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

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

Public Hearings

Audience publique

Commissioner

L'Honorable juge /
The Honourable Justice
Bruce Cohen

Commissaire

Held at:

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

Thursday, May 5, 2011

Tenue à :

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

le jeudi 5 mai 2011

Errata for the Transcript of Hearings on May 5, 2011

Page	Line	Error	Correction
23	12	their pretty	their prey
40	23	expansive	expensive
77	37	join	joint
78	4	in Richmond experiments	enrichment experiments
7,87,88, 89,91,92		daphnia	Daphnia (capitalize throughout transcript)

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Brian Wallace, Q.C. Lara Tessaro	Senior Commission Counsel Junior Commission Counsel
Tim Timberg Geneva Grande-McNeil	Government of Canada ("CAN")
Tara Callan	Province of British Columbia ("BCPROV")
No appearance	Pacific Salmon Commission ("PSC")
No appearance	B.C. Public Service Alliance of Canada Union of Environment Workers B.C. ("BCPSAC")
No appearance	Rio Tinto Alcan Inc. ("RTAI")
No appearance	B.C. Salmon Farmers Association ("BCSFA")
No appearance	Seafood Producers Association of B.C. ("SPABC")
No appearance	Aquaculture Coalition: Alexandra Morton; Raincoast Research Society; Pacific Coast Wild Salmon Society ("AQUA")
Tim Leadem, Q.C.	Conservation Coalition: Coastal Alliance for Aquaculture Reform Fraser Riverkeeper Society; Georgia Strait Alliance; Raincoast Conservation Foundation; Watershed Watch Salmon Society; Mr. Otto Langer; David Suzuki Foundation ("CONSERV")
No appearance	Area D Salmon Gillnet Association; Area B Harvest Committee (Seine) ("GILLFSC")

APPEARANCES / COMPARUTIONS, cont'd.

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

APPEARANCES / COMPARUTIONS, cont'd.

No appearance	Sto:lo Tribal Council Cheam Indian Band ("STCCIB")
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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Vancouver, B.C. /Vancouver
(C.-B.)
May 5, 2011/le 5 mai 2011

THE REGISTRAR: Order. The hearing is now resumed.

ANDREW TRITES, recalled.

JOHN FORD, recalled.

PETER OLESIUK, recalled.

MR. LEADEM: Good morning, Mr. Commissioner. For the record, Leadem, initial T., appearing as counsel for the Conservation Coalition.

CROSS-EXAMINATION BY MR. LEADEM, continuing:

Q Gentlemen, I want to begin by taking up again some of the themes I was developing with you yesterday afternoon. And invariably we are about halfway through these projects, these research projects, and invariably when one looks at the recommendations, one sees things such as we need to do research in these areas, we need a better dataset, we need this, we need that, and I suspect that's what the rest of the projects that are also going to say, we need more research. And is that just the nature of science, that science always needs more research or needs more data?

I just throw that open as a general discussion, and then I want to take up some questions from that. Dr. Ford, you seem to be nodding your head.

DR. FORD: Yes, I think that, you know, it's a very good question and certainly worthy of considerable discussion. It's an interesting one. I think in terms of the requirement for more research, when we're being faced with fairly specific questions such as these that have been raised about the effect of marine mammals on sockeye salmon, these are difficult animals to study compared to many terrestrial animals, and so some of the questions are fairly straightforward, but are very difficult in practice to collect the kind of information we need to address those questions. And so we are making progress, but at times it's slow.

New technologies have become available to provide greater insight into the diet of marine mammals through chemical tracers like fatty acids and stable isotopes or genetic analysis of prey remains, but these are recent innovations and they're just now being implemented in field studies. So indeed, you know, there is -- these animals are fairly data poor, especially with regard to some of the pressing questions that we've been deliberating on.

Q All right. Dr. Trites?

DR. TRITES: Yeah, I agree with the point you're making. I mean, so often in science we ask sometimes simple questions, but those questions only give us sometimes, you know, a simple answer. They often raise two or three more new questions. I think the one thing I've learned to appreciate over time is that essentially the more we learn, the more realize how little we truly understood.

What we tried to do with our recommendations is not do the catchall phrase at the end which just says "Give us more money and we'll answer more questions".

Q I'm sure you would take it if were someone were offering it.

DR. TRITES: Yeah, but we're trying to sort of focus things and where the biggest gaps were, by identifying six species we think should get some more focus if the primary question is sockeye salmon. And also that final recommendation which was the power of using a model to synthesize what we currently understand to help focus our research to get the best value out of the money that might be put forward to answer the key questions that may resolve some of those key uncertainties.

Q And, Dr. Ford, when you were giving me your answer, you talked about some of these issues around research were difficult issues. I take it "difficult" can be equated to "costly"?

DR. FORD: Indeed. Marine mammals can, depending on the species of course, be extremely expensive to study. They're in often remote areas, at sea, and require large ships to get out there to undertake field studies. So that is often a limiting factor in progress of towards some of these questions.

Q And I would suspect that, Mr. Olesiuk and Dr. Ford, as staff scientists for DFO, that you're in

a world where you're scrambling for dollars, is that right, or is that a fair statement?

DR. FORD: We're certainly operating as efficiently as we can with the resources we have available, and there's always more that could be done with greater resources. As I mentioned, you know, in my research groups, the priority activities it does involve considerable time at sea, and the reality is that those costs can be prohibitive to do everything we'd like to do.

Q Mr. Olesiuk, is your...

MR. OLESIUK: Yeah, I was just going to say that, yeah, we are scrambling for research funding, and it is, I think, the nature of science that there's always going to be new questions arising. But I think if you look at the Science program, pinnipeds, we've been at it a little longer than cetaceans, about three decades we've been doing serious science in DFO. And there really has been very measurable progress. We know a lot more about abundance, status, diet, you know, prey requirements of these animals than we did 30 years ago. And our questions now are becoming more focused on very specific issues and, you know, I think that's the nature of science.

Q But if I can get the focus back to the key question that this Commission is facing, is what was the cause of the 2009 decline. And if you can put it in that stark language, I suspect that at the end of the day we're not going to be able to say that "X" is the cause, but we're likely to say that the salmon have been declining, it's like a death by a thousand cuts, as I think you've said, Dr. Trites. It's like this is happening through a number of contributing factors.

And that is perplexing, because then if we were depending upon science to provide the answers, then there are two key questions that come out from that: (1) is where are we going to find the funding to allow science to show us the way through this predicament, and (2) who is going to control what kind of science gets done? Because you are focusing upon predation and that may not -- that may be a contributing cause, but who is going to be pulling the strings and actually saying what science should go forward. And I wonder if any panel members have any

reaction to what I've just suggested.
DR. TRITES: Maybe if I can just start on that. You know, there's a big focus on what research has DFO done. At the same time there's a lot of research being done on marine mammals by NGOs, by academics. So, for example, I lead a program that has both cetacean and pinniped research, and I have 14 researchers working on pinnipeds. A lot of that money is coming from -- it's not coming from the Canadian government, it's coming from external sources, private foundations, U.S. sources. So there are other people contributing to trying to answer some of these questions. A lot of it are focused on why marine mammals are abundant in some areas, declining elsewhere.

In terms of who sets those agendas, it's often by -- I guess there's a variety of ways that that gets done. But I just want to make the point that there are different groups doing research. I think all are contributing to answering some of these key questions.

Q And, Dr. Ford?
DR. FORD: If I can, I think if I understand your question, it's really where do we go with predation specifically as a factor in the 2009 situation with Fraser River sockeye, as well as the decline over the 15-year period under consideration. I think what will come from this process here, as well as other related processes, such as the Pacific Salmon Commission Synthesis Workshop, last June it was, that addressed multiple hypotheses of factors that could have played significant roles in the overall picture, I think the result of these kinds of efforts will ultimately result in the most likely significant factors, you know, in this Fraser River sockeye situation, and that ultimately will steer the future direction for much of the science.

I think we're all in agreement that marine mammals seem to not -- there's no evidence that they played a role in the situation in 2009. They may have played a role in the overall decline over the past 15 years, as a result of increasing predation levels for various reasons, mostly to do with changes in abundance. And research in this area of the role in the overall ecosystem to include predation on all species, I think will

continue, and may help shed further light on the contributing factor of marine mammals than we now understand.

Q It strikes me that the scientific community is very much a collaborative community. You get together from time to time to discuss the results of your research. You share data where it can be shared without somebody scooping your paper. And you basically, it seems, it strikes me that it's a pretty transparent kind of process that leads to the development of science. Am I completely wrong in that approach?

DR. FORD: I think in the case of our work, much of the research that we undertake to provide science advice for DFO management is certainly reviewed by peers, both internally and externally, especially if it is ultimately published in the open scientific literature, and that process of review and revision is as hopefully transparent as it can be, so it is very much a collaborative effort.

Q And you would agree with me, Dr. Ford and Mr. Olesiuk, as DFO scientists that it would be important for you to share the results of your work and to basically get it out to the public so everyone is aware of it. Isn't that accurate?

MR. OLESIUK: Yes, I would agree, and it's not just getting out the final result, but working with our colleagues during the intermediate processes so they can identify problems and weaknesses before we get too far along.

But getting back to your question as to how do we proceed from here and set priorities, and identify, as John as said, with a relatively high degree of confidence, we can conclude that marine mammals were not responsible for the low returns in 2009.

As far as the general decline in productivity, I think we've narrowed it down to, you know, a couple of marine mammal species. And in the case of sea lions, we've identified when and where they are now feeding on sockeye. Then we've had a series of workshops in DFO where we get together with our colleagues that are studying salmon, and they're looking at the migration routes of salmon, where the mortality is occurring, and based on that, we are going to come up with presumably some sort of multidisciplinary

projects where we're combining the factors that could be causing mortality with information where that mortality is occurring.

Q My time is drawing to a close with you. I wanted to just get your reaction to one question I had about Exhibit 795. This was a DFO Synthesis Workshop on the Decline of Fraser River Sockeye. Am I right in assuming that this was a workshop that was conducted by and for DFO scientists alone and not the greater scientific community?

DR. FORD: Yes, that's correct. It was just a follow-up to the Salmon Commission-sponsored meeting last June.

Q Yes.

DR. FORD: And it was basically to continue that effort towards reviewing available evidence leading to again, as it says, synthesis to try and keep some momentum going, you know, internally to keep addressing these questions and steering direction for future research.

MR. LEADEM: Thank you. I'm afraid my time is up. Thank you for the discussion.

MS. REEVES: Good morning, Mr. Commissioner, Reeves, initial C., for the First Nations Coalition. And just for the benefits of our panel, the First Nations Coalition includes the First Nations Fisheries Commission, which is a provincial organization, the Council of the Haida Nation, three Saanich First Nations, as well as tribes from Chehalis up to the upper headwaters.

CROSS-EXAMINATION BY MS. REEVES:

Q I have two series of questions and my first questions will be directed towards Dr. Trites. Mr. Lunn, could you please pull up Exhibit 783, the Technical Report, and I'd like to go to page 11. And at the second paragraph of the report on page 11, it says:

> Another aspect of environmental conditions relates to the impact of water temperature. While temperature will have a direct influence on metabolic rates of sockeye salmon it also impacts other parts of the ecosystem, including the risk of predation.

And then it just talks about how this was illustrated, and Petersen and Kitchell:

> ...predicted that warmer climactic conditions can lead to an increase in predation rates in the range of 26-31%.

And our question is this, if warmer climate conditions did lead to an increase in predation rates of, say, 26 to 31 percent in marine waters, which predators on your list would become an immediate or a significant concern to sockeye salmon, and in this case Fraser River sockeye salmon?

DR. TRITES: Yes, good question, but I'm not sure that I can give you a definitive answer to it. What's a bit surprising, I think, to a lot of people is realizing that one of the consequences of warming oceans is that it's going to affect the food requirements of fish. And it's because it's going to raise their metabolic rates, they're going to have to eat more food to compensate for that. To require more food, they're either going to take greater risks to be out and be exposed to be eaten by other predators that also have increased feeding requirements, as well. so it's hard to say at this point who is going to come out the victor in all that, except there's a realization that all the fish are going to require more food, and that food has to come within that fish community.

Q But what about migrating animals. How would that impact them?

DR. TRITES: Are you referring in this case to fish --

Q Yeah, I mean (indiscernible - overlapping speakers).

DR. TRITES: -- or to mammals?

Q Or mammals, I guess, if you speak to your --

DR. TRITES: The mammals are not going to be affected in the sense of -- their metabolic rates are not going to be increased. They're breathing air. They're not acquiring their oxygen out of the water. So if anything, for the mammals, what will be affecting them is whether or not the distribution of the fish shifts, are they moving. Although some of those fish may also now be exposed to more predation.

This is really theoretical and we're guessing, and time will be the -- what will show us in fact what is or will happen and occur. Right now the projections of these have been coming from models, are projecting increased food requirements, increased risk of being eaten, and for marine mammals, they may not suffer directly, but they, too, will be playing a role in changing the face of our ecosystems.

Q Right. And I guess that leads into my next question, and one of your last recommendations on page 83 - I don't know if we need to go there - talked about the need to create an ecosystem model as one of your recommendations. And given the complexity of the system, including climate changes, would you agree, I guess, that we would need ongoing monitoring of all these factors, including climate, temperature, and that sort of thing if we're going to keep updating the models?

DR. TRITES: Yes, I would agree, but at the same time it may not be necessary to monitor everything in great detail. We have a lot of knowledge already, and the model helped bring what we do know together in a way that we can evaluate it with a common set of indices. So and then over time the model can be updated as better information comes in, or we may identify from the model what the key information gaps are, and therefore help to focus our research efforts, as well as our research dollars to get that information. So the models are very valuable tools for such like creating an encyclopaedia of knowledge, in this case here for the sockeye salmon, what we do know and what we need to learn.

Q Okay. I'm just wondering about, given ecosystem modelling, and I'm not sure if you're able to answer this question, but are you aware of bringing in traditional ecological knowledge of First Nations indigenous people into ecosystem modelling and...

DR. TRITES: I, as a member of COSEWIC, we have a subcommittee that does bring traditional knowledge to our committees. It influences the status reports we do. And so that information is used. Sometimes it may not be quantitative, but it is qualitative in a way that we can put into the models to look at changes over time, for example.

So the models are built with a wide variety of information, and certainly do value any insights that people have about the systems, how they were and what's being seen today. Sometimes the models are also very good for, you know, even verifying observations that people have made using a different set of data, a different set of observations, and then collectively they help to build a fuller understanding of what has happened.

Q And perhaps I could just ask you, Dr. Ford, or you, Mr. Olesiuk, is DFO Science, if you're working on an ecosystem approach, which is suggested in the Strait of Georgia study, is traditional ecological knowledge being used in the creation of indicators for that model?

DR. FORD: I can't speak to the modelling exercises, because that's outside of my area. But I can confirm that traditional knowledge is incorporated wherever possible in development of recovery strategies for species that are listed under the ***Species at Risk Act***, including all the whale species, and other marine mammals, sea otters that had been listed, so that is an important component of those efforts.

MR. OLESIUK: And in the case of my work, the modelling I'm doing, we're working with species that I don't think there is a history of any sort for hake in the Strait of Georgia that I'm aware of. But our general marine mammal, our pinniped assessments, we try to gather as much knowledge from all sources before we go out and survey a new area, for example, and we'll work with all groups, including First Nations, to sort of identify where haul-out sites are and to make sure that we include them in our surveys.

Q Okay. Thank you for that. I guess my next set of questions will be directed to you, Mr. Olesiuk, and anyone else can follow up. I am specifically talking about now pinnipeds and harbour seals. And, Mr. Lunn, if you could pull up Exhibit 796 and go to slide 30. Thank you.

Mr. Olesiuk, yesterday in testimony you talked about that harbour seals had not been systemically studied on the Fraser River and no study had been done, and then you talked about that studies could be done. And I believe yesterday one of the study papers suggested that

you had an outline of how that could be done. And I'm wondering about this thing, this table here, and it gives an estimate of harbour seals. Now, did that include in the Fraser River, or this is estimate outside of that?

MR. OLESIUK: It does not include the Fraser River. And the information that we have, there were studies done in the '50s at both the upper reaches of the Skeena and Fraser River, and as far as we know there are seals a long ways up the river, but in relatively low abundance. And probably an insignificant number, compared to the B.C. population.

Q Right. And what would that be based on, like, how would you know that number of abundance?

MR. OLESIUK: It would be based on the surveys that were done up there in the '50s, where they made a concerted effort to -- and noted large concentrations of seals at the mouth of the Fraser, but very few seals upriver. We do include the animals in the lower part of the river in our surveys. And then just anecdotal reports we receive from, you know, fishery officers, whoever are in those areas, what we get are reports of scattered individuals, not -- I don't know of any major haul-out sites.

Q But other than the 1950 study there's nothing more recent to say whether the abundances of harbour seals in the river may have changed since the 1950s to today, there's no systematic quantitative data of that?

MR. OLESIUK: No systematic quantitative, just these anecdotal reports.

Q Okay. And so then yesterday you were speaking of a follow-up workshop with DFO scientists where you worked on sort of the widely perceived predators. You discussed that yesterday. And one of the things I wanted to know is what do you think drives the wide perception, I guess, that harbour seals, because you mentioned harbour seals as one of the widely perceived predators. What do you think drives that perception, then, if there isn't actual quantitative data of the number of seals in, say, the Fraser River?

