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.

Monday, October 25, 2010

Tenue à :

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

le lundi 25 octobre 2010

Errata for the Transcript of Hearings on October 25, 2010

Page	Line	Error	Correction
ii		Brian J. Wallace	Brian J. Wallace, Q.C.
ii		Wendy Baker	Wendy Baker, Q.C.
ii		Jon Major's title is incorrect	Document Reviewer
ii		remove Tim Timberg	replace with Jonah Spiegelman
ii - iv		did not attend	remove: Boris Tyzuk, Q.C., Barron Carswell, Lisa Glowacki, Judah Harrison, Joseph Arvay, David Robbins, Gary Campo, John Gailus, Karey Brooks. Barbara Harvey, Bertha Joseph, Joseph Gereluk, Nicole Schabus, Krista Robertson, Ming Song, Allan Donovan, Mike Walden, Steven Kelliher
ii		Tim Leadem	Tim Leadem, Q.C.
ii		add for Rio Tinto	Charlene Hiller
iv		James Walkus is not a participant and R. Keith Oliver is not counsel	remove names from record
iv		Musgagmagw Tsawataineuk Tribal Counsel	Musgamagw Tsawataineuk Tribal Council
34	47	Mark	Marc
89	15	DAVID WELCH	MIKE LAPOINTE

APPEARANCES / COMPARUTIONS

Brian J. Wallace	Senior Commission Counsel
Wendy Baker	Associate Commission Counsel
Brock Martland	Associate Commission Counsel
Patrick McGowan	Associate Commission Counsel
Kathy L. Grant	Junior Commission Counsel
Mitchell Taylor, Q.C. Tim Timberg	Government of Canada
Boris Tyzuk, Q.C. D. Clifton Prowse, Q.C. Barron Carswell	Province of British Columbia
John Hunter, Q.C.	Pacific Salmon Commission
Chris Buchanan	B.C. Public Service Alliance of Canada Union of Environment Workers B.C. ("BCAUEW")
David Bursey	Rio Tinto Alcan Inc. ("RTAI")
Alan Blair	B.C. Salmon Farmers Association ("BCSFA")
Michael Walden Christopher Sporer	Seafood Producers Association of B.C. ("SPABC")
Gregory McDade, Q.C. Lisa Glowacki	Aquaculture Coalition: Alexandra Morton; Raincoast Research Society; Pacific Coast Wild Salmon Society ("AQUA")
Margot Venton Tim Leadem	Conservation Coalition: Coastal Alliance for Aquaculture Reform Fraser Riverkeeper Society; Georgia Strait Alliance; Raincoast Conservation Foundation; Watershed Watch Salmon Society; Mr. Otto Langer; David Suzuki Foundation ("CONSERV")
Don Rosenbloom	Area D Salmon Gillnet Association; Area B Harvest Committee (Seine) ("GILLFSC")

APPEARANCES / COMPARUTIONS, cont'd.

David Butcher	Southern Area E Gillnetters Assn. B.C. Fisheries Survival Coalition ("SGAHC")
Christopher Harvey	West Coast Trollers Area G Association; United Fishermen and Allied Workers' Union ("TWCTUFA")
Keith Lowes	B.C. Wildlife Federation; B.C. Federation of Drift Fishers ("WFFDF")
Tina Dion Joseph Arvay	Maa-nulth Treaty Society; Tsawwassen First Nation; Musqueam First Nation ("MTM")
	Western Central Coast Salish First Nations:
David Robbins Gary Campo John Gailus Robert Janes Karey Brooks	Cowichan Tribes and Chemainus First Nation Hwlitsum First Nation and Penelakut Tribe Te'mexw Treaty Association ("WCCSFN")
Brenda Gaertner	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)
Barbara Harvey	Adams Lake Indian Band
Rob Miller	Carrier Sekani Tribal Council ("FNC")
Bertha Joseph	Council of Haida Nation
Joseph Gereluk	Métis Nation British Columbia ("MNBC")

APPEARANCES / COMPARUTIONS, cont'd.

Tim Dickson Nicole Schabus	Sto:lo Tribal Council Cheam Indian Band ("STCCIB")
Allan Donovan R. Keith Oliver Steven Kelliher	Laich-kwil-tach Treaty Society James Walkus and Chief Harold Sewid Aboriginal Aquaculture Association ("LJHAH")
Lisa Fong Ming Song	Heiltsuk Tribal Council ("HTC")
Krista Robertson	Musgagmagw Tsawataineuk Tribal Counsel ("MTTC")

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Vancouver, B.C. /Vancouver (C.-B.)
October 25, 2010/le 25 octobre 2010

THE REGISTRAR: Cohen Commission is now resumed. Commissioner Cohen is presiding.

THE COMMISSIONER: Good morning. Before I call upon Mr. Wallace, I wish to make some brief opening comments. The reasons for this inquiry are well-known to us all. The steady and profound decline in Fraser River sockeye has made it important to thoroughly investigate the reasons for the decline and the long-term prospects for Fraser sockeye stocks, as well as to address the management of the fishery.

This year's extraordinary return of in excess of an estimated 30 million sockeye to the Fraser, the largest in decades, has renewed hope for the sustainability of the species; while at the same time has raised new questions surrounding the issues relating to past declines. Obviously the declines, which triggered this inquiry, must now be investigated and assessed in the context of this year's exceptional result.

In the past months the commission's legal and science teams and our administrative staff have been working very hard in preparation of this milestone in our activities, namely the commencement of our evidentiary hearings. In the weeks leading up to today, the commission has conducted ten public forums on the mainland and Vancouver Island. These forums have been very well-attended and many in attendance have presented articulate, sincere and fulsome oral and written submissions covering most, if not all, of the issues being investigated by the commission. While these submissions have at times been critical of all of the stakeholders in the inquiry process, all have shared a common and at times passionate commitment to the sustainability of Fraser sockeye salmon, and many have offered important insights into the issues under investigation.

In addition to the public forum, the commission made 14 site visits. The first site visit was to view a First Nation driftnet fishery at Cheam Beach near Agassiz which was followed by visits to hydro-acoustic counting stations, hatcheries, land and ocean-based salmon farm facilities, a First Nation dip net fishery and traditional fish drying practices, operating and historic canneries, a museum addressing all of the aspects of the history surrounding the salmon fishing industry in this province, a pulp mill, a sockeye randomization project and spawning grounds. The final public forum held in Kamloops this past week was followed by a visit to the amazing site at the Roderick Haig-Brown Interpretation Centre on the Adams River where we all viewed first-hand the majesty and wonder of the thousands of sockeye who have returned to their spawning grounds in this most beautiful of wild rivers to carry out a ritual of rebirth that is thousands of years old.

In every public forum we were welcomed by a First Nations elder who underscored the importance of our work to that First Nations territory and which launched the presentations from a truly wide cross-section of interested public. I am grateful to those who attended the public forums, including those participants and their counsel who were able to attend. I am also grateful to all of the hosts of our site visits who were so gracious with their time and hospitality while they explained in detail their operations and practices and helped to educate me, commission staff and the representatives of the participants in attendance on the many elements and facets involved in the different aspects of the fishery.

For me, it was an honour and a privilege to have the opportunity to travel to many locations in the Fraser watershed and along sockeye migratory routes where the Fraser sockeye has played a key role in the cultural, social and economic fabric of these communities and where there is a commitment to preserving this iconic fish in the interests of all British Columbians and Canadians. On a personal note, I was often moved by the warmth and passion with which presenters made their submissions at the public forums, addressing the sustainability of the Fraser sockeye.

I observed commercial fishers heading out for the openings and returning with their catches. I observed sport fishers on the Fraser and along the coast. I observed the joyful atmosphere on the Steveston dock this summer as the fishers and public came together to celebrate the large return of Fraser sockeye.

I was particularly moved by the openly expressed excitement of the scores of young children on school field trips to the Weaver Creek spawning grounds and the Adams River as they watched in awe the spawning habits of thousands of Fraser sockeye. This emphasized to me the importance of this inquiry and how its outcome will resonate with future generations of citizens who deeply appreciate the work that is being done to research and observe the Fraser sockeye in the context of the human and environmental impacts upon their survival.

Along with the education I received as part of my attendance at the public forums and site visits, I also came away with a sense of the complexity of the issues being investigated and the challenges we all face in addressing those issues within a short timeframe and with limited resources. The submissions we have received at the public forums and on our website will no doubt help to enlighten us on the issues at hand, as will the review and research of the many scientists who will soon be filing their reports. In this regard the hearings will be informed by the results of as many as a dozen contracted research projects being undertaken by leading salmon biologists and aquatic scientists.

It is within this context that information and preparation that we commence the evidentiary hearings which will hear from many witnesses over the coming weeks, giving their testimony covering the areas that the inquiry is mandated to investigate. All of this past work and the future work of the commission has been and will be conducted not to seek to find fault on the part of any individual community or organization, but with the overall aim to respect the conservation of Fraser sockeye salmon and to encourage broad cooperation among the stakeholders.

At this point I wish to express my appreciation to the participants and their counsel who have worked diligently in preparation for the hearings in the spirit of cooperation that is expressed in the commission's mandate. It goes without saying that this proceeding is not a trial but an inquiry with a specific purpose, set of goals and strict limits on time and resources that I believe can be achieved with the continuing cooperation of all involved in the process.

Time and again at the public forums and at the site visits, I heard the expression that "we are all in this together and must work in unison if we are to ensure the survival of Fraser sockeye". I was struck by the common will to do what is necessary to conserve Fraser sockeye and I remain cautiously optimistic that while principled and reasonable people may disagree on the process or the path to achieving this result, that nevertheless with a collaborative effort, answers can be found and recommendations achieved to address the concerns of everyone involved in the process.

In saying this, I am old enough and hopefully wise enough to be under no illusions about the difficult issues we face together and the different viewpoints and solutions which exist amongst the stakeholders in this process. But I firmly believe that all are committed to implementing steps towards achieving the goal of securing a sustainable Fraser sockeye salmon resource for all of the generations to come.

Finally, I wish to say that the commission's interim report which will be filed with the government on October 29th will contain a thorough listing and summary of the reports which over the decades have dealt with some or many of the issues this commission is mandated to investigate. These past reports have served as a valuable background, context and resource to me and commission staff; however, the findings of fact, conclusions and recommendations that I am directed to deliver as part of the mandate of this commission will be based on the whole of the evidence gathered in this inquiry process.

Thank you all for being here this morning, for your patience in listening to my comments. I now invite Mr. Wallace to get the proceedings underway.

MR. WALLACE: Thank you, Mr. Commissioner. Good morning. My name is Brian Wallace and I'm senior commission counsel and I would ask -- what I'm about to say is really just a number of housekeeping things. The first one is that we'd ask you to introduce yourself each time you come to the mike, even though you're all becoming more and more familiar to us all. We need to have a record that clearly identifies who is speaking, so I'd ask you to do that.

I just have a couple of things to say. This week is really just an introductory overview week. Today we start with a primer on the lifecycle of the Fraser sockeye and that is essentially the first building block to establishing our -- the evidence in this commission. Tomorrow and Wednesday participants will have the opportunity to make submissions on the aboriginal and treaty rights framework that informs decision-making on Fraser sockeye and on Thursday and perhaps Friday we will hear from four witnesses who will provide their perspectives on the meaning of conservation in the context of the Fraser sockeye. I just remind you that detailed evidence will be called later in the hearings, the things that will be raised this week, and as such it's our expectation that examination by participants on these issues this week will be limited, if any.

A couple of things I'd like to mention. Each week I plan to update the hearing schedule. You received an updated hearing schedule on Friday and any week in which there has been changes made to what's coming up or additions, we will again circulate a new revised hearing schedule on Friday afternoons. One thing about documents. We hope to run this inquiry as mainly a paperless hearing. Exhibits will be tendered through Ringtail, so that participants will all have access to them that way.

Please try to give John Lunn, our hearing coordinator, advance notice of documents that you wish to put to a witness. If a document is not in Ringtail, commission staff will need to scan it and enter it so again, advance notice would be very helpful. There will be a file in Ringtail field for exhibits which should make searching easy.

Last Friday I also circulated a note on hearing process overview. I'd ask you to review that. It covers a number of issues that we think may come up. For example, it sets out the order for cross-examination and submissions, the default order. We leave it open to participants to negotiate changes if they wish to do that and to advise again John Lunn in advance.

Now, these plans, of course, will not hold up ultimately because there will be lots of things that will intervene and I would be pleased to hear from anyone at any time during the course of this as to how you think we might make this work more effectively. At the end of the day, we all want this to be efficient and for the commissioner to have the information and submissions he needs in as straightforward a way as possible.

Those are my opening remarks and I -- again, I'd be pleased to speak to any participants about how we might better organize things. At that point, Mr. Commissioner, I would introduce Wendy Baker, who will introduce our first panel.

MS. BAKER: Thank you. Mr. Commissioner, what we have intended to do on our first day is have three Fisheries biologists come and speak to the commission about the lifecycle of the salmon. What I intend to do is qualify each of the witnesses, then each witness will produce -- will go through the PowerPoint presentation. They've each prepared a PowerPoint presentation. They'll go through that pretty much on their own, and we'll do all three PowerPoints in sequence and then the witnesses will be available for cross-examination. We will mark the PowerPoint presentations as exhibits as we go through.

We have, just by way of overview, we have Mr. Mike Lapointe here to talk about the overview of the Fraser sockeye in the fresh water beginning phase of their life; Dr. Welch to talk about the marine phase of Fraser River sockeye and Mr. English, who will be talking about the migration of Fraser River sockeye through -- from Alaska to their spawning destinations.

So I'll start -- we have one other point, we have the three witnesses sitting as a panel and they do have a mike that is on them that -- so which will allow them to walk around if they want to go to the PowerPoint presentation and point things out. They've suggested that might be useful for them, so they're -- they may be doing that, if there's no objection. The PowerPoints will be shown on all of the monitors around the room as they go through their evidence.

So I'll start with qualifying Mr. Welch to begin. Mr. Welch will be --

THE REGISTRAR: Excuse me --

MS. BAKER: You need to affirm all these people? We'll do that and then I will begin the qualifications.

THE COMMISSIONER: Yes, Gentlemen, I need you to stand, please.

THE REGISTRAR: Do you solemnly affirm that the evidence to be given by you to this hearing shall be the truth, the whole truth and nothing but the truth?

Witness number 1, how do you respond?

DR. WELCH: I do.

THE REGISTRAR: Witness number 2?

MR. LAPOINTE: I affirm.

THE REGISTRAR: Witness number 3?

MR. ENGLISH: I affirm.

THE REGISTRAR: Witness number 1, would you state your full name?

MR. WALSH: My name is David Warren Welch.

THE REGISTRAR: Thank you. Witness number 2?

MR. LAPOINTE: Michael Francis Lapointe.

THE REGISTRAR: Thank you. Witness number 3?

MR. ENGLISH: Karl Christopher English.

THE REGISTRAR: Thank you. You may be seated, Gentlemen. Thank you.

MS. BAKER: I'll start with Witness Number 1, Mr. Welch.

EXAMINATION IN CHIEF ON QUALIFICATIONS OF DAVID WELCH BY MS. BAKER:

Q You have a degree from the -- a B.Sc. from the University of Toronto in Biology and Economics?
A Correct.
Q And a Ph.D. in Oceanography from Dalhousie University?
A Correct.
Q You are the president and CEO of a company called Kintama Research Corporation; is that right?
A Yes, it is.
Q And you are the chief architect of POST OTN array and can you describe what that is?

A It's a marine telemetry array to measure the movements, migration and survival of fish such as salmon.
Q Okay. And over your career, you have published many articles in peer-reviewed publications; is that correct?
A Yes.
Q Including such papers as a paper in 1998 *Thermal Limits in Ocean Migrations of Sockeye Salmon*?
A Yes, I did.
Q Okay. And in 2004 *Early Ocean Survival and Comparative Marine Movements of Hatchery and Wild Juvenile Steelhead*?
A Correct.
Q And other -- many, many other peer-reviewed publications; is that correct?
A Yes.
Q And you've also received a number of awards and recognitions for your work with respect to sockeye and other fish in the Pacific Northwest; is that right?
A Yes, it is.
Q All right. Including Prix d'Excellence from Fisheries, Oceans in Canada in 2008 and 2007, dealing with the POST project which you described earlier?
A Well, that's actually incorrect. There's two different awards, but it was for my global warming and thermal limits work from the 1990s.
Q Okay. But you have lectured, of course, on POST at various conferences and other...?
A Yes, many times.
Q Okay. And you have -- your research has been highlighted on Knowledge Network TV and in other forums?
A Yes, it has.
MS. BAKER: Mr. Commissioner, would you like me to qualify the witnesses individually or to go through the qualifications of all three and ask them all to be qualified at once?
THE COMMISSIONER: I think it would be just as efficient and convenient to do all three now and come back to each one for their PowerPoint presentations.
MS. BAKER: Okay. Thank you. Next I would ask -- sorry. I'll wait till the end.

EXAMINATION IN CHIEF ON QUALIFICATIONS OF MICHAEL LAPOINTE BY MS. BAKER:

Q Mr. Lapointe, you have a Master's in Zoology from the University of British Columbia?
A That's correct.
Q And you currently work at the Pacific Salmon Commission; is that right?
A That's correct.
Q As the chief biologist?
A That's correct.
Q And you've been a biologist with the Pacific Salmon Commission since 1992?
A That's correct.
Q You also have published many articles on salmon and salmon biology?
A Not quite as many as David but yes, I have.
Q Including publications on stock identification of Fraser River sockeye using micro-satellites and major histocompatibility complex variation is one?
A Yes, that's an example, yes.
Q And abnormal migration timing is another area you've published on?
A That's correct.
Q Okay. Papers with respect to DNA identification of salmon stocks?
A That's correct.
Q Okay. And many other -- many other topics.
A Yes, that's correct.
Q And you've spoken widely on Pacific salmon biology and particularly the Fraser River sockeye salmon?
A Yes, I have.
MS. BAKER: Okay. Thank you.

EXAMINATION IN CHIEF ON QUALIFICATIONS OF KARL ENGLISH BY MS. BAKER:

Q Mr. English, you're a fisheries scientist. You've been a fisheries scientist for 29 years?
A That's correct, yes.
Q And you are the senior fisheries scientist -- or a senior fisheries scientist with LGL Ltd.?
A Yes, that's right.
Q And what is that company?
A It's a private consulting company operating Canada-wide and in the U.S.
Q And is your work with LGL, does it include work on

Pacific salmon fisheries?
A Yes, quite extensive, almost all that 29-year period has been spent on Pacific salmon.
Q Okay. And you have designed and implemented studies to improve the quality and quantity of information available for management and assessment of Pacific salmon?
A That's correct.
Q Okay. And you have done projects throughout B.C. and Washington State, Alaska and the Yukon on salmon?
A That's correct.
Q All right. You have also -- have a Masters in Zoology from the University of British Columbia?
A Yes, that's correct.
Q And a B.Sc. in Aquatic Sciences from Cornell University?
A That's also correct.
Q And do you have any publications in peer-reviewed publications?
A Yeah, there's quite a variety spanning from juvenile fish feeding studies right through to Fraser sockeye studies, very similar to the information I'll be presenting today.
MS. BAKER: Mr. Commissioner, I would ask that all three of these gentlemen be qualified as experts in fisheries biology.
THE COMMISSIONER: Yes. I think perhaps because I'm used to a different forum, Ms. Baker, that before I qualify them, I would offer to participants --
MS. BAKER: Absolutely.
THE COMMISSIONER: -- and I would ask Mr. Wallace if this would be appropriate, the opportunity to cross-examine on qualifications.
MR. WALLACE: Clearly, Mr. Commissioner, if there's an objection or someone wishes to challenge something, this is the appropriate time to do that.
THE COMMISSIONER: Are there any of the participants' counsel who wish to ask any questions of these three witnesses at this time? If not, then I'm content, Ms. Baker, to qualify them in the areas of expertise which they have just addressed.
MS. BAKER: Thank you.
THE COMMISSIONER: Thank you.
MS. BAKER: So the first witness will be Mr. Lapointe, who will be providing a PowerPoint presentation on

the Fraser River sockeye freshwater life history. And if that could be brought up.

MR. LAPOINTE: That's actually David's. Sorry.

MS. BAKER: That's...

MR. LAPOINTE: Perhaps, John, while you're firing that up, I'll just start with a few introductory remarks.

MS. BAKER: Can I -- is the mike on for you?

