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

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

Public Hearings

Audience publique

Commissioner

L'Honorable juge /
The Honourable Justice
Bruce Cohen

Commissaire

Held at:

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

le lundi 19 septembre 2011

APPEARANCES / COMPARUTIONS

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

APPEARANCES / COMPARUTIONS, cont'd.

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

APPEARANCES / COMPARUTIONS, cont'd.

Tim Dickson	Sto:lo Tribal Council Cheam Indian Band ("STCCIB")
No appearance	Laich-kwil-tach Treaty Society Chief Harold Sewid, Aboriginal Aquaculture Association ("LJHAH")
No appearance	Musgamagw Tsawataineuk Tribal Council ("MTTC")
No appearance	Heiltsuk Tribal Council ("HTC")

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THE REGISTRAR: The hearing is now resumed.
MS. BAKER: Thank you. Good morning, Mr. Commissioner. Today we'll be dealing with Technical Report number 6 that came out of impact assessment with David Marmorek.

Before we get started, there's a couple of housekeeping matters that are outstanding. In the July marine hearings, Dr. Tim Parson was a witness and a number of documents were referred to by him. Ms. Gaertner asked him to produce those articles to us over the course of the break, which was done, and that was circulated to all parties just after September 1 when it was sent to us. So I'd like those three articles now marked as exhibits.

The first one would be something that I can't even pronounce. "Scientific Values as Indicators of Trophic Position and Competitive Overlap for Pacific Salmon", which is an article by Welch and Parsons in 1993. That would be the first exhibit.
THE REGISTRAR: It will be marked as Exhibit 1892.

EXHIBIT 1892: Welch and Parsons, d(13)C-d(15)N Values as Indicators of Trophic Position and Competitive Overlap for Pacific Salmon, 1993

MS. BAKER: Thank you. And the next article is "Sea Surface Temperature and the Pre-Season Prediction of Return Timing in Fraser River Sockeye Salmon," an article by Blackburn. That's it.
THE REGISTRAR: Exhibit 1893:

EXHIBIT 1893: Blackbourn, Sea Surface Temperature and the Pre-Season Prediction of Return Timing in FRSS, 1987

MS. BAKER: And the last one is "Locations of Marine Animals Revealed by Carbon Isotopes," an article MacKenzie Palmer et al." Sorry, I don't see the year.
THE REGISTRAR: Exhibit 1894.

EXHIBIT 1894: MacKenzie, et al, Locations of Marine Animals Revealed by Carbon Isotopes, 2011 [Scientific Reports]

MS. BAKER: Thank you. And then coming out of the marine hearings in August, a request was made of Sergio di Franco by Mr. Rosenbloom which was followed up in writing and circulated to all parties as well. The response from Canada is in an email to me and Ms. Tsurumi, and it has some text provided by Mr. Di Franco as well as a table of figures which is attached to the email, and that would be, once it's pulled up, could be marked as the next exhibit.

THE REGISTRAR: Exhibit 1895.

MS. BAKER: I believe we're still waiting to get it on the screen.

EXHIBIT 1895: Email from DOJ (Grande-McNeill) to Commission re Information Request of S DiFranco, with Attached Chart "Cohen Enquiries Recoveries 2006 to 2011," Sep 9 2011

MS. BAKER: There, and then there should be a table behind as well, yes. Thank you.

So we have today --

THE COMMISSIONER: Just before you get underway, Ms. Baker, I just wanted to welcome to the hearing room a group of students, I think perhaps 30 in number, who are here from Simon Fraser University, and they are students in the resource and environmental management faculty, so we welcome them here today. Thank you very much.

MS. BAKER: Thank you. Our witness today is David Marmorek with ESSA Technologies and I'd like to have him sworn, please.

THE REGISTRAR: Good morning, sir. If you could just turn on your microphone, please. Thank you.

DAVID MARMOREK, Affirmed.

THE REGISTRAR: Would you state your name, please?

A David Marmorek.

THE REGISTRAR: Thank you. Counsel?

MS. BAKER: Thank you.

EXAMINATION IN CHIEF ON QUALIFICATIONS BY MS. BAKER:

Q Your company and you are the lead author of Technical Report 6, Fraser River Sockeye Salmon, Data Synthesis and Cumulative Impacts?
A Yes.
MS. BAKER: Thank you. Could I have that marked as the next exhibit?
THE REGISTRAR: Exhibit 1896.

EXHIBIT 1896: Marmorek et al, Cohen Commission Technical Report 6 - FRSS: Data Synthesis and Cumulative Impacts, Apr 2011

MS. BAKER: Thank you.
Q And there was an addendum done to this report which has actually already been marked as an exhibit in these hearings. It's been marked as Exhibit 1575 if that could just be brought up. Thank you.
That's the addendum that was prepared?
A Yes.
Q Thank you. And lastly, you prepared an errata sheet on September 13 to correct a few typographical errors and clarify a number of things in the report. It's a one-page document on the screen now. Do you see that?
A Yes.
Q Thank you. And that's the errata sheet you prepared?
A Yes.
MS. BAKER: Thank you. I'll have that marked, please.
THE REGISTRAR: Exhibit 1897.

EXHIBIT 1897: Marmorek et al, Errata Sheet for Exh 1896, Cohen Commission Technical Report 6, Sep 13 2011

MS. BAKER: Mr. Commissioner, I would like to go over a little bit of the background of the witness, but I have also previously circulated the areas of expertise I'd like to have the witness qualified in. I circulated this to all parties in advance, and I think I've given a copy of this to you as well so you can follow along. The areas of expertise I'd like to have him qualified in are aquatic ecology, including the effects of human

activities on aquatic ecosystems, fish habitats and fish populations, environmental impact and ecological risk assessment, adaptive management, experimental design, decision analysis and modelling, and technical facilitation of interdisciplinary scientific workshops.

Q Now, just to review some of your background, you are an aquatic ecologist and you're the president of ESSA Technologies?

A Yes.

Q And you're also an adjunct professor at the School of Resource and Environmental Management at Simon Fraser University?

A Yes.

MS. BAKER: Sorry, Mr. Marmorek's c.v. has already been marked in these proceedings, and I'll just have it pulled up. It's Exhibit 566, just to follow along. Mr. Marmorek's c.v. was marked in the course of the Technical Report number 3 hearings.

Q Now, you have spent a number of decades working in areas like simulation modelling, ecological risk assessment; is that right?

A Yes.

Q Aquatic ecology?

A Yes.

Q Experimental design, statistical analysis?

A Yup.

Q Integration of large-scale research and monitoring programs?

A Yes.

Q Adaptive management and decision analysis?

A Yes.

Q All right. And you've also applied some of those skills working with humans and facilitation and team leadership; is that right?

A That's right.

Q Okay. I'd like to ask you a little bit about some of your past experience. I'm not going to spend too much time on it, it's written in the c.v., but just in terms of the work that you've done can you talk to us a little bit about the work you've done in the Columbia River and the PATH process there?

A Sure. Starting about 1993, I was asked to facilitate comparisons amongst different simulation models that were being used to forecast the survival of endangered chinook salmon, both in the river and over their entire lifecycle. And

that work sort of morphed into something called PATH, Plan for Analyzing and Testing Hypotheses which involved about 12 agencies over about six years looking at the question of whether it was better to barge salmon down the Columbia River past the Snake dams and Columbia River dams, eight of them, or whether it was better to breach the four Snake River dams. So that was a very controversial topic involving fairly adversarial circumstances.

Our team from ESSA basically led both the technical facilitation of that as well as integration of models and publication of various results which were extensively peer-reviewed by that inter-agency group as well as reviewers before they were published in journals.

Q Right. And have you done any work in the Fraser River basin?

A Yes. Going back to the times of the green plan in the early 1990s, we looked at the fate and effects of pulp mill effluents, did various work on the Fraser as part of the State of Environment Report that -- B.C.'s first State of the Environment Report in 1993.

Going back even earlier, in the 1980s we looked at various harvest management questions, return of Fraser River stocks for in-season management, and more recently, of course, worked with the Pacific Salmon Commission on the Fraser sockeye decline last year in June 2010.

Q Thank you. And you've of course authored numerous peer-reviewed publications; is that right?

A Yes, that's right. They're listed in the c.v.

Q That's right, pages of them, and a number, over 100, I think, technical reports as well.

A Yes.

MS. BAKER: Mr. Commissioner, I asked my friends to advise me if they had any difficulties with the expertise that I proposed to have him qualified in and I have heard nothing from them, so I propose that he be qualified in those areas.

THE COMMISSIONER: Yes. Thank you, Ms. Baker.

MS. BAKER: Thank you. And the report that's now marked as Exhibit 1896, the Technical Report 6, had a number of different authors involved. Some of them have already had their c.v.'s marked in these proceedings. Those would be, just for the

1 record, Marc Nelitz --
2 MS. TSURUMI: I don't see him as an author on that.
3 A Katie.
4 MS. BAKER: Anyway, sorry, Katherine Bryan. Bryan's
5 c.v. is Exhibit 564. And Katherine Wieckowski,
6 her c.v. is Exhibit 570.
7 We have a number of other authors on this
8 report. Our practice has been to mark the c.v.'s
9 of the authors in these proceedings, so I'll do
10 that now. The first one would be Darcy Pickard,
11 if that could be pulled up. Thank you.
12 Q Now, this is the c.v. of Darcy Pickard who worked
13 on this report with you?
14 A Yes.
15 MS. BAKER: I'll have that marked, please.
16 THE REGISTRAR: Exhibit 1989:
17
18 EXHIBIT 1898: *Curriculum vitae* of Darcy
19 Pickard
20
21 MS. BAKER: Thank you.
22 Q The next one would be Liz Martell, and this is
23 similarly the c.v.?
24 A Yes.
25 MS. BAKER: Thank you. Have that marked, please.
26 THE REGISTRAR: Exhibit 1899.
27
28 EXHIBIT 1899: *Curriculum vitae* of Liz
29 Martell
30
31 MS. BAKER:
32 Q The next one would be Clint Alexander. Again...?
33 A Yes.
34 MS. BAKER: Thank you. Have that marked, please.
35 THE REGISTRAR: Exhibit 1900.
36
37 EXHIBIT 1900: *Curriculum vitae* of Clint
38 Alexander
39
40 MS. BAKER: Thank you.
41 Q Lorne Greig?
42 A Yeah, it's Gregg (phonetic), yes.
43 Q Greig, sorry. This is his c.v.?
44 A Yes.
45 MS. BAKER: Thank you. I'll have that marked, please.
46 THE REGISTRAR: Exhibit 1901.
47

EXHIBIT 1901: *Curriculum vitae* of Lorne Greig

MS. BAKER: And the last one is Carl Schwarz.
A Yes.
MS. BAKER: Thank you.
THE REGISTRAR: Exhibit 1902.

EXHIBIT 1902: *Curriculum vitae* of Carl Schwarz

EXAMINATION IN CHIEF BY MS. BAKER:

Q I'd just like to have you give us an overview of the steps or the components, I guess, that you took in creating the report that's now marked as Exhibit 1896 if you can just describe, in a summary way, and we'll get into it in a bit more detail, but the components or steps that you took in creating the report and coming to the conclusions you came to.

A So basically seven steps. So we first developed the approach that we were going to use for the qualitative and quantitative analysis of the evidence. Then we had a workshop on November 30th and December 1st of last year with about 30 people, both authors and reviewers of the Cohen Commission reports.

The third step was getting as much of the data as we could from those authors on the various potential stressors affecting sockeye as well as the productivity data, and organizing that data into a relational database for further analysis.

The fourth step was doing a retrospective ecological risk assessment or cumulative impact assessment based on the Cohen Commission Technical Reports that were relevant to that, and additional evidence from the PSC report on sockeye decline.

The fifth step was the quantitative statistical analysis which was in support of that synthesis of evidence looking at alternative hypotheses about what sets of stressors might have affected which life history stages and ultimately overall lifecycle productivity.

Then we wrote the technical report and revised it in response to the fairly extensive reviews, and then the last step was the addendum

on aquaculture that you just mentioned earlier.
Q Okay. And can you identify for us what your key conclusions were as a result of this work?
A Sure. So the first is that before attributing causality, you need to look at the overall pattern of change in sockeye productivity within both Fraser and non-Fraser stocks. In section 4.1 in our report summarizes the work from Peterman and Dorner and others, Skip McKinnell and so on, about what that pattern is. Because that's I think the first conclusion.

The second one is in terms of the primary factors responsible for the long-term declines in overall Fraser sockeye productivity and the 2009 low returns. So we concluded, first of all, that marine conditions interacting with climate change during the coastal migration stage were the likely primary factors for the long-term decline over the last 20 years in Fraser River sockeye productivity, and that marine conditions were likely to be the primary factor responsible for the poor returns in 2009 in both the Strait of Georgia and Queen Charlotte Sound.

With respect to the returning run of spawners from the mouth of the Fraser back to the spawning ground, climate change and en route mortality has definitely affected harvest and escapement, but not productivity measured as recruits-per-spawner, because that recruitment already includes harvest and en route mortality. It's basically escapement plus harvest plus en route mortality. So that did not affect the overall trends in sockeye productivity.

Other possible primary factors in the productivity declines include predation on adult sockeye as they come back to the mouth of the Fraser and climate change in the early life history stage from egg to smolt.

We were not able to draw any conclusion on diseases because of lack of data on the exposure of Fraser sockeye to diseases, and disease transmission from aquaculture we concluded was either unlikely or a possible primary factor depending on which of the two aquaculture reports one uses as evidence.

All the other factors we considered to be unlikely to be primary factors responsible for the

1 overall decline in productivity. For example,
2 many of the freshwater habitat factors, though
3 they may well have contributed to changes in some
4 stocks in some years -- so, for example, delayed
5 density dependence appears to have been
6 responsible for some declines and productivity in
7 the Quesnel sockeye stock in some years, but was
8 not a primary factor responsible for the overall
9 decline across all the stocks.
10 And finally, there are many gaps in existing
11 information which make this whole process
12 difficult, so both assessing the exposure as well
13 as the correlation of those exposures with changes
14 in productivity as well as having life-stage
15 specific survival and condition information. So
16 that led to some of the recommendations that we
17 have.
18 Q Okay. Thank you. Now, you've identified that
19 when you prepared this report, you looked at the
20 technical reports prepared for the Cohen
21 Commission, and you also looked at the PSC report
22 in June of 2010?
23 A Yes, we did.
24 Q Did you do any independent research for this
25 report?
26 A Well, some of the things that I just mentioned
27 were independent in the sense that they hadn't
28 been done before, and we weren't picking them out
29 of the existing Cohen Commission reports or the
30 PSC reports. So developing our approach to
31 retrospective ecological risk assessment, that was
32 novel, although based on existing published
33 methods.
34 The quantitative statistical analyses were
35 new and the synthesis both within and across life
36 history stages and going across all of these
37 reports was new research. Our recommendations
38 really built on what was already in those reports,
39 but we added some of our own ideas.
40 Q Okay. And did you independently assess the
41 validity of any of the technical reports prepared
42 for the Cohen Commission?
43 A No, we didn't 'cause we weren't asked to do that.
44 We did carefully examine the methods that each of
45 those authors used, and we looked at the reviews.
46 It was the responsibility of the reviewers to
47 review those reports.

Q The reviewers being the reports that you see attached at the end of each technical report?
A Right.
Q Okay. And then in the technical reports, if knowledge gaps were identified, would those knowledge gaps then carry forward into your reports? For example, were you asked to address any knowledge gaps that had been identified in the technical reports for the Cohen Commission?
A We were not asked to fill them, but in the sections where we discussed what we need to know better, and in our final -- I think it's section 5.2 in "Recommendations", we carried forward some of the recommendations from those reports.
Q And just kind of a background piece, I'd like to get into the report and have a figure in front of us as I ask these questions.
MS. BAKER: If you could go to page 10 of the report. Sorry, it's the actual page number, not the pdf number, yeah. There.
Q So there's a figure there on the screen which you call the "Cumulative Stress Model" and I just want to have that up there, and then ask you the question. Your report is called "Data Synthesis and Cumulative Impacts", and in looking at the cumulative impacts on Fraser River sockeye, were you able to assess first how the stressors within each lifecycle combined in a cumulative or in an interactive way to create the specific impacts on the fish?
A Actually, if you wouldn't mind, I would prefer to have page 18 up here to talk about that question.
Q Sure.
A We can come back to this page --
Q Yeah.
A -- later, but I think this is the better figure for the question you're asking within each life history stage.
Q All right. So this is figure, just for the record, 3.3-1.
A Right.
Q And it's called "The conceptual model of the life history of Fraser River sockeye".
A So this is complicated, though one reviewer thought it could be more complicated. Anyway, what we did is we went through all of the technical reports and looked at the candidate

stressors affecting each life history stage. Some of those reports were focused on particular stressors like contaminants or aquaculture or disease or predators, whereas some other reports were focused on particular life history stages, so there was a report on fresh water which looks at egg, alevins, fry to parr and smolt, things you see at the top of figure 3.3-1, and there was a report on marine conditions which looks at the post smolt part of that figure.

So we basically built up this conceptual model of the candidate stressors affecting each life history stage from those reports and from the workshop, and some of the reports, particularly those that looked at life history stages, like the freshwater report and the marine report, also looked at some of the potential interactions amongst these factors and how they could combine.

Also, the en route mortality report looked at combined interactions like temperature and pathogens, disease, harvest, all combining.

So the main thing was we tried to list all the plausible mechanisms and then consider how those might have interacted, although we don't actually have very little (sic) hard evidence on how they interacted.

Q One of the things that we were looking at, I guess, or what the title suggests is that you're going to be able to actually assess how a stressor in one life stage could impact those fish as they moved through their lifecycle. Are you able to do that, or were you able to do that?

A So only in a conceptual way or a theoretical, in the sense that the data don't really exist to sort of carry forward from each life history stage the changes in survival and condition.

What we did do, though, is in the analyses we looked at, particularly the correlational part, we're looking at factors which occur within each life history stage and considering how they ended up affecting the overall lifecycle productivity. So to the extent that there is some correlation there -- let's say that as productivity declined, some particular stressor went up or increased, you're looking at how an effect, within the life history stage, basically propagated to affect the overall life history or the overall lifecycle

1 productivity.
2 Q But what we are not able to do, I take it, is see
3 how the sort of thousand cuts, the small assaults
4 on the fish as they go through their lifecycle
5 maybe have a greater impact than the whole, so you
6 could see what a primary impact might be, but you
7 may not be able to understand how a number of
8 small non-lethal effects would have a cumulative
9 effect over the life history.
10 A Well, you don't know that very well, except for
11 those life history stages where you do have some
12 estimates of survival within it, so, for example,
13 if you take the freshwater life history stage, we
14 have nine of 19 Fraser River stocks where we do
15 have some estimate of survival from spawners to
16 mostly fry, in a couple of cases smolts, and we
17 can look at the patterns over time for that life
18 history stage, and generally speaking, they
19 haven't gone down. So we can say for that life
20 history stage that the cumulative effect of all
21 the factors operating on at least those nine
22 stocks, at least to the fry stage for seven of
23 them, doesn't appear to have negatively affected
24 their survival or caused a decrease in trend and
25 survival over the last 20 years, which is the
26 period of interest.
27 So that's the power of having data that
28 discretely summarizes the survival within each
29 life history stage, because you are effectively
30 looking at what's the cumulative effect of all
31 those things, at least up till that point.
32 Now, there could be a delayed effect, so an
33 animal may acquire some disease in that stage and
34 survives fine, there's no trend there, but later
35 on when it gets out to sea, that could end up
36 affecting its survival. So again, you can't
37 really distinguish that unless you have better
38 estimates of survival at each life history stage.
39 Q All right. And is that something that you are
40 able to do on the evidence available today, now?
41 A No. Only -- well, to a limited extent, in the
42 sense that, as I just indicated, we have data --
43 for example, for the seven stocks, we measure fall
44 fry. We know the survival from spawners to fall
45 fry, but then after that, we're basically going
46 from fall fry all the way back to recruitment.
47 That's a pretty big box. That includes downstream

1 migration, coastal migration, returns. So we
2 haven't been able to distinguish that with the
3 exception of a few acoustic tag studies, but only
4 for a few stocks here and there.
5 So that's the gap.
6 Q Okay. And that impacts our ability to understand
7 these cumulative impacts as we're going through
8 the life cycle.
9 A Yes, I think the key way to think about this is
10 that the first thing you want to try to determine
11 -- this is what a lot of the work in the Columbia
12 River has done with PIT-tagged fish for example --
13 is in which life history stage is the bottleneck
14 occurring, and then what are the factors most
15 correlated with that decrease in survival.
16 You need some contrast, either over space or
17 time, in those stressors to be able to deduce
18 which of those factors are most likely.
19 Q And we're not able to do that on Fraser River
20 sockeye, is that what you're saying?
21 A Well, we've done the best job we can with the data
22 we have.
23 Q No, I'm just trying to identify that there are a
24 bunch of data gaps that prevent you --
25 A Yes.
26 Q -- from doing that full analysis.
27 A That's right. You can't do it as well in the
28 Fraser as you could in the Columbia because of the
29 data that you don't have.
30 Q Right, okay. Going back to Figure 2.3-1, which is
31 on page 10, the first one I asked you to look at.
32 A Yeah.
33 Q What does the dotted yellow line indicate in the
34 A-1 and the A-2?
35 A So this is a conceptual figure. On the Y axis you
36 have a measure of cumulative stress, and if you
37 get to 1, you're dead. On the X axis, you have
38 the different life history stages, so -- and these
39 are just different pathways that an individual
40 salmon might follow.
41 So A-1 is a fish that experienced lots of
42 stress as a fry, perhaps there wasn't enough food
43 or perhaps there were bad environmental
44 conditions, so it almost died but not quite, and
45 then got all the way through to the adult stage
46 and then experienced some other stress, maybe a
47 predator, maybe some disease, and died.