MR. OLESIUK: Well, what drives the perception that they're a salmon -- a key salmon predator is that their predation on salmon is concentrated in

rivers and estuaries where there tend to be a lot of people. A large prey like salmon are brought to the surface and so you can see seals feeding on salmon. Small prey like herring are consumed underwater. Hake are consumed at night when they migrate up in the water column. So if you watch seals feeding, basically what you see them feeding on is salmon. So that's why they're perceived to be the most important pinniped predator.

In reality, the Steller sea lions are the most important predator, but their predation is occurring offshore, ten to 30 to 40 kilometres offshore, as salmon are entering coastal waters. And that's out of sight, out of mind, people don't observe that and you don't appreciate the level of predation that's going on.

Q Right. Mr. Lunn, if you could take me to our Tab 3, and this a letter to the Marine Mammal Coordinator for Fisheries and Oceans in the Pacific Region, and from Keith Forrest, who is a test fishing biologist, and here they're discussing a test fishing site and predation by harbour seals. And in the second paragraph they talk about:

> ...the Cottonwood and Whonnock test fisheries severely impacted by seal presence and predation. Seals now consume a significant proportion of salmon that are caught - up to 100% of the catch.

Now, yesterday you referred to marine mammals taking stock at certain specific sites like test fishing sites. Am I to understand that's known as depredation, is that the term that you used?

MR. OLESIUK: Yes.

Q Okay. And I guess I'm wondering is if the test fishing sites and these kinds of, I guess, letters and that sort of thing, sort of drives that idea that harbour seals are high predators within the Fraser River, when people see them at test sites and that, taking a lot of salmon. Would you agree with that?

MR. OLESIUK: Yeah, and that's just part of the perception issue. The seals are opportunistic predators. They'll take the fish wherever they are most vulnerable, and if that's in nets and at

weirs and things, that's where they'll take fish over rather than free-swimming salmon.
Q Right. And I guess my final question in this line of questioning is do you think that the Department maybe perhaps could better communicate the results of, say, your research to date, and perhaps the Technical Report, that harbour seals you don't believe are a major predator, somehow to offset that perception, even for our clients who have, you know, a concern or about these issues. Is there something that could be done in terms of communicating that low level, lower levels of predation.
MR. OLESIUK: There is, and we have in the past, and it's too far in the past, put out sort of brochure-type documents that translate our research into information for public consumption. And we should be doing more of that, it just...
Q And perhaps just a follow-up question then is, so those pamphlets are no longer being produced for the public by DFO?
MR. OLESIUK: They're not. The last one was really done in like the late '80s and is outdated.
Q Right. And is that just a funding issue, or...
MR. OLESIUK: It's a funding and priority issue. I think there's been a more recent cetacean pamphlet put out that -- I'll let John answer that.
DR. FORD: That's true. There are efforts also under -- more so in recent years with providing information on the DFO website, and so that is becoming, I think, more and more the sort of forum for interacting with the public in terms of providing science information.
Q Right.
MR. OLESIUK: And I should add that I forgot that when we write a technical report and it's peer reviewed, there is almost always an accompanying Science Advisory report, and those are written for managers, but the requirement is that we eliminate scientific jargon. And so that a naturalist or an interested person would find those useful, and they are posted on our website.
Q Right. And are these scientific data or science outcomes, if you will, communicated at broader meetings, do you know, I mean, do you report out to managers, and then if there's meetings between First Nations along the Fraser River and managers

from DFO, do you know if this information that you've found through your scientific studies is communicated to First Nations?

MR. OLESIUK: Yeah, and again insofar as sort of time allows, we do, you know, I routinely give talks to various, from naturalists to sport fishing organizations, to, you know, commercial fishery management groups, give talks on sort of an update of the work we're doing and what the priorities and issues are.

Q Okay. I think I'll just leave that line of questioning there. My last question for you, Mr. Olesiuk, is yesterday you talked about harbour seal impacts, and you mentioned that they may have -- or, you may have actually been speaking also for Steller sea lions, it wasn't clear, had small depressed -- could have an impact on small depressed salmon stocks.

Yes, sorry. Perhaps I could just mark our Tab 3 as an exhibit, sorry.

THE REGISTRAR: Exhibit number 799.

EXHIBIT 799: Letter from K. Forrest to M. Joyce re Initial Trials of an Electric Pulse Deterrent System to Protect Salmon Catches in Gillnets from Predation by Harbour Seals in the Fraser, November 2, 2006

MS. REEVES: Thank you.

MR. OLESIUK: Yes. And that is particularly an issue for harbour seals.

Q Harbour seals.

MR. OLESIUK: Impacts on salmon stocks.

Q And what depressed salmon stocks were you specifically referring to there?

MR. OLESIUK: The best-known cases are Puntledge River summer chinook, but I think those, there are similar issues with several chinook stocks in the Strait of Georgia, Cowichan chinook, Quinsam chinook.

Q Right. And did it relate at all to Cultus or Sakinaw sockeye?

MR. OLESIUK: Well, Sakinaw sockeye is another -- would be a prime example, that there was an anecdotal information that seals were feeding on salmon in the small river that connects Sakinaw Lake to the Strait of Georgia. And we did actually issue --

there are so few sockeye that it wouldn't be practical to go in there and do a Science assessment, but we did issue a nuisance seal licence to remove any seals feeding in that immediate area, just because that run was so seriously depressed.

Q And what about any of the other Fraser River sockeye, would it impact any of them?

MR. OLESIUK: I don't think Fraser River sockeye, but if you look at some of the steelhead runs and some of the depressed coho stocks, I would have concerns with seal predation on those stocks.

MS. REEVES: Okay. Thank you for that. Those are my questions.

MS. TESSARO: I'm not sure if Mr. Timberg has any questions in re-examination.

MR. TIMBERG: No.

THE COMMISSIONER: Ms. Tessaro, I wonder if I could just ask one brief question of this panel.

QUESTIONS BY THE COMMISSIONER:

Q I ask it because Mr. Leadem raised it, and I'm not sure in fairness to the three of you, whether you're the appropriate panel members to answer. But I was trying to -- perhaps, Mr. Lunn, if we could bring up Exhibit 795, and I think Dr. Ford mentioned that this April 2011 in-house DFO session or workshop was a follow-up to the June 2010 Pacific Salmon Commission Forum; is that correct?

DR. FORD: That's correct.

Q Right. What I was trying to understand, and again in fairness to you, you may not be the people to answer this, but within DFO, or within the larger community of science, and I'm talking about Science within DFO and the larger community, is there an ongoing overarching body that does the macro analysis, drawing together all the streams of research that are taking place, trying to understand it, and then share that in a way that allows you to draft an agenda for some suggestions to go forward, other than on a reaction basis where there's some event that you react to, but on an ongoing basis. Now, you may not know because you're working in specific areas, and you may not be aware of this, but I'm just trying to

understand, and your answers to Mr. Leadem about who's going to draw the agenda, who's going to drive the research. I think Dr. Trites mentioned there are private foundations and obviously universities and others who are involved in a variety of research projects. I'm just trying to get a sense of is this a scrambled situation in our world of research, or is there actually some game plan here now in 2011 and going forward that takes advantage of all this work that's been done and tries to get a sense of for the politicians and the bureaucrats and the managers, where should they be going forward, and where should they be assigning the resources to go forward?

DR. FORD: I think those are excellent questions, and if I could speak broadly, of course, DFO Science is involved with a wide diversity of different kinds of research activities on a wide variety of different taxon groups, from whales to seals to invertebrates and fish and so on, and those in, I think, historically, we're rather isolated in their direction. I think with the move broadly towards ecosystem-based management, and I think the Strait of Georgia Research Initiative is an example of how to catalyze those kinds of interactions and those kinds of syntheses that are needed to better understand the interconnections between predators and prey, for example.

If I could provide perhaps just a quick example in my own area. We about five years ago discovered that resident killer whales, which I was describing yesterday, appeared to be dependent on chinook salmon to the point that several years of depressed chinook salmon abundance availability in the late '90s caused a very significant increase in the mortality rate of killer whales. And so it appeared that there's a strong connection there. And when chinook stocks recovered in the early 2000s and went above the long-term average, the killer whale mortality rates went down below normal. And so as a result of that, we've been working with internally to work with chinook salmon managers to better understand the -- how for us in the marine mammal section, how salmon management functions and how predation is incorporated into the management plans.

And this has then led to an upcoming series -- or I should say a recent meeting that took place in March where we brought together experts from DFO Science, in terms of salmon and marine mammals, DFO salmon managers, and also our colleagues from the U.S. National Oceanic and Atmospheric Administration, and science personnel in both mammals and salmon, to start better understanding what can be done to accommodate the needs of these predators in the management of fisheries. And this now is going to lead to a series of workshops co-sponsored by DFO and NOAA in the U.S. over the next two years to better refine the kinds of management tools that we have at our disposal to ensure that these ecosystem connections are recognized in fisheries management to provide for, in this case, the recovery of killer whales.

So that's just an example of how these different disciplines are brought together.

Q Thank you. Dr. Trites?

DR. TRITES: Maybe I can give you sort of my perceptions as an academic. I think the killer whale example that Dr. Ford just gave is a good one in a sense, but that's a cross-boundary issue and almost by definition then brings in the U.S. researchers from the other side.

I think in terms of fisheries management, let's say within British Columbia, as an academic, I don't feel that there is a game plan. I think we look towards DFO to take leadership in this. But often I think the academics would feel that their opinion is that we are training the graduate students to ultimately be fisheries managers or the major fisheries researchers. I think there's a tendency to feel quite cut off from that as a result. There are a number of independent initiatives. I think some of the foundations would probably share some of those same views. I think we could be doing a lot more together.

This ecosystem research initiative was a wonderful initiative, but the academics aren't involved. There was no money to include. And so I think that there are initiatives that could be taken to make sure we have all the brightest minds in British Columbia working together to solve these problems. But at this point I think there's

too many independent initiatives and we can do a lot more by working together.

THE COMMISSIONER: Mr. Olesiuk?

MR. OLESIUK: Yeah, and I was just going to follow up. And again I think the ecosystem research initiative stands out as an example of a project that was not reactionary to any issue, it was more visionary. We recognize the Strait of Georgia is an important ecosystem, and the theme of the whole project was to sort of plan for what the Strait will look like 30 years from now in the future.

And I think what's happened, though, is that we now have the ***Oceans Act***. It used to be the Department of Fisheries operated solely under the ***Fisheries Act***, which was basically resource management. I think we now, with the ***Oceans Act*** have a much broader mandate that will hopefully increasingly consider the broad ecosystem interactions.

THE COMMISSIONER: Dr. Ford, did you want to add...

DR. FORD: I just wanted to follow-up on a comment Dr. Trites made, and I neglected to mention that in these upcoming -- in this recent meeting to do with killer whales and chinook salmon, there were in fact representatives from academia, from non-governmental organizations involved in the workshop that was a three-day workshop, I believe. And in these upcoming joint meetings with our U.S. colleagues, it's actually going to be -- these meetings, these workshops are going to be modelled after the PSC meeting from last June, where there's an expert panel who will be overseeing all the science that's presented and discussed, and they will synthesize recommendations from those discussions. And that panel will not include, it will be dominated by non-governmental science representatives from universities and elsewhere.

THE COMMISSIONER: Thank you.

DR. TRITES: And just as a final point, I think that killer whale workshop is a great example and a great model of the way things could be, and it would be nice to see that extended to other species, such as sockeye salmon.

THE COMMISSIONER: Thank you very much.

MS. GAERTNER: Mr. Commissioner, I wonder if I might follow with one question based on your question, if that's possible, and I think it's an important

-- I mean, I very much appreciate the nature of the importance of your question, and it's one that's been one that my clients watch with much care. And so if I could just contribute to this dialogue, I would like to. And it's Brenda Gaertner for the First Nations Coalition.

CROSS-EXAMINATION BY MS. GAERTNER:

Q I heard in the question, a part of the Commissioner's question, this notion that science should take the lead. My clients, of course, might take issue with that, Commissioner Cohen, because in our view ecosystem management, of course, is something First Nations have been doing all their life, and so they believe they have something very important to contribute in that. And that ecosystem management requires a collaborative look, right from the get-go, on how we look at the environment, how we feel as part of the ecosystem, how we are a part of the ecosystem, what indicators we look at, what questions we ask of science, who reviews the results, all of those things.

And so I wonder if you, as learned people in this field with different perspectives, might also want to add a comment on how important it is to have the body that's asking the questions to reflect deeply, a multidisciplinary approach, including very respectfully the First Nations' approach to the ecosystem.

DR. TRITES: Perhaps I'll start on that. I wasn't saying that science should take the lead. My feeling was that DFO as the management agency should be playing a greater leadership role in this. In doing so, I believe they should be more inclusive. I feel particularly academics, NGOs, First Nations, people who are concerned about the health of our oceans, and long-term sustainability. So I think indeed it does take a more collaborative approach. I think the workshop that Dr. Ford made reference to is a good example of bringing people together. And I think even that initiative can be expanded. Hopefully we'll see more of that in the future.

Q Dr. Ford.

DR. FORD: I'm definitely not the best to address

broader policy issues for DFO. I can only really speak to my own area of experience in interaction with First Nations in the science that we undertake. And we do work very closely with various different First Nation groups on surveys for marine mammals, cetaceans, in various regions of the British Columbia coast that are funded by the ***Species at Risk*** program. We work very closely with them to -- in survey designs, in collection of data, and in basically providing guidance to help address the kinds of questions they have in regions, in the different regions of the coast. So we have and are working quite closely with different First Nations groups at that level.

MR. OLESIUK: And I'll just say I do think there has been an improvement in our sort of consultation and inclusion of all interests, including First Nations. If you look at, you know, recovery planning of something under ***SARA***, or development of that sea lion management plan, those things we tend to have workshops that are, or meetings that are inclusive rather than exclusive and try to have all interests represented including First Nations, I believe.

MS. GAERTNER: I'm not going to take any more time, Commissioner Cohen. This is a topic that we're going to pursue hopefully more with the next panel, so it's great that we have the opportunity now.

THE COMMISSIONER: Thank you very much, Ms. Gaertner.

MR. TIMBERG: Mr. Commissioner, I have one brief question just to follow up on your question.

CROSS-EXAMINATION BY MR. TIMBERG, continuing:

Q The question is who at DFO is the person who could provide the Commissioner with an answer to this question about a macro analysis of science projects?

DR. FORD: I believe it would be Dr. Ian Perry, who has been overseeing the Strait of Georgia Ecosystem Research Initiative. I think he would be the best person to go to first.

Q Okay, thank you. Mr. Olesiuk, do you have anything further?

MR. OLESIUK: No, but and if you -- for who is included in these discussions, I would look at the Marine

Mammal Coordinator and the ***SARA*** Coordinator to see who are invited to participate in these processes.

MR. TIMBER: Thank you.

MS. TESSARO: Mr. Commissioner, I have just three quick issues in re-examination, which will take us no further than 11:00.

RE-EXAMINATION BY MS. TESSARO:

Q The first question is for Mr. Olesiuk and Dr. Trites. I'm going to see if we can achieve some agreement on slide 27 of Exhibit 796. Both of you commented on either this slide or another version of it. Mr. Timberg put this slide to you, Mr. Olesiuk, and a similar version was commented on by Dr. Trites, although the fish, the species were ordered differently in the other version. And my question is, looking at that red bar of sockeye or pink -- I'll ask you, Mr. Olesiuk, first. As a basic default scientific assumption, wouldn't one assume that that large -- that 15 percent bar there would mostly likely break down in similar proportions as the sockeye and pink in the other bars?

MR. OLESIUK: That --

Q Could I ask you to turn on your mike, please.

MR. OLESIUK: Yes. That concept is right. If you could go to maybe the next slide or the slide after, can we just advance one at a time here. I will -- yeah, that's actually the slide, that's the key slide right there. And that you have, you would partition the unknowns based on what is known.

Q Right.

MR. OLESIUK: And so most of the sockeye that sea lions are consuming are on the Scott Islands, that pie to the left. And there are -- I would draw your attention to the three sections on the right: the dark red is the known sockeye, the red is the unknowns, and the pink are pink salmon. And so you would partition them based on where the unknowns occurred, not just in the whole sample. And so based on that, I would kind of assume that about half of the unknowns would be pink and half sockeye. And then the rest of the sockeye are being consumed along the West Coast, a much lower fraction of the total. And in that case the

unknowns occur where relatively few sockeye were identified and lots of pink, and I would partition those based on -- the unknowns based on the relative percentage of the knowns. And then you need to weight these according to how many sockeye are being consumed in each of those areas. But it's kind of 50/50, because most of the sockeye are in the Scott Islands.

And just that I realize that the timing is awkward, but I expect to have the results of those unknowns next week, so it's...

Q Oh, you shouldn't offer things like that. I'm just teasing you. I'm just teasing you.

I'm going to ask Dr. Trites if he could comment on that assessment of how one would, in Mr. Olesiuk's words, "partition the unknown".

DR. TRITES: No, I would do just as he's done, and expect the results will come out that way. And we'll see when those DNA results come back, if the expectation that there's probably more pinks in that unknowns than sockeye stands up or not. But that would be my guess.