EXAMINATION IN CHIEF BY MS. BAKER:

MR. LAPOINTE: Can you hear me? Everybody hear me? Okay? Good.

Commissioner Cohen and commission counsel and staff, participants, participant counsel, guests, media, I guess today we're going to kind of turn the courtroom into a bit of a classroom and the purpose of doing that is not for us to kind of impress you with the breadth of our knowledge and go into some intricate detail about the different topics we're going to speak to, but it's really actually to empower you with a common set of information that will hopefully help us communicate better with each other, because after all, you know, the success of these hearings is going to largely rest on our ability to communicate with each other.

So I want to acknowledge right off the bat that the perspectives that David and Karl and I are going to provide to you today are a particular perspective. They're a science perspective. They're based on years spent in the university, in classrooms and labs, some time in the field, but it's certainly not the only form of knowledge or way of learning about Pacific salmon and their ecology and life history.

There's another form of knowledge called traditional ecological knowledge, which is the knowledge of Canada's first peoples and unfortunately, neither David or Karl or myself are qualified to speak from that perspective, but we certainly acknowledge its importance and I'm sure there will be an opportunity at some point in the future for that perspective to be brought to bear on this important issue. So we just hope that what we provide you provides a foundation and it complements whatever information may follow over the course of these hearings.

So that -- I'd like to start off by trying to advance my first slide here, which when I point the arrow, John, it does not seem to be doing. I'll try the other arrow. We're going to try to restart this. Sorry for the technical difficulties.

MS. BAKER: Mr. Commissioner, while we wait for that, I wonder if it would make sense to have the first PowerPoint marked as an exhibit for the reference on the transcript?

MR. LAPOINTE: Thank you, John.

THE COMMISSIONER: Yes, Ms. Baker. Do you wish to do that now?

MS. BAKER: Yeah. I think we should mark this now as the first exhibit.

THE COMMISSIONER: All right. Does Mr. Registrar have that exhibit?

THE REGISTRAR: Yes.

THE COMMISSIONER: He has it. All right. Thank you. Exhibit 1 then.

EXHIBIT 1: PowerPoint presentation titled "Overview of Freshwater Life History"

MR. LAPOINTE: Okay. We're in business here. I thought I'd start off with a roadmap of today, the rest of today. I'm going to start off here -- well, you are here first at the egg stage and we're going to get to the egg stage in a few minutes, but before I do that I'm going to probably walk you through this lifecycle more times than you'd care to see it. We're going to start off on the right-hand side. There -- I'm going to provide a few remarks about life history in general and a little bit more detail on the freshwater phase and then David Welch is going to come up and talk about the phase from smolt to subadult and then finally, David will pass the baton to Karl English, who will talk about the return migration.

Now, if you guys are really good students and you're getting a little weary, the commissioner might give us a little bit of a caffeine break at some point in here, but that's certainly up to his discretion. It could get a little weary for you guys, but hopefully not too weary as we go along.

So I'm going to start off first talking about sockeye habitats and I'm going to go around the lifecycle once again, beginning from the time that these fish spawn until they emerge from the gravel as fry for about a period of eight to ten months they spend time in rivers and streams of various widths and lengths. Following that phase, they migrate to a lake where they spend approximately one year; a little bit of time in a stream, migrating from their lakes to the ocean, where they spend between two and three years. For Fraser sockeye, about 90 percent of these fish on a parent year basis would come back after two years at sea and about ten percent after three years at sea.

In between these phases in the ocean and in their streams, they're in estuaries so the Fraser River estuary, which is just outside our windows here, and for the juveniles, that would be a period of about a week or so. For some of the adults, late-run sockeye, for example, might spend several weeks off the mouth of the Strait of Georgia prior to migrating upstream.

Now, these estuaries can be particular stressful times for sockeye at both phases. It's a period where they're adjusting to either going from freshwater into saltwater or the opposite, from saltwater to freshwater, and that involves a lot of physiological changes and so forth, so they can be particularly stressful periods during migration.

One more time around the loop here, I want to just give a timeline, and I'm going to focus on the 2009 return as an example because it was the events of the 2009 return in part that were responsible for stimulating the formation of this commission, so the parents of the 2009 return by and large would have spawned in 2005 in the Fall. In the winter of 2005, the eggs would be in the gravel, overwintering in the gravel.

In the late winter, so now I'm talking about January, February, March of 2006, it would be overwintering in the gravel. They would -- the alevins would form and they would be in the gravel. In the Spring the fry would migrate to a lake, as I say, where they'd spend one year, so this is now the Spring of 2006. In the Spring of

2007, they enter the ocean and migrate to sea. And then they leave the Strait of Georgia, migrate following that red path here which I can point out to you, following the red path on this map and I'm going to try not to blind the gentleman that's sitting right here, making this loop in the Gulf of Alaska, spending, as I said, about two years for the four-year-olds, three years for the five-year-olds, returning in 2009 in the case of the four-year-olds or 2010 in the case of the five-year-olds.

So one more time around this loop with some jargon which you may get exposed to over the course of these hearings. The year that the parents spawn is commonly referred to as a brood year, sometimes abbreviated BYR or BRYR. And again, that would be 2005. There's this period of overwintering, '05, '06 when the eggs and the alevin are in the gravel. Emergence would occur in the calendar year following the year of spawning. Lake entry year, again, 2006, migrated to a lake. Ocean entry year would be 2007, that's frequently abbreviated OEY in the literature. And then return year or recruitment year, 2009.

Now, when we use the term "return" or "recruitment" in Pacific salmon, we are talking about the number of maturing offspring that come back. Some of them may be harvested, some of them may end up on the spawning grounds and in the case of the Fraser sockeye, some actually may die en route and neither be harvested or be found in the spawning grounds. So it's important to know that that recruitment term encompasses both fish that are caught, fish that end up on the spawning grounds and also fish that may in some cases die en route in the case of a very adverse migratory condition, for example.

Okay. So now that you're all experts in the lifecycle of Fraser sockeye, I can ask my first question. Now, I have to actually check with the commissioner here because I'm not actually sure if a witness is allowed to ask a question in this kind of proceeding, so, Mr. Commissioner, would it be okay if I asked a question of our group here this morning?

THE COMMISSIONER: You're the expert, Mr. Lapointe.

MR. LAPOINTE: Okay. I have a feeling that I might have a bit of a reluctant classroom here, so I need to ask if I could exempt their answers from cross-examination, sir, because I have a feeling that they might be a little reluctant otherwise.

All right. Let's go ahead then. The category is scale aging, so it's kind of like *Are You Smarter Than a Fifth Grader*, but please don't hesitate to jump in with an answer.

This is a picture of a sockeye scale and the question, it's a little bit cut off on the bottom, "How old is the fish that this scale came from?" I gave you a little bit of a help here. I've highlighted some things in colour there and but you still have to think about (indiscernible). Anybody want to offer a guess?

MS. GAERTNER: Four years.

MR. LAPOINTE: Four years? Did you say four years? You said four years? She's right. Excellent.

Okay. So if you look at this scale, on the bottom right, your bottom right, that kind of rough bit, that's the shiny bit that makes a fish shiny when you look at it from the side. It's kind of like the white of your fingernail. It's the oldest part of the scale. And as you move up from the bottom right to the top left here, in this direction, you can see there are these dark rings that are formed periodically as the fish grows, and little white spaces in between. Those are called circuli, okay? And what I've tried to help you see here is areas where these circuli get closer together.

There's three areas here on the scale which -- where the circulis are close together. Those are called annuli and they're formed in the winter, when the growth slows of these fish. So you can see on this scale there's three annuli, so there's the freshwater zone right in the very middle there. There is the first marine year, and then there is the second marine year, so this fish has three winters on its scale and it's a four-year-old because the first winter they're eggs in the gravel, right? They don't yet have a scale. So you count up the number of winters and add one and that's how old the fish is. The little bit of growth at the very end at the top left there, that's just the growth that happens after the winter, before it comes back to its natal stream to spawn in.

So it's pretty hard for anybody for the Pacific Salmon Commission to give a talk about life history without showing you a scale. It's just one of the things that we have to do.

The spacing between these circuli is roughly proportional to the amount the fish grows, so you can see as you move -- oops, go back. As you move from the freshwater zone to the marine zone, they get farther apart and that's because the fish is growing more during those phases. Okay?

Now, I need to talk a little bit about the Harrison sockeye because you're going to hear over the course of the hearings, I think, something about Harrison. They have a different life history and they have been showing some trends in their abundances of -- in recent years that are different from some of the other sockeye. So in red there is what I've just described to you a number of times in terms of the most Fraser sockeye have this life history and I just want to walk through and contrast the Harrison for you.

So rather than spending a year in a lake, Harrison fish basically go to sea almost immediately after they emerge from the gravel, spend time in sloughs and estuaries for a few months, so they're entering the marine areas less than a year, the following calendar year, after spawning. It does look like these fish are spending some time in Georgia Strait, perhaps a few months, and maybe Georgia Strait is kind of like the Harrison Lake, if you like.

The rest of the life history is pretty similar, two and three years at sea. Harrison come back as three- and four-year-olds because they don't have that year in the lake and their age of maturation is much more variable than the other Fraser sockeye stocks. It's not like 90 percent and ten percent. It's quite -- quite variable from year to year.

So the ocean entry years would be 2007 for the age three Harrison fish compared to 2007 for the age four fish from the other sockeye or 2006 for the age four fish compared to 2006, the age five fish. So this may become important. It's more just kind of a note for you to have in your back pocket as you go along, because you're going to hear more, I know, from David, about Harrison in a few minutes.

Okay. So let's start with the egg phase then. This is a picture of five sockeye eggs and just to give you an approximate scale, and there is variation, you could fit those on a dime probably. Okay? If someone has a dime in their pocket, you kind of know how big these eggs are.

Now, these particular eggs have reached what's called the eyed-egg stage, so you can see some little eyes in there that are the eyes of the fry. The length of time to reach the eyed-egg stage is really dependent on water temperature, so there's some experiments that are -- have been ongoing recently by Jenn Burt and Scott Hinch's lab at UBC and what she's found is that Weaver Creek sockeye eggs would reach the eyed stage in about 25 days at ten degrees Celsius, but only 12 days at 16 degrees Celsius. So the warmer the water, the faster the development.

How many eggs do Fraser sockeye have? Here's just a sampling of egg stocks in the watershed. You can see the number of eggs per female ranges anywhere between about 3,000 to 4,000 eggs. Again, fecundity varies with the body size. Bigger fish tend to have more eggs and sometimes larger eggs. Egg size also varies with the substrate that these fish spawn in. If you spawn in fine substrate you're likely to have smaller eggs than if you spawn in very coarse substrate.

After the egg stage comes the alevin stage where these alevins carry around this backpack, if you like, of food that nourishes them from -- for six to ten weeks. They're not particularly good swimmers and I'm sure that if you had a backpack strapped to your chest with six to eight weeks provisions, you wouldn't be a very good swimmer either. And as a consequence, they tend to be in the gravel because it's kind of hard to escape from predators when you've got this load on them. This is about their size, as an example, a handful of alevins, if you like.

So again, they're nourished by the egg sac, still in the gravel, poor swimmers and again, that stage lasts somewhere between six to ten weeks, depending upon water temperature again. When the yolk sac is actually absorbed into the body cavity, it's called buttoning-up, it's just a term that you may see if you're in the literature.

Okay. What can cause egg and alevin mortality, this is a diagram that I borrowed from Tom Quinn. You can't quite see the acknowledgement at the bottom of the slide there, but it will be in your hard copies. Anything inside this oval is what we would call approximate cause of mortality, so predation, there's one on the right here I can't see that's called dig-up - a very scientific term, desiccation or freezing, scouring, suffocation, these are all things that can cause mortality at this stage. And then I'm just going to bring in some things from the outside that affect these different approximate sources, so things like the density of spawners. If you have more fish in the spawning grounds, you're more likely to have your red dug up by a fish that spawns subsequent to you than if there are fewer. Obviously, the earlier-spawning females are more likely to have their eggs dug up than the later timed ones. Bigger females do dig deeper reds and so if you're a bigger female, you're less likely to have your red dug up.

There are low flows that can result in desiccation or freezing. If you were at the Adams this year, the river is about two feet higher than normal and I suspect if that does drop, some of the fish you may have seen spawning near the margins, their eggs may actually end up being frozen and they may not end up contributing to future generations.

You can also have things like high flows, the Seymour River, there's a very big storm event around the 20th of September, washed out five bridges on the Seymour River. It was after all the early fish had spawned and I suspect that it had probably a pretty negative effect on the spawning success of those animals in that particular stream. Fine sediments, obviously, can create situations of suffocation or low oxygen and then, of course, there's predators and I don't know if you can quite make that out. That sculpin is just about to fit that egg in its mouth. So fish and birds are all predators of these animals and they can certainly key in at certain key times during life history.

Tom did not include diseases and parasites here but clearly, they can play a role in mortality. So there's a lot of things that can go wrong when you're one of these small animals growing up to become a fry.

Speaking of fry, here is the fry stage. There's different terms used to describe fry. The term "parr" is quite often used in Europe and it refers to these vertical bands that you can see. They're called parr marks. It's juveniles is used, fingerlings are used, lots of different terminology and it's really not worth getting into a debate about when to use one or the other. They're sort of synonymous in many ways.

Fry now have to feed. So they no longer have this backpack of food. They've got to find some food. They're about an inch long, 28 millimetres long at emergence. Again, these are averages. And it's obviously very important to get to your lake when the zooplankton are available. One of their favourite treats is something called daphnia. This is obviously not drawn to scale. Daphnia might be a few millimetres long. And they're very abundant in many of the B.C. lakes.

Okay. So fry migration downstream to lakes, sometimes this can be as short as a few hundred metres. In other cases, it might be more than a hundred kilometres. That's a fairly significant journey for a fish that's, you know, about an inch long.

Lake residence for a year, they say, from about May to May in sort of round numbers. One of the interesting things about fry and actually, David Levy has done quite a bit of work on this topic, is that they actually undergo vertical migrations through the water column. At dawn and at dusk they're near the surface where they're feeding, and then during the daylight, bright daylight hours, they actually migrate deeper and that's thought to be a predator avoidance type situation. They are visual feeders. They have to see to feed, but so are their predators. So there's quite a bit of work that's been done on the vertical migration of these animals.

Okay. After fry stage comes a process called smoltification and one of the main things that happens is this physiological change that's required to now go from living in freshwater to living in seawater. There are also behavioural changes. So they don't vertically migrate any more. Now they're migrating in a certain direction, hopefully towards the outlet of their lake. Sockeye don't tend to be that territorial, but other juvenile sockeye are and so they lose that territoriality behaviour, so now they're migrating in a direction and they're schooling up more.

They develop an ability called compass orientation. There's actually been some very interesting work done putting a juvenile sockeye in a magnetic field and changing the direction of the magnetic field and the fish actually change the direction that they're pointing with their head. So this is thought to perhaps help them navigate their way out of their lakes and downstream. They get that silvery body colouration and they're leaving the lakes at about three inches in length, 80 millimetres.

The downstream migration now of the smolts to the ocean can be quite extensive, anywhere from 40 kilometres for a population like Widgeon Slough to 1200 kilometres for something like the Early Stuart. Now, I'm going to show you some information about Chilko sockeye a little later on and just for your information, they migrate about midpoint of this. It's about 650 kilometres from Chilko Lake down to the mouth of the Fraser.

The sources of mortality here are very similar to the sources of mortality. These are just, as I say, not a complete list. Obviously, if you're a fry and you get to your lake at a time when the food is not there, that's not a good thing and you might, in fact, potentially starve or at least have slow growth and be vulnerable to predators. Predators, again, fish and birds, and they do key in on the times when they're either migrating in high densities or when they're feeding. Disease is another factor, either directly or indirectly through increasing vulnerability to predators. Environmental stressors, temperature, that transition from freshwater to saltwater, those are all factors and, of course, these things can all interact in some way.

Now, I've talked about water temperature. I think three or four slides now have mentioned it and it's really important for the spawning time of these animals. The idea is that the development of the egg to fry is controlled by water temperature and the offspring that reached the lakes when the zooplankton are abundant are going to have the highest probability of surviving. So there's a very strong selection to spawn at a time such that your offspring are going to go through that temperature environment and emerge and reach the lake when the food is abundant. And as a consequence, within Fraser sockeye if you look across over 60 years of records, the peak of spawning in these populations will be with almost the same calendar week from year to year, maybe within ten days. That's how strong the selection is to spawn at the right time.

Okay. What are kind of the survival rates from egg to fry survival? Here I've got data for seven populations here. There's a little bit of difference, if you look at the right-hand columns here, the time of the fry estimate, there's a difference in the time of the life history when the fry estimates are made, which has an impact on some of these numbers, so, for example, for Early Stuart and Stellako, the fry are estimated as they're migrating out of their streams into a lake, and the average egg-to-fry survival across the time series for those two populations is around 21 percent.

Quesnel and Lake Shuswap are measured in their lakes in the Fall about six months after spawning, so this is acoustic survey that you use to estimate the populations of those juveniles. Their egg-to-fry survival is lower, four and five percent. Weaver Gates and Nadina all have very high egg-to-fry survival and some of you probably know that these three populations all have artificial spawning channels. I don't know if any of you have visited Weaver, Weaver is just a -- it's an artificial stream. Usually it's groundwater-fed. The flows are controlled. The predators are excluded. Everything is just, you know, the perfect habitat for these fish, and not surprisingly, they have much better egg-to-fry survival.

Now, I'm going to talk a little bit about the Chilko smolt program, and Chilko, for those of you who don't know, is right about there in the middle of the watershed, highlighted in red circle there. And the reason I'm going to talk about that is that Chilko is the only Fraser sockeye population in the watershed which has a very long time series of estimates of smolts leaving their lakes or leaving the lake, I should say.

So I happened to visit the Chilko smolt program in 2008 and Chilko has had this weir since 1949, there's been a weir and this is the weir here, this V-shaped fence here. This walkway that's going from the shore outward is actually the catwalk to get to these two small little aluminium shacks here, and in the evening, these are all little juvenile Chilko smolts here. The smolts school at the opening of this weir, funnel into this opening. And I think you should be able to see at the very bottom of that photo a white sort of what looks like a window and, in fact, that is a window, and that's what's used to open up and allow the smolts to migrate through these two little aluminium shacks that you can see.

When they get into that -- into that shed, there is a digital camera which is mounted looking down towards the bottom and that digital camera takes pictures periodically on a certain sampling protocol - I don't know exactly what the timing of the pose is, but the photos look something like this photo in the bottom right there. So these white rectangles are about two feet by four feet and you can see the individual smolts that are on there, the time is recorded. This is taken with my camera and not with that camera that's used in the actual sampling. And so you can get an estimate of the number of fish per unit time, expand it by the time that you're sampling and not sampling, you get a total estimate of the number of smolts leaving Chilko Lake.

Now, of course, in 1949 we didn't have digital cameras and so forth. It was a four-by-eight sheet of plywood and big lights and a single lens reflex camera with black and white film and so forth, but the methodology has been pretty systematic since 1949. So you can get a lot of information from the Chilko program. It would be nice, obviously, to have this in other spots in the Fraser watershed.

So what I've developed is this sort of lifecycle survival table, just to give you a bit of a reference on average. Now, Chilko does have a fry program, but the fry program doesn't enumerate all of the fry, so I couldn't actually use the fry data from Chilko to fill in some of the blanks on this chart. The egg-to-smolt survival for Chilko is about four percent on average, egg-to-smolt survival. And all I've done is I've partitioned the egg-to-smolt -- or egg-to-fry and fry-to-smolt survival, the two components of that egg-to-smolt survival, with data from the literature. And Quinn, Tom Quinn's book suggests that the egg-to-fry survival is about half of the fry-to-smolt survival, so that's why I've got kind of Chilko in quotes. I don't have the actual data for Chilko to fill this table in.

But just walking you through, starting at the top, again Chilko females have about 3,000 eggs. At a one-to-two ratio of egg-to-fry survival to fry-to-smolt survival, about 14 percent of the fry or 433 fish would make it to the fry stage. And then at 29 percent fry-to-smolt survival, another 127 would make it to the smolt stage. The average smolt-to-adult survival for Chilko is about nine percent, so nine percent of 127 is about 12, so that means that of those 3,000 eggs, 12 or 4 out of every 1,000 survive to the adult stage.