A-2 represents a situation where this was a fish that survived that early life history crunch whereas most of its brethren died, and so there was less intra-specific or within-species competition, so as they went down to the mouth of the Fraser, it actually found there was lots of food to eat because there were fewer competitors around, so there's actually a decrease in stress.

So you can have these kind of compensatory effects that occur between life history stages. They're not always necessarily additive or cumulative or synergistic as you go through life history stages.

Q Okay. And you talk about that in your report. At some point you talked about compensatory reduction and this is an illustration of what you were referring to?

A Yes.

Q Okay. Page 22 of your report, you talk about a weight-of-evidence approach that you use to assess whether a stressor or a factor made a substantial contribution to the decline. Can you explain that weight-of-evidence approach?

A Sure. So this is what we were talking about when we said we adapted a retrospective ecological risk assessment framework. So we went through basically four sets of questions here, and I'll just read them 'cause it's simpler.

Plausible mechanism:

Does the proposed causal relationship make sense logically and scientifically?

Is it possible that contaminants could harm fish? Yes.

Is there evidence that sockeye populations are, or have been, exposed to the causal factor?

So another example there would be we have some data on contaminants regarding their exposure and how that's changed over time.

Correlation/Consistency:

1 Is there evidence for association between
2 adverse effects in sockeye populations and
3 presence of the causal factor, either in time
4 or space?
5
6 So in the case of contaminants, to continue that
7 example, in general contaminants did not increase
8 as sockeye productivity decreased, which suggests
9 there is not evidence for an association. So
10 that's the kind of question we were trying to
11 answer.
12 Then the fourth category is "Other Evidence"
13 which can be supportive, so things which say,
14 well, are there certain thresholds which suggest
15 that the exposure level, when above those
16 thresholds -- in the case of contaminants, that
17 report specifically looked at thresholds, hazard
18 thresholds they called them, for each of the
19 measured water quality and sediment parameters.
20 Then "Specificity", this is where, if there's
21 a particular kind of effect in the population
22 that's caused by exposure to a certain stressor,
23 so you might say there's a certain kind of
24 physiological response to a certain contaminant,
25 and you can then look for that response if you
26 have those data, or if there have been experiments
27 on them.
28 "Experiments" in a laboratory or in a field
29 are also quite helpful in confirming the causes of
30 things, so the experiments that were done in the
31 field, for example, on en route mortality by Tony
32 Farrell and others, where they put fish through a
33 kind of exercise machine and see at what
34 temperatures they die, confirms that certain
35 temperatures kill them.
36 Then "Removal":
37
38 Has the removal of the stressor led to an
39 amelioration of the effects in the
40 population?
41
42 Well, that relies, really, on some contrast
43 happening in that stressor.
44 So those are the categories of evidence that
45 we looked at, and then organized in that decision
46 tree, Figure 3.3-3.
47 Q So that's on page 24. As we wait for this to get

1 settled on the screen, can you explain how you
2 applied that weight-of-evidence approach to this
3 tree?
4 A Sure. So it basically takes those questions that
5 I just outlined and goes through asking whether a
6 given factor or hypothesized stressor passes
7 various tests. So the first case is, is the
8 mechanism plausible? In almost all of the cases
9 in all the reports, the answer to that was yes.
10 The only exception was in the Noakes report. He
11 felt it was not plausible that waste from salmon
12 farms could have an effect.
13 Then we moved to the exposure question, which
14 I just described, for contaminants, and here we're
15 addressing are there data by which you can assess
16 changes in exposure over time or over space? For
17 many of the hypthesized stressors, we didn't have
18 exposure data, and I should say for one of them we
19 had no data, and that was for pathogens. So no
20 conclusion was possible.
21 So the middle box, there, when it comes to
22 exposure, we had exposure data but it wasn't
23 likely that the fish actually got exposed to those
24 stressors. That would be the case for something
25 like mining or small hydro where there were so few
26 mines or small hydro facilities within the Fraser
27 basin that it's very unlikely that sockeye
28 spawning and rearing habitats were exposed.
29 So if you get past that set of questions, you
30 then follow the "Yes" box and you come down to,
31 okay, so it looks like there was some exposure.
32 Is there any correlation or consistency? I ran
33 through an example earlier for contaminants where,
34 in general, the answer to that was no. There was
35 not consistency in the change in the stressor and
36 the change in productivity.
37 Now, in some cases, we got through that box
38 and down to, yes, it looks like there was some
39 correlation that was consistent with the
40 hypothesis, and so we moved down to the bottom box
41 and "Other Evidence". So that's where the climate
42 changes and changes in marine condition ended up
43 being either possible or likely factors for some
44 of the life history stages. They got all the way
45 down to the bottom box.
46 The predators, as far as returning adult
47 salmon, there was some exposure data that looked

1 some predators had increased over time, and so it
2 looked like it might be possible but there really
3 weren't good correlation analyses. So we ended up
4 at the bottom without enough evidence to say
5 anything other than it was a possible factor.
6 Q When you speak about contaminants in this example,
7 are you referring to the contaminants that were
8 measured in Technical Report 2, or are you also
9 including the contaminants that Don Macdonald
10 identified as being unmeasured, for example,
11 endocrine disruptors and emerging contaminants?
12 A Just the ones that were measured. For things that
13 aren't measured, we would end up in the same place
14 as disease of no conclusion possible.
15 Q And again, your focus throughout was to look at
16 primary driving factors; is that right?
17 A That's right. What are the primary factors
18 responsible for driving the overall long-term
19 declines in productivity of Fraser River sockeye,
20 productivity over the last 20 years, and we also
21 looked at non-Fraser sockeye to help distinguish
22 amongst those hypotheses.
23 So some of those that are unlikely fell in
24 the unlikely box to be primary factors, they could
25 still be contributory factors.
26 Q And the non-Fraser stocks, was that the work in
27 Technical Report 10?
28 A Yes.
29 Q All right. Now, what does this kind of work tell
30 us, or this kind of analysis tell us about each
31 life stage, then?
32 A So again, we're looking at the relative likelihood
33 of each factor within each life history stage
34 being a primary driver of the overall declines in
35 Fraser River sockeye productivity over the last 20
36 years.
37 Q And this kind of analysis, does it allow you to
38 tell us anything about the entire lifecycle of the
39 fish?
40 A So because our primary response variable is the
41 overall productivity of Fraser River sockeye
42 across these 19 stocks, we are looking at
43 correlations between the stressors and overall
44 lifecycle productivity. So as I said earlier,
45 it's still our conclusions, within each life
46 history stage, do in fact still relate to the
47 overall patterns over the whole lifecycle.

1 As I said earlier also, we do have data for
2 juvenile survival per spawner for nine of those 19
3 stocks, so that also provides something about what
4 happens within the life history cycle.
5 Q Just to go back in the report, page 14, you talk
6 about -- there's a section in your report, 3.2,
7 that's titled, "Unknowns, Unknowables, Knowledge
8 Gaps and Data Limitations." I know you've talked
9 a little bit about some of these already, but just
10 at the bottom of the page, you talk about the
11 evaluation of alternative hypotheses, and a couple
12 of principles that underlie that analysis. Can
13 you explain those principles?
14 A Sure. Well, the first one is sort of the general
15 principle of science is that you can only reject
16 hypotheses or provide evidence against hypotheses.
17 You can't confirm that they're absolutely true,
18 and those for which you have less evidence against
19 them are the ones that become more likely, and the
20 other part there is that correlation does not
21 represent causation, and so we have to be very
22 careful which variables we use to look at
23 correlational patterns. There has to be a
24 reasonable plausible mechanism before you include
25 a given variable in a correlation analysis.
26 Now, if you find out that, as the example I
27 had earlier on contaminants, that there is not a
28 correlation, that suggests evidence against that
29 hypothesis.
30 Q And in terms of data limitations in the evaluation
31 process, were those identified by you?
32 A Yeah, the data limitations -- at the end of each
33 section, we have things we need to know better,
34 and then we summarize those in section 5.2.
35 Q And what are the main, the dominant limitations if
36 you can, or the ones that sort of stood out for
37 you as being the most problematic?
38 A So the first I already mentioned is that when you
39 want to determine at which life history stage
40 bottlenecks are occurring, it's really helpful to
41 have information on survival through each of those
42 life history stages, and also the condition of
43 fish for each of those life history stages. Now,
44 you can't get that perfectly, it would be too
45 expensive, but we could certainly have more
46 information than we currently have.
47 Then the second is, as we've just gone

1 through that decision tree figure, there's gaps in
2 the information on exposures and a shortage of
3 quantitative analyses of correlation and
4 consistency, which make it hard to get all the way
5 down through that tree. You know, an example
6 would be if we had information on diseases, we
7 could say a lot more about the likelihood of that
8 stressor actually being responsible for some of
9 the declines that we've observed.
10 Q I think that covers off most of the knowledge gap
11 points I wanted to talk to you about. What about
12 the unknowables? Page 16 you describe a challenge
13 as the third challenge as unknowables. What are
14 you trying to describe there? What's an
15 unknowable?
16 A So first of all, it's hard to know exactly how a
17 salmon dies unless it ends up in a fishing net, a
18 predator's stomach or there's some sort of massive
19 fish kill like happened in the Cheakamus River a
20 few years ago with caustic soda spill.
21 So you can really only infer how a fish died
22 indirectly by looking at strong contrasts across
23 time, across stocks and across space. So ideally
24 you have contrast in survival, and we have a lot
25 of that because productivity trends are varied
26 over time and over space. So then we can look at
27 the contrast in stressors, but you're never going
28 to know ultimately exactly how those fish died.
29 Even if you could measure all the stressors -
30 and you can't - you're never going to have for all
31 the coastal migration period full knowledge of all
32 the predators, competitors, food supply
33 contaminants, temperature, conditions, exactly.
34 So that's essentially unknowable. There is
35 incomplete information. So you're going to have
36 to make inferences based on contrasts. And it's
37 really unknowable exactly how all of those
38 stressors ultimately combine to hit that 1.0
39 mortality part on the graph we were looking at
40 earlier.
41 Q Okay. The bulk of your report is where you
42 examine each of the different life stages, and
43 you've broken them into five different life
44 stages. Do you have the same degree of confidence
45 in your conclusions for each life stage, and if
46 you don't how would you rank your confidence in
47 the different life stages?

A So on a relative basis, with the highest level of confidence first and going down to the least -- it would be interesting, people might debate this, but I would put from the mouth of the Fraser to the spawning ground at the highest level of confidence that got quite accurate estimates of survival and of a lot of other exposure factors, temperature and disease.

Q That's life stage 5?

A Life stage 5. Then next I would put egg to fry because we do have, as I mentioned, seven stocks where we have a egg to fry survival and two where we have egg to smolt survival. We actually have data there. Then next I would put -- that would be life stage 1.

The next would be life stage 3, the coastal migration because there are data on catch per unit effort, for example, in the Strait of Georgia which is sort of an index of abundance, and kind of like an index of survival.

Then I would put the smolt out-migration stage, life stage 2. That is from the time smolts leave a rearing lake to the time they get to the estuary. We really have very little data on that. There are a few stocks with acoustic tags, but not many.

Then the last one with the least level of confidence would be stage 4, which is the growth in the North Pacific where they're out there for a couple of years. We really don't know very much about what they're exposed to and what happened to them until they start coming home.

Q Okay. Thank you. Well, I'm going to go through your life stages starting with 1 and going to 5, not in the order of confidence. So the first one that you refer to, of course, is the egg to fry which begins at page 39 of your report.

You prepared in your errata sheet some comments on what the other evidence column means here. So the conclusions are actually on page 48. I was just identifying where the chapter or section begins. So if we go to page 48, you've got the conclusions section which is a table summarizing some of the points that we'll be discussing.

In your errata you've identified Table 4.2-1 as having some changes, so I'm just wondering if

you can relate those errata comments to the table. It's a bit difficult with only one screen.

A No, that's fine. It's probably fine to just leave the errata up, or I can read from it and you can put the other table up. Basically, as we just talked about on page 22, the other evidence column refers to the fourth set of questions in that decision tree. So when we say "no" in that table -- if you go back to --

Q Sorry, can I just --

A -- page 48.

Q Thank you.

A Yeah, oh, that's good. So when we say "no" that indicates that the other evidence was not available for the listed stressor; in other words, threshold, experiments and that sort of thing. It's hard to do an experiment on the proportion of a watershed that's been forested. You can't fit it easily into a lab. So there were not information available for those stressors where it says "no".

So "yes" means that other evidence was available. For example, on contaminants, water use, there are some lab studies that have been done. There also have been lab studies done mostly on hatchery fish for diseases, except we don't have exposure data. So "yes" means that other evidence was available for listed stressors from those reports and provided additional support for the hypothesized stressor.

"Against" means that other evidence was available and was contrary to the hypothesized stressors so, for example, there were detailed studies done on the Nechako, large hydro, which indicated that it was not likely to have had a significant effect on the overall declines in sockeye over this period of time.

Then "Mixed" means that other evidence were available, some supporting and some negating the hypothesized stressor.

Q Okay, thank you. And the "Likelihood" column, can you just explain for us what you're assessing there?

A So when we went through that decision tree, this is the conclusion that we came to regarding -- and it's in the first sentence of the caption of Table 4.2.1. It's:

1 ...the relative likelihood that potential
2 stressors encountered by Fraser River sockeye
3 salmon during life history stage 1 (including
4 eggs, alevins, fry, and parr), have
5 contributed to overall declines in
6 productivity in recent decades.
7
8 Q Okay. And contaminants, as we've already talked
9 about earlier, when we see contaminants on this
10 line, that's referring simply to the measured
11 contaminants that were in Technical Report 2?
12 A Correct.
13 Q So it does not include endocrine disruptors or
14 emerging contaminants.
15 A Correct. One would come to the conclusion that no
16 conclusion was possible.
17 Q Pathogens, I think you've already described that
18 there. Why do you say there's no assessment of
19 likelihood is possible for that one?
20 A Could you repeat that, sorry?
21 Q For pathogens, why is no conclusion possible for
22 the likelihood --
23 A Because there are -- it says "few data", but there
24 are essentially insufficient data for assessing
25 the exposure of sockeye to disease, as explained
26 in Dr. Kent's report.
27 Q And I think you may have already answered this,
28 but I'll just -- just for clarity, while these are
29 not -- where it says that it's under the column
30 "Likelihood", it says it's "unlikely". That's
31 unlikely to be a primary driver, but it doesn't
32 necessarily exclude impacts of those stressors on
33 other life stages; is that right?
34 A That's right. They could be contributory factors.
35 Q And the next life stage is 2, smolt out-migration,
36 and this is one where you indicated you had a
37 lower level of confidence in the data, and why is
38 that?
39 A Basically because we don't have estimates of
40 survival from the time that smolts leave a rearing
41 lake to the time they get to the estuary, so it's
42 hard to know how that life history stage has
43 changed over the period of interest.
44 Q Okay. So the conclusion, you did a similar table
45 for that life stage like the other ones, and it's
46 on page 54. Actually before I get to that table,
47 I had a couple of other comments I wanted to make,

sorry.

Section 4.3.1 talks about plausible mechanisms. I think we've reviewed now what that means. That's on page 50. At the last sentence there, you talk about:

> Earlier outmigration could lead to a mismatch between the arrival of salmon smolts in the Fraser estuary and Strait of Georgia...

You talk about earlier out-migration leading to a mismatch between the arrival of salmon smolts in the Fraser estuary and Strait of Georgia. You talk about earlier out-migration leading to a mismatch. Is that also possible for late out-migration as well? As you excluding later out-migration?

A Both could be a problem. Any mismatch could be a problem.

Q And I think you have an errata on this page as well. The last paragraph, 4.3.2, "Exposure of Fraser River Sockeye to Stressors". The errata sheet is on the page -- perhaps it's easier if we just have the text of the document. Thanks.

You see in the fourth line down, it says:

> ...they generally spend only two months in Stage 2 migrating downstream the ocean...

A Right. That was incorrect, and that was basically -- that two-month period was meant to describe the period within which all Fraser stocks might be migrating actually came from the contaminants report. So it's obviously much less time that each stock spends migrating downstream.

Q It's more in the range of seven to ten days?

A Right.

Q Now, sorry, I'm skipping around a little bit. We looked at the table 4.3-1 which I don't think we need to spend a lot of time on that. We've identified, I take it, the same explanation for other evidence would apply on this table. It's at page 54 of the report. The same analysis under the "Likelihood" column, although it's for a different life stage; is that right?

A Yes.

Q Okay. And same for contaminants. It again

relates only to the measured contaminants; is that right?
A Correct.
Q I'll move to life stage 3. So this is coastal migration and migration to rearing areas. That begins on page 55. Plausible mechanisms that you set out at the bottom of page 55 and over to 56. We've heard in these hearings evidence of harmful algal blooms and I don't see that listed under this section. Is that a plausible mechanism as well for declines in the coastal migration and migration to rearing area phase?
A Yes, it is. That was an oversight. We do mention it later on in section 4.7 of our report, page 88, but it should have also been mentioned in this section here.
Q Okay. And then at page 64 of this section, you look at conditions in the Queen Charlotte Sound and the Strait of Georgia, and you can compare them. You did some additional analysis of data in this section; is that right?
A Yes.
Q Okay. So what was done?
A So maybe you could go to page 67. I'll just look in my report.
Q Next page.
A Actually, let's look at page 66, I'm sorry. So we assembled the data that were available for various time periods for the Strait of Georgia and the Queen Charlotte Sound, and the reason for doing that was to explore -- again, this was a preliminary analysis of which variables were best correlated with the changes in overall lifecycle productivity.

We also included information in these analyses of the spawning abundance of all these stocks as well.

So the variables that you see listed here, the last column in Table 4.4-1 shows the start of the available data. So we used -- for this analysis, between 1969 and 2004, we used anything which started before 1969, so that excluded chlorophyll measurements for both Queen Charlotte Sound and Strait of Georgia, and also average sea surface temperatures in Queen Charlotte Sound which started later, so we included the other variables, then off you go onto the next page.

1 There you can see the variables that were
2 included in this time period and the ranking of
3 the model at the bottom is the relative degree of
4 support of that model in the data. That is, the
5 relative ability of each model to explain overall
6 patterns of changes in sockeye productivity across
7 all of the -- actually there was 18 stocks we
8 included here. We left out the Pitt.
9 So the top three models here all had --
10 actually if you could stay on the top -- the top
11 three models all had relatively similar level of
12 support and the top ranked model here was Strait
13 of Georgia temperature. The second one was Queen
14 Charlotte Sound salinity and discharge, and the
15 third were all at the variable. So basically our
16 conclusion from this is there isn't a clear
17 difference in the explanatory support between
18 conditions in those two regions over this time
19 period.
20 Q Okay. Were there any shortcomings in the data
21 available for use there? For example, were there
22 things missing in the Queen Charlotte Sound data
23 that you had for the Strait of Georgia data?
24 A Right. We were missing temperature for the Queen
25 Charlotte Sound for that analysis and we're
26 missing chlorophyll for both.
27 Q Okay. Then the next table down, 4.4-3 is the time
28 frame 1980 to 2004.
29 A Correct. And now we have the temperature data.
30 We still don't have the chlorophyll data. So it's
31 basically similar to the previous analysis.
32 In this case, the top three models - you can
33 see the ranking at the bottom there - were all
34 including Queen Charlotte Sound temperature which
35 is negatively correlated with sockeye productivity
36 and salinity which was positively correlated
37 across all of those top three models.
38 The Strait of Georgia models for this time
39 period showed relatively little support in that
40 they were lower ranked models, significantly
41 lower.
42 Q Okay. And then you turn the page and you look at
43 4.4-4 and one page over again is 4.4-5. This is
44 where you compare the importance of chlorophyll in
45 the Straight of Georgia and the Queen Charlotte
46 Sound, the importance of that measurement in
47 explaining the productivity of Fraser River

sockeye from '96 to 2004; is that right?
A Yes, that's correct. Now, that's a shorter time period, and because it's a shorter dataset, we weren't able to compare the relative importance of the Queen Charlotte Sound variables and the Strait of Georgia variables in one analysis. Otherwise, we'd have too many parameters for the length of the dataset. So we just looked at them separately.

