le 9 mars 2011

THE REGISTRAR: Order. The hearing is now resumed.

SCOTT HINCH, recalled.

EDUARDO MARTINS, 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.
THE COMMISSIONER: What is your time estimate, Ms. Callan?
MS. CALLAN: It's approximately 30 minutes.
THE COMMISSIONER: Thank you very much.

CROSS-EXAMINATION BY MS. CALLAN:

Q Dr. Hinch, the seven of the last ten summers have been the warmest on record for the Fraser River. Can you identify specifically which years were the warmest?
DR. HINCH: I can't give you all of them off the top of my head. Do you want to help me on the number?
DR. MARTINS: I can't remember off the top of my head, either, but I know 2004 was one of the warmest -- was the warmest we have on record. 2009 was a warm year, as well, but I'm sorry, I can't remember all of the years. I can't say for sure.
Q Now, you've also given evidence that 13 of the last 20 summers have had the warmest water temperatures on record.
DR. MARTINS: Yes.
Q Do you recall which summers those were?
DR. MARTINS: Yes, 2004, 2009, but these are the only ones I can say for sure which we --
DR. HINCH: 1998 was another one.
DR. MARTINS: 1998, yeah.
DR. HINCH: They're all referenced in papers that we've cited.
Q And those years had corresponded with low returns for sockeye salmon?
DR. HINCH: Well, not necessarily low returns. You mean returns to spawning grounds?

Q That's correct.
DR. HINCH: Years with higher temperatures for some of the runs corresponded with low returns to spawning grounds.
Q Okay. And certainly if we refer to your report, which is Exhibit 553, and turn to page 88, 1988 and 2004 do correspond with low returns.
DR. HINCH: Sorry, say that again?
Q 1988 and 2004 do correspond with low run size?
DR. HINCH: 1988?
Q Yes.
DR. MARTINS: This is for Late runs, 2004 is a low return year.
DR. HINCH: No, no, 1998, for the return you'd have to look at the Early Stuart, because the temperatures were critically high early in the summer. So if you go to 1998 for the Early Stuart figure, figure 2.3 you'll see one of the highest *en route* losses ever for that group of fish. So again, you've got to take this is in the stock-specific context, the run-timing context.
Q Okay. Yesterday you used the word "hypothesis". Can you provide to the Commission a definition of how scientists specifically use this word.
DR. HINCH: A hypothesis is a possible explanation for a phenomenon.
Q Okay. And generally at what point in the scientific experiment do you come up with the hypothesis?
DR. HINCH: It depends. You may come up with a hypothesis before, a priority based on theory, or you may make observations, empirical observations and develop a hypothesis from that.
Q And yesterday you used the word "physiological signature". Can you describe to the Commission what you meant by that term.
DR. HINCH: Sure. A physiological signature would reflect a suite of characteristics that we can measure in the individual fish's physiological systems that would be predictive of some behaviour or some element of fate. So it would be a suite of features that we can detect either with plasma, muscle tissue, or other related items.
Q Okay. And yesterday you also used the term "genomic signature".
DR. HINCH: Yes.
Q Can you distinguish how that is different --

DR. HINCH: From physiological?
Q That's correct.
DR. HINCH: A genomic signature is a physiological signature, so it's sort of subsumed within that, so it would be based on genomic data, which is a more specialized suite of information than just standard physiological information.
Q Okay. And can you describe how the term "genomic signature" is different from the word "genome" or "genetic makeup"?
DR. HINCH: The genomic signature is a term that genomic scientists use to reflect the functions of genes. So each gene controls one or several proteins. And so when these genes are either turned on or turned off, they are activating proteins either on or off, and as the suite of genes are activated, they are signalling an entire physiological system which invokes all of those proteins to be active or not active.
Q Okay. So it would be the expression of --
DR. HINCH: It's an expression of.
Q -- the gene.
DR. HINCH: Yes. Yes, thank you.
Q If the Commission could turn to Exhibit 558. I understand that you were the co-author of the *Science* paper "Genomic Signatures Predicted Migration and Spawning Failure in Wild Canadian Salmon"?
DR. HINCH: Yes.
Q Can you describe what your role was as the co-author?
DR. HINCH: I was the lead person dealing with the telemetry systems, the collecting of the telemetry data, supervising graduate students that were involved in that project, and assisting in the write-up of the paper.
Q Okay. Can you clarify how many ocean-tagged fish were used in the analysis?
DR. HINCH: I believe it was 38.
Q Okay. And how many freshwater-tagged fish were used in the statistical analysis?
DR. HINCH: In terms of tagged in the river, it was around 100.
Q Okay. How did these numbers differ from the total number of fish that were tagged?
DR. HINCH: Total number tagged, I'm sorry. You mean as associated with other studies that were

ongoing?
Q Well, for the purposes of this study you tagged a number of fish.
DR. HINCH: Yes.
Q But my questions earlier --
DR. HINCH: Okay.
Q -- were the ones that were included in the statistical analysis only.
DR. HINCH: All right. Yes. That particular year in the ocean there was probably several hundred that were tagged.
Q Okay. So why were fish that were tagged excluded from the statistical analysis?
DR. HINCH: The first reason is that we had to focus on individual stocks. And so when you're tagging these in the ocean, you don't know who you're tagging. So we would have tagged across dozens of stocks of fish. And so we have to wait until the stock ID information comes back at the end of the season to make sure we can focus in on the stock of interest. In that case, I believe it was Adams-Shuswap we were trying to focus in on. That was the first limiting factor.

The next one is that we had to make sure that fish that we used in the analyses at minimum made it into the Fraser River and at least past the region of most intense in-river fishing, so that we could attempt to exclude the potential effects of fishing mortality.

And so when we do all these things, the sample sizes start to shrink.
Q Okay. And you'd agree that the samples that you used were spread across three different stocks only?
DR. HINCH: Well, actually in the ocean just one. The ocean-tagged fish was just the one stock. In the freshwater tagging it was across three stocks.
Q Now, given that there are three different stocks that were utilized, would you have liked to have used a larger sample size?
DR. HINCH: We always like to use larger sample sizes.
Q And for your perspective, what sample size would have been ideal?
DR. HINCH: Oh, we had sufficient power, statistical power to do the analyses we did. Especially given the fact that in terms of a migratory animal, this technique had never ever been used before. So we

felt the sample sizes were adequate, and certainly the results we found were quite powerful, given what the sample size was.

Q Certainly. But they would be on the small size.

DR. HINCH: Yes, they would be. But for a genomic study, again given that each slide to run is like $300/$400, there's also a cost factor that comes in, too.

Q Okay. So as a result of this paper, you'd agree that the genomic signature affects different sockeye stocks differently?

DR. HINCH: Well, we can't tell that from the ocean results because we only looked at one stock in the ocean tagging. In the freshwater tagging there was a stock effect.

Q Okay. So in your paper the Scotch Creek stock correlated with the genomic PC1 positive signature, which is the healthy stock.

DR. HINCH: Mm-hmm.

Q But Lake Shuswap, Adams and Chilko did not?

DR. HINCH: That's correct.

Q Okay. Is there any correlation between the recent Shuswap and Chilko returns this year?

DR. HINCH: This particular year?

Q Yes.

DR. HINCH: I don't know.

Q Okay. And was there any correlation between the recent Scotch Creek results?

DR. HINCH: I'm sorry, recent Scotch Creek results in...

Q In the last year.

DR. HINCH: I don't know.

Q Okay. And you did report tagging experiments in 2006. Will you be publishing results from the subsequent years?

DR. HINCH: That was 2006.

Q Oh, so 2007, 2008?

DR. HINCH: 2010, we just recently did it this past year. We were not able to do it in those other years. So, yes, we anticipate moving forward on that.

Q Okay. Now, one of the factors that could have affected your results was the issue of delayed mortality due to handling and tagging. Would you agree with that?

DR. HINCH: It's a concern, but we've looked at in other papers the effects of holding and handling

fish, and we believe that the effects were relatively minimal. And again one of the reasons that we wanted to minimize that potential effect was to make sure that we're only considering fish that were tagged in the ocean long after they would have reached freshwater. Most people agree that tagging effects are relatively short-lived and so if you can let fish go after a couple of days of handling, their behaviour can revert back to what one would consider somewhat normal. So we weren't looking at fish immediately after we tagged and released them in the ocean. So the ocean results are certainly very strong in that regard.

Q Okay. However, you'd agree that in other studies, tagging and handling effects can be up to 15 percent of mortalities?

DR. HINCH: Mm-hmm.

Q Now at this point you're not in a position to identify the cause of the genomic signature as a virus?

DR. HINCH: That's correct.

Q And you've certainly not been able to link it to an existing virus yet.

DR. HINCH: That's correct.

Q Okay. So at this point the virus is only a hypothesis?

DR. HINCH: That's correct.

Q Okay. And you have no idea whether or not the potential agent that causes the genomic signature is endemic?

DR. HINCH: That's correct.

Q Or introduced.

DR. HINCH: Mm-hmm.

Q And for the Commission's purposes, can you describe what is meant in scientific communities by the term "endemic" or "introduced".

DR. HINCH: Endemic means natural to the system, that it's always been there, or been there for a long time, and introduced is it's come into the system recently.

Q Okay. So alternative possibilities exist for why this genomic signature occurs.

DR. HINCH: Yes.

Q Okay. One could be stress of the fish?

DR. HINCH: Yeah, and I guess the issue is that identifying alternatives with the genomic

signature is difficult because a lot of the factors are correlated when it comes to a particular causal agent like disease. So diseased animals are stressed. But other things can cause stress, as well.

Q Okay. And what would those be?

DR. HINCH: The, and I mentioned this yesterday, sort of the inability to properly osmo-regulate, the inability to transition from a saltwater environment to a freshwater environment. That could certainly cause stress. There are increased, as I mentioned yesterday as well, increased rates of maturation. If a fish is maturing more rapidly and yet it's still being held or it's still behaviourally existing in saltwater, that can cause increased stress as well.

Q Okay. And definitely inflammatory responses?

DR. HINCH: Any system that's put out of homeostasis, any time your physiological system is pushed out of homeostasis, you get a stress response. I mean, that's what stress is for, is to bring you back into a normal system. And so any time a fish is pushed, and this is a completely natural phenomenon, fish get stressed because a predator chases them, and if it wasn't for the stress response, they couldn't escape the predator. And so the stress response is there as an adaptation. And then the fish deal with the stress response, and then it disappears, the response disappears or the result of the response disappears in the fish after a period of time.

Q Okay. And one other hypothesis is that these fish have a greater demand for energy.

DR. HINCH: That hypothesis in terms of the early migration has largely been ruled out because the fish that are migrating in early are more mature, and we believe the energy is being diverted towards that maturation process because they're not feeding. So it's more of an ancillary response, we believe,

Q Okay. So the patterns associated with stress and immunity in the mortality-related signature fish are also consistent with response to viral infection?

DR. HINCH: Yes.

Q And some of the functional signature that you

found is not related to a viral infection?
DR. HINCH: Again it's a hypothesis. It could be explained by other stress-related factors that we don't know what they are.
Q Okay. And within the shifting metabolic pathways within a mortality-related signature, lower energy reserves or higher demand, energy demand, may be indicated?
DR. HINCH: Right. And again it could be that's pulled along with the more rapid maturation response that we're also detecting.
Q Okay. And there is an up-regulation of the lipid metabolism within the genomic signature?
DR. HINCH: Yes.
Q Okay. And can you describe what "lipid metabolism" is for the Commission?
DR. HINCH: That just means energy use, they're using their fats.
Q One of the other interesting issues found in the paper was that the fish had faster migration speeds than the healthy fish.
DR. HINCH: And part of that is consistent with the whole Late run phenomenon that fish are departing the coastal waters, not holding there, so, yes, their migration rates are accelerated because they're leaving and moving into the river.
Q Okay. So while they're in the river they are swimming faster, though, than the other fish?
DR. HINCH: Yes, they're swimming faster, as well, when they're there.
Q And they're arriving ten to 15 days faster than the healthy fish?
DR. HINCH: Yes.
Q So this could be a potential explanation that they're swimming faster and that they're using -- they're degrading quicker because they're swimming much faster?
DR. HINCH: It's not that they're degrading faster, it's an indication that again that they're on a migration trajectory and the desire to reach spawning grounds is probably more intense. And that would relate also to the more rapid maturation that we're detecting as well.
Q Okay. Now, the paper is only confined to adult sockeye salmon.
DR. HINCH: Yes.
Q Okay. And at this point you've not narrowed down

when the genomic signature first gets expressed?
DR. HINCH: In the paper we don't talk about that at all.
Q Okay. Do you have an idea when it first expresses?
DR. HINCH: I don't have an idea. I'm not doing the genomic work. But I suspect my genomic colleagues would be better to address that.
Q Okay. So you don't know if they first start in smolts in freshwater.
DR. HINCH: As I understand it, it can be detected in other life stages, but I don't know how the transfer, if it is a disease, how the transfer would occur, or how that particular signal propagates itself through the life history of the fish, because we don't do those life history studies.
Q Okay. So that would be a question best for Dr. Miller.
DR. HINCH: Yes.
Q Okay. All right. *Parvicapsula microbicornis* is a parasite that's located in the Fraser River estuary?
DR. HINCH: That's correct.
Q Okay. And it's an endemic species to that area?
DR. HINCH: That's right.
Q Okay. And it's not located in the Broughton Archipelago?
DR. HINCH: Well, it's a brackish water estuarine parasite. It occurs in lots of river systems outside of the Fraser, but it's confined to those estuaries.
Q Okay. And can you describe what you meant by that term?
DR. HINCH: Which term?
Q The very large term that ended with "estuary".
DR. HINCH: Oh, so it occurs naturally in the estuaries, so the areas where rivers meet oceans. And certainly in other river systems as well it is a native parasite that lives part of its life in a worm, and when the adult salmon are passing back upstream, they are exposed to this particular parasite, they pick it up, we believe that it passes through the gills and ends up in their kidneys.
Q Okay. Now, there is some earlier consideration before your paper was published of haemorrhagic

lesions.
DR. HINCH: Yeah, again that's Dr. Miller.
Q Okay. Can you identify for the Commission how the fish in the study were killed?
DR. HINCH: Which fish in which -- we weren't killing these fish in the *Science* paper.
Q Okay. So there was no blunt force trauma before the samples --
DR. HINCH: We wouldn't be able to track them if we did that.
Q Okay.
DR. HINCH: So these fish were all gently handled, put transmitters in them, a little biopsy taken and then released.
Q Okay. Were there any studies that were done for the purposes of the paper where fish were killed?
DR. HINCH: I don't think for the purposes of this paper, but certainly we do what we call destructive sampling at the same time as we're doing our tagging. So you would also take some samples where you sacrifice the fish and take different organs and other tissues for extended analysis.
Q Okay. And did you take some at the time when you were doing the tagging study?
DR. HINCH: For this study we did take some at this time, but I don't think that's reported in this paper.
Q Okay. And how were those fish killed?
DR. HINCH: Oh, those fish would be killed by concussion.
Q Okay. So blunt force trauma.
DR. HINCH: Yes. Yes.
Q Okay. And are you aware if blunt force trauma can cause haemorrhagic lesions?
DR. HINCH: I do not know.
Q Okay. So that would be a question most suitable for a veterinarian pathologist?
DR. HINCH: Sure.
MS. CALLAN: Okay. Those are my questions. Thanks.
DR. HINCH: Thanks.
MR. McGOWAN: Mr. Commissioner, I believe Mr. Blair is up next.
MR. BLAIR: Mr. Commissioner, for the record, my name is Alan Blair, I appear as counsel for the B.C. Salmon Farmers Association, and I expect I'll be in the range of some 30 minutes.

CROSS-EXAMINATION BY MR. BLAIR:

Q Doctors, thank you both for educating a room full of lawyers. We're a little short of scientists this side of the microphone, so thank you for your insight. A question for either or both of you. Perhaps I'll start with you, Dr. Hinch. It's a broad statement and so please feel free to listen to it carefully, and if you agree, great; if you don't, please indicate where you may disagree.

But I'm going to suggest to you both that the scope and impact of climate change on ocean and freshwater habitat are a critical limiting factor in the recovery of wild salmon stocks, even to keep the wild salmon stocks at their current levels, and certainly to have them increase. So climate change is a limiting factor, a significant limiting factor.

DR. HINCH: Insofar as we're talking about the Fraser sockeye?

Q Yes.

DR. HINCH: Yes, I would agree.

Q Yes. And --

DR. MARTINS: Yes.

Q -- yes, you agree?

DR. MARTINS: Yes.

Q And I'm going to, as a layman this side of the microphone, break it down to simple language and I'm going to put it in three major categories, and again feel free to disagree if you do. What I think I take from the reports you've put together and all of the material and background material that you've referenced and we've had the benefit of reading, I hear you say that the effect on Fraser River sockeye is particularly acute because of three major factors, and I'll go into them. I'll list them firstly and then I'll break them down a little bit: Water warming, and by that I mean in the ocean and in the freshwater habitat for Fraser River sockeye is my first point. Acidification of the ocean, which has been described as being underway and its multifaceted effects, mostly on food chain, food abundance as a feed for sockeye salmon and other, Fraser River sockeye. And related to that is food abundance itself, which may be distinct from acidification. Those are my top three.

DR. MARTINS: Okay.
Q Are they your top three, or would you add any, or would you take any of those out?
DR. HINCH: I'll go first, or you --
DR. MARTINS: Okay.
DR. HINCH: Okay, I'll take it first. In a context of warming, certainly for the adult stages we've been talking quite a bit yesterday, warming is really important an issue, a limiting factor for several of the populations that we discussed, not necessarily all of them. The warming that we mentioned in our paper that talks about coastal issues that may pertain to juvenile fish, it is a concern insofar as that it's a correlate of other factors. The warming itself is not pushing fish into lethally high temperatures like the levels we're seeing in the river. But it's a correlate with food production systems and perhaps predator systems, which actually ties in with your third point, that food abundance and that. So that is a concern because it does, those things are linked together as we reviewed yesterday, the Pacific decadal oscillation and El Niño and those things are in the wrong direction and they're creating warm conditions with predators coming into our coast. And, yes, that's a significant issue for juvenile salmon.

The acidification issue, very little research has been done on it, but it is very concerning because of how rapidly it seems to be changing in the coastal areas in particular.

DR. MARTINS: Yes, I agree with Scott on everything. And just to add more on the acidification issue, we don't know anything about it in terms of how it affects salmon or fish in general. We know that in the future it might be an issue in terms of how it affects the food that they will eat in the ocean. Some studies on other species of fish have shown that acidification, the levels that we are expecting with climate change might have a direct effect in how the fish perceive their environment, the presence of predators. And so we don't know if that will be case with sockeye. It's something we have to research.
Q Any other top three, top five? I know yesterday when you were being asked questions on funding, you were quick to take the top three to about

eight, and we understand that.
DR. HINCH: Well, I think one of the most concerning things for me is the extremes. We're already seeing extreme temperatures and those are unpredictable.
Q I'm sorry to interrupt you, but I meant in addition to water warming and acidification and food abundance.
DR. HINCH: Okay.
Q Are there any other broad layman's topics that you might add to that top three or five list?
DR. MARTINS: I'm not sure. I don't have any, haven't seen any evidence that it's a current issue, but in the future it might be. It's the increasing rainfall during wintertime, which might increase flows and affect the eggs that are incubating.
Q So changes in precipitation?
DR. HINCH: Yes.
DR. MARTINS: Change in precipitation, yes.
Q Which might, of course, relate back to water temperatures in a sense.
DR. HINCH: Yes.
DR. MARTINS: Yes.
Q As well as water quality and abundance?
DR. HINCH: Yes.
DR. MARTINS: Yeah.
Q Last chance, any others?
DR. HINCH: Those are big three you hit.
Q Okay. If we could look to the issue of water warming, what I take from your summary, and again the reports we've all had a chance to read, is that greenhouse gases is widely viewed as the culprit for causing the greenhouse effect and the warming of the planet, maybe not universally agreed to, but for the purpose of my question, I'm going to suggest that you might agree with that as a fundamentally important step. I think one of you may have said it was the highest in 650,000 years, the level of greenhouse gases, methane and...
DR. HINCH: It was in one of the reports. I don't think we physically stated it, but...
Q Right. But that order of magnitude, very high over a very long interval.
DR. HINCH: That's what the IPCC report said, yes.
Q And I think I understood the reports that I read to suggest that even if we didn't increase

greenhouse gases beyond current levels, the effect of them now being at this elevated level would almost certainly result in an increased ocean water temperature gradient beyond a normal range.