Now, historically on an average basis historically, maybe 70 percent of those fish would be harvested. The exploitation rates have been lower in recent years, but about 70 percent, so that would mean eight would be removed for harvest, leaving four for spawning for future generations. So, you know, this mass of eggs shrinks pretty fast to a pretty small number.

Now, I want to introduce this concept of productivity. It was in some of the videos that were on the commission website. In fact, I probably should go back here and just mention that on the video on the Cohen website, I think it mentions the figure of about ten percent egg-to-smolt survival and maybe three to five percent for smolt-to-adult survival. For Chilko I have those numbers roughly transposed, but they both work out to about four out of a thousand eggs making it to adult stage. There's certainly a lot of variation. These are just averages, examples for your reference.

Okay. Productivity - how many offspring from a given pair of spawners return as adults? Well, for Fraser sockeye, the average would be about five returns per spawner. Now, it should be quite self-evident but in the absence of harvest, you need at least one return per spawner to replace yourself, right? So on average, five returns per spawner would leave some fish available for some other purpose, 'cause you need one -- and this concept of replacement is often -- you may run into it if you get some presentations on stock and recruitment, that you need one spawner for every spawner to replace the previous generation.

So let's come back to our little lifecycle diagram here and talk about this number 12 here, so 12 adults were produced by 3,000 eggs, that's two spawners, right? There's one male and one female, so 12 divided by two is six returns per spawner. It's right about the average. Okay?

Now, I'm going to turn this concept around on you and talk about mortality. So rather than talking about the fact that you have 14 percent of the eggs surviving, I'm going to talk about the fact you have 86 percent dying, so rather than having 433 survivors, you're going to have 2567 dying. Okay? Just to show you in a pie-chart kind of the disposition of those 3,000 eggs. So these are now mortalities. Okay? So of the 3,000 eggs, about 2567 are lost in the egg-to-fry stage, okay? About 306 lost in the fry-to-smolt stage, about 115 in the smolt-to-adult stage. If the fishery takes 70 percent of the 12 that are left, then that would be eight in catch and four in spawners.

And there's a few points I want to make on this pie chart. First one is that most of the mortality, the blue and the yellow here on this chart, occurs in fresh water. So that's the importance of freshwater habitat. I'd be willing to bet, Commissioner Cohen, that you heard a lot about habitat in your hearings over the -- in your public meetings that you've had. Well, habitat is critical. Most of the mortality occurs in fresh water.

The other thing you can notice here is that within a cohort the fishery actually accounts for a teeny fraction of the mortality, eight out of the 3,000 eggs. And so fishermen are often frustrated, say well, gee, you know, you're always pointing the finger at us. We only impact 8 of these eggs and there's all these other force mortality. Well, within a cohort, they're right. Within a cohort, fishery doesn't impact.

But, and it's an important but, and that's why I've put it in big font and underlined it, when you're talking about the next generation, you have to remember that the fishery harvest, every female that's harvested has potentially 3,000 eggs that are going to contribute to the next generation. So within a cohort, fishery is a small fraction of the total; but if you're talking about between cohorts and future generations, the fishery is a large component.

So you can get battles between groups talking about this, but really, they're both right. It's just a perspective, the part of the life history that they're referring to is slightly different.

Last point I want to make with this pie-diagram is that even though all that pie is sucked up by the freshwater mortality, almost all of it, you know, what is it, 2873 eggs or something of the 3,000 eggs, even though that's where a lot of the mortality happens, there's still enough variation in the marine mortality - in other words, this number of 115 smolts that might die on average at that stage - there's still enough variation in that to cause quite a bit of variation in the overall returns even though it's a small fraction of the total mortality.

And I'm going to give you an example, again going back to our little table here, so on average over 60 years for Chilko about nine percent of the smolts survive to the adult stage and that leaves 12. What about the variation from year to year? Well, we're very lucky to have that Chilko program and we can show you this chart, and this is just the marine survival, smolt-to-adult survival, the comparable numbers to that nine percent average on the previous slide for each of the parent years, the brood years, years of spawning, from 1949 to

2006 brood. And you can see that in 2009 that horrible return that we had of 2009, the survival was only .3 percent. That's three out of 1,000, .3 percent. Okay?

In contrast, if you look at the 1986 brood or the 1990 return, we have had smolt-to-adult survival estimates as high as 23.4 percent. Now, if you're curious, we just have our in-season data so far. They're still -- we don't have the estimates from the spawning grounds for Chilko yet for this year, but it looks like this year's run for Chilko anyway will have about a six percent smolt-to-adult survival. So think about .3 percent versus 23.4 percent applied to the number of smolts, 127 smolts on average that would make it out of these lakes.

What it would mean is that instead of nine percent, if you had a worst case scenario, let's say .3 percent, that means of that 127 survivors to the smolt stage shown in yellow there, you'd only have .4. That's like one out of every 7500 eggs making it, right?

In contrast, you go to the best case scenario, the 23 percent, you've got 30 of these animals surviving to the adult stage. So you can imagine that over the last couple of months here, I've had quite a few people come up to me and say, "Hey Mike," you know, "why are these returns so variable from year to year?" I mean, we had 1.5 million in 2009 and then we've got 30 million in 2010, what the heck is going on? Well, as I think I've shown you, at the extremes, and this is over a 60-year period, marine survival variation alone can result in returns that differ by about a factor of a hundred. It's actually a factor of 75, 30 over .4. And as I just told you, the last two years it's about a factor of 20, right - 1.5 million versus 30 million. So it's the variation in the marine stage that can create huge variations in these returns on an annual basis.

Now, I guess kind of the kicker on this stuff, and one of the issues is that we don't actually know very well -- we know -- we have hypotheses, but it's not very well understood what causes this variation. We have ideas. And more importantly, the magnitude of this variation really can't be predicted in advance. So this variation is something that, you know, the Fraser panel, the groups I work with, is used to dealing with. It's the reason that we have things like in-season management, but it's not something that we can predict and we shouldn't as a public at large be expecting forecasts to be that accurate because of this inability to predict this variation.

Okay. I talked about the Chilko program. I'm just going to bring in some information from the Quesnel and Shuswap Lake programs to talk a little bit about density dependence here. As I said earlier, Quesnel and Shuswap Lake have acoustic surveys in their lake. They survey the lake, get an estimate of the abundance of fry in the summer and the Fall following spawning so their first year in the lake. And what I've got here is a chart for the Quesnel Lake sockeye with the average number of spawners here in different ranges, so zero to 250,000 up to greater than a million and then the column on the right is the average fry per effective female. It's kind of like the freshwater productivity. How many fry per female are associated with these different levels of spawner abundance? And you can see a decreasing trend from about 305 there on the far right, the top far right there, with low numbers of spawners to about 39 with abundances greater than a million.

Now, I needed to define one more piece of jargon here and this is this effective female term. This is a kind of a Fraser sockeye specific piece of jargon. Every year on the major spawning grounds, female carcasses are surveyed to see how many eggs they have in them. Now, if you die with all of your eggs, you're obviously not a very effective female spawner, so that would count zero. If you're a dead female and you don't have any eggs, you're a hundred percent effective. And then they have a score of about 50 which relates to a female that has some of her eggs.

So what they try to do is adjust the number of females for this proportion of them that retain or not retain a number of their eggs when they're surveyed on death. So that's just a piece of jargon that you may run into later on in the course of the proceedings.

So we can take this information and we can plot it. We can actually look at the absolute number of fry here now, so on the vertical access there is the total abundance of fry in millions that are in Quesnel Lake in the Fall. The -- and it's plotted against the number of effective female spawners. And the point I want to make here is that beyond some level of spawner abundance, fry abundance remains roughly the same. And I've just drawn by hand that red dashed line for you to help you see that.

This pattern is consistent across all the Fraser sockeye lakes and I'm going to show you some more examples here. Here's the Shuswap Lake sockeye, so this is where the Adams River, where the Adams River fish weir, if you went to the Adams River, this is where these fish are headed next Spring. Again, low abundances of spawners, very high rates of fry per female, dropping down at the very extreme level of spawner abundance to about 43 fry per female. Same plot, there's fewer data points out there at the extreme range, but you don't get this continuing increase in the abundance of fry with -- as you put more females on the spawning grounds.

Chilko sockeye, but now we're talking about smolts now, so there's the abundance of juveniles leaving the lake. Same pattern. Okay? And the same kind of a plot here, where you can see that you could almost make an argument for Chilko that at some levels of spawner abundance, you actually get fewer fry than you do otherwise.

Now, if you draw that dashed line across to the vertical access there, and you look at for Chilko perhaps around 40 million, that's sometimes called the juvenile habitat capacity. Okay? And there's been work done within the Fraser, and this is work largely done by Jeremy Hume and his colleagues at Cultus Lake lab, where they can relate the capacity of these lakes to the surface area of the lake. Okay?

So that's the next slide and what I've got is a table of the surface areas of the Fraser sockeye nursery lakes. There's 26 of them. I've cut it off, so that you can actually see this from the back of the room, so there's probably about 14 or so on there. Stuart Lake, 357 square kilometres.

For a reference, Stanley Park is about four square kilometres. So Stuart Lake is a pretty big lake, right? Okay.

And they're just ordered and a couple points I want to make, one is that these top eight, largest eight lakes, account for about 80 percent of the rearing capacity for Fraser sockeye. Okay? And if you look at that list and you look at lakes like Shuswap, Quesnel and Chilko, those three lakes alone are probably accounting for most of the adult production right now. So there isn't a ton of diversity in large production of these nursery lakes.

Now, what I've done is I've just added these on top of each other. The total nursery capacity is about 2500 square kilometres and plotted it on a graph, display the information in a slightly different way, and that's this next slide. Those are the eight lakes. They're just ordered across there, so you can see some of the other lakes that are contributing here.

Now, I don't want to give the misimpression that somehow the biodiversity of Bowron or Chilliwack or these lakes that are small on your far right is not important. Okay? There are lots of reasons that biodiversity is important. Maybe some of these lakes will be more resilient to climate change, for example. Okay? Harrison sockeye don't even rear in a lake. Harrison Lake's on there but that's where the Weaver Creek sockeye rear, so Harrison sockeye aren't even on this chart and they've been doing something -- their life history, something about them has obviously been favourable for them 'cause they've been on the increase over this time. So that's not the point. The main point I want to say is at least from the perspective of juvenile production, the juvenile production that's going to produce the very big runs like we had this year is going to come out of these big lakes. Okay?

So this is a movie that I took at the Chilko -- or I didn't take it, Steve Latham took it at the Chilko smolt fence and these are -- Chilko smolts kind of gathered at the mouth there. They were bouncing off his snorkel. I just thought since you guys have probably had a chance to see the abundance of adults, you might appreciate seeing the abundance of juveniles. There is a lot of smolts gathering in, trying to come out of Chilko Lake. And next I've got to send them kind of on their way to David, because he's going to talk about the ocean phase, so these are smolts now that are swimming downstream out of the Chilko River towards the ocean and David is going to tell you all of what happens to them after that.

So, you know, these are pretty amazing animals. I hope that you've got that impression and these pictures kind of point it out. They're sort of sauntering their way down the Chilko River.

Now, that is the conclusion of my formal presentation. I just want to point out to you that in your distribution you'll see a couple of supplementary slides. I referred to some references in my talk. The references are here. There's also some additional references that I didn't cite that you may find helpful. There's some good books out there on juvenile sockeye. There's a couple slides here on how we age fish that I thought you might want to refer to at some point. I'm not going to speak to those, but they will be part of the packet that is in your distribution.

So thank you for your time. I hope you're hanging in. And I guess we'll pass it on to David here, Wendy, or...?

MS. BAKER: Thank you. Mr. Commissioner, do you want to carry on with the next? I think it'll be another half-hour or more of evidence. Or did you want to take the morning break now?

THE COMMISSIONER: No, I think, looking at the time, it might be most convenient to take the break at this point.

MS. BAKER: Thank you.

THE COMMISSIONER: And then come back with the next presenter.

MS. BAKER: Thank you.

THE COMMISSIONER: Thank you.

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

(PROCEEDINGS ADJOURNED FOR MORNING RECESS)
(PROCEEDINGS RECONVENED)

MS. BAKER: Mr. Commissioner, the next witness will be Dr. David Welch, and again, he has prepared a PowerPoint presentation to deal with the marine phase of the Fraser River lifecycle and once that's called on the screen, I would ask that that PowerPoint be marked as the next exhibit in the hearing.

THE COMMISSIONER: That'll be marked as Exhibit 2. Thank you.

EXHIBIT 2: PowerPoint presentation titled "Marine Phase of the Fraser River Sockeye Lifecycle"

EXAMINATION IN CHIEF BY MS. BAKER:

DR. WELCH: Okay. Well, thank you very much. Commissioner Cohen, a housekeeping note associated with the PowerPoint there are notes on each page and I'm going to leave off the attribution of my colleagues that have developed the scientific research that I'll refer to here. But there are notes that provide that entry into the scientific literature.

I'm also reminded of a famous British South African writer in Britain called Laurens van der Post who wrote a book almost fifty years ago called *A View of All of the Russias*. And his point was that in his 300-page book there were over 200 language groups in Russia, so it was almost impossible to write a book of that nature. My task here is similar today because we know even less about what happens in the ocean than what happens in Russia, even in the time of Soviet Union. But my challenge here is to give you a relatively simple overview that is focused on the Fraser River and try to frame what we do and don't know.

So first slide, please. All right. Not yet. All right. So in my general outline I'm going to take you through a two-and-a-half to three-and-a-half-year period. The juvenile year the smolts enter the Strait of Georgia and then beyond, they migrate up the continental shelf and then in their immature years, most but not all stocks of Fraser sockeye spend their life in the open ocean. And the question mark there is because it's so important but so little known relative to the other areas. And then my remit is to cover briefly the return migration back to Vancouver Island and the survival. Where can it change? What could in the particular context of the Cohen Commission's mandate, why could 2009 have seen such poor adult returns?

The brief life history here, the marine phase, has -- covers a two-and-a-half to three-and-a-half-year period as my colleague, Mike Lapointe, has pointed out and I'm going to cover the periods covering the smolt and the immature fish. I'll also be referring to the smolts as the juveniles in their first summer and fall in the ocean.

Some geography is appropriate here for the members that are attending to give you a broader perspective on where we are going to take you. From the lower right, we have Juan de Fuca Strait, the Strait of Georgia, Johnstone Strait, Discovery Passage, Queen Charlotte Strait and, of course, within that the Broughton Archipelago and then Southeast Alaska where the panhandle to the north there.

Offshore we have Queen Charlotte Sound in yellow, which is the marine area between Vancouver Island and the Haida Gwaii, formerly the Queen Charlotte Islands, now Haida Gwaii to the north and then farther west you'll see Kodiak Island, the Alaska Peninsula, the Bering Sea to the far left, the Aleutian Islands are a chain of volcanic islands arcing out from the Alaska Peninsula and then in the North Pacific Ocean there is, in the right-hand area, the Gulf of Alaska, which is, I point out, is where most Fraser sockeye take up residence ultimately. So these are landmarks that I'll be referring to in my presentation.

So the known ocean distribution of British Columbia sockeye was defined in the 1960s and '50s by research done by U.S., Canada and Japanese scientists and the blue line which I've just outlined here shows the approximate location of British Columbia sockeye of all known populations. And that's determined from work that occurred in the 1950s and '60s, tagging fish with simple tags that at sea they were caught in this area and then at least one was returned and was caught in a

British Columbia river or in British Columbia coastal waters, so that defines essentially the known limit to the distribution. It does not mean that there are no B.C. sockeye that moved beyond this. It simply means this is -- this is what's known in terms of direct measurements of adults or subadults that returned to British Columbia waters.

Within the juvenile marine migration phase, there's two aspects that I'm going to focus on. One is the Strait of Georgia and then the second is the coastal shelf northwards. And the key point that I'd like to emphasize here for Commissioner Cohen is there's a mixture of migratory and non-migratory sockeye populations from the Fraser that have different behaviours. So most Fraser sockeye stocks are going to migrate north rapidly.

Harrison Lake sockeye - and I apologize, this should be Harrison River sockeye remain as long-term residents within the Strait of Georgia and some other stocks such as rivers in Smith Inlet on the Central Coast that collapsed back in the 1970s, are thought to remain as residents in Queen Charlotte Sound, based on DNA sampling. I won't be mentioning them further here, but it's an important point that it's not just the Fraser sockeye that have collapsed in the past.

The next graph shows the trends in productivity that I think most will be well familiar with. The point that I'd like to simply make here is that in the lower left Harrison, which is outlined in yellow, has a productivity trend that's the opposite of virtually all other populations. It's been going up over time. And the Harrison sockeye have both radically different marine migration behaviours and different marine survival patterns. So where that's known, I'm going to contrast it in my presentation simply to make the case as to something about what's different between these.

The early sea migration was really defined by the late 1970s and early -- pardon me, the late 1970s and early 1980s with the majority of fish being detected using conventional nets as moving north as shown in this diagram and out through Discovery Passage to Johnstone Strait to the north, with only a small number of fish moving to the southwest through Juan de Fuca Strait. Some of the work I've been involved with the POST telemetry array will be used to motivate an animation to show this afterwards and give a broader concept of the rates of movement and the directions.

So for the timing, as Mike Lapointe has said, the Fraser sockeye are near the southern limit of their distribution and on this chart I've marked two populations from the Fraser River which are Cultus Lake and Chilko Lake, showing the mean date that they migrate out of the respective locations. Cultus Lake is down near the mouth of the Fraser and they leave in very late April and Chilko Lake, they leave in early May. And acoustic tag data that we've had in the past indicates that for the Cultus Lake stock, they reached the mouth of the Fraser River four days after release at Cultus Lake and some work I've done with my colleague, Scott Hinch at UBC on Chilko sockeye this year that's not yet complete, we found that they reached the mouth of the Fraser River from Chilko Lake in eight days.

So at the speed that -- most fish move at about one body-length a second when they're migrating. That implies that they're moving at just under ten kilometres a day out so to reach the north end of Vancouver Island, they will achieve that in about another 45 days, 46 days, for the normally-sized while smolts. So the average Strait of Georgia, Johnstone Strait, Queen Charlotte Strait residency is thus about 1.5 months and making the entry into Queen Charlotte Sound as mid to late June.

Now, within the Strait of Georgia, here's a plot from some of the DFO data on the July Strait of Georgia survey that goes on and it shows the trawl survey dates where trawls were done, the black horizontal lines show the range of dates that the trawling occurred over and the red dot shows the middle point. And it simply makes the point that sockeye catches are dropping off very rapidly in July because it's the tail end of the run for most of the smolts that have migrated out.

If we then move to the outside waters, my colleague, Dr. Mark Trudel at the biological station in Nanaimo has carried on work that I started a number of years ago and this is a summary for all Fraser River sockeye that was recently published and it shows the distribution along the coast. So in the upper right we have the May/June samples from all years; the lower left the July/August; the upper right the October/November or autumn period; and then February/March of the subsequent year. So this gives you a sense of where sockeye are caught. There was sampling in virtually all of these areas so the triangles showed the locations where Fraser sockeye are caught.

So in the May/June period -- which one was the -- so in the May/June period, we can see that the sockeye are caught -- yeah, maybe that one will work better. In the May/June period you'll see that the sockeye were caught just to the north of -- sorry, the Fraser sockeye were caught just to the north of Vancouver Island. In July/August they were captured all the way along from Southern Vancouver Island up to Kodiak Island in the Gulf of Alaska and then in October/November, there are still sockeye and again, to emphasize this is all stocks found in Queen Charlotte Sound and off the Alaska panhandle, as well as sockeye out off the Alaska Peninsula about 3,000, 3,500 kilometres away. By February/March, there are still sockeye, Fraser sockeye, caught off the west coast of Vancouver Island and a sporadic scattering of them up to the north along the continental shelf.

If we look at contrast, the West Coast of Vancouver Island sockeye, so these are not Fraser sockeye, there's quite a remarkable difference in one aspect, which is by October/November, none of the West Coast Vancouver Island sockeye are found off the West Coasts of Vancouver Island except a single individual in over these multiple years. They are found to the north, essentially following the Fraser sockeye migration route, as well.

And if we look at Harrison River sockeye, for the first three of those periods there are no Harrison River sockeye collected anywhere on any of those samples, but by February and March of the year after ocean entry, they've appeared off the west coast of Vancouver Island. So they have a unique timing. They presumably stayed within the

Strait of Georgia. In fact, you'll see that in the next slide. They've stayed within the Strait of Georgia for a long period of time when the other Fraser sockeye stocks have left.