And maybe one other point to make in this is you have to keep in mind that these were samples that didn't come from the mouth of the Fraser. They came in this case from the Scott Islands. And so we're making assumptions that all those are Fraser River sockeye. Some of those could have been Columbia River or other runs. And so you have to keep in mind that without doing more work, you have to figure out the origins of that DNA, which runs they were. We're making some assumptions here about how to break that up by rivers.

Q That's helpful, thank you. My second question is for Dr. Ford and Mr. Olesiuk, and this relates to Exhibit 797, if we could pull that up, Mr. Lunn. Mr. Olesiuk, you were asked by Mr. Timberg whether you agreed that the Steller sea lion management plan is similar to resident killer whale management that Dr. Ford had described earlier. Do you remember that question?

MR. OLESIUK: Vaguely.

Q Could I ask you to turn on your mike.

MR. OLESIUK: Yeah, I vaguely remember it.

Q And your answer to the question was yes, and I'm going to suggest to you and to Dr. Ford that the

way that DFO manages salmon and resident killer whales on one hand, and the way that DFO manages salmon and Steller sea lions on the other hand, is clearly different in one fairly obvious respect. And so my first question for you, Mr. Olesiuk, is that this Management Plan for the Steller Sea Lion obviously does not identify critical habitat, right?

MR. OLESIUK: Correct. And I think there was a question I was asked of what are the requirements for a species of special concern, and the requirement is a management plan, but not definition of critical habitat. If a species is threatened or endangered, that requires a recovery plan, which is different than a management plan, and designation of critical habitat.

Q Exactly. And so, Dr. Ford, in contrast, for the resident killer whales, DFO as a function of that recovery strategy is actually required to legally protect salmon availability as a part of the resident killer whales' critical habitat, right?

DR. FORD: That's correct.

Q And so my final question is one that arose out of the discussion we've been having with -- arising from the Commissioner's question about is there an overall game plan for all these science pieces to come together, and my question is, in your work as marine mammal scientists doing this research and looking at the relationship between marine mammals and their prey, and salmon, who at DFO gives you, if anybody, direct guidance on ensuring that your science is part of that overall management game plan. Who do you understand to be the captain of the team? Who's creating that game plan and saying, we need this science from you, Dr. Ford, or we need this science from you, Mr. Olesiuk, to ensure that the marine mammal piece of our big game plan is fit. Do you know of that person exists?

DR. FORD: In terms of marine mammal interactions with management, it's really facilitated by the Marine Mammal Management Coordinator, Paul Cottrell, who is in Fisheries and Aquaculture Management, and interacts with various fisheries managers as well as with habitat issues that would potentially impact marine mammals. So major construction projects, seismic exploration surveys for

geophysical research, you know, these kinds of things could have impacts on marine mammals. So the marine mammal management coordinator is the key sort of liaison with all these other sectors.

Q So "liaison" is a very interesting word, and that's how I also understand Paul Cottrell's very important role, he's liaising between the managers and the scientists. But who is making -- who's designing the game plan that Mr. Cottrell is being responsive to? That's more the question. Who's deciding, for example, how marine mammals and their pretty will be co-managed in the Strait of Georgia. Do you know who on the other end of Paul Cottrell is making that decision, or giving that direction?

DR. FORD: That's a difficult question. It depends on, you know, the species involved, the kinds of interactions that are -- that reveal themselves to be significant. And I think I can just speak again to the resident killer whale/chinook interaction as an example of the kinds of -- the process that was involved. When it was -- as soon as it was recognized that chinook salmon were sort of counter-intuitively so important to these animals, that triggered a series of interactions with management to better understand again how predation is taken into account and then what the next steps might be.

So I just think it really is through an ongoing sort of dialogue interaction between Science and Management, and again facilitated by the Marine Mammal Manager to bring those groups together.

Q Dr. Olesiuk, is there anything you disagree with in that?

MR. OLESIUK: I don't disagree, but I was going to say that we are, like I mentioned before, it's a two-way street. We are constantly feeding up to managers what we think are issues that might be important. But ultimately, we don't decide what assessments to do, you know, whether to go out and do a sea lion study or a harbour seal study in a certain area. Those come through management questions, requests for science advice. And then that in turn translates to allocating and identifying priorities for funding, and that would be done, at my level, the priorities are set by

our Division Chief, who would, "Okay, well, management is asking for this particular advice. Can we afford to do it? How are we going to, you know, how much is it going to cost?"

Q My last question is just who is your Division Chief, what's that person's name?

MR. OLESIUK: Laura Brown.

Q Right, thank you.

MR. OLESIUK: So that she is Marine Ecosystems and Aquaculture Division.

MS. TESSARO: Thank you. Mr. Commissioner, we're at eleven o'clock. I'm going to suggest that we take an early break to facilitate the panellists changing.

THE COMMISSIONER: Thank you very much, Ms. Tessaro.

MS. TESSARO: 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.

MR. WALLACE: Good morning, Mr. Commissioner, Brian Wallace, Commission counsel. I am here to introduce the second panel on the predation hearings. These gentlemen will address the issues principally of fish predation but also there will be some discussion of birds. Dr. Christensen has been here before, yesterday, and has been affirmed. And next to him is Mr. Jeremy Hume and Mr. Gordon McFarlane. And I wonder, Mr. Giles, if you could affirm the new witnesses.

THE REGISTRAR: Yes.

JEREMY HUME, affirmed.

GORDON McFARLANE, affirmed.

THE REGISTRAR: Would you state your name, please?

MR. HUME: Jeremy Hume.

THE REGISTRAR: Thank you. Would you state your name, please?

MR. McFARLANE: Gordon McFarlane.

THE REGISTRAR: Thank you. Counsel?

MR. WALLACE: Thank you.

EXAMINATION IN CHIEF ON QUALIFICATIONS BY MR. WALLACE:

Q Mr. McFarlane, let me start with you.
MR. WALLACE: I would ask, Mr. Lunn, if you could put Tab 24 from the Commission's documents on the screen, which -- I'm sorry. That's the wrong one. Mr. McFarlane is Tab 25.
Q Just, if I may, briefly, Mr. McFarlane, the document on the screen, is that your *curriculum vitae*?
MR. McFARLANE: Yes, it is.
MR. WALLACE: Mr. Giles, could we mark that, please, as the next exhibit?
THE REGISTRAR: Exhibit 800.
MR. WALLACE: A milestone.

EXHIBIT 800: *Curriculum Vitae* of Gordon McFarlane

MR. WALLACE:
Q Mr. McFarlane, you are a DFO scientist *emeritus*?
MR. McFARLANE: Yes.
Q At the Pacific Biological Station. And you graduated from the University of Winnipeg in science in 1971 and have been involved, I think, in fisheries research ever since?
MR. McFARLANE: Yes, that's correct.
Q And for the last 30 years, you have studied marine life extensively in the Georgia Strait, correct?
MR. McFARLANE: As well as other parts of our coast, yes.
Q Thank you. And that research centres on biological parameters, that is, age, growth and mortality, et cetera, to be used in stock assessments and examining climatic and oceanic factors influencing the dynamics of marine fish and the physical, biological and fisheries oceanographic linkages of large marine ecosystems. Does that cover it?
MR. McFARLANE: Yes, that covers it.
Q Thank you. In the course of this research, am I correct that you have done a fair amount of field research collecting and analyzing stomach content data on predator-prey relationships in British Columbia waters?
MR. McFARLANE: Yes.
Q And you have studied the biology and distribution

of sharks and skates off the west coast of Canada?
MR. McFARLANE: Yes, I have.
Q You were, I think, the head of Marine Fish Population Dynamics at PBS from '92 to 2000?
MR. McFARLANE: Yes.
Q And the head of the Groundfish Research Section prior to that?
MR. McFARLANE: Correct.
Q You're a long-time member and advisor to the International Negotiating Teams for the INPFC, the Canada/U.S. Groundfish Committee PICES, the Pacific Hake Scientific Working Group, that's correct?
MR. McFARLANE: Yes.
Q And you've participated in the development and conduct of a number of international research projects?
MR. McFARLANE: Correct.
Q I understand you've authored some more than a hundred primary publications on biology and over a hundred technical publications relating to stock assessment of pacific marine fish?
MR. McFARLANE: Correct.
MR. WALLACE: Mr. Commissioner, I would submit that Mr. McFarlane is qualified, by his experience, as an expert to speak to marine fish predation on sockeye salmon.
THE COMMISSIONER: Thank you.
MR. WALLACE: Thank you.
Q Mr. Hume, I'll ask Mr. Lunn to put your *c.v.* on the screen.
THE COMMISSIONER: Did you wish to mark the earlier *c.v.*?
MR. WALLACE: Oh, thank you, Mr. Commissioner.
THE COMMISSIONER: Or has it been marked?
THE REGISTRAR: That was marked as 800.
THE COMMISSIONER: That's 800?
MR. WALLACE: Thank you.
Q Mr. Hume, can you identify this document on the screen as your *curriculum vitae*?
MR. HUME: Yes, it is.
MR. WALLACE: And Mr. Giles, could you mark that, please, as the next exhibit?
THE REGISTRAR: Exhibit 801.

EXHIBIT 801: *Curriculum Vitae* of Jeremy Hume

MR. WALLACE:
Q Mr. Hume, you have a Masters degree in aquatic ecology from UBC in 1979, correct?
MR. HUME: That's correct.
Q And your career has focused principally on research into the ecology of juvenile salmonids, particularly sockeye salmon?
MR. HUME: That's correct.
Q You first conducted research, I believe, for DFO on juvenile sockeye in Babine Lake. You were then with the B.C. Ministry of Environment where you conducted research into management-related freshwater fishery problems, correct?
MR. HUME: Yes.
Q And for the last 24 years, you have been the senior fisheries biologist for DFO's lake research program, the principal objectives of which are to determine the trophic status, productive capacities and limiting factors for sockeye salmon rearing in nursery lakes?
MR. HUME: That's correct.
Q Okay. Am I correct that during the course of this work, you have also dealt in field research collecting and analyzing data on the abundance, survival and growth of juvenile sockeye in lakes, and in recent years you have initiated and conducted and reported on the Predator Control Program for northern pikeminnow in Cultus Lake?
MR. HUME: That's correct, yes.
Q You have authored some ten primary and over 50 technical publications concerning the biology and ecology of juvenile salmonids in freshwater ecosystems?
MR. HUME: Yes.
MR. WALLACE: Mr. Commissioner, I submit Mr. Hume is qualified by his education and experience to speak to freshwater predation on sockeye salmon.
THE COMMISSIONER: Thank you.
MR. WALLACE: Thank you.

EXAMINATION IN CHIEF BY MR. WALLACE:

Q Thank you. I wonder if I might start --
MR. TIMBERG: Mr. Commissioner, I'm just wondering if we could change the exhibit number. We provided the Commission with a redacted version of the résumés that took out personal information. We

have that in the list at the -- this is the Commission's list of documents at Tab 24. And then I have a CAN number, also. The Commission provided a redacted version at Tab 24.

MR. LUNN: The Commission list?

MR. TIMBERG: The Commission list, yeah.

MR. WALLACE: The one I have is not redacted. May I suggest that we find the redacted version and replace --

MR. TIMBERG: We have it right here and I have the CAN number, too, if Mr. Lunn wants that; it's 185597.

MR. LUNN: That's the document that we filed. It is listed as Tab 24 with that CAN number so I imagine there's a redacted version elsewhere.

MR. TIMBERG: Okay. Well, we have a redacted version. Okay. Well, sorry about that. We'll have to deal with this later.

MR. WALLACE: I suggest that we will replace this with our redacted version, taking out Mr. Hume's personal information today, I hope. The same issue arises with respect to Mr. McFarlane's *c.v.*

Q Thank you. Mr. Hume, you've had an opportunity to review the Project 8 report that the Commission had from Dr. Christensen and Dr. Trites?

MR. HUME: Yes, I have.

Q Do you have any comments on the assessment in that report of the potential impacts of freshwater fish predators?

MR. HUME: Yes, I do. I agree in general with their assessment that freshwater predators probably did not contribute to the decline in sockeye production in the Fraser River. I base that on my own research looking at a fry abundance in Quesnel, Shuswap and Chilko Lakes and finding no change in survival rates with time in those lakes, which indicates the mortality problems are not occurring in freshwater. So in general, I agree with their conclusions.

I note that they have missed a few important documents in their research. The first one was in 1941 by Dr. Ricker on consumption of sockeye salmon by predacious fish in Cultus Lake. The second one would be a paper by Ward and Larkin on cyclic dominance in Shuswap Lake where they studied rainbow trout predation as well. And a third one that's also in Shuswap Lake in 1989 by Gilhousen and Williams where they studied a number

of predators of sockeye salmon, including rainbow and cutthroat and burbot as well.

Q Thank you. You have also written on the issue of rainbow trout predation on sockeye, correct?

MR. HUME: I have, yes.

MR. WALLACE: And I wonder, Mr. Lunn, if we could have Tab 30 from the Commission's documents?

Q And this is a document that you were a co-author on I see, Mr. Hume, in 1989, which deals with rainbow trout predation on sockeye. What was your overall conclusion in that report?

MR. HUME: For the larger rainbow size classes, kokanee and sockeye salmon are a major food source for these fish and, in fact, the larger, what they call trophy rainbow trout, require the presence of either kokanee or sockeye in the lake with them in order to reach their large size. We were looking at this study from a rainbow trout point of view rather than from a sockeye point of view so their actual impact on sockeye wasn't considered in the study but they did provide, particularly in dominant years, a major source of food for the rainbow trout in the lake.

Q Thank you. And does this paper reflect your current view on this relationship?

MR. HUME: Yes, it does.

MR. WALLACE: Thank you. I wonder, Mr. Giles, if we could mark the 1989 paper referred to of Parkinson, Hume and Dolighan as the next exhibit?

THE REGISTRAR: Exhibit 802.

EXHIBIT 802: Size Selective Predation by Rainbow Trout on Two Lacustrine Oncorhynchus nerka Populations by Parkinson, Hume and Dolighan, 1989

MR. WALLACE:

Q Next paper I would like to direct your attention to, Mr. Hume -- actually, let me just introduce this by referring to your work in Cultus Lake. You've been actively involved there with respect to the pikeminnow and the removal program over the years?

MR. HUME: Yes, I have.

Q I have a couple of papers here that I'd just like to refer you to and perhaps you can use those as a vehicle to tell us how information and knowledge

on the pikeminnow and the effectiveness of the program have developed over the years. And the first paper I would refer to is at Tab 34 of the Commission's book of documents. And this is a 2005 paper by William Gazey. And you're familiar with that paper?

MR. HUME: Yes, I am. Sorry. It's not what's up on the -- oh, yeah, okay.

Q I think the copy we have is missing the cover page.

MR. HUME: Right.

Q So you really have to go to the third page to see the author's name. And that paper identifies depensatory predation as the causal mechanism for low freshwater productivity.

MR. HUME: I believe that's on the next page.

Q Yes. That conclusion is on page 3 under "Conclusions". Thank you. Now, first of all, can you explain in lay language what that means and provide us your views as to whether that is an accurate assessment?

MR. HUME: Depensatory mortality is -- I always have a hard time explaining this one. Basically, say, if you have a fixed number of predators that are always hungry so that they try to eat as much as they can. If there's a small number of fish in the lake, the predation rate on those fish will be higher than if there's a larger abundance of fish. So in very low prey densities, the mortality rate will be higher on the fish than at the high prey densities.

Q Thank you. And is that the issue in Cultus Lake?

MR. HUME: Yes, it is.

MR. WALLACE: Mr. Giles, could you mark that paper by Mr. Gazey, please, as the next exhibit?

THE REGISTRAR: Exhibit 803.

EXHIBIT 803: Report and Recommendations prepared by William Gazey, April 27, 2005

MR. WALLACE: Now, if I may ask you, Mr. Lunn, to put Tab 32 on the screen, please?

Q Now, Mr. Hume, this is a paper that you co-authored, the CSAS paper, in 2010. And that's a more recent assessment of the status of Cultus Lake sockeye, correct?

MR. HUME: Yes, it is.

Q And it discusses, I think, the efficacy of the recovery measures up to 2010 as well?
MR. HUME: That's correct.
Q Now, that assessment looked at the predator control measures?
MR. HUME: Yes, it did.
Q Can you give us your views on the efficacy of the predator control? The predator at issue here is the northern pikeminnow, correct?
MR. HUME: Yes, we removed only northern pikeminnow from the lake.
Q Okay. Can you just describe that program and the limits or not on its effectiveness?
MR. HUME: In 2004, we did a mark-recapture population estimate of the pikeminnow in the lake and came up with approximately 60 to 70,000 adult northern pikeminnow in the lake. From starting in 2005 through to, well, currently, right now, it's still ongoing. we removed approximately 45,000 adult pikeminnow from the lake. Of course, there's been replacement from the younger-year classes into the adult life history stage but we removed a significant proportion of the northern pikeminnow from the lake. This has resulted in increased survival at the current densities of sockeye in the lake, as we saw increased survival for those fish relative to years to when no pikeminnow removal occurred.
Q Is there a lesson to be learned about the effectiveness of predator removal programs from the Cultus Lake circumstance?
MR. HUME: It's hard to expand this study to other lakes in the system. Every system will be different. Cultus Lake is a fairly small sockeye-rearing lake with a relatively easy population of predators that we could capture and remove. Certainly, in Cultus, it's shown to be an effective method to work at low sockeye densities. Actually, if we go to Figure 11, I believe it is, in this paper. I'm not sure what page number that is, I'm sorry. Towards the end. Figures are all at the end.
Q Page 41.
MR. HUME: So this figure shows survival on the vertical axis potted against the total number of spawners in the lake. The diamonds are there's no pikeminnow removal and the circles are years when

we did have pikeminnow removal. You can see at higher densities that there's no apparent effect on survival at the high densities, whereas at the low densities, we seem to have a -- we appear to have a much higher survival rate for fish, say, less than 6,000 spawners in the lake. So I guess what we can learn from this is that for populations that are in trouble, low densities and spawners, this may be a way to help rebuild the population by increasing their survival. The lake is very small. It's unknown whether this technique could be transferred to other larger systems.