DR. HINCH: Yes.

Q Over the next several decades.

DR. HINCH: There's going to be a significant lag effect even if we were to stop the rate of increase of greenhouse gases.

Q Right. And so you both agree on that?

DR. MARTINS: Yes.

Q Any estimates, the lows to highs, or is that too much of a black box?

DR. MARTINS: Of warming?

Q The increased water temperature in the ocean, if greenhouse gases remained the same, which seems unlikely, but sort of taking the best case scenario.

DR. MARTINS: I can kind of remember air temperatures globally, they range from one to six degrees, but I can't say if that's going to be the same --

DR. HINCH: In the ocean.

DR. MARTINS: -- range of temperatures in the ocean.

DR. HINCH: I mean, right now they're predicting up to a two-degree warming in the near future in our region for oceans, and I mean these are generally conservative estimates. And certainly in the freshwater stages those are conservative estimates.

Q It's an important distinction, and thank you for adding it, two degrees warming in our area as opposed to globally, because we really are trying to focus ourselves on the Fraser River --

DR. MARTINS: Yes.

DR. HINCH: Yes.

Q -- salmon stocks. And again, using that focus, I think I understand from your reports and the other information that counsel and the Commissioner have benefited from over the last several months, salmon, sockeye salmon, but salmon generally are critically sensitive to increases in temperature, true?

DR. HINCH: True.

DR. MARTINS: Yes.

Q And in particular, dealing with sockeye, I think you've said even yesterday, and we've heard it many times, that sockeye in the Fraser River are

near the southern boundary - near the southern boundary - of their habitat generally.
DR. MARTINS: Yes.
DR. HINCH: That's right.
Q Related to temperature, or just historically?
DR. HINCH: Just historically, I mean, they existed a bit farther south than they currently exist today, but not much further.
Q And one of the effects of global warming and warmer water generally might be that the Alaskan stocks, because they're in colder water and further north might actually benefit, and the southern stocks, for example, the Fraser River, it may be detrimental to them, correct?
DR. HINCH: That's correct.
DR. MARTINS: Yes.
Q Now, you mentioned precipitation, Dr. Martins, so perhaps we'll just go there. I think I understand the effect of your comment on precipitation is while we haven't noticed large increases in precipitation necessarily on coastal British Columbia, there have been some higher extremes in the upper watersheds of the Fraser River?
DR. MARTINS: Yes. There's a report that shows a map of change in precipitations in different seasons.
Q Yes.
DR. MARTINS: And if you look at these maps, change in precipitations, increase in precipitation have been highest in the interior regions than the coastal regions, especially in the southern coastal --
Q I don't recall -- I'm sorry.
DR. MARTINS: -- especially in the southern coast of B.C.
Q I don't recall whether or not the information indicated that the precipitation came at different times of the year than traditionally. Is it later, or was there any study done of that effect?
DR. MARTINS: I'm sorry, I don't understand the question.
Q Okay. Heavier rains in August than we used to have, or is it the heavier rains in May, or do you know if that was studied?
DR. MARTINS: Not in a particular month. They showed these by season.
Q All right.
DR. MARTINS: So we have the maps for winter, spring,

summer and fall.
DR. HINCH: So there will be more precipitation coming as rainfall generally on the province-wide scale, which would therefore take our snowmelt-dominated systems, like the Fraser, and push the peak runoff earlier in the season.
Q Right. So with the reduced snowpack, which we've all become accustomed to hearing about, receding glaciers and less snowpack --
DR. MARTINS: Yes.
Q -- and increased precipitation in the form of rain, which exacerbates that problem --
DR. MARTINS: Yes.
Q -- you have a quicker, earlier freshet.
DR. HINCH: Yes.
Q With higher velocity and as a result less water to come down later in the summer where you would traditionally get a snowpack melt?
DR. HINCH: Exactly.
Q A good summary?
DR. HINCH: That's right.
DR. MARTINS: Yes.
Q And so for the salmon stocks that are coming back later in the year, they will suffer a greater burden as relates to water quality, temperature, velocity --
DR. HINCH: Well, not velocity, actually --
Q Sorry, no velocity.
DR. HINCH: Velocity would be even much easier for them.
Q Much easier.
DR. HINCH: But the temperatures could be even higher.
Q Right.
DR. MARTINS: Yes.
Q So when we look at what management strategies we might do, and I'm not going to steal the thunder of some of the people that I think are coming after me, but when we look at the strategies, we perhaps can't cool the water, but we might shift when we harvest.
DR. HINCH: Or which stocks you put more emphasis on harvesting, or where you harvest them.
DR. MARTINS: Yes.
Q Right. I guess my point is, if the stocks that are coming early that are running into high flow, warm water, are going to suffer higher *en route* mortality, you might harvest those and let the

ones that are going to come through later, where the issues aren't quite so extreme. Have you thought about that?

DR. HINCH: Oh, people think about that a lot. But that's two issues there. First, it's a biodiversity issue. You're talking about potentially fishing stocks, especially the Early ones that are not doing well right now, even harder, which would probably not be a good idea from a conservation perspective. However, the stocks that are migrating in what we call the earliest right now, the Early Stuart, they're coming in just after the peak, current peak freshet, the current peak discharge is occurring. If the current discharge gets earlier, then the discharge that they're encountering, if they don't change their time, would actually be lower.

So from a discharge perspective we don't see that as an issue. Discharge is going to become less of an issue in terms of creating a barrier to migration as we once used to study it back in the '50s and '60s, when we were concerned with fish passage issues. It usually was because of high discharge. We're probably not going to see that as an issue in the future for sockeye anyway, because of when they come in and when the peak discharge is going to be shifted towards, temperature will assume a much larger role early on in the season.

Q I only wanted to touch on that in part to demonstrate that while I appreciate this is the climate change panel, my point, I guess, is that while we may be able to manipulate timings around harvest, so harvest management, we can do that to greater or lesser success based on everybody's perspective and what is important to protect. But the underlying issue is we're trying to avoid the relentless climate change bus, which is driving towards us, and we can't stop that bus, can we, the climate change bus. We can't cool the water, we can't reverse acidification, we can't reverse it.

DR. HINCH: No, cooling the water is difficult on a watershed scale. Certainly it can be done on really small scales, I suspect. What you can do is to ensure that you're protecting habitats that would otherwise be warming further, you could

ensure that they don't warm any further. And certainly in some of the smaller streams and spawning areas, you can protect those and make sure riparian coverage and other objectives are met so that that doesn't happen. And as I mentioned yesterday, protecting lakes and lake environments. These are our best thermal refuges we have at the moment and the fish use them.

Q And that's a habitat protection management issue?

DR. HINCH: As much as anything. I mean, when it comes to thinking about how you manage and protect lakes, you have to consider that these aren't just protected for one set of values, they're a thermal refuge. So we have to start thinking about them in that context when we go to manage them for any use.

Q It does sound a little bit, though, like the changes that we might be able to make, take away all the cottages around the lakes to make sure that we have cover, for example, some of these changes which you might make would be difficult to make, unpopular, and still a small improvement against this --

DR. HINCH: Yeah, I'm not talking about, you know, protect the foreshore issues. I mean, the lakes are not -- that's not going to change the temperature of the deep portions of lakes, and that's where --

Q What do we do to improve a lake, then?

DR. HINCH: Well, it's not about improving, it's protecting it. So making sure that you're not -- I mean, there's been a lot of talk about taking water out of deep lakes, take water deep out of lakes and using that to cool other areas. And I'm suggesting that that might not be the best strategy because you're just robbing Peter to pay Paul in some cases. So it's better to protect what you have at the moment, and we know the fish use them, and those that use them do benefit from them.

And it's also to make people aware that this is critical habitat. Those lakes are critical habitat for thermal refuges, and they're going to be even more important in the future. So it's as much about education and knowledge as it is about doing anything differently, in some cases.

Q Well, you raise a very interesting point. Often

countries, not just communities such as British Columbia, think about what can we do as a country even with respect to climate change because it is a global issue. And so your point's a good one. We, in British Columbia, may not be able to do anything about greenhouse gases in a significant way. Are you suggesting that if we want to deal with the effects of climate change as it relates to salmon stocks in the Fraser, our best bang for our buck is habitat protection?

DR. HINCH: It's got to be one of our tools. And the other thing, I mean, you're probably well aware, and a long time ago people were talking about shuttling water all over the province towards the Southern States. And every once in a while these issues come back, and I think we have to be well aware of just how important our cold water is, and not just for drinking and for sharing with our neighbours in the south, but also for protecting salmon stocks.

Q So habitat protection, what else can we do in the face of climate change?

DR. HINCH: A lot of what we're going to have to do will be accepting that temperatures are going to rise in the river anyhow, and that there will be increased levels of mortality as associated with that, which means that we're probably not going to be able to harvest as many fish if we want to meet certain stock conservation targets. So that is probably an inevitability for some stocks.

Q Sockeye?

DR. HINCH: Of sockeye. Potentially other species, too, I mean, we're focusing a lot on sockeye, but, you know, this will affect all, all species. They all have their own unique thermal issues.

Q So there's two, habitat protection, perhaps --

DR. HINCH: Harvest management.

Q -- harvest management.

DR. HINCH: We are also hoping that stocks and populations will continue to adapt. I mean, that's certainly, as I said in the Columbia River system, we've seen changes in their migration timing associated with the much higher warming that they witnessed there. As this adaptation continues, can we hold on? Can we ensure that we're protecting and conserving long enough to allow the populations to go through what is a

natural process that they may have to go through rather quickly.

Q So here we're speaking about the biodiversity of the stocks --

DR. HINCH: Yes.

Q -- that are going to our river systems.

DR. HINCH: Yes, I am.

Q You gentlemen are experts in climate change. Is there any greater threat to Fraser River sockeye today, 2011, than climate change?

DR. HINCH: I'm hard-pressed to find a greater threat.

MR. BLAIR: Thank you. thank you, Mr. Commissioner.

THE COMMISSIONER: Thank you, Mr. Blair.

MR. McGOWAN: Mr. Leadem will be next.

MR. LEADEM: Good morning, gentlemen. My name is Tim Leadem. I represent a group of conservation societies, environmental groups. Mr. Commissioner, I estimate I will be about 40 minutes in my cross-examination.

CROSS-EXAMINATION BY MR. LEADEM:

Q I want to begin by looking primarily at what we can do. I think that you have done a great job of describing some of the difficulties and the problems in great detail, and scientific detail. And I'd like to focus on what we can do about it, and perhaps pick up a little bit of what Mr. Blair has been discussing with you. And to that end, I want to examine the filling the scientific gaps that you call it, Dr. Hinch. And there's two big questions I have about that, and those are who is going to pay for this, and who is going to coordinate this. And let me try to break it down this way. If we focus on the financial aspect, you're calling for a wide array of research across a lot of fields, and there's limited sources of funding. Do I have that right?

DR. HINCH: There's definitely a limited source of funding. Yes.

Q And so if I were to break it down into the sources of funding that we could call upon to fund some of these projects, if not all of them, I look to government grants, I look to private grants, I look to academia in part, and then I look to the Government of Canada, because they are responsible for this fish. Do I have that right? Have I

covered more or less all the bases here?
DR. HINCH: Let's see. Yes, I guess. There's, I mean, maybe you mentioned this, you mentioned private funds, private grants?
Q Private grants.
DR. HINCH: Yes. Yeah, I think you hit them all. I mean, those are really broad categories, within those there's quite a lot of variability in terms of where you get money.
Q Right.
DR. HINCH: It's not quite that simple. And academia itself has no money for research.
Q Right.
DR. HINCH: We have to get the money --
Q They supply the office.
DR. HINCH: They provide the office and the people, in some cases, but the money to do the research comes from those other sources.
Q So a lot of what you do as a scientists is actually chasing the buck, I mean, you're chasing --
DR. HINCH: That's a lot of what I do.
Q Right. And so in terms of the percentage of where you're getting funding, and if you're able to tell me this, fine, if you're not. What I'm curious about is how much money you're getting from DFO in terms of a percentage.
DR. HINCH: It's a hard thing to answer because we've established, not just myself, but lots of colleagues have established partnerships with DFO, and the partnerships often involve the utilization of facilities, equipment and expertise. A lot of those things, it's hard to assign a dollar value to. I mean, they're providing them. We are providing, or going after money through often federal agencies, or sorry, federal funding sources to have some of the operating costs paid for. So in terms of the operating costs, it's probably 80 percent through government agencies such as NSERC, which is where most of us in Canada get our funding.
Q And I'm not familiar with that acronym.
DR. HINCH: That acronym, NSERC, N-S-E-R-C, stands for the Natural Sciences and Engineering Research Council of Canada.
Q Thank you. The other thing that occurred to me when I was trying to figure out how we're going to

move forward in terms of helping the salmon survive, which is what my clients are mostly concerned about, is that you have all this science that ought to be done, but how are you going to coordinate how the science gets done and how it's going to be applied.

DR. HINCH: Yes.

Q And to a certain extent, thank god you're not like lawyers where you fight amongst yourselves a lot, but there's a certain amount of collegiality with scientists. And, for example, you have conferences, you discuss ideas, there's a free dissemination of ideas. Do I have that pretty well right?

DR. HINCH: Mm-hmm. Yes.

Q But there doesn't seem to be that leadership that I can look at, at the scientific community and say that someone, some group has assumed leadership in determining where the research is going to focus. Do I also have that right?

DR. HINCH: There is no formal organization of academics that gets together and decides what the priorities of research would be and who is going to lead it. What usually happens is it takes one or two champions within an academic organization and they take it upon themselves to forge the relationships and partnerships that spawn a much larger enterprise of research. And certainly that's the sort of approach I've taken, and other colleagues of mine have taken. And so we've managed to create those groups without having to go through formal channels. We've been the ones that have just done it ourselves, because we know that's the only way at this point that we can get information to management.

Q Right. And we saw an example of that with respect to the proceedings --

DR. HINCH: Yes.

Q -- of the workshop that you hosted.

DR. HINCH: Yes.

Q With respect to the Late run, the early entry of the Late run, to try to come to grips with solving that issue.

DR. HINCH: Right. And the ontogeny, the beginning of that was seven or eight years earlier with a small group of academics and DFO and Salmon Commission biologists sitting down and saying "We need to do

something and so let's put our heads together," and it was organically created. And that group has grown to include dozens of academics and government scientists in a really collaborative framework.

Q And you certainly would encourage the full cooperation and attendance from all of the entities.

DR. HINCH: Yes.

Q All the scientific community at these workshops, at these symposia, and so forth.

DR. HINCH: Yes. We do our best to be as inclusive as possible.

Q Now, I look south of the border, and I know that there is a National Oceanic and Atmospheric Administration that deals specifically with fisheries. Do we need something like that in Canada? We had something called the Fisheries Research Board of Canada years ago. Do we need to have something that's a little bit independent of the government, free from some of the governmental constraints?

DR. HINCH: I'm not sure how independent NOAA is of the government. I think they're integrated into it. I do agree we need a framework that allows government scientists and academic scientists and private scientists to create these partnerships, encourage them and help get them going so that we can address applied topics in a timely fashion. Because at the moment it's done as I said organically by somebody saying "We need to do this," and they put a lot of their time and effort into it.

Q All right. I want to move on a little bit, and thank you for that discussion. And I want to talk about what I'm going to call "mitigative measures". Mr. Blair talked a bit about this as well. And by mitigative measures, just so you know what I'm driving at, I mean steps or actions that could be taken to increase the likelihood of the survival of the Fraser River sockeye salmon in a changing world.

You address some of these in your paper, and I found the actual commentary from one of the reviewers of your paper to be quite interesting. And that I'm going to focus upon pages 113 and 114 of your paper, where the reviewer in this case I

think is Dr. Ken Ashley.
DR. HINCH: Mm-hmm.
Q And Dr. Ashley in point number 4, I guess there was a generic question about to all the reviewers are there other recommendations. He makes some recommendations, and I just want to tease out your response to it. Because I know you have a response that's contained in bold at the bottom, towards the bottom of page 114, but I want to go back and actually revisit some of his suggestions and just see specifically what your reaction to them would be. He talks about in the first paragraph under 4:

> ...habitat protection recommendations did not propose any innovative, large scale concepts to cool the Fraser River...

And he goes on to say:

> I would recommend that an interdisciplinary workshop with fisheries scientists, professional foresters, environmental and civil engineers be held to examine the feasibility of large scale biotic...and abiotic ideas...

What's your reaction to that?
DR. HINCH: You see there's a paper cited there, McDaniels et al, 2010.
Q Yes.
DR. HINCH: That was a workshop that I attended that --
Q In fact, you're a co-author of that paper, are you not?
DR. HINCH: Yes, I was. That workshop had 15 to 20 panel of experts. They were all well-known sockeye biologists and policy managers, and there was a lot of discussion then about what mitigative measures could be taken for the future. And one of the ones that was posed as a straw argument, and then largely shot down for a variety of reasons, was the idea of mass-scale cooling of Fraser River areas. And that was what I was drawing my comment on, was that, well, the consensus from that group was that this is probably not a good idea for a variety of reasons. Now, we did not have any civil engineers present,

and Dr. Ashley's a civil engineer. But indeed it just seemed to most of the biologists that there would be a lot of other problems, and actually the habitat managers that were there also thought there would be lots of problems with trying to achieve that particular objective.

Q Right. In terms of that paper, and because you were an author on it, and I don't necessarily want to take you to that paper. But as I read the paper, one of the findings was that the salmon are adapting and they're quite a resilient species. And so before you go in and start to perform these vast mitigative measures, where you're not sure what you're going to actually affect, you should perhaps look at what the fish themselves are doing, and how they're adapting, and then try to hone in on how human interaction can assist the fish in doing what it does best, namely adapting to local conditions.

DR. HINCH: Yeah, it was, yes, and that was a consensus, and that, I mean, that is based on their opinions of the people that were thinking what the risks would be for going into, for large-scale manipulations.

Q Right.

DR. HINCH: And it just seemed too risky, given that we need to look at what the fish are telling us.

Q Getting back to Dr. Ashley's commentaries, at the bottom of page 113 he makes the point:

> In terms of habitat protection, a logical recommendation is for the Provincial Government, who has statutory authority for water management in British Columbia, is to quickly identify and enact groundwater and surface water thermal protection zones on all Fraser River sockeye ecosystems in BC.

And he talks, goes on to explain how that could be achieved. And it's interesting, because Dr. Ashley used to be head of provincial Fisheries, as I understand it. Was that right?

DR. HINCH: I don't know if he was head, I know he worked for provincial Fisheries.