This is some data that my colleague, Dr. Dick Beamish, at the Biological Station in Nanaimo has given me and it shows samples -- it's from a paper that he's currently completing for publication and it shows samples of the DNA composition of Fraser -- of sockeye caught in the Strait of Georgia in September or November, September to the left and November to the right, and almost 99 percent of the fish that are caught in that period are Harrison River sockeye. There's only a tiny sliver of the other Fraser stocks that are remaining there by September or November. So presumably the Harrison fish stay sometime in the winter, move to the West Coast of Vancouver Island and the theory is that they then remain as coastal residents off the coast of Vancouver Island for the rest of their life history until they come back in.

Now, the early summer juvenile sockeye abundance in B.C., if we want to now turn our sights somewhat farther offshore -- sorry, along the coast but outside the Strait of Georgia, Dr. Trudel at DFO very graciously gave me this data that's under preparation. I've contrasted here the 2007 smolt migration with the 2008 smolt migration. This is for, of course, the failed 2009 return and the very abundant 2010 return of sockeye in the Fraser River. So the graph, if we take the 2007 graph, 2008 is the same. From the bottom to the north we have West Coast of Vancouver Island in the bottom and then moving north off the north coast of Vancouver Island, Triangle Island, Queen Charlotte Sound, the West Coast of the Haida Gwaii and Hecate Strait and then up to Southeast Alaska to the north. And there's -- Dr. Trudel has pointed out both an outer coast, an outer route, and an inner route movement pattern, so the second column for 2007, there's a sample here that's all green for Triangle, Queen Charlotte Strait, Queen Charlotte Sound area and then to the east of the Haida Gwaii area within Hecate Strait. So 2008 is similarly interpreted.

The key point for putting this up is that the green shows the Fraser River sockeye caught in the trawl based on DNA sampling and assessment of the source of each individual. And if I then move this forwards, I've crudely outlined here in red where the Fraser sockeye are found and their proportion. So there are two points here. So in 2007, the Fraser sockeye formed a component of the run up in Hecate Strait and also in Queen Charlotte Sound to the south. So in Queen Charlotte Sound, virtually all of the sockeye caught were Fraser sockeye and in the inner route off Hecate Strait, the Hecate Strait Fraser River sockeye formed just under half the catch. If we move to 2008, it's somewhat more abundant than in 2007 but it's not the 20-to-one or 30-to-one, 20-to-one change in the relative abundance one would expect based on the success and the failure of those runs to come back as adults.

If we then look at the sampling that was done, so the sampling, of course, there are more refined ways to do this than to just simply report the numbers of fish that are caught. Technically we'd also like to control for the number of trawl catches that were done, but they won't be too different and the key point here is that between years, between 2007 and 2008 there is not a large difference in the sockeye catch overall. So neither the abundance of sockeye in the trawls or the proportion of Fraser sockeye in these locations really portend the 20-to-one difference in the adult return rates that were achieved by that time. So this is data that I just received last week and it needs to amend something I'd said in a submission I made to the commission some months ago, which was the 2007 appeared to be anomalous in the poor Fraser sockeye survival to Hecate Strait. The 2008 data says it's not too dissimilar.

We now turn our sights to the first autumn at sea. The offshore migration was really thought to be a movement along the coast shown by these large broad arrows and then in the first autumn and winter at sea, simply it was thought that the smolts or the juveniles would turn left and move out into the Gulf of Alaska at that point. And this was based on work done from the 1960s. Some of the contribution that I made and which has been continued since then at DFO is to look at the juvenile distribution along the shelf. The key point here is that the red dots show locations along the shelf where one or more salmon were caught in the trawl and the yellow crosses show where there were no salmon caught of any species. So that includes Fraser sockeye if they were there. And the two black lines outlining the edge of the continental shelf here are the 200-metre and the thousand-metre depth contours, so that's the true edge of the continental shelf or the edge of the continent. So the smolts are staying within this area for long periods of time, much longer than that earlier conjectural graph would have suggested.

If we look first in October, the salmon catch for all species, in this case the peach-coloured circles are scaled with the size of the catches from the trawl per 30 minutes are found again on the shelf within the thousand-metre depth contour along here and offshore, although we catch -- we do have zero catches on the continental shelf in October, consistently offshore we never caught any of the juveniles. So they seem to be staying in this case resident on the shelf for many months because these animals even at their size when they first enter the ocean at ten kilometres a day, they could have moved past this area had they wished to. There's no question they could have either swum offshore or swum north and swum out of this area if they'd wanted to.

So some of these animals are remaining as longer-term residents within the area and if we take it to the next slide, this is the Alaska Peninsula at the end of November and early December. It's based on the one cruise that I did in 1997 to this area. This is what got me convinced that automatic sampling methods that didn't require people going to sea was absolutely critical because in the three weeks that it took from Kodiak Island to the south, southwest, we only had a day and a half of fishing and the rest of the time on a boat that cost $15,000 a day was spent holding on, trying to wait for the weather to come down, which is typical for that time of year.

The key point that comes from here on a scientific perspective is that our first transect in was four days of steady fishing heading in towards Kodiak Island and at the end of November, still none of the salmon were found off the shelf. We reached the shelf edge and then there were large catches of salmon on the continental shelf off the Alaska Peninsula.

Subsequent to that, over a three-week period, we sampled offshore on these two-day periods and we found almost none of the smolts were off the shelf. Finally, on December 7th, I can't show it because the camera is in the way, but the far left-hand side ten percent of the -- sorry, ten percent of the juvenile salmon were caught off the shelf with half the samples we did on the 7th of December 1997, and this is the first real evidence we had for salmon starting to move off the shelf. So if this data is credible, what it's indicating is that the juvenile salmon remain on the shelf for very long periods of time, out to the start of the Aleutians. The Dutch Harbour is the start of the Aleutian Islands to begin with.

In the second and later years of life at sea, we can move forwards and some data that's just been published by some of our Alaskan colleagues show the distribution of -- the distribution of stocks of sockeye from different areas in the Bering Sea. The peach-coloured area to the -- on the right shows all of British Columbia and Southeast Alaska stocks and what can be seen from this is that only a very few B.C. and Southeast Alaska sockeye combined were found in the Bering Sea, in the central area of the Bering Sea, but as a proportion of the overall sockeye out there, it's only a very few fish that are found in that area.

There was a conjectural model that was developed by French and colleagues some 40 years ago now on what the movements of sockeye were. This is -- this is where science becomes -- meets art. It was the best guess that the biologists at the time could identify with the technologies at their hands and the data that they'd collected, and it shows a pattern of movement back and forth which Mike Lapointe has already indicated to you. My personal view on this is that it's simply the best guess we can make, but it's a lovely work of fiction that fits the very thin amounts of data that we have, but I don't think that it's necessarily appropriate or correct for Fraser sockeye or possibly for any species of -- any stock of sockeye salmon. I think they're doing something much more sophisticated than this, but the data is too simplistic to really tell you what Fraser sockeye are doing.

Some hint of this can be seen from the tag recoveries in the offshore in June. Dr. McKinley published this a number of years ago and he showed that the centre of distribution of where sockeye returning to these five river systems came from was as shown here. So the dots don't say that all of the Fraser sockeye are sitting at that particular location. It says that's where the average latitude and longitude of the returns were. There were distributional overlaps amongst these stocks, but one of the key points was that the Fraser sockeye from a statistical perspective had a distinctly different position in the offshore Gulf of Alaska than the Skeena, the Nass, the Rivers Inlet sockeye or the Columbia.

So even though this is one species of salmon doing one thing in the offshore, it's -- all sockeye are not the same. They appear to be doing something different within this area which I, as a biologist, can't tell you what it was or why it's important for different stocks to be in different areas.

Now, some of the work I did in the late 1990s for the Department of Fisheries and Oceans involved looking at the offshore distribution of salmon relative to the temperature limits on where they were found. We have this data for all species, but this particular paper that I'm citing here is for my own work with Japanese colleagues for the North Pacific and it shows the sockeye abundance for three areas of the North Pacific, the Western North Pacific, Central North Pacific and the Eastern North Pacific or the Gulf of Alaska in the columns and in each of these panels, which are the rows are by months, it shows the abundance of the sockeye in the catches that have been collected over the last 50 years.

And if we expand just the July data, we can look at this again on a larger scale just to give you a sense of what's happening. There is -- the dots show the individual catches and the abundance of sockeye and if we take the Central North Pacific here, where there's the most data, there's a very sharp drop cut-off in the abundance of salmon at just over ten degrees. It's about 12 degrees Celsius. And then the curve that's through there is a statistical model that shows how the average abundance of the sockeye drops with temperature as the temperature increases. And it's a precipitous drop which is pretty evident from the data and it shows that the animals stopped moving to the south in the offshore at quite low temperatures. During migration in the Fraser River, they're migrating in temperatures up to 12 degrees Celsius -- sorry, 20 degrees Celsius. Essentially over the 45-year period in the offshore we -- none of the scientists involved in any of these many surveys ever caught a sockeye in over about 12 degrees Celsius water in the Central North Pacific. In the Eastern North Pacific there is a little bit more rough or ragged edge to this, that my conjecture is that that's simply because the sockeye are now choosing to migrate back home and to get back into British Columbia you have to migrate through warmer waters.

Well, the -- one of the more profound implications of these very sharp limits to the distribution comes from looking at what the global warming models that the various models under the IPCC, the International Panel on Climate Change have looked at and projected it where they are. This graph, the top graph, shows on the December distribution of the seven degree Celsius isotherm, that's in light blue, and that shows essentially water that would be -- that sockeye choose to live in at the current -- under the current climate. It's pretty good match with what the real data shows, that this is computer-generated data of where the seven-degree temperature limit is and in July the data that I just showed you, this shows the offshore distribution of 12 -- sorry, 14-degree Celsius temperatures in July. So it doesn't quite cover the Gulf of Alaska and areas where we have sockeye, but it's fairly similar.

The reason this is of concern is that essentially throughout the year these are just two months for this. All of the global warming models predict that under a doubled CO_2 climate, which we should expect around 2050 at best guesses right now, the temperatures that sockeye prefer to live in move up into the Bering Sea or in the -- in July actually mostly up into the Okhotsk Sea, which is the sea to the north of the Bering Sea.

Now, whether sockeye will continue to do this in the future and why they don't do it now and how important it is for their life history is purely a matter of conjecture and speculation right now, but if they do do this, the point is that in July, they would not actually be able to migrate back to British Columbia at all because the Alaskan land mass is between British Columbia and where the projected temperature distribution is, acceptable distribution of temperature is for sockeye. So potentially in the future, there are some very profound implications for the productivity of these animals since it says that they're -- for whatever reasons, they are choosing to respond to temperature in a very sensitive way.

We now turn to the maturation and the return home. The graph on the right-hand side -- sorry, the left-hand side shows how the sea temperature off Vancouver Island is related to the proportion of the sockeye returning to the Fraser River that choose to migrate north coming in through Queen Charlotte Sound and Johnstone Strait. The other alternative, of course, is to go south and around Juan de Fuca Strait to the south. And basically over about a two-to-three-degree Celsius change from about ten to 12 or 13 degrees Celsius, it switches from being entirely a migration in through Juan de Fuca Strait to the south to a migration at higher temperatures of being 80 or 90 percent coming in through the northern route through Johnstone Strait.

Now, in the -- there are a number of papers that have been published looking at this migration of the adult -- of the maturing adults coming back in. The one that I've chosen to highlight here shows the correlation between the offshore temperatures right across the Gulf of Alaska with the returning -- the northern diversion rate as this is shown. And essentially what the authors showed is there's a dashed line along here where there's maximum correlation between the offshore temperatures at any of these locations and the proportion of fish coming around Vancouver Island to the north. So essentially, anywhere along that line has equally good predictive capability of telling you where the sockeye would return. And what I've put on here as the red star is where the centre of the Fraser sockeye distribution was from the tagging work that I showed you several slides earlier. So although it's just -- they're independent data sets. They do seem to correlate fairly well, that the animals are in an area where those temperatures are a pretty good predictor of the diversion rate and the tagging data from the 1960s suggested that they were out there at virtually where that dashed line indicates. So it's fairly consistent.

If we turn to food and survival, this is very complicated and I've chosen in my 30 minutes to really minimize it because the short answer is that sockeye eat just about everything. As small animals they're eating plankton, as larger animals they're eating fish and squid, as are most of the salmon that are out there.

One of the key aspects is that there were large changes in the zooplankton between the 1950s and '60s shown in the upper right, and the 1980s to 1989 period, when there was more than a doubling of the abundance of plankton which would fuel the basis of the food chain in the offshore. And the key point here is that the offshore Gulf of Alaska also changes over time. Sockeye populations have built up around the Pacific Rim. In this slide you see that there was a very large change in the plankton out there that was coincident with this.

Now, I have to apologize at this point. I have left a slide out of my submission from next -- from when I submitted it last week. It shows the concurrent changes in the abundance of sockeye caught during these two periods in the offshore, showing the same matched abundance change. So there's a much larger catch of sockeye everywhere in the North -- sorry in the Gulf of Alaska in the 1980 to '89 period than there was in this earlier period, so not only did the plankton change between the '50s and the '80s, but also the sockeye did, which we know is true both for Fraser River specifically but also around the Pacific Rim. And Alaska had a very large increase in sockeye abundance, as well. So I'll have to submit that to the commission afterwards as a correction to this once I get the slide.

If we take a look at the 2010 Fraser sockeye return, and I should put a disclaimer in here. I have a conflict of interest that I have to declare. My wife is one of the co-authors on this paper. This shows the offshore abundance of chlorophyll, which is the pigment that's in plants that fuels the bottom of the food chain. In August of 2008 the upper left-hand graph shows from two satellite measurements shows the remarkable increase in chlorophyll within the Gulf of Alaska. If you look in the upper right-hand corner, there's a square here which is the area that was sampled from the satellite record and it -- and the peak shown in the line graph on the left-hand side shows a very large increase in the chlorophyll concentration in the offshore. Chlorophyll is the pigment that plants use to grow and produce and there was a massive increase.

The reason for that almost certainly is because of a volcanic eruption in the Aleutian Islands that occurred in August of 2008. The lower left-hand graph shows a satellite composite of several different overpasses by satellites showing the plume of ash that goes out across the North Pacific and into the Gulf of Alaska and the lower right shows a computer model of the timing of the ash dispersal. So this, for a time, the magnitude of the eruption was sufficient to shut down the airport in Anchorage, Alaska. So it was a very large eruption and you can see the ash fall in the lower right-hand side that basically within three days the yellow dots, it had either reached the centre of the Gulf of Alaska or some of it had blown onto Northern British Columbia and Southeast Alaska.

Now, the reason this is important is that ash is a basalt material and it's rich in iron. The North Pacific Ocean and the Antarctic Ocean are the two ocean areas in the world where plant growth is not limited by nitrogen and phosphorus, so the normal things that gardeners are familiar with. They are, in fact, limited by the amount of iron as a trace element that's out there and because there's not enough of that, it prevents the plants from uptaking the other nutrients that are actually in abundance, super-abundance out there.

So the reason for the slide is to show that in August of 2008 there was a very large amount of chlorophyll across the Gulf of Alaska, and if I switch to the next slide which is from the same paper, the top left shows August 2005 satellite imagery, lower left shows August -- sorry, top right shows August 2006, lower left shows August 2007 and lower right shows August 2008. So this is just prior to the 2008 out-migrating smolts going offshore which formed the 2010 return. So what's quite visible from this is there is, in the lower right-hand graph which is August 2008, far more yellow out here which is the colour scale for chlorophyll than in any of the prior years. So what happened at that time was a volcanic eruption just prior to the onset of winter of 2008 and associated with that was a very large plankton bloom that stretched across much of the Gulf of Alaska, including where Fraser sockeye were.

So I'd like to switch to the animation now of Cultus Lake sockeye migration, and if you can start it and then just hold it, pause it right as soon as it starts. So this work is based on some of my current work on developing a marine telemetry array for measuring survival of sockeye -- well, not just sockeye salmon, but other species of salmon, as well, and eventually other fish, but the reason that we're going to show this now is to summarize the overall movements of one stock of Fraser River sockeye.

So if you could maximize that, just hit F11. All right. And so this particular year we've published this, it's in the notes. What's published is the out-migration of 2007 smolts. What's not published is a paper that we have now in review talking about the adult returns that have come back from this. So Cultus Lake is in the Lower Fraser River and in the four years 2004 to 2007 we acoustic -- we surgically implanted acoustic transmitters into the smolts and then released them at the outlet to the Cultus Lake to go out and out the -- over the marine telemetry array. So the -- if I can show you here, the magenta lines show the Northern Strait of Georgia line which stretches from Comox to Powell River. It's sitting just off the sea bed or actually it's in mid-water column, across the northern tip of Texada Island. There's a line just north of Port Hardy stretching across from Browning Pass to Duval Point on the mainland side. These are about 20, 25-kilometre long sub-arrays of receivers. We have a line across from Sheringham Point to Pillar Point on the Washington Coast and then on the outer coast, just north of Quatsino Sound, we have a subarray sitting at Lippy Point, stretching out to the edge of the continental shelf, to just about the 200-meter isobath.

And then within this area, we have some receivers in the lower Fraser River, the farthest up the river that my company maintains is Mission, just below Cultus Lake, and during the 2007 out-migration there were also some receivers in Howe Sound. So what we're going to do now is -- and a little bit of geography here on the map, so there is a graft -- sorry, there is a date down here which shows the day of the year. What we will do is we will animate the movements of each of the animals that are acoustically implanted and then released at Cultus Lake. There were 200 in 2007 so if you can start the animation...

We animate those movements out based on the speed of movement to the detections at each of the points and there's a couple of points here, so there are only a few fish that go out Juan de Fuca Strait, six in 2007, two of them then reach up to Lippy Point on the northwest coast. All of the others go up the Northern Passage through Johnstone Strait to Queen Charlotte Sound. And amongst those fish that have gone past, there were two that were -- we've highlighted as red dots.

Now, if you can pause that. All right. So those two animals are going to return in 2009, so that's two out of 200 or one percent return, and what we did was we programmed the tags, because there's a limited battery power for the tags. We programmed two periods of transmission into them.

We turned the tags on on the 13th and 14th of May 2007. They turned off on the 27th and 28th of June 2007 which was fortunately just after the bulk of the smolts had gone out over the Northern Passage and they're going to turn back on on the 26th and 27th of July.

Now, actually, if I can bring this animation back, something I hadn't thought of. Pardon me. If I can borrow the mouse. I'll take it back to there and run it from there. There are going to be two red dots moving up through Johnstone Strait. Those are the two adults that will come back. So one was at the leading edge of the pack and the second one you can see up in Johnstone Strait heading towards the northern end of Vancouver Island now. So they've now passed -- they passed the northern end of Vancouver Island about a week apart.

Now, when they come back in, what you're going to see is they will come in off the offshore, so the first one you'll see coming in from the north and it arrives just a week after the -- we guessed and turned the tag on and you'll see it starting to move down. It was detected on the outer edge of the Lippy Point subarray. The other tag will now be coming in from the left. We've simply had it flying in from Japan because we didn't know where it came from, but the two animals passed the Juan de Fuca Strait subarray within 12 hours of each other, so pretty remarkable, given they'd left a week apart and they both took the route that they didn't go out -- and then they were both detected with very little delay going up through the Fraser River and were detected as far as Mission, which was our last receiver in the Strait of Georgia -- or in the Fraser River, pardon me.

All right. So if we move forwards then, we can use this as a concept of what happens. The one thing that I can't show you off that animation but from prior years, we've never detected any of those animals up on the Alaska line. They should have reached there, particularly in 2005 when we tagged a lot of animals. So my suspicion is that the Cultus Lake sockeye are staying somewhere between the north end of Vancouver Island and Queen -- and the Alaska Panhandle, but we can't say where.

If we now look at the overall movements, we can break the survival into three patterns. So one is from release to the mouth of the Fraser River in orange; one is from the mouth of the river to northern Strait of Georgia, Texada Island; and the third is through Johnstone Strait, Discovery Strait, Broughton Archipelago to the Queen Charlotte Strait subarray.

And if we look at that, the 2007 smolts are in yellow. Now, we published this in May 2009 just a few months before the collapse occurred and what's completely evident is that we failed to predict the 2009 adult return, as well. The survival out of the Fraser River, the Northern Strait of Georgia and Queen Charlotte Strait was very similar to the other years. These are, I should mention, larger smolts than the normal hatchery run. We used those because particularly it gave us the ability to put in a tag that was large enough so that we could also monitor the adult return back in.