Q The turning point in this model seems to be around 6,000 spawners and this is in a lake that would support how large a spawning population?

MR. HUME: We estimate that it could support anywhere in the 70 to 80,000, 60 to 80,000 range.

Q Has there been any study on the impact on other ecosystem impacts from the predator removal program in Cultus Lake?

MR. HUME: There is some work being done, yes. Our regular mid-water trawl work that we do on the lake monitors all pelagic fish in the region. As well, we do an annual spawning or beach seine survey around the lake, usually in September, looking to detect gross changes in population estimates and populations of other fish.

Q Are you able to draw any conclusions about the impact of the program on other parts of the (indiscernible - overlapping speakers)?

MR. HUME: The data hasn't been completely analyzed but certainly there's been nothing that's looked surprising in a quick examination of the datasets.

Q You say nothing that looks surprising?

MR. HUME: Sorry. There's no obvious increase in abundance of any species that we -- seeing the same sorts of abundance of species that we've always seen previous years.

Q Thank you, Mr. Hume. Mr. McFarlane, let me ask you the same question. Do you have any comment on the assessment of the Project 8 report on potential impacts on Fraser River sockeye of marine fish predators?

MR. McFARLANE: I've read the report. And I don't have any differences of opinion on their final conclusions, which is that marine fish probably

was not a major factor in the 2009 reduced returns. I also agree that much of this is based on limited data on many of these species and that, in general, it would be nice to be able to look a little more closely at some of the species, as they suggest.

Q Okay. So you would agree with the recommendations as well?

MR. McFARLANE: I agree with the recommendations in general, although I would change one or two of them up a little bit in terms of species group, which we looked at in terms of the development of a predator or a prey diet database.

Q Can you be more specific?

MR. McFARLANE: Yes, on which one?

Q What changes would you make on the species?

MR. McFARLANE: There's a number of things. If you want to stick to the Strait of Georgia versus the open ocean, there's different species groups you would want to concentrate some of your efforts on. If you were looking at the Strait of Georgia only, I would concentrate on a number of species and I haven't got in front of me, sorry, which ones I'm thinking of.

Q Perhaps have a look at page 82 of the Project 8 report. I'm sorry. I've forgotten the exhibit number.

MR. LUNN: Could you say the name of the document again?

MR. WALLACE: It's the Project 8 report.

MR. LUNN: 780.

MR. WALLACE: 780, thank you.

MR. McFARLANE: Okay. They've basically come up with six species that they would recommend are potential predators of interest that more information is probably needed on. Most of those species are outside of the Strait of Georgia. I don't disagree that it would be nice to have more information on those species but there are a number of other species outside of the Strait of Georgia that they also have talked about in their report where more diet data would be needed.

I'm thinking specifically of things like northern stocks of arrowtooth flounder and some of the other groundfish species. In the Strait of Georgia, I think it's important to concentrate studies not only on the two species mentioned

here, which are river lamprey and the common murre.

I would suggest that there should be a lot more work on some of the other species, such as dogfish sharks. Now, that's as a potential predator but there are other species in the ecosystem context that should be looked at as well, which are not predators but may be competitors.

MR. WALLACE: Thank you. Mr. Giles, did I mark the 2010 CSAS report on the status of Cultus sockeye as an exhibit?

THE REGISTRAR: You did not. That will be Exhibit 804.

MR. WALLACE: Thank you.

EXHIBIT 804: Status of Cultus Lake Sockeye Salmon, CSAS 2010

MR. WALLACE:

Q Thank you. Mr. McFarlane, you have some expertise in salmon shark, I think, among other sharks.

MR. WALLACE: I wonder if I could have Tab 26 put on the screen, please?

Q This is a 2010 report done by Williams and others. You're familiar with this report, Mr. McFarlane?

MR. McFARLANE: Yes.

Q And do you agree with the conclusions of the authors on the salmon shark?

MR. McFARLANE: Well, there's a number of conclusions. One is that they wanted to attempt to come up with some sort of reasonable biomass estimate. Another is that they don't actually conclude much in the way of importance of salmon shark. They present a lot of their interpretations of what might be important, for example, predation on Fraser River sockeye, predation on other species, which apparently are in the hot zone that they speak of, those types of things. So do I agree that what they've done is reasonable and are the conclusions reached reasonable based on their analysis? In general, I think. I was confused as to why they limited their data in certain ways. I'm not sure I agree with the idea of using these types of techniques for sharks.

The line transect theory and whatnot and models are difficult at the best of times, let alone for sharks. However, given that these

people are good at this type of work for marine mammals, I think if we accept that their conclusion is that in the hotspot that they speak of, which is the southern tip of Queen Charlotte Sound or Queen Charlotte Island in Queen Charlotte Sound, that there may be in the neighbourhood of 10,000 sharks, of which possibly 4,500 sharks are salmon sharks, okay, I accept that that's an estimate that comes out of their analysis. You then have to say to yourself, okay, does 4,500 sharks over the course of July and August in certain years because in some years they found no sharks, does it mean anything in terms of impacts on the actual dynamics of the stock? Obviously, it means something to the individual fish that got eaten but does it mean anything to the dynamics? And there's not a lot of information.

In Project 8, it recognizes a lack of diet information on salmon sharks but they're episodic feeders. They're also opportunistic feeders. They feed on a lot of things other than salmon. That particular area is fairly rich in other species of forage fish, particularly in the last number of years, sardine. One of the reasons the whales seem to congregate off that area is the presence of sardine. So all those things together indicate to me that, yes, there's salmon shark there. In my own studies of look at bycatch in other fisheries, that also shows up as an area of salmon shark abundance, as does other areas on our coast. It's not the only one.

And so the question really comes down to, is there evidence that they are feeding on salmon in that area? There is no evidence and that doesn't mean they aren't. It means there's actually no data from that area. However, in areas where there is data, salmon shark definitely feed on salmon, hence their name. But there has been no linkage between salmon shark predation and declines or increases, for that matter, in salmon population. And I'm speaking specifically of Prince William Sound where most of the work on salmon shark has been done.

MR. WALLACE: Thank you. Mr. Giles, could that document, Shark aggregation in coastal waters of British Columbia of Williams *et al*, 2010, be marked as the next exhibit, please?

THE REGISTRAR: Exhibit 805.

EXHIBIT 805: Shark aggregation in Coastal Waters of British Columbia, 2010

MR. WALLACE:
Q Dr. Christensen, I'll take you to Canada's Tab 13 and 14. These are two papers that relate to the rhinoceros auklet, a bird found on Triangle Island off the northwest coast of Vancouver Island, I think. And these two papers, you're familiar with those?
DR. CHRISTENSEN: Yes, I am.
Q And I take it, they both come to the conclusion that the rhinoceros auklet is a bird that we ought to be paying attention to in the context of predation on early sockeye migrants into the ocean, correct? That's their conclusion?
DR. CHRISTENSEN: Yes.
Q And yet the rhinoceros auklet didn't make the cut in your analysis. I'm wondering if you've considered these remarks and what your views are?
DR. CHRISTENSEN: We did look at information about the species when we wrote the report. We had a lot of species to cover. We did not find it likely that this would be an important species based on that information. And in examining what we could find of information about abundance and trends in the species, the conclusion was it was a fairly rare species and that there was no indication that its abundance had been increasing in recent decades. So they were the reasons why we did not include it.

In examining it again now, I find it very unlikely that it would have any significant impact on the Fraser River sockeye salmon given the very limited time that there's an overlap in spatial distribution, given the numbers. Compared, for instance, to salmon shark we just heard about, rough indications would be that salmon sharks could probably eat to order of magnitude more than the rhinoceros auklets. So overall, I do not think that this is a species that may have contributed significantly to the predation mortality of Fraser River sockeye salmon.
MR. WALLACE: Thank you. Mr. Giles, may I ask you please to mark first the Environmental Control of

the Breeding Success of Rhinoceros Auklets at Triangle Island as the next exhibit?
THE REGISTRAR: Exhibit 806.

EXHIBIT 806: Environmental control of the breeding success of rhinoceros auklets at Triangle Island, British Columbia

MR. WALLACE: And the document that's at Tab 14 of Canada's book, Forage Fish of the Pacific Rim as Revealed by Diet of a Piscivorous Seabird Synchrony and Relationships with Sea-Surface Temperatures as the next exhibit?
THE REGISTRAR: 807.

EXHIBIT 807: Forage fish of the Pacific Rim as revealed by diet of a piscivorous seabird: synchrony and relationships with sea surface temperature

MR. WALLACE:
Q And Dr. Christensen, I believe you have summarized what you've just told us in a short document that you provided to us and we've circulated.
MR. WALLACE: Could that be put on the screen, please, Mr. Lunn, Dr. Christensen's response?
Q Do you recognize that as the response, which is in written form, pretty much what you just gave in evidence?
DR. CHRISTENSEN: That's correct, yes, though this one does not talk about the -- how much they would have consumed.
MR. WALLACE: Thank you. I'd ask, Mr. Giles, if this could be marked as the next exhibit?
THE REGISTRAR: Be 808.

EXHIBIT 808: Rhinoceros Auklet (Cerorhinca monocerata) and Fraser River sockeye salmon

MR. WALLACE:
Q Finally, Dr. Christensen, this morning, there was a discussion about DFO's ecosystem research initiative arose and this is a topic that you and Dr. Trites address at page 78 of the Project 8 report.
MR. WALLACE: If that could be put on the screen, please, Mr. Lunn?

Q I think the tenor of your comments in the report itself are that the level of support for this initiative is insufficient to ever meet the goals of integrated management. Could you care to expand on that and any other comments from what you heard on the discussion of the ecosystem research initiatives at DFO?

DR. CHRISTENSEN: It is clear that the scientists at DFO are doing an incredibly good job from moving the research ahead and that they are doing this with very limited resources. If I look at the ecosystem research initiative and the documents that describes this, I find a lot of good intention in it. I do, however, not see a clear strategy in the way it has been implemented. The funding envelope of, I think, around 500,000 -- well, it's 2.3 million for five areas, which on average, would be four to 500,000 is a very limited amount of funding for a research initiative that is fundamental for where DFO is moving with its integrated management. The way that this funding has been broken up into piecemeal practice to me indicates a lack of strategy.

It's small projects and I have problem seeing how this initiative is going to prepare DFO and the overall community here on the west coast when it comes to predicting how the Strait of Georgia will look in 2030, which is a key objective of this research. So I really feel that this funding has been used to do more of the good work we are already doing. That was in quotation mark, as "we" not "me". But the good work that the DFO scientists is always doing, it's been allocated for that use, as far as I can see from the documents. And it has not been used strategically to promote the chief objective.

MR. WALLACE: Thank you. Mr. Commissioner, I have no further questions for this panel. And Mr. Timberg is next in line.

MR. TIMBERG: Yes, for the record, Tim Timberg for the Government of Canada. And with me, my colleague, Geneva Grande-McNeill.

CROSS-EXAMINATION BY MR. TIMBERG:

Q We've heard this morning about conversation about the importance of data and the importance of ecosystem modelling. And I'd like to start with you, Mr. Hume. Can you explain for the Commissioner, whether your work includes collection of freshwater data?

MR. HUME: Yes, it does.

Q And can you describe what that means? What do you do to collect that?

MR. HUME: Our lakes research program studies juvenile sockeye fry in lakes, well, obviously in lakes. We collect physical, chemical and biological and limnological data from the various trophic levels that supply food to the sockeye salmon, as well as occasionally look at the predators of salmon as well but also their competitors, too. The fish part of the data is collected through hydroacoustic population estimates and was with actual physical sampling through mid-water trawling.

Q Okay. And can you describe generally the areas where that data is collected?

MR. HUME: We've sampled just about every sockeye-rearing lake in the Fraser River system except for a few of the very small ones or lakes with very low populations of sockeye. And we have detailed data over a long time series going back to 1975 for Quesnel, Shuswap Lake, Cultus Lake and off-and-on for Chilko Lake as well. And a few other lakes as well we have time series but not as long as those.

Q Thank you. And Mr. McFarlane, can you explain whether you in your work collect marine data and, if so, what kind of data do you collect?

MR. McFARLANE: Yes, I do. Generally crews go out to answer a question or a specific set of questions and it could be things like examining the abundance and distribution of specific species or a specific group of species. As part of that, we would also collect other types of information: age, sex, length, all of the biological parameters that would allow us to say something about the stock structure. In many cases, in my own surveys, I generally try to take diet information from the key species as well as the incidental species I'm taking. Some other groups do the

same. Some do all the first parts but not the diet part. It is time consuming.

We also take physical oceanographic and biological oceanographic, so lower trophic level abundance of copepods, euphausiids, that type of thing, along with all the other information. So at sea, those are basically the types of information that we would use. And we use equipment, such as trawl nets, traps and long lines, as well as, in some cases, we might put out specialized gear for specific purpose such as modified gillnets in some cases, very seldom. All of our diet work comes from trawl nets because, of course, they're passive in terms of they're not drawing the fish to a bait of any kind.

Q Right. And Dr. Christensen, do you collect any data in your work in the freshwater or marine waters?

DR. CHRISTENSEN: Not in my current work, no.

Q Okay. And I was just wondering if, Mr. McFarlane, you could comment on the relationship between data and ecosystem modelling? And we've heard that ecosystem modelling earlier is not very expansive but I'm wondering about the cost to collect this data and the relationship between data and ecosystem modelling?

MR. McFARLANE: Yes, depends on the ecosystem model, I suppose, but if we're talking about the type of modelling that's suggested in the report, which is ecopath with ecosim, it is very data-hungry in terms of diets, consumptions, abundance estimates for numerous species and that type of information so collected at sea and transferred into databases which can then be used. Building the model, I mean, Villy's the guru of building these types of models and I'm sure he's correct in saying that he can build them pretty quickly. The ones I've worked on are very nice to work with but the collection of the data is incredibly expensive in terms of dollars and in terms of ship time.

Q Okay. So would it be fair to say that you need both then? You need the data to feed the model?

MR. McFARLANE: Well, it would be fair to say to me, absolutely.

Q Okay.

MR. McFARLANE: Otherwise, you have to make the data up.

Q All right. And does anybody else on the panel have a comment with respect to that relationship?
DR. CHRISTENSEN: What Sandy McFarlane said is totally correct. One question, though, is what data do we need? As it was pointed out this morning, scientists always want more data. We cannot collect all the data and it's very important that we use models to guide us with regards to what kind of data do we need to collect? So a starting point is what policy questions are important? We use the models to guide us and to guide not the least a very expensive data collection. That can be much more efficient if it is driven by model studies.
Q Thank you. Mr. Hume, if we could --
MR. TIMBERG: Mr. Registrar, actually, if we could turn to Canada's list of documents, Tab 1. And if we could turn to page, it's 1330 in the top right-hand corner. And we'll be looking at the text on the right-hand side of the page.
Q Mr. Hume, before I get to a specific question with this document, would you agree that over the entire lifetime of a sockeye population, most mortality occurs in freshwater?
MR. HUME: Yes, I would.
Q And using this document, could you explain to us the freshwater mortality and in stages? I'm going to sort of break down the stages from egg to fry. What is the freshwater mortality between going from egg to fry?
MR. HUME: Around 8 percent overall for all salmonids. Sockeye, probably a little bit higher than that, around maybe 10 percent, 10 to 15 percent. Sorry. Survival, that is, not mortality.
Q Okay. And we're looking here and so, first of all, can you identify this document that we have in front of us?
MR. HUME: Yes, I can.
Q Okay. What is it?
MR. HUME: It's a comparative review of Pacific salmon survival rates by Dr. Bradford.
Q And he's a colleague of yours?
MR. HUME: Yes, he is.
MR. TIMBERG: If we could have this marked as the next exhibit?
THE REGISTRAR: Exhibit 809.

EXHIBIT 809: Comparative review of Pacific salmon survival rates

MR. TIMBERG: And going back to page 1330.
Q Then what you've just said about the rate of mortality, the 8 percent, then you're getting that in the end of the first column on the right-hand side there?
MR. HUME: Yeah, it's 8 percent survival; it's 92 percent mortality.
Q Okay. That's helpful. And then can you explain the freshwater mortality from the smolt stage to entering marine waters? What have I missed? Oh, we've done egg-to-fry. Sorry.
MR. HUME: We don't actually know what --
Q Sorry. I'm going to backtrack. I've missed a step here. We've done egg-to-fry and I'd like to now ask you from fry-to-smolt. And I understand that's at the bottom of the next paragraph.
MR. HUME: Actually, the next numbers that he provides there are total mortality from eggs to smolt?
Q Yeah.
MR. HUME: So that includes the egg-to-fry mortality as well. But it's 2 percent survival or 98 percent mortality on average occurs.
Q And that's for the sockeye salmon?
MR. HUME: That's for sockeye salmon, yes.
Q All right. And then my third question then is, what can you tell us about freshwater mortality from smolt to the marine waters?
MR. HUME: Well, we can't say a lot about that at the moment actually because until very recently there's been virtually no work done on mortality within the smolt migratory corridor. There's been one study done by Dr. Welch using acoustic tags and the POST system, which I believe mortality from -- that was large atypical smolts released from Cultus Lake. They were very large, about double the size, well, more than double the size of normal smolts. And they had a high mortality, I believe around 40 percent mortality by the time they left Cultus Lake until they passed receivers at the mouth of the Fraser River.
Q All right. And so what would you say then is the overall freshwater survival?
MR. HUME: Very low. Again, it's somewhere in the range of 2 percent.