So within the Queen Charlotte Sound, chlorophyll was very important. It was in the top four ranked models and so that was interesting. Then within the Strait of Georgia, salinity was most important in the top-ranked Strait of Georgia models, and that was negatively correlated. So the more saline it gets, the worse it was within this time period. Again, it may be different within a longer time period.

Q And then are you familiar with the work Jim Irvine has done in relation to chlorophyll-a levels in Queen Charlotte Sound and Chilko productivity?
A Yes.
Q And how do the conclusions that Jim Irvine has drawn relate to the work that you're showing us here on Queen Charlotte Sound and the importance of chlorophyll.
A So they're generally consistent in the overall conclusions and they're somewhat different in the details. So I'll just quickly run through some of the differences. They don't really affect the consistency, but they're important.

So Jim used Queen Charlotte Sound chlorophyll for the first three weeks of April and related it to the marine survival of Chilko sockeye only. We used chlorophyll data for April and May plus other variables such as discharge, salinity, temperature and spawners to attempt to predict the overall productivity for all of the Fraser stocks, not just the Chilko.

So it's interesting that despite the fact the analysis was structured quite differently, we came up with similar results. In the six models that used chlorophyll, the productivity was positively related to April chlorophyll in all six and it was positively related to May chlorophyll in five out of the six models. So it's pretty similar outcome to Jim, different type of analysis.

Q And in this inquiry, we had some reports prepared by Dr. Beamish and others of his group and they were entered into evidence in July, in our hearings in July. Have you read those reports?
A Yes.
Q All right. And do those reports change any of your conclusions?
A No. The main conclusion that's relevant here is that marine conditions have a significant effect -- marine conditions during the coastal migration stage have a significant effect on declines in Fraser sockeye productivity, and that's consistent with what reports by Dr. Beamish and his colleagues found.

Whether that mortality occurs in the Strait of Georgia which Dr. Beamish is mostly focused on or in Queen Charlotte Sound, which Dr. McKinnell focused more on, doesn't affect our conclusion.
Q And I'd just like to go to the table for this life history stage which is similar to the ones we've already looked at, page 70.
MS. BAKER: This is referred to in the errata sheet, but please don't put the errata sheet up on the screen. We'll just ask Mr. Marmorek to explain it.
Q You see under the "Correlation and Consistency" and under the "Other Evidence" column, there's a little dash which we haven't seen before and no data. What do those mean?
A So if you recall the decision tree that I described earlier, Figure 3.3-3, the dash means that we didn't get all the way through that decision tree to that column, and therefore it didn't need to be analyzed. So in the first row of Table 4.4-6 for pathogens, there were not enough data on exposure to pathogens to merit going to -- you can't correlate data you don't have.
Q All right. For predators, to contrast with pathogens, how does the no data column then compare to the little dash under the pathogens column? What's the difference?
A So we do have some data for some predators in terms of how they've changed over time, both in fresh water and in the ocean and have included those data. However, until we did our own statistical analyses, there weren't any

1 correlational analyses in Technical Report 4, was
2 it, I believe, on predators. I can't remember now
3 which --
4 Q Nine.
5 A Okay. Oh, eight.
6 Q Right.
7 A Technical Report 8. Anyways, Villy Christensen
8 and Andrew Trites report, that's easier for me to
9 remember than the number.
10 Q Okay. The "Likelihood" column, we've already
11 talked about what that means. I just note at the
12 bottom of the very last line before the heading
13 4.47, it says:
14
15 The conclusion is thus that it is very likely
16 that marine conditions during the coastal
17 migration life stage contributed to the poor
18 returns observed in 2009.
19
20 And the "very likely" is contrasted with the
21 "Likelihood" column that we see there for marine
22 conditions where it just says "likely". What's
23 the distinction you're drawing there?
24 A So in the table, we're talking about the overall
25 declines in productivity over 20 years, and in
26 that sentence that you just quoted, we're talking
27 about what happened to the returns in 2009, for
28 which there's a lot more evidence.
29 Q And then we see both "marine conditions" and
30 "climate change" on that table, and we've heard a
31 lot about both of those. Are they mutually
32 exclusive or do they actually overlap in some
33 ways?
34 A They overlap in a lot of ways, and that's
35 discussed in Technical Report 9, I believe, by
36 Scott Hinch and Eduardo Martins, so they talk
37 about how climate change can affect conditions in
38 the ocean in terms of food availability.
39 Also Technical Report 4 talks about past
40 changes in marine conditions and temperature, and
41 looks at future changes in marine temperatures
42 with climate change and discusses how some of the
43 extreme past temperature years look a lot like the
44 expected future years, say in 2080.
45 So what we have is overlap there where
46 climate change is likely to increase temperatures,
47 and increased temperatures are likely to be bad

for food production and changing the kinds of predators that sockeye are used to, all of which is not good for Fraser River sockeye.

Now, for Alaska sockeye, a little increase in temperature can be a good thing.

Q Thank you. Now, the next life stage is 4, which you describe as growth in the North Pacific and return to Fraser, so where does this life stage begin, just physically. Is it at the end of Queen Charlotte Sound?

A I think, yeah, once the fish get up into the Gulf of Alaska.

Q Okay. So up past Hecate Strait?

A Mm-hmm.

Q Now, this one would appear to cover two different areas. There's the coastal area in Alaska but then also the North Pacific and the return home. So is that right, first of all?

A That's correct.

Q Okay.

A Until you get to the mouth.

Q Okay. So is there a difference in the amount of information that's available to allow an assessment on the return to the Fraser that's a return journey versus the growth in the North Pacific phase of their life, so two different parts to it.

A Yes, we tend to have more information once they get close to shore so, for example, in the report on page 75, we have the percent of salmon that are returning by different routes. Like we have the northern diversion, or -- in the Strait of Juan de Fuca, and so we get more information primarily from test fisheries as the salmon get close to home.

Q And this is a life stage where you feel you don't have a lot of confidence, there's not a lot of data available for you to assess; is that right?

A Yeah, it's a big blue box.

Q Okay. Your conclusion box is set out on page 79. I think we've clarified now what all of the different marks mean in this box. I won't take the time to do that.

But with respect to the different factors set out there, there's nothing for contaminants. Is that because the report by Don MacDonald didn't include marine contaminants?

A That's correct.
Q So can we assume by looking at this report that marine contaminants are a non-issue?
A No, you can't assume that. It would fall into the same part of the decision tree as pathogens or unmeasured contaminants like endocrine disruptors that you mentioned earlier.
Q The last stage is the migration back to spawn, and this stage is the stage you feel you have the most confidence in the data for; is that right?
A Correct.
Q And that begins at page 85. I think there's just an errata correction we want to make under the "Conclusions" section. The first line I think there's a correction you want to make there.
A Right. We need to replace:

> ...life history stage 2 (smolt migration from rearing habitats to the Fraser Estuary)...

With:

> Life history stage 5 migration back to spawn.

I was guilty of copying and pasting.
Q I think we've all fallen victim to that. All right. Now in this conclusion table which is on page 86, if we just scroll down, you have a different conclusion for pathogens than you have previously. In the previous life histories you've noted that there was not evidence to support many of these analyses. But here on the return through the Fraser, return to the spawning grounds, you now say that there is some data. What are you referring to there?
A So under the other "Evidence" column, as I was talking about earlier, there have been very extensive studies by Scott Hinch and Dr. Farrell and many others on the health of fish as they're making their way home to spawn, and levels of disease, physiological condition. And those are field studies, and they're quite well correlated with survival measurements from tagged fish, radio-tagged fish. So there are a lot more data for that life history stage.
Q Okay. Then under "Likelihood" column for climate change, temperatures and en route mortality, you

have two conclusions. One says "definitely" and one says "unlikely" which appear to be radically opposite. Can you explain what that means?

A Yes. So these are very important footnotes. So if you take the "definitely" first, it has footnotes B and C there which means harvest and escapement. So the en route mortality - and there's graphs in here that were drawn from the report by Martins and Hinch - shows that en route mortality has increased over time and has been very substantial particularly for the Early run and Late run sockeye.

So that affects the number of fish that get back to the spawning ground, or would, if you had the same level of harvest, and harvest has been reduced accounting for the expected en route mortality. So there's definitely an effect of climate change and temperatures on both harvest and escapement.

However, as I mentioned earlier, the way in which recruitment is measured is escapement plus harvest plus en route mortality. So it's essentially the number of fish that return to the Fraser prior to any harvest or prior to any en route mortality, so that declining productivity cannot be explained by en route mortality because en route mortality is already included in it, already included in recruitment. In fact, as en route mortality goes up, recruitment would go up. So it's unlikely to be an explanation of declining lifecycle productivity.

Q And then the addendum, which was earlier marked in these proceedings as Exhibit 1575, you have a similar conclusion table in that document, and that's at page 18 of the report, and it spills over two pages. There, okay.

Now, again, you have two contradictory notations for disease of salmon farm origin, and you'll see that on page 19 there. It says "possible" and "unlikely". Can you explain what you're talking about there and can they be reconciled?

A So our job here was to look over the work that Dill and Noakes did and look at what the implications of their conclusions were for our overall conclusions in Technical Report 6. It wasn't our job to try to reconcile them or read

the 250 references that they referred to, only 25 of which they looked at in common, by the way.

Anyway, so we basically said, well, if you took Dill's report as evidence, your conclusion would be that disease from salmon farm origin was a possible contributor to the overall declines in sockeye salmon. And if you took Noakes' report, your conclusion would be that that was unlikely.

Q Okay.

DR. BAKER: And then just one last figure before the break. The Figure 3, if you just scroll down, Mr. Lunn, follows this table.

Q What is that indicating to us?

A So as it says at the bottom, these are the mechanisms identified as possible or no conclusion possible based on Dill, 2011. So greyed out in this figure are the hypothesized mechanisms that both authors cumulatively were looking at in terms of causal pathways by which sea lice waste, escapees, and disease could potentially affect sockeye salmon from salmon farms.

So the ones that are -- that was the overall diagram, and then the ones that are greyed out are the ones which were considered to be unlikely, and the ones that remain are those that Dill considered to be possible, whereas Noakes considered all of those pathways to be unlikely.

MS. BAKER: Thank you. Mr. Commissioner, we could take the break now if that's convenient.

THE COMMISSIONER: Yes, thank you.

THE REGISTRAR: The hearing will now recess for 15 minutes.

(PROCEEDINGS ADJOURNED FOR MORNING RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: Order. The hearing is now resumed.

MS. BAKER: Thank you.

EXAMINATION IN CHIEF BY MS. BAKER, continuing:

Q The last part of your addendum I want to go to is the Table 3, which is just following this table that's on the screen. All right. And this table, I just want to identify that it replaces Table 4.7-1 that's in the main report.

A That's correct.

Q Okay. And it is a summary of all of the analyses that you've done for each life stage, basically taking the likelihood column and importing it for each life stage; is that right?
A That's correct.
Q Okay. And we would like to use the addendum one, because it includes the fish farm issues?
A Yes.
Q And that's on the following page, if you just keep scrolling up. That's the whole table. Okay, thank you. Now, moving back to the main report, Table 4.7-2, this is the very last section of your report, and I'd like you just to explain what -- well, first of all, there's an errata and we might as well clear that up right away. That's on the following table. You've got two tables here, 4.7-2 and then 4.7-3. There we go. So there's an errata correction that you wanted to make on the first column there, the header?
A Yes. So the first two columns state life stage and the first column should be stressor category i.e. Cohen Commission technical report.
Q Okay. Thank you. Now, with these two tables that we've just thrown up on the screen with no explanation yet, what are you actually showing us here? What was the analysis that was done?
A So we're looking at the relative ability of different combinations of variables to explain the observed changes in sockeye lifecycle activities, somewhat similar to the Queen Charlotte Sound/Strait of Georgia analysis we talked about previously.

So what we did for that is we carefully lined up all the explanatory factors to match the life history stages and age structure of each of the stocks, so, for example, April to August sea surface temperatures in the Strait of Georgia. And for the first table we grouped those explanatory factors by life history stage. If you could please go back to Table 4.7-2. That's great. Just to the top. Yeah, so you can see the column headings there. So we had incubation to lake rearing, outmigration, coastal migration, and so on. And the "X's" in the shaded grey cells here represent the variables that were included in that model. So M4, for example, coastal migration, includes Strait of Georgia discharge,

and so on down there.

And so we were basically curious about which of the life history stages had the explanatory factors that were most correlated with the overall lifecycle productivity, given the data that we had. And then the following table - you don't have to go there; we just looked at it - is we grouped the explanatory factors according to the technical reports. So each of the technical reports that were received, so for example, we would use just the contaminant information, or we would use just the predator information. Rather than organizing it by life history stage, we just organized it by report.

Q Okay. And what conclusions did you draw?

A So for the table we're looking at here, Table 4.7-2 -- I wonder if there's a better table to see. I guess that's the best one. Leave it there, that's fine. So for that table, the three models with the highest relative level of support - again, these are relative levels of support - included the -- the first was the model which included factors for all of the marine life history stages. The second was a model with the factors for the coastal migration stage. And the third was factors with -- was the life history stage for the return to the Fraser.

So over this time period and the data -- and give the data that we had available from 1969 to 2001, the marine phase factors appear to have the best ability to explain the patterns and productivity. And then, when we looked at the analysis by the Cohen Commission project, the model with the highest level of support included all 34 factors, so basically throwing everything into the soup. And the factors, when we looked separately, at the separate reports, the ones which came next was a model with data for predators and alternate prey and factors for the Lower Fraser/Strait of Georgia.

And so it was a bit surprising that the best model would be the one with all the factors, because the criterion that we're using to assess the relative level of support, AIC criterion, penalizes models which have a lot of variables in it.

So overall, the bottom line is that from the

lifecycle analysis, the marine phase factors appear to have the best ability and we generally -- we conclude that it's best to look at this using a lifecycle approach rather than a project approach.

Q Okay. And then page 95 of your report, which follows these tables, just before you say the relative -- in the paragraph above, The Relative Importance of Different Stressor Categories, you state, at about -- the line's nine, so part -- about halfway through that paragraph:

> The strength of any conclusion that freshwater life stages are not as important as marine life stages can only be as strong as our belief that the assemblage of variables described above is a reasonably accurate representation of the freshwater component of the life history of Fraser River sockeye salmon.

What does that mean?

A So all of these results are only as good as the data that you put into them, and for the freshwater life history stage, there really weren't many datasets available within the time we had and may not be available, period. So, for example, we had to use air temperatures instead of lake or stream temperatures as a proxy variable for freshwater conditions. So ideally, you would have a lot more data on freshwater conditions.

Q So if we accept that the freshwater life history stages are not as important as marine life stages in describing the productivity decline, does that mean that freshwater stressors are having no impact on productivity?

A No, it doesn't mean that. And first of all, you have to remember this is only one part of what we did. This quantitative analysis is supplemented by the main part of the report where we're looking at all the results for Technical Report 3 by Nelitz, et al, and Technical Report 12, and looking at all of that information. So all it means is that within this particular analysis that the freshwater indicators we had in our database were not as strongly correlated as the marine indicators with changes in lifecycle productivity.

One other thing I should point out in passing is that all of these models included the spawners, allowing for density-dependent effects in a Ricker-style model from the parent generation subsequently to the overall lifecycle productivity. So you can think of that is that if there were significant density-dependence, and there is because the coefficients for spawners are always negative in all these models, so that's carried through in the analysis. You can think of it as a freshwater event, the number of spawners that has ramifications over the entire lifecycle.

Q And looking at these models that this section is dealing with, there's a comment by one of the reviewers, Sean Cox, that there's no indication of variation in salmon productivity explained by the alternative models, and he comments that no r-squared values were provided. So I just wanted to talk to you a little bit about that. First of all, what is an r-squared value and how does it help us understand how well a model explains the data being assessed?

A So r-squared is also called the coefficient of determination, so it's the fraction of the total variability in a dependent variable, and in this case we mean the total variation in sockeye productivity log recruits per spawner over all 18 stocks that's explained by the variables that you include in a given model. So a simpler example would be you might say well, 70 percent of the variation in somebody's income, or in people's income over a sample, is made up by their level of education and their level of work experience. And so in that case, r-squared would be .7.

Q Okay. Without those r-squared values, are you able to say that one model with a certain set of variables can explain the changes in productivity better than another model?

A Yes. We can still say that one model has more support in the data than another model. The AIC criterion that we use tells you the relative level of support, which is what we were interested in, because we were looking in a retrospective way. It doesn't tell you the total proportion, the variation in productivity that is explained. And if we'd had time, we would have included the r-square in the program that we ran for this. We

1 did an output of the r-squareds for all the -- all
2 the analysis. We had about three weeks from the
3 time we got all the data to finish the report. So
4 it was quite a crunchy time.
5 And so it's a good suggestion that Sean Cox
6 made, and we could certainly go back later and do
7 it.
8 Q Okay. Without those r-squared values being
9 included, what we couldn't say, for example, is
10 that -- well, we could say, for example, that
11 Model 10, as you've done, describes -- which looks
12 at marine variables, that it describes
13 productivity better than variable -- models that
14 look at variables in other life stages, but what
15 we can't do is assess the percentage of the
16 variation in the data that's actually explained by
17 Model 10 or by any of the other models; that's
18 what you're telling us?
19 A Yes, that's correct. I'll just note in passing,
20 something that -- I looked at the Connors et al
21 report, and although it was a very different kind
22 of model, it didn't have as many covariates
23 included in his long-term analysis, he had
24 r-squareds around .7. He also included -- sea
25 surface temperature also included spawners. So
26 although we haven't calculated it, my suspicion is
27 that we would have r-squared values in the same
28 general ballpark.
29 Q Okay. And for the purposes of your analysis,
30 which, as you said, was a retrospective analysis,
31 you didn't think that r-squared values were
32 important to have?
33 A It's not as critical if you're not attempting --
34 if you're attempting to create a model which you
35 hope to apply prospectively; that is, to make
36 predictions in the future, it's not as critical to
37 have it. There's also some limitations in
38 r-squared, because the r-squared doesn't take into
39 account the number of parameters used to fit a
40 model. There is an adjusted r-squared measure
41 that does take that into account. So the AIC
42 measure was, I think, adequate for what the
43 purposes that we wanted to use, looking
44 retrospectively.
45 I'll just point out that if you had a set of
46 models and all of them had the same number of
47 parameters and you used both r-squared and AIC,

it's likely that the rank order of those models would be similar, because AIC is considering to what degree the model variables explain the variation in the data.

Q All right. But couldn't say that without -- without the r-squared value, you couldn't say that the marine explains 70 percent --

A Correct.

Q So it could be better than the other ones, but it could be that the other ones are ones and marine is a two?

A No, that's right, you don't know the absolute proportions, yeah.

Q Okay. Then moving on, I'm running out of time, so I want to just go quickly through a couple things. On page 100, Table 4.8-1 sets out other factors which could potentially contribute, and you've set them out clearly, but I wonder if harmful algal blooms should be added to that list? Sorry, Mr. Lunn, if you can just keep moving it forward? Okay, there we are.

A Yes, it should be.

Q Then the last section I'd like to go to are the conclusions and some of the recommendations that are set out. So at page 104, at the top right, at the -- talking about what happened at the PSC Panel. It says:

> There was consensus among the group that a focused oceanographic and fisheries research program targeting the Georgia Strait, Queen Charlotte Sound and extending along the continental shelf to the Alaska border would [useful].

Have you given any thinking to who should participate in such a thing and how it would be structured or who would be responsible to organize or fund it?