Q Right. And what's your reaction to that, in terms of the habitat protection and groundwater protection?

DR. HINCH: I mean, I'm all for groundwater protection. It just it seemed that the scale at which this was being suggested, without going into each situation being somewhat different, each lake issue, each lake system very different. Many of these lakes are in somewhat remote areas that this wouldn't necessarily be an issue for. Certainly it would be for some. I just thought it was perhaps too broad of a recommendation, so I don't think we were -- we were not not endorsing it, but we weren't going to be suggesting it necessarily ourselves.

Q But it may be something worth exploring.

DR. HINCH: I think again the protection, thermal corridors and the protection of streams, and this is an issue mostly for smaller streams. Again the warming of the Fraser is not a riparian issue, a riparian plant/vegetation issue. But certainly the smaller streams, and this is where the spawning issues could come in and pre-spawning mortality, where temperatures are also an issue, riparian protection and groundwater protection would be important in those circumstances.

Q Okay. He goes on to cite examples about thermal loading from industry. We've got a number of sewage treatment plans on the Fraser River, and I know that we're going to get to that in due course. We haven't yet gotten there in terms of our hearings. But what's your reaction to actually taking a look at that, because obviously any little bit helps, I mean, if you're --

DR. HINCH: Yes. I think any little bit helps and that was certainly something that came up at our conference on Late run sockeye. That, you know, there are issues we still don't understand about chemicals and contaminants and pollution, and it's true, we don't understand it. What the role in the greater scheme of things for sockeye is perhaps yet to be determined.

After all, sockeye, this is a migratory corridor for sockeye, both the juveniles and the adults. Most of them don't spend a lot of time in these areas, so we just don't know. And again, this comes back to my point I made yesterday. We don't know anything about the juvenile really to speak of, anything about the juvenile life stage in terms of how long they're spending in

freshwater, where they're spending it as they're migrating out, who they're interacting with.

Q You would probably support Dr. Riddell's work on tagging the smolts from Chilko Lake that he told us about a few weeks ago, and following the tagged smolts out to sea.

DR. HINCH: I'm a co-author on that, yes. So, yes, I support it.

Q And then he goes on to talk about predator control and so you've already indicated that that is an issue that really should be examined in terms of the fish.

DR. HINCH: Yeah, and I'm particularly concerned in the Interior with the spread of bass and how they're going to do much better in a warmer Fraser watershed.

Q I want to now turn to a specific topic of mitigative measures in the management context, and I want to do so by referring you to your paper "Pacific Salmon in Hot Water: Applying Aerobic Scope Models and Biotelemetry to Predict the Success of Spawning Migrations". And I wonder, Mr. Lunn, if you can pull that paper up. You should be familiar with this, Dr. Hinch, because --

DR. HINCH: Yes, we talked about yesterday at the beginning.

Q Right. I found the paper to be a fascinating study and it was a team approach, as well, Tony Farrell from UBC and yourself, along with Dave Patterson from DFO --

DR. HINCH: Yes.

Q -- were some of the authors; Mike Lapointe from --

DR. HINCH: Salomon Commission.

Q -- Pacific Salmon Commission.

DR. HINCH: Yes.

Q And I want to refer you to page, the discussion, at 705, and the first full paragraph on the left-hand column that begins "More broadly". 705, please, Mr. Lunn. There we go. And the first full paragraph beginning "More broadly", and perhaps for ease I'll just read it into the record:

> More broadly, this article provides compelling evidence regarding the mechanisms by which large-scale animal migrations may

> fail in response to climate change...and provides opportunities for using physiological tools to enhance the conservation and sustainable management of fish and wildlife during periods of environmental uncertainty.

And it goes on to say after quoting from another paper, you say:

> Thus, fisheries managers, who must develop population-specific management strategies during periods of climate change, may find models of temperature dependence of aerobic scope, such as the one presented here, to be useful predictive tools.

Now, I'm just going to stop there, because we heard some evidence of management adjustments and the focus upon temperature.

DR. HINCH: Mm-hmm.

Q But this takes it a step further. It really refines it, doesn't it.

DR. HINCH: Mm-hmm. Yes.

Q So what you're looking at then is for specific conservation units, you're looking at temperature opts.

DR. HINCH: Yes.

Q And temperature crits, right?

DR. HINCH: That's right.

Q There's critical temperatures and optimum temperatures. And what you're trying to do is then if you're aware of those parameters for the conservation units, it puts you into a state where you can predict what is likely to occur in the Fraser when you know the ambient temperatures.

DR. HINCH: Yes.

Q For each specific conservation unit.

DR. HINCH: Yes. You would be at a place where you could certainly predict whether fish are going to live or die based on knowing those critical temperatures.

Q Right.

DR. HINCH: Yes.

Q And so you as an author advocate the DFO fisheries managers to take full note of this and to build this into a predictive model, to enable them to

make much more specific --
DR. HINCH: Yes.
Q -- rational decisions for the harvest as it's occurring in season; is that right?
DR. HINCH: Yes. Yes, and we actually recommended that in the Conference Proceedings report that was also put into evidence yesterday.
MR. LEADEM: Mr. Commissioner, could this article be marked as the next exhibit, please.
THE REGISTRAR: Exhibit 561.

EXHIBIT 561: Farrell, Hinch et al, "Pacific Salmon in Hot Water: Applying Aerobic Scope Models and Biotelemetry to Predict the Success of Spawning Migrations"

MR. LEADEM:
Q I want to come back just briefly to the Miller paper, because it seems to have attracted a lot of attention. And I read through the Miller paper and I don't propose to understand it, and I know Dr. Miller is going to come later on and talk about the genomic signature. But what struck me about the paper is perhaps something that is not in the paper *per se*, but the process of how the paper came into being. When I read the paper, I noted, and you can probably best speak to this, that the field telemetry work that gave rise to the sample size was actually done in 2006.
DR. HINCH: That's right.
Q Is that right?
DR. HINCH: That's correct.
Q And then the paper comes to fruition in 2011, and to me, a non-scientist, that strikes me as being a long gestation period for a paper.
DR. HINCH: You know, it's not necessarily unusual. With these types of major collaborative efforts, especially ones involving molecular biological techniques, it can take a while to bring all the pieces together. We were just getting going on this whole molecular project at that time, so it took quite a while to bring the pieces together. My anticipation is that we would be much quicker now, given the same sort of results, now that we have the team in place and the funding in place for that. But it took a while.
I mean, nobody had ever done this on wild

animals of this scale before. Interpreting those what are called genomic signatures was not an easy task. In some cases, you know, you're drawing on the medical literature, human medical literature to understand what genes do. Now, the genes do the same things in animals across the spectrum, but you have to be able to interpret those from a fish perspective. And so to be able to do that took a lot of people a lot of time. We're much better at it now and much faster at it.

There are other research though that would occur in 2006 that we're still working on publishing, and some of it has to do with is just framing it for the journals correctly, and finding that peers have problems with it, and reworking it, re-analyzing it, resubmitting it. It's a long arduous process. It's never as quick as putting out a consultant report that we can also do. This is something that we have to make sure is done right.

Q Is part of the delay also occasioned because of the cost? I mean, you mentioned that each of the slides to determine the genetic makeup --

DR. HINCH: For one fish it was over $300 to do one slide, yes.

Q So is that also a factor in contributing to the delay? I mean, you can do the field telemetry work.

DR. HINCH: Yes. But you have to have the money to do the analyses afterwards.

Q Right.

DR. HINCH: That's certainly a concern for this year. We've got the data in place, now can we get the funding to make sure that the analyses get done. And that's a continual problem from one year to the next.

Q So if I can try to sum up a lot of what you've said, in terms of where we are and where the science is right now, I would try to sum it up this way: that, yes, we've got a species of fish that's in trouble and part of that trouble that is occasioned on the fish is climate change; is that right?

DR. HINCH: Yes, part of it is.

Q It's not the total picture, but it's certainly part of it.

DR. HINCH: That's right.

Q And in an era of climate change it falls to science and to humans to try to help the fish as best they can, right?
DR. HINCH: Yes.
Q And in order to preserve as much of the biodiversity as possible, we have to focus upon the specific stocks, as you call them, or conservation units.
DR. HINCH: Right.
Q And try to preserve as much of that as possible, because we don't know which fish is actually going to provide the clue to survival in a different world where temperature regimes are much higher than they are now.
DR. HINCH: That's right.
Q And the predicament that you have as a scientist is that you simply don't have enough money to be able to go out and do all the research that you would like to do to be able to focus your attention on trying to solve some of these problems.
DR. HINCH: I mean, I don't to fall back on "Poor scientists, we're underfunded," I mean, we've heard that a lot and I suspect we all feel we're underfunded in everything we do. I think part of the issue is we need direction. And we go out of our way -- my group goes out of our way to go to the management agency, say "What would you like done? What would really help you in addressing salmon conservation?"
Q Right.
DR. HINCH: And so we try to -- so in that way we're not just going all over the place doing things that are interesting to do, but they're also interesting and definitely applied. The hope is that agencies then can step up, and this is important, and we're going to help you do this. And I think to the degree they can, they do that. But I think that's where the help would -- I'd really like to see more help when we're going, saying, "We want to do things that are applied that are going to help your mandate and we'll work together with you on this. Let's make it work from a financial perspective." And I've just seen agency budgets cut for science over the last several years, and it's making it harder for us to do that type of applied assisted work.

Q Right. And when you say agency, the specific agency is DFO, is it not?
DR. HINCH: Well, DFO, the Salmon Commission, and provincial agencies as well.
Q Right.
DR. HINCH: We have worked with them.
Q And all of the government entities that should be funding the research to drive this forward to solve the dilemma, they're not stepping up to the plate in terms of the financial contribution, are they.
DR. HINCH: I feel more could be done, and we do a lot of going to ENGOs for assistance, as well, and trying to get help there, but it's never enough. But of course, you know, we all feel it's never enough.
MR. LEADEM: Thank you. Those are my questions.
MR. McGOWAN: This might be an appropriate time for the morning adjournment.
THE REGISTRAR: The hearing is now adjourned for ten minutes.

(PROCEEDINGS ADJOURNED FOR MORNING RECESS)
(PROCEEDINGS RECONVENED)

MR. ROSENBLOOM: Thank you, Mr. Commissioner. My name is Don Rosenbloom. I appear on behalf of Area D, Gillnet, Area B Seiner. Mr. Commissioner, I have estimated my cross-examination to be, approximately, 45 minutes.
Members of the Panel, I have to compress eight areas that I wish to examine you into such a short timeframe and I'll do my best, and I ask your cooperation in terms of your responses.

CROSS-EXAMINATION BY MR. ROSENBLOOM:

Q I first want to feed on an exchange between you, Dr. Hinch, and the last counsel, Mr. Leadem, in respect to the funding issues and the shortage of funds.
You've told us the common sources of funding for these projects. Firstly, in terms of government funding of scientific work through the agency you spoke of, the National Council, and so on, is Canada typical of other countries in the field of aquatic studies in terms of the

governmental participation in the funding of scientific work?
DR. HINCH: Yes.
Q I assume from that response that the American government is no better nor worse in terms of the percentage of funding?
DR. HINCH: Oh, I don't know about percentages. I mean, structurally, they're similar in terms of how this would happen. The Americans, in my understanding, looking at the research that goes on, it's like an order of magnitude, more funding available for the same types of research.
Q Yes, but I was really speaking to, really, the question of commitment by government to fund scientific work in Canada as opposed to other countries.
DR. HINCH: Right.
Q Is the commitment, from your perspective, probably somewhat average?
DR. HINCH: Yeah, I would say average.
Q All right. Now, obviously, there is tremendous dependency by you, a scientist in terms of NGOs, private foundations, and so on, and I gather from reading some of the material leading up to this inquiry, that American foundations play a major role in the funding of the scientific work being conducted on sockeye salmon in the Fraser?
DR. HINCH: In terms of how the funding feeds through the Vancouver Aquarium to maintain the post lines, yes.
Q Yes, but am I correct in suggesting that American foundations have funded a number of other major scientific studies in respect to sockeye of the Fraser?
DR. HINCH: Not specifically to Fraser sockeye, but to sockeye and fish in general, that we've taken advantage of.
Q All right. Now, you spoke about the telemetry work and you spoke about the cutting off of funds for that. Is there an explanation to give, from your perspective, as to why funding was cut off in terms of LGLs work with telemetry?
DR. HINCH: My understanding is it was a sunset program and this was the way it was laid out, there'll be so many years of doing this and if funding could be found to continue it, it would. My understanding is that in the grand sense, no

funding has been found to continue with the way things were in the past.
Q Okay. Now, lastly, on the funding side of it, can you imagine how this Commission, by way of a report that will, of course, be released at the conclusion of these hearings, how a report from this Commission could be influential in attracting significant funds for scientific work, both in terms of greater governmental commitment to the scientific work and, indeed, the NGOs and the foundations.
DR. HINCH: Very instrumental, highly instrumental.
Q And why do you say that?
DR. HINCH: Groups listen to people in authority that are talking about major issues. They're less likely to listen to academics and even less likely to listen to some individual government scientists, but when reports like this get put together that are a compilation of many, many individual perspectives that have been thought through for two years, then I think that's going to be quite influential.
Q So just totally on a hypothetical basis, if this Commissioner chose to indicate in the report, after hearing evidence over many, many months, that certain research was necessary to answer some of the critical questions that really were posed to the Commissioner by way of his terms of reference, you believe that would be influential, both in governmental and non-governmental agencies; is that correct?
DR. HINCH: That's correct.
Q Thank you. And obviously, in a perfect world, if we could dream for a moment, you would want the Commissioner to speak to the 10 projects that you listed in Report number 9?
DR. HINCH: I believe they're important.
Q Yes. Thank you. I want to move on to the next thing, and unlike some of the parties to this, I don't have a battalion of scientists behind me to assist me in understanding some of the scientific work. I saw inherent in your report, Report number 9, more than a slight contradiction, and I want to just pose this with you and clarify it for the record.
MR. ROSENBLOOM: I'm referring first in Report number 9, which, of course, is Exhibit 553, to page 52,

if Mr. Lunn would be good enough to put that up.
Q And Dr. Martins, basically, this is under a heading, "3.1 Climate Change Effects." This is the summary, the abstract. I'm sorry, this is not the abstract, this is at the summary, at the conclusion of your report. And I'm down at the bottom of that page, where you say collective, but I believe it was your work, Dr. Martins:

> Overall, the weight of the evidence on the adverse effects of recent warming on survival of some individual life stages, as well as it's possible cumulative effects across life stages, suggests that climate change has been a possible contributor to the observed declining trend in abundance and productivity of Fraser River sockeye salmon over the past 20 years.

Let me stop there for a moment. We, as lawyers, have been trained about words like "possible" and "probable," and --
DR. MARTINS: Mm-hmm?
Q -- and we learn that "possible" is obviously of a lesser likelihood than "probable."
DR. MARTINS: Mm-hmm.
Q Now, so we have you saying, if I understand this correctly, that the recent warming, the effects of recent warming on survival at the various life stages is a possible contributor to the issue of abundance of sockeye, correct?
DR. MARTINS: Yeah. Correct.
Q And then I come, in my non-scientific approach, to the next page, page 53, under the heading, "3.2. En route and pre-spawn mortality," and this is more your colleague, Dr. Hinch's purview, and it reads, the first paragraph:

> *En route* loss --

Which, presumably, is, if I may interrupt for a moment, one of the life stages we're talking about:

> *En route* loss has occurred in all run-timing groups of Fraser River sockeye salmon over the past 17 years and there is ample evidence

that adverse environmental conditions, in particular, those related to thermal issues, are largely responsible for the patterns.

DR. MARTINS: Mm-hmm.
Q Now, I see a contradiction there and I'm sure it's not and so if you would explain to me --
DR. HINCH: Sure, yeah.
Q -- how we have a possible effect of these thermal changes --
DR. HINCH: Right.
Q -- in the first paragraph and what I see here.
DR. HINCH: So in the first paragraph, that's considering a life stage, across all life stages.
Q Yes.
DR. HINCH: And as you may recall from our literature review, some life stages, we have very little on, or the information is not consistent so in those cases, we're saying this is possible at that life stage, or it's unlikely at certain life stages. Some life stages were likely or very likely. So in the entire life history component, when you look at it from one -- you know, from birth to death, across the -- from egg to spawner, in that context, climate change, on the grand scheme of things is possible.

When you look at en route mortality and related to thermal issues, there's no question that it is a significant component of en route mortality, the thermal issues. So that's dealing with one life stage.

Q Yes.
DR. HINCH: The adult life stage.
Q And that one life stage has, as you have shown it in your paper, a high mortality rate, a concerning mortality rate?
DR. HINCH: Yes, for some stocks.
Q Yes, for some stocks.
DR. HINCH: Yes.
Q And with those stocks, you are going on record here in terms of your position that there is very clearly a strong causal linkage?
DR. HINCH: Between en route mortality and temperature in some stocks.
Q Correct.
DR. HINCH: Yes.
Q Thank you. Now, I want to come to the exchange

that you had yesterday with Mr. McDade and partly with other counsel today regarding the science article. And if understood the evidence yesterday with Mr. McDade, basically, Mr. McDade was questioning you about why you had not referenced either the article or the opinion stated in that article in the project, document, Project 9, before us, and I think you explained because of the embargo. And then you have been cross-examined from Mr. McDade and by others about it.

My question to you is now that you have the embargo lifted on that paper, have you told us everything that you would want to tell us in terms of the findings of that paper and its relationship to the work you did on Project 9 and on the subject matter? Put another way, Dr. Hinch, my instinct is to say to you, if you haven't, to ask the Commission to do a supplementary paper, be it a short paper, but to bring us up to date because it is critical for us as a commission, that the Commissioner give his report based upon the most current --

DR. HINCH: Yeah.

Q -- information, academically.

DR. HINCH: I guess in terms of a further summary of that paper, I would probably defer that to the lead author to do that, since she would be able to do it equally well and it's really her responsibility, I view, to talk about the disease issues in particular.

What the paper shows is consistent with some of the other work that we found, and I mentioned that in our review, as well, that's it's consistent with the fact that fish that are migrating in early are compromised from a physiological perspective in some manner. The earlier work that I cited couldn't pinpoint the particular cause of the compromise and even in this case, we're still talking about a hypothesis, in this case a purported virus. And we're focussing again, in this paper, mostly on Late run fish. So we're not focussing on most of the other run-timing groups.

Q I appreciate that. All that I care about is, as we all walk away from this hearing, have you informed the Commission of everything that is relevant from your findings or hypothesis of that

paper, science --
DR. HINCH: Yes.
Q -- with what you have been mandated to --
DR. HINCH: Yes.
Q -- present to us today in terms of Project number 9?
DR. HINCH: I believe, in terms of the testimony I've given and the additional information that's come out, I have.
Q Yes.
DR. HINCH: Yes.
Q I come next to an exchange you had first up this morning, I believe counsel from the Province of British Columbia. And I want to concentrate for a moment with you, Dr. Martins, and your analysis of the 2009 run, and the 2010 run, the variance in abundance of those two runs. You then focussed in your evidence on the ocean temperature, the sea surface temperatures of the 2007 and 2009 years. And I believe, and I had a computer problem, I had to walk out just at a point where counsel for the Province of B.C. was asking you a little bit about the correlation of the temperature issues and the abundance. And I believe that she asked you if the figures of warming for previous years shows also a reduction or decline in abundance, and I believe you said yes to that. Do I have that generally correct? In other words --
DR. MARTINS: I'm not sure I answered that for that particular question.
Q Let me ask my own question, then, to be quick about it.
DR. MARTINS: Yeah.
Q What I want to know is you have intrigued me and at least by saying, "Look, when we look at '09 and look at '10 --
DR. MARTINS: Yeah?
Q -- and we look back two years, we see a significant variance in ocean temperature --
DR. MARTINS: Mm-hmm.
Q -- in 2007 and 2008," correct?
DR. MARTINS: Yeah.
Q My question to you is have you been able to correlate that in other years --
DR. MARTINS: Mm-hmm?
Q -- there is a very direct correlation between temperature and abundance. And put another way, I

apologize, but can you point to other years where the ocean temperature has been significantly colder than average and where we have had had increased abundance of sockeye.