Q All right. And what would be the percentage of survival in a year for a good return?
MR. HUME: Freshwater?
Q Yeah. I'm trying to ask for a range so if the average is 2 percent, I'm wondering if you could give us a range like a bad year and a good year.
MR. HUME: Well, a bad year would has certainly been observed in some years to be less than 1 percent. And up to maybe 7 percent survival.
Q And 7 percent for a good year?
MR. HUME: For a good year, yeah.
Q All right. And can you explain the role that predation plays in this low freshwater survival rate?
MR. HUME: Well, the causes of mortality in the freshwater is quite varied and not very well understood, to be quite honest, presumably. From the egg deposition to emerging fry, mortality certainly plays a role. Sculpins and other small fish and invertebrates such as dragonfly nymphs and things like that will be large causes of mortality. But also in that stage, just simple physical forces, excessive stream flows caused physical disruption of the eggs, just being dislodged from the gravel and floating downstream causes problems.

Other factors would be disease and parasites at various stages. The fry are very vulnerable to predation presumably when they first leave the gravel and are migrating down the stream and then they typically spend quite a bit of time along the shorelines before they get out into deeper water.

Q Okay.
MR. HUME: And they'd be quite vulnerable there as well.
Q So what information would be helpful to better understand then Fraser River sockeye in a freshwater environment?
MR. HUME: Well, a continuation of what we're doing, looking at longer-term datasets and other lake systems would be very useful. But I think our biggest area of lack of knowledge is what's happening the smolt migratory corridor. We don't even know what the mortality rate is or what causes mortality or whether there is points where mortality is higher than in other points along the system. So that would probably be my major

recommendation would be look at both the smolts and also look at the condition of the smolts as they leave the lakes for energy content, see their ability to withstand the rigours coming up.

Q Okay. Thank you. And can you describe whether your work takes into account ecosystems?

MR. HUME: Yes, it does. We certainly study both the physical and chemical environment that the fish live in. We do primary and secondary trophic-level studies as well. We've developed models looking at primary production as a predictor of care and capacity for sockeye-rearing lakes. Not to the same extent, but we've also done studies on top down control of sockeye salmon through predator work that we've done on both Cultus and Quesnel Lake.

Q Okay. And is your work incorporated into forecasting models at DFO?

MR. HUME: Yes, it is.

Q Okay. I think you answered this question this morning but just for clarification. I think you said that there's no evidence that mortality of Fraser River sockeye in freshwater is increasing. Is that --

MR. HUME: That's correct. Well, the lakes that we've studied. So we have fry data collected in the fall of the year for a number of years for Quesnel and Shuswap Lakes and as well as the long terms. That goes back to 1975. And we also have long-term smolt data from Chilko Lake, which goes back to 1948. And in all three of those cases, there's no indication that there's been any downward trend or upward trend, for that matter, in survival over that time period.

Q And what's the importance of the long-term data series? Why is it important to have long-term data?

MR. HUME: So we can answer the questions just like what you asked me.

Q All right. Thank you. Mr. McFarlane --

THE COMMISSIONER: Mr. Timberg, I wonder if I could just --

MR. TIMBERG: Certainly.

THE COMMISSIONER: -- for my understanding, if I could just go back a step through Mr. Hume. You've asked him about survival rates and he's talking about some of the elements that bear upon this and

he mentioned Cultus, for example. But just so I understand, are we talking about where the spawning is in the river or are we talking about where the spawning is in the lake? Are there differences between those two aspects of spawning history?

But more importantly, I'm not quite sure I fully understand what are the elements, how he's tying this together with, for example, he talked about the data that he's collected with regard to the rearing capacity of these lakes? How is this all tied together in terms of answering your question about survival rates? For example, he mentioned disease but he's mentioned parasites. He's mentioned some of the elements that make the fry vulnerable to predation.

I'm just trying to understand where food comes into this in terms of what's available for these fry in the lake system and how that bears upon their survival. So I'm just not sure I'm getting the picture here of all of the elements that bear upon the survival of the fry. I certainly understand some of the elements he's talked about but how do I tie together all of these elements?

So where the fish spawn, to me, is something that would be helpful to understand where he's making these and the relationship of the lake to survival and the relationship of these other elements to survival, be it parasites, disease, whatever. Are there different studies going on here or are you talking about one study, or is this different data that he's collected or is it a single set of data? I'm just not clear on this.

MR. TIMBERG: I'll do my best, Mr. Commissioner, to walk you through that. I've been given 60 minutes to do so much. It's difficult so we're rushing.

THE COMMISSIONER: I realize that. I'm just getting a bit lost here.

MR. TIMBERG: No, fair enough. I'm just noting the pressures we're all under to try to explain a lot in a short period of time.

Q Mr. Hume, what I'll ask you to do is walk us through. And you tell me if this is the appropriate approach to help unpack this. My thought is that you should first talk about the egg-to-fry stage in the river and the different

impacts that happen with respect to freshwater survival in the river, in the egg-to-fry stage. Then perhaps you could talk about the fry-to-smolt stage with the lakes and survival in freshwater lakes. And I think then the third stage is the smolt-to-ocean part, which you've said we don't really know very much about yet. So my thought is if you could unpack the first two stages, perhaps sort of the first year in the river, the egg-to-fry and then move on to the year in the lake?

MR. HUME: Perhaps I should first just say a little bit about what we do do and what we don't do.

Q Sure.

MR. HUME: Our work doesn't look that much at the causes of mortality for sockeye. We're looking mostly at the results of the various mortality factors that have been happening to the fry sockeye populations.

Q And when you say the results, why is that?

MR. HUME: So we do that by determining abundance. We know the number of spawners and we determine abundance at various life history stages. Sometimes we do summer surveys and as well as fall surveys so we can break that mortality down to various life history stages. We do very little work on actual factors that are causing the mortality to these fish at the time. Certainly, there's a difference in survival rates between -- well, I'll just stop there.

Q So perhaps I'll just ask you if you could focus then on the work that's being done and the information you have on the first stage between the egg and the fry stage in the rivers.

MR. HUME: Our larger freshwater research group has done some work on egg-to-emergent-fry, which we call the fish as they leave the gravel and migrate down to the lake. But I haven't personally been involved with that.

Q Okay. And are you able to comment on any of the factors that are at play that result in such a low survival rate at that stage?

MR. HUME: Well, from my Cultus Lake project, we've certainly seen the fry-to-smolt survive work that's not published yet but we're just developing the data now, is that by removing the pikeminnow from the lake or reducing the numbers of pikeminnow in the lake, we're increased the over-

winter survival of these fish by almost double. So on average, we were getting about 22 percent survival from fall fry to smolts going out of the lake in the following spring and now it's more than double; it's around 50 percent, 55 percent survival on average.

Q All right.

MR. HUME: So indicating that predation is certainly a major factor in mortality during at least that time period of their life history.

Q And are there other factors that you're aware of with respect to that life stage between egg and fry? And if not, is there someone that could inform us on that stage?

MR. HUME: It's an area of research that we haven't really looked into all that much, to be quite honest.

Q Okay. Moving then from the fry-to-smolt stage, can you describe for the assistance of the Commissioner, the work that you're doing with respect to the lake survival and your understanding of how the lake operates with respect to salmon productivity?

MR. HUME: Certainly. Survival in lakes tends to be density-dependent. What we do know is that survival is density-dependent in the lakes in most cases. The causes of the mortality, we haven't put a handle on. We know that predation must play a fairly large role given the fact, well, our Cultus experiment, but also sockeye fry are found in large amounts in certain fish species such as the trout, cutthroat and rainbow trout. Burbot are also found to contain large numbers of sockeye fry. Fry predation rates are lower but pikeminnow tend to be very abundant so they make up for low predation rates by large abundance.

MR. TIMBERG: Okay. And I'm just wondering if we could turn to Tab 45 of Canada's list of documents?

Q And I understand this document is some of the results of DFO's lake research program. Perhaps you could use this to explain these results for us?

MR. HUME: Well, this is the results of our fall fry acoustic estimates of the abundance of sockeye fry in Quesnel Lake. It's plotted against effective female spawners on the bottom axis.

Q That's the amount of female spawners. And on the

left is the fall fry. What does this tell us?
MR. HUME: Well, what it tells us is that at a certain density of abundance female spawners, the mortality rate increases to keep the fall fry abundance basically at a constant level. We've fitted a Ricker curve to this dataset and you can see at the far end that it's decreasing. The solid line is dropping down but in actual fact the measured abundance estimates that we received, the abundance of fall fry, we've measured and those really high densities has not decreased, as the model would predict, indicating that perhaps another model that doesn't decline at high densities would be more appropriate.
MR. TIMBERG: All right. And Mr. Commissioner, perhaps this is time for the lunchtime break. And I'll work with the witness to help fully explain this issue for you.
THE COMMISSIONER: Could you scroll down just a little bit? All right. Thanks very much.
MR. TIMBERG: Thank you.
THE REGISTRAR: The hearing is now adjourned till 2:00 p.m.

(PROCEEDINGS ADJOURNED FOR NOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: The hearing is now resumed.
MR. TIMBERG: And it's Tim Timberg for Canada, with my colleague, Geneva Grande-McNeill.

CROSS-EXAMINATION BY MR. TIMBERG, continuing:

Q Mr. Hume, I'd like to review the various factors affecting freshwater survival with you and then I'll turn to Mr. McFarlane to discuss marine freshwater survival.
Going back to a conversation before the lunch break, can you summarize the factors that affect freshwater -- perhaps first, before we talk about freshwater egg to emerging fry freshwater survival, where do fish spawn? Where do sockeye salmon spawn in the Fraser River system?
MR. HUME: In the Fraser River, most of them spawn upstream, tributaries upstream to their rearing lakes. A few of them spawn downstream from the rearing lakes, such as Chilko Lake. A few spawn

in the lake itself, in the gravel beds along the shoreline. In most cases, that's just a few. They'll be a combination of upstream spawners and lake spawners. But in Cultus Lake, they're entirely lake spawners.

Q So Cultus Lake is unique in that it's entirely lake spawners?

MR. HUME: Unique in the Fraser River system, yes.

Q Okay. All right. And so, then, with that knowledge about the locations, what are the factors that affect freshwater survival on eggs to emerging fry?

MR. HUME: Well, they're all affected by disease, parasites, predation, possibly lack of oxygen. In the rivers they have another extra factor that would include high flood events, which actually just move the gravels, dislodge the eggs and actually physically damage the eggs as well.

Both lakes and river spawners would be also affected by sedimentation.

Q All right. And then if we move on to -- if you could explain what are the factors that affect freshwater survival from emerging fry to smolts, and perhaps again, first you should talk about the location where emerging fry to smolts live.

MR. HUME: Well, depending on where the eggs were deposited, the fry that spawned in rivers will come out of the gravel and migrate either down to the lake or swim upstream to the lake depending on where they were born. Then, typically, they migrate along the shoreline as they disperse throughout the lake. As the season progresses, they'll migrate offshore and into deeper water --

Q Okay.

MR. HUME: -- and start undergoing vertical migration so they'll actually migrate down, deep water during the day, to avoid predation.

Q And you're talking about in the lakes?

MR. HUME: In the lake itself, once they've moved offshore. So this would be, say, a typical lake such as Shuswap, they'd come out of the gravel in around late April, May, migrate along the shoreline, start moving offshore in early June and through to the end of July. Then from end of July onwards, they would be out in deep water mostly.

Q All right. Do some emerging fry to smolts not move to the lakes but stay in the river?

MR. HUME: There is a river type of sockeye, yes, such as at the Harrison. It's the main example in the Fraser River.
Q And so that's a unique characteristic of the Harrison?
MR. HUME: It's not unique to sockeye in general, but it is -- I believe actually Widgeon Slough is also a river-type sockeye. They basically come out of the gravel and migrate downstream immediately to the ocean. Then they go a very short time period where they're -- well, the smolt, they spend a very short time in fresh water.
Q Right. And so can you then, for the assistance of the Commissioner, what are the factors that affect the freshwater survival in lakes and/or rivers of the emerging fry to smolt stage?
MR. HUME: Predation is obviously one factor. Food supply may be problem if the high densities or the lake is nutrient poor which may not actually directly kill them, it may make them more -- because they're slow-growing makes them more vulnerable to predation for a longer time period, and therefore may actually increase the mortality rate.

At the same time, they may also be more susceptible to disease. It's very hard to distinguish, to tell -- we do have very little information on diseases actually killing off fry because basically we can't observe that in the wild.
Q Okay. Just so I can get a list in my head, what you've said is that the factors that affect freshwater survival from merging fry to smolts are predation, nutrients in the lakes and disease. Are there any others or are those the three factors?
MR. HUME: Those would be -- well, parasites also. There's a parasitic copepod which can affect some stocks particularly.
Q Okay. And I'd like to sort of talk about lake productivity, then, with this nutrient point that you've raised. How do we understand lake productivity? How do we look at that?
MR. HUME: Well, lake productivity is driven mainly by the nutrients in the lake itself. So most Fraser River lakes are, relative to lakes in general, say, throughout North America, are quite

oligotrophic. It means that they have very low nutrient levels. This is fairly typical of sockeye-rearing lakes, though. But it's atypical of lakes in general.

Q Okay.

MR. HUME: But the level of nutrients that are available determines how much phytoplankton can grow, and that in turn controls the zooplankton which the sockeye feed upon.

Q That's their food at that stage?

MR. HUME: Yeah.

Q And is that what we call a "bottom-up process"?

MR. HUME: Yes, it is.

Q All right. And with that description of lake productivity, how does predation fit into this?

MR. HUME: Predation is a top-down process.

Q And what does that mean?

MR. HUME: It means the bottom-up process means the production of the fish are controlled by things coming from the lower trophic levels and nutrients. Top down means a higher trophic level such as predatory fish, piscivorous fish feeding on them, control the abundance of the sockeye, the fry in the lake.

MR. TIMBERG: Okay. And then if we could then return to Exhibit -- oh, we have Exhibit 45. Perhaps we could have this marked as the next exhibit. That was Tab 45, for the record.

THE REGISTRAR: Exhibit 810.

EXHIBIT 810: Examples of results produced by DFO's Lake Research Program

MR. TIMBERG:

Q So looking at Exhibit 810, can you just help us understand what the "x" and the "y" axes shows here?

MR. HUME: The "x" axis is effective female spawners. This is a graph of Quesnel Lake, Quesnel Lakes. The bottom axis is effective female spawners in millions of fish starting -- it goes up to two million fish on the right-hand side. The "y" axis, or left-hand axis is the number of fall fry estimated, abundance of fall fry done through our acoustic and bottom trawl surveys.

Q All right. And what does the red square show us?

MR. HUME: The red dot is the results of a model that

we built based on the primary productivity of the lake, and what the model does is estimates the carrying capacity, optimum escapement to the lake, and also the -- actually, what it really estimates is the maximum biomass of the lake in support, and then it uses some rough numbers to estimate the optimum escapement to the lake that would produce that biomass.

Then it's further using an average fry size. We can actually then use and turn that into estimating the total number of fall fry or smolts that would be produced by that optimum escapement.

Q And so in this instance, what does it tell us about Quesnel Lake?

MR. HUME: So from Quesnel Lake, what we're suggesting is we can produce -- the lake can support about 60 million smolts. It would take approximately 750,000 effective female spawners, 1.5 million spawners in total.

Q And where are you getting that from? Is that the start, or is that the --

MR. HUME: No, the 1.5 -- sorry, I just multiplied effective females by two. So total returns to the lake would be 1.5 million.

Q Okay.

MR. HUME: The graph shows 750 (sic) female spawners.

Q All right. And then if we could turn to the next page of this exhibit. If you could assist us to let us know what this graph shows us.

MR. HUME: We've applied our PR - we call it a PR model or photosynthetic rate model - we've applied this model to many of the Fraser River's sockeye rearing lakes. So the blue bars in this graph, so they're showing - when we're presenting the data in this case - is the number of spawners per hectare lake surface area so that we can compare all the graphs, the relative productivity of each lake to each other.

Q So you've done this for 18 sockeye lakes?

MR. HUME: Yes.

Q And should we be careful about the green bar? The green bar says "Maximum observed spawners". That's not an average. Could you explain --

MR. HUME: It's not an average, no. It's in the last 20 years. This is maximum observed spawner ever that we've seen for each one of these lakes.

Q All right. And so if the blue bar is tall, like

take for example Anderson Lake, and the green bar is low, what does that tell us?