So the survival was as high or higher than in prior years, so where did the 2009 adult sockeye fail to survive is obviously the key question. Unfortunately, we didn't do the work in 2008, so we have no idea what the baseline would have been for the big adult return that came in in 2008.

Now, what we can do though is look at the relative mortality that's occurring during these two phases. So if we take survival from Cultus Lake to Queen Charlotte Strait, survival was 28 percent or just over one in four fish made it up to the north end of Vancouver Island. So I've reversed the normal way we describe this and I've set it as salmon per survivor. So for every 3.6 fish that were released, one made it to the north end of Vancouver Island a little over a month later, which is normally considered when most of the mortality happens for salmon.

In contrast, the acoustic telemetry results show that we had a one percent return of the adults two out of the 200 came back which was in line with what happened for the Cultus Lake run as a whole. Well, we had 28 percent survival to the north end of Vancouver Island and one percent coming back, so the implication of that is that it took 28 fish that have passed the north end of Vancouver Island to make one adult that came back. So if the acoustic telemetry date is credible, it suggests that almost four times more -- sorry, seven times more mortality is still to come after passing the north end of Vancouver Island as occurred to the north end of Vancouver Island.

So I'd like to summarize this now. So Fraser sockeye smolts travel long distances along the continental shelf before eventually migrating to the offshore North Pacific. That gives a narrower focus on where the sockeye problems could have developed during the first year. They're not offshore. They are remaining on the continental shelf. And when they do move to the offshore area, the distribution of B.C. sockeye is mainly in the Gulf of Alaska.

Now, clearly the offshore phase is the least well-understood but abundant sockeye stocks from the Bering Sea also could occur here, as well as other B.C. sockeye stocks that did not collapse in 2009. Now, 2010 we're receiving at least anecdotal reports that there were high sockeye returns occurring across the North Pacific, so the causes of the dearth and the surfeit of sockeye may well be different.

Essentially all Fraser sockeye stocks to our knowledge other than Harrison migrate out of the Strait of Georgia and quite quickly, at about just under ten kilometres a day, migrate 400 kilometres through the Strait of Georgia to reach the Queen Charlotte Sound subarray telemetry array in about 40 days and they had good survival. Harrison sockeye, which had been increasing in productivity are an anomaly. They migrate to sea soon after birth, remain long periods in the Strait of Georgia and then apparently exit via Juan de Fuca Strait and overwinter on the West Coast of Vancouver Island. So very different behaviour, very different survival patterns. And long-term residence in the Strait of Georgia or not migrating north through Johnstone Strait is thus associated with the higher marine survival pattern that's been seen for that stock.

A personal caution and thought based on my career, adult returns in fisheries are generally thought to be determined early in their life history, so typically for salmon, right after they -- if not in the river right after they hit the ocean, Mike Lapointe has spoken about that. As a result of that assumption, there's a tendency to assume that events early on determine the adult returns. In my own view over the last 30 years, what we as a profession have often done is make a simplifying assumption to make the research simpler, but we've not been successful at testing whether that assumption is right. We've gone on that basis of that assumption that things happen very early on and that later on in life is not as important for maintaining fisheries. My own guess or prejudice is that that assumption and failing to test it may be part of the reason why we're so unsuccessful as fisheries biologists at really managing fisheries and recognizing the collapses, whether it's northern cod that collapsed on the East Coast or Fraser on the West Coast.

And an important point which is my personal professional opinion is that it's important to remember that a survival drop to one-tenth of the return can happen anywhere in the life history. It doesn't have to happen early on. So long as there's a one-tenth drop, you're going to get a one-tenth drop in the adult returns, so that's a key point. That simple point is often overlooked because we're often trying to simplify a very complex and costly phase of the life history of marine fish, salmon included, to make the work simpler, but that assumption is almost never tested.

And I'll leave it at that point.

MS. BAKER: Mr. Commissioner, we could start with our next witness for ten minutes and then break, or we could come back a bit early.

THE COMMISSIONER: I would respectfully suggest that just looking around the room, I think it might be appropriate to break at this time and come back at 2:00 and hear the next witness all the way through without a break.

MS. BAKER: Thank you.

THE COMMISSIONER: I believe the presentation we just received has now been marked as Exhibit 2, is that correct?

MS. BAKER: That's correct.

THE REGISTRAR: That's correct.

THE COMMISSIONER: Thank you very much. We'll then take an adjournment until 2:00 p.m. Thank you.
THE REGISTRAR: The hearing is now adjourned until 2:00 p.m.

(PROCEEDINGS ADJOURNED FOR NOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: The hearing is now resumed.
THE COMMISSIONER: Ms. Baker?
MS. BAKER: Mr. Commissioner, the next witness is Karl English who will be providing a PowerPoint presentation on the migration of Fraser sockeye from Alaska to their spawning destinations and when that PowerPoint is pulled up on the screen, I would ask that that again be marked as the next exhibit.
THE COMMISSIONER: Very well, thank you.

EXAMINATION IN CHIEF BY MS. BAKER:

MR. ENGLISH: Thank you. My mike on? I'm good. Well, I want to thank Mike and Dave for the two previous presentations, Mike especially for setting the stage, providing the life history data as he mentioned. For those that may not have been here this morning, this talk is just at the final stages with the adults returning. Dr. Welch provided some of that information and it'll be a bit of overlap between our two presentations.
I'd also like to acknowledge the importance of science in generating a lot of the information I'll provide, but also the contributions of a variety of First Nations that I've had the pleasure to work with, both on the Fraser and elsewhere. So it isn't just data that comes from scientific studies. It's data that comes from working with a lot of very knowledgeable First Nation leaders and their fisheries people.
That's been a huge benefit to me over the years, probably more in the north where I spent more time than on the Fraser, but in the last ten years working on the Fraser.
The first picture there shows you the pretty striking difference between what a sockeye looks like as it enters the lower Fraser River, and one that's on the spawning grounds up in the Adams

River. We're going to step back to -- if this thing works -- maybe it might have to be restarted again, or...

Okay. All right. So the first slide here talks about the various fisheries that are encountered -- that encounter sockeye, fishing areas from the southern southeast Alaska right through to Washington State. So in the top left-hand side of the figure, of the map, shows southern southeast Alaska and then Haida Gwaii and then the north end of Vancouver Island. Then down at the bottom right-hand corner, Washington State fisheries and, of course, the entry to the Fraser River.

Obviously, as David Welch described, the ability of the sockeye to these various fisheries depends a lot on their migration path.

Here's -- the first graph shows what we typically call a northern approach or northern diversion route where the sockeye have made a landfall up off the Queen Charlotte Islands or southern southeast Alaska. And I first encountered this personally in '83 when we were tagging for a northern tagging study and actually putting tags on what we thought were Nass and Skeena sockeye stocks out of southern southeast Alaska, and a number of them were recovered in Johnstone Strait. So this isn't just conjecture that these fish go through these areas.

Subsequently, there's been stock composition done in those southeast Alaskan fisheries and they found significant numbers of Fraser sockeye in certain time periods intercepted in those fisheries.

When they go through from the north and go through Johnstone Strait, it makes them accessible to the major Johnstone Strait fisheries. This is a more typical pattern in what we call El Nino years, which is when there's warmer water further north in the Pacific, and so the fish make their landfall in Alaska. It's also more typical later in the run, so you'll see in a few slides the fact that sometimes -- or very often the diversion changes over the course of the run quite dramatically.

If you look at a more southerly approach where they're making landfall off the south of

B.C., they're not going to be as vulnerable -- or vulnerable at all to Alaskan fisheries, only a little bit in the north coast, and mostly coming through Juan de Fuca Straight, and that's called southern diversion. This is the typical pattern for migration of sockeye in most years in June, July and early August.

This graph shows very clearly this is for the -- on the Y axis here, you have diversion rate. On the bottom axis, you have the time through area 20. Area 20 is the Juan de Fuca Strait, and so the diversion is referred to as the portion of the run that's moving through Johnstone Strait. So while they often put things up at area 20 dates, the diversion is measured as the portion going through Johnstone Strait.

You can see for -- this is -- shows three years, 2002, 2006, 2010. These are all what we call a dominant Adams River year or dominant Shuswap cycle year, just like the year we're in, obviously, 2010. You can see how the diversion rate changes from being usually fair low early in the season, and then rising dramatically around early August, and then the vast majority of the fish going through Johnstone Strait late in the year.

So in terms of -- once they've determined which direction they're going to come in, then the other issue is what they do when they approach on these different routes, and of course the timing of their arrival in Johnstone Straits (sic) or Juan de Fuca can affect all the fisheries or does affect all the fisheries, and a number of the other steps in their migration.

The next phase is once they're gone through these approach fisheries, they now enter lower Georgia Strait and there could be some delay of the fish off the mouth or some number of fish that just migrate directly into the river. And then there's river entry timing. Obviously all these things affect the availability to fisheries.

So if we break these down in terms of the components that affect the timing for timing -- for movement into the George Strait area, or in through these approach routes, it's mostly going to be what's happening on the northeast Pacific, either El Nino events or climate-related changes in the northeast Pacific ocean structure that's going to affect when they arrive back. So it's factors outside of Georgia Strait.

The amount of delay that occurs off the mouth of the Fraser is going to be a function of run timing group, so not all the different timing groups behave the same, and I'll get into more detail of that in a minute. It can also be affected by the abundance of those groups and the amount of overlap between the various timing groups. Fish maturity will have a factor in there as well, and a number of environmental conditions, tides, river flow and temperature.

Then the factors that determine just when the fish that are delaying off the mouth of the Fraser, enter the Fraser River, will again be a function of some of these factors. So again, fish maturity, stock group -- so the stock group is the timing groups of Fraser sockeye -- and then environmental factors.

If you look at these, there's four different timing groups and probably end up becoming more familiar with as time goes on, but the three of them here that exhibit similar behaviour as they approach are the early Stuart timing, early summer and the summer runs, and they all have different management assessment sort of structures for each of the fisheries -- each of the stocks, sorry.

The reason why I put these three together is that each one of these groups enters the Fraser River with little or no delay off the mouth of the river. So when there's assessment programs in Johnstone Straits or Juan de Fuca, they expect to see the fish in the river in a matter of six to ten days from Johnstone Straits test fisheries and five to six days from the Juan de Fuca test fisheries.

The fourth timing group, the late run group, has exhibited two very distinctive types of behaviour. They come in their late run because they come in slightly later, but not a lot later. Their migration is very similar to that of summer run stocks when they're coming through these approach areas, but they can delay off the mouth of the Fraser for quite a period of time, 20 to 30 days or maybe even longer in some years. Or some parts of the run will enter right at the same time as the -- or with little or no delay, just like summer run fish. It's this variability in behaviour that has been the focus of some major studies started in 2002, 2003 right through to this past year when we've been tagging on the approach routes and looking at migration into the river.

So as with the summer run, the amount of travel time, they're usually a little bit slower moving than summer run stocks, you know, six, seven, eight days to get into the river, but when they're moving directly through to Mission -- or this 25-plus days of delay as we experienced for a lot of the fish this past year.

Just to give you an idea of how fast they're moving, these summer run stocks and late run stocks are going to be moving between 35 and 45 kilometres a day in the ocean.

There's a few charts here that show for -- and these obviously can be done up for a variety of the years. I focused in on this dominant late run Shuswap cycle year, which is the same one we're in this year, so 1990, 1994 are two years prior to when we had observed a lot of fish entering early. If you look in the time period here, it shows summer run in blue, the early summers in yellow. These are Scotch and Seymour, the two primary early summer stocks, and red is the late run, primarily the Adams River or Shuswap stocks.

Prior to 2000 -- or prior to -- yeah, it was 2000 that the DNA analysis techniques allowed for distinguishing stocks using their DNA as opposed to scales. There really wasn't any way of reliably distinguishing these yellow fish from these red fish because they weren't yellow and red in the water. They all look the same. Their scale pattern, which Mike showed you earlier, which is used to distinguish between the different lakes, was very similar because they rear in the same lake. They're both rearing in Shuswap Lake.

So this created a problem. So most of the separation here between early fish and later was based on the assumption that because they have earlier spawning timing, they had to be those fish that come in early.

What happened in 2000 -- in the year 2000, they developed the stock ID methods using DNA so they could actually distinguish these two populations and you can see in the lower graph that there is timing -- times when, in fact, for a lot of the run, were -- in both the lates and the early summers are coming in at the same time. Ninety-eight ('98) was the last year prior to -- for this particular run, this a four-year cycle for the Adams stock -- that they didn't have the DNA data. And for the latest two years, you can see the pattern has been consistent where we have Scotch and Seymour, the early timing stocks and late run coming in at the same time, and starting as early as late July. So we have late run fish entering the Fraser River as early as late July, where the bulk of them enter in early September to mid-September in every one of these dominant cycle years, but there's always some that enter early.

These -- I should have probably mentioned at the beginning, this is timing at Mission now. This isn't the area 20, so this is when the fish actually migrate past the Mission hydro-acoustics site. And these numbers are all adjusted numbers, post-season, for 2006 and these numbers are the preliminary for 2010 available on the Salmon Commission website.

So if we move into the Fraser River now and look at the various components of getting the fish home, so now they've entered the lower River here and they've got this long migration past Mission, which is located near the -- just below the mouth of the Harrison, past Hope, and all the way up to the spawning areas as far up as the Stuart system in the very top part of the figure you're looking at.

We have, for a number of years, deployed monitoring locations along the river, the main stem and in the tributaries, and put radio transmitters in fish to look at how fast they will do this migration, and also assess their passage through some of the challenging areas. This is a picture of the Bridge River rapids location near -- just above Lillooet. It's one of the areas that -- a lot of people think that Hell's Gate is the only place where there's a problem for fish passage on the Fraser. Well, salmon are challenged for quite a bit of their migration.

This is another one.

Here, if you're looking just upstream, you can see the degree to which the river is very channelized, very canyon oriented with a number of constriction points where the fish have to migrate up against quite considerable current. This is looking upstream from Kelly Creek. Kelly Creek is just above Bridge River rapids area up to the Chilcotin. You can see similar types of migratory challenges, areas in the Lower Thompson as well.

So despite all those challenges, fish -- these sockeye have an incredible ability to swim upstream at speeds, in freshwater, equivalent to what they're doing in the ocean. This is an example of just one fish that we tagged in the lower Fraser in 2006. It's an early Stuart sockeye and it's migrating from Mission all the way to the early -- to the Stuart system up here right in the top part of the graph in 16 days, which is 800-some kilometres at a pace of 45 -- average speed of 45 to 50 kilometres a day. Mother Nature has some pretty amazing talented fish.

They're the fastest of the sockeye. Chilko and a lot of the summer runs are a little bit slower in their migration, but not much, thirty-five to 40 kilometres a day. There's quite a rigorous migration challenge that's between the Chilcotin junction and the spawning grounds up near Chilko Lake, which means that the length of time it takes a fish to move from between those two spots can be quite considerable, in fact is almost half the migration -- the in-river migration rates for these fish.

This is a fish that was tagged, in this case, out in Johnstone Straits, took it seven days to enter the Fraser River and then migrated up and was 31 days reaching the spawning areas in the Chilko system. So it's basically, you know, 24 days in migration in fresh water.

I put two up here for the -- these are Adams River fish. Their DNA stock ID'd as Adams fish, even though one did not make it back to the Adams and the top one did. The top one -- they were both tagged on the same day in 2006, in early August, in Juan de Fuca Strait at the bottom corner of each of these graphs, bottom left-hand corner. The first one on the top of the graph, it took 30 days for it to reach Mission. Now, it could swim very readily from Juan de Fuca Strait to Mission in probably seven to eight days, and in fact its fellow migratory out here did in fact swim there in eight days.

But the first one likely delayed -- we didn't have -- there's no way of detecting these radio tags in marine waters. That's the reason for using acoustic tags in what David Welch's studies have done. The studies where we have applied both acoustic and radio tags to migrating adult salmon have shown that the fish move quite rapidly down through the Straits -- or up through the Straits here, and holding off the Fraser River mouth for considerable period of time for those that delay.

The top one here is taking about 23 days to migrate in freshwater up to Little -- past the Little River receiver, which is just near the mouth of the Adams, and then there's often another delay there for a few days before they enter the Adams River where I guess people have been seeing them recently.

The bottom graph shows a fish that entered right away with virtually no delay and, in this case, it was tracked to a location just above the Spences Bridge area near the Nicola junction. It took it 17 days to get there from release or about nine days in-river migration. But that was the last place we detected that fish, and it was during a period of high temperature and a lot of the fish were observed dying en route in that year, and hence the term "en route mortality" which is -- you'll hear -- another one of those terms you'll hear referred to quite a bit for late run fish, because it can be quite significant in years like this, 2010, and other late run years.

This chart shows a summary of just some of the migration speed data, putting it all on a single chart where you have the migration speeds across the bottom, the different reaches, Mission to Hope, Mission to Hell's Gate, Mission to Thompson, to the Chilcotin junction, up to the Quesnel junction, and then some of the reaches within the Thompson system. The purpose of this is just to show that late run fish in the brown here are -- tend to be and have been consistently slower moving in-river and somewhat slower in the ocean migrating than the other stocks.

The summer runs, whether they're early summers or the summer in blue here, tend to migrate at about the same rate through all these reaches, and you can see the overall migration speed for early Stuart is the fastest, getting upwards of 40 kilometres a day compared to the other runs.

This is where the fun really starts, when you're putting transmitters in fish and you're actually putting a temperature logger on the fish to figure out what the fish is experiencing on an hourly basis during an extended migration from the release site - in this case in the Mission area - all the way to the spawning site which is Scotch Creek.

So this is actually a Scotch Creek fish. It's an early summer timing group and it's -- here we're referring to as a pre-spawn mortality. So it didn't die en route, but it didn't successfully spawn. And the only reason why we know that is because when they recovered this tag on the spawning grounds, it was a female and she still had her eggs. That's what people will be referring to when they talk about pre-spawn mortalities, fish that's made it all the way to the spawning ground but doesn't deposit the eggs, dies before spawning. There's some ample examples of those, I think, up in the Adams and Shuswap system this year.

The concern obviously from the biologists, and from all people concerned with the stocks, is why these fish are going through this tremendous migration and then not finishing their job and spawning. So a lot of it we believe is due to temperature, and you can see the temperatures here. I talk about fish in the ocean choosing temperatures in the 12 to 14 degrees or cooler range, they're having to encounter temperatures here in the lower river in the 18 to 20 degrees range on a daily basis while swimming upstream and encountering fisheries and everything else.

It can get warmer in periods. Like you can see here, we're over 20 degrees for this fish. This is the temperature experienced by the fish. It isn't just something we're measuring, you know, somewhere else. This is actually the data recorder on the fish.

Then once it's -- you can see where it is, the different reaches as you move up this red line from Rosedale to Hope to Sawmill, Hell's Gate, Thompson, Spences Bridge. This particular area here where the temperature was very warm was the cause of a lot of fish not even making it further than that point in 2006. This was again, just one of the -- example of many fish tracked in 2006.

The other interesting thing is you can see the temperature dropping down for the fish for periods here, and this is when it enters a lake. So it's typical if they have to migrate through lakes, they use the cool water in the lakes to get their temperature back down to where they want to be, and you can see this fish choosing to go back down to this 11, 12-degree water. This fish could readily swim through Kamloops Lake in three days. So while we don't know precisely where this warm water is being experienced here for a day, we believe that it's at the outlet of the south Thompson going -- flowing into the upper end of Kamloops Lake. That's where this fish wants to go, wants to move through and up into the south Thompson and then up into Shuswap Lake.

It's made three attempts here to come out of the lake, back in the lake for a period, back out the mouth for warm water for a period, then back into the cool water, and then finally holding at the mouth here for a day and then deciding it's going to push through into Shuswap Lake.

The accumulation of temperature for an individual fish -- so these are accumulated temperature units, ATU's, could readily determine and be related to the survivorship of fish both to the spawning grounds and also the potential for pre-spawn mortality. So these studies that have combined both temperature and migration are telling us a lot about what these fish are encountering and potentially why they're dying.

For late run, the research done in 2002, '03, '06 -- and these are the combined efforts of the Salmon Commission, ourselves, DFO and a lot of First Nations assisting with tag recovery and in-river monitoring and catch-monitoring programs. So piecing it all together to try and figure out what is the pattern of mortality for late run fish? Why do late run fish that -- and are at different times, from early August through to late in September -- why do they have -- appear to have different survivorships? So we quantified this with these figures for tagged fish in these three different years.