DR. MARTINS: Mm-hmm. The first thing, just to make clear, because the points I was making mainly yesterday about '09 and '10 are not our findings, these are findings from another report that it's coming out so I can talk briefly about this, I just don't want to go into details.

Q Yes.

DR. MARTINS: Because these are not my findings.

Q Thank you.

DR. MARTINS: The other point, if there has been any correlations between abundance and temperature in the year that the -- two years before the fish had gone to sea, we had -- there are some papers out there, we are not the authors on those papers, that relate productivity or the catch of the fish when they return to environmental variables like temperature, salinity, upwelling in different time lags. These time lags --

Q In the marine environment?

DR. MARTINS: In the marine environment.

Q Yes.

DR. MARTINS: These time lags would correspond to the time the fish were still in freshwater, the fish were leaving to sea, the fish were in the open ocean, or the time the fish would be returning, okay? So what these findings generally show is that in the particular case, when the fish is going out to sea, there is a negative correlation between the temperature they encountered. For the particular case of the Fraser River fish, there's a negative correlation between the temperature in the ocean when they leave to the production of fish two years later. So that means the warmer the temperatures when they leave, the lower the production two years later.

Q Yes.

DR. MARTINS: That's what I can tell you. I don't know any specific year. We don't usually look at specific years unless in a case like '09/10, where we have some extremes. We usually look for patterns. We have a general pattern where the -- when you have a high temperature in the ocean, when the fish are migrating out of the freshwater,

two years later, there's usually a lower production.
Q So based upon that correlation, presumably, harvest managers should have a sense, two years in advance of harvest, of the health of the returning stock?
DR. MARTINS: It's complicated to do that because when you look at these correlations, they are not very strong. There's a lot of --
Q Sorry, they're not very strong?
DR. MARTINS: They are not very strong.
Q Thank you.
DR. MARTINS: but they are significant, but they don't explain all the variability in the number of fish that is returning. Okay? So there are a lot of unexplained variability in the numbers, but there is, in general, a trend. So ocean conditions definitely seem to play a role, but they are not the whole story.
DR. HINCH: And my understanding is that the management agencies currently do that, they do look at these environmental conditions in advance to get some ballpark about what they're expected to translate into.
Q Thank you. In your report, in fact, in the abstract, you say, in part, and I just want clarification of this -- excuse me just one moment, please. You talk about adaption strategies, I'm just having trouble tracking it down in my report, to the findings that you've made, and I'm interested in knowing what those adaption strategies are. Is this the WSP that you're talking about, or other --
DR. HINCH: Oh, yeah, I see the line you're talking about.
Q Okay.
DR. HINCH: These were actually out of papers that we reviewed. These weren't our recommendations, necessarily. In fact, we didn't propose most of the ones that were in these other reports, but there was a whole series of them that had been reported.
DR. MARTINS: Yeah, these recommendations, they're not new, they're not ours.
DR. HINCH: Yes.
DR. MARTINS: They have been out there for a while, and there's a series of papers that go into the

details of each one of them.
Q Thank you very much. Dr. Hinch, you have concluded in the paper that there's no field evidence for negative effects of temperature on egg survival. Do I have that correct?
DR. HINCH: There's been no published studies in the peer-reviewed literature that have shown that.
Q With the greatest of respect, may I suggest to you that at UBC, there was a Master's thesis in 1996 by a Scott Cope --
DR. HINCH: Mm-hmm.
Q -- that indicated that very low egg survival rates of Early Stuart spawners occurred in a year when the spawners had been subjected to high temperatures before spawning. Are you familiar with that paper?
DR. HINCH: Yeah. Yeah, I'm familiar with Scott and his work.
Q Yes, and would you agree that that is field evidence that we're talking about?
DR. HINCH: Yes, it was a thesis so it's harder for us to track down the information in theses so --
DR. MARTINS: Just a question, sorry, because you're saying we didn't say there's no field evidence of a negative relationship between temperature and survival of the eggs, right?
Q Well, the paper, your paper --
DR. MARTINS: Yeah.
Q -- said that --
DR. MARTINS: Yeah.
Q -- and I'm going to suggest to you that, in fact, there is field evidence --
DR. MARTINS: Yeah.
Q -- through way of this Master's thesis.
DR. MARTINS: But what I think you're telling us is that in this study in particular, the author was looking at what did the adults experience in the migration and how this related to survival of their eggs, right?
Q Yes.
DR. MARTINS: So this is a different thing of what we are looking at. This would relate to what we're referring as inter-generational effects.
Q Yes.
DR. MARTINS: Okay?
Q Yes.
DR. MARTINS: Yeah, so that wouldn't fit into our

description of survival due to temperature and eggs, it would relate to a relationship between what the adults experienced and how this is carried over to the offspring.

Q All right. I understand. Thank you. The next series of questions I have relate to evidence that has been tendered in these proceedings by a few witnesses, and particularly by Mike Lapointe, and I just want to briefly refer to it and ask for your comments because it relates to stressors in the in-migration and it pertains to some of your evidence yesterday.

I'd refer firstly, in transcript, to January the 18th, page 86.

MR. ROSENBLOOM: Mr. Lunn, I think, has this keyed up for your purposes. So page 86, and I believe if you go down to line 42, and before you're reading it, just to explain the context of this, Mr. Lapointe testified on a few occasions to the issues of net avoidance. These weren't his words, but that the proliferation of fishing, net fishing upriver, in his opinion, had an effect on the mortality rate of the fish. And if we can go down to line 42, at page 86, first at page 86, line 42, it should read, yes:

> It is not the catch part of that that concerns me, it's the interaction with the gear in the context of warm water. So what I'm trying to say here is that if fish are encountering gear more frequently because there's more gear in the water during these warm temperature years, that could exacerbate the mortality impact. In other words, an additional stressor that the fish have. So it's not about the poaching issue, or any of that stuff, it's just about the gear fishery interaction and how that may be exacerbated by warm river temperatures that, you know, is something I would flag as a potential concern.

And then a little further down, line 14, 15, in part, he says:

> ... when there are fisheries occurring. Fish tend to be moving offshore. A fish that's

offshore is in the current. It's got to do more work to get to where it needs to go than a fish near shore. So it doesn't necessarily have to be a physical, you know, entanglement and escape ...

And so on.

DR. HINCH: Mm-hmm.

Q I think you got the point.

DR. HINCH: Yeah.

Q And he spoke to it the next day, too. Would you subscribe to that aspect of the issues pertaining to mortality, contributing to mortality?

DR. HINCH: Yeah, it's an issue that we are currently studying and Mike Lapointe's certainly a partner in that research.

The additional stressors that can be imposed behaviourally on these fish because of encountering some type of handling, or avoiding a handling event in the river under high temperatures could increase rates of mortality. We don't know what those exact levels are. How much of the metabolic scope, for instance, is lost, how much additional stressor is added is still what's uncertain, but yes, it is a contributor and we don't know to what level that's a contributor.

Q We may not know to what level, but it's intuitive to be of the opinion that clearly it is a contributor to the mortality rate?

DR. HINCH: Well, in terms of the fish being taken out of the river, yes.

Q No.

DR. HINCH: There's fish harvested and that's a mortality rate.

Q No, I'm not speaking of that, I'm speaking of the fish avoiding the net systems in back eddies, in foreshore areas, as a result, having to take their migration in the stronger current areas of the river.

DR. HINCH: Again, the fact that fish are moving into stronger current areas doesn't necessarily mean that they're going to be dying at higher rates. It could put them at a higher risk, but the telemetry work that's been done certainly shows that fish can get through these areas. Some fish get through these areas, some fish get tangled in

nets and get out of nets and get to spawning grounds. And we see lots of marked fish on spawning grounds so we know that that's happened. The quantification of that, however, is what's alluded us.

Q Well, we have heard evidence that there is a greater net fishery, a more prolific net fishery in more recent times.

DR. HINCH: Yes, and in warmer temperatures, as well.

Q And in warmer temperatures.

DR. HINCH: Yes.

Q And you are testifying, are you not, that this may well be an added contributing factor to the mortality issue?

DR. HINCH: It can be an added contributing factor.

Q Thank you. I come now to the issue of the premature entry in the Late runs into the river, and I believe I heard you yesterday speak of the Columbia River, and I believe you testified yesterday that they, too, are experiencing premature entry of the Late run, or do I have that correctly?

DR. HINCH: No, not in those words. What's going on is that there has been shift in the timing of stocks to what appears to be avoiding the peak temperatures that they once encountered, and by doing so, they're actually able to -- it's in a way that is benefiting them. The early migration of Late runs is in a direction that's not benefiting them. So they are behaving in a way that's maladaptive whereas the sockeye in the Columbia are migrating earlier, the steelhead are migrating later. In Eastern Canada, Atlantic salmon are migrating -- I can't remember if it's early or later, but it's in a direction that's avoiding the historical peak temperatures that's increasing.

Q And I believe you spoke of stock issues with the Okanagan fish of the Columbia and in Idaho?

DR. HINCH: Yeah, the returns to Okanagan sockeye in recent years have gone up a fair bit. The Idaho stocks have never been doing very well at all.

Q Do we have anything to learn from the American experience at the Columbia in terms of telemetry studies and in terms of grappling with the issues of climate change?

DR. HINCH: They are just embarking on telemetry

studies in Okanagan sockeye now. They're trying to replicate some of the things that we've been doing in the Fraser. I think what's remarkable about the Okanagan sockeye, and we may be able to learn from this, is that they do encounter really high temperatures during their migration. I view that group of fish very similarly to some of our Summer Run fish, in terms of the temperatures they encounter, and I'd like to learn a lot more about their physiology and their behaviour to know how they can cope and what that may offer us insight into how some of our stocks may be able to adapt and cope.

Q I see. And yet, you would agree with me that their stock have always encountered warmer temperatures --

DR. HINCH: Mm-hmm.

Q -- on entry than, obviously, at the Fraser?

DR. HINCH: Yeah. Well, they're encountering higher temperatures at the moment.

Q Yeah, but with a greater variance now than 20 years ago?

DR. HINCH: You know, I don't know the -- I can't speak to the variance in the Columbia, I just know the averages. I know the average has gone up.

Q Thank you. You also spoke briefly yesterday of the Americans at the Columbia River inserting a new type of receiver --

DR. HINCH: A transmitter.

Q -- a transmitter, I should say --

DR. HINCH: Yes.

Q -- into the fish. This is technology not currently being applied in Canada?

DR. HINCH: No, it's very new. It's called a JSAT tag. They're micro -- well, not microscopic, but they're very tiny and powerful and they have the possibility of being put into tiny, tiny fish and they're smaller than most of the current other transmitters that are available on the market.

Q And are they embedded in the same manner that --

DR. HINCH: Yeah.

Q Yes?

DR. HINCH: Yes.

Q And they're more expensive?

DR. HINCH: Actually, per tag, they're less expensive. What would be more expensive for us is that we'd have to change all of the infrastructure that's

currently in place to listen for them.
Q Right. Which would make it very costly?
DR. HINCH: Initially. The start-up costs would be costly, but in the long term, it could be much cheaper.
Q Yes.
DR. HINCH: It just depends on how long you run these programs for.
Q And we -- I have noticed that telemetry is being used in an effective way in terms of ecological study with satellite tracking for the various species, for example, Leatherback Turtles, and so on.
DR. HINCH: Yes. Yes.
Q Is there a future for satellite tracking of the mobility of Fraser River salmon, or is that way off in the future?
DR. HINCH: No, in fact, I just received an email the other day of an opportunity to work with a group in the States to test some brand new satellite transmitters that would be of the right size to put in ocean-going premature salmon as they're heading into the open ocean.
Q And that would be very exciting, would it not, because it would start giving us answers to some of what I'll call the vacancy --
DR. HINCH: The black box.
Q -- the gaps in our knowledge out in the marine environment, particularly in the Gulf of Alaska?
DR. HINCH: Yes, this information is not really out there anywhere.
Q And knowing that this is a possible direction, can you see foresee in the near future applications for grants for research which would apply this new technology with the satellite tracking devices so that we could start answering these critical questions of marine environment?
DR. HINCH: I don't know where to go for funding for this.
Q No, you don't know, but you do know where to go to inform us whether it is, in your opinion, a worthwhile --
DR. HINCH: Yes.
Q -- direction and you do know where to go to make a recommendation to this Commission, you're here.
DR. HINCH: Okay. Yes. I think it's extremely important and if we had the opportunity to access

that technology and that research, I would jump on it, and I know other colleagues would jump at it, too.

Q When do you imagine that the technology will be of such a state that you, as an academic, would be comfortable pursuing an application for such a project? Are we there yet?

DR. HINCH: We're here, we're here now. The technology as I was made aware of very recently is there. What we now need to do is find the money.

Q And you will state for the record that in the field of ecological study with a number of other species, satellite tracking is now the norm for investigation?

DR. HINCH: It is, and up until recently, it was focussed on larger animals because of the size of the satellite transmitters.

Q But now, you believe the technology may allow salmon to be tracked in such a fashion?

DR. HINCH: Yes.

MR. ROSENBLOOM: I hate indicating that I've completed my examination in advance of what was my prediction, but, for once, I have. I thank you very much for answering my questions.

MR. McGOWAN: Mr. Commissioner, Mr. Harvey is going to go next. He's switched places with Mr. Eidsvik.

THE COMMISSIONER: Yes.

MR. HARVEY: Chris Harvey for the Area G Harvesters and the UFAWU.

CROSS-EXAMINATION BY MR. HARVEY:

Q Dr. Hinch --

THE COMMISSIONER: Your time estimate, Mr. Harvey, sir?

MR. HARVEY: I beg your pardon?

THE COMMISSIONER: Your time estimate?

MR. HARVEY: My time estimate is about 20 minutes so I should finish by the break.

Q Dr. Hinch, I am not going to spend my limited time asking about the warming trend because I gather there's little we can do about that. I want to ask you first about some things we perhaps can do something about. Firstly, the mortality-related genomic signature that you mentioned as being in response to a virus affecting the fish before river entry, now, is that something -- that's something, I think you said, causes the aberrant

early migration of Late run stocks?
DR. HINCH: It's a purported, a possible virus.
Q Possible.
DR. HINCH: And it's associated with the early migration, but it doesn't explain all of it.
Q Yes.
DR. HINCH: And it's associated with mortality at different rates, but it doesn't explain all of it.
Q All right. Is there any reason to believe that this virus was not always present in Fraser River sockeye?
DR. HINCH: The purported virus, as I understand from my genomic colleagues, appears to be novel so it seems to be new to the system in terms of our knowledge of viruses.
Q Well, our knowledge, of course, is always advancing and is always new. Is this something that could have always been there, but --
DR. HINCH: That we didn't look for? Yes, it's possible it could always have been there and we haven't looked for it before.
Q Yes. All right. Who is the expert on that subject?
DR. HINCH: That would be Dr. Miller.
Q Yes, thank you. And as I understand it, this I'll call it a purported virus, I think you're more comfortable with that, is something that affects all species of sockeye, but some more significantly than others?
DR. HINCH: Well, we've only looked at -- with this analysis, we've primarily just looked at Adams-Shuswap. We also looked at two other stocks in terms of the paper that you're referring to. I'm not aware of what other stocks Dr. Miller has looked at in addition to those so I can only speak to those particular ones.
Q All right. Is this virus something that can be eliminated or is that --
DR. HINCH: That's out of my area of expertise.
Q Oh, all right. But of course, we should be able to address fishery practices that exacerbate the effects of that virus, purported virus?
DR. HINCH: Okay.
Q Now, you mentioned the abrupt shift in 1992 in migration behaviour.
DR. HINCH: '96.
Q Or '96, sorry.

DR. HINCH: For the Late runs, it was '96.
Q '96, I see. And was it '92 in respect to some other runs?
DR. HINCH: No, '92 was the year when we started to see en route loss being recorded or observed in the databases of the management agencies.
Q I see. And Mr. McDade asked you, followed along this line, and I think you indicated that there was nothing abrupt about climate change, but there was an abrupt change in en route mortality commencing in 1992?
DR. HINCH: Yes, and I also commented that prior to 1992, there's indications that there could be some en route mortality occurring, likely at much lower levels, it just wasn't recorded as such in the databases.
Q Yes. I had an opportunity to look at some of the reports relating to 1992. One was the Pearse-Larkin report, although I couldn't find the Pearse part of it, but the Larkin technical appendix makes this note, and I want to ask if this is consistent with your knowledge. This is page 23, for the record, of the technical appendix to Managing Salmon on the Fraser River, by Peter H. Pearse [as read]:

> On the spawning grounds, from 20 to 50 percent of the Early Stuart fish that arrived were apparently unable to negotiate the counting fences and spawning down -- and spawn downstream. 25 -- or 12 percent of the arrivals died before spawning.

And then it continues on page 24 [as read]:

> An additional source of stress and mortality may have been the gauntlet of gillnets in the river. 50 to 60 percent of the Early Stuart spawning fish were net-marked, a two to threefold greater incidence than in other years. Females predominated in spawning populations, 63 percent, a further sign of intense gillnet selection. Higher than usual rates of net marking were also observed in the Chilko and Stellako stocks. Fish that had been caught and had escaped had undoubtedly been stressed by the experience

and rendered much less capable of coping with high-temperature regimes.

It continues on page 25 [as read]:

Fish commonly die in gillnets, but then drop out of the nets and are not caught. Experienced native fishermen at Yale remarked on the large numbers of dead fish drifting downstream, many of them gillnet marked.

This is in 1992 [as read]:

At the Mission echo sounding site, the number of dead fish observed floating downstream was roughly 30 percent higher than in 1990 and 1991, even though the abundance of salmon was substantially less in 1992.

Is that consistent with your knowledge of the increased en route mortality in 1992?

DR. HINCH: There's a lot in what you've asked.

Q But --

DR. HINCH: In terms of consistent, I'm just looking at the en route loss information from 1992. For the Early Stuart, it looks like it was about 30 percent that year. And for the Early Summers, it looks like about eight percent. About the same for the Summers, and none reported for the Late runs.

Q Yeah. This evidence of in-river nets having a detrimental effect on fish migration, that's something that you were aware of, I expect?

DR. HINCH: Yes.

Q Is that right? Yes. In fact, I think you've agreed that freshwater data indicates that some fisheries occurring in lower river at higher temperatures are inadvisable?

DR. HINCH: Yes. And that's why, with a lot of our telemetry work, we try to avoid using fish that would have disappeared for whatever reason in the areas where there's heavy fisheries.

Q Yes.

DR. HINCH: We try to make sure at least the fish could have gotten out of that area and then we compared those fish to fish that made it further along.

Q Yes. The other report I was able to find, and I

don't know if it's in evidence, is the Pacific Salmon Commission -- the Report of the Fraser River Panel to the Pacific Salmon Commission in the 1992 Fraser River Sockeye Salmon Fishing Season, and it states, at page 28, that -- and it refers to a closure. There was a closure of the fishery on August 16th or 17th, and it says this [as read]:

> Indian fishing impacts on Summer run sockeye migrating past Mission prior to August 16th were high, as well.