MR. HUME: Anderson Lake is capable of spawner density of about approximately 100, 110 spawners per hectare, and so far we've only, in the last 20 years, observed about 40 spawners per hectare in that lake.

Q And that was the maximum observed?

MR. HUME: That's the maximum observed, yes.

Q Do we need to consider the fact that these salmon co-migrate when we look at this chart?

MR. HUME: It's one way of looking at relative productivity of various lakes, various sockeye conservation units. So, in this case, the Shuswap and Cultus Lake are an example of two stocks that migrate at the same time. Cultus Lake is obviously, in recent years, has not produced anything near its capability, whereas Shuswap has been over -- has at least one year which is well over its estimated carrying capacity.

Q So fisheries management, they have to balance those lakes out to ensure that they're -- that you ensure sufficient returns of each lake.

MR. HUME: This is one measure of that. Stock productivity is partly due to freshwater factors, but also marine survival and marine productivity would affect it as well. This is just one factor that goes into the whole mix.

Q Okay. Thank you. I'd like to then move onto the question of -- now moving from smolt to the marine water.

THE COMMISSIONER: Mr. Timberg, is this graph on the screen part of Exhibit 45 -- I'm sorry, Exhibit 810?

MR. TIMBERG: Yes, it's the second page.

THE COMMISSIONER: Thank you.

MR. TIMBERG:

Q Mr. Hume, then, earlier, before the lunch break, we were talking about smolts to marine and you talked about the need for further data on that information.

MR. TIMBERG: I'm wondering if we could turn, Mr. Registrar, to Exhibit 804. This is a document that Commission counsel entered this morning.

Q If we could turn to page 37. I understand that this graph shows on the left side, smolt-to-recruitment survival, so that's outgoing smolt.

And then their returns as adult fish --
MR. HUME: Yes.
Q -- on the left-hand side. Then on the bottom, it's the brood year, so that's the year that the eggs were laid.
MR. HUME: That's correct.
Q So what does this graph tell us about freshwater to marine survival from smolts to recruitment returns?
MR. HUME: It shows a number of things. One is it shows that the Cultus -- if you look at the "Cultus Wild" line, which is the solid black line, and compare that to the Chilko line, you can see that they're fairly well together, so it appears that maybe mortality factors that affect one are affecting both stocks at the same time.

Secondly it can show us that for Chilko, survival is being slowly decreasing over time, so it started off in 1999 at approximately eight percent survival, and it's decreased now down to 2005, which is the brood year in question for the inquiry, to well less than one percent survival.
Q Okay. Thank you, Mr. Hume.

I'd like to now turn to discussing marine survival rates, and Mr. McFarlane, can you describe the most vulnerable stage for salmon in the marine waters?
MR. McFARLANE: I believe the most vulnerable stage is immediately upon ocean entry, probably within the first four, maybe five weeks.
Q And so where would that be? That would be in Georgia Strait?
MR. McFARLANE: For these stocks, yes.
Q Okay. And why is that your opinion?
MR. McFARLANE: Well, I'm not a salmon biologist, but I think it's becoming generally accepted that this is the case. There's been a fair amount of recent work on what's called the critical time-critical period hypothesis which indicates you sort of have to make it or break it very early in your ocean career, not unlike us.
Q Okay. All right. And so what's your opinion on the causes of decline, then, of the Fraser River sockeye salmon in 2009?
MR. McFARLANE: From the evidence I've seen, I believe that the problems were with the Strait of Georgia system in early 2007, and it was related to a very

low productivity of the Strait, and by "productivity", I mean the same as Jeremy just explained for fresh water. It's the lower trophic level success of the feed.

Q Okay. So it's sort of a nutrient issue. What are the species in the Georgia Strait that are competing with sockeye salmon when they enter the marine waters?

MR. McFARLANE: Well, the dominant species that would be considered competitors would be herring, chum, pinks. Although in 2007, I believe that wasn't a major pink year. You would also have other species such as chinook and coho.

Q All right. Is that the only other species competing with sockeye salmon in the Georgia Strait?

MR. McFARLANE: Probably not. There are other species which -- their early life history stages would also eat much of the same types of food. That would include things like Pacific hake. There's two other small what you could consider forage fishes which have a fairly significant abundance we think, although there's been virtually no work done recently on them, are one called a Leurroglossus, one called a Myctophid or midshipmen, and they are in fair quantities in the mid-water. They're not right at the surface like these other species.

Q I think for the record, somebody's going to have to spell those words, or provide them in writing after your oral testimony, so we'll do it after your oral testimony. We'll get that in writing to help the record here.

MR. McFARLANE: Okay. I know how to spell them.

Q Well, we'll keep moving.

MR. McFARLANE: Okay.

Q And so going back, then, in the spring of 2007, what was your understanding of the ocean entry of the sockeye salmon in the Georgia Strait?

MR. McFARLANE: Well, again, this is from other people's work, but the data I've seen indicates that the overall abundance -- and this is based on trawl surveys in the Strait in around June and July. The overall abundance of these species was reduced. We're talking all of the species, not just sockeye. And the condition factor of these smolts, so that -- you could think of it as their

robustness, their fatness. It's a relationship between the length of the smolt and the weight of the smolt. It was the lowest on record for many of these species.

The same applies to herring. The juvenile herring were in extremely poor condition. This generally relates to ability to survive through the critical period of time. The predation might have an impact.

So the important thing is, I think, that you might want to take from this is that when you have fish in the poorest condition at this time, you'll see some immediate types of mortalities. But it's also indicative that there'll be mortalities following this time. It basically says they're going to be in a bad state. So they all don't die on the same day, they may continue to die over the next number of weeks, possibly even number of months because, like other animals, as they get sicker or don't respond to any other food sources, they can't make it.

Q Okay. And do you have a recommendation on how to better understand this early entry of sockeye salmon into the Georgia Strait?

MR. McFARLANE: Well, if you mean --

Q What more information would be of assistance to understand this?

MR. McFARLANE: If you wanted to design a program that looked directly at the relationship between sockeye smolts and some of these factors we've been talking about in terms of predation and competition and whether it's a bottom-up or top-down system, I would design the survey to go out there at the specific time, so this would be -- I would look at it in early spring to early summer, so let's say April to June or early July, and I would study all aspects of the system at that particular time.

That would include the physics of the system, wind patterns and nutrient patterns which would give you initial indication of productivity levels, study the lower trophic levels which is again the feed for these species, and then study the species themselves, the upper pelagic species which are the salmon species we mentioned, herring.

I'd also look at the other potential predator

species --
Q Mm-hmm.
MR. McFARLANE: -- which Villy and Andrew Trites had in their report, which would include things like hake, dogfish, pollock. But I'd also look at some of the other potential competitors which would include the other species I mentioned such as Leurroglossus and Myctophids.
Myctophids, now -- so you're directing or making a very directed ecosystem-type study to answer a very specific question. So you're not going out there -- it's not like what the ERI program is designed to look at, which is a much broader, broader approach.
Q Okay. Perhaps we could turn to Project number 8 and turn to the recommendations at page 83. I note that the report recommends further data on six species, of which four of them are not located in the Georgia Strait. The report only recommends further study on river lampreys and common murre. Would you care to comment on that, or would you add to that list just to --
MR. McFARLANE: I would add to it. This list is -- I mean, some of these potential predators occur in waters just north of Georgia Strait and on up towards Alaska. So if you're looking at it through its whole life history, I think you would want to examine those species, and others, in those other areas as well. So these would be in addition to what I said for the Strait of Georgia.
Q Okay, thank you. And you mentioned dogfish and pollock.
MR. McFARLANE: Yes.
Q Can you perhaps describe why we would look at pollock in the Georgia Strait?
MR. McFARLANE: It's a species that's present in the Strait. It tends to be in the southern part of the Strait and it is a fish eater, so that it is a potential predator, has been identified. I'm not suggesting it is a predator of any consequence as far as sockeye are concerned, but I think when you're looking at trying to answer the question you are, which is what happened to these sockeye once they entered ocean waters, you want to examine all the potential predators. So this is why I would conclude that, remembering that when they enter the water, there's a lot of mortalities

going on for a fair amount of time, so we're looking at -- I don't think anyone would disagree that salmon are being eaten by a number of species. That's just the way it is in this world.

The question is are these species having an impact on the dynamics of those salmon? My belief is that it is a bottom-up situation which is a productivity controlled area, but in order to actually ascertain that and in order to study that into the future, you want to look at both top-down and bottom-up. A program such as I just said would give you that ability.

Q Okay. Thank you. Before we move off of the recommendations, recommendation number 3 on page 83, it's the third paragraph, calls for a central database. Do you have any comments with respect to that recommendation?

MR. McFARLANE: My comment would be that, to begin with, and to get it off the ground, number one I agree on central databases. I think it would be a good thing. But I think the best way to go about this would be to have it as an actual metadatabase where you identify what data there is, the area of whatever data you have is taken, and the custodian of the -- the timeframes that are available, and the custodian of that data and the contact information for that custodian. I think that would give everyone access to what they need. It would let them know what's available, but it would also ensure that the proper explanations came along with the data, how it was taken, all those sorts of things, and probably, I would think, lead to collaborations. I've certainly done this type of thing with other datasets and I find it very useful.

Q All right. Thank you. Before we move off of the recommendations, did you have any other comments on the other four recommendations?

MR. McFARLANE: Well, I certainly agree with the next one as we just talked about, which is focus some of this salmon research work once the fish enter the sea, so no argument there.

Conceptual ecosystem model, sure. I mean, I do that myself. I actually worked with some of Villy's students on these types of things, and it's always beneficial.

Q So perhaps, just while we're on that point, could

you describe some of your work using ecosystem models? Is that something that's being utilized by DFO?
MR. McFARLANE: Ecosystem models are being utilized by DFO, yes. I've looked at -- I've participated in studies using ecopath with ecosim which is the model that is recommended here.
MR. TIMBERG: And perhaps we could turn then, Mr. Registrar, to Tab 20 of Canada's list of documents.
MR. McFARLANE: What's Tab 20?
MR. TIMBERG:
Q Who is Ian Perry and Diane Masson?
MR. McFARLANE: Dr. Perry and Dr. Masson are both co-chairs of the Strait of Georgia ecosystem studies initiative.
Q And could we turn to the abstract at page 3? And this abstract, perhaps you could just tell us what this document is first, just in general. I note it's a draft document. What's your understanding of what this CSAS document is intended to do?
MR. McFARLANE: Could you show me the title again, sorry, so I can tell you what it is? Framework for the -- oh, okay. This is the actual working paper for the Strait of Georgia ERI, building the framework for the ecosystem approach. This --
Q So perhaps we could turn to page 3 of the abstract. It might help. So this, as I understand it, this document is summarizing the ERI project that recently concluded; is that...?
MR. McFARLANE: This document would be -- yes, this would be basically -- because the ERI project isn't actually concluding for another -- or I guess it just concluded in the past month -- that this would have included all the information up to that point on the various programs that were going on at the time. I believe it also will provide a series of recommendations and that sort of thing in establishing and providing an actual framework for future work.
MR. TIMBERG: Okay. If this could be marked as the next exhibit, please.
THE REGISTRAR: Exhibit 811.

EXHIBIT 811: DFO document entitled, "A framework for an ecosystem-based approach to managing the Strait of Georgia" by Ian Perry and Diane Masson

MR. TIMBERG: And if we could then turn to Tab 19 of Canada's list of documents.
Q I understand this is like an Executive Summary of that document; is that correct?
MR. McFARLANE: Yeah, this is a Science Advisory Report which basically pulls what the subcommittee that reviewed the previous document would consider the major points that should go into a document for easy access for everyone, not just Science people.
Q Okay.
MR. McFARLANE: So it gets rid of a lot of the science and concentrates on the actual conclusions and recommendations.
MR. TIMBERG: And if we could then have this marked as the next exhibit.
THE REGISTRAR: Exhibit 812.

EXHIBIT 812: Executive Summary of Exhibit 811, Science Advisory Report

MR. TIMBERG:
Q If we could turn to page 8 of this document and I'd like you to comment on the knowledge gaps identified by DFO in the Executive Summary.
MR. McFARLANE: Okay. Yup, those are knowledge gaps.
Q All right. And if we could then turn to the next page to "Conclusions and Advice". So these are the -- maybe we'll just let the document speak for itself in the interest of time. I just note at the next page, at the bottom of the page, has recommendations. I'm not sure if you've had an opportunity to review the recommendations?
MR. McFARLANE: Yes, I have. I would say that in the previous part that you just skipped over, there's a timeline there that I think is very important.
Q Okay. If we could perhaps go to that, then.
MR. McFARLANE: It goes from short-term to mid-term to longer term research type approaches. I think it highlights a pretty reasonable approach to trying to determine what we can expect might happen in the Strait of Georgia over the next number of years. I do agree with some people who suggest

that this is -- that possibly DFO has not been putting enough effort -- and by "effort", I don't mean of individuals; I mean of money.

Q So this, then, is part of the Science's --

MR. McFARLANE: This is the Science operational plan, basically.

Q Plan to move forward in the next five years.

MR. McFARLANE: Yes, that's right. Yes.

Q Okay. Thank you.

MR. McFARLANE: Now the recommendations?

Q Yes, do you have any comments with respect to the recommendations?

MR. McFARLANE: Well, I do in terms of I think they're excellent recommendations. They seem to be in the order that follows the previous plan, the immediate, mid-term and longer term things that should be worked on, and I particularly agree with the recommendations 1 to 5, which is the synthesizing of the results right now. But basically to get into the selection and evaluation of indicators and monitoring programs, the operationalize (sic) of collection of data, which is always difficult to keep that sort of thing going, and the development and evaluation of the models developed under this initiative. That includes linking these models together from the physics right through to the higher trophic levels.

I think that will generally lead to the final approach which would be to bring together the appropriate people from all the different stakeholders, and people who are interested in the Strait, and you can then, from there, get their ideas for setting out the objectives for how you would actually build an ecosystem management approach.

This is basically an ecosystem assessment approach, not a management approach. So this is the science that goes into the management, but it does not incorporate the actual management objectives or how it would be implemented.

MR. TIMBERG: Okay. Thank you. If we could then turn to Tab 37 of Canada's list of documents.

Q This is a document, a PICES scientific report number 25.

MR. McFARLANE: Yes.

Q And it's an international program on climate

change and carrying capacity. Were you a co-author of this work?
MR. McFARLANE: Yes, I was.
MR. TIMBERG: And if this could be marked as the next exhibit.
THE REGISTRAR: Exhibit 813.

EXHIBIT 813: PICES Scientific Report No. 25

MR. TIMBERG:
Q If we could turn to page 1, there's an introduction here. For the assistance of the Commissioner, can you -- first of all, can you perhaps describe the larger work of which this paper, I understand, was part of. The larger work?
MR. McFARLANE: This is, basically, it was conducted by a task team under the auspices of PICES. The task team was called the Basin Studies, "Basin Scale Studies" task team or BASS. It looks at the two North Pacific gyres, the eastern gyre and the western gyre. Now, those fall within, you can see, ESA and WSA on the map.
Q And this is work that's international; is that correct?
MR. McFARLANE: Yes, it is. It's joint work between the six PICES nations.
Q Okay. We can look those up. So just before we get into the details of this, just --
MR. McFARLANE: Yes.
Q So how do those six nations work together on doing research?
MR. McFARLANE: The six nations get together and discuss research, formulate plans on where the most benefit might derive from, from doing certain types of projects together. It doesn't really support research itself. The individual countries still continue to do their own research. This is more of a guiding group that allows people to get together to develop their thoughts and to actually develop some joint programs for information exchange and that type of thing.
Q All right. And so I'm just cognizant of time, but if you just give a quick overview of the intent of the project and then we're going to jump to the conclusions.
MR. McFARLANE: Okay. The project was set up because

it was recognized by the six nations of PICES that a lot of things were going on in the two gyres, the eastern gyre and the western gyre. So why don't I just skip to the eastern gyre right now because you can use all the same stuff for the western.

It's very productive areas in the open ocean. It's a tremendously important rearing ground, or whatever type of ground you want to call it, for salmon. And it seems to respond to the same decadal scale type shifts or regime shifts that the coastal areas respond to. The people sitting on the BASS task team felt that it would be very useful to bring together as much information as we could on those gyres to build some conceptual models and then to take it one step further and try and build an ecopath with ecosim, ecotrophic model of the gyres with the hope that we would begin to understand how these gyres might influence coast systems because they're almost certainly linked.

Q All right.

MR. McFARLANE: That was the intent.

Q Okay. If we could then turn to page 37 of the document, and if we could look at that. What was the conclusion as it relates to predation, and specifically with salmon, in this report.

MR. McFARLANE: Well, the conclusions were fairly similar to the conclusions in Technical Report number 8 here, in that the -- there's a lot of information that is required still to ensure we have an understanding of the system, that there should be some directed studies on specific aspects of species that were out of the modelling exercise that appeared to be possibly of quite a bit of importance, and that the improvements to the models require that type of information, both diet information and abundance information.

Q All right. And I note there in the first paragraph, it says we need better data on biomass trends for as many species as possible, especially competitors and predators of salmon such as flying squid, pomfret and sharks.

MR. McFARLANE: Right.

Q Okay. And then over the page, it references a table at Table B-4 which is at page 56. This is where they recommend additional species that need

more data. Perhaps you can just briefly tell us what this table tells us.