A So that question wasn't really part of our terms of reference, but I think the first thing would be to clearly set out the objectives for the research groups, so what decisions are you hoping to inform, what level of accuracy and precision is required for those decisions, and what's the level of -- what are the scientific questions that helped to inform those decisions. So rather than

1 just, you know, going out and doing a bunch of
2 research.
3 Logically, I think it would be led by the
4 federal agencies responsible for Pacific salmon,
5 so that would include DFO, NOAA Fisheries, Pacific
6 Salmon Commission - I guess that's an
7 international agency - and then they would get
8 data and have participation from a whole bunch of
9 others, so leading researchers, international
10 organizations, like PICES, Alaska, Washington,
11 Oregon, Idaho state fisheries agencies, First
12 Nations, NGOs, provincial agencies, fish farmers.
13 But it would be led, I think, by those federal
14 agencies. That's just my, you know, off-the-cuff
15 thinking on this.
16 Q And then you also talk about database improvements
17 being needed and being identified as a problem
18 among the researchers. What's needed, and how
19 would it be accomplished?
20 A So I think the first thing is to have excellent
21 data on Fraser River sockeye and non Fraser River
22 sockeye productivity and stressors and to know
23 exactly where those data came from, and then to
24 design a database that way so that it facilitates
25 answering the specific questions and making the
26 specific decisions that I described earlier.
27 Q And who would maintain such a database and fund
28 the effort?
29 A Logically, I think it would be the same agencies,
30 the federal agencies that I described earlier.
31 They're the ones who have the most data and they
32 would get other datasets from other people.
33 Q All right. And in preparing your report,
34 Technical Report 6, you actually created a fairly
35 extensive database; is that right?
36 A Yes.
37 Q And is that database useful for future analysis?
38 A Yes, I think so. It was done for internal use, so
39 it doesn't have a users guide and all the other
40 things that one would want to have before it were
41 made public. And it also would be good to add
42 some of the stressor variables for the non Fraser
43 stocks, but I think it's a reasonable start.
44 Q Okay. And then you have a set of recommendations
45 set out beginning in -- or set out in a table,
46 Table 5.2-1. It's on page 108, or, sorry, it
47 begins, and in each of these -- in the column

1 called Comments and recommended research and
2 monitoring activities, we see various
3 recommendations being bolded. What is that? Why
4 are you bolding things? What does that indicate?
5 A So I think we had, I don't know, was it 24 or
6 something recommendations, something like that,
7 and we thought it was important to highlight those
8 which were relatively more important, recognizing
9 that the final prioritization is something that
10 would have to go through a quite extensive process
11 of thinking about the decisions that need to be
12 made and inputs to those decisions required,
13 precision of information for those decisions.
14 Notwithstanding that, we looked at this and
15 you see there's two columns there; one on
16 explanatory importance, and one on relevance to
17 management actions. So explanatory importance
18 means what's the relative ability of information
19 within each of those rows, each of those life
20 history stages, to explain what's going on. And
21 relevance to management actions is, well, how much
22 would that information be used for actually making
23 decisions on, say, harvest, habitat, hatcheries,
24 hydro. And so we basically used those columns as
25 a guideline for bolding certain portions.
26 So if you go down a little further, to the
27 section on coastal migration, everything's bolded,
28 because we have, from our work and from the work
29 done by the various technical reports, concluded
30 that that has a -- the coastal migration phase has
31 a high level of explanatory importance. It's also
32 highly relevant to management actions.
33 Q And do you have any suggestions to throw out there
34 on how to prioritize all these different
35 recommendations?
36 A So if you could go, Mr. Lunn, to page 107 down
37 there, the questions there. So I think I've
38 already described these, and so in the interests
39 of time it may be easier for folks to read this
40 than for me to read it. I think the key things
41 are, what are the decisions, what are the inputs
42 to those decisions, and how much information do
43 you need?
44 So if you think about preseason forecast, how
45 much precision do we want to have on that? Do we
46 want to be able to say, "Well, things are likely
47 to be relatively poor, average, or relatively

1 good," or do we want to be much more precise than
2 that? That affects how much information you need.
3 And then it's also sequencing the efforts.
4 So having certain rules, so sort of contingent
5 rules, if we learn something then we might need to
6 do something else. And also, you know, what are
7 the cost-effective tradeoffs. So, for example,
8 you need to consider how much budget you have, and
9 you might not want to sacrifice your in-season
10 monitoring programs to get better preseason
11 estimates, for example. So there are tradeoffs
12 there that have to be carefully considered.
13 MS. BAKER: Thank you. Those are my questions, Mr.
14 Commissioner. So Canada will be first, and
15 they've got a 30-minute allocation.
16 MR. TIMBERG: Yes, Mr. Commissioner, it's Tim Timberg,
17 and Charles Fugère for participant Government of
18 Canada.
19
20 CROSS-EXAMINATION BY MR. TIMBERG:
21
22 Q I'd like to start, Dr. (sic) Marmorek, with your
23 role as a facilitator at the June 2010 Pacific
24 Salmon Commission Workshop. And if we could have
25 Exhibit 73 brought up. Thank you. If you could
26 just look at the title page there, I note your
27 name's there under "Prepared by". It says, Dr.
28 Peterman and then yourself. Can you explain for
29 us what your role was at the Pacific Salmon
30 Commission Workshop?
31 A Sure. We were working with both the Pacific
32 Salmon Commission, Department of Fisheries and
33 Oceans and NOAA Fisheries, a committee, to design
34 the workshop and -- so that committee met and
35 discussed which hypotheses should be included. We
36 facilitated those discussions prior to the
37 workshop. We developed some forms, which are
38 included in this report, for participants to
39 comment on, evidence they felt was relevant.
40 At the workshop, itself, we served largely as
41 timekeepers, and subsequent to the workshop the
42 panel met, led by Randall Peterman, and assembled
43 the main portions of the report, and we worked
44 with the Panel and with Dr. Peterman to help pull
45 all that together. There were various further
46 conference calls with the Panel on key points that
47 we helped to facilitate.

Q Okay. Thank you. And did you, personally, contribute any science research, yourself, to the workshop, or were you just a facilitator?
A I wouldn't say "just" a facilitator. Yes, we --
Q Fair enough.
A We did not present any independent research, and we worked to integrate the information that was presented. For example, the table that's in this report of evidence for and against, I prepared, which was based entirely on what the Panel had written, but it was just a summary.
Q Okay. Thank you. If we could then turn, to refresh our memories, we've got, at page 4 of this document, we've got the nine hypotheses. And the Panel, at the top of page 5, if we could look at that top paragraph there, so here this is under the, I guess the executive summary. It says the Panel -- I'm just reading from the document:

> The Panel concluded that the available evidence for and against each of the nine hypotheses does ***not*** point to a single cause of either the poor adult returns of Fraser River sockeye in 2009 or the long-term decrease in returns per spawner.

Do you still agree with statement?
A Yes, I do.
Q Okay. So we're not looking for one -- there's not one hypotheses out there, then, that explains what we've been seeing?
A That is correct, though I think it's fair to say that some are more likely than others to be primary causes.
Q Right. Thank you. And then continuing on with that executive summary, it says:

> Instead, the evidence suggests that multiple causal mechanisms very likely operate simultaneously and that their effects may be additive multiplicative (i.e. synergistic), or may tend to offset one another's effects.

And do you still agree with that?
A Yes, I do.
Q Thank you. And if we could then turn back to your -- and then at page 9, just to refresh our

1 memories, is the Table E-1, where the Pacific
2 Salmon Commission set out their various
3 hypotheses. If we could turn, then, to your
4 report, exhibit -- at page 36, Exhibit 1896.
5 Sorry, I'm at the last page. It's the last -- the
6 second-last page of the executive summary. The
7 pages are not numbered, unfortunately, Mr. Lunn.
8 It's right at the very beginning. It's a section
9 that's titled, Recommendations for Research,
10 Monitoring and Synthesis. There we go.
11 And here I'm just noting that under this
12 section you start off by saying:
13
14 Researches at the Cohen Commission workshop
15 agreed with the [Pacific Salmon Commission]
16 report,
17
18 and it goes on, and that's really part of your
19 conclusion with your report, now, they're
20 consistent? I guess that's my main question is:
21 Would you agree that both the Pacific Salmon
22 Commission report from June 2010 and your paper
23 have very similar conclusions?
24 A Yes, I would. I think the only distinction is
25 that we had more information, particularly on non
26 Fraser stocks, and also had some more information
27 on marine conditions which slightly changed but
28 didn't radically change the conclusions.
29 Q Thank you. And the membership at the Pacific
30 Salmon Commission workshop and the scientists that
31 worked on the -- your ESSA report, you'll agree
32 that those are different scientists, despite the
33 fact that you were at the Pacific Salmon
34 Commission, the scientists at the Pacific Salmon
35 Commission were different than the people who
36 worked on the ESSA report?
37 A Yes, they are different. However, I think it's
38 important to note that our report is a synthesis
39 of the technical reports done by all of the Cohen
40 Commission researchers. So I actually think of
41 our team is including all the people who worked on
42 those reports as well.
43 Q Right. And so you'll agree that despite the
44 different scientists that were involved, they came
45 to a very similar outcome?
46 A Yes. I think there's, as you would expect them on
47 scientists, you know, some interesting arguments

1 between was Queen Charlotte Sound or Strait of
2 Georgia more important in 2007, but in general
3 people agree.
4 Q Okay. Thank you. I'd like to now just ask some
5 questions about the stage 1 of your report, and
6 I've got just a couple of questions. We'll just
7 walk through the lifecycles, as you've put them
8 out.
9 If we could move to -- back in the two pages,
10 Mr. Lunn, to the start of the executive summary,
11 Stage 1. One more page, please. Thank you. So
12 here, with respect to Stage 1, you state that --
13 basically, you say that climate change is a
14 possible factor with respect to the causes of
15 decline for Stage 1, and you talk about climate
16 change throughout the report. So I'm just
17 wondering, what's your definition of climate
18 change? What do you mean when you say climate
19 change is a possible factor?
20 A Okay, so there's two questions there. So my
21 definition of climate change would be the increase
22 in greenhouse gases and associated changes in both
23 temperatures and circulation in the ocean and
24 other factors driven by that increased amount of
25 heat in the atmosphere. And here we were
26 following or synthesizing the work that Scott
27 Hinch and Eduardo Martins had done in their
28 climate change report in which they noted that
29 temperature changes could have both positive and
30 negative effects on incubation emergence in
31 freshwater rearing. And so we carried that
32 through as a possible factor. It had exposure in
33 the sense that temperatures have been shown to be
34 increasing, certainly in the Fraser, and other
35 data showed temperature increases in many
36 tributaries, so it remained a possible factor.
37 Q So when you say "climate change", are you seeing
38 that as increased variability, or are you seeing
39 that as an increased general temperature rising?
40 A Certainly both occur. With climate change in this
41 context, for this specific section, we were
42 relating it more to increases in temperature,
43 because that's what Scott Hinch and Eduardo
44 Martins had referred to.
45 Q All right. Would you agree that climate change
46 manifests itself in a variety of factors, then?
47 A Absolutely.

Q Okay. And would you agree that climate change is not a mechanism, per se?
A A mechanism of causing mortality, is that what you mean? Or a mechanism for what?
Q Well, it's not a separate factor onto itself, that it's a combination of factors come together, when we think about climate change?
A I guess I'd describe climate change as a driving force which can ultimately affect sockeye through many different mechanisms in many different life history stages, if that's what you meant. That's certainly how I would describe it.
Q Okay. Thank you. And how is climate change, then, different from changing marine conditions?
A Well, first of all, climate change can also occur in the freshwater part of the lifecycle, not only in the marine system. So the various mechanisms that are discussed in the climate change report include both changes in freshwater as well as changes in marine systems, so Hinch and Martins talk about, for example, in the marine side climate change, changes in temperature can effect food conditions, can effect prey, can effect predators, can effect competitors. Obviously, marine conditions are strictly in the marine. They're going to be influenced by climate change, but climate change is larger than that, so changes in hydrology, for example, over freshwater, as well as changes in temperature, incidents of extreme weather conditions. Those are all climate change mechanisms which would not occur in the marine system.
Q Thank you. So then, with respect to Stage 1, you've -- going back to your executive report, you say that we feel -- and I'm reading from your report, that:

> We feel...confident in this conclusion because juvenile productivity...has not declined over...eight of the nine Fraser sockeye stocks where it has been measured.

So can you explain what you mean by that statement there?
A So in nine of the stocks we have some measure of juveniles per spawner. In seven of those stocks, it's fry per spawner; in two of them it's smolts

1 per spawner. And in eight of the nine, and those
2 data are listed at the back of the PSC report,
3 there hasn't been any trend over time in juvenile
4 productivity, either an increase or a decrease.
5 And in the nine, which I believe is the Gates
6 sockeye stock, there has been an indication of
7 some decline.
8 Q All right. And so based on that, then, you
9 conclude that you can eliminate a whole suite of
10 stressors as being a likely cause of decline as a
11 result of this conclusion, right? And then you
12 list these factors that we see before us:
13 forestry; mining; large hydro; small hydro, et
14 cetera?
15 A No, that's -- what you stated isn't the way we
16 stated it. We looked at a whole bunch of
17 evidence, particularly from freshwater -- pardon
18 me, the Technical Report 3, in order to draw the
19 conclusion that these habitat factors were
20 unlikely to be the primary drivers. It wasn't
21 only the juveniles per spawner data. There's a
22 whole bunch of analyses in Nelitz et al, about the
23 cumulative stress factors. And secondly, we're
24 not eliminating it as a potential contributing
25 factor; we're saying it's unlikely to be a primary
26 factor driving the overall declines. It could
27 still be a contributing factor in some watersheds,
28 to some stocks, in some years.
29 Q Right. So if I understand your analysis, then,
30 you're really focusing on juvenile productivity,
31 but I'm wondering if you'll agree that there may
32 also be a problem with juvenile viability, and by
33 "juvenile viability" I mean the health broadly
34 defined of the juvenile fish?
35 A That's certainly possible. If we had disease data
36 from juvenile stages through smolt stages through
37 adult stages, we might be able to test that
38 hypothesis as well as condition information. We
39 don't have that information.
40 Q Right. But you'll agree that it's important to
41 study both productivity and viability; they're two
42 separate ways of trying to understand the health
43 of --
44 A Yes, I think that is important, and it's in our
45 recommended research and monitoring in section
46 5.2.
47 Q Great. Thank you. I'd like to now move to

1 Canada's list of documents, Tab 2. We've listed a
2 paper here by Petrosky and Schaller, and I note
3 you've quoted it at page 45 of your expert report,
4 titled, Influence of River Conditions During
5 Seaward Migration and Ocean Conditions. Are you
6 aware of this paper?
7 A Yes, I am.
8 Q All right. And as I understand it, this paper is
9 about the influence of freshwater factors,
10 primarily dams, as you talked earlier, in the
11 Columbia River, having a delayed mortality impact
12 on the fish when they entered the marine waters;
13 is that a fair summary?
14 A It's a consideration of both freshwater factors as
15 well as ocean conditions effecting survival rates.
16 MR. TIMBERG: Okay. Thank you. If this could be
17 marked as the next exhibit.
18 THE REGISTRAR: Exhibit 1903.
19
20 EXHIBIT 1903: Influence of river conditions
21 during seaward migration and ocean conditions
22 on survival rates of Snake River Chinook
23 salmon and steelhead, by C.E. Petrosky and
24 H.A. Schaller
25
26 MR. TIMBERG:
27 Q And at the top of page 522, which is, I think, I
28 believe the next -- I'm not sure of the page. Mr.
29 Lunn, if you could go to the bottom, just it's 522
30 at the top. So, right, so the top right-hand
31 corner, Mr. Lunn, if we could blow up that section
32 there.
33 There's a quote here from the authors that I
34 thought I would ask your opinion about. At the
35 top right-hand corner it says:
36
37 The NPCC noted that while we cannot control
38 the ocean, we can monitor ocean conditions
39 and related salmon survival and take actions
40 to improve the likelihood that Columbia River
41 Basin salmon can survive varying ocean
42 conditions.
43
44 Would you agree that this statement can apply
45 equally for the Fraser River for sockeye salmon?
46 A Yes, I would, although I would caution that if
47 conditions in the ocean are really bad, the

ability to improve the likelihood may be difficult.

Q Okay. And then the next paragraph down starts with:

> Recruitment success in the ocean environment is generally believed to occur largely during the first critical months at sea...

and do you agree with that statement?

A Yes, I think that's true for most Pacific salmon.

Q Thank you. And then over the page, it states, at the top, left-hand corner, over the page, if we could look there, the second sentence says:

> First year ocean survival reflects the influence of near shore and broad scale environmental conditions, but may also be influenced by the condition of fish when they reach saltwater due to experiences in an earlier life stage.

And I presume you would agree with that?

A Yes, I would.

Q Thank you. And so this concept of delayed mortality or delayed effect, that's something we should be aware of when we're considering Fraser River sockeye salmon?

A Yes, we should.

Q And going back to my question about the importance of monitoring juvenile viability along with juvenile productivity, can you comment on what your suggestions are with respect to how to monitor juvenile viability; what should be done for that?

A Well, if we could go to our report on page 108, so the first row of that table says, for parental spawning success and incubation:

> Although an unlikely explanation of past declines, spawning success and incubation could relate to disease concerns and/or become higher priority in the future with climate change.

And then, as you follow down through there, there's various suggestions on how to monitor.

1 So, for example, suggestion number 4 says:
2
3 assessments of freshwater smolt production
4 and health for a strategically selected
5 cross-section of stocks.
6
7 Q All right. That's helpful. So I understand
8 there's sometimes a debate on where to put
9 resources. Should resources be put towards
10 counting fish at their different locations to
11 capture their different life stations, or should
12 debates -- or should resources be placed to study
13 fish health to understand the health of the fish?
14 What's your thought on those two monitoring
15 approaches?
16 A I think the first thing you have to decide is what
17 questions you're trying to answer and what
18 decisions you're trying to make, and then, what
19 are the inputs to those decisions, and then decide
20 how to collect that information.
21 So, you know, if you're trying to make a
22 decision on harvest, you're going to want very
23 specific information on the expected returns, both
24 prior to and within the season. If you're trying
25 to make decisions on what's the long-term future
26 of sockeye and what's happening to them, you need
27 a more comprehensive understanding.
28 So my way of thinking about this is that -
29 and it's not just my way, it's the common way of
30 looking at things - is you first try to identify
31 where the bottlenecks are, so where are -- where
32 is survival declining, within which life history
33 stage, and then look within that to try to define
34 what the stressors are there.
35 So first understand the survival and
36 condition within each life history stage, and then
37 look within that -- those where it appears that
38 there are problems to understand the mechanisms
39 and stressors.
40 Q And so in doing that, then you would want to look
41 at both sides, you'd want to look at the health
42 and at the productivity?
43 A Yes.
44 Q With respect to -- I'd like, now, to have a brief
45 conversation on pathogens. And you've stated
46 that, in your evidence this morning and in your
47 paper, that it's not possible to reach a

1 conclusion on pathogens due to data gaps; is
2 that --
3 A That's correct.
4 Q And I'd like to compare what this report says to
5 the Pacific Salmon Commission report. If we could
6 go to page 5 of the Pacific Salmon Commission,
7 which is Exhibit 73, again. And page 5, and it's
8 the middle paragraph of the square box, and again,
9 we're still in the executive summary. And it
10 says, in the middle paragraph there:
11
12 From the available evidence, the Panel also
13 deduced that freshwater and marine pathogens
14 (that is, viruses, bacteria, and/or
15 parasites) are an important contributor to
16 both the poor returns in 2009 and the long-
17 term decrease in productivity, but again,
18 data did not permit distinguishing further...
19 It is conceivable that pathogens picked up in
20 fresh water did not cause mortality until the
21 ocean life stage. The Panel members' views on
22 pathogens ranged from a *very likely*
23 *contributor* to a *possible contributor* to the
24 Fraser sockeye situation... Panel members
25 believe that diseases caused by these
26 pathogens are likely made worse by natural
27 and anthropogenic stressors.
28
29 So would you agree that the Pacific Salmon
30 Commission's conclusion on pathogens are
31 considerably stronger than your paper's
32 conclusions?
33 A I'd say they're somewhat stronger. If you'll note
34 in the table, or in the passage you just read,
35 there was, by far, the widest range of uncertainty
36 on pathogens within the Panel from "very likely"
37 to "possible", and our job was primarily to
38 synthesize the work done by the Cohen Commission
39 authors, and Dr. Kent's report essentially said
40 there are no data.
41 And so I would say that we followed a
42 somewhat more rigorous and perhaps harsher
43 decision tree than the Pacific Salmon Commission
44 Panel did in deciding what conclusion we would
45 come to, as I explained earlier to the counsel for
46 the Cohen Commission in Table 3.3-3. So with
47 respect to diseases, without data, we were not