It became pretty clear that if they entered before the middle of August, there was a very low probability of survivorship to the spawning grounds. These are the en route losses. You could have pre-spawn mortality on top of this. So if it's entering in late August and surviving at a 50 percent level, that doesn't mean that 50 percent are going to spawn. It just means 50 percent are going to make it to their spawning grounds.

But you come in -- if you're a late run fish coming in, in late -- in mid to late September, you have a better than 90 percent chance of both making it to the spawning grounds and usually pre-spawn mortality drops off for those late arrival fish. So there's better survivorship to spawn, better spawning success.

This just is a picture of what the fish look like up in the Adams River. People may have seen something similar this year where they're doing escapement monitoring. They apply tags to fish at these sites, do mark or capture work to assess the population size, but they also use that -- these surveys to assess pre-spawn mortality as well as the sex composition for the runs. They can get their effective females numbers.

Of course, not -- Mike alluded to the fact that sockeye in the Fraser seem to be very specific into their timing for spawning periods, so I thought I should put up one chart here that shows the different run timing groups in colours so for early Stuart in brown at the bottom, yellow for early summers, summers in blue and late run in red.

These are the different conservation units. It's another term people will be referring to probably from time to time. There are 25 routinely assessed conservation units for Fraser sockeye. There's more in total, but these are the 25 where there's good time series of data sets.

They represent the vast majority of the conservation units for Fraser sockeye and they all have their own specific escapement timing period and spawning period. You can see the range from early Stuart and actually Chilko in the lower end -- sorry, not Chilko -- Chilliwack in the lower end which is just above the Mission area right through to -- and they're coming in, in early July, and moving right up into the spawning areas very quickly 'cause it's a short migration, through to the Shuswap complex and also Cultus, which people will get very familiar with that name. It's one of the latest timing for spawning stocks of Fraser sockeye.

I just thought we should put up some pretty pictures of the Adams River fish. These are the grandparents, a couple of grandparents here, a male and a female in this picture. In 2002 this slide was taken and we had a number of these fish tagged and tracked in that year, and this is the Adams River spawning grounds.

There is lots more data, but I figured that probably will cover it until there's questions. Thank you.

MS. BAKER: Mr. Commissioner, I have no questions arising.

What we have given all of the participants is an order for cross-examination which we will follow. Because Mr. Lapointe is an employee with Pacific Salmon Commission, our rules provide that his counsel has the first opportunity to ask questions, and then we'll move back into the order that the participants have been provided, which is 1 to the end. I can assist in that if people are not sure where they go in the line-up, but we also have the numbers of the front of the desk, so people should know where they go. After the Pacific Salmon Commission it will be the Government of Canada followed by the Province, and I can assist beyond that if we need to.

Now, again we have about a half hour before the break and then 45 minutes after that, and we're hoping that people will keep their questions to a minimum. All these witnesses will be returning in the hearing to give full evidence, so the intention today is to provide more of an overview than anything else, so clarification on

what they have heard is appropriate, but in-depth cross-examination, I submit, should wait until the witnesses come back for a full day of proper hearing. Thank you.
THE COMMISSIONER: Thank you.
Mr. Hunter.
MR. HUNTER: Thank you, Mr. Commissioner. I have no questions of the panel.
MR. TAYLOR: I have a couple of questions, or a few questions, if I may, and I will remember what Ms. Baker has just said about the panel coming back later on. My first question is of Mr. Lapointe.
MS. BAKER: Excuse me, Mr. Taylor, we do need to identify ourselves each time we speak.
MR. TAYLOR: Oh, I'm sorry, Mitchell Taylor for the Government of Canada.

CROSS-EXAMINATION BY MR. TAYLOR:

Q Mr. Lapointe, I expect you are familiar with the terms "delayed density dependence" and "cyclic dominance"; am I correct?.
MR. LAPOINTE: Yes, that's correct.
Q And those terms apply to the Fraser sockeye, do they?
MR. LAPOINTE: Yes, they do.
Q Can you briefly explain what they are?
MR. LAPOINTE: I will try.
MR. ENGLISH: You wanted me to do that one, didn't you.
MR. TAYLOR:
Q I don't mean to put you on the spot if there's an indication there that Mr. English is the better panel member to do it.
MR. ENGLISH: No, no, he's the better one.
MR. LAPOINTE: I'll try to do it.
I'll start with "delayed density dependence".
Some of the figures that I showed at the very end which related the fry production to the abundance of females in the brood year, in the parent year, delayed density dependence extends that out to say that the parents in the brood year might not just affect the abundance of fry that they produce, but also subsequent abundance and survival of fry of subsequent generations. So it's extending the effect of density beyond the effect of the parents on their offspring to the

effect of the parents on subsequent offspring. And there are a number of statistical models have been fit to Fraser sockeye which demonstrate that this -- that those models actually do fit the pattern of returns of Fraser sockeye. But basically it's an extension, and the reason for the term "delay" is that it occurs not just immediately after on their offspring, but on subsequent offspring.

So that's the definition I would offer for "delayed density dependence".

Now, "cyclic dominance" is going to be a little bit more difficult I think for me to summarize succinctly, but I will try as best I can.

There are some theories that would suggest that that delayed density dependence is something that is inherent within the biology of the fish, and that term has been called "cyclic dominance". So the idea that the largest returns in this case, and Adams River would be a great example because this year was a great, very large return of the Adams River. The Adams River pattern of returns would show a very large run, which would be the 2010 return, followed by a run that's slightly smaller, perhaps, you know, half, half the size, followed by two much smaller runs that would be orders of magnitude smaller.

Cyclic dominance refers to the concept that that pattern is controlled intrinsically within the biology of Fraser sockeye, and one of the mechanisms that could be controlling that would be this delayed density dependence idea, which we introduced earlier on.

So I think I'll stop there and see if that helps you, and if I can offer clarification, I'd be happy to do so.

MR. TAYLOR: I think that is fine. Thank you very much. My next few questions are of Dr. Welch.

Q You referred, Dr. Welch, to some tagging that you had done where you tagged smolts. Can you say what the implication on your study of using larger smolts, which I gather was the case for tagging.

DR. WELCH: Well, there's -- so the question is whether the larger smolts have an effect on their survival and it would be different for the small smolts.

Q Yes.
DR. WELCH: So since we don't have direct data on the survival of small smolts we can't answer that directly.
But last week I became aware of a paper that's just being published by DFO staff member, Dr. Jim Irvine and a colleague, showing that the survival rates of Chilko one-year-old smolts and two-year-old smolts was virtually identical over the last half century. So those are not the runs that -- or the run that we did the work on. But that work suggests that the survival rate of larger and smaller smolts is -- is very similar, if not identical.
Q Would you expect, however, that the survival rate for larger smolts, all things being equal, would be better for the larger than the smaller?
DR. WELCH: That's a long-standing theory. There's been very little data to support that over the range of size of smolts that's been done. Certainly large fish like adults coming back have better survival per year than small smolts. But I don't think there's any direct data to point to that.
Work we've done in the Columbia River shows that over the range of smolt sizes that we have been tracking and measuring, the survival rate has been independent of the size of the smolts that we've tagged. So it's not a complete answer and it doesn't apply to the Fraser sockeye, but most of the very recent work that we've done, which not all of it's published, indicates that survival does not strongly depend on the size of the smolts that we've looked at so far.
Q At the same time is it the case you don't rule out that your study could be biased low for mortality in Georgia Strait of the Fraser sockeye?
DR. WELCH: It's certainly a possibility. What we're looking at is the survival across the life history, and also the survival between years, which seems to be constant, or similar, rather.
Q Have you heard the proposition or theory that in 2007 in July there was a low abundance of food in Georgia Strait due to the shallow depth of the water layer that supports nutrients?
DR. WELCH: Yes, I have.

Q And is that something that's a fairly well accepted point? That is to say, there was a shallow depth of the nutrient-supporting water in that year?
DR. WELCH: I can't comment, because I haven't seen the data.
Q Okay. Now, I understand from what you said earlier that you have studied the sockeye and specifically Fraser sockeye for many years now.
DR. WELCH: Correct.
Q And am I correct in what I take from your earlier evidence that you didn't see the dismal returns for 2009 coming before it happened?
DR. WELCH: That is -- that is correct.
Q Now, some of the slides that you used, I believe were from Marc Trudel, were they?
DR. WELCH: That is correct, yes.
Q And you know him to be a DFO scientist?
DR. WELCH: Yes, he is.
Q And in fact am I correct that you and he collaborate in some of your work together?
DR. WELCH: Yes, we do.
MR. TAYLOR: Thank you.
MR. PROWSE: C. Prowse for the Province. I have no questions, Mr. Commissioner.
THE COMMISSIONER: Thank you.
MR. BUCHANAN: Thank you. Chris Buchanan for the PSAC. We also have no questions of this panel.
MR. BLAIR: Alan Blair for the Salmon Farmers. We have no questions.
MR. BURSEY: David Bursey for Rio Tinto Alcan, we have no questions. Thank you.
MR. McDADE: Gregory McDade for Dr. Morton and the Aquaculture Coalition.

CROSS-EXAMINATION BY MR. McDADE:

Q I just have a couple of questions for Dr. Welch in terms of the migration of smolts in the 2007 year.
Am I correct, Dr. Welch, that in the 2007 year -- or let me ask a more general question. It seems from your presentation that the Fraser River sockeye migrate primarily up Johnstone Strait to the north. There are other stocks, though, that migrate up the West Coast of Vancouver Island, for instance the West Coast stocks.
DR. WELCH: Sorry, the West Coast Vancouver Island

stocks?
Q Yes.
DR. WELCH: Yes. So the majority of Fraser sockeye are thought to migrate up Johnstone Strait, the northern exit. The tagging work we did in multiple years certainly showed over 90 percent -- well, probably over 95 percent of the Cultus Lake sockeye that we studied migrated through Johnstone Strait. A few percent in some years migrated out Juan de Fuca Strait.
Q And the stocks of the Columbia River are also thought to migrate up the West Coast of Vancouver Island and not Johnstone Strait?
DR. WELCH: That's correct. So Dr. Trudel of DFO has genetic data now showing the Columbia River sockeye migrate up the West Coast of Vancouver Island. I don't -- I'm not aware of any data showing Columbia River sockeye migrating into the Strait of Juan de Fuca.
Q Okay. And the Harrison stocks are largely resident. They don't migrate up through Johnstone Strait.
DR. WELCH: So I have a couple of slides that were specifically on that. I think the most accurate way to respond is that we don't know how Harrison sockeye move out of the Strait of Georgia in the fall. It's clear they're in the Strait of Georgia, from Dr. Beamish's studies, at least until September and November and then they move out to the West Coast of Vancouver Island, according to Dr. Trudel's analysis. It's thought that they move out Juan de Fuca Strait but no one knows for certain.
Q And is it -- am I correct that in the 2007 migration year, which would be the 2009 returners, the Columbia River stocks did well?
DR. WELCH: 2009 adult return of Columbia River sockeye was exceptional. The best in about 50 years.
Q And the -- the adult returners on the West Coast of Vancouver Island were good, as well?
DR. WELCH: Average to slightly above average, I believe, but I'd qualify that in that I'm not positive of -- it's certainly not a reduced run.
Q And Harrison stocks were also doing well?
DR. WELCH: Very well according to the data we have, yes.
Q So that the Fraser River problem in 2009 appears

to be isolated to those stocks that were running up Johnstone Strait.
DR. WELCH: That's correct.
Q And your telemetry study indicates that as of the exit from Johnstone Strait, your view would be that mortality rates were normally what would be predicted?
DR. WELCH: They were not what would be predicted. What would have been predicted was a much higher mortality rate in the Strait of Georgia because the preceding assumptions and science were that most of the mortality happened -- that mortality rates were very high after entering the ocean and that most of the mortality took place at that time. Our results show that most of the mortality happened after they passed the north end of Vancouver Island.
Q Now, you have suggested in a submission you made to the Commission that much of the mortality may have occurred in the 20- to 30-day range after leaving Johnstone Strait; that's right?
DR. WELCH: That was my submission, yes.
Q And but let me go back to the Columbia River stocks and the West Coast of Vancouver Island stocks. They also go into the Gulf of Alaska?
DR. WELCH: I'm not aware of any information on where West Coast Vancouver Island stocks go. There is certainly evidence for Columbia River stocks going into the Gulf of Alaska.
Q So in effect they go into similar environmental conditions to the Fraser River stocks that have left Johnstone Strait?
DR. WELCH: So far as we are aware. Yes.
Q So wouldn't -- so doesn't this suggest that there's something happening to those fish who take Johnstone Strait that is unique to those stocks in the 2009 adult returners, that that's where we should be looking for the problem?
DR. WELCH: That possibility is certainly one of the top ones.
Q And that's where we have the concentration of aquaculture facilities.
DR. WELCH: There's aquaculture facilities on the West Coast of Vancouver Island, as well. But there are certainly many in Johnstone Strait, as well.
Q And your -- your submission to the Commission suggests that the time of disease transmission for

many diseases is in that 20- to 30-day range, or sorry, disease, fatalities from disease?
DR. WELCH: I would phrase it differently. What I had said in the submission is that based on the data from Dr. Trudel that I was privy to in June, it appeared that the Fraser River sockeye were in much reduced abundance by the time they reached Hecate Strait, about 30 days after passing out of Johnstone Strait, Queen Charlotte Strait.
The data that I received from him last week, which -- about ten days ago in preparing the submission for this Commission, I had asked him for both the 2007 and 2008 data to compare that. So I was surprised to see that the 2007 Fraser sockeye proportionate abundance up in Hecate Strait was not as small as I had thought. And I was also surprised to see that the 2008 smolts were not as abundant as I would have expected in Hecate Strait, which was the point of one of my slides.
Q Yes. But there is still -- you still -- there was a significant difference. It wasn't in the proportion you expected, but there's a significant difference.
DR. WELCH: Significant difference in what, please?
Q In terms of the proportion of smolts surviving.
DR. WELCH: There was -- there were a smaller proportion of Fraser River sockeye in the 2007 catches than in 2008.
Q And so it still continues to suggest that there is some causation -- causative factor in Johnstone Strait that could be the cause of some of this mortality.
DR. WELCH: In my submission to the Cohen Commission, which I've put together in June and was published in mid-July, I said that this is correlation, not causation, and it's very important to identify a direct effect and not -- not assume that there is causation. But those two events did co-occur in 2007. There was a very bad return in 2009 and those smolts did migrate through Johnstone Strait to Queen Charlotte Strait and appeared to have good survival, but by the time they came back, as I demonstrated, their survival was much lower. Where that survival was lower, after passing beyond our telemetry array, we can't specify.
Q All right. So we don't have the cause -- we don't

have enough data at this point to prove causation, but we do to suggest a correlation.
DR. WELCH: Correct.
MR. McDADE: Thank you.
MR. LEADEM: My name is Tim Leadem. I represent the Conservation Coalition. I have a few general questions to ask of the panel.

CROSS-EXAMINATION BY MR. LEADEM:

Q Mr. Lapointe, you mentioned the term "biodiversity" without really explaining it in full, and since this is the first time that we've heard that term in evidence, I wonder if you can take some time to elaborate on the terminology of biodiversity and why it's important.
MR. LAPOINTE: I'll try. So when I use the term "biodiversity", I mean the, I guess diverse groups of populations that would contribute to the overall aggregate population of Fraser sockeye. Within the Wild Salmon Policy context the term "conservation unit" is used, and Karl showed some data for conservation units. So I would describe it as the sort of geographic, bio-geographic suite of stocks and populations and habitats in which they live. Certainly probably obviously a genetic basis for that because of the fact that Fraser sockeye very much home to their natal streams every year.
In terms of why it's important, a whole host of reasons. But primarily because these stocks do have different traits, and those traits may confer them some survival advantage to particular environmental factors or other factors that affect them. It's very much analogous to, you know, diversity of performance in, you know, like a stock portfolio. If you have some populations that do better in some circumstances than others, then having a very diverse portfolio means that your group of populations is much more likely to persist in the event that there is some set of environmental factors that would threaten their existence.
A good example would be something like climate change. Some of these populations may very well be more robust to warmer temperatures in adverse conditions than others. So I guess that's

what I would try to offer up as my definition of biodiversity.

Q That helps. So it's fair to say, then, that the more diverse that you have in terms of the conservation units, the better off you are in terms of achieving some sustainability of the species?

MR. LAPOINTE: Certainly, yes. From a species sustainability perspective, diversity is definitely an advantage.

Q You mentioned the Chilko Lake Weir. Is that operated by Department of Fisheries and Oceans?

MR. LAPOINTE: Yes, it is.

Q Are you aware of any other weirs that count the smolts as they exit the lakes?

MR. LAPOINTE: There is a weir at Cultus. Cultus has had a weir sporadically and more intensely in the last few years. And there's been a few other sort of one-off or two-off events within the Fraser of weirs that have occurred in some of the past years. But Chilko is the primary one that's had this very consistent long-term monitoring.

Q And as a scientist, you find that information useful to be able to have counts on smolts that are exiting lakes?

MR. LAPOINTE: Absolutely. It's the only way I could have provided you the information about the relative mortality of different life stages. So in the context of 2009 and trying to understand where and when to look for potential causes of the low return, unless you have mortality at different life stages, you really just would have a big black box where you have some estimate of the number of spawners and some estimate of the number of returns and no way to know where in that four-year life history the bottleneck might occur.

Q And you would argue certainly for a larger dataset to be able to draw better conclusions; is that fair to say?

MR. LAPOINTE: Yes, it is. Chilko is actually quite unique in some respects. The fry of Chilko actually migrate upstream. It's one of the only populations where the fry actually migrate upstream in that very narrow area near shore. So Chilko may or may not be representative, and obviously without other information from other stocks, we don't know that.

Q And generally speaking scientists like to have more datasets available to them.
MR. LAPOINTE: Of course.
Q Dr. Welch, with respect to the work that you performed, why did you pick the Cultus Lake Conservation Unit to focus upon your study?
DR. WELCH: Well, there were two reasons. One is it's one of the two endangered sockeye stocks in British Columbia, the other being Sakinaw, which we've also worked on, and the other is logistic ease. It's of the sockeye populations it was one where we could readily get our hands on to do the surgical tagging.
MR. LEADEM: Thank you, those are my questions.
MR. ROSENBLOOM: It's Don Rosenbloom, and I appear on behalf of Area D Gillnet and Area B Seiners. I would like to direct my questions to Mr. English.

CROSS-EXAMINATION BY MR. ROSENBLOOM:

Q Mr. English, you have focused on the in-migration or return of the sockeye into the natal streams. I'd like to just spend a moment asking you questions regarding the matter of the in-migration, either internally through the Johnstone Strait as opposed to heading down the West Coast and into the Strait of Juan de Fuca. Do you have information as to the percentage of the run, on an average, that would choose one routing as opposed to the other?
MR. ENGLISH: That graph that I showed up there shows how the percentage changes during the year, and the Salmon Commission would have overall for the entire season the percent that shows one route or the other for that whole season. But it really depends very heavily on the amount of the run that comes in early versus late that determines the diversion for the year.
Q Can you give -- I'm sorry, yes. Can you give some sense of the extreme from year to year of an average that would go one route as opposed to the other -- as opposed to another year?
MR. ENGLISH: I think the range -- Mike probably would be a better person to answer that, but the ranges I've seen have been usually on the order of 40 to 60 percent. So 40 percent going through Johnstone Straits in a low diversion year, in total, and 60

to 80 percent in a high diversion year.
Q Okay. Now, my question is this. Are you aware of studies that have been done in respect to mortality rate with one routing in-migration as opposed to the other routing in-migration?
MR. ENGLISH: Well, we could take some inferences from the tagging that we have done in Juan de Fuca Strait, and similar tagging done at the same time ion Johnstone Straits. And seen quite a range of mortality, essentially measured as the portion of the fish that we tag that actually make it to our in-river detection sites. And then --
Q Mm-hmm.
MR. ENGLISH: Sorry.
Q Go ahead.
MR. ENGLISH: Yes. And in the year when we did it exactly parallel, 2002, we saw some of the pictures from that particular year, we had tagged in both locations simultaneously throughout the late run. We saw very clear pattern that when the bulk of the tags are being put on fish on the route where the majority of the fish were going, and in that year -- if I had that graph up I could show you, but it shows the proportion going through Johnstone Straits was only about ten percent early in the year in the beginning of our tagging program. So most of them are going through Juan de Fuca Strait. And we had what we call pretty high survival for the tags, about 70-plus percent of the tags were detected in the river.
When the run shifted -- and early in the season we had very low survivorship for the fish going through Johnstone Straits. When the run shifted and it exactly changed where 90 percent was going through Johnstone Straits, later in the year we had an almost identical shift in survivorship. So the fish that we tagged were surviving better with the bulk of the run. So where the bulk of the run was going, the survivorship was better. Now whether that was due to the fish being -- the tagged fish being selected by predators, or some other factors, versus it being the tags were being completed representative of the untagged population is still a question. But definitely we had better survivorship for fish that we tagged on the route

where the majority of the fish were headed.
Q All right. And so listening to you carefully, you did not see a correlation in respect to mortality issues based upon the route, whereas you did based upon whether the abundance of the stock were heading down one route as opposed to the other.
MR. ENGLISH: That's correct.
Q Is that your evidence?
MR. ENGLISH: That's correct, yes.
MR. ROSENBLOOM: Thank you very much. No other questions.
MS. BAKER: Mr. Commissioner, I notice that it's three o'clock. Did you want to take a break now or should we press on?
THE COMMISSIONER: The hearing will now recess for 15 minutes.