MR. McFARLANE: This is simply the groups of species or the species or groups of species that were used in the model. It is the table indicating the data quality as we determined it to be using the data pedigree model which is basically assigning a number to it that says we either think the data is very good or very poor.

In this case, the colours represent how we felt about that data ranging from very poor, which is red, and excellent, which is green.

MR. TIMBERG: Thank you. In the interest of time, those are all my questions.

MR. WALLACE: B.C. was on the list but has no questions. Mr. Leadem, thank you.

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

CROSS-EXAMINATION BY MR. LEADEM:

Q In the limited time that I have available to me, I wanted to focus upon ecosystem-based management and talk about how that can be achieved. I realize that we're supposed to be talking about predation, but we seem to be talking more at generalities when we're talking about ecosystem-based management. So I want to focus on that because I found the discussion in Project 8, particularly at pages 77, 78 and 79 to be very informative.

And so, Dr. Christensen, I'm probably going to start with you and then get some other comments from the other scientists on the panel. I think it's important for us to understand the "why". Why should management be focused upon the ecosystem and not just simply managing the sockeye from a sustainable aspect?

DR. CHRISTENSEN: Well, first of all, thank you for the question. I was wondering whether I would get any.

Management should also focus on sustainability aspect of it, that's clear. That is where we have our traditions for -- that's where we have tradition for emphasizing. But it's also quite clear that that cannot answer what has happened to Fraser River sockeye over the last

decade or two decades. All indications are that marine survival has been declining. That's what we've heard here. We are in want of good explanations for that.

That, by itself, is a good reason for looking at what happens at the ecosystem level. So it's really to try to understand that and also to see what management actions might be taken. To me, that's important reasons.

Q And I suppose the question comes down to this: Do we know enough about the ecosystem to allow management decisions to be based upon our knowledge of ecosystems? Are we still in the learning phase about the ecosystems or do we know sufficient amount so as to enable managers to start to incorporate ecosystem knowledge and values into the decision-making processes.

DR. CHRISTENSEN: Well, if you look at how this has progressed in Canada, it certainly looks like we don't know enough. I compare to other countries and I see Canada not being a leader, to be very diplomatic. Rather, Canada has provided intention that is going to take that direction, but not follow suit as far as I can see.

We need to try. We need to start. We need to start doing it. We need to start making the analysis at the ecosystem level. Certainly a lot of work has been done on this. By doing this, we become better at it. We ask the right questions, we find out what kind of research is needed, what kind of data is needed. We can't just wait until it's perfect. That means it will never happen.

Q Right. I'm looking at your report at page 79, Dr. Christensen, and the next to the last paragraph that begins [as read]:

> Overall Canada has not moved very far towards ecosystem-based management.

And then you go and draw some comparisons between U.S. and Canada, and then you further then go on to say, at the very end of that paragraph:

> Australia is possibly leading on implementation of ecosystem-based management and has done so by initially "letting the policies move ahead of the science".

I really find that interesting and I'm going to see if I can get some understanding of what you mean, or what Mr. Smith meant when he communicated those words to you of letting the policies move ahead of the science.

And let me tell you why. Because in my mind - and maybe I have this all wrong - we have the Wild Salmon Policy which says that there will be ecosystem indicators, Strategy 3 of the Wild Salmon Policy deals specifically with ecosystem values and indicators, and so it seems like we have the words and the policy but we don't seem to be moving ahead.

Okay. So with that background, maybe you can explain how you let the policies move ahead of the science.

DR. CHRISTENSEN: What happened in Australia was that a senior colleague, a scientist called Keith Sainsbury, was quite influential in impacting the policy there. He talked to people, he explained what is involved in what he'll call integrate management (sic), so multi-sectoral management of the oceans. The politicians listened to him and they basically made policies that implemented this.

Then the scientists were really forced to move very, very quickly. They had to adopt quick approaches for guiding the actual implementation. They asked much better questions after this happened. They had to take a number of shortcuts and they burnt their fingers a few times, but the outcome was quite clear that they are now a leader in this field. I'm sorry...?

Q But if I can draw back, now, to a discussion about Canada and the Wild Salmon Policy because -- you're familiar with the Wild Salmon Policy, are you not, Dr. Christensen?

DR. CHRISTENSEN: Not in details, but I have looked through it and I have an idea about what it covers, but I --

Q Right. And you're aware that it sets out mechanisms for determining benchmarks and conservation units in order to preserve biodiversity of the salmonid species, and then goes further and talks about habitat and how you need to have habitat factored into the Wild Salmon Policy.

It goes a step further to Strategy 3 which talks about the need to incorporate ecosystem values, so you're not just looking at the salmonid species, but you're looking at them in the context of the entire ecosystem.

All right. So if you can accept that that's a very brief synopsis of the Wild Salmon Policy, and we have that in place in Canada, how do you see us falling flat because, you know, we seem to have a policy in place, and yet at the same time we don't seem to be making much progress on it.

DR. CHRISTENSEN: Ecosystem-based management is not a question of measuring the temperature and adding an indicator and saying we are considering the ecosystem. It's much more a question of how do you deal with trade-offs? These trade-offs involved interest groups with some going beyond what we normally look at. It's not just a question of the traditional way of making management.

Trade-offs involve that you have to make choices. You need to make clear objectives for the management. You need to consider how you evaluate different stakeholder groups, different interest groups, that there would be conflicting outcome of this. It has to be much wider, and these things have to be explicitly considered. The interest groups have to be clearly involved in the definition of how you do this -- how you set the objectives, how you deal with trade-offs. That needs to go in, and that's hardly scratched. As I read the Wild Salmon Policy, the surface is hardly scratched.

Q Okay. I'm going to allow the other panel members to comment on any of the discussion so far. Mr. McFarlane, do you want to add anything about how do we move forward in terms of developing ecosystem-based management for the salmonid species, particularly Fraser River sockeye in Canada.

MR. McFARLANE: Well, in terms of ecosystem-based management, I would have comments. In terms of how we do it in relation to Fraser River salmon, I probably would bow to people who actually study those types of things, although I did outline how I would look at it from a science perspective.

Q Yes.

MR. McFARLANE: I agree with what Dr. Christensen just said in terms of ecosystem assessment versus ecosystem management. They are basically two different disciplines. Ecosystem assessment is the science part of trying to understand how the ecosystem works, the functional aspects of it, whereas ecosystem management is the -- how you protect the resilience of that ecosystem given the various demands made on that ecosystem by various groups.

So, as he said, the trade-offs are really the bread and butter of how you manage the ecosystem, and it requires the -- you know, people really wanting to work together to do that. So you have to have the right people in the room. They have to really be serious about trying to come to a consensus on what trade-offs are reasonable in order for everyone to benefit, as well as for the Strait of Georgia to maintain its resilience.

So we're not there yet. We're not even close to ecosystem management. Fisheries -- you know, ecosystem fisheries management, we're progressing on a little bit, but ecosystem management, we're very far away from that.

Q Are we somewhere along the track towards developing knowledge of ecosystem assessment?

MR. McFARLANE: Yes.

Q You make the point of bifurcating ecosystem assessment and ecosystem management.

MR. McFARLANE: Yes, I do.

Q Surely we're somewhere along the line or the track of determining what the ecosystem is like, even though it may be very complex. We can do energy analyses, we can do water fluxes, we can do all kinds of things that are crucial to our understanding of the trophic levels in ecosystems, so somewhere we're along that pathway.

MR. McFARLANE: Yes.

Q So have we advanced sufficiently to enable managers to then take the next step and to start to incorporate that knowledge into developing these trade-offs as you call it?

MR. McFARLANE: In my opinion, yes, we're progressing nicely along that line. Again, if you're thinking managers as fisheries managers, that's only one component. There's many other components to land use and --

Q Right.
MR. McFARLANE: -- those types of things that have to be incorporated into those decisions.
Setting up a marine protected area, or a marine park or terrestrial park on the shores of any of these systems requires a whole different group of people to come in and start being part of the whole dynamic.
Q So doesn't it come down to this, is that the problem is that we're really isolating Fraser River sockeye and we're saying, well, if we're just simply going to focus on Fraser River sockeye, we'll manage it in this way, but you're telling me that you can't just take the fish out of the water, because if you do that, you know, you take the fish out of the water, it's going to wriggle around for a while but then you're going to lose whatever value the fish might have. So you really need to put it all together. Is that what you're saying?
MR. McFARLANE: I don't remember that, actually. Sorry, I'm maybe -- the fish out of the water part is where you started to lose me.
Q Okay. Well, forget my analogy then.
MR. McFARLANE: Okay.
Q Just drop my analogy.
MR. McFARLANE: All right.
Q It was probably a weak analogy to begin with. I was just trying to strive for just some way to describe the fact that if we simply focus upon the Fraser River sockeye as a single aspect, we're going to be missing a great component and that's all the ecosystem-based values that you know about.
MR. McFARLANE: Yes, in terms of if you're going to use just the Fraser River sockeye as your basis for managing all of the Strait of Georgia. That, I don't think, would be anyone's intent.
But if you're looking at answering very specific questions, you can design programs incorporating the ecosystem assessment and eventually the ecosystem management approach to answer very specific questions, but there would also be a total approach for the Strait of Georgia.
People have talked about the spatial components of these things, setting up marine

reserves and things. Where do you place log booms? Where do you place aquaculture sites? Those are all components of ecosystem management, but they have to be based on some knowledge of those areas. In this particular case, we've been talking about the Strait of Georgia and the Fraser River sockeye, so you would try and use that information -- develop information bases for those things.

For other questions, which are also part of the ecosystem approach to managing the Strait of Georgia, you would require information on those types of things also, absolutely.

Q Mm-hmm. Dr. Christensen, do you have any other comments? I know I'm running late on time. Dr. Christensen, just one last comment from you.

You've heard the discussion around ecosystem assessment, ecosystem-based management. Where are we along that paradigm in your view? Are we very far advanced?

DR. CHRISTENSEN: In Canada in general, or with regard to Fraser River sockeye or both?

Q With regards to Fraser River sockeye, because that's the question in the room.

DR. CHRISTENSEN: May I step back and just make an observation? Based on the experience I've got from this work that I'm engaged in here, I started out here -- I was definitely not a salmon expert. I know how to work with food webs, that's where my experience is, how to evaluate numbers. So I basically had to review what's known about Fraser River sockeye all the way from spawning till they come back again, the whole process. In doing so, I came across a quote from David Starr Jordan who was the first president of Stanford University more than 100 years ago. He was also an eminent scientist and he was quoted for saying that to evaluate the knowledge about sockeye Fraser (sic), the sockeye leaves the fresh water and they go ten miles offshore and they stay there for two years until they come back again.

This was pointed out during this process here as illustrating how far we have moved in 100 years with regards to knowledge about sockeye salmon in general. However, when going through the material that's available, looking for data about numbers, predation, what we know about that whole life

cycle, I really got to question whether we have moved very far beyond what David Starr Jordan described more than 100 years ago.

The questions we heard from the counsel for Canada all dealt with fresh water and coastal zone, but the two years they spend offshore were not even touched upon apart from the study, the BASS study which, however, didn't produce numbers that were useful in this context here; that was not the focus.

So if we are going towards ecosystem-based management with regards to understanding the ecosystem of which the Fraser River sockeye salmon are an important part, we need to look at the whole life cycle, including the ocean phase. We need to know much more about what's happening there, and we need to also make it very clear what it is we know about that. I would say we have not moved very far.

Normally, I make models which are quantified with data. I tried to do that here as well, but there were just too many unknowns, too many unknowns for me to want to stand here today and defend those numbers. That's why I didn't do it. I tried. So I don't think we have moved that far in this 100 years.

MR. LEADEM: Thank you. I could carry on all afternoon in this kind of discussion, Mr. Commissioner, but unfortunately my time is limited so I will have to leave the podium.

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

MR. WALLACE: Thank you, Mr. Leadem. Would this be a convenient time to take the afternoon break?

THE COMMISSIONER: Yes, please.

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

(PROCEEDINGS ADJOURNED FOR AFTERNOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: Order. The hearing is now resumed.

MR. HARVEY: Yes, Mr. Commissioner, I think I'm up next. It's Chris Harvey, for the Area G Trollers and the United Fishermen Allied Workers Union.

CROSS-EXAMINATION BY MR. HARVEY:

Q Gentlemen, I'd like to start at page 79 of the report, technical report number 8, because the authors there, and Dr. Christensen, you're one of the joint authors, say, firstly, about halfway down, at the end of a paragraph:

> Concepts such as predation, prey, or food webs are not even mentioned.

These are comments made about the Wild Salmon Policy. Then the next paragraph, it's stated there:

> There are no indications from the PSC website and publications...that ecosystem-based management or food web considerations are factored into the advice they give.

Then on the bottom of the page, you say:

> The focus of fisheries management on short-term tactical advice and setting annual quotas, while ignoring the longer-term strategic decisions that are fundamental for implementation of ecosystem based management, appears to be a global problem that has not capitalized on the progress made in developing the science needed to support ecosystem based management... Notably, ecosystem-based management calls for evaluating trade-offs, which may be severe, and which in turn have socio-economic consequences. Such trade-offs are seemingly ignored in the Wild Salmon Policy.

Dr. Christensen, you and Dr. Trites make some very significant points here, and I don't want to deal with the absence of a socioeconomic analysis discussion, because we've canvassed that with other panels, but what I did find most interesting and what confirmed an impression I had from other panels, was your conclusion that ecosystem-based management or food web considerations are not being factored into fisheries decision-making, and I take it that you've come to the conclusion that

DFO in its fishery management decisions is failing to properly take into account the broader ecosystem effects of their decisions on -- such as effects on predation, prey and food webs. Does that basically capture the gist of your comment?

DR. CHRISTENSEN: Well, as an academic, sometimes you can get carried away with what you're writing and not be 100 percent fair. But I think overall, as you expressed, it captures what it was we intended, yes.

Q Yes. And you've mentioned a lack of data, but I wonder if it's not just a lack of data, but in some areas there, there may be good data, but the ecosystem data tends not to be factored into the decision-making process.

DR. CHRISTENSEN: Typically, the decision-making process calls for information about the species that is being managed locally in that area, with that management, based on not factoring in other parts of the ecosystem, and the consequences that the actions may have on other parts of the ecosystem. In general, yes, that is the status in Canada.

Q Yes. And I'm wondering if that's a structural problem within DFO in the sense that there's no scientist in chief, as it were, drawing together all the different scientific data as it exists and collating it?

DR. CHRISTENSEN: There are activities within DFO that assembles that information, but it is minor activities and it's not within, you know, the core of what's happening there. In principle, DFO has embraced ecosystem-based management through its implemented management, but from what I can read and hear about this, it's only in principle. The actual implementation seems to be wanting or lacking far behind. It's not moving very fast.

Q Yes.

DR. CHRISTENSEN: We heard that also, even on the -- from a previous question here on this panel, from what's up there, now, on the screen with how the PICES 2010 report on components of integrated multi-sector ecosystem-based management where Canada only scores on its policy for the SARA acts, and I may note, by the way, that this conclusion is written, actually, by DFO scientists, the contribution to the PICES report,

it's not just an academic exercise.
Q The gentleman in Australia who you mentioned who got the system going there to a pretty high level, was he a scientist?
DR. CHRISTENSEN: The person who suggested this was a very senior scientist. He had actually just been awarded the Japan prize, a very prestigious prize, but he was talking about policies and impacting policies. So he was suggesting it, but it was the politicians who moved on it and who actually made it law, even though science was not ready.
Q Yes. All right. Now, the general comment of yours is that -- as set out on page 79 that we've been discussing, is meant to apply as much to freshwater ecosystems, I think, as marine ecosystems; is that right?
DR. CHRISTENSEN: Yes, though I must admit I know less about freshwater ecosystems than I do about marine.
Q I see.
DR. CHRISTENSEN: But I have seen nothing that indicates that freshwater ecosystem management in Canada has moved any further than the marine has.
Q Yes.
DR. CHRISTENSEN: And actually, it probably have moved less --
Q Yes.
DR. CHRISTENSEN: -- with regards to ecosystem-based management.
Q Do you think it's possible that this problem that you've identified may have something to do with DFO's inability to reverse the long-term decline of Fraser River sockeye?
DR. CHRISTENSEN: I certainly don't think that that is what's driving DFO, but I do not consider DFO to be very proactive, I should say, on moving on these aspects. It is a big bureaucracy and there's a lot of inertia in such a big system.
Q Yes. All right.
DR. CHRISTENSEN: And I do not -- I cannot blame them for what happens to Fraser River sockeye, but I can say that we know surprisingly little about why there has been 10, 15, 20 years declining in Fraser River sockeye.
Q Yes. And you would expect, with all of the scientific knowledge available, that there would be a better understanding of the reasons for the

decline; is that consistent with your views?
DR. CHRISTENSEN: When I accepted to write the report and was looking forward to this big task of summarizing what is known about salmon, I certainly realized that -- I certainly knew that a very large part of the DFO body is spent on salmon research, and so I had certainly expected that there would be more information about the environment in which they live, and by "environment" I'm not just talking about freshwater habitat.
Q Yes. Freshwater and ocean environment?
DR. CHRISTENSEN: And not just habitat, but also the ecosystems --
Q Yes, yes, right.
DR. CHRISTENSEN: -- in general, but the important parts I found very little information about who are they together and what is the importance of this.
Q Yes. At page 76 of your report you discuss the role of predation in dominance cycles - that's the four-year cycle that we're familiar with - and you say that in spite of considerable work - this is the second paragraph - in spite of considerable work that has been done by the previous fisheries commission, there's -- no clear answer is evident as to the causes of the dominant cycle. I wonder if, by clear answer, you mean proven beyond any doubt, or proven beyond reasonable doubt? I'm using terms that lawyers are familiar with perhaps more than scientists.