1 able to draw a conclusion, and what I found in
2 past areas is that the range of hypotheses and
3 degrees of belief is very large until you actually
4 get data.
5 Q Right. But I understand at the Pacific Salmon
6 Commission that there was expert evidence there,
7 that Dr. John Winton was present, and he's a
8 renowned expert in the United States on pathogens,
9 and so the Pacific Salmon Commission was able to
10 rely on his expert opinion; is that not part of
11 why this stronger statement was made?
12 A Yes, I think Dr. Winton provided his opinion on
13 it. I would say that the Cohen Commission gave
14 him an opportunity to give a more thorough and
15 detailed look at diseases in the work that Dr.
16 Kent had. I mean, Dr. Winton basically went to a
17 workshop, listened to some presentations, and then
18 had a couple of days to work on this. Dr. Kent
19 had a lot more time to go through this a lot more
20 systematically and write a more detailed report.
21 Q Okay. Thank you. I'd like to move on, now, to
22 some questions about Stage 4. If we could go back
23 to your expert report, page 91, and here you are
24 quoting from McKinnel in the second paragraph
25 about -- and you talked about that this morning,
26 about:
27
28 ...biologists rarely observe death by natural
29 causes of Fraser River sockeye at sea.
30
31 Would you agree that in a good year we have
32 approximately 90 to 95 percent marine water
33 mortality for sockeye salmon?
34 A If you're talking about from the smolt stage to
35 recruits, yeah, marine survival rates, in a good
36 year, are probably four to six percent or
37 something. So I'm taking the opposite point of
38 view.
39 Q Sure.
40 A But it comes out to the same number.
41 Q Right. And in a bad year, we have 98 to 99
42 percent marine water mortality, or one to two
43 percent survival?
44 A Yeah, or worse.
45 Q Right. And so we're searching for a cause for an
46 additional plus or minus five percent mortality in
47 the marine stage to explain poor years as compared

to good years?
A Yes, I think that's correct. In a paper, which I think one of the other participants will present earlier (sic) by Dr. Hyatt, shows that you can use temperature and salinity and El Niño versus La Niña events to actually make that discrimination between good and poor ocean survival, for some stocks.
Q Right. And you'll agree that we really don't know the cause of this high mortality rate in the -- of sockeye in the marine waters?
A Well, I think we can describe the plausible mechanisms. They get eaten by other things, they die of starvation. There are other reasons by which they die. As to exactly what kills them, no, we don't know that.
Q And you'll agree that dead salmon, the mortality, are rarely found and without the bodies you can't really do biopsies or study them to determine the cause?
A Yes, I'd agree with that. And even if you had the bodies, you don't necessarily know what killed them.
Q Right. And that's part of the difficulty in testing for diseases or contaminants, because we don't have the bodies to conduct studies?
A That's correct. Although you certainly could collect fish, for example, at the trap near Mission, and you could collect fish from the Strait of Georgia, and analyze contaminant body burdens and diseases. There's certainly a possibility of doing that.
MR. TIMBERG: Mr. Commissioner, I've been given an extra 10 minutes by my fellow participant, the B.C. -- the salmon farmers, so I'll continue through till 12:30, and I may have one question upon my return.
MS. BAKER: Sorry, I think you need to finish at 12:30. I don't think there will be any time after that.
MR. TIMBERG: Well, my friend has passed me a note saying I can continue, so I will speak to him at the lunch break and I reserve the opportunity to possibly have one question after lunch.
Q If we could go to page 105 of your report. Under the section 5.2.2 Synthesis of Recommendations, you state -- you're talking about your recommendations, now:

1 ...5.2-1 is a synthesis of research and
2 monitoring recommendations, based on the
3 Pacific Salmon Commission report, discussions
4 at the Cohen Commission workshop, the
5 Commission's Technical reports, and this
6 cumulative effects assessment.
7
8 So I'm just clarifying that you started off with
9 looking at the conclusions of the Pacific Salmon
10 Commission and then you layered the work of the
11 multiple reports, and then your cumulative impact
12 assessment; is that accurate?
13 A That's correct. And the workshop, as it states.
14 Q Yeah, okay. And earlier in direct from Ms. Baker,
15 she asked you about -- you stated that you need
16 excellent data -- you were talking about data
17 improvement and you suggested that we need
18 excellent data on Fraser River and non Fraser
19 River sockeye. Perhaps you can clarify the
20 importance of why we need data on non Fraser River
21 sockeye and we always talk about just the Fraser
22 River here, and I'm curious to hear your
23 explanation.
24 A The ability to test these hypotheses of what
25 caused declines in salmon, as you stated earlier,
26 is very difficult to do directly, because you
27 don't have autopsies and the like, and so you're
28 relying on indirect evidence, and what you're
29 looking for are contrasts. You're looking for
30 contrasts in productivity across different stocks,
31 some higher and some lower, and you're looking for
32 contrasts in stressors, some higher and some
33 lower.
34 And so the work on non Fraser stocks is very
35 helpful for illuminating what's the pattern that
36 we're trying to explain. For example, Columbia
37 River Okanagan sockeye more specifically, returned
38 in record numbers in 2009, whereas we know the
39 Fraser did awful. And so looking at that helps to
40 illuminate what could be the possible differences
41 between them, in this case, going to a different
42 part of the ocean, going around the west coast of
43 Vancouver Island rather than Georgia Strait and
44 Queen Charlotte Sound. So those kinds of
45 contrasts are enormously valuable.
46 Q Thank you. Could we move to page 29 of your
47 report? This is the Fraser River sockeye salmon

1 productivity chart. And if we could just look at
2 that. And would you agree that for the period
3 1952 to about 1990, early 1990s, the average
4 productivity was about approximately six adult
5 fish returned for every spawner that spawned?
6 A Just eyeballing, it looks a little lower than six,
7 but around there.
8 Q Okay. Thank you. If we could then move to Tab 8
9 of Canada's list of documents. This is Exhibit
10 1851. And what we've done is we've updated this
11 chart with information from the Pacific Salmon
12 Commission. Have you had a opportunity to see
13 this before?
14 A Yes, I have, this week, along with 61 other
15 documents.
16 Q All right. Last week Mike Bradford spoke about
17 this document. Would you agree that in 2010, and
18 this is certainly preliminary data for 2010/2011,
19 that in 2010 the productivity returned to its
20 historic average of approximately six adult
21 returns per spawner?
22 A Yes.
23 Q And what do you make -- and then, in 2011 it's a
24 bit lower, it's somewhere around four. But I'd
25 suggest -- would you agree that in 2011 that's
26 still within the low range of its historical
27 productivity?
28 A Recognizing that those are our preliminary
29 numbers, because you don't have the full age
30 structure, that looks to be at the low end of the
31 historical range, yes.
32 Q And what do you make of this increase in
33 productivity in 2010 and 2011?
34 A Well, first of all, it's good news. Secondly, as
35 we talk about in our report, in 2008, the
36 conditions in the Gulf of Alaska, and this comes
37 from Skip McKinnel's report, were the coolest
38 they'd been in about 35 years, and that seems a
39 reasonable explanation, since sea surface
40 temperatures are strongly related to availability
41 of food in particular, and other things, as to why
42 the returns in 2010 are better.
43 As to why the returns in 2011 are better,
44 we'll have to look back at conditions in 2009. I
45 know there was, I think, a La Niña event which
46 overlapped into 2009, so there was somewhat cooler
47 conditions, at least over the winter and so on.

So there is that variability and, you know, we're dealt a nice hand in 2008 and a somewhat good hand in 2009, but it doesn't mean you'll get a good hand in the next game of poker.

Q Mm-hmm. And so that's looking at productivity. I'd like to have the same discussion about run size. So this is showing productivity. So in 2009 we have a very, very poor run size, but in 2010 we get a historic run size. And do we need a theory that can explain both low and high run sizes? How do we understand that.

A Well, if I could answer your question by going to a figure in our report on page 37 of our report? So the total return is going to be the number of spawners times the recruits per spawner. And so these four graphs are organized by brood year. And so in the top left panel you have the returns 2002 -- 1998, 2002, so then that would be also 2006 and 2010, which you can see are dominated by the red or Late Shuswap stock.

So 2010 had the benefit of both higher recruits per spawner, as you were just shown, like around six, but also had the benefit of a pretty large cycle year in the late Shuswap stock, and you can see that they're a lot lower, the red is a lot lower in the other brood years in the other three graphs. So the total return is just the number of spawners times recruits per spawner. It's just straight math.

And when you have more spawners, even if you have the same recruits per spawner, you're going to get more returns. And that's why you can see, you know, over those -- each of those big Adams year runs, you get, you know, more recruits.

MR. TIMBERG: Thank you. I note the time, Mr. Commissioner.

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

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

(PROCEEDINGS ADJOURNED FOR NOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: The hearing will now resume.

MR. TIMBERG: I have one final question for you, Dr. Marmorek. And, for the record, it's Tim Timberg and Charles Fugère for the Government of Canada.

CROSS-EXAMINATION BY MR. TIMBERG, continuing:

Q If you could go to page 9, the last paragraph there. It just states that:

> The scope of the present cumulative effects analysis is limited to the scope of the Cohen Commission technical research projects as a whole. Our cumulative effects analysis has been conducted within the universe of the other technical projects and the data available from within those projects. This is not a cumulative effects study of Fraser River sockeye salmon within the broader realm of all available scientific literature, research and reports.

And so my question is: Just for clarity, you'll agree that this report does not consider the testimony and cross-examination of the authors of the other technical research projects that appeared before this Commissioner?

A It doesn't consider the testimony. It does consider their reports.

Q Yeah, thank you. It's just their reports?

A Yes.

MR. TIMBERG: Thank you. Those are all my questions. And for the record, I think I've used up 11 minutes of the time that was allotted to me.

MR. PROWSE: Mr. Commissioner, Cliff Prowse, for the Province of British Columbia, and I have, I think, 25 minutes left, and I think I'll be less than that.

CROSS-EXAMINATION BY MR. PROWSE:

Q Might I have Canada's document Tab 1, please. This is an operational policy statement addressing cumulative environmental effects under the ***Canadian Environmental Assessment Act***. Have you been involved in any projects that have involved environmental assessments under the ***Canadian Environmental Assessment Act***?

A The company, as a whole, has, and I'm involved with one right now which will be, but I haven't had a lot of experience with it.

Q All right. And you've been involved in other

1 kinds of environmental assessments in --
2 A Yes, I have.
3 Q -- other jurisdictions? And this is the
4 practitioner's guide, so it's basically telling
5 people what they have to do with respect to
6 cumulative environmental effects if the ***CEAA*** is
7 triggered, as I understand it. This kind of
8 assessment of environmental effects is not -- this
9 would be within, I think, what -- in the statement
10 you just read, would be within the broader
11 literature about environmental effects. This
12 isn't the kind of literature that you've
13 considered for purposes of this report?
14 A Well, we did look at how cumulative effects
15 assessment is considered under ***CEAA*** when we were
16 designing our approach to this retrospective
17 ecological risk assessment. The key difference
18 here is that cumulative effects assessment under
19 ***CEAA*** is looking forward as a project and then
20 you're looking at what other projects can be
21 reasonably foreseen to also be occurring in the
22 future that might interact with the effects of the
23 project. So that's one difference.
24 The other difference is that the way this
25 operational policy statement work is, it's centred
26 on the project as opposed to centred on the valued
27 ecosystem component which is, in this case,
28 sockeye. So we're looking at all the different
29 factors that can effect sockeye and addressing it
30 from that point of view, which some of my
31 colleagues, like Lorne Grieg, who was on this
32 study, have argued there's a better way to
33 actually do cumulative effects assessment.
34 Q All right. And are there any conceptual
35 differences, apart from the ones you've mentioned,
36 between the approach you've taken and the one
37 that's embodied in this kind of an approach that
38 are important for the Commissioner to know?
39 A I think it's fundamentally different, and the task
40 here is to look retrospectively and say, "What are
41 all the different factors," and how they
42 interacted to have affected sockeye, as opposed to
43 saying, "Here is one project and how could that
44 project, going forward, affect a variety of
45 different environmental components, including
46 other possible projects that might occur?"
47 This particular practitioner's guide I don't

1 think is really relevant to what the task that the
2 Cohen Commission had to do.
3 Q I'm going to get this muddled up, but there's a
4 saying, I think, in the -- if you're approaching
5 your financial planner, that past results aren't a
6 guarantee of future performance.
7 A Mm-hmm.
8 Q How does that concept apply to what you're just
9 saying, because aren't we in the Commission really
10 concerned with future performance and that's the
11 only reason why we're interested in the past
12 results?
13 A Well, I think that's a good warning, both
14 financially and biologically, in that the sequence
15 of ocean years which may occur in the future could
16 be quite different from what has occurred in the
17 past. There are many alternative futures, whereas
18 there's only one past. The actual question that
19 all of the main authors of these reports were
20 asked to look at is, What's the relative
21 likelihood of these different stressors of having
22 influenced the past.
23 Now, how you best manage fisheries going
24 forward is really a good question. That's not a
25 question that we were addressing, nor is it a
26 question that most of the other reports were
27 addressing, with the exception of the ones that
28 were looking at fisheries management.
29 MR. PROWSE: Mr. Commissioner, for the record, could we
30 mark this as the next exhibit, please.
31 THE REGISTRAR: Exhibit 1904.
32
33 EXHIBIT 1904: Addressing Cumulative
34 Environmental Effects Under the ***Canadian***
35 ***Environmental Assessment Act***
36
37 MR. PROWSE:
38 Q So going forward in your report, you were asked to
39 look at research projects going forward.
40 A Mm-hmm.
41 Q And so I think it's --
42 A Yeah, page 103, I think.
43 Q Yes. In particular, there's Table 5.2-1 at page
44 108, Mr. Lunn. This is in the current exhibit.
45 So in this report, you've selected
46 recommendations broken down by life stage and then
47 you bolded 12 of them. And you've also -- I guess

1 the first question is: You've talked about, I
2 think, having an integrated approach to all this,
3 so that you're doing research on everything.
4 Maybe I've misstated that. Can you explain how
5 you would select, going forward, the research
6 areas that you've honed in on here?
7 A So, first of all, it's not up to me to make that
8 decision. And in the testimony that I gave
9 earlier to the Commission lawyer, I outlined on
10 the previous page - Mr. Lunn, if we go to 107 -
11 what I think the criteria would be for further
12 prioritizing this list. So those four questions
13 that you see up there on page 107 are the --
14 represent the process that we would recommend
15 using and the process that we've used in other
16 projects for trying to prioritize.
17 Q All right. And you referred to the -- some EPA
18 data quality objectives processes, which I take it
19 you've utilized in other projects?
20 A Yes, going back to the 1980s and acid rain and
21 many other applications since then.
22 Q And does the EPA have an overarching integrated
23 scheme for their projects, or is this something --
24 is this really a tool that you use on specific
25 projects within the EPA realm?
26 A This is more used within specific projects within
27 the Environmental Protection Agency. That was how
28 it was originally designed. So if you wanted to,
29 for example, design if a river were polluted or
30 not, that you would lay out what your decision
31 criteria were for making that decision where all
32 the inputs were and then design a study
33 accordingly to fit that.
34 That having been said, we found it applies
35 quite well to broader situations where you have
36 multiple potential research and monitoring
37 projects that you might do, and by asking the
38 question, "What are the decisions you really want
39 to make and what are the inputs of those
40 decisions," certain things rise to the top as
41 being more important than others.
42 Q All right. So in this, I guess, within the world
43 of the Cohen Inquiry, then, the participants can
44 make recommendations about how this approach would
45 be applied and the Commissioner may choose to
46 adopt this system or some other system or adopt
47 these recommendations, and those would all be made

as a recommendation to the Government of Canada in this instance. Have you considered or written about different options for decision-making as to who would make these overall arching (sic) decisions? For example, there's -- some people refer to a forest - sorry, not a forest - I think a fisheries research board that I think is a past entity that had some coordinating function, but have you written on that topic as to how do you decide who should make that decision?

A No, I haven't written specifically on that topic. What I found in other projects with similar challenges is that the best way to make those decisions is to have a good dialogue between the managers who need the information and the scientists who produce it, so that the managers keep the scientists relevant to their real decision needs and the scientists keep the managers realistic with respect to what can or cannot be answered by science. So I really believe that it's a mix of the two that's required.

Q Okay. I'm going to digress from this point, simply to ask: The subject of contaminant has come up in the hearing and this morning you told Ms. Baker, a few times, that -- your comments were you've written about contaminants as based on known contaminants, as opposed to the unknown or emerging contaminants and endocrine disrupters, where simply they're not known, so you haven't considered them in your report; is that a fair statement?

A That's a fair statement.

Q I understand, from your resume, that you were involved with pulp mill standards, going back 20 years ago or so, 15 or 20 years ago; is that right?

A We weren't involved in development standards. We worked with Environment Canada and the B.C. Ministry of Environment on looking at the fate and effects of pulp mill effluents in the Fraser Basin. It was more attempting to decide what were research and monitoring priorities, and some modelling was involved with a professor from Simon Fraser University.

Q So you may or may not have a view on this, but my question is: How do we understand the evidence

we've had in this inquiry from Mr. MacDonald and others about that it should be an important project to look at, endocrine disrupters and contaminants of emerging concern, as opposed to looking backwards to the studies that you would have been involved with at that time, or the Governments were involved with at that time, about pulp mills, which I think largely succeeded in cleaning up the matters that were -- the matter of concern. Is this just a generational iterative process that, in the future it's always good to do an update and look at these things, or how would you explain that?

A Well, I think new stressors emerge and it's a good idea to do some studies to assess, "Is this a big problem or a small problem?". I don't think it should be that hard to collect some smolts at the outlet of the Fraser and examine them for contaminant burdens and get better estimates of exposure, and then do a kind of screening assessment on how large or small the problem is.

One thing I'll note in context here, and it comes back to the comments I made earlier to Ms. Baker about the pattern, is that you do, unfortunately, see these productivity declines in a lot of sockeye stocks that are from essentially pristine watersheds in the central and northern parts of B.C. and southeast Alaska. So if it were purely contaminants that were a driving factor, whatever they were, you would wonder why, in pretty uncontaminated systems, you would also be having those declines.

Q All right. Within your recommendations, the problem I want to pose to you is: We are probably living in a world of short governmental dollars, so there, I think there was, evidence in the spring that there was an anticipated five percent budgetary cut across the board, including the Department of Fisheries and Oceans. So in that context, it would seem to me that if you were able to say, "Here's the top three projects, and if we could do just these top three projects we would really come to a breakthrough in our understanding of the problems," that that would be a nice position for us all to be in. But I take it, from your table, that you think that we're in a world where there's many different possible causes

1 working in different combinations, different from
2 year to year, and that a comprehensive approach
3 seems to be what you're recommending here?
4 A Well, I think you also have to recognize, when you
5 start talking about future budget cuts, there's
6 been a huge number of historical budget cuts, and
7 so if you say to the Department of Fisheries and
8 Oceans, "Well, we'd like you to be able to answer
9 all these questions when things go wrong, but
10 we're not going to actually give you any money to
11 do it," I don't think that's a fair way of
12 approaching it. So my approach to this, or our
13 team's approach to this was to say, "Here is what
14 we think would be required to answer both
15 management and scientific question adequately."
16 Now, if there aren't enough resources to do
17 that, I think there needs to be a very careful
18 consideration by a lot of people, as I outlined in
19 what you see on page 107, as to what the trade-
20 offs would be. And so I'm not going to throw out
21 my best three guesses off the top of my head as to
22 what would be the best, because I don't think
23 that's the right way to make that decision. I
24 think you'd really have to systematically analyze,
25 what are the benefits and costs of doing each of
26 these things and of not doing them, what are the
27 risks of not doing them.
28 Q In that context, I noted in your resume that you
29 had had some involvement with Carnation Creek
30 research that has been done by Peter Tschaplinski
31 and others.
32 A Mm-hmm.
33 Q Is that an example of a long-term project that has
34 some messages about importance for understanding
35 problems going forward?
36 A Well, they're looking at effects of forest
37 harvesting on salmon and it's been a very valuable
38 project with a long history. I think that there's
39 always a compromise between a very intensive look
40 at one watershed, like Carnation Creek, versus an
41 extensive look at a bunch of watersheds, and I
42 think you need both of those kinds of studies,
43 because if you just look at one place, it's not
44 going to be representative of all those places.
45 SO the 64 stocks that Peterman and Dorner looked
46 at give us a very broad look, but not very deep,
47 and whereas the work that, say, is done on

1 Carnation Creek or on the Kehoe River by Bruce
2 Ward, gives a much deeper look at, you know, a few
3 places. You can't afford to do that everywhere,
4 but I think you need both.
5 Q But, in particular, you need a long time series of
6 data to --
7 A Correct.
8 Q So it's important to keep it going year after
9 year?
10 A Absolutely.
11 Q I wanted to ask you, briefly, about work you've
12 done for the Province of British Columbia -- that
13 your firm has done for the Province of British
14 Columbia to do with sensitive watersheds and a
15 watershed evaluation tool. Can you just explain
16 that to the Commissioner to the extent you're
17 aware of it?
18 A Sure, I've been involved in that work. Going back
19 to the '90s, there was something called the Forest
20 Practices Code, and every watershed that was
21 scheduled for harvesting had to go through a
22 watershed assessment procedure. And then around
23 2000 they decided that they didn't want to make
24 forest companies do that for every single
25 watershed, so they developed this watershed
26 evaluation tool which was basically a method of
27 rating the relative sensitivity of different
28 watersheds, and then those that had the most
29 important fisheries or fish populations, and they
30 could be either from a number of harvested fish or
31 from an endangered species or a species at risk
32 point of view, or were most vulnerable, because
33 steep-sided watersheds and other geomorphic
34 features made them more vulnerable to the
35 forestry, that those would be designated as
36 fisheries-sensitive watersheds, and so the
37 Province has gone through and identified those.
38 And then we've been working with the Ministry
39 of Environment at a sampling design and, instead
40 of monitoring protocols that could be used both
41 with remote sensing information as well as field
42 protocols to try to assess the relative
43 sensitivity and the current status of watersheds,
44 both before and after forest harvesting, and some
45 of those methods are just being tested in the
46 field actually next week.
47 Q Thank you. Now, I think, judging by the exhibit