(PROCEEDINGS ADJOURNED FOR AFTERNOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: Mr. Commissioner, the last PowerPoint was not marked yet. It is now Exhibit number 3.

EXHIBIT 3: PowerPoint presentation titled "Migration of Fraser Sockeye from Alaska to their spawning destinations"

THE COMMISSIONER: Thank you, Mr. Registrar.
MR. BUTCHER: Mr. Commissioner, David Butcher, I have no questions for these witnesses today.
THE COMMISSIONER: Thank you, Mr. Butcher.
MR. HARVEY: So it's, Mr. Commissioner, Chris Harvey for the United Fisherman Allied Workers' Union and the Area G West Coast Trollers.

CROSS-EXAMINATION BY MR. HARVEY:

Q I have a question for Mr. Lapointe and it relates to the slide and the evidence which went to the spawning grounds. And what you were describing, I think, Mr. Lapointe, if I'm not putting words in your mouth, that each spawning ground has a carrying capacity; is that a fair generalization?
MR. LAPOINTE: I guess what I was referring to, more than the spawning ground per se, was the lakes that the juveniles rear in have a capacity.
Q Yes. So the levelling off that you showed after a

certain number of spawners is basically controlled by the carrying capacity of the lakes?
MR. LAPOINTE: That's correct.
Q Yes. And does each system, then, have an optimum carrying capacity, optimum level of spawners?
MR. LAPOINTE: I guess I would need some help in having you define "optimum," relative to what objective?
Q Well, optimum in the sense of ensuring a sustainable return, and optimum in the sense of ensuring that harvest potential is not wasted, because those two considerations can be achieved at the same time, can they not?
MR. LAPOINTE: So when you use the term "wasted," what, specifically, do you mean by that term, could I ask, please?
Q Well, isn't -- "foregone harvest opportunity," isn't that a term you understand?
MR. LAPOINTE: Okay. So you mean that there would be some level of abundance where there could be greater or lesser foregone harvest opportunity, when you use the term "wasted," is that correct?
Q Yes. Well, if -- what I'm trying to convey is that -- and I got this sense from your evidence, that when you reach the level where the -- where you're not getting an increased production from the number of spawners, or the increasing number of spawners that you put on the grounds, what -- that situation will represent a foregone harvest opportunity?
MR. LAPOINTE: It certainly could. So in terms of sustainability, any of those levels of juvenile abundance would be potentially sustainable. It's not like a higher abundance level is not sustainable, but from the standpoint of foregone catch, if putting 2 million fish on the spawning grounds produces the same number of returns as producing -- putting one million on the spawning grounds, then, clearly, the disposition of that difference between those two numbers, one million fish, could be available for harvest, potentially.
Q Yes. Yes. Now, the -- I just want to move on, but with that in mind, to the importance of data collection on the returning adults, you mentioned that -- and you demonstrated a wide variability in marine survival rates. I think one of your slides indicated a survival range of 0.39 percent to 23.4 percent?

MR. LAPOINTE: That's correct. That's for the Chilko stock, yes.
Q That's for the Chilko stock. And you said that the causes of that vast variation are not well understood, and the magnitude cannot really be predicted?
MR. LAPOINTE: That's correct.
Q Yes. That would seem to indicate that the -- that early data collection on the returning adults is of critical importance to in-season management?
MR. LAPOINTE: Yes, that's correct. And as you know, that's our primary responsibility at the Salmon Commission, is to conduct that in-season data collection.
Q Yes. Yes. And just to generalize, that data collection, in the past, was achieved largely through the interception fisheries; was it not?
MR. LAPOINTE: Definitely, in years when there were more consistent patterns of commercial fisheries, that commercial fisheries data did feed into the assessments.
Q Yes. And in more recent years -- well, let me use a term, there's a term sometimes referred to as gauntlet fisheries, and I think that is meant to describe, correct me if I'm wrong, but meant to describe commercial fisheries extending from the mouth of the river out to sea, to the north end of Vancouver Island, and along the west coast of Vancouver Island?
MR. LAPOINTE: Sure, a gauntlet fishery would be the sequence of fisheries from the marine areas right through into the Fraser River.
Q Yes. And the seaward end of that gauntlet has basically been cut down over recent years, has it not?
MR. LAPOINTE: So are you talking about the geographic extent, or the intensity, or both, or --
Q Both.
MR. LAPOINTE: Yeah. So there were fisheries, fairly regular fisheries that would occur as far seaward as the Queen Charlotte Islands, west coast Queen Charlotte Islands.
Q Yeah.
MR. LAPOINTE: Those fisheries no longer exist. The west coast of Vancouver Island fisheries no longer exist. Area G --
Q Yes.

MR. LAPOINTE: -- the group that you represent. And so the fisheries, commercial fisheries now, in years where we have fisheries, would typically start at the top of Johnstone Straits. And so yeah, the geographic extent has definitely decreased. Intensity has also decreased in most years, although 2010, in terms of intensity, wasn't that different from some of the historical years, past years.
Q And with the decrease in the geographic extent of the gauntlet fisheries, has that, to some extent, made it more difficult to arrive at an early prediction of run size and to make the necessary in-season management changes?
MR. LAPOINTE: To some extent, yes, although the fisheries, particularly on the west coast of the Queen Charlottes, weren't that well related to overall abundance. In fact, it would be very typical in years when we had -- when those fisheries did occur, for the peak of the catch in those fisheries to occur almost the same time as the peak catch in Johnstone Straits. In other words, there seems to be a group of fish that would hit the west coast of Vancouver Island, and even though there would be perhaps a very significant catch, and those were troll fisheries up in that area, there wouldn't be a lot of abundance associated with it. It would almost be like most of the run that hit that area was harvested. So they didn't -- they provided a bit of a signal, but they didn't provide a very reliable signal of what was to come in the seaward areas because they just weren't that well related with the abundance that fell subsequent to that. It's possible that something more seaward could be designed, but it would require a broader and a more systematic geographic extent than what occurred in the traditional commercial fisheries that occurred, say, in the west cost of Vancouver Island in the past.
MR. HARVEY: Thank you. I think those are my questions.
THE COMMISSIONER: Thank you, Mr. Harvey.
MR. LOWES: Mr. Commissioner, J.K. Lowes for the B.C. Wildlife Federation and the B.C. Federation of Drift Fishers, and I have no questions.
THE COMMISSIONER: Thank you.

MS. DION: Tina Dion for the Maa-nulth Treaty Society, Musqueam Indian Band, and Tsawwassen First Nation standing group. I have one question, and that's for Mr. English, but I'll start with the comment made by Dr. Welch.

CROSS-EXAMINATION BY MS. DION:

Q You've made reference to the importance of traditional ecological knowledge with respect to First Nations and the fishery, but Mr. English, you specifically mentioned the contribution of First Nation leaders and their fisheries people, as you put it, that you benefited from their knowledge up north, as well as in the Fraser River. And I just wanted to ask whether it was fair to say that your understanding of the traditional ecological knowledge is based on historical knowledge about fish cycles passed down inter-generationally by First Nations people?
MR. ENGLISH: Well, it's a combination. The experiences I've had working with First Nations people in the field have provided their insights into what's going on with populations, and I have, in turn, provided my insights back to them, and so it's a give and take process where we exchange ideas and talk with elders at times, talk with young people at times. And you know, I don't profess to have a really in-depth understanding of traditional knowledge, but I've been trying to incorporate the opportunities to gain that whenever possible. And, I guess, some of it actually comes more from the Yukon and in the Nass than more from the Fraser. I've had somewhat less time and less opportunity on the Fraser to engage in that as much as in the Yukon and in the Nass River.
Q But as a general statement, you'd agree, though, that it's information that is passed down inter-generationally from one generation to the other?
MR. ENGLISH: Oh, yes, for sure. Yeah, and it's a long history of some very interesting things that I'm sure the people on the committee would like to hear at some point, but maybe not now.
MS. DION: Good. Thank you.
MR. JANES: Robert Janes for what's been termed the Western Central Coast Salish standing group.

Gentleman, I, for the most part, will direct my questions to Mr. Welch, save where I direct otherwise. Although, if any of you feel you have something useful to contribute, please sail in as they're relatively generic questions.

CROSS-EXAMINATION BY MR. JANES:

Q And I noticed, through all of your evidence, all three of you, on a number of occasions, you mentioned that there were areas of uncertainty, or there were information gaps, or limits on the data that were available. And I take it that good science involves recognizing and accounting for uncertainty in the data that you have and in the conclusions that you draw from that data; is that fair to say?
DR. WELCH: Yes, it is.
Q And as part of doing good science, you try to identify uncertainty where it exists in your work; is that fair?
DR. WELCH: Yes, it is.
Q And in certain cases, you can even try to quantify the uncertainty, using statistical techniques; is that fair?
DR. WELCH: Correct.
Q And again, you'd also try to provide explanations for the uncertainty, where those explanations are available?
DR. WELCH: Possibly. That's a rather broad question to answer simply.
Q And just taking it a step further, then, as -- and as I think you've shown in parts of your evidence, you know, part of the scientific process is -- involves articulating the methods of trying to shed light on the areas of uncertainty, or limit the uncertainty, the areas of uncertainty where that is maybe possible?
DR. WELCH: Correct.
Q And in terms of the scientific understanding of the Fraser River sockeye lifecycle, I'm going to suggest that there is -- there a number of areas of what I'd call significant uncertainty, and I'd just like to sort of take that apart, but as a general statement, is that fair to say?
DR. WELCH: Yes.
Q And let's look first at the issue of trying to

forecast sockeye returns. One reality is there is a reality of natural variability in terms of how the returns occur; is that correct?
DR. WELCH: Correct, in all phases of the life history.
Q Right, and that can be influenced by things like weather patterns like El Nino?
DR. WELCH: Yes.
Q And I think you gave an example, and I just want to try to take a moment to make sure I understand the significance of one of your slides, Dr. Welch, which is slide 32, I believe it is, in Exhibit 2, which is where you referenced the 2008 volcano event?
DR. WELCH: Correct, yes.
Q To make sure I really understand what you're getting at there, as I understand it, this is a situation where there was a volcanic eruption, I believe it actually erupted into an unusual storm system that resulted in a dispersal of ash over the ocean; is that fair?
DR. WELCH: Yes.
Q And that resulted in a growth in plankton, as measured by the abundance of chlorophyll in the water?
DR. WELCH: Yes, and also the animal plankton that was measured from direct measurements at sea.
Q Right. And the hypothesis, I think, that you're putting forward is that -- or -- and it is just a hypothesis at this point in time, is that that may well be part of the explanation of the incredibly abundant salmon this year; is that fair?
DR. WELCH: Yes, it's -- several slides there point out that in the 1950s and '60s, plankton was much less abundant than in the 1980s, presumably due to climatic changes, and the sockeye abundance offshore in those areas was much more abundant in the period of high salmon -- high plankton abundance. And the 2008 volcano resulted in a very large plankton bloom in the late summer of 2008.
Q And then that plankton bloom may well have been in the area where the Fraser -- what were to become the Fraser River sockeye run in 2010 were living at that time?
DR. WELCH: Yes, to the extent that we know it, yes.
Q So they have -- so possibly they have more food and so possibly there's higher returns?

DR. WELCH: Correct.
Q But that's an example of natural variability. But I'm going to suggest to you that there's also uncertainty that we see that just flows from the fact that there are data gaps or sparse data with respect to many aspects of the lifecycle; is that fair?
DR. WELCH: Well, as a scientist, the answer is we always have data gaps. We always -- no matter how much we study, we will always discover new areas or avenues of research.
Q But isn't it fair to say that in science, there are real differences in terms of your feelings about being able to draw conclusions, depending on whether you have very sparse data such as, for example, one data set, as opposed to you have many data sets?
DR. WELCH: I'm not quite sure the motivation for the question so I'm having difficulty answering it.
Q Okay. Well, a number of times in all of your evidence you mentioned, "I used such and such an example because of the fact we have good time series data."
DR. WELCH: Correct.
Q Right? And what that's an indication of is that you have data that extends over many years, for example; is that fair?
DR. WELCH: Yes.
Q So that it allows you to feel that you have some certainty about the fact that the observation you've made isn't an anomaly; is that fair?
DR. WELCH: That's one approach to science. Another approach to science, which is the more -- not common for fisheries, but the common one for science is to do direct experimental tests and manipulations.
Q Right, and in fairness, it's that we can't really do that in the large with the pacific salmon species. I mean, they're a natural species, you can't control them in the laboratory or very easily run large-scale experimental --
DR. WELCH: Well, in fact, we can now. It has not been done as a routine basis, but it's certainly now technologically feasible to do it.
Q But in terms of the types of work that you've been doing and the types of studies you've been working with, having more data, and you've mentioned this

in your evidence with Mr. Leadem, preferably over many years, with separate observations, allows you to feel more certain that what you're observing is a regular phenomena rather than, for example, an anomaly caused by a volcano in one year?
DR. WELCH: That's true, but the caveat that I would put on that is that long-time series of data that are simply observational do not allow you to necessarily distinguish between events that occur. The relevant one for the Cohen Commission is that we have a 20-year decline in marine survival of most stocks of Fraser sockeye salmon. Simply having 20 or 40 years of data on plankton abundances will not show proof of what is occurring, it's simply a correlation. And there are many examples in science where correlations may be very high, but may be completely incorrect.
Q Fair enough. And there's no doubt that I'm not trying to ask you to agree with the proposition that gathering data is the whole of the scientific process. There's obviously analysis and trying to understand the causal relationships, but having data and more data is a critical part of reducing uncertainty when you're testing hypotheses; is that fair?
DR. WELCH: Yes, I agree.
Q And in many areas of what you've been describing in, really, all three of your evidence, there are situations where you have relatively limited data sets; is that fair?
DR. WELCH: Yes.
Q And so for example, one example, when we're looking at the high seas example of where you show the stocks in different areas of the Gulf of Alaska, am I right in understanding that that's essentially based upon one set of observations in the 1960s?
DR. WELCH: Yes, and then a second set in the 1980s.
Q So we have two data sets, essentially?
DR. WELCH: Two periods of study in the offshore.
Q All right. And it may well be that there's a number of factors that could vary there, such as what happens over the course of one year, or maybe from year to year, they -- you have different areas; is that fair?
DR. WELCH: Yes, I assume so, yes.
Q And in the case of more complex systems, the

uncertainty that's introduced in terms of a general scientific proposition, I'd suggest, the uncertainty that's introduced by having sparse data becomes greater the more complex the system is; is that fair?
DR. WELCH: Yes.
Q And the Fraser River sockeye cycle is, I suggest, relatively high on the level of complexity in terms of the number of variables in terms of habitat and the changes over time that we're facing; is that fair?
DR. WELCH: It's a philosophical point. I suspect my personal view is that it's probably simpler than we understand, but we don't have the data to understand it well enough.
Q So maybe once we've got the data, it might turn out that there's some simple things, but right now, there seem to be a lot of pieces to the system and we don't necessarily understand or have the data to understand how all the pieces fit together; is that fair?
DR. WELCH: Yes. Actually, let me rephrase it, it's we don't have the data to fully understand the system. I think we can go some way towards addressing those points.
Q All right. I'd suggest compared to many types of scientific questions, like, if you were taking -- at one extreme, you know, the question of does the earth go around the sun, rather than the sun go around the earth, we can say there's a high degree of scientific certainty about that proposition; is that fair?
DR. WELCH: Well, yes, but Copernicus was almost burned at the stake for making that statement.
Q Right. My point exactly, is that if we come to more -- but if we come to the day, we're a little bit closer to Corpernicus' time around the certainty of some of the propositions that are put forward about Fraser River salmon stocks than perhaps we are about the situation in astronomy today; is that fair?
DR. WELCH: Yes, I would agree.
Q I'm not offering you up for the stake, though, trust me. And another thing I'm going to suggest that complicates the scientific uncertainty that you face is the reality that we have changing environmental circumstances around the Fraser

River sockeye; is that fair?
DR. WELCH: Yes, it's a very serious issue that I'm concerned about.
Q And I'm just going to suggest that's not just climate change that we're looking at. I'm going to suggest to you that the introduction of human harvesting has been an environmental change for the sockeye salmon from the time that the aboriginal people started harvesting; is that fair?
DR. WELCH: Yes.
Q Essentially, an introduction of a new predator into the system?
DR. WELCH: Yes.
Q And as harvesting techniques have changed and increased, that has also changed the environmental circumstances of the sockeye?
DR. WELCH: Well, in biological terms, it's increased the evolutionary selection on the animals.
Q It's created an evolutionary pressure?
DR. WELCH: Correct.
Q Right. And another example that would come along is the change in habitat that's been occasioned by human settlement at the mouth of the Fraser and along the Fraser that's also what I'd call a confounding factor in the scientific analysis of what's happening to the sockeye salmon; is that fair?
DR. WELCH: Yes.
Q And I'm going to just try to get some components of that. For example, the construction of Vancouver, Surrey, Richmond, Chilliwack, all these places going up the Fraser River is a significant environmental change in the habitat of the sockeye compared to the habitat in which they originally evolved; is that fair?
DR. WELCH: Only if they went into the side channels that were formally there. A lot of the delta is now -- Richmond/Delta is now build on dyked land that was originally the estuaries that haven't been there for 100 years. So if they go straight out to sea, and always have gone straight out to sea, they wouldn't have had very much effect relative to if they had gone into the sloughs and backwaters that used to exist to a much greater degree now -- then than now.
Q Right. So for example, if the original estuary

and sloughs were rearing habitat, then there's been a significant change in the rearing habitat for the salmon, but we just don't know?
DR. WELCH: Well, the only stock that that would apply to, so far as we know, is the Harrison that seems to rear in the Lower Fraser somewhere, that we don't well understand. The other sockeye certainly go straight out to sea and up the Strait of Georgia very quickly and don't seem to take advantage of that habitat, cannot take advantage of that habitat.
Q Today?
DR. WELCH: Today.
Q And sorry, and my point is but as to what happened 150 years ago, before these areas were built, we don't really know what the situation was, do we?
DR. WELCH: Well, likely, those animals that took advantage of the habitat that's no longer there are simply extinct and they're not part of the biodiversity that we are trying to manage now.
Q Or -- and looking at the sockeye salmon, to the extent that they may have used those areas, it may be that they are living now in a somewhat less favourable habitat than the one in which they evolved?
DR. WELCH: Give me a moment to try to phrase this. Environmental change has been going on for over 12,000 years. So the end of the last ice age came abruptly 12,000 years ago, and where this courthouse is, and the Fraser River, was occupied by a two-kilometre thick ice sheet. So there was no Fraser River until the ice sheet started to recede very rapidly, starting 18,000 years ago, and it was gone by 12,000 years ago. Sockeye repopulated the Fraser River at that point and there have been radical changes in environment since that time, going forwards. But the last ice age took about 120,000 years so British Columbia, as an environment, didn't exist for 120,000 years and then in the interglacial that we're in now, it's been around for 10,000 years.
So environmental change has always been with us. It's likely to be increasing dramatically under the projections of global warming.
Q Right. And in fairness, is that -- that while evolution can happen very quickly, is that rapid changes in habitat can be -- in fact, be quite