That's when the fishery was open [as read]:

> However, removal rates were close to zero for fish migrating after that date, as these fish were protected by closure of mainstream Fraser River Commercial and Indian fisheries by the Minister of Fisheries. Arrival of Chilko sockeye at a counting site below Chilko Lake showed that nearly 100 percent of the Chilko fish that migrated past Mission after August 16th arrived at the site, compared to 21 percent of the fish that migrated from August 2nd to 8th, and 52 percent of the fish that migrated from August 9th to 15th. This latter group was partially protected by upstream closures.

So that is an indication, I expect, of what you referred to as the effects of freshwater fisheries?

DR. HINCH: Yes.

Q Yes, all right. And I think you said there are not coldwater refugias in the Lower Fraser; is that correct?

DR. HINCH: That's correct.

Q Yeah. But there are back eddies where the fish tend to gather to recover and recover their strength, is that --

DR. HINCH: We don't see fish really slowing down. The telemetry data suggests that once they've begun their migration, they've entered the river, they move at a pretty steady pace of I think it's about 30 to 50 kilometres a day and there's not a lot of slowing. Where slowing has been observed, and not

just in our work, but in other work, is where they do encounter a cool water tributary, potentially. But if anything, when the water's a bit warmer, they tend to want to move through it quicker.

Q All right. I'm going to read you some passages from the evidence of Ian Todd, who was with the Pacific Salmon Commission for a number of years. He was with the DFO from 1953 on. In 1985, he joined the Pacific Salmon Commission, or '86, I should say, and became the executive secretary, and he describes how the salmon act in the Lower River, and I want to ask you if this is consistent with your knowledge. He starts, he describes the 1992 fishery. He said [as read]:

> It became evident that there was a --

MR. McGOWAN: Sorry, Mr. Harvey, I apologize for interrupting. I wonder if you could just indicate where the evidence is taken from and if it's from this Commission --

MR. HARVEY: Yes.

MR. McGOWAN: -- what the date of the evidence was.

MR. HARVEY: Yes. No, it's not from this Commission, and it's from a transcript. I understand -- it was Mr. Eidsvik who gave it to me and I understand he's going to be putting it in later. It's a transcript of proceedings at trial at 222 Main Street, 7th -- I'm sorry, this passage is from 16th October 2002.

MR. McGOWAN: Mr. Commissioner, we have been following a practice in the Commission of giving notice of documents we intend to put to witnesses to allow them to have an opportunity to review them. This is the third document my learned friend has put to the witness and I haven't risen before because he's simply read the proposition and asked the witness to respond to it, but we seem to be going down a road of reading lengthy passages from documents the witness hasn't had the opportunity to look at before, and it's a matter of some concern.

MR. HARVEY: Well, you know, I appreciate that. I'm trying to follow up with some -- to get a little more precision on the threats, which is, I think, the way Dr. Hinch put it, that are present in fish migration in the Lower Fraser, the Lower Fraser

being one of the serious areas. I wanted to read him a description of the fish in that stretch and what they do in that stretch of river.

THE COMMISSIONER: I think, Mr. Harvey, you know, the difficulty of referring to evidence which was part of another trial --

MR. HARVEY: Yes.

THE COMMISSIONER: -- without, of course, giving Commission counsel and perhaps the witness an opportunity to review the circumstances and context in which that evidence --

MR. HARVEY: Yes.

THE COMMISSIONER: -- was given, if you could put the proposition you wish to put without referring to the transcript, that would be helpful.

MR. HARVEY: Yes, all right.

Q The proposition, well, I've already dealt with the 1992 fishery, I want to ask you this, the proposition being this, that at Hell's Gate, in 1992, Hell's Gate fishways, prior to the closure of the fishery -- I'm sorry, after the closure of the fishery, there was a steady stream, and this is prior to the closure of the fishery, there was a very -- there was perhaps 50 to -- I'm sorry. There was a very limited number of fish passing through the Hell's Gate fishways, but after the closure of the in-river fishery, this is between Mission and Yale, there was a steady stream of highly-coloured fish visible migrating upstream, nose to tail, observer's estimate, over 90,000 fish in one day. That's a day or two after the nets were pulled from the river. Is that consistent with your understanding of the effect of nets in the river between Mission and Yale?

DR. HINCH: Between --

MR. McGOWAN: Mr. Commissioner, I wonder if it might be helpful to first identify whether or not this is within either the knowledge or the area of expertise of the witness.

MR. HARVEY: Yes, all right.

Q Well, is this, the migration patterns with nets in the river and nets not in the river, is that something within your area of experience?

DR. HINCH: To a small degree. Again, I draw from our experience with telemetry and tracking fish through the river during periods when fisheries are occurring and, in fact, usually, there's

always fisheries occurring when we're tracking our fish. I guess it's difficult to ascribe a lot of credibility to visual observations made at Hell's Gate. I've done a lot of work at Hell's Gate and it's really hard to see fish, even under the best of circumstances, and I've always been concerned about the quantitative assessments of numbers that have come from there. It's often hard to put a lot of precision in those, in my view.

In terms of migrations, certainly, you know, fish -- certainly, fish will attempt to avoid -- are we done? Does that mean I can stop now?

MR. HARVEY: Just an interruption in migration. Please continue.

DR. HINCH: Just like a net in the water, I suppose. So now, certainly, fish can be -- their passage can be interrupted as they encounter fisheries of any kind, not just nets, but other fisheries. Certainly, angling, as well, can interrupt their migration and it will slow them somewhat. However, again, during all the tracking we've done, even when there's nets in the water, they do tend to move rather quickly. And that's my concern with relying too much on really old information, and looking at visual observations because we realized after a lot of our telemetry studies began, that our -- the visual observations aren't necessarily the most accurate ones in terms of looking at migration, and timing, and patterns, and relative abundance. So I guess I'd be hard-pressed to make comments on what happened back then because I'm not comfortable with the numbers.

Q And there are others more experienced than you in the --

DR. HINCH: I think you could probably get some insights from Mike Lapointe and others with a more historical perspective from the Salmon Commission, because that's where this information probably came from originally.

Q Yes. All right. Well, at any rate, I think you'd agree with this proposition, that one of the strategies that can be adopted to assist the migration of fish under the stressful circumstances that you've described is to minimize in-river fisheries in particularly the warm areas of the Lower Fraser River; is that correct?

DR. HINCH: Yeah, I guess I can reword that along that

line that, certainly, additional stressors applied in any way to migrating fish during warm periods adds additional risk to their ability to get to spawning grounds.

Q Yes, all right. Now, with respect to the -- again, to the purported virus, there was evidence earlier in this Commission from a panel that had Dr. Walters on it, and Jim Woodey, and there was mention in that evidence of high-rearing densities in the rearing lakes. This is what Dr. Walters said, and I'll just ask you to comment whether it's relevant with respect to the purported virus. He said [as read]:

> That really feels like the high escapements and high smolt, high-rearing densities in the lake stimulated something to develop in the lake that is now killing Chilko smolts after they leave the lake at very high rates. Our best candidates for such a something is parasites and diseases. I got a grad student to go through and look at a large number of Chilko smolts I collected over the years at the Chilko fence. She found really high parasite loads in these smolts, higher than had been found in other stocks. It's quite possible that high escapements combined with fertilization of the Chilko led to a dramatic increase in parasite loads ...

Et cetera. And then he makes reference in this passage -- yes, I'll carry on because he makes reference to you [as read]:

> ... led to a dramatic increase in parasite loads being carried in these fish and that's what's killing them at such higher rates now, as you've heard about from Scott Hinch's tagging study, and so on. We really need some serious basic research on mortality, agents and the freshwater system and how those may be carried later in the lives to cause mortality after they leave the freshwater.

Is there anything you'd like to comment on with respect to that?

DR. HINCH: Yeah, what he's talking about that we are in need of is studies looking at what I would call intergenerational effects, so looking at how -- or cross-generational effects, at how one life stage influences another in terms of its health or condition. And I would agree we know very little about that.

Q All right. Do you think that the high-rearing densities in the freshwater system, spawning grounds, and the rearing lakes might exacerbate the purported virus that you spoke of?

DR. HINCH: I don't know. I couldn't answer that. We just don't know enough about what this purported virus is.

Q I see. My final subject is with respect to the warming trend. You said, I think the warming trend will definitely continue. The only subject of debate is the rate of warming; is that correct?

DR. HINCH: That's correct.

Q Yes. Some -- and I think I can summarize your evidence this way, that some sockeye stocks are better able to cope with the warming trend than other sockeye stocks?

DR. HINCH: That's correct.

Q Is that right?

DR. HINCH: Yes.

Q And the graph given at page 89 of this technical paper, Number 9, shows the Weaver stocks at the high end of the range?

DR. HINCH: That's right.

Q Are the Cultus stocks similar to the Weaver stocks?

DR. HINCH: They would be. The problem with assessing en route loss in Cultus is that they spawn in the lake and so the mortality that occurs, that we observe there, we may be calling pre-spawn mortality. So if you were to look, then, at Figure 2.12 on page 94, you'll see there, where we can look at pre-spawn mortality, which probably incorporates some en route mortality to a degree with the Cultus fish, and you can see the triangles, the green triangles being at a much higher and more variable level --

Q Yes.

DR. HINCH: -- since the mid-'90s.

Q So is it fair to say that the Cultus species is not one that copes well with this warming trend?

DR. HINCH: Well, yeah, it's Late run stock like the others on that particular figure, and Late run stocks, in general, aren't coping well with -- because of the Early migration phenomenon and all the issues associated with putting them into warmer waters than they're normally exposed to.

Q I suppose the phenomenon of natural selection, the Darwin theory, survival of the fittest --

DR. HINCH: Mm-hmm.

Q -- applies in this area, as in other areas?

DR. HINCH: Yes, and we would have expected that because this is such a maladaptive behaviour, this early migration, that over a very short number of generations, it would be selected out, if it was under strong genetic control, but it suggests that at this point, that's not happening. In terms of the behavioural change that's going on in the Strait of Georgia.

Q Yes. Would it be a reasonable conclusion to draw from the fact that the warming trend is bound to continue and that some stocks are better able to cope with that than others, that the best -- that it would be a better -- or the best long-term fish management strategy would be to focus on those stocks that have shown that they are able to cope with warming and to put less emphasis on the stocks that are less able to cope with warming?

DR. HINCH: Well, I think you're getting at the biodiversity issue here.

Q Yes.

DR. HINCH: And again, we don't know -- just because a stock has difficulty coping with the warming, it doesn't mean it doesn't have the potential, through evolution, through the mechanisms you mentioned earlier, to adapt over time. And it may take several generations before this happens. And, again, it's the few individuals that have the right genotype that will be able to survive these conditions. They'll be the ones within a population that ultimately reproduce more and survive and so on. So I think it would be a bad idea to be focussing just on the ones that can cope because we don't know what the genetic components are of the stocks that are having difficulty right now, how well they will be able to take over and adapt in the future.

Certainly, we've seen this happen in other

animal populations so I think we have to be risk averse in protecting our stocks.

Q So is this what you're saying, that there is insufficient evidence yet to show which are the fittest and which are the weakest?

DR. HINCH: Well, in terms of under current conditions, the stocks that encounter the highest temperatures naturally at this point seem to be able to cope the best and, certainly, the suggestion is that they are adapted best to that historical temperature context. The ones that are getting pushed out of their historical context to the greatest degree, which, in this case, happens to be the Late runs because they're migrating in so early, those are the ones that are suffering the highest levels of mortality. So they're the ones that are not coping as well. They would cope much better with the range that they historically encountered.

Individuals in that population, though, within a population, certainly can cope. There is variability. Not every fish dies. So the hope, from a conservation/biology perspective, is that some individuals -- those individuals that are able to cope within a population, not the average individual, but the individuals on the ends of the distribution that can cope will be the ones that will propagate further into the future, and that's what I'm suggesting we need to hold onto and look forward to if we expect these populations to persist in a warming Fraser.

THE COMMISSIONER: Mr. Harvey, I note the time, are you done?

MR. HARVEY: Yeah. I think I am done, yes.

THE COMMISSIONER: We're going to adjourn. Counsel, I don't know who's left, but we have, as you know, from 2:00 to 4:00 this afternoon for this panel and that's it for this panel so I would ask you to put your heads together and divide up the time as equally as you can to ensure that you all complete by 4:00 this afternoon. Thank you very much.

THE REGISTRAR: The hearing is now adjourned till two o'clock.

(PROCEEDINGS ADJOURNED FOR NOON RECESS)
(PROCEEDINGS RECONVENED)

MR. McGOWAN: Yes, Mr. Commissioner, you're going to be hearing from Mr. Eidsvik and then Ms. Gaertner.
MR. EIDSVIK: Good afternoon, Commissioner, my name is Philip Eidsvik for the record, for the Area E Gillnetters Association and the B.C. Fisheries Survival Coalition.
THE COMMISSIONER: And your time estimate, Mr. Eidsvik?
MR. EIDSVIK: My time estimate is 15 to 30.
THE COMMISSIONER: Thank you very much.
MR. EIDSVIK: Hopefully sooner, Mr. Commissioner.

CROSS-EXAMINATION BY MR. EIDSVIK:

Q Mr. Hinch, I'm going to try and narrow down the places where we can have impacts of global warming help the Commissioner understand the impact of global warming and water temperatures since 1992. And I gather that's your period roughly when you say that we start seeing these increased warm water events.
DR. HINCH: Well, I mean the river's been warming for the past 60 years. In the past 20 years, we've seen -- sorry, about a two-degree warming in the past 60 years; just about a one-degree warming in summer temperatures in the past 20 years. The 1992 year comes into place in terms of the dataset that the management agencies collect dealing with en route loss.
Q Okay. Thank you for that. Now, if there's a good return of sockeye in relation to its escapement four years previous and if we have a good return and they're caught in a public commercial fishery and the Aboriginal food fishery in marine areas so we get a good return to the mouth of the Fraser River, can we say that ocean conditions weren't a factor in that period? Or deleterious ocean conditions, negative ocean conditions?
DR. HINCH: If you get a good return to the Fraser mouth, is that...?
Q Mouth of the Fraser River based on escapement four years previous?
DR. HINCH: Right. So expected or better than expected based on those numbers?
Q Yeah.
DR. HINCH: Then I guess you could conclude that the conditions during the life history prior to that, which would include ocean and juvenile freshwater

stages were good, were not adverse.
Q Okay. I guess that helps a lot. Since 1992, can you tell me the years that we didn't -- where we had an escapement number of X that should have produced roughly a return of Y, yet we had a crash? And 2009 is an obvious example. And I wonder if there's any other years.
DR. HINCH: Well, I guess I'm just recalling the -- and this wasn't in our report. I'm just recalling the general decline and productivity trend that I know the Commission has seen that recruits per effective spawner relationship that starts to decline in the early '90s and declines pretty steadily until 2009 and then bumps up a bit in 2010. I mean it looks like from that figure that productivity has been on a slow, steady decline since the early '90s.
Q Well, 2009 was obvious. We had pretty good, not great escapement, but we had decent escapement?
DR. HINCH: Yeah.
Q We had pretty good smolt --
DR. HINCH: Yeah.
Q -- and smolt size out of the lakes and you would expect X to come back roughly.
DR. HINCH: Yeah, and we saw very low -- I mean we were below replacement, as I recall, for that particular year. But on years prior to that, again, going back to that relationship that I know the Commission has seen before, it's almost it was like a steady decline from the early '90s to that point where the productivity rate just continually got lower and lower and lower and lower. So that was occurring. Looking at that relationship, it didn't look like any one year stood out; it was a steady decline through that time period for productivity, which is a bit of a different metric than spawning ground abundance.
Q Okay. So that kind of helps us on the ocean. I guess you can't point to any single year that stands out like 2009 then?
DR. HINCH: Well, I guess 2009 stood out insofar it was the poorest of that decline so it sort of reached the nadir.
Q So now we go into the lake system. Now, if we have fairly good fry survival, fairly good smolt exit from the lakes, fairly good size, you can say that climate conditions inside the lakes and

rivers weren't too bad.
DR. HINCH: Well, I guess I would say the growing conditions were good and climate would be a part of that.
Q Okay. So do you know any years when we had bad egg-to-smolt survival and bad smolt escapements?
DR. HINCH: Yeah, I haven't looked at those data to know which years were good or bad or indifferent, sorry.
Q But that would help us understand if global warming was having an impact in the lake system?
DR. HINCH: You would need to look at those datasets and look at the interannual variability in those data to get an idea of how specifically climate was affecting or potentially affecting that life stage.
Q But you haven't done that research, I guess?
DR. HINCH: No, that wasn't part of our mandate.
Q Okay. 1992, Mr. Harvey raised a few issues about '92 and you'd briefly talked about Hell's Gate. And in Hell's Gate, the fish go through the stream. Hell's Gate is on -- the fish ladder is on one side. If you had a number of days where you had passages roughly of 2,000 and then all of a sudden you had the nets removed out of the river and the next day you had a passage of 90,000, would that indicate to you that nets were a factor?
DR. HINCH: I guess I come back to my original concern with that particular year and that particular observation. I've worked at Hell's Gate before and I just have my concerns about using visual observations of fish passing through there as a means of assessing relative abundance. In some cases, it's really hard to see the fish coming through there and it really depends a lot on the day and the conditions of the day. And so I guess I'm reluctant to want to answer a particular year and a particular -- because I haven't seen those data and I just am concerned about the quality of them, I guess.
Q So you can't make any suggestion if the data indicated that there was 2,000 gone by on Monday, the nets are pulled out on Tuesday and 90,000 fish go by on Wednesday, you're not going to read anything into that?
DR. HINCH: I would have to confirm the veracity of the

data for me to say anything.
Q Okay. Assuming the data was accurate.
DR. HINCH: If the data were accurate, I guess the implication is that the nets could have had a role to play.
DR. MARTINS: Can I add something?
Q Yeah.
DR. MARTINS: Just one thing you have to keep in mind when looking at this kind of data. There is no constant number of fish entering the river at each day. So we have to look at the distribution of fish that are entering the river during the runtime. So it doesn't mean that if you take a net out of the river there is more fish because you took the net out of the river; it could just be because a couple days later there were more fish entering the river just because of the distribution of entry, timing of each particular run.
Q And how long does it take for a salmon to get from the mouth of the river to Hell's Gate?
DR. HINCH: Well, they travel at about 30 to 40 kilometres per day so, what's that, about five to seven days? Seven days perhaps.
Q So then if you had no fish on day one at Hell's Gate, 2,000 fish on day one at Hell's Gate and 90,000 on day two, wouldn't really make much difference how many fish were entering the river.
DR. MARTINS: Well, I'm not saying that the fish would take two days to get from the mouth of the river to the Hell's Gate but there could be fish that had already entered the river a long time ago and they are just behind the two days before Hell's Gate they might be getting there. I'm not trying to argue against you, just trying to tell you that you cannot just take one factor out because there are other confounding factors that might be responsible for the observations, if they are accurate.
Q Yeah, I appreciate that. So on another example, and I'm going to put this to you, if when the nets are in the river, only 21 percent of the fish that were going to the Chilko system were getting by the nets and then you took the nets out of the river and all of a sudden a hundred percent of the Chilko fish were getting to the spawning grounds, would you infer that the nets were a factor?