1 number of your resume, that you were probably a
2 co-author on the Technical Report 3?
3 A That's correct.
4 Q And so I had a very high overview level, I recall
5 that Katherine Wieckowski did an approach to the
6 Wild Salmon Policy that was sort of a shortcut
7 tool. I know I'm grossly oversimplifying. Do you
8 recall that?
9 A Well, we'd have to get out Technical Report 3, if
10 you actually want to look at it. But basically,
11 she looked at a number of existing status
12 assessments for the 36 conservation units and
13 while that work was ongoing there was another
14 report, I think the first was Pestal et al, and
15 then there was another report by Grant et al, and
16 so sort of compared the two and looked at how the
17 two different status assessments turned out. And
18 most of them didn't actually change very much. So
19 I don't know what you mean by a shortcut. It was
20 basically using the information that was available
21 to provide some kind of status assessment for the
22 36 conservation units.
23 Q Have you been involved in work on the Wild Salmon
24 Policy, apart from that -- apart from that report?
25 A We have done some work. We did some work for
26 Pacific Fisheries Resource Conservation Council on
27 the Wild Salmon Policy, looking at, I think they
28 call it, other ecosystem values, so essentially
29 other animals that benefit from eating salmon and
30 what the implications are of different escapement
31 policies that way.
32 We've also done work on the Wild Salmon
33 Policy with the Department of Fisheries and Oceans
34 on the habitat side, in terms of habitat
35 indicators, and co-authored a document. I think
36 Heather Stalberg was the first author on that.
37 Q All right. So Strategy 4, as I understand it, is
38 intended to deal with some form of integrated
39 management. Have you, first of all, done any work
40 or writing on that? Probably you may have done
41 that on the PFRCC document?
42 A No, we're not involved in Strategy 4. I don't
43 remember right now all the numbers in the Wild
44 Salmon Policy, but I think it was 2 and 3, rather
45 than 4. One of my colleagues, Mark Nelitz, may
46 have gotten involved in some of that work.
47 Q All right. Commission Counsel, this morning,

1 marked three documents, documents 1892/93/94,
2 which were papers by Welch and Parsons and
3 Blackbourn and MacKenzie and others; are you
4 familiar with those?
5 A I'm just trying to remember which -- these are...?
6 Q These were miscellaneous papers. They --
7 A Are these the ones with the pesticide use, or --
8 Q No, no.
9 A No? Which ones?
10 Q This is on sea surface temperatures and --
11 A Oh, I'm sorry. Sorry, Welch and Parsons.
12 MS. BAKER: (Inaudible - off microphone).
13 MR. PROWSE: All right. All right.
14 A Sorry, no, I'm familiar with some of the work by
15 David Welch, but I'm not familiar with the -- oh,
16 sorry, these ones that were marked this morning?
17 No, this is the first time I'd seen these.
18 MR. PROWSE: All right. I have no further questions,
19 Mr. Commissioner.
20 MR. HOPKINS-UTTER: Good afternoon, Mr. Commissioner.
21 Shane Hopkins-Utter, representing the B.C. Salmon
22 Farmers Association this afternoon. And by my
23 count, after Mr. Timberg had some of our time, I
24 count that we have 20 minutes remaining.
25
26 CROSS-EXAMINATION BY MR. HOPKINS-UTTER:
27
28 Q Dr. Marmorek, today I'm going to ask you some
29 questions about modelling, generally, and the
30 first thing that I'd like to ask you about is the
31 use of benchmarks. Mr. Lunn, if you could please
32 pull up Tab 2. This is Technical Report 1896 at
33 pdf 29, page 13. The second paragraph, beginning
34 with, "Rocket science".
35 A Oh, I like this paragraph.
36 Q I do, too, which is why I wanted to ask you about
37 rocket science being used as a benchmark. Maybe
38 you could just start us off with that, because I
39 think after a very long time in hearings and being
40 lawyers, we've come to appreciate the complexity
41 of this, but I think your words will capture it
42 best.
43 A Well, I should mention that this particular
44 paragraph had two completely opposite reactions to
45 it. Randall Peterman asked if he could use it in
46 an address to the American Fisheries Society, and
47 Sean Cox said it was nonsense and should be

1 removed. So given that range of benchmarks for
2 this benchmark paragraph, the point here is that
3 there is a lot of variability, particularly in the
4 ocean, where it's not well monitored and the
5 interactions can vary from year to year, so it's
6 extremely difficult for fisheries scientists to
7 predict what the recruits per spawner are going to
8 be from a given parent generation.
9 And so the metaphor here, and I think Sean
10 Cox's objection was, "There's no place for
11 metaphor in science writing," is that a rocket
12 scientist would have to deal with continuing
13 changes in the sort of ground conditions from year
14 to year and the ability to monitor that variation.
15 I don't know if it's really a benchmark in
16 this context for science, I just think it means
17 there's a lot of difficult -- I should mention
18 that Sean Cox said, in his review, that fisheries
19 scientists were not smart enough to launch
20 rockets, so that's the counter view here.
21 Q So in your opinion, would you prefer the weight of
22 evidence leaning toward Peterman's assessment?
23 A Understandably.
24 Q Moving on, well, given the complexities that
25 you've just spoken of, I understand that models
26 are generally used to be a type of representation
27 of reality. Is that something that you would
28 agree with, a mathematical representation of a
29 reality?
30 A It's a simplification of reality for the purposes
31 of answering some question of interest. And the
32 famous saying is that "All models are wrong and
33 some are useful."
34 Q Well, you also noted, earlier, that the best model
35 that you were able to come up with was, I think
36 you used the word, surprisingly, was the one that
37 actually included the most factors, so the most
38 real world factors. Was that --
39 A Actually, no, that wasn't true. That was in one
40 case. We went through several different analyses.
41 That was true for the case where we were looking
42 at combining or using all the Cohen Commission
43 projects as away of organizing information. When
44 we organized it by life history stage, actually,
45 models which use less information proved to be
46 more informative.
47 Q You also mentioned that, and I think it was in

that same context, the AIC can penalize for having too many variables. Is that one of the weaknesses of AIC?

A No, it's not a weakness at all; it's a strength. Historically, biologists tended to throw all the things they'd monitored into the computer and, you know, they'd run 100 variables and five of them would come out significant and they'd say, "Oh, these must be important," and that would happen just if you threw random numbers in. So the stress of the Burnham and Anderson approach, who prompted AIC in the 1990s, was to make very specific hypotheses and test only variables related to those hypotheses and to, in fact, penalize models which threw more variables in but didn't get any better explanation of the data.

So essentially you try to get the best possible explanation, in this case of sockeye productivity, with the least number of variables.

Q From my recollection, is that the r-squared you should be seeing some improvement as you go?

A The AIC measure is a measure which includes the likelihood of the data given the models and the measure of how many variables you use, so that's different from the r-squared that we talked about earlier.

Q Mr. Lunn, if you could pull up Tab 12. This is Spanos, and I know I'm going to mispronounce it, so I'll just us the AIC and the Reliability of Inference: Model Selection Versus Statistical Model Specification paper published in 2010.

Are you, in fact, aware that there are criticisms of the AIC, as evidenced in this paper?

A Yes. And since we received those, which was five o'clock Friday, we actually had Carl Schwarz, head of statistics at Simon Fraser University -- he was the chair of the Simon Fraser statistics department, look over this paper, and we also looked it over.

MR. HOPKINS-UTTER: Mr. Lunn, could we mark that as the next exhibit?

A Would you like me to comment on that paper?

Q Yes, yes, absolutely. Sorry. Before I forget.

A So the two points in the paper that Spanos et al -- Spanos raises here, the first is that AIC approaches:

1 ...give rise to unreliable inferences,
2 primarily because their choice within a
3 [prescribed] family of models (a) assumes
4 away the problem of model validation, and (b)
5 ignores the relevant error probabilities.
6
7
8 Q So if those two faults are committed, then it will
9 give rise to unreliable inferences; is that what
10 the paper is saying?
11 A That's what the paper is saying, so I don't agree
12 with it for a number of reasons. First of all,
13 these AIC statistical methods have been used in
14 the scientific literature over the last 15 and 20
15 years, and as described in Burnham and Anderson,
16 1998; and, secondly, the -- if you go through the
17 process I just described earlier, whereby you
18 define your hypotheses based on biological theory
19 and examine the relative level of support for each
20 model, using AIC and other criteria, goodness of
21 fit measures of how well the model fits, examining
22 residuals and doing other things, then it's a
23 quite valid approach to do, and we did that, we
24 applied it appropriately.
25 And I'll just say that while there are parts
26 of that Spanos paper that Dr. Schwarz agreed with,
27 there were other parts which he did not agree with
28 at all.
29 Q Dr. Marmorek, I hate to interrupt, but I do have
30 limited time, unfortunately, and I was just
31 wondering if you were, in fact, aware of the
32 criticisms that some others make. You have stated
33 on the record that you disagree with them,
34 however.
35 A Correct.
36 MS. BAKER: Mr. Commissioner, the witness was in the
37 middle of an explanation. My friend put the
38 article to him. The witness is allowed to explain
39 whether he agrees with it or not agree with it. I
40 mean, he wants to have this marked as an exhibit.
41 He at least needs to allow the foundation to be
42 met or not met.
43 THE COMMISSIONER: Carry on.
44 A I think the key point, here, is that if you
45 carefully decide which hypotheses you're testing
46 and then look at various diagnostic information,
47 including AIC and other measures of goodness of

fit, that they're wholly appropriate, and that the criticisms outlined in this paper are not a problem.

MR. HOPKINS-UTTER: Thank you for your answer. Sorry for trying to interrupt.

Mr. Lunn, could you please take us to Exhibit 1896, Technical Report 6, at pdf 116 -- oh, I'm sorry, could we please mark that as an exhibit, Mr. Registrar.

THE REGISTRAR: Yes, that will be 1905.

MS. BAKER: Again, Mr. Commissioner, the witness actually did not adopt anything or accept anything in this journal article, so I'm not sure that it should be marked as an exhibit.

MR. HOPKINS-UTTER: Mr. Commissioner, I would suggest that, as has been the practice throughout these Commission hearings, I've asked questions of the witness on the paper, he recognized it, he acknowledged that he gave it, and he gave his opinion on it.

THE COMMISSIONER: Very well, we'll mark it as an exhibit, thank you.

THE REGISTRAR: So marked.

EXHIBIT 1905: Akaike-type Criteria and the Reliability of Inference: Model Selection Versus Statistical Model Specification, by Aris Spanos

MR. HOPKINS-UTTER: I'm sorry, what was the number for that?

THE REGISTRAR: 1904 -- or, I'm sorry, 1905.

MR. HOPKINS-UTTER: Thank you.

Q Dr. Marmorek, I note this table 4.8-1, it says:

Other factors potentially contributing to the decline of Fraser River sockeye salmon that were not considered within the spectrum of Cohen Commission technical reports.

And the list includes competition with pink salmon, hatchery fish, increased predation. So is it not true that there are a number of other factors that potentially contributed to the decline that just weren't being considered in the Commission reports?

A Well, we mentioned one this morning of harmful

1 algal blooms, and my sense is - I'd have to check
2 - that virtually all of the other factors that
3 were considered by the Pacific Salmon workshop in
4 June of 2006 -- sorry, 2010, are listed here. So
5 in terms of primary factors that might be
6 explaining the overall decline, I don't think
7 there are any others. I welcome your suggestions.
8 Q I'm not the scientist, unfortunately. May we move
9 to pdf 124, Mr. Lunn, of the same report. A
10 little further down the page. Actually, at the
11 bottom of the page, I believe. Thank you.
12 So this is the cell downstream migration to
13 estuary. It reads, on the right-hand column:
14
15 We do not know the survival rate of smolts
16 during their downstream migration, or when
17 they arrive in the Fraser estuary (vital to
18 understanding potential mismatches between
19 arrival times and marine plankton blooms).
20
21 And you give some recommended activities. The
22 next page, Mr. Lunn. At the top, under numbers 7
23 and 8.
24 So is it true that the bold highlighting
25 indicates what is a high priority in this table?
26 A Those are the ones which we thought were, if you
27 had to divide them roughly in half, those were the
28 ones that we thought would be in the -- at the
29 higher level priority. Others might disagree.
30 Q And number 8 reads:
31
32 Estimates of the size and health of smolts
33 arriving in the Fraser estuary (e.g.
34 pathogens, contaminant body burdens, lipid
35 reserves),
36
37 That's not in bold text, is it?
38 A It's not in bold text, but it's still there, which
39 means it's still something we think is worth
40 doing.
41 Q And are you aware that on August 24th Dr. Miller -
42 I'm going to paraphrase what she said - but Dr.
43 Miller gave evidence that the signature or, sorry,
44 the parvovirus may be coming from the freshwater
45 environment due to the higher prevalence in smolts
46 as they leave freshwater, entering the marine
47 environment. Would that testimony suggest that

this number right here should be considered a higher priority?
A I think it goes back to deciding, as I said at least two or three times, what the decisions are you want to make and what are the most important inputs to those decisions, as I was just speaking to your colleague about the data quality objectives process. So the relative importance of genomic studies versus all these other things need to be examined in the context of what you're going to do with that information for what decisions.
Q Mr. Lunn, page 66 of this report -- I'm sorry, pdf 66, page 50. No, you actually had it on the screen. Under 4.3.1, the second sentence beginning with:

> Nelitz et al. (2011) point out that sockeye salmon smolts are cued to migrate towards the ocean in response to changing environmental conditions, which includes responding to day length, lake springtime temperatures...

I'll skip down:

> Earlier outmigration could lead to a mismatch between the arrival of salmon smolts in the Fraser estuary and Strait of Georgia, and the timing of plankton blooms that are essential for growth and survival in Stage 3 (coastal migration).

Do you agree with this assessment that climate change can, in fact, affect the timing of salmon outmigration and availability of plankton blooms?
A Yes, I do, and with the clarification that was mentioned earlier, that it could be that you arrive either too early or too late.
Q So one way or the other --
A Mm-hmm.
Q -- the smolts could be entering at a different time and the, I guess, the environment hasn't caught up, at that point, with their new timing?
A Or the environment has changed in a different direction. They both could be changing in different directions for different reasons.
Q Mr. Lunn, could you please take us to page 63, paper page 63 of this report, second paragraph

1 down. Dr. Marmorek, would you agree with the
2 statement that you have here, the second sentence:
3
4 This suggests that there is strong evidence
5 for a direct impact of climate change on
6 sockeye salmon.
7
8 A So I think earlier I was asked about the overlap
9 between changes in marine conditions and changes
10 due to climate, and I think the key, here, is that
11 climate change can and has increased sea
12 temperatures and is likely to increase them more
13 so, and that changes in sea temperatures affect
14 prey, predators, competitors, in various ways. So
15 I think for here we're talking, now, about the
16 coastal migration stage, which is why we concluded
17 that this was a likely factor, both marine
18 conditions and climate change.
19 Q Thank you. And on the next page, Mr. Lunn, page
20 64, under Conditions in Queen Charlotte Sound
21 versus the Strait of Georgia, I'm just going to
22 note, briefly, Peterman et al, that's the PSC
23 report, Exhibit 73:
24
25 ...concluded that it was "very likely" that
26 physical and biological ocean conditions
27 inside [Strait of Georgia] during this life
28 stage had been a "major factor",
29
30 And they rated this as "likely" in contributing to
31 poor ocean returns in 2009. And the Cohen
32 Commission rated these similar conditions in the
33 Strait of Georgia as being "likely". Would you
34 agree that this, in fact, confirms that both of
35 those workshops concluded that it was either very
36 likely or likely that the Strait of Georgia played
37 a role or overall for 2009 returns, that is, in
38 fact, what this said?
39 A I think that's what the workshop said, and then I
40 think the work that was done subsequently in the
41 reports was a lot more thorough, in terms of the
42 work by Dr. McKinnel, at looking at the
43 conditions, actually, within both the Strait of
44 Georgia and Queen Charlotte Sound. And there's
45 other work that's been already provided by Dr.
46 Beamish which provides further evidence.
47 So I think we got -- we made a lot of

1 progress, iteratively, amongst the different
2 workshops, but also in the reports and articles.
3 Q So those environmental conditions, then, at play
4 seems to be, from my non scientific background, a
5 significant role?
6 A Correct.
7 Q And isn't it also true that the top-ranked model
8 that you discuss at the bottom of page 65 was, in
9 fact, for the Strait of Georgia? I'm sorry, "The
10 analysis of this time period showed," -- I'm
11 reading 65, Mr. Lunn, at the bottom:
12
13 ...that there is support for both [Queen
14 Charlotte Sound] and [Strait of Georgia]
15 models - the top ranked model was for [Strait
16 of Georgia], the second for [Queen Charlotte
17 Sound], and the third was the global model,
18 including both regions.
19
20 So that is in fact, true, that the Strait of
21 Georgia was the top-ranked model for this
22 particular model -- analysis, I'm sorry?
23 A Well, I think you have to put this model work in
24 context, right? We took the data that was
25 provided to us, and the main purpose, just as I
26 said earlier, our main purpose was to see if we
27 could disprove some of the hypotheses that came
28 out of the Cohen Commission reports, particularly
29 on marine conditions. So if it had turned out
30 that marine conditions, for example, the variables
31 that were in there had no support, whatsoever, in
32 the productivity measures for sockeye, that would
33 make us wonder, "Hmm, I wonder what's going on?"
34 So the fact that it came out that both Strait of
35 Georgia, on one case, and Queen Charlotte Sound
36 were good at, let's say, relatively good at
37 predicting sockeye salmon productivity and that we
38 could not reject that hypothesis, it doesn't mean
39 that these models are right. As I said earlier,
40 all models are wrong, some are useful. This was
41 useful in the sense that it allowed us to not
42 throw away some of the conclusions that we'd
43 already gleaned from the other Cohen Commission
44 reports. It didn't contradict the conclusions
45 we'd already came to by synthesizing the
46 information in those reports.
47 Q And in my final minute, I would just like to ask

1 something that you just brought -- well, you just
2 brought up. Why is it significant to attempt to
3 disprove hypotheses rather than to prove theories?
4 A I think the -- it's the basic approach of the
5 scientific method, which is that as long as events
6 occur in a way that is consistent with a theory,
7 you can't reject it. But if an event then came
8 along that was contradictory to that theory, you
9 would then be able to reject it. So if you went
10 along and said, "Well, the last 10 years this
11 seems to be correct, therefore it must be true,"
12 what would you do in year 11 when you found out
13 you were wrong? So that's why it basically comes
14 to the idea that you can only disprove hypotheses,
15 and those which have failed to be disproven over a
16 long period of time gradually become accepted.
17 MR. HOPKINS-UTTER: Thank you very much, Mr.
18 Commissioner, those are my questions.
19 MR. McDADE: My name is Greg McDade, I'm counsel for
20 the Aquaculture Coalition.
21
22 CROSS-EXAMINATION BY MR. McDADE:
23
24 Q Doctor (sic), you've probably had the most
25 challenging job of the various report writers, as
26 you had to put them all together.
27 A By the way, I appreciate everyone calling me
28 "doctor", but it's really just "mister", so I
29 thought you might want to correct that.
30 Q I'm sorry.
31 A My initials are "D.R."; my parents strategically
32 named me that way, but...
33 Q Well, D.R., I think it's -- you've noted quite
34 clearly in your addendum report, and that's where
35 I'm going to focus, is I think that's Exhibit
36 1575, that the reports of Dr. Noakes and Dr. Gill
37 were somewhat of an anomaly in this matter in that
38 they were fairly significantly different from each
39 other, they came to opposing conclusions. And I'm
40 interested in how you attempted to resolve that
41 matter. As I understand it from your report, you
42 didn't really attempt to weigh those reports
43 against each other or to choose who was right.
44 A Well, maybe we could go to -- Mr. Lunn, if we
45 could go to page -- the Table 2 in page 18 and 19,
46 I think that's informing this discussion. So we
47 went through the decision tree, the retrospective

ecological risk assessment tree, and admittedly, neither Dill nor Noakes nor any of these authors had used that approach in organizing their reports. But we basically pulled out -- we mimed those reports to say, "Well, where do they differ and where are they similar?"

And so if you look down the mechanism column, you know, across waste, escapees, sea lice, disease - salmon origin, disease -- those are the four, really, they basically all agreed that there was a mechanism. Noakes did not agree that there was a plausible mechanism by which waste could affect sockeye salmon.

When it came to exposure, they agreed that there was unlikely to be exposure to a significant fraction of sockeye salmon for either waste or escapees. They disagreed on sea lice, and they disagreed on disease.

When it comes to correlation consistency, they felt there was no correlation or consistency for waste, escapees and sea lice; they all came out the same way, Noakes and Dill, but they disagreed on disease. So essentially, as you said, it wasn't our job to reconcile them. Our job was to look at what the implications would be if you used one report versus the other report for our overall conclusions.

So what it comes down to is they came to unlikely conclusions by somewhat different pathways in our decision tree, but nevertheless, the same conclusion and -- with the three first rows there, but in the last row, in disease, came to different conclusions. So we basically just carried -- said, "Well, if you accept Dill, then this is what you would conclude, and if you accept Noakes, this is what you can conclude."

Q And I'm going to focus, for the rest of my examination, on the question of disease.

