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.

Wednesday, January 26, 2011

Tenue à :

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

le mercredi 26 janvier 2011

APPEARANCES / COMPARUTIONS

Wendy Baker, Q.C. Maia Tsurumi	Associate Commission Counsel Junior Commission Counsel
Mitch Taylor, Q.C. Hugh MacAulay Jonah Spiegelman	Government of Canada ("CAN")
Boris Tyzuk, Q.C.	Province of British Columbia ("BCPROV")
John Hunter, Q.C.	Pacific Salmon Commission ("PSC")
No appearance	B.C. Public Service Alliance of Canada Union of Environment Workers B.C. ("BCPSAC")
Charlene Hiller	Rio Tinto Alcan Inc. ("RTAI")
Shane Hopkins-Utter	B.C. Salmon Farmers Association ("BCSFA")
No appearance	Seafood Producers Association of B.C. ("SPABC")
No appearance	Aquaculture Coalition: Alexandra Morton; Raincoast Research Society; Pacific Coast Wild Salmon Society ("AQUA")
Tim Leadem, Q.C.	Conservation Coalition: Coastal Alliance for Aquaculture Reform Fraser Riverkeeper Society; Georgia Strait Alliance; Raincoast Conservation Foundation; Watershed Watch Salmon Society; Mr. Otto Langer; David Suzuki Foundation ("CONSERV")
No appearance	Area D Salmon Gillnet Association; Area B Harvest Committee (Seine) ("GILLFSC")

APPEARANCES / COMPARUTIONS, cont'd.

No appearance	Southern Area E Gillnetters Assn. B.C. Fisheries Survival Coalition ("SGAHC")
Chris Watson	West Coast Trollers Area G Association; United Fishermen and Allied Workers' Union ("TWCTUFA")
No appearance	B.C. Wildlife Federation; B.C. Federation of Drift Fishers ("WFFDF")
No appearance	Maa-nulth Treaty Society; Tsawwassen First Nation; Musqueam First Nation ("MTM")
No appearance	Western Central Coast Salish First Nations: Cowichan Tribes and Chemainus First Nation Hwlitsum First Nation and Penelakut Tribe Te'mexw Treaty Association ("WCCSFN")
Brenda Gaertner	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)
No appearance	Adams Lake Indian Band
No appearance	Carrier Sekani Tribal Council ("FNC")
No appearance	Council of Haida Nation

APPEARANCES / COMPARUTIONS, cont'd.

No appearance	Métis Nation British Columbia ("MNBC")
No appearance	Sto:lo Tribal Council Cheam Indian Band ("STCCIB")
No appearance	Laich-kwil-tach Treaty Society Chief Harold Sewid Aboriginal Aquaculture Association ("LJHAH")
Lisa Fong Benjamin Ralston	Heiltsuk Tribal Council ("HTC") Articled Student
No appearance	Musgamagw Tsawataineuk Tribal Council ("MTTC")

TABLE OF CONTENTS / TABLE DES MATIERES

EXHIBITS / PIECES

Vancouver, B.C. /Vancouver (C.-B.)
January 26, 2011/le 26 janvier 2011

THE REGISTRAR: The hearing is now resumed.
MS. BAKER: Thank you, Mr. Commissioner. Today we are starting on the topic of Forecasting, and we have with us Ms. Sue Grant.
THE REGISTRAR: Good morning.

SUE GRANT, affirmed.

THE REGISTRAR: Would you state your full name, please.
A Sue Grant.
THE REGISTRAR: Thank you.
MS. BAKER: Thank you.

EXAMINATION IN CHIEF BY MS. BAKER:

Q Ms. Grant, I am just going to go through a bit of your background with the Commissioner. Your *c.v.* has been provided and it's in Tab 1 at the materials we have given you, and it is CAN185936. You have a Bachelor of Science in Marine Biology from McGill?
A Yes.
Q And a Master of Science in Environmental Biology and Ecology from the University of Alberta?
A Yes, that's correct.
Q And you are presently doing graduate work in Quantitative Methods in Fisheries Management?
A Yes -- it's part of a diploma, select courses.
Q Okay. And that's at Simon Fraser University?
A Yes.
Q And at Simon Fraser you're working with Dr. Randall Peterman on some courses?
A No, it's a variety of professors that I've taken individual courses with to upgrade my analytical skills, or to keep them fresh.
Q One of them is Dr. Randall Peterman?
A That's correct.
Q Okay. And you're currently the Program Head for Sockeye and Pink Analytical at Fraser River Stock Assessment; is that right?
A Yes, that's correct.
Q Okay. And you've been in that position since 2008?