DR. MARTINS: I would have to look at the other factors that were occurring at the time. Do you know any other factors?
Q So you're saying that you can't infer anything from --
DR. MARTINS: Not just by taking one piece of evidence. You would have to know if these same conditions that they were experienced at the same time.
Q Well, let's look at it in the context of water temperature then.
DR. MARTINS: Yeah.
Q Does water temperature change overnight?
DR. MARTINS: Yeah, well, it doesn't change overnight but it does change with all the seasons.
Q Okay. So if you had a whole bunch of fish that weren't getting through on Monday and all of a sudden the nets were removed on Tuesday and then you did have many thousands of fish getting through, would you say that's a water temperature effect or a net effect?
DR. MARTINS: I'm not saying it's a water temperature effect. I can say it's a timing effect --
Q Thank you.
DR. MARTINS: -- because you can see the distribution of the fish.
Q Now, Mr. Hinch, you remember in -- and I don't know if it was 1992 or 1994 but you wrote an article in the Vancouver Sun saying you basically knew what had happened to the fish. Do you remember that?
DR. HINCH: I didn't write an article in the Vancouver Sun.
Q You didn't ever write an editorial, an op ed piece?
DR. HINCH: No, I never wrote an op ed piece. There may have been somebody that interviewed me and wrote an op ed piece. I didn't write any.
Q Thank you for that. Now, going into the Pearse report, you must be familiar with it because he studied water temperature. What conclusion did they conclude about the impact of water temperature in 1992? Do you remember what number they said mortality?
DR. HINCH: I can't recall the specific numbers that...
Q 1994, do you remember what Fraser concluded?
DR. HINCH: Just in terms of the total mortality attributable to temperature? Is that what you're

asking?
Q Yes.
DR. HINCH: I can't recall the specific number.
Q Would it surprise you if Pearse said 10 percent and Fraser said 15?
DR. HINCH: For those two years?
Q For '94 and '92.
DR. HINCH: Perhaps back then it wouldn't have surprised me given what we didn't know. And now that we know so much more about the thermal biology and thermal ecology, and we were quite naïve back then on all of those issues.
Q 2004, we had another temperature event.
DR. HINCH: Yes.
Q And the Early Stuart run was hit pretty hard.
DR. HINCH: Yes, I recall that.
Q Now, do you remember that the Pacific Salmon News Released Number 9 on September 3rd, its comment saying that Early Stuart sockeye migration conditions temperature was only slightly above normal? Do you remember that?
DR. HINCH: That was a Salmon Commission report published back then?
Q Well, no, I don't think we need to go into the report. Would it surprise you if an authority concluded that migration conditions during the Early Stuart run were perfectly normal or pretty close to normal?
DR. HINCH: We also had DFO people back then saying that every fish passed through Hell's Gate successfully and we just know that that wasn't the case. I just think we've learned a lot since, in the ensuing 30 years, 25 years, about fish passage and thermal biology and we knew very little back then.
Q Well, I guess what I'm getting at, if the Early Stuart run, and I put it to you this way, if it was shown in 2004 that temperatures during the Early Stuart migration were close to normal or normal, would you discount thermal shock as being a factor in the disappearance of those fish?
DR. HINCH: My recollection of the Early Stuart migration, because I was tracking fish that year in '94 in the Fraser Canyon, I recall that when temperatures were 16 degrees or below, I believe that was the number, they were migrating what I would think they would be normally, temperatures

rose above that. As I recall, we started seeing transmitters disappearing. That was the first ever transmitter study, by the way, done so we had no baseline to compare it to. But it seemed to me back then that temperatures above 16, 17 degrees were starting to become a problem for that group of fish and turns out when we start looking at thermal ecology now, indeed temperatures that are getting into that range begin to become a problem for them.

Q But if temperatures during that period were pretty normal, you'd have to say we ought to look somewhere else other than temperature.

DR. HINCH: Well, again, I recall them being at those levels so normal -- that's certainly not normal. I mean the long-term average when the Early Stuarts enter the river, as I recall, is between 15 and 16, or 14 to 16, so when you get above that you're getting outside of normal.

Q Now, one of the studies that you cited in your report was a study called "Resistance of Adult Sockeye to Acute Thermal Shock" by, I think Jensen and --

DR. HINCH: Servizi.

Q -- Servizi?

DR. HINCH: Yes.

Q Now, their study concluded that the upper lethal limit was 24 degrees. It was a lab experiment, mind you, and obviously conditions in the river are different. But I thought what was interesting was they discontinued the test after 15 days at 21 C because all the fish were still alive.

DR. HINCH: Yeah, I commented on this yesterday. It became apparent after reviewing old archives and talking to colleagues who had worked with them that they were using antibiotics and other disease agents in their experiments to keep the fish alive under their length and periods and when we do that in lab studies, yeah, you can keep fish alive a lot longer under higher temperatures but when you don't do that and let naturopathogens in the water do what they do, then indeed you see the lower temperatures having its toll.

Q So temperature itself is not the factor, it's complications arising from temperature?

DR. HINCH: It's two things. So you can have these acute issues with temperature that aren't related

to the complicating factors and the two things would be metabolic or cardiac collapse, which can occur rapidly at certain temperatures. We call those "critical temperatures". If the temperatures aren't quite at critical levels but they're still high, then you can have these associated factors like disease and stress and energy exhaustion playing a role.

Q Okay. In your report, there's not a lot about fishing but I know in another study the influence of extreme water temperatures on migration in 1998, which I gather was another temperature event, a lot of pretty smart people participated in that report?

DR. HINCH: That was a DFO technical report?

Q Yes.

DR. HINCH: Is that correct? Yes.

Q Jim Woodey and a number of others participated in that.

DR. HINCH: Yes, that was 1998.

Q Well, actually it was a 1998 fishery.

DR. HINCH: That's right.

Q They wrote it in 2000.

DR. HINCH: Published in 2000. Yeah, I recall that.

Q Yeah, one of the statements in there that I think is important, and I'll read it to you, and I'd like your opinion on it, and they talk about fish behaviour in response to a gillnet fishery.

MR. EIDSVIK: Now, Mr. McGowan may have something to say about this.

MR. McGOWAN: Yes, I do, Mr. Commissioner. This is another document that the witness I don't think has been given notice of so I think it's important in terms of fairness to the witness that prior to him being asked to answer we make sure that he is sufficiently familiar with the document that he feels he can give an adequate answer.

MR. EIDSVIK: Mr. Commissioner, and I agree with that normally but Mr. Hinch included it in his study, he referred to it, he cited it. I expect that he would be familiar with it.

MR. McGOWAN: Yeah, I'm not suggesting Mr. Eidsvik not ask the question. I'm just alerting you to the fact that the witness may not know it's coming and to be cautious that he has adequate time to consider his answer and see the document, if necessary.

MR. TAYLOR: I'm not objecting to this particular question but I am adding in my comment. Mitchell Taylor speaking. I see a trend emerging of Mr. Eidsvik coming up with new documents, and Mr. Harvey was doing the same, without either the witness or counsel -- certainly, the witness needs to see it but I think counsel should see it, too, and that's the point of the two-week and one-week. And you're probably not concerned with the details of that, Mr. Commissioner, but there are protocols over giving notice and they're not being followed. And at the same time, this is not a test for the witnesses, although both Dr. Martins and Dr. Hinch are doing pretty good with what I'm regarding is a test in these questions, "Do you recall this from 20 years ago?" and so forth. But notice is important and there's a reason for it, as we all know.

MR. McGOWAN: Yes, Mr. Commissioner, I agree with Mr. Taylor that notice is important. I've spoken with Mr. Eidsvik about it and he's assured me that he's going to bear those comments in mind and make every effort to comply with that going forward.

MR. EIDSVIK: And Mr. Commissioner, I wouldn't be citing this document if it wasn't included in the study. And I wasn't aware that if an expert witness had tendered a study as part of their evidence that I would have to give notice on the evidence already tendered by the expert witness. But in the future, I'll make sure that even when we're citing a report that they've relied upon that we'll cite that we're going to rely upon it.

Q Are you familiar with the little section in the paper on fish behaviour where they talk about --

DR. HINCH: It was a big document so you might have to read --

Q Yeah, it was a big document.

DR. HINCH: -- to me the section.

Q Well, it's going to the point again of temperature -- sorry -- of what I call fishing-induced mortality in high temperature situations.

DR. HINCH: Okay.

Q And they say that periodic gillnet fishery openings in the Fraser River available to First Nations and they looked at how those openings impact fish passage and they said, "The fishing period of July 30th to August 2nd is illustrated."

And they say, [as read]:

> On the day prior to the opening, fish passage was concentrated and all transducer aims at a range three to six metres from the transducer. While the nets were in the water, fish passage was concentrated towards the river bottom at an increased range from shore. Passage numbers dropped dramatically from an average of 1,000 fish per hour to less than 200 fish per hour at the onset of the fishery.

And then they talk about a second one [as read]:

> The reaction of fish to a gillnet fishery was also observed during the 1997 sockeye migration. On the day prior to the opening, fish were distributed throughout the water column at a range of 3.5 to four metres from the transducer. During the fishery, 74.6 percent of the detected fish were in the bottom three aims and were further back from the shore. On the day following the closure of the fishery, fish moved back towards shore and were evenly distributed through the column. Clearly, in-river gillnet fisheries caused delays in migration and likely forced the fish into river locations that are suboptimal migration habitats.

Would you agree with that statement?

DR. HINCH: Yeah, just to put it in context, that, I believe, has to do with fish that would be passing either -- it would either be near Mission or Qualark, I can't recall which hydroacoustic facility they're referring to. And what they would be talking about is the change in behaviour of fish, where they're passing by relative to the transducer locations that are detecting their location in the river. In terms of fish changing their behaviour, I mean the data are what they are. If the fish are moving away from their transducers, I believe that's what they did. I can't state equivocally whether I would agree that it was because of a particular fishery. I would have to refer you to the authors to talk about

specifically in that case; however, if that was the case, whether it put fish at a disadvantage because it's delaying them. We don't know about the delay because the transducers don't look at individual fish; they're just looking at groups of fish. So from an individual level, you don't know if an individual was delayed or just moved further away and came up and made up the difference in time that it was changing its behaviour. I do agree that, you know, forcing a fish to -- or having a fish put into a higher flow environment adds risk to that fish in terms of energy exhaustion and potential slowing the migration. So that part I could agree with.

Q So if the Commissioner is to sit down at the end of the day and say, "I conclude water temperature is it," and he goes home --

DR. HINCH: Well, I hope he doesn't conclude that's it.

Q But let's say that he does and he doesn't look at the other factors that affect fish migration in the river, the Commissioner would be in error; is that fair to say?

DR. HINCH: Yes, he needs to look at all the factors that would affect fish migration.

Q And some of those factors would be fishing effort --

DR. HINCH: Yes.

Q -- legal and illegal --

DR. HINCH: Fishing effort, however you define it, yes.

Q -- the effect of having nets in the river on fish passage --

DR. HINCH: Yeah, and I mentioned this earlier, it's not just nets in the river. I mean fish get affected by other things in the river. I don't want to pick on anglers but there's a lot of anglers in the river, too, that are in recent years been targeting sockeye. So any activity that takes place in the river during the migration under high temperatures has the ability to add additional stressors, which could have a negative consequence to those fish migrating up-river.

Q And I guess there's a reason why you didn't include these kind of details in your report. Can you tell us why?

DR. HINCH: We weren't directed to focus on the fisheries aspect because there was another report, as I understand, that was focusing on fisheries.

Q So only on water temperature for good reason.
DR. HINCH: Yes.
Q Then I'll leave that and I'm going to read one statement but it's a broad statement about science, the role of science, so I don't think anybody will be offended. And I'm glad to see my friend is coming over with a towel, that I've knocked my water glass over. Are you familiar with the work of Robert Lackey, who is a --
DR. HINCH: I know of some of his work, yes.
Q Yeah. In Salmon 2100, which I think is an interesting book, he talks about a conference. And I'm not going to ask you about this conference - you weren't there - but just on the general view of science, which I think is important. And he's talking about a conference they had [as read]:

> It was not unusual, like so many others, these professional meetings tend to blur together, as has become typical in California, Oregon, Washington, Idaho and southern B.C. A group of salmon experts had been assembled to discuss policy and management options that might help restore wild salmon while minimizing the impacts on competing societal interests. The atmosphere surrounding this conference, typical of nearly all salmon meetings, was a mixture of policy complexity and scientific uncertainty overlaid with informal public veneer of optimism. As always, the unspoken premise was if the experts could just solve the scientific challenges, or if could just get sufficient money to do more of what we already doing, salmon runs could and well be brought back to significant and sustainable levels.

And then he goes on [as read]:

> In contrast to the public conference during the day, the tone around the table in the evening was decidedly different. Yes, everyone agreed salmon recovery was technically complex and scientific uncertainty certainly do abound but the limitations to wild salmon recovery were not

primarily scientific even though most of the day's discussions is focused on scientific topics. Instead, they recognized dramatic policy changes must be implemented if the long downward trend in wild salmon abundance was to be reversed.

And I'm just curious. And he concludes saying [as read]:

Amidst all the discussion of scientific and technical matters, such policy changes are simply not on the table.

Is that a common thing among scientists that, you know, we recognize science has its limits but if we don't deal with issues like human population pressure, fishing effort in the river, then our science is not --

DR. HINCH: Yeah, Dr. Lackey is certainly a strong proponent of the human population growth issue as being one of the major overarching issues dealing with the health of salmon. And I guess to be fair to him, you know, his world focus, in many cases, is the Pacific Northwest U.S. states where things are really bad for salmon. Much, much worse in some cases in a general sense than there. Certainly, we scientists view the right policies and the right management actions as critical to utilize the science that we're helping to generate for them. So I would agree insofar as that we have to have effective policy and effective management because the best science in the world, if it's not utilized properly, isn't going to help us.

Q Now, the people I represent are fishermen. If there's no fish, they're pretty well out of business. If there's no global warming, no temperature issue, are you out of business? Or do you just move onto a different study of subject? Because you've spent a lot of time on this.

DR. HINCH: I've spent a lot of time on this. Actually, I spend a lot of my time doing other research as well. And I like to work on applied research. Climate change is one of the biggest applied aspects we have. I do a lot of work in forestry impacts and land use impacts, which I

suspect, unfortunately, are going to continue to persist in the future so I'll always have research to do, I think.

Q And I have one last question and then I'm done. And again, I won't ask you to comment on whether it's right but would it surprise you that in 1961 the Salmon Commission was saying something like [as read]:

> As long as freshwater production is satisfactory, the isolation of the marine environment, principally that in the in-shore area is an apparent cause of highly variable mortality justifies the management principles used regardless whether the returning run is large or small. A return to stable meteorological conditions would certainly tend to stable the production of Fraser sockeye and pink salmon.

Are you surprised to hear that from 40 years ago?

DR. HINCH: It wouldn't surprise me that it came from that era. I guess what we've learned since then is that climate variability is real. It's variable in freshwater and marine environments. And every species deals with it differently depending on where they're spending their life, in freshwater and marine systems. So that was a historical perspective that the marine systems were driving everything and although the marine systems are important we can't exclude what goes on in freshwater.

Q But in the end, when we asked about freshwater smolts, that part of it at least is okay.

DR. HINCH: We don't know a lot about freshwater smolts.

Q But what I was getting at earlier, if the abundance and size of smolts that leave after --

DR. HINCH: We have information on one or two populations and that's what the management system is using. Largely, they use Chilko data for the size and relative abundance. We have a little bit of data from some other groups but for the grand scheme of things we don't know.

DR. MARTINS: And I suspect we have information for the number of fish that are leaving the lakes but not if they are surviving the downstream migration.

DR. HINCH: Well, even then we only have a few lakes anymore that are assessed in a large way.
MR. EIDSVIK: Those are my questions, Mr. Commissioner. Thank you for answering them.
DR. HINCH: Thank you.
MS. GAERTNER: Mr. Commissioner, it's Brenda Gaertner and with me Leah Pence for the First Nations Fisheries Coalition. I want to thank everyone for me being able to say easily that I expect that I'll be about 45 minutes. It could go as long as an hour but we'll be well finished before the end of the day hopefully. And I want to thank the witnesses for the work that you've done in the time that this Commission is being completed and for your helpful evidence so far. The First Nations Coalition is primarily interested in trying to flesh out from your reports certain areas of further research and some questions that we have as around that. And then I want to do some clarifications on the evidence to date and then move to the recommendations and talk about those.

CROSS-EXAMINATION BY MS. GAERTNER:

Q Just two clarifications. One that came from Mr. Eidsvik's cross-examination or examination of you just now. He asked you to remark on whether good numbers at the mouth reflect that there aren't marine influences on them. And I just want to ask you whether you agree with me that numbers don't tell you about the health of the fish and that there easily could be large numbers that are carrying hypothetical viruses or diseases or other genetic vulnerabilities at that point in time. Would you agree with me on that?
DR. HINCH: Yes.
Q And so it isn't really good numbers at the mouth that gives us any comfort; it's really the health of the fish that's going to give us much more comfort. And that's an ongoing piece of work; is that correct?
DR. HINCH: That's correct.
Q And then, similarly, in a conversation you had with Mr. Blair earlier today, I think, Mr. Hinch, you said that you would be hard-pressed to find a greater threat to Fraser River sockeye survival

than climate change. Perhaps I haven't quite read your report correctly or heard your evidence but for me I understood it's really climate change and it's interaction with a whole lot of other impacts, including cumulative impacts. Have I heard that? So it's not really climate change by itself; it's really --

DR. HINCH: It's setting the overarching issue and all these other interacting things that play into that. So it's setting the tone for all these other things that I believe you're inferring.

Q It's setting the tone for your research and as it relates to Fraser River sockeye salmon, that's correct?

DR. HINCH: Yes.

Q And that tone includes a fair bit of uncertainty as around other impacts; is that correct?

DR. HINCH: Yes.

Q So it's really the uncertainty of a whole bunch of impacts that we're all challenged with right now; is that correct?

DR. HINCH: Yes, and the risk that they could pose.

Q Thank you. That's very helpful. Now, I want to just turn a little bit, I've just got a couple questions on the approach and methodology of the report. In particular, we understand that time did not allow a comparative analysis of climate change impacts of other runs and other places and that you were instructed to work on, these are my words, a fairly Fraser River sockeye-centric approach to this work. Can we be confident that the information and opinions in your report are not inconsistent with what we're learning about sockeye salmon in other regions and climate change or that you would have brought to our attention any significant concerns from those others?

DR. HINCH: Are you referring specifically to the review of the literature or the adult mortality patterns?

Q Any conclusions or opinions in the report. I'd like to know, or I think it would be useful for us to know, whether or not there's any vulnerability in those conclusions, in any of them, based on the Fraser-centric nature of the report.

DR. HINCH: Right. It was Fraser-centric. Mind you, most of the literature that we were able to identify on sockeye was largely Fraser to start

with. And so for the most part, what you see is what's out there in the published literature.

Q All right. Then going to the second part of the report, the same question apply?

DR. HINCH: I have not explored those patterns in other major river systems in the same regard, although I did discuss in terms of timing and temperature what's going on in the Columbia River. And the temperature issues there are much more severe and fish migration timing has actually been altered, it appears, in relation to river temperatures with some of the sockeye stocks migrating in earlier and steelhead migrating later. Stocks are doing much more poorly in a general sense in the Columbia system. There are some that are not, just like in the Fraser there's some doing well and some that are not. And I guess so there are similarities in that regard.

Q So that work on the Columbia supports your conclusions and opinions that it's very important to stay conservation unit focused when it comes to climate change?

DR. HINCH: Yes, there are unique populations in both.