A Okay.

Q And disease arising from fish farms. Now, if we go to page 14, the top -- sorry, one page earlier that that. Yes. So if we highlight the last half of the first paragraph there:

> ...Dill's [2011] examination of further evidence led him to believe that disease transfer from salmon farms is the most likely

1 mechanism of concern that could explain the
2 negative correlation between salmon farm
3 production and sockeye productivity described
4 by Connors...
5
6 So we have Dr. Noakes saying one thing and Dr.
7 Dill saying another. You don't evaluate who's
8 more likely to be correct?
9 A That's correct. We do recommend that we actually
10 get some disease data.
11 Q Yes.
12 A And actually, so did Noakes and Dill.
13 Q Yes. But if Dr. Dill is right, that disease
14 transfer from salmon farms is a most likely
15 explanation for the negative correlation between
16 salmon farms and sockeye productivity, that may be
17 the explanation for these long -- or at least one
18 major explanation for the long-term decline in the
19 productivity?
20 A I don't think Dill said that salmon farm
21 production was the most likely factor causing the
22 decline of sockeye productivity - we'd have to go
23 to his report - but I don't believe he ever said
24 that it was most likely. I think what he said is
25 that of the various mechanism by which salmon
26 farms might affect salmon productivity, disease is
27 the most likely causal pathway. That's quite a
28 big difference.
29 Q Yes. And that's part of what the challenge we
30 have before us, is that in the absence of
31 empirical evidence, or empirical proof of these
32 pathways, you're left with plausible hypotheses or
33 plausible mechanisms, right?
34 A Yes, that's correct.
35 Q And in the difficult task that the Commissioner
36 faces here, I think it's fair to say that there's
37 not a lot of empirical evidence about wild salmon
38 catching disease, whether it's from farms or any
39 other source, that's something that you've
40 identified as that lack of empirical evidence?
41 A That's correct. We identified it as a gap and as
42 a need to be filled.
43 Q Right. And so if one hasn't done any studies on
44 these questions, one's not going to find any
45 empirical evidence?
46 A By definition.
47 Q And as you also, I think, it's fair to say, it's

very, very difficult to actually prove the cause of disease in the wild population of fish, because the dead fish disappear before you could test it?

A I haven't actually said that. I think that if you went, and as we say in the conclusions to this report, if you went out and measured the incidents of diseases in areas close to or far away from fish farms or before and after sockeye pass fish farms, you would be able to get some useful information. The greater the level of contrast in exposure, the better.

And just as an addition to that, when the Okanagan First Nation was considering reintroducing sockeye into Skaha Lake, they went through three years of disease studies and had assistance from DFO and others and measuring diseases in Columbia River sockeye versus diseases in fish in Skaha Lake, and they found out there really wasn't much difference, and so they proceeded with that experiment.

So I think you can gather information on disease and make sensible decisions, if you get the data.

Q So it's possible to design studies that would show these links, if they're there?

A I think so.

Q And that's not really rocket science, is it? That's a pretty obvious way to do it, isn't it?

A It is good fishery science. Now, there are some wrinkles in that if you find a high instance of disease in a population and then you later find very low instance of disease in the population, as Michael Kent said, that could either be because the disease disappeared or because the fish that had the disease died. So it's tricky. And I think it's useful to use some of these acoustic tagging information, where it's possible to actually get a much better estimate of exposure.

Q But if I accept that evidence, that it's feasible to design studies that would tell us something about -- on an empirical level about disease, the plain and simple fact is, to the best of your knowledge, nobody's done those studies?

A To my knowledge, and also to Dr. Kent's knowledge, in his report.

Q Did you run across any information to suggest why someone wouldn't have done such an obvious study

1 over the 20 years that fish farms have been in
2 place?
3 A Well, I know there have been studies done on pink
4 salmon, and I also know that it's been a challenge
5 to get collaboration amongst the various groups to
6 undertake such studies.
7 Q And so let me just wonder aloud about the wisdom,
8 perhaps, of going and looking for empirical
9 evidence when no one's done the studies. That
10 would be a pointless exercise, wouldn't it?
11 A I think it's worth looking for whatever evidence
12 exists and doing -- making the best judgments that
13 you can, given that evidence, and we were relying
14 on Dr. Kent's summary of disease information to
15 conclude that there wasn't much information and,
16 therefore, that no conclusion was possible about
17 disease. So we were assuming that he had scoured
18 what was available.
19 Q Yes, and let's accept that as a given fact, that
20 Dr. Kent is right, that no one has done any
21 empirical studies and so it's not possible to find
22 those kinds of empirical proof. That's a
23 reasonable statement, isn't it?
24 A I think we're just repeating the same thing I just
25 said, so...
26 Q Okay. Well, let me say this: In science, when
27 you haven't done the studies that are necessary to
28 establish the empirical connection, that doesn't
29 mean the harm doesn't exist?
30 A Oh, that's correct, something could be happening
31 that is not good for you or for the fish and we
32 haven't done a study to detect it, yes.
33 Q Well, and science -- there's a body of science
34 that talks about risk or likelihood of something
35 existing that isn't based on direct empirical
36 evidence, that's common in science, that you have
37 evidentiary studies but you also have theoretical
38 studies?
39 A There are theoretical studies, but in the absence
40 of evidence there are many possible theories as to
41 what's going on. I've seen many examples over my
42 career where people argued vociferously over some
43 particular parameter or mortality rate, and when
44 they actually got the data there wasn't much to
45 talk about anymore. So I think the simple answer
46 is, go out and get the data, because otherwise
47 there's a very wide range, just as we see here

1 between Dill and Noakes' conclusions, in the
2 absence of information, and all there really was,
3 was Connors' estimate of total farm production and
4 Noakes questions to the degree to which that
5 represents diseases, it's a very indirect
6 indicator, it's still the only indicator that he
7 had that was available to him. So I think the
8 answer is to get the information.
9 Q So if there's no empirical evidence one way or the
10 other, it would certainly be wrong to say that
11 diseases coming from fish farms are not the cause
12 of the 2009 sockeye decline? You simply have no
13 proof of that at all, do you?
14 A Okay, so now you've asked a question with respect
15 to one year's poor returns, namely 2009, and
16 asking a question, if you don't have any empirical
17 evidence, are you able to reject salmon farms as a
18 cause of that decline? So I would argue that
19 based on the fact that the difference between 2009
20 returns and 2010 returns was something like a 14
21 of 15-fold change in recruits per spawner, that
22 it's pretty unlikely that there was a 14 or 15-
23 fold change in the amounts of disease occurring
24 between the 2009 returns and the 2010 returns. In
25 other words, I would say it's pretty unlikely that
26 the main cause of the variation between those two
27 years was due to salmon farms is much more likely,
28 as we've said in our report, that it was due to
29 marine conditions, specifically temperatures and
30 lack of circulation and the like.
31 This is not to say that salmon farms have had
32 no effect. As we've said several times today,
33 things which are not the primary factors
34 responsible could still be contributing factors.
35 Q Well, and when one talks about cumulative impact,
36 which is the title of your paper, if disease
37 combined with bad ocean conditions causes
38 mortality, that would be a direct effect, wouldn't
39 it; it would be a cumulative effect?
40 A It's possible that disease and marine factors
41 could combine. As for when we talked about
42 disease earlier and because we said, "Well,
43 because we have no data, no conclusion is
44 possible," I think you still need to come back to
45 that and say, "In the absence of actually having
46 data on the exposure of sockeye to that stress,
47 you're not able to draw a conclusion as to its

1 relative likelihood of being a primary factor."
2 Q So doesn't disease, by its nature, when it becomes
3 epidemic, isn't it episodic?
4 A It can be. There are some other diseases which
5 enter into populations and stay in those
6 populations for long period of time. They don't
7 necessarily always go up and down.
8 Q Yes, but it's not uncommon a disease can have a
9 very significant effect in a given year and not so
10 much in the year before and the year after?
11 A That can happen.
12 Q Yes.
13 A I agree.
14 Q So you can't really draw those conclusions even
15 from 2009 and 2010, can you?
16 A So your argument, as I take it, is that in the
17 absence of any disease information, but based on
18 the fact that some diseases go up and down, that
19 diseases could be responsible for the 15-fold
20 fluctuation in recruits per spawner between 2009
21 returns and 2010 returns? I guess, in the absence
22 of any information which would show one way or the
23 other that there were massive outbreaks of
24 diseases, you couldn't reject that. It seems
25 unlikely, though, in that you would think that if
26 there were massive outbreaks of diseases you would
27 have heard something about it from the fish
28 farmers and you would have read -- seen something
29 about it in the database that has been collected,
30 admittedly only for a very short period of time.
31 So I think looking at that data, which showed
32 basically no trends in diseases, the work that --
33 the database that Korman -- Josh Korman put
34 together --
35 Q Did you read the --
36 A -- becomes a bit of a stretch to say that the --
37 how likely it was that there was a sudden big
38 disease that nobody detected.
39 Q Did you read the cross-examination of the Project
40 5 and Project 1 reports?
41 A Parts of it. It's pretty long. I didn't read all
42 of it.
43 Q Were you aware that there were diseases found in
44 that database that were -- that 60 percent of the
45 time were identified as unknown or open?
46 A Yes, I read that portion.
47 Q That's a pretty significant fact, isn't it?

A Again, we're talking -- yeah, I believe that -- I think it was something like it went from two percent to five percent in the total number of fish, or something like that, wasn't it? So that seems a fairly small --
Q The question is --
A -- it seems a fairly small proportion, to me. That doesn't mean to say -- I don't think you can say anything about the amount of disease that existed prior to them monitoring for disease in fish farms, you know, so prior to 2002 we don't have a very good estimate, and I think that Brendan Connors did the best he could to use the salmon farm production as a proxy indicator, if you will, for disease.
Q So let me ask you this. In the debate between Dr. Noakes and Dr. -- or Dr. Noakes' criticisms of Dr. Connors --
A Oh yes.
Q -- methodology, you're familiar with that?
A Yes.
Q Where do you stand on that? Was Dr. Connors right or wrong?
A So the truth is somewhere in between. Some of the points that Noakes made, this is Exhibit 1538, which I looked at last week, was farm production used by Connors is not an adequate proxy variable for disease, and I agree that it would be much -- I agreed it would be much better if there were farm-specific levels of production and a much longer time series of disease, and also that he didn't have to aggregate the data to avoid -- for proprietary reasons. So I think it would be much better if there were more detailed information, but historical data doesn't exist. I think it was reasonable to use that as a proxy measure, just like sea surface temperature is a proxy measure for a bunch of other things, food production.
Some of the other criticisms, IHN was not detected prior to 2003. Well, we don't actually have good disease data prior to 2003. If we did, we'd use it. BKD was more of a problem for Pacific than Atlantic salmon. Well, Pacific salmon were mostly used before in the earlier time period, so it's not unreasonable to assume a proportionality between production and disease, if there were disease. We don't know that there were

1 disease. But it's not an unreasonable proxy
2 indicator.
3 And then, I think there were some other
4 criticisms. We said pink salmon may influence
5 Fraser River sockeye salmon, although there is no
6 strong evidence to support this assumption.
7 Actually, there is. In the PSC report, Appendix
8 C-E16, Greg Ruggerone's analysis is quite strong
9 correlative evidence of pink salmon effects on
10 Fraser sockeye. Noakes said that Connors did not
11 account for density dependence because he didn't
12 use residuals from the stock recruitment curves,
13 but he did actually -- he didn't use the
14 residuals, but he included spawners, so he does --
15 and all of his models include density dependent
16 effects.
17 So all in all, I didn't think the criticisms
18 from Noakes about Connors' work, rather, were
19 sustainable. I think there are certainly
20 weaknesses in the historical dataset, and it would
21 be much better if there had been per farm
22 production data and actual disease data going all
23 the way back to the 1980s, but it didn't exist.
24 Q But there's nothing wrong with Dr. Connors'
25 methodology, given the data he had to work with?
26 A I didn't see anything wrong. I thought he was
27 quite careful in the way he went through his work.
28 Q So let me ask you about something -- I -- well,
29 can I put Exhibit 1482 on the screen? Can you
30 just blow up the abstract part of that?
31 There is a body of literature that's been
32 introduced, some of it which has been introduced
33 as exhibits into this Commission, which
34 established that aquaculture facilities are, in
35 theory, an ideal place for disease to generate and
36 emerge. You're familiar with that body of
37 literature and certain --
38 A I haven't seen this paper before. I have heard
39 about those ideas. I'm not as familiar with the
40 literature as either Dr. Noakes or Dr. Dill are.
41 Q Well, as you point out, Dr. Noakes didn't really
42 look to this body of literature, and Dr. Dill did.
43 A What we pointed out was that there were only 25
44 references amongst the 250 that they had in
45 common, and we also recommended that some
46 independent scientists actually work on reviewing
47 all this literature.

1 Q In the absence of empirical evidence, because the
2 studies just haven't been done, if you have
3 evidence from other places and you have
4 theoretical evidence and plausible hypothesis upon
5 a biological level that fish farms are likely to
6 be ideal breeding grounds for disease, shouldn't
7 that be relevant in assessing the risk? Isn't Dr.
8 Dill right to refer to that kind of literature?
9 A I think it's reasonable to look at that other
10 literature in terms of assessing the risk. In
11 terms of evaluating how large that risk is, as I
12 said earlier, until you have data, the range of
13 tangible hypotheses is really large. So I don't
14 think it's that difficult to collect that data
15 and, therefore, rather than making inferences
16 entirely based on evidence from other places, I
17 think it would actually make sense to get the
18 data.
19 Q But in the meantime, until you've done some
20 empirical studies, if you have scientific evidence
21 that a particular activity is potentially harmful,
22 how do you take that into account in terms of
23 whether, for instance, how to site -- whether to
24 site fish farms in the middle of wild salmon
25 migration routes? How does one evaluate risk in
26 the absence of empirical evidence?
27 A Well, I think that you try to use information on
28 past locations, in this case fish farms, and
29 observe what has happened to animals moving past
30 them. You try to gather all the information that
31 you can and make your best judgment. And I think
32 that, you know, some of that's what the Cohen
33 Commission's doing overall here, is trying to make
34 their best judgment based on incomplete
35 information on a number of factors, including fish
36 farms.
37 Q So, I mean, to be -- to use a metaphor, if you
38 have an explosives factory that hasn't blown up
39 for three or four years but creates a risk, does
40 it make sense to site it in downtown? Or would
41 you send your children to a school next to an
42 explosives factory? Isn't risk a factor to be
43 considered, even though you lack empirical
44 evidence, and isn't that what Dr. Dill was doing?
45 A Well, I think there's pretty strong empirical
46 evidence that explosives explode, and I don't
47 think there's quite as strong empirical evidence

1 that --
2 Q That fish farms cause disease?
3 A -- that fish farms have caused disease in sockeye
4 salmon, and so I think it's reasonable to combine
5 what evidence you have and make your best
6 judgments, just as Dr. Dill did, and just as
7 Dr. Noakes did, as well. They made different
8 judgments, you know, based on the evidence they
9 looked at. I think it would be valuable to have
10 other independent scientists look at it. I still
11 would argue that, you know, if it took you 10
12 years to get this information, okay, maybe you can
13 make a judgment now, but if it takes you one year
14 to get the information, why not just go out and do
15 it?
16 MR. McDADE: Mr. Commissioner, I note the time. I have
17 about four minutes left. We can either take the
18 break now or --
19 THE COMMISSIONER: Carry on.
20 MR. McDADE: What's that? Continue?
21 THE COMMISSIONER: Carry on.
22 MR. McDADE:
23 Q Now, let me just change gears for a second,
24 because I was struck by the logical wisdom by what
25 you said when you said it makes sense to look for
26 the bottlenecks, in terms of the life history
27 stage, and then look for the stressors within that
28 particular bottleneck.
29 Now, if we were to apply that approach here,
30 am I correct in hearing you that one bottleneck
31 you had identified is the early marine stage, or
32 the coastal migration stage in terms of the life
33 history stage?
34 A Yes.
35 Q And when one looks at that bottleneck and the
36 stressors that have -- are new in the environment
37 since this long-term productivity decline in 1992,
38 I hear your report talking about climate change or
39 marine conditions as one stressor that may have
40 changed. Are there any others that shout out at
41 you on the coastal migration phase?
42 A Well, clearly, fish farms are one candidate
43 stressor and they were included in our conceptual
44 model. I wonder if I could quickly get, Mr. Lunn,
45 if you could go to page 34 in our report. Just by
46 way of answering this question, I think it's
47 really important, as I said at the beginning, to

1 think about the overall pattern that it is we're
2 trying to explain, and it's not only the pattern
3 of decline in the Fraser stocks, these are non
4 Fraser stocks.
5 Now, they've also, if you look at the
6 Southeast Alaska stocks and you look at the
7 Yakutat stocks and you look at the Central Coast
8 stocks, which have very minimal exposure to fish
9 farms, they've also shown declines. So this isn't
10 to say that fish farms could not have effected
11 Fraser River stocks, but I don't think there is
12 sufficient -- I don't think fish farms are a
13 sufficient explanation for the pattern of decline
14 in sockeye, generally, between Washington and
15 Southeast Alaska.
16 Q So the fact that the Okanagan and Columbia stocks
17 did well in 2009, when the stocks that migrated up
18 the inside passage, that would be a relevant fact
19 to you, too, wouldn't it?
20 A Yes. And the work that Kim Hyatt's done shows
21 that there were very different temperature
22 conditions on the outer side of the west coast of
23 Vancouver Island where those stocks were going
24 than occurred in the Strait of Georgia, in 2007,
25 which was the migration year for those smolts.
26 So what I'm pointing to is it's not just fish
27 farms that differ between the inside and outside,
28 there's also man other oceanographic variables
29 that can differ.
30 Q Can we go to - I'll just finish off in a minute or
31 so here - can we go to page 23 of the addendum
32 report, 1575. I just want to identify -- sorry,
33 numbered page 23. Yes thank you.
34 You've made two pretty strong
35 recommendations, as I see it here. In the third
36 line below the bold headings, you say that the --
37 there are three categories of high priority data
38 which need to be incorporated into the database.
39 One, is fish health in farm salmon; two, is water
40 quality in the vicinity of salmon; and three, is
41 wild sockeye post-smolt survival estimates before
42 and after passing salmon farms. Now, I think
43 we've discussed that already.
44 A Yes, I think so, yeah.
45 Q And these you describe as high priority, because
46 they're potentially different if the answers are
47 positive?

A I think it's necessary to get data to test alternative hypotheses.
Q And further down the page you acknowledge the recommendation of Drs. McAllister and Carruthers, that one idea would be to experimentally manipulate the intensity of salmon farming by having fallow years and seeing what the outcome would be. Now, that seems to make sense. Do you think that's appropriate to the risk?
A I think that creating as strong contrasts as possible in both space and time has been shown in many other environmental stressors to be the best way to try to find a signal. Now, that having been said, I'd just add one additional thing, is you should do it in a way that doesn't get confounded with pink salmon. So if you did it every odd year, fallowed every odd year, that would really screw up your experimental designs. You might want to do it one out of every three years, get it out of sync. So you basically want to separate the signal from the noise.
Q Can we have Exhibit 1573. Now, there's one place -- 1563, I'm sorry. That didn't look at all -- there's one place on the coast where the salmon migration migrates to a very narrow place and where there's a great number of fish farms. Would that be the most sensible place to do that experiment?
A I haven't really thought about it before. I think if you could create contrasts between the highest level of exposure and the least, that would be the most informative. So I'm not sure, in this diagram, whether the salmon going along Johnstone Strait would be less exposed than the salmon which are going inland through some of those areas where we've got lots of pink dots, but I think you'd have to think about that and try to get as much contrast in exposure as possible so you could test the hypothesis.
Q Well, in 2007, the Chinooks, those farms that were growing Chinooks in that area where removed and weren't present in 2008. Don't we, in fact, have the fallowing -- if that's true, that's the nature of the fallowing experiment you might do, and we might see what the difference is in returns in 2009 and 2010?
A Oh, I don't think you'd want to look at returns,

because then you're integrating all sorts of other information. What I would suggest is that you'd want to look at acoustically tagged fish so you could tell exactly where they went and what exposure they had, and then look at diseases in co-migrating fish. Maybe you can't look at the disease without sacrificing the fish beforehand, but I think you want to look at disease and health of those fish. Returns have every other factor influencing them as well, so I don't think it would be a very good test to just look at returns.

MR. McDADE: Thank you. That's my time, Mr. Marmorek.

A Thank you.

THE COMMISSIONER: Thank you, Mr. McDade.

THE REGISTRAR: The hearing will now recess for 10 minutes.

(PROCEEDINGS ADJOURNED FOR AFTERNOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: The hearing is now resumed.

THE COMMISSIONER: Mr. Leadem.

Mr. LEADEM: Good afternoon, Mr. Commissioner, good afternoon, Mr. Marmorek. My name is Tim Leadem. I represent the Conservation Coalition, groups such as the David Suzuki Foundation and other environmental groups in these proceedings.