A Yes.
Q And prior to that you were the Acting Program Head for Sockeye, Pink, Chum, and Creel at Fraser Stock Assessment.
A Yes.
Q And you were there in that position for about four years?
A Yes.
MS. BAKER: I'd like to have the *c.v.* marked as the next exhibit, please.
THE REGISTRAR: Exhibit number 350.

EXHIBIT 350: *Curriculum vitae* of Sue Grant

MS. BAKER:
Q Now, we've asked you to come here today to talk about pre-season forecasting. As the Program Head for Sockeye and Pink Analytical Programs, you are in charge of generating the run size forecasts for Fraser River sockeye salmon; is that right?
A That's correct.
Q And for what stocks are run size forecasts developed?
A There's a total of 19 forecasted stocks, and these forecasted stocks are rolled up into a total of four run-timing groups, based on when they enter the Fraser Watershed. So the first run-timing group to enter the Fraser Watershed is the Early Stuart run, and that includes the Early Stuart stock. The second run-timing group to enter the Fraser Watershed is the Early Summer run, and that's comprised of eight stocks. That includes Bowron -- should I -- would you like me --
Q No, eight is fine.
A That detail is not required.
Q Yes.
A So there's eight stocks with the Early Summer run. There's four stocks associated with the Summer run-timing group, and six stocks associated with the Late run-timing stock -- group. And in addition to the 19 forecasted stocks, there's a number of miscellaneous stocks -- a number of miscellaneous populations that are also forecasted.
Q Okay. And we have heard about CUs in the Fraser sockeye system, these 19 stocks, are they related to the CUs that we've heard about in the -- in the

Fraser system?
A There's overlap between the conservation units that have been identified. So in some cases there's a direct relationship between the forecasted stocks and the conservation units. And in other cases one stock might be comprised of multiple conservation units and in other cases a stock -- there might be multiple stocks that are comprised of one conservation unit, so there's a little bit of -- there's a little difference between conservation units and stocks.
Q Okay. And why do you use these 19 stocks, then, when you're doing your modelling?
A The 19 stocks encompass the bulk of Fraser sockeye abundance within the Fraser watershed, and including the miscellaneous stocks. So the 19 forecasted stocks comprise 95 to 98 percent of the total abundance in the Fraser watershed. And the miscellaneous stocks comprises a significantly smaller component of the total abundance. But the forecasted stocks represent the bulk of the abundance of Fraser sockeye in the watershed.
Q Okay. Is there data available for those 19 stocks that allow you to use them in your modelling?
A Yes. The 19 forecasted stocks have both stock and recruitment data associated with them. And what I mean by stock and recruitment is, stock is -- what we use is effective female spawner abundance, which is female spawner abundance and their spawner success, so how successful they were in spawning in terms of their egg contribution. And in addition to stock, the recruitment component of the data, the dataset we use, is catch plus escapement. So that's the core data we use for the 19 forecasted stocks.
Q And you've mentioned that you do forecasts for the miscellaneous stocks where there's no recruitment data; is that fair?
A That's correct.
Q Okay. You just use a different method?
A The miscellaneous stocks have only escapement data associated with them. So instead of paired stock recruitment data for the 19 forecasted stocks, the miscellaneous stocks only have escapement data associated with that. And what I mean by that is effective female spawner abundance data is what we specifically use. So there isn't a paired

recruitment time series associated with that small number of miscellaneous stocks.
Q Why do you not have the recruitment data for the small stocks?
A These are very small stocks for the most part. So for example, the late run miscellaneous group is called the miscellaneous non-Shuswap group, and it's comprised of small populations within the Fraser Watershed that -- these populations rear in Harrison Lake. And they're very small populations that would be at this -- because they're so small, it would be really hard to pick them up in fisheries that are breaking catch composition into the individual stock components. So for the miscellaneous runs, they are miscellaneous stocks, not associated with a broader stock that cannot be teased apart within the catch composition, so we can't establish a recruitment time series for them.
Q And when you're doing the pre-season forecast, you're working with a computer model, inputting data into that model. That's the basic concept; is that right?
A Yes. There would be a variety of models that we would use.
Q Okay. But it's a -- it's a mathematical kind of model that you put the data into?
A That's correct.
Q Okay. And what data is used, what data is entered into those models or variety of models to allow you to do the work?
A There --
Q Sorry, and then if there's different types of models, you could maybe just establish the broad categories of types of models.
A Okay. There are two categories of models that we use in the forecasting process. The first type of model is called a biological model, and these models incorporate what I'd mentioned earlier, the stock and recruitment time series. And the biological models establish a relationship between the spawner abundance and the recruits, the resultant recruits. And so the core data that would go into these models, for example, the classic biological model would be the Ricker model, which is one that's probably come up in previous testimonies. And did you --