Q All right. Just another question about methodology, or actually this may not be methodology but a curiosity. My client's longstanding relationship with the Fraser River and its nursery lakes and all of those triggered my interest in a comment that was made at page 16 of the report. And you'll find it in the second paragraph and I need you to turn to it specifically because there's a word in there that I won't be able to say. And it's the "Dynamics of Sockeye Salmon", that paragraph, "Abundance and productivity is particularly sensitive." And then you go to the paleolimnology records and then what is that, a salmon-derived nutrient? What is that?

DR. MARTINS: It's a --

DR. HINCH: Stable isotope nitrogen 15.

DR. MARTINS: Yeah, nitrogen 15 that the fish can only acquire when they are feeding in the ocean.

Q All right. So the Alaskan records show that there:

> ...are large shifts in sockeye salmon abundance over the past 2,200 years, which have occurred during major changes in the

climate of the northeastern Pacific Ocean.

Did your project consider similar records for lakes in the Fraser watershed?

DR. MARTINS: One of the reviewer comments were about this so he started looking for this information. I got to find the report that was mentioning some work that some researchers were trying to do with the Fraser River. And that conclusion is that the technique has some limitations. And one of the limitations of the technique is that when the nitrogen that is derived from the catchment from the watershed is more abundant than the nitrogen that come from the fish, it's hard to track the same records. So in the case of the Fraser River what the authors found is that it's not possible to track these sorts of abundance in terms of what the sockeye have deposit.

Q So there's no need to focus on which Fraser nursery lakes might provide this information to us?

DR. MARTINS: For the lakes, they tried to look and find for this sort of information. They couldn't find any evidence.

Q All right.

DR. MARTINS: They tried to associate the breedings that they have from these salmon-derived nutrient to some known changes in the abundance of sockeye like after the Hell's Gate slide and they couldn't find any evidence. And that just supports some of the more general understanding that these techniques cannot be applied to every single lake. There are some limitations to it.

Q Okay.

DR. MARTINS: Only some particular conditions can use these techniques.

Q Thank you. That's helpful to know. And then now I want to turn to a question around traditional ecological knowledge and the value that that would have in this type of work. Obviously, neither your literature review nor your work to date has included that. But one of your conclusions is that one of the expected changes, as a result of climate change, is phenological changes, correct? Would you agree that traditional ecological knowledge could be very useful to scientists when looking at those changes, in particular,

geographically-specific observations around the changes in migration?
DR. HINCH: Absolutely. And I should correct you that I actually have done some work in that regard.
Q As it relates to this report.
DR. HINCH: Well, I think it might be cited, too.
Q Okay. Sorry.
DR. HINCH: It's okay. No, it's worth mentioning again. It was some work we did with the First Nations in the Lillooet region where we were asking them about their perspectives on climate change and also their perspectives on the quality of salmon. And what was interesting was the perspective that the harvesters were believing that the fish were migrating in earlier than they normally would have been catching them and that the flesh quality was poor. They weren't able to dry them as effectively. And in the paper that we wrote, we suggested that what they might be perceiving is indeed some of the early migration of the Late Runs. And the flesh quality issues could well have to do with the fact that many of these fish are somewhat compromised physiologically and that flesh tissue could well be different than they're typically used to. And so I thought there was an interesting parallel going on between what some of our science was suggesting and what those observations were.
Q And so that's an indication of how useful traditional ecological knowledge may be in beginning to inform our observations around climate change?
DR. HINCH: Yes, and it was certainly supporting what we had seen with not traditional knowledge, with western-based scientific approaches. And it was also interesting to get their perspectives on how they felt what the future held for them in terms of a warming future. And they all believed that things were going to change even more.
Q Another area that I would like to explore with you is the area of what I understand, and again I'm not a scientist, but what I understand to be called the temperature oxygen squeeze factor. You're familiar with that expression?
DR. HINCH: Sort of.
Q In particular, you note at page 20 of your report that the climatic variables are temperature, what

you call the master environmental factor flows, salinity, currents, precipitation, upwelling, pressure and wind. As I understand it, a secondary impact of higher temperatures is that there can be an increase in the metabolic rates of lake ecosystem biotic processes and changes in the water acquiesce dissolved oxygen supply. Would you agree with me on that?

DR. HINCH: Yes.

Q And that in warm years, there is a reduced oxygen supply in the lakes, potentially?

DR. HINCH: Yes, but that depends on where you are in the lake. So a lot will depend on whether you're in the upper layer where temperatures are warming even further. So the lakes in the summer tend to be stratified. So you have an upper layer that's warm and you've all experienced this. If you ever dove into a shallow lake from your boat, your head gets this ice cream headache as soon as you penetrate a few metres down because you cross over the thermal barrier. So all small lakes, especially in the summer, have this really warm surface layer followed by a dramatic decrease in temperature, what's called a thermocline. Depending on the type of lake, below the thermocline, that area of lake can be well oxygenated and cold throughout the year. The upper portion of the lake could be reduced in oxygen, as water temperatures warm, because there's a direct inverse relationship between water temperature and oxygen.

Q Are you aware of any studies in the Fraser River watershed that are looking at the lakes for this factor?

DR. HINCH: I can't say I know it for that factor, no. There are groups working on lakes but I don't know about that particular factor.

Q Are there key locations other than lakes along the migratory route of the Fraser River sockeye that we need to be concerned about oxygen supply at all, other than the lakes?

DR. HINCH: Well, again, the concern for sockeye in terms of oxygen may have a bit to do with the juveniles, the life history as they're living for a year or so in the lakes; however, much of their life is spent usually in the colder, deeper water because they need that cold temperature and that

water is also more oxygenated. So I'm not sure how important that oxygen squeeze is from a physiological perspective. If these fish are spending much of their time below that layer where the oxygen squeeze exists. But in terms of ample oxygenated cold water, that bottom layer of the lake, which is the largest volume of the lake, that is what I've used as the most critical thermal habitat that requires consideration and protection.

Q All right. And is there any interaction between oxygen concentration and chemical pollutants or algae growth?

DR. HINCH: There can be. Under some circumstances, warm temperatures and low oxygen, with the right level of nutrients in the water body, can fuel blooms of algae or bacteria.

Q Is there any concern that you would have in the lower Fraser around that?

DR. HINCH: Possibly. It might be an issue with some of the small lakes that are close to major urban areas.

Q All right. In your report at page 24, you're talking about the relationship between temperature and en route mortality and the variability amongst the stocks. And then you go on to say there are barely any thermal refuges in the lower Fraser, which "limits the ability of sockeye salmon from most stocks to behaviourally thermoregulate during the early portions of their up-river migration". It seems from that paragraph that you're emphasizing the early portions of up-river migration; is that correct?

DR. HINCH: Yes.

Q And I would like it -- some further information, I think, would be useful to all of us what you mean by "the early portions of up-river migration" geographically. Are we talking about the Strait of Georgia, the mouth of the Fraser, all the way up to the lower Fraser and to what point? I think that's extremely useful.

DR. HINCH: Okay. So the context then is exclusively within the Fraser River itself. So I'm not talking about the coastal migration. We're talking about once they're in the river because generally these fish, based on our observations, don't reverse course and go back out to the Strait

of Georgia. Once they're in, they're in. So any thermorefuge that may have exited in the ocean is no longer available for them because they've switched their bodies to be freshwater fish and studies we've done suggest that when you take freshwater fish like sockeye and put them in saltwater tanks, they don't like it very much. So they are on a one-way trajectory in terms of their path. When they get into freshwater, and in most cases I'm talking about stocks, and most of these stocks do migrate long distances. There's only a few that are really short-distance migrants. So for those that are migrating long distances, you know, over four or 500 kilometres, the first part of their migration is the lower Fraser. So for instance, from the mouth of the Fraser, let's say, to Hell's Gate. That area in there is what I would call the lower Fraser. And then we get into the middle and upper reaches of the Fraser after that.

Q And is that the area you were referring to when you said the "early portions of up-river migration"?

DR. HINCH: Yes.

DR. MARTINS: The paper recite here, if I'm not mistaken, they tracked the fish from Mission up to the confluence with the Thompson.

Q All right. Thank you. And so if we were looking for habitat refuges or anything like that that we would want to give a priority, in your opinion, it's in that area of the river that you'd wanting to be looking at?

DR. HINCH: Well, based on the telemetry work and the thermal data that these fish collect for us, because we put thermometers in them and then we recover the thermometers at the end of the day, they tell us that they are not able to find thermorefuges during that lower portion of the Fraser migration. So if they are there, they're not finding them and where they do exist tend to be larger river confluences like the Thompson River, for instance, which can be a cooler temperature depending on the time of year. And that would offer some refuge for them if they were to hang out there for a while. But what we don't find is these fish, as they begin the migrations, going way off course to find a lake that's not on

their migratory route. So if there's a lake that's on their migratory route and they have to transit through it, then they will do so at depth.
Q Okay. I'm now going to turn to the area of what I'm going to coin as "management actions" and I think that they fell within your soft infrastructure recommendations, if I've got that right. Have I got that right, Dr. Hinch?
DR. HINCH: I think so.
Q And so I particularly want to ask the question from your expertise, how can management actions best respond to the lack of information, the growing information, that we need around climate change and the impacts to salmon, in particular, applying the precautionary approach when making decisions? Would you agree that the systematic integration of climate variation and change effects will require steps to de-emphasize the role of preseason run size predictions and management activities?
DR. HINCH: I can't imagine it would decrease our need for that information
Q No, de-emphasize the role of preseason run size predictions in management activities. So maybe I'll break that question --
DR. HINCH: Maybe rephrase that.
Q I won't rephrase it but I'll break it down a bit.
DR. HINCH: Okay.
Q And I'll let you know where I'm going with it. If we need to watch salmon, as I understand your evidence correctly, and if we are expecting growing changes in migration patterns and migration timing and all of those things and, i.e., that we won't be able to predict that very well, would you agree with me that de-emphasizing the role of preseason run size predictions is going to be necessary when looking at responding to the variations of climate change?
DR. HINCH: Okay. I think I know what you're asking. As I understand preseason estimates, I mean there's a lot of error involved in them and I think you're going to hear testimony to that effect.
Q Yes, we've heard evidence about how we get to run size predictions.
DR. HINCH: Yes.
Q And we've also heard evidence on the role of

preseason run size predictions, in particular, the challenges associated with identifying the peak.
DR. HINCH: Okay. All right.
Q The Commissioner has heard all of that already. And so I'm trying to link the challenges associated with that inherently and the challenges associated with climate change inherently.
DR. HINCH: Okay.
Q And if you link the two of them together and apply precaution, would you agree with me that we need to de-emphasize preseason run size predictions when making management activities and deciding on harvests?
DR. HINCH: I guess what I can say is preseason predictions are going to be much more challenging to make and they're going to be less accurate, I suspect, given the future variability that we expect caused by climate.
Q So if they're less accurate, you would agree with me that it wouldn't be useful to emphasize them?
DR. HINCH: I just don't know what the emphasis is so I'd have trouble with agreeing with that until I know what we're talking about in terms of emphasis.
Q Okay. So you can expect that they could be less accurate?
DR. HINCH: Yes.
Q All right. Thank you. You'll also agree, and I take it from your evidence, that it's going to be important to emphasize preseason and in-season monitoring of both the salmon themselves and key environmental conditions that influence the salmon, that that's where the focus should be, on both of those.
DR. HINCH: There should be focus put towards that, yes.
Q And then would you agree with me that in order to respond to this, we're going to have to maximize our and by that I mean human adaptive capacity in response to this so we can expect variations, we can expect variations that we weren't expecting, in fact; is that correct?
DR. HINCH: Yes, and I think we've witnessed that in the last couple of years.
Q Do you have any suggestions on how we might be more useful and what kind of adaptive capacities might be more useful?

DR. HINCH: More useful. In terms of improving the current system, in that regard in terms of if that's what you mean by "more useful", I know the management system management folks have told me they would like to know in advance of the fish returning what is the likelihood that groups are going to have a high risk of mortality or low risk of mortality. And they would like to do this, I believe, in a stock-specific/run-specific fashion, if it was possible.

What that speaks to is something I mentioned yesterday, which is trying to come up with predictive measures that are easily and rapidly determined on groups of fish while they're returning during the migration but well enough before them getting to major fisheries so that information could be turned around quickly and management decisions or management actions could be modified based on whatever preseason or in-season actions at that moment had been decided upon.

So for instance, having these biomarkers that I mention, if those sorts of things were available so that groups of fish could be rapidly assessed for their ability to cope with migration conditions that were coming, whether this be a stress biomarker, a disease biomarker or things like that, that's what is currently being investigated, that those could add information to the management system that would help them be better equipped to make decisions about how risk averse they need to be. And this all feeds back into not getting a more accurate number of what harvest is, I think, as much as getting a better picture on how to be risk averse and what level of aversion you need to employ in a particular season.

Q Thank you. That was helpful. But on a simpler note, would you also agree that the efforts behind the Wild Salmon Policy, which haven't been noted right now, in particular the efforts to get very conservation unit specific is going to be of critical importance going forward?

DR. HINCH: It is in light of how we're showing stock-specific differences in coping with changing climates.

Q In your soft infrastructure discussion, you say:

> ...adjust fisheries management practices so as to ensure the achievement of escapement goals...

Is there anything else more specific you'd like to provide on that?

DR. HINCH: In that summary, that was taken from another section where it was written a bit more broadly. Again, dealing with understanding the stock-specific/conservation unit specific angle to coping with changing climates and that that has to be -- and it is, I believe, starting but it has to be more incorporated into the management system.

Q All right. One of the observations that a number of my clients further up the river have provided, including some of the observations that have been brought to my attention from the area that you have worked in, in the Lillooet area, is the increasing observations up-river on sea lice. And so I'm just wondering, is there any possible interactions between climate changes and the increasing sea lice or other parasites that you're aware of?

DR. HINCH: Well, the parasite that I've worked on most has been *parvacapsula minibicornis*, which we've talked about earlier in the day, which is that parasite that's picked up in the estuary, as the fish migrate in as adults through the gills and transferred to the kidneys. And it's a race against time then in that regard between whether the parasite kills the fish before they spawn or whether they spawn and then it kills them. But I don't do sea lice research. I don't know a lot about the observations you're talking about.

Q All right. And so you're not aware of it being linked to any of the climate change matters that you're looking at?

DR. HINCH: It may be but I'm not aware of it.

Q Okay. Would you agree with an observation that the stock-specific mortality factors that you've referred to in en route mortality suggests that run-timing, aggregate management methods are inadequate or I might go as far as saying obsolete at this point in time if we're looking at the sustainability of Fraser River sockeye salmon?

DR. HINCH: Well, certainly it's a concern that we are lumping so many conservation units or stocks into

small number of run-timing groups. And we know that there is the stock variability in terms of their ability to cope with changing environments. I guess the only small comfort in that is that certainly the Summer Run group does seem to be coping the best and they do tend to get managed as a group but there's a lot of overlap in run-timing groups. You know, Early Summers overlap with Summers and now Late Summers overlap with Summers and so the timing issues are somewhat complex and not easy to disentangle when it comes to managing at the stock level.

Q And that might be totally inadequate if we're actually trying to deal with things like en route mortality.

DR. HINCH: Especially if we're trying to deal with it in the context of the Wild Salmon Policy and conservation units.

Q I'm going to turn in a moment to other fisheries impacts but I also wanted to have you speak specifically about catch-and-release fisheries. In particular, given the concerns around additional stresses that are occurring en route, when we've got higher temperatures, would you agree that catch-and-release fisheries should not be promoted and that there should be a precautionary approach to the use of those fisheries?

DR. HINCH: In Atlantic Canada, they have policies for Atlantic salmon that sport fisheries must stop, I believe, at 18 degrees in some river systems. We don't have such policies at this point in place on the west coast, at least in the Fraser, for looking at -- and it's not just catch-and-release fisheries. It's really, as I mentioned earlier, any type of handling stressor, and that can involve a targeted catch-and-release fishery. It can also include other fisheries where fish escape from capture. I mean the same processes are involved in terms of fishes having strenuous exercise, high stress levels, potentially air exposure depending on whether the fish escaped from type of gear and then were exposed to air accidentally or intentionally. So I think in the grand scheme of things, we have to consider at higher temperatures how we're going to have to limit these types of handling activities.

Q At higher temperatures, we need to consider all fisheries. That's what I think I've heard you just say. And the effects of all fisheries that might have on salmon.
DR. HINCH: Well, again, coming back to the stock-specific nature of this, I think it can't be a blanket number for a blanket river. We know now a lot more about the stock-specific nature of their ability to cope with these additional stressors. So in my view, we should have a run-timing, conservation unit, stock-specific guideline for how we manage these extra stressors under different temperatures. It's easy in the east coast because they only have one species and there's not many of them. It's much more complex where we've got a species that acts like different species because of how unique some of the stocks are.
Q And clearly, selective in-river fisheries would be potentially the lowest impact or at least the most manageable impact on specific stocks.
DR. HINCH: It really depends on whether the fish can escape from those fisheries incidentally. So I mean we're doing research right now in comparing different gear types, which include gillnets, seines and angling and dip nets, the things that we might use ourselves for capturing fish. And if you can guarantee a fish is captured and it's not escaping or releasing, then the temperature issue is less of a concern. The concern is whether a fish can be affected by a particular handling method and then get away. So if something was very effective at retaining fish and not having them escape or intentionally being released then that would be a better approach for use than approaches or gears where fish can get in and get out and in that process injure themselves, stress themselves and, therefore, be compromised in a way that higher temperatures could further affect them.
Q And catch-and-release, particularly the recreational catch-and-release, you're most typically bringing the fish out of the water --
DR. HINCH: Yeah.
Q -- and you not necessarily have people that are going to be skilled at removing the hooks and putting them back in the water in a way that

minimizes impacts; is that correct?

DR. HINCH: I've seen some pretty skilled anglers do that. It really comes down -- and we're doing a lot of work in this now where we're -- it's all about education in some cases of how you handle the fish. And under certain temperatures maybe we shouldn't be handling them at all. But in terms of the air exposure issue, that's something that can be minimized depending on who's doing it and how you're doing it. The same would apply to the recent growth in beach seine fisheries. So in the last two years, we've seen this opportunity presented to some First Nations groups and we've worked with them looking at incidental bycatch of coho, in particular. And it is possible to get endangered fish out of these nets and release them but there's lots of issues still in terms of can you do that in a way that's not stressing the fish because of the high density and crowding of the species you're trying to target? And can you do it in a way that doesn't air expose the fish? And how does temperature play into that? And to be honest, these things are right at the edge of where we are and it's hard to know what the guidelines and recommendations might be. But these are the issues that certainly we're all confronting right now.

Q So clearly, a recommendation that would be useful from yourself to us and Mr. Commissioner, as he looks at this, is that in high temperatures in the river, harvesting and the type of harvesting should be looked at very carefully and applied very precautionarily?

DR. HINCH: That's a good way to summarize it.

Q Thank you. All right. I want to just turn now to pre-spawn mortality. And I noted at page 46 of your report, and again, you can go to it but I think you'll immediately get where I'm going here. You mentioned the high variability amongst the stocks and the run-timing groups and the years with respect of pre-spawn mortality. And then you go to the next step and say:

> Across all run-timing groups over the entire 70-year period, pre-spawn mortality averages about 10%.