CROSS-EXAMINATION BY MR. LEADEM:

Q I want to commend you firstly for a very readable report.

A Thank you.

Q I come down on the side of Dr. Peterman and like the analogies, because sometimes if we can analogize correctly, we can usually understand concepts which are often difficult, and so I find that it's very useful to try to do that. So if at any time during your answers you want to use metaphors and analogize, please do so. And I also happen to like colourful language, so you can insert that, as well.

I want to begin by drawing your attention to the workshop that you facilitated back in November 30th of last year. I think it was a two-day workshop. And my understanding is, is that you facilitated a workshop at which all of the

1 scientists who were preparing reports for the
2 Commission, the expert reports or technical
3 reports, as we've come to call them, assembled and
4 over a two-day period addressed a number of
5 concepts, discussed the reports amongst themselves
6 and was a fair exchange in information, as
7 scientists are very often capable of doing. Is
8 that correct, do I have that right?
9 A Yes, that's correct. Now, this was November 30th,
10 and December 1st, and so the draft reports for
11 each of those studies were in varying states of
12 completion. So Dr. McKinnell's report was already
13 done, but others were still in process, so there
14 were varying stages.
15 Q One of the tasks that you did during that workshop
16 was to focus upon the 2010 PSC symposium that was
17 the year before in June of 2010, and then you
18 asked some of the participants at the workshop in
19 November of 2010 to comment on the PSC workshop.
20 And I want to just go with you to those results.
21 I think they're at the tail end of your report.
22 A Yeah, that's right, the last two pages.
23 Q Actually, 1896, Mr. Lunn, and if we could go to
24 PDF 362. You state there in Appendix D that:
25
26 Workshop participants were asked to examine
27 the PSC Report...
28
29 This is the one that Dr. Peterman and yourself I
30 think were the facilitators of at SFU in June of
31 2010; is that right?
32 A Well, Dr. Peterman was the head of the Science
33 panel and the lead author on the report, and we
34 worked as facilitators and assisted.
35 Q So if I look at this table, I think it's in two
36 sections, there are a number of alternative
37 hypotheses to explain the 2009 decline. And what
38 I think, if I'm reading this report correctly, the
39 top bar, the one in grey is the PSC and then the
40 workshop that you facilitated in June -- or sorry,
41 in November would be in yellow; is that right?
42 A Yes, that's correct. If I could just make a
43 couple of clarifications. First of all, for each
44 of these hypothesized factors in the leftmost
45 column in this Appendix D, we're looking at both
46 the overall trend over the last 20 years, as well
47 as the 2009 low returns.

1 The other thing to mention is that the PSC
2 report, we had the workshop and then the panel met
3 and considered their recommendations over a series
4 of conference calls and exchanges of emails.
5 Whereas the workshop that we did for the Cohen
6 Commission on November 30th, December 1st, we had
7 maybe a couple of hours at which we had subgroups
8 meeting to explore these ratings. So there really
9 wasn't as much time --
10 Q Yes.
11 A -- or thought given to it.
12 Q Right. I understand that. We heard evidence also
13 from I think it was Dr. Rensel from -- who had
14 testified to this Commission with respect to
15 harmful algal blooms that he was part of the PSC
16 workshop, but I think there was a contingent from
17 the United States that left, so they didn't get a
18 chance to vote. Do you recall that?
19 A That actually isn't the way it happened at the PSC
20 workshop. What happened was that the -- we met in
21 subgroups and got input from those subgroups on
22 particular hypotheses, and I was actually in the
23 group that Dr. Rensel was in that dealt with
24 harmful algal blooms and contaminants. That
25 information was brought back to the Science panel
26 and it was actually Brian Riddell who wrote the
27 chapter dealing with contaminants and harmful
28 algal blooms. So there's a lot of consideration
29 that went into that, actually, by the PSC Panel.
30 Not so in the Cohen Commission, but it was
31 considered in the PSC group.
32 Q All right. What I want to focus on is "Marine
33 ecology", the fourth hypothesis down on the left-
34 hand column. And it was broken down into two
35 discrete areas, the Strait of Georgia and then
36 outside the Strait of Georgia. And so if I
37 compare those for the overall, I take it that the
38 dark shading meant that there was emphasis to be
39 placed on that topic by the PSC workshop; is that
40 correct, do I have that right?
41 A Right. So a major difference between the PSC
42 workshop is at the PSC workshop we heard a lot
43 about conditions in the Strait of Georgia, and the
44 panel was convinced by those presentations that
45 the Strait of Georgia were more important than the
46 conditions outside of Georgia Strait, both for the
47 overall changes, as well as the 2009 poor returns.

1 Now, the Cohen Commission, particularly Dr.
2 McKinnell, presented other quite convincing
3 evidence that there were weird things going on in
4 2007 in Queen Charlotte Sound, as well, and that
5 the Strait of Georgia wasn't quite so bad. And so
6 those scientists at the workshop came up with
7 stronger weighting on conditions outside of
8 Georgia Strait.
9 Now, there's been further work done since
10 then, which seems to indicate that both are
11 important, so, you know, the truth may be simply
12 that.
13 Q Somewhere in the middle.
14 A Yeah.
15 Q So if you were looking at marine -- the marine
16 ecology to substantiate a hypothesis for the long-
17 term decline, as well as the 2009 decline, you
18 really wouldn't want to dissect out the Strait of
19 Georgia and simply focus upon that singularly.
20 You would really want to look upon the total
21 marine environment and include Queen Charlotte
22 Sound as well.
23 A Yes, I would.
24 Q if I could now ask you to turn to PDF 304, these
25 pages are unnumbered. I think what I'm going to
26 do is go back into the workshop and some of the
27 reporting out that I think that you did of that
28 workshop. I gather this is your work, Mr.
29 Marmorek?
30 A Sorry, we're talking about the workshop that was
31 done for the Cohen Commission? Yes.
32 Q Yes.
33 A We wrote the report from that workshop.
34 Q Okay.
35 A Yes.
36 Q So under the heading "Research and Monitoring
37 Recommendations", and if I could just flip the
38 page to PDF 305, and the second full paragraph on
39 that page, I just want to take you there because
40 this is one of the themes I've been pursuing
41 throughout the body of work that I've been doing
42 through this Commission. You say there:
43
44 One of the resounding issues throughout the
45 workshop was researchers' difficulty in
46 obtaining and understanding data from the
47 existing databases. Considerable effort

1 should be spent building and maintaining an
2 integrated database, with focused research
3 and monitoring goals in mind.
4
5 And then you go on to say:
6
7 The database should include the historical
8 sockeye data with clear metadata as well as
9 data from current and future monitoring.
10
11 And:
12
13 In order for this to be useful to scientists,
14 it would need to be regularly updated and
15 maintained.
16
17 So I'm just going to stop there and see if I can
18 expand a little bit on that, because all the
19 scientists who participated were complaining to
20 you, I gather, about the lack of consistency in
21 the data and the ability to use data sources from
22 different areas and be able to make them
23 compatible. I'm not a mathematician, so I'm
24 paraphrasing very roughly. So is that basically
25 what the problem was, or is it a little bit more
26 complex than that?
27 A Well, I wouldn't say that all the scientists were
28 complaining about this. I think one of the
29 difficulties which existed was assembling all the
30 productivity information on sockeye and getting
31 that into a consistent format. The different
32 stocks -- within a given stock there are different
33 life history patterns. Some fish spend one year
34 in fresh water, some spend two, they spend varying
35 amounts of time in the ocean, and you have to line
36 all of that information up if you're going to do
37 these correlative analyses. And then the stressor
38 information also comes from a whole bunch of
39 different databases.
40 So, you know, I think the Cohen Commission
41 has really catalyzed quite a bit of good effort
42 that way. And the database that we assembled for
43 this study, although it just was an internal
44 database, it's structured in a way that could be
45 built upon. So I think we're making progress on
46 both getting the metadata together, as well as the
47 stressor information and the sockeye information.

1 Obviously that would need to be updated every
2 year, and you're not going to have a budget like
3 the Cohen Commission does every year, so this has
4 got to be made part of common practice.
5 Q So in terms of any recommendations with respect to
6 the data, can you help us at all in terms of how
7 accessible this database should be, whether
8 scientists who study in this realm should have
9 access to it, whether there should be some limits
10 on it, who gets to control it, who gets to put
11 data into it. Do you have any recommendations
12 with respect to those kinds of topics?
13 A I think that past experience elsewhere has
14 indicated that the people who are closest to
15 collecting a particular kind of data. So let's
16 say for example, the Okanagan First Nation and DFO
17 collect Okanagan sockeye data, are the best ones
18 to organize that information and then say we're
19 happy with our analyses for this year and put that
20 out, and then get that in a common framework. And
21 then if there is some update to that, they
22 discovered that there was an error, then they can
23 update that information. I think then you can
24 feel fairly assured that that information has been
25 carefully checked, and then put into a centralized
26 or integrated database, which I think should be
27 publicly accessible.
28 There are examples like that in the Columbia
29 Basin, there's something called StreamNet where
30 there's public access. There's also the Columbia
31 Basin Fish and Wildlife Authority has a publicly
32 accessible web accessible set of information. The
33 key thing is it has to be carefully checked before
34 it goes in there.
35 And as far as being able to do analyses on
36 the data, provided that it's -- that data has been
37 quality checked, I don't see any reason why
38 anybody shouldn't have access to the full suite of
39 data, and that will stimulate different kinds of
40 analyses, which I think is healthy. The key thing
41 is that what goes into it has to be carefully
42 checked and so there has to be one group that's
43 responsible for assuring that it is good quality.
44 Q Mm-hmm.
45 A That's very important.
46 Q Yeah, I remember that acronym, garbage in, garbage
47 out, so that if you're not putting in very

1 reliable data, then you're obviously not going to
2 be able to get the results that you want at the
3 end of the day from being able to analyze that
4 data and to synthesize it and have it form the
5 basis of reports.
6 A Yes, and the other thing is the metadata, which is
7 the data about that data, that says this is how it
8 was acquired. These are the sampling methods.
9 These are where the data came from, all those
10 other details, extremely important.
11 Q Now, in addition to some of the workshop that
12 focused on PSC, there was a full range of
13 discussion about some of the projects that were
14 ongoing, and I want to take you to some of the
15 minutes --
16 A Sure.
17 Q -- of that meeting that occurred, as well. If we
18 can go to PDF I believe it's 327. Now, at that
19 time my understanding as the group Counterpoint
20 was actually going to file a report on "Status of
21 DFO Management and Science" and as it turned out
22 that report never did get filed; is that right?
23 A That's what I've heard, but I haven't been
24 tracking the thousands of documents that have been
25 filed.
26 Q It certainly wasn't one that you analyzed when you
27 came upon your cumulative effects analysis at the
28 end of the day?
29 A No, it wasn't, because it didn't pertain to
30 describing the different stressors that we were
31 analyzing.
32 Q And I'm just going to take you to some of the
33 discussion that ensued when Edwin Blewett was
34 presenting on behalf of this topic. If we can
35 just go to the next page, PDF 328, please, Mr.
36 Lunn. And at the bottom you'll see that there's
37 some discussion. There's a discussion, that's Dr.
38 Skip McKinnell from PICES, is that right, who
39 is --
40 A Yes.
41 Q -- saying:
42
43 Did you consider looking at the number of
44 primary publications by DFO authors? You
45 will likely find that the amount of science
46 done as a proportion of the actual work they
47 do has been shrinking over time. It would be

1 useful to see a graph on the number of
2 published articles on Fraser sockeye where
3 DFO scientists were the senior authors.
4
5 And then that discussion is then followed up by
6 Dr. Peterman, and that continues on to the next
7 page. Do you recall that discussion?
8 A Yes, I do.
9 Q And that's a fair or accurate representation of
10 the discussion that ensued about that topic, is it
11 not?
12 A Yes. My recollection is that Edwin Blewett did
13 include some information at least on scientific
14 publications in the executive summary of his
15 report, but I don't know if it was exactly what
16 Skip McKinnell was asking for.
17 Q And similarly the next topic at PDF 330 was
18 "Diseases and parasites" and this was a
19 presentation by Dr. Kent, was it?
20 A Yes.
21 Q The lead author for that. And then if you follow
22 through to PDF 331, there is then a discussion
23 that ensues. I imagine that what happens, Dr.
24 Kent - I wasn't there, and would have loved to
25 have been there, but I'm glad you did not have
26 lawyers there, quite frankly - but essentially, as
27 I understand it, someone presented the topic for
28 about 15, 20 minutes and then there was an
29 opportunity for discussion from the attending
30 scientists of that person, is that --
31 A That's correct.
32 Q -- basically the framework. So the discussion
33 that ensued after Dr. Kent presented his paper was
34 mostly between Dr. Reynolds and Dr. Kent, that
35 that would be Dr. John Reynolds, who was one of
36 the outside reviewers and a professor at Simon
37 Fraser University; is that right?
38 A Yes, that's correct.
39 Q And so he says at the conclusion of the
40 presentation, he says "How specific" -- or he asks
41 a question:
42
43 How specific are these pathogens to specific
44 species of salmon? And is it a good idea to
45 restrict the scope to known cases involving
46 sockeye?
47

And Kent says:

> I don't exclude any from the list. Where sockeye are less susceptible to disease, I would put it as a moderate risk assessment.

And then Dr. Reynolds says:

> Is that a good criterion to use? If studies show sea lice can infect other species of salmon, it might be useful to tackle it head-on, to take sea lice out of the picture.

So once again the discussion carries on for several pages after that, but essentially that would be an accurate representation of the discussion that ensued following Dr. Kent's presentation, would it not?

A Yes. We had a very good recorder who taped the proceedings and then transcribed them, so I think this is an accurate description of the free-ranging discussion. I guess what I would say is that it's a free-ranging discussion at a workshop, and I think in general you need to look at all the information in detail, you know, to make decisions, rather than a five-minute discussion.

Q Yes, I appreciate that. On page PDF 332, I just want to focus on a comment that Dr. Kent made in response to Dr. Rick Routledge, who was one of the outside reviewers. He's also a professor at SFU, is he not?

A Yes, he is.

Q And about one-third of the way down Dr. Routledge asked:

> Is there any evidence of vectors for disease to consider?

And then Dr. Kent says:

> You can show in lab studies that *Lep*...

And that would be the louse, the salmon louse, *Lep*.

A Mm-hmm.

Q

> ...can jump from adult fish. Some pathogens

1 for example are transmitted via leeches but
2 can also transfer through the water.
3
4 And he goes on to say:
5
6 Could sea lice be transmitting disease?
7
8 He asks himself that question.
9
10 In freshwater, there have been increases in
11 snail-borne disease due to increasing numbers
12 of snails.
13
14 And then he goes on to discuss a whirling disease.
15 And then Dr. Reynolds chimes in and says:
16
17 A recent paper showed sea lice do jump from
18 host to host in the wild. Male *Lep* jumped
19 from pink to coho smolts.
20
21 So that once again was a flavour of the discussion
22 that occurred with Dr. Kent and Dr. Reynolds and
23 Dr. Routledge concerning the vectors, the
24 possibility that disease could be vectored, as you
25 will, by something such as *Lep*; is that fair to
26 say?
27 A Yes, that's correct, and in the conceptual
28 diagrams that we were looking at earlier from our
29 addendum, that causal pathway is represented.
30 Q And one final topic that I want to focus on, if we
31 can go to, I think the next page, PDF 333, Don
32 MacDonald, who was the author of, I think, the
33 technical report on contaminants, then presented,
34 and he presented his findings and then there was a
35 brief discussion that ensued following his report,
36 mostly with Dr. Peterman, Dr. Routledge, who once
37 again that followed the presentation of Mr.
38 MacDonald's report, was it not?
39 A Yes, that's correct.
40 Q I just find this whole process to be rather
41 invigorating and enlightening, unlike this kind of
42 a situation where it's very controlled, where I
43 get to ask the questions and hopefully you get to
44 respond. When scientists meet, it seems to be a
45 free-ranging debate. And so I think at the end of
46 the day, one of the things that I've been
47 proposing is that there be some way to move

1 forward on the science that needs to be done.
2 You've identified, for example, some specific
3 scientific research areas that you would like to
4 see followed. And you've identified those in
5 bold, and you've identified them with respect to
6 lifecycles and life stages of the salmon. And
7 others have preceded you to the podium and
8 obviously they also have specific research topics
9 that they would like to see done; more often than
10 not it happens to coincide with the area of
11 expertise that they happen to be involved with.
12 But I guess I want to come back to this. If
13 we're going to move forward in terms of the
14 science, and the ability of science to really
15 grapple with this issue of what's behind the
16 decline of the sockeye, or how can we ameliorate
17 the condition of the sockeye, what kind of
18 apparatus can you envisage being brought forward
19 to see that that work is conducted and carried
20 out?
21 A So first of all, I think it's important to point
22 out that our recommendations in section 5.2 were
23 not just our suggestions --
24 Q Yes.
25 A -- or my ideas. These were built, as we said
26 earlier, on the work that came out the Pacific
27 Salmon Commission workshop, as well as the
28 recommendations of all the Cohen Commission
29 researchers. So and as I was saying earlier to
30 the Cohen Commission lawyer, I think the first
31 step is to decide what are the key management
32 decisions that need to be made, and what are the
33 scientific uncertainties that affect those
34 management decisions, and then to have a dialogue
35 between managers and a subset of scientists from
36 DFO, NOAA Fisheries, Pacific Salmon Commission,
37 plus others, you know, academia, but a smallish
38 group, a manageable group, to winnow down that
39 list to set forth a sequence of studies that are
40 cost-effective for answering specific questions
41 and to put in place the infrastructure that will
42 maintain those studies for a sufficient length of
43 time so, as was mentioned earlier, that we have a
44 continuing time, which I think was with the lawyer
45 from the Province.
46 So, you know, as I was asked earlier by the
47 Commission lawyer, that's my opinion how to set

that up. There may be a better way, there may be other people who have better ideas about that, but that wasn't within our terms of reference to decide, you know, or recommend that kind of structure. It just seems logical, given who has the mandate. In the United States NOAA Fisheries does, in Canada DFO does, and both on the PSC, so those seem like logical leaders to tackle it.

Mr. LEADEM: All right. We'll come back to that concept tomorrow. I think we're at the end for today, Mr. Commissioner.

MS. BAKER: Thank you, Mr. Commissioner. I wonder if we can organize our timing for tomorrow. We'll be starting at 9:00 and ending at 3:00, and I was going to propose that we could maybe go from 9:00 to 10:30 and take a break at 10:30, and then go from whenever we come back from that break to 12:30, just the one break in the morning. Would that be acceptable?

THE COMMISSIONER: I guess my answer is we'll see, but that sounds like not an unreasonable proposal, Ms. Baker. But just before we break I just wanted to ask a question to clarify something that Mr. Leadem asked the witness. And I must apologize. I'm not sure that I -- it's possibly Exhibit 1896. It was the paragraph dealing with database, Mr. Leadem, that you were asking the witness about. And I just -- is that Exhibit 1896?

Mr. LEADEM: That was 1896.

THE COMMISSIONER: And it might have been -- was it page 305, possibly?

Mr. LEADEM: It was PDF 305, I believe.

QUESTIONS BY THE COMMISSIONER:

Q I'm sorry, PDF 305 -- I apologize, that's probably it. Yes.

A Sorry about the pagination, that's our fault.

Q No, that's fine. I'll just take a moment just to ask you this, and I'm not being facetious, but what do you mean by "database" in the context of this paragraph?

A So an organized form of data includes for this problem all the information on the numbers of spawners from each stock, the age structure of each of those stocks, so how many return as three-year-olds, four-year-olds, five-year-olds, how

many years they spend in freshwater, the proportions and so on, which can vary by year. So and then that's for both -- that would be for both Fraser stocks, as well as for non-Fraser stocks.

And then the information on various stressors, which we were discussing earlier with respect to the analyses that were included in section 4.7 of our report. So for example, I'll just find the section here, page 93, not PDF page but the actual page, yes, this table. That's an example of the kind of stressor variables which would be helpful to include in such a database.

And a database, a relationship database is an organized framework which links information by stock, by year, by location, by type of information, by variable name. There's a nice description of it in Appendix 3 of our report. It's a very structured way of organizing information as opposed to what generally exists, which are a whole bunch of different spreadsheets that are different for different stocks and in different locations and for different stressors. And what we had to do was basically grab all that information and organize it into this structured framework and relate them all. So that's what we call an organized database.

Q And that's what you're speaking of.

A Yes.

THE COMMISSIONER: You can follow up tomorrow with that, Mr. Leadem.

Mr. LEADEM: Thank you, Mr. Commissioner.

THE COMMISSIONER: But I appreciate the answer. Thank you very much.

A Thank you.

THE REGISTRAR: The hearing is now adjourned till 9:00 a.m. tomorrow morning.

(PROCEEDINGS ADJOURNED TO SEPTEMBER 20, 2011 AT 9:00 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.

Diane Rochfort

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

Karen Hefferland

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

Pat Neumann