Because if you looked at the question on a balance of probabilities, you could say what probably caused -- or science could say what probably causes the dominant cycle, could it not?
DR. CHRISTENSEN: No, I cannot -- I'm not an expert in this area and I should not answer it.
Q Yes, all right. But you would expect the answer to be found in the ecosystem interactions involving the food web, predators, diseases, parasites, and that sort of thing, would you not?
DR. CHRISTENSEN: As an ecologist, I'm fascinated with the lifecycle of sockeye, how they seem to move, how they do move through many different habitats and how they minimize the risks faced throughout the whole lifecycle. It's something that seems to be -- it's an incredibly fascinating aspect we

have here. They spawn in nutrient-poor areas, they grow up in lakes where there are probably about as little nutrients, few predators, they move through the whole ocean, following production, only showing up in big numbers every four years, so they can really confuse predators. It's an amazing strategy.

Q Yes.

DR. CHRISTENSEN: So I'm fascinated by this. But now I've talked myself completely out of answering your question, sorry.

Q Well, no, that's helpful. The dominance cycle is one of the fascinating things about sockeye, isn't it; one very large year, then a subdominant year?

DR. CHRISTENSEN: Sure.

Q And obviously that results from something in the freshwater system, because it's a different cycle for different stocks, correct? If it were caused by something in the ocean environment, it would be the same throughout for all different stocks; you'd accept that, I expect; is that correct?

DR. CHRISTENSEN: Yes, I will, and I also -- the samples I've seen of where attempts have been made to break those cycles have not been very promising.

Q Yes.

DR. CHRISTENSEN: More disastrous than promising.

Q Yes.

DR. CHRISTENSEN: But, really, this is an area where I'm not an expert.

Q All right. But you would expect that an understanding of the ecosystem interactions that cause cyclic dominance to be quite essential to sound fishery management decisions?

DR. CHRISTENSEN: Yeah, in the terminology we're using here, I would consider this a prime suspect, that it has to do with predation as well, yes.

Q All right. This Commission is mandated to make findings of fact regarding the causes of the decline of the Fraser River sockeye, and I wonder if you consider it to be possible that the cause, or at least one of the causes or factors for the decline may be found in the ecosystem interactions taking place in the freshwater stage of the sockeye?

DR. CHRISTENSEN: I have seen no clear indications that it should be in the freshwater stage. What I have

heard is it's likely to be a question of reduced marine survival.

Q All right.

DR. CHRISTENSEN: Though it should always be clear, as pointed out in the panel this morning, that we know very little of what happens from the period they leave the rearing lakes until they come back again.

Q Yes.

DR. CHRISTENSEN: So it could also be the outward migration, the early life stage in the ocean, that is the critical aspect.

Q But Dr. Christensen, we know a great deal more about what happens in the freshwater system than in the ocean, and yet we can't explain the causes of cyclic dominance.

DR. CHRISTENSEN: To me it looks like research has been focused under the street light, really, where it's easy to do the research. By that I mean in freshwater and focused on habitats --

Q Yes.

DR. CHRISTENSEN: -- and not in the ocean. So yes, you're right.

Q But your inference that the cause is in the ocean seems to be somewhat at odds with your -- with what we have -- somewhat at odds with our inability to understand what causes cyclic dominance, and that obviously takes place in the freshwater.

DR. CHRISTENSEN: That is a good point, yes.

Q At page 73 of your report - there's a graph, Mr. Lunn - of the increased spawner abundance in the last two decades, quite a dramatic increase. This is, of course, in the freshwater system. And at the bottom of that graph, figure 36, you pose a question - "you" I'm talking about you and your join author:

> Number of effective spawners of Fraser River sockeye salmon. The number of spawners has increased in recent decades. Has this lead to more, but smaller smolts in poor feeding condition that will be more susceptible to predation.

And I don't think you answer that question; is that right?

DR. CHRISTENSEN: No, we do not answer that. It is well-known that smaller smolt will have a higher mortality rate, so we can expect -- and we've seen that from in Richmond experiments in freshwater, that there is a correlation between the size and the survival rates.

Q Yes.

DR. CHRISTENSEN: We've also heard, including this morning from Dr. McFarlane, that indications are that productivity has been decreasing in Strait of Georgia -- actually, also in the Queen Charlotte Sound, I know. So the '90s have been a poor period out there as well.

So I can certainly easily imagine that we have a combination of effects here which could include smaller smolt, because there are more, and also poor ocean conditions.

Q And the smaller smolts, because there are more, as you say, would necessarily involve smolts that are less capable of withstanding poorer ocean conditions?

DR. CHRISTENSEN: The mortality rate for smaller smolts can be expected to be higher.

Q Yes.

DR. CHRISTENSEN: We do have to see that in the context that there are always more of them.

Q Yes.

DR. CHRISTENSEN: So that is a balance there.

Q All right. You say that --

DR. CHRISTENSEN: For which we need calculations.

Q Yes. On the next page, 74, there's an interesting paragraph under that graph. You say:

> Related to this is that the Fraser River sockeye may have become the unwitting victims of their own success. As shown in Figure 36, the numbers of effective spawners of Fraser River sockeye salmon have increased in recent decades, which in turn may have increased intraspecific competition and exposed smolts to higher rates of mortality. Previous studies have shown that increased sockeye fry abundance leads to lower average weight of smolts, and that the total biomass of a smolt year class may decrease with increasing number of spawners... The implication of this is that increased escapement may lead to

higher predation mortality in the ocean where there is a strong positive correlation between size and survival...

So this phenomenon of increased escapement may lead to smaller smolts with less energy reserves, and also smolts of a size that are more susceptible to marine predation; is that right?

DR. CHRISTENSEN: Yes, see how you see the academic getting carried away in writing. I did write this. This is suddenly an interesting hypothesis that's formulated here. It's one for which I can put the forwards but I do not have clearer evidence that says that this is the smoking gun or something that looks like this.

Q Yes. All right.

DR. CHRISTENSEN: But I certainly would not rule out what's here. I think it's an interesting thing for consideration.

Q Yes. Now, I asked some written questions. I think probably it's Mr. Hume who will have the answer to this. I asked some written -- questions in writing to Mr. Ryall. I don't think we've put them in as an exhibit yet, but one of those questions I asked [as read]:

Do you, or does DFO generally accept that in Quesnel Lake fall fry collected in the fall of 2002 and 2003 were among the smallest ever recorded, 2.7 grams and 1.9 grams, respectively, from Quesnel Lake, as noted in Exhibit 417, page 28.

And the answer I got from Dr. Ryall was that [as read]:

This question is best addressed by DFO stock assessment staff and PSC biological staff.

I think I would like to take the opportunity of having Mr. Hume on this panel, to ask whether he can confirm that data.

MR. HUME: The 2002 brood year of smolts were the smallest -- or fall fry were the smallest we've ever observed. 2001 brood year, fry were small, but were not outside the expected range for that density.

Q All right. Well, we'll take the 2002 brood year, then, fry. Is the size that you determined an indication of ecosystem interactions?
MR. HUME: Sorry, I don't understand the question.
Q Well, is the fact that the fry are smaller, it seems obvious to me, but you can correct me if I'm wrong, the fry were smaller because the food web was depleted by the extremely large number of sockeye fry; would that be a fair inference to draw?
MR. HUME: In 2001 and 2002 we had the highest escapement to Quesnel Lake that had ever been observed, and we did not do any limnological sampling in 2001, but we did in 2002. Nutrient levels that increased in the lake in 2002, as fully expected from fertilization from the carcasses, but we -- but the phytoplankton that was produced by that nutrient was unusual in that it produced a large bloom of phytoplankton, called tabellaria, it's a diatom called tabellaria, which was a colonial diatom, and the evidence is a little unclear, but it's unlikely to be a preferred prey item for daphnia so that much of the nutrients produced by the carcasses were diverted into a trophic trap, I guess you could call it, where the food -- the nutrients didn't work their way up the food chain to the sockeye fry. So we're speculating that the fry grew poorly that year because of the high -- because of this tabellaria that -- there was an extremely large amount of tabellaria that was in the lake and, I think, unprecedented from anything we've ever seen before.
Q All right. There's a graph in the material I produced, at Tab 11, that I think comes from your data collection work. This was sent to me by Dr. Walters, Carl Walters, and I think he said that it came from your analysis. Can you confirm that?
MR. WALLACE: Have the witnesses seen this document?
MR. HARVEY: Yes. Yes, he has.
MR. HUME: I have seen this.
MR. HARVEY: It's Tab 11 in my production.
MR. HUME: Dr. Walters presented this at a small meeting we had about four years ago. I really haven't had a chance to discuss it with him, at that time, even, or since. I do recognize the data.

Q Yes. You recognize the data, and I think you were involved in the collection of that data, were you not?
MR. HUME: Yes.
Q Okay.
MR. HUME: My program was -- collected most of the daphnia and that.
Q Yes. What this seems to show, it's got, if we look right to the bottom of the page, the day of the year, starting at zero through to 360. So this is a time sequence. And if we look at the top graph, of course, the fall fry time would be towards the right-hand side of the graph; is that right? When we talk about fall fry, do we mean --
MR. HUME: No. This is the graph of daphnia biomass.
Q Oh, daphnia biomass. So this is the food web, one of the --
MR. HUME: This is the primary food item that sockeye fry feed upon.
Q Daphnia, is that a kind of a fly?
MR. HUME: Sorry?
Q Is a daphnia --
MR. HUME: Daphnia is -- it's commonly called a water flea, but it's a cladoceran zooplankter, which doesn't look at all like a flea.
Q All right. So I won't try to tie it on my gear.
MR. HUME: I could draw you a picture, but...
Q I'm always looking for fishing advice. And then you write, this is one of the principle food sources of sockeye fry?
MR. HUME: It's their favourite food, and if it's present they'll feed on it --
Q Yes.
MR. HUME: -- in exclusion of others.
Q If these lines in the graph are right, they seem to show the daphnia are in the top graph, at any rate, which is the dominant year run, shows the daphnia dropping off quite dramatically in the fall?
MR. HUME: Yeah, well, I mean, without really understanding the origin of everything in this graph, the big, brown points that extend from one edge of the graph to the other, I believe are probably a model that Dr. Walters put together to mimic what's going on in the graph. I don't know of -- I'm not even sure that they're the same line in each graph.

Q Well, let me just ask you the question. Did your research determine that the daphnia biomass dropped off in the fall in the dominant run years when there was a lot of fry on the --
MR. HUME: Yes, that's true. It drops off quicker in the fall.
Q Yeah. That's sometimes called "overgrazing", I think, the overgrazing effect; is that right?
MR. HUME: It's certainly a grazing effect.
Q Yeah. And does it mean that the fry going into the winter have depleted energy reserves?
MR. HUME: Not necessarily. There is still -- I mean, there's still -- it looks like there was a considerable amount of daphnia present in the lake at that time, so you have -- that's one of the reasons we measure fry size, weight and length. We should also be looking at energy content, itself, which is something we haven't done to date.
Q All right.
MR. HUME: And in fact, I would say that fall fry in the dominant years, in general, tend not to be smaller than in the other years; in fact, they're probably a little bit larger than in other years.
Q Well, let me ask you to explain the document that Mr. Timberg put in. It's Exhibit 810. Because you may be the only -- I'm sure you're the --
MR. HUME: One of the responses so you can get high densities instead of low growth is higher mortality, and so this graph, here, shows that, that we're done...
Q But what is causing the mortality? Because if I interpret this graph correctly, we have the effect of female spawners across the bottom --
MR. HUME: Mm-hmm.
Q -- and up the -- in the Y axis, the fall fry in the millions, and the top most amount of fall fry, there's one towards the left right up near the top, and one way off on the right up near the top at the same level. And I think you mentioned a levelling off effect. So with the effect of female spawner abundance increasing, you get an increasing number of eggs and an increasing number of hatching fry --
MR. HUME: That's fine.
Q -- why don't you get an increasing number of fall fry?

MR. HUME: Because mortality also increases with density. Actually, in the predation report, Figure 1 in the predation report shows the relationship here quite well and that mortality increases with density.
Q Before we leave this one --
MR. HUME: And but growth doesn't.
Q What causes the mortality? That's what I'm getting after.
MR. HUME: Well, as I think I explained earlier, we don't have a definite smoking gun. We assume that they probably are growing slower, and so the smaller fry are probably preyed upon at a higher rate than --
Q But food web interactions may have a role to play as well, correct?
MR. HUME: Yes, it's all food web interactions, yes.
Q In other words, there's a limit to the amount of food that a lake system can carry; is that correct?
MR. HUME: That's right.
Q And this limit is reached and shown by the levelling off of the --
MR. HUME: Well, what we're seeing is that the sockeye fry respond -- or the sockeye fry population responds by increasing mortality but maintaining a more or less constant size at high densities.
Q But the ones that manage not to die, I would expect they would be weaker than --
MR. HUME: On average they're about -- and so, say, fish from -- on this graph here, fish from, say, a million to 1.8 million effective female spawners, so the right-hand side of the graph they're all approximately the same size.
Q Same size, but --
MR. HUME: On average.
Q -- if there's --
MR. HUME: At the time of sampling.
Q If there's a higher mortality occurring as you expand along the X axis, surely the ones --
MR. HUME: The smaller --
Q -- that survive are not as strong as they would otherwise be, if they were near the left-hand end of the axis?
MR. HUME: Well, I mean, all we -- the only information we have on their strength, as such, is their weight.

Q Dr. McFarlane mentioned the smolts reaching the gulf being - he used the terminology - robustness and fatness, no doubt trying to give us something we could understand, but is there a difference in the -- how do you assess robustness in a fry? Is that energy levels?

MR. HUME: Well, it is energy levels, which we don't measure, but we measure, instead of energy levels, we measure their weight and their length, and from that you get a ratio of those two and you can do something called "condition factor", which is a crude measure of energy content.

THE COMMISSIONER: Mr. Harvey, I think Dr. Christensen wanted to say something.

MR. HARVEY: Oh, yes.

Q Dr. Christensen, did you want to say something?

DR. CHRISTENSEN: If I can just answer your previous question, looking at the daphnia graph we had before, to me it certainly indicates that in the higher cycle -- in the dominant years the abundance of daphnia in the autumn would be one to two orders of magnitude lower than in the off cycle years. That seems to be the clear conclusion from that. You asked that specific question. This is all I can see from -- this is what this graph indicates. And that means depletion of the food resource in the dominant year, as indicated from these results.

Q Yes. And that would be a normal ecosystem consequence of greater abundance of the predators on that food web?

DR. CHRISTENSEN: This is what we would expect would happen, yes.

Q Yes.

MR. HUME: In Quesnel Lake we have the dominant and the subdominant years overlapping in escapement numbers, so that for the same density of -- or same escapement level or approximate same escapement level you can -- we can have -- we have fry from the same -- we have measures of fry from the same escapement size, but in two -- in a dominant and subdominant year, and in general we find that the fry in the dominant years are as large as, if not larger, than the fry in the subdominant years. And again, or as well, they're also -- it's not such a good overlap, but in the two following non-dominant years the fry are

smaller again.
Q So there must be some ecosystem carryover that --
MR. HUME: We're speculating. This is possibly shown by what you're seeing in these graphs here. I'm quite hesitant to put a lot of faith into these graphs, seeing as this data has not been reviewed by yourselves. It is my data, but it was an exercise that we were doing with Dr. Walters.
Q Have you never plotted your data onto a graph such as this?
MR. HUME: Well, no. Well, no, I, personally, haven't. This --
Q All right.
MR. HUME: My program looks at two separate -- well, my program has two biologists; one is a limnologist who basically works with this dataset; and I work with the fish, mainly. There's a bit of an overlap in the status side here and we -- I mean, I just -- I'm not confident, I'm not comfortable in discussing this data in great detail without having actually reviewed it more thoroughly.
Q But you don't have a better graph than this?
MR. HUME: Not at the moment, no.
MR. HARVEY: I wonder, with those qualifications, if this could be marked as the next exhibit?
THE REGISTRAR: Exhibit Number 814.

EXHIBIT 814: Daphnia biomass charts of Quesnel Lake

MR. WALLACE: Mr. Commissioner, I see it's a little after 4:00. Is this convenient, Mr. Harvey?
MR. HARVEY: Yes.
THE COMMISSIONER: What's the program for tomorrow, Mr. Wallace?
MR. WALLACE: Mr. Commissioner, we have, following Mr. Harvey, Ms. Gaertner, and Mr. Harvey estimated one hour, and has now been at it for about half of that, so he should be through by 10:30, and Ms. Gaertner for an hour or so, so something around 11:30, quarter to 12:00 for the break.
THE COMMISSIONER: Thank you.
THE REGISTRAR: The hearing is now adjourned for the day and will resume at ten o'clock tomorrow morning.
(PROCEEDINGS ADJOURNED TO FRIDAY, MAY 6, 2011 AT 10:00 A.M.)

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

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Pat Neumann

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

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Karen Acaster

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

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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.

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Karen Hefferland