difficult for species to adapt to; isn't that fair?
DR. WELCH: Rapid changes in the environment, yes.
Q Right. And many of -- I'm going to suggest to you that many of the human-induced changes that we've seen in the Fraser system, I'm going to suggest to you, have been, on an evolutionary scale, relatively rapid; isn't that fair?
DR. WELCH: Certainly, yes.
Q And so I talked about urbanization, but also there are other habitat changes like the effects that forestry may have had on the river system?
DR. WELCH: There are certainly impacts potentially, yes.
Q Right. The Hells Gate event, just another example; is that fair?
DR. WELCH: Yes.
Q I'm going to suggest to you another recent example of an environment change which we'll be looking at in the course of this hearing, I'm going to suggest to you is the introduction of salmon farming into the runs in which the -- the areas in which the salmon pass through; is that fair?
DR. WELCH: It's certainly a topic that should be looked at, yes.
Q Right. But it carries with -- it's effectively changed the environment, I'm going to suggest relatively abruptly?
DR. WELCH: Well, that's a statement that I have no data on to comment on.
Q In evolutionary terms, the change from having no salmon farming to having salmon farming has been a relatively abrupt change. I'm asking you what the effect of it has been, just that it's been a relatively abrupt change.
DR. WELCH: If salmon farms have an effect on wild sockeye stocks, they -- that is an abrupt change. If salmon farms have very little or no effect on wild salmon, they will not have an effect on those stocks.
Q Right. So --
DR. WELCH: So the essential question is what is the degree of an effect that salmon farming, aquaculture, has on the wild sockeye runs.
Q Right. But in terms of the effect, if salmon farming had been introduced over a period of 5,000 years, the salmon would have a chance to adapt to

it in a Darwinian sense of the word, in a way that they might not, say, by becoming extinct in this sense of the word; is that fair?
DR. WELCH: As with any other stressor, if it was introduced over a longer period of time, there's more time for adaptation.
Q Okay. And the last one that we've all talked about is climate change is obviously another significant factor in terms of change in habitat.
DR. WELCH: Did you -- sorry, did you say the most significant factor?
Q No, no. Another --
DR. WELCH: Yes.
Q -- significant factor. Who knows if it's not significant or not?
MS. BAKER: Mr. Commissioner, I note we have six other participants and 15 minutes and I wonder if Mr. Janes is going to be much longer?
MR. JANES: I'll be very quick.
Q So just -- then just catch onto the question of aboriginal knowledge, I'm going to suggest to you that one of the values that aboriginal knowledge can bring is that it can bring a perspective which scientists can use over the question of a historic perspective on what the habitats and the behaviour of the salmon were historically; is that fair?
DR. WELCH: Yes.
Q And that's something that may not be easily accessible through ordinary scientific methods today; is that fair?
DR. WELCH: Correct.
Q And just one question about your Slide 36 which is the smolts to adult return numbers, this is the one where you point out that there seems to be a great deal of mortality in the ocean, rather than in the Strait of -- in the strait. The fact that the mortality occurs in the ocean does not necessarily imply that the thing that killed them happened in the ocean. And let me give an example. If, for example, it's sea lice is the hypothesis that we're -- that attach themselves to the smolts while they were passing through the Johnstone Strait, but it didn't kill them till 20 or 30 days later, when they're out in the ocean. That would give the appearance of higher mortality at sea, correct?
DR. WELCH: Yes. So any disease that would have a

latency period between infection and mortality.
MR. JANES: Right. Thank you.
MS. GAERTNER: Good afternoon. It's Brenda Gaertner for what has been called the First Nations Coalition. For those of you -- perhaps I'll just introduce it. I represent the Haida Gwaii and then I come down and I represent people from the South Vancouver Island and then into the Fraser, all the way up to the far points of the Early Stuarts. And I also represent organizations that some of you may have had some involvement with over the years.
I'm not here -- I'm just going to ask a couple of introductory questions. I understand I'll have an opportunity to ask each of you questions later on as we proceed. But I have a couple of clarifying questions that I wanted to ask and I'll just start in the order that you guys presented and then go back.

CROSS-EXAMINATION BY MS. GAERTNER:

Q So Mr. Lapointe, at Slide 9 and 10 of your presentation you talked about the -- you have a word -- you have a sentence called:

> Overall returns will continue to depend on production from largest systems.

And by that I take it to mean you're talking about the larger lake systems?
MR. LAPOINTE: That's correct.
Q And it's fair to say that any one of those large lake systems are divided up into a lot of natal streams; is that correct?
MR. LAPOINTE: Absolutely.
Q And so when we get to something like -- let me just get to your slide, the Stuart Lake, for example, we've got about 39 streams or so or 40 streams that go into the Stuart Lake; is that --
MR. LAPOINTE: That sounds about right. Yeah.
Q Is about right?
MR. LAPOINTE: Yeah.
Q And something in the Shuswap we've got even more?
MR. LAPOINTE: Yes.
Q Yeah. And so when we're talking -- when you're talking about the rearing lakes accounting for 80

percent of the juvenile varying capacity, that's not breaking down to those smaller streams yet, are we?
MR. LAPOINTE: No. Absolutely not. It's an aggregation of streams in each case.
Q All right. Mr. Welch, I just have a question of -- and I think it picks up from where Robert Janes just stopped, and it's just a clarifying question again. Were you involved in the PSC work in June of this year? Were each of -- I was going to ask each of you. There was a workshop that the Pacific Salmon Commission held amongst -- in June for three days and there has been a report that's come out.
DR. WELCH: David and Karl were not. I was. I was there.
Q Okay. Great. What I -- and again, I'm not a scientist, but what I got when I read that was an influence of the Georgia Strait on some of the questions that are being asked about the 2009 year and Mr. Welch, I see that you've taken it one step further at Slide 15, if I may and I just want to ask this question, which is if salmon are exposed to one of a multiple number of impacts, be they -- I've heard lethal, sublethal and all the various different levels of impacts that one may have, it's quite clear that when they die by those impacts is hard to predict.
DR. WELCH: As a -- as a broad blanket statement, yes, that's correct.
Q Okay. I'm going to go to -- I'm going to be very broad today and we'll get to more specific. Mr. English, I have a couple of questions for you. Was I to interpret from the slides that you gave, especially when you got to where we're now having DNA samples in addition to the tagging, that the lates are coming back earlier or that we're just learning that the lates are spread out as much as they are into the early summers?
MR. ENGLISH: Well, it's probably both. We've learned a lot more since we had the capability to do the DNA analysis and separate out the early time Shuswap stocks from the later time one, but there's also late run stocks that spawn in the lower part of the Fraser, as well, Cultus being one of the best-known, the Harrison that we've talked about today, as well, and Weaver Creek are

all late-run stocks in the lower end of the system and they are doing things somewhat differently than -- at least the Harrison has been doing things quite a bit differently than other stocks in coming back quite a bit earlier. And that appeared to begin in the mid-'90s and so it was the reason for a lot of concern in the mid-'90s about early entry and higher en route and pre-spawn mortality for late-run stocks.

Q Is there an indication of why they're coming back earlier?

MR. ENGLISH: Well, the -- there's speculation that it's due to shifts in climates. It's also determined by the possible effects of other -- it's both the timing of return and the entry into the river, and there's some indication from some of the work we've done with looking at the relative abundance of summer-run fish that summer -- the growth of summer-run populations is having an influence on late-run stocks and drawing them into the river earlier. These are all theories we've been testing for a number of years, but some of them seem to be pretty consistent and pretty supported by the data.

Q Okay. And then I just had a -- this is a very simple question. When do the returning sockeye stop eating?

MR. ENGLISH: Well, it's a good question, but -- do you want to try that or...?

DR. WELCH: It's a simple question. There's not a simple answer to it, unfortunately.

Q Sorry.

DR. WELCH: The trawlers that drag baited lures behind the boat catch sockeye despite the fact that they're not supposed to be feeding in the Strait of Georgia, so they're still biting at things even when they're supposed to have terminated their feeding. They're certainly feeding before they reach Vancouver Island and I think they're still feeding on the West Coast of Vancouver Island, but the thought is that they're shutting down their digestive tract by the time they're coming into the Strait of Georgia.

Q So by the time they hit the mouth of the river, they're pretty well finished eating and they're going to make that last trek of their life without further food?

DR. WELCH: Well, the digestive tracts actually --
Q Too cold.
DR. WELCH: -- energetically, it's the third-most energy-demanding organ in our bodies, the brain being the first, the heart the second. So it makes sense to, if there's not much food around or if you're going to be moving into the river to shut down your digestive tract, so you're not running an expensive piece of machinery.
Q Now, I've been trained much more by indigenous experts rather than scientists, and so I have a couple of questions that are trying to bridge that world view, if I may, the first being today I've heard a lot about the lifecycle of the salmon, but I sure haven't heard a lot about the other species that are involved in the lifecycle of the salmon and I wonder if all three of you might comment on that. As I understand it, the ecosystem of the salmon is a very complex ecosystem that's affected by a lot of other animals and a lot about -- a lot of other health of the ecosystem. Would any of you like to comment on that?
DR. WELCH: Well, I can speak from my presentation, the remit was to frame it in terms of what we know about the migrations and survival of Fraser sockeye, so certainly they're embedded in those ecosystems throughout their life history. But the need really, as I understood it, was to set the terms on the general knowledge for the start of the commission.
Q I guess the -- Mr. Lapointe?
MR. LAPOINTE: Sure. I'll try, Brenda. That's one of the reasons why I asked the clarification about the term "waste".
Q Mm-hmm.
MR. LAPOINTE: Clearly, salmon carcasses provide nutrients that feed forests. Lots of predators on salmon-bearers, sea gulls, eagles, lots of the components of the ecosystem feed on either the fish themselves or nutrients that the fish provide, so it's very broad ecosystem, you're quite correct in pointing that out.
MR. ENGLISH: I can add one last point 'cause I think it will be remiss in not saying that the salmon are really important for people and been that way for a lot of years, but they're -- in the ecosystem they represent actually a very small

part of the biomass that's out there, and you really need to be aware of the fact that if other things happen with other prey species -- there are very small salmon, the size of your finger, are very -- very attractive target for a lot of other predators, and if you have an abundance of other prey species in that size class like sardines and anchovy and sand lance or needlefish, other prey organisms, then there's a buffer, if you like, for salmon. If things happen with those other prey species, such that they're not as abundant, then salmon could become a more important part of the target for other predators.

So on top of all the other complexity that we've talked about in terms of their migration, you have a whole series of other predators other than humans that are out there wanting to eat something and depending on the timing of the arrival of salmon and the relative abundance of the other prey that are out there, you can have quite dramatic changes in these -- and it's probably -- has a lot to do with the marine survival, why you see such large range in marine survival. It's a big ecosystem; lots of other things happen.

Q The other part of the -- I’m going to say the difference of the world views, perhaps, but -- or maybe it's the complement between the world views, it's a better way of putting it, is that I've heard a lot today about measuring the health of the salmon by the number of salmon, and I would think that there are other indicators for salmon health besides the number of salmon. Are there other indicators that scientists typically use?

MR. ENGLISH: In almost every -- like Mike got into the discussion with biodiversity and what you want to see is not just one population which is super-abundant and therefore you think you're in good shape because there's lots of one of your populations out there. You want to see that there's a variety of populations that are contributing a variety of age classes, so that you're buffered against changes in environmental conditions, so it is -- it's much different than just a straight numbers game. You're looking at the overall health of the population of the species, whether it's sockeye in this case or

chinook or coho, there's lots of different river systems, different lake systems that are contributing and you want to see that you're not eliminating, you know, elements of that equation, so that you're just relying on a few.
Q Thank you. The other area that I was going to touch on with respect to indicators of health are the actual quality of the salmon itself, and over the years I've heard from elders up on the Fraser River a lot about the quality of the salmon and I've heard things like soft and mushy, and then I've heard wormy. And then more recently I've heard stunned and shocked a lot. And then again more recently I've heard lesions and an increasing number of lesions on the skin of the sockeye. These are all, I would say, more qualitative rather than -- well, more qualitative measures, but I would like each of you or any one of you to comment on what we're seeing or what you imagine you're seeing when you're seeing those changes to the actual sockeye themselves.
DR. WELCH: I'll start off. That's a very interesting observation that I wasn't aware of. Soft tissue actually is probably a reflection that there's not much fat in the animals. Sockeye store fat as oil in the muscles and as they migrate up the river, for example, they burn that oil or fat to fuel the migration and they replace it with water. So as they progress up the river, their shape doesn't change, but they replace fat, which is energy-rich, with water and they become softer.
One of the things when I was in DFO I often regretted that we didn't do was over 20 years or more measure the fat content of the animals moving into the river because it would have been a very interesting indicator. And the reason we didn't -- I didn't start that was it was just a very expensive program and there wasn't a source of funding for it. But it's interesting that you've said there's -- there is knowledge of that because it would tie in with potentially the poor marine survival that also perhaps the animals are not feeding as well and they're --
Q Or working harder?
DR. WELCH: -- softer as a result.
Q Or working harder, I would suggest? Having to work harder through the environment and getting

rid of their oil sooner as a result of that?
DR. WELCH: I won't comment on something I can't advise on at this time.
Q Possible?
MR. ENGLISH: If I could recommend that when you haul Scott Hinch up on the -- in front of the inquiry here, that he can answer more directly to the question of the fat content and the health of the fish in terms of their physiology. It's been an integral part of our telemetry work that we've been working with the physiologists, taking samples in a way that doesn't injure the fish, doesn't affect their migration. We've been able to track them to spawning ground after them taking some physiological samples and doing fat probe which is a technology which allows them to get a reading of a fat content of the fish without injuring the fish at all. It's just like a little microwave scan of it, so there's methods that Scott can probably help with that.
MS. GAERTNER: I'm just about finished.
MS. BAKER: Mr. Commissioner, I just note we -- we're at four o'clock and we have five more participants who have an opportunity to ask questions. I just remind my friends, they -- these witnesses will be back, we will be able to get into quite a lot of depth with them.
MS. GAERTNER: I've been on my feet for ten minutes.
MR. LAPOINTE: I actually had something to offer, Brenda, on the --
MS. GAERTNER:
Q Yeah. I saw that. I'd like you to, please.
MR. LAPOINTE: If you think about what's happened in the last 15 years of Fraser sockeye there's been two very, very significant biological changes. One of them is that based on Environment Canada records of river temperatures, we've had something like eight of the ten warmest summer Fraser River water temperatures occur in the last 15 years, so when you have that kind of event happen, you're going to expect fish to show some signs of being exposed to those kinds of temperatures.

The second very significant biological event, and Karl touched on it a bit in his presentation is the fact that some of these late-run sockeye are migrating upstream much earlier than they did before. I actually had one of the First Nations fishers call me and tell me about the mushy observation and it didn't surprise me at all that fish that were coming in earlier than they normally had or were being exposed to temperatures that were significantly warmer than what they would have would show some signs. All these fish, after all, die eventually. I mean, you hope they die, you know, after they spawn as opposed to before they spawn. So they're all getting disease and, of course, temperature accelerates the progress of that disease, so I think these observations are quite complementary with the events that we have been seeing in the Fraser in the last 15 years.

Q And the lesions?

A Again, it's a sign of disease, so disease progression is accelerated in warm temperatures and when you have some of these late-run Fraser sockeye are coming in so much earlier, they're probably exposed to temperatures that are perhaps five degrees Celsius warmer than what they're used to. That's a really big difference for a fish to be exposed to that and have to be running this effectively a marathon a day, if you like, on its way to the spawning grounds.

MS. GAERTNER: Those are my questions.

THE COMMISSIONER: I wonder if I might just ask commission counsel if he could just assess of the, I think you said five remaining counsel who have not yet indicated whether they're going to ask questions, if I could just get a reading of who is going to ask questions and how much time they might need, that would be helpful.

MS. BAKER: Thank you. I don't have that information, but perhaps they could each just identify if they're planning to ask questions or not.

MR. DICKSON: Sto:lo Tribal Council, I'll be about five minutes.

MS. FONG: Lisa Fong, Heiltsuk Tribal Council, no questions.

THE COMMISSIONER: Is there anyone remaining of counsel who are here today who would be intending to ask questions other than the one that indicated he would be? If not, would it be acceptable to all counsel and to commission counsel if we just allow counsel to ask his questions and conclude this panel today? Is that agreeable? Thank you very

much. Sir?
MR. DICKSON: Mr. Commissioner, Tim Dickson for the Sto:lo Council --
THE COMMISSIONER: I think you're --
MR. DICKSON: Oh.
THE COMMISSIONER: You have to identify yourself and just turn on your mike.
MR. DICKSON: Oh, my apologies. Tim Dickson for the Sto:lo Tribal Council and Cheam Indian Band.

CROSS-EXAMINATION BY MR. DICKSON:

Q Dr. Welch, you were speaking of the increase in the zooplankton in 2007 because of the volcano eruption -- sorry, in 2008 because of the volcano eruption and then that may or may not have impacted on more food for the returns that came in in 2010 and may have been an cause in their higher returns and I'm just wondering whether you have any data on the amount of zooplankton in 2007.
DR. WELCH: Well, my wife does. She's the plankton biologist and she runs a program that transects the Gulf of Alaska each year through the Spring and summer months, but I would disqualify myself as professionally competent to tell you the details without checking first.
Q Fair enough. I certainly wouldn't force you to. Mr. Lapointe, you spoke of the artificial spawning channels and them having a higher egg-to-fry survival rate. And so I'm curious whether you would expect if more channels were constructed, would this assist in sockeye productivity?
MR. LAPOINTE: It certainly could in that life stage. I would hazard a guess that perhaps not all of the effects of spawning channel would be viewed as positive. When you provide fish with an artificial substrate, it can and has caused genetic selection for things like body size, so you have to ask yourself whether a long-term spawning channel would generate a fish that is more robust or less robust to environmental changes, so certainly from a stage-specific survival, could be quite beneficial and that's, in fact, why they were built in the first place, but in the long term there can be negative effects, as well, because you're creating an artificial environment and, of course, the environment

outside is changing, so I think there would be some debate amongst geneticists about whether it would be beneficial or not.
Q Thank you. And just in a -- on a topic somewhat related, on biodiversity, you were speaking of one of the benefits of biodiversity being that you have a portfolio of stocks and so when conditions change, some stocks may do better, some may do worse. But it provides you with a buffer, some more certainty and ability to weather change; is that correct?
MR. LAPOINTE: That's correct.
Q And so would it be correct to say that in terms of species survival, maintaining or improving biodiversity becomes more important as variability in the environment increases?
MR. LAPOINTE: Yes.
Q Mr. English, you were speaking of the late runs holding off the mouth of the river and the timing of that delay. I'm wondering when you close down the assessment fisheries in a normal year and I'm wondering whether they are closed now for this year?
MR. ENGLISH: Well, that's probably more of a question for Mike, because --
Q Right.
MR. ENGLISH: -- he does the assessment fisheries.
Q Fair enough.
MR. LAPOINTE: Our test fisheries basically are stopped when we run out of fish and so I think this year the last fishery to shut down was probably the test fishery at Whonnock and it concluded about the 4th or 5th of August -- of October, sorry, sometime in that range, late September or early October.
Q Thank you. Mr. English, the tagging studies that you have conducted, I'm curious about how long such studies of that kind have been performed. How long do they go back historically?
MR. ENGLISH: The specific telemetry studies that I referred to on the Fraser sockeye started in 2002 and they were not annual for the entire run. We focused on different questions in almost every year. 2002, 2003 we were focused on the late run early entry question; 2004 was focused in on just the Harrison run; 2005 focused on summer run survivorship; 2006 involved all the run timing

groups from early Stuart right through to the late run, as did 2007 and 2009 and '10 have focused on all the timing groups. But those are the -- that's the full extent of the telemetry studies on the Fraser. Similar technology has been used on the Nass, the Skeena, the Columbia River, for back into the late '80s on some of those systems.

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

THE COMMISSIONER: Thank you very much, Mr. Dickson. I just want to check again, does that conclude all counsel who wish to ask questions today? Thank you, counsel, for your cooperation. I appreciate that. And thank you to commission counsel and to the members of the panel.

I take it then, commission counsel, that we are adjourned for the day?

MS. BAKER: We have no further questions, yes, and we can adjourn.

THE COMMISSIONER: Thank you very much. Until ten o'clock tomorrow morning then. Thank you.

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

(PROCEEDINGS ADJOURNED AT 4:12 P.M. TO OCTOBER 26, 2010 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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Susan Osborne

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

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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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Pat Neumann