DR. HINCH: Yes.
Q I'm particularly concerned about this averaging of 10 percent. You'd agree with me that that does not necessarily reflect some very high maximum issues that we have for certain stocks; is that correct?
DR. HINCH: That's correct.
Q Would you also agree with me that under the precautionary approach principle, we would have to either use numbers very specific to a conservation unit or use the maximum annual pre-spawn mortality of a runtime aggregate?
DR. HINCH: Sorry. Use it in what context?
Q If you were actually trying to take into consideration the anticipated pre-spawn mortality and you were trying to look at what type of pre-spawn mortality you were planning for or predicting or --
DR. HINCH: Expecting.
Q -- expecting and if you were actually going to apply a precautionary approach --
DR. HINCH: Okay, yes.
Q -- you either have to get very stock-specific and not use any kind of mean, or if you've got an aggregate, you're going to have to use the maximum likely pre-spawn mortality?
DR. HINCH: That's a good point. And I think you can go further and instead of looking at that figure, which is on page 95, if you look at the figure where I actually break it down by stock for the Late Run groups the page before that, on 94, you can see that, what you're suggesting. So if you go to the page prior to that, Figure 212, thank you, you can see that indeed at the stock level you can really start to see the extreme variability and the relatively high levels. When you aggregate them, then you tend to be dominated by the group that is largest. And in some cases, that group might not be showing the same pre-spawn mortality levels as all the other groups.
Q Thank you. Just before I go to your recommendations, there is a couple things I wanted to bring current. I've heard a number of suggestions around fishing effort and the impacts that that might have on en route loss. And I want to go to Exhibit 333, if I may, and that's an exhibit that Mr. Lapointe presented to the

Commissioner when talking about en route losses. And in particular, he mentioned five particular areas.

MS. GAERTNER: On the second page, Mr. Lunn.

Q Five particular areas that show differences between the estimates and concerns with the numbers. And he spoke about the Mission escapement bias, he spoke about in-river catch estimation biases, he spoke about en route losses being actual deaths that occurred and spawning escapement biases. And then he spoke about the imprecision of all of those. Is that a good summary of the types of things that need to be considered when looking at the numbers, as it relates to en route loss?

DR. HINCH: Yes, those are the limitations of the en route loss numbers.

Q Great. And having considered that and looking at that in relation to the work that you've done, is there any concerns that you have about the confidence of the numbers that you've relied upon to reach the en route loss numbers that you have provided to us and the nature of the concerns around that? Or do you feel fairly confident that the numbers that you've been provided are useful and reliable enough to reach the conclusions you've reached?

DR. HINCH: Well, I start with the biotelemetry data that I introduced first thing yesterday showing fairly strong relationships with different temperatures and showing stock-specific differences. That biotelemetry data then was supported by a lot of our laboratory physiology data. Once I saw that those things were linking in a logical and understandable way, when we go to look at the en route loss patterns and we started seeing the same types of en route loss patterns that we can see in terms of en route loss patterns in relation to temperature like we were seeing with the en route mortality from telemetry results in relation to telemetry, it gave me a lot more confidence that the en route loss data have meaning in terms of en route mortality.

Q Thank you. So you don't have any concerns with the numbers that you've been provided and the conclusions that you've made?

DR. HINCH: No.

MS. GAERTNER: I want to move forward then to the area of recommendations. I will be another ten or 15 minutes, Mr. Commissioner. Would you like me to just push through or would you like to take a break? Push through. All right.

Q Dr. Hinch, you were at a meeting of a number of scientists that happened in December of this year. It was a scientist think tank looking specifically at Fraser sockeye 2010; is that --

DR. HINCH: That's at Simon Fraser University?

Q Yes, it was.

DR. HINCH: Yes.

Q And also present at that meeting were people like Dr. Brian Riddell and Dr. Peterman --

DR. HINCH: Correct.

Q -- and Mike Staley and Carl Walters and Ken Wilson and a number of other eminent scientists, many of whom have been before this Commission. And you'll recall that in looking at the remarkable turnaround, as some might call it, and I might just call it a remarkable return, we don't know if it's a turnaround yet in 2010, and the steps forward, that you actually did some considerations about moving forward and what you might do; is that correct?

DR. HINCH: Yeah, I believe I left the room when we started talking about moving forward so I'm not sure I was there for the moving forward parts. I was only there for part of that meeting. But I did read the think tank statement and I didn't have significant problems with the statement.

Q All right. Then we can go forward, I think.

DR. HINCH: Go ahead, sure.

Q In particular, in the work of those scientists in December, they raised some concerns around collective uncertainties and, in particular, the relative roles of climate change, aquaculture and fisheries management in determining salmon returns. Is that something that you recall or you recall reading?

DR. HINCH: I recall reading that in their final statements.

Q And would you agree that those are the collective uncertainties that need focusing with respect to understanding better the abundance and lack of productivity in Fraser River sockeye?

DR. HINCH: It's certainly a set of them.

Q Two more areas. One will get eclipsed into the next, I think. You've mentioned challenges with funding and it'll be no surprise that that's what we've heard a lot about at this inquiry. And you've mentioned ENGOs and government funding. Is there any industry funding for research that's going on right now that you're aware of? And what portions of industry funding happens in this area?
DR. HINCH: What particular industry would you specifically be naming?
Q Well, as it relates to Fraser River sockeye salmon, the industry that tends to harvest a predominant amount of those sockeye salmon.
DR. HINCH: I can only speak for my personal experience.
Q Yes, and from that experience...?
DR. HINCH: From that experience, not much.
Q And I've also heard about an organization called the Canadian Climate Impacts and Adaptation Network, which was an organization established by the Natural Resources Canada in 2001.
DR. HINCH: Yes.
Q Are you familiar with that organization?
DR. HINCH: I'm somewhat familiar with it.
Q And I also understand that that was closed by the Harper government in 2007; is that your understanding?
DR. HINCH: Sounds correct.
Q And is that an organization that could be useful in a go-forward basis to help us begin to work collaboratively on climate change impacts and adaptation or is that something that you think is of value or should we be focusing on things like that or...?
DR. HINCH: I do think we need a concerted effort and some way of organizing that concerted effort. The problem with some of these concerted efforts is they get too large and the things get diverted in terms of the way funds and objectives get dealt with. So I think we'd have to think really carefully about what that organization could or should be. But I do believe we need something.
Q Maybe picking up exactly on that matter and the questions that Mr. Leadem raised with you about a sort of overarching research board or something like that, do you see that necessarily being an integrated board that includes, government, ENGOs

and academics? And would you see that board also being useful for leveraging funds --
DR. HINCH: Yes.
Q -- and for developing priorities as to the spending --
DR. HINCH: Yes.
Q -- of funds?
DR. HINCH: I think it has to include all the players. It has to include the scientists, from ENGOs, academia and government. We have to be doing not just basic research but applied research. You need the people at the table who can tell you what those real applied issues are. And we also need to be working with the local ENGOs, who are, in some cases, doing the work right now or who have access to the issues that academics don't. Certainly, that's been my experience for how things have worked the best. My concern is always getting this thing to work is getting too big, too administrative, too bureaucratic but we do need to have the government involved at different levels. And I think that's missing right at the moment.
Q And you'd agree with me that it would also be extremely useful to have First Nations involved and --
DR. HINCH: Yes.
Q -- traditional ecological knowledge and its important role alongside science, as being a key component of that work?
DR. HINCH: Yeah, right now one of our big research programs involves the Chehalis First Nations. And without their help and access to territorial area, we couldn't do the work we do. And they've been participating in all of our workshops and it's certainly good to have that perspective.
Q Thank you. One final area of questions is that on January 27th of this year, Dr. Riddell gave evidence to this inquiry and he was specifically giving recommendations around the expanded work on understanding juvenile outmigration. And he got a little bit more specific than you've gotten in your evidence and I just want to know if you would agree with him or not with respect to this. In particular, he promoted a site about a third of the way up the Johnstone Strait where you could find a way to monitor the rate of passage of the Fraser sockeye moving through the Johnstone

Strait. Would you agree that that would be useful?

DR. HINCH: Are we talking about a new spot or one that currently exists? Because I think if I know what he's talking about it's --

MS. GAERTNER: Perhaps if we could go to the transcript and have him review that, that might be the safest way of doing that. And if I could go to January 27th, page 77 of the transcript. And he's answering questions of mine.

Q And as I want to do, my question is fairly long [as read]:

> Q But if we are trying to use hydroacoustics and these other integrated processes that you were mentioning today that have been part of your effort and DFO's efforts to better understand juvenile outmigration, including specifically what's going on in Johnstone Strait, and the health and abundance of juvenile outmigration, what would you recommend?

And his answer is long, but if you would like to just review it on the screen and then let us know whether or not...

DR. HINCH: Okay. I think I know where he's going.

Q All right. And did you take both the additional site in Johnstone Strait, which is how I understand the evidence to be, there's an improved sensor array at the north end of the Strait that he's recommending, there's a gap of information in the Hornby Denman area that he's also recommending and there's also at the top of Queen Charlotte Sound.

DR. HINCH: Yeah, I think a lot of this was motivated two-fold. One was to get a better idea of where juveniles disappear and in some ways getting at the aquaculture issue trying to tease apart in relation to major aquaculture activities where fish are disappearing. There's no doubt that there's not enough acoustic receiver curtains out there at the moment to address that issue. So if that is a question that we need to pursue then we definitely need more lines to be able to do that. The ones that are there are inadequate. The other reason they're inadequate at the moment is because

the technology is outdated.

We need to use smaller transmitters, if we're going to put them into the small fish that we need to, and, as a result they have to be replaced with a next generation of receiver system. They'd probably be put back, in those cases, into the same locations but we'd also be putting them into new locations as well to try to more carefully identify site-specific survival and mortality patterns. And I think tied in with this, and I know David Welch, who's mentioned in this statement as well, I know he may have talked to this Commission about this already but he would like to initiate experiments where you can expose fish to different stressors and release them and allow them to migrate across these lines in these areas as a way of testing hypotheses directly about aquaculture and other stressors.

Q Thanks. And just continuing on from Dr. Riddell, Mr. Lapointe raises the particular issue of needing to modify the receivers; is that --

DR. HINCH: Yes, that's what I'm talking about, yes.

MS. GAERTNER: All right. Those are my questions, Mr. Commissioner.

THE COMMISSIONER: Thank you, Ms. Gaertner.

MR. McGOWAN: Mr. Commissioner, I have just a couple of brief questions in re-examination.

THE COMMISSIONER: Just before you do, I just have one quick question --

MR. McGOWAN: Certainly.

THE COMMISSIONER: -- to ask the panel. I take it that your report and the evidence that you've given in this proceeding around the impact of climate change has not changed the cyclical nature of sockeye in the sense that we have heard evidence here about the life cycle of the sockeye salmon and the one-and-a-half to two years spent in freshwater and roughly one-and-a-half to two years or maybe a bit longer in saltwater. But your research that's contained in this report and your evidence does not suggest to me, or I haven't heard you say, that it has changed the cycle of the sockeye track. So despite the warming of the ocean and despite the warming of the river system, they have not altered from their cycle and nor have they -- and I don't know whether this is even within the records of research but nor have they

changed their destination.
DR. HINCH: Right.
THE COMMISSIONER: In other words, they haven't repopulated to avoid warmer waters?
DR. HINCH: Yeah, in terms of the last question, we have not seen that, to my knowledge. Interestingly, pink salmon seem to be expanding their distribution northward in the Fraser River and they are a highly-adaptable species in terms of temperature, perhaps the most adaptable, so it's interesting that they should be doing that over the last ten or 15 years. In terms of changing the life cycle, no, we haven't seen a lengthening of it in any general sense. You know, four years is still the typical age. There's some, you know, a few five-year-olds and a few three-year-olds but that doesn't seem to change in a consistent way, as you might expect with climate change.

That's not to say that they couldn't do that and certainly some predictions of experts are that you might expect them to spend longer in the ocean if indeed they can't reach critical size limits out there because of poor food or growing conditions. And they have the capability to do this. We know they can stay out there to be five years old. And we know in Alaska they can spend two years in freshwater. So it's within the realm of the possible and that could be one adaptation strategy that these fish adopt. Of course, in so doing, you lengthen the generation time so you are reducing productivity, in essence, by having that life history change occur. But it is a way that they could respond.

THE COMMISSIONER: So do I understand then from your report and from your evidence that the only alteration is the one that you have testified about, which is the early migration of the Late Run?
DR. HINCH: Right. And that, I can't see as being an adaptation in any stretch of the imagination, to climate change because it's putting them into the freshwater environment at the completely wrong time unlike what we've witnessed in the Columbia where the stocks that have changed their run-timing seem to be doing so by putting themselves into a more favourable river environment.

THE COMMISSIONER: So it's just, as far as your report's concerned and your evidence is concerned, it remains a mystery. It is not an adaptation?
DR. HINCH: It's not adaptation.
THE COMMISSIONER: Right.
DR. HINCH: No, and as we've reviewed two, three, four hypotheses that could be responsible for that, yes.
MS. GAERTNER: Mr. Commissioner, may I just ask one question arising from that question?
Q It may not be an adaptation but it could be a response.
DR. HINCH: Oh, yes. Those aren't the same things, though.
Q I know. That's why I'm making that distinction. I think that's an important component. And the distribution metrics that are important parts of benchmarks for conservation units may become critically important in looking at that; is that correct?
DR. HINCH: Yes.
MS. GAERTNER: Thank you.
THE COMMISSIONER: Mr. McGowan?
MR. McGOWAN: Thank you, Mr. Commissioner.

RE-EXAMINATION BY MR. McGOWAN:

Q Dr. Hinch, I just have a few brief questions to follow up on some of the questions you were asked by my colleagues here. I want to start with a couple of questions about some of the evidence you gave when you were being questioned by Mr. McDade. He was the first lawyer that asked you questions after I did.
DR. HINCH: Okay.
Q Do you recall that?
DR. HINCH: Sort of.
Q Okay. Yes, you've been through quite a lot since then. He was asking you about the piece of your report dealing with en route loss and took you to the piece on en route mortality and specifically to the place in your report where you identified en route loss as critical. You recall he talked to you about the importance of using a word like "critical" in a scientific paper. And he suggested to you, and you agreed, that without the factor of en route loss, we may not be seeing the

abundant loss we have. And you agreed with that. Do you recall that?
DR. HINCH: Yes.
Q And then he followed that up with another question to you and he suggested that en route loss is the single greatest factor leading to decreasing abundance.
DR. HINCH: I think I responded in some stocks.
Q Yes, in some stocks. Now, if we look, for example, at a year like 2009, some of the evidence we've heard would suggest that much of the loss that was occasioned in that year occurred prior to the fish coming back to the river at all. Is that your understanding?
DR. HINCH: Yes, although we did have en route loss as well in 2009.
Q Yes. So my question is, when you talk about en route loss, that, of course, only accounts for the loss of fish insofar as their loss in-river?
DR. HINCH: Yes.
Q And when you suggested that en route loss or agreed that en route loss was the single greatest factor in some stocks, were you comparing it to other factors that may be having an effect in the marine environment?
DR. HINCH: I was mostly comparing it to among stocks.
Q Among stocks. Among stocks in the river?
DR. HINCH: Yes.
Q Okay. Thank you. Another area of examination that he engaged in with you related to the Miller article, Dr. Miller's article that you were a co-author on. And you recall that there were some questions about the genomic signature described in the paper?
DR. HINCH: Yeah.
Q Yeah. In his question to you, some of the questions which you answered and agreed with, he used the term, and perhaps you didn't catch it, but it sort of stuck with me. He used the term "viral signature" in the questions. Now, let me ask you, first of all, in the *Science* paper, the paper in *Science*, does it use the term "viral signature"?
DR. HINCH: The term "viral signature" has been used -- if it wasn't used in the *Science* paper, I have seen it used in other documents that involved that genomic response. A signature doesn't mean a

virus. A virus signature doesn't mean a virus.
Q Okay.
DR. HINCH: It means a purported virus.
Q Is a genomic signature synonymous with a viral signature in the way you're using it?
DR. HINCH: A genomic signature doesn't have to be a virus signature. A genomic signature is just a -- I'm trying to think of an analogy that would be simple.
Q Well, let me ask the question a different way. Would you describe the signature that was discussed in the paper as a viral signature, or is it more appropriately termed a genomic signature, or could either term apply?
DR. HINCH: Well, it's a genomic signature that suggests a virus as being responsible for it.
Q Okay.
DR. HINCH: I mean that's the best way...
Q Thank you.
DR. HINCH: It's a condition. It's a signature of condition and these fish had a different condition.
Q Thank you. Mr. Rosenbloom asked you some questions and you may recall that he asked you about questions that led you to give evidence about a satellite tracking device. And in fact, you referred to an email that you got just a short time ago, which you took as an indication that the technology is now there to do this research. And if I understood your evidence, and correct me if I'm wrong, but I think I understood you to say the technology is there, we're ready to go, we just need the money.
DR. HINCH: Yes.
Q Is that the state of things?
DR. HINCH: Yes.
Q I wonder if you can give the Commissioner any sense at all of what sort of money we're talking about? What's the ballpark required to fund the piece of research that you're considering, the one that you described for us?
DR. HINCH: Well, I mean to be fair to satellite telemetry research, it's got that gee whiz, really cool angle to it, nobody's ever done it before, we'd learn something new on just a very few fish because it's so expensive. So when you think about these research recommendations, you have to

weigh in where you're getting your best bang for your buck in terms of making the most novel contributions to science and helping management. That satellite technology stuff would certainly be the most novel scientific thing we could achieve. In terms of helping management, I suspect you would want to invest your limited research dollars into improving and expanding our current infrastructure for tracking individuals so that we know where they are in as best a manner as we can, both as little fish and as big fish.

Q Can you give the Commissioner any indication --

DR. HINCH: Of what that would cost?

Q Yeah, what the magnitude of resources required for these investigative efforts might be.

DR. HINCH: We're talking tens of millions of dollars.

Q Okay. Well, that puts it in context. Thank you. And finally, just a short time ago, Ms. Gaertner was asking you about the precautionary principle and how it might be applied with respect to the management of in-river fishing during times of high temperature and you agreed that one ought to take a very careful look at fisheries. And I think you were talking about fisheries targeting sockeye, whether they be lined fisheries or net fisheries or otherwise; is that correct?

DR. HINCH: Mm-hmm.

Q Would the same careful consideration have to be given to fisheries that were perhaps targeting other fish but that have non-retention bycatch implications for sockeye?

DR. HINCH: Yes.

MR. McGOWAN: Okay. Mr. Commissioner, those are the questions I had in re-examination and that concludes this witness' involvement.

THE COMMISSIONER: Thank you very much, Mr. McGowan. And to all of the participant's counsel and participants who were on the mark with respect to their time estimates, thank you for that. I want to express the Commission's appreciation to Dr. Scott Hinch and Dr. Eduardo, but is it Martins?

DR. MARTINS: Martins, yeah.

THE COMMISSIONER: It's been pronounced different ways so I wanted to make sure I wasn't offending you by --

DR. MARTINS: No, no, that's fine.

THE COMMISSIONER: Okay. But I wanted to thank you

both very much for the time you've taken to inform this Commission and through your report and for answering the questions of all of the participants who have been asking you questions over the past two days. So thank you very much for that.

DR. MARTINS: You're welcome.

THE COMMISSIONER: I understand we're adjourned until ten o'clock tomorrow morning; is that correct?

MR. McGOWAN: That's correct, Mr. Commissioner. Thank you.

THE COMMISSIONER: Thank you very much.

THE REGISTRAR: The hearing is now adjourned until ten o'clock tomorrow morning.

(PROCEEDINGS ADJOURNED TO MARCH 10, 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.

_____

Irene Lim

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

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Karen Acaster