Q Yes, what was --
A For clarification, would you want a lot of detail on...
Q Just the types of data that would be --
A Okay.
Q -- used in that kind of biological model.
A Okay. So for some of these biological models that we use, such as the Ricker model is one of the models, would be -- the core data is, as I mentioned earlier, paired stock and recruitment data. So that's escapement data, as well as catch plus escapement data, so it's paired, and that's fundamental to the models.
Escapement is being used as a predictor variable in the models, but we have a number of stocks where we also have juvenile data, and for these stocks there are some cases where we may use juvenile data as predictor variables as opposed to escapement data, because it eliminates some of the uncertainty in survival in the freshwater environment. So it gets us one step closer to the returning fish. So in some cases where we have juvenile data, we'll use that.
We also use jack data for one model in particular, that's Cultus. Jack data is generally not available at the time of forecasting because it's from the -- the year that the -- the year just before the forecast is being generated, but in some cases we do have jack data. And then the other piece of data that we use for the 19 forecasted -- for the 19 forecasted stocks in terms of biological models is also environmental variables. So specifically for biological models we can also incorporate environmental variables into the models. And these include things like sea surface temperature, Fraser discharge, et cetera.
In terms of the naïve models --
Q Sorry, so that describes the biological models. And then is there another type of model that you use?
A Yes. The other broad type of model that we use has -- historically we've called them naïve models, because these models don't establish any relationship between the spawning abundance and the resultant recruits, but instead are forecasting abundance based on summarizing the

time series data that we have.

So for example, for -- one example of a naïve model would be a time series average model, what we call a TSA, in short form. You'll see them on the forecast tables. The TSA model or time series average model would just average the returns over the historical time series, and use that average to predict what we would see next year. So next year's return would simply be the average of the historical time series. So that's one example of a naïve model.

In the 2010 forecast, we've added a couple of models that include brood year escapement multiplied by recent productivity. So they're also using recruits per spawner, like average recruits per spawner productivity in recent years multiplied by the brood year escapement. And those models are -- they are now using a predictor variable brood year escapement, so that's why we've changed the name from naïve models to non-parametric models, because we're not doing any parameter estimation like we are in the biological models, but we are using a predictor variable. So that's the core, for the 19 forecasted stocks, those would be the core models and the data inputs.

Q All right. And is the data that's available to you sufficient for running these models to predict the run size forecast, or to create the run size forecasts?

A The stock recruitment data that we use for Fraser sockeye is globally accepted as being amongst the best stock recruitment time series for salmonids. So that's throughout the world. So we're starting off with a very good stock recruitment time series. So from that perspective, we have a good time series for stock recruitment data.

The key pieces of information that we probably require more information, more research on, is the survival part of the whole stock recruitment relationship, understanding what are the mechanisms driving survival for Fraser sockeye. And this would include research in the freshwater environment and the marine environment. A lot of this is ongoing and it is part of both within the Department of Fisheries and Oceans, as well as external groups are, and universities are

continually conducting research and updating our knowledge on survival information for Fraser sockeye, and salmonids in general within the Fraser watershed. However, that still is a missing element to -- improvements to the forecasting process is getting even more information and understanding what the survival mechanisms are for Fraser sockeye.
Q You indicated that in the biological models you have some juvenile data for some stocks that helps you. Do you have juvenile data on all stocks?
A No. We have -- I'll start with just the -- starting with just the core stock that has the longest time series of smolt data. Smolt data is, in terms of juvenile data, it's the furthest along within the freshwater lifecycle. So you can have fry data that occurs within the freshwater environment. While they're still within the lake we can have fry data from hydroacoustic surveys, fry data from different trap projects. So there's several populations where we have all this fry information. But the -- and we can use that within the forecasting process, this -- this early juvenile life history data.
But the even better juvenile data is smolt data, because it's further along in the life history in the freshwater environment. So if we forecast with smolt data, we are eliminating all the uncertainty and survival in the freshwater environment. So we don't have to predict any more what kind of mortality is going on in the freshwater environment, as we do for stocks that don't have smolt data.
So if we're just forecasting with adult spawners that return to the spawning ground, we're forecasting the future based on all of the uncertainty we have with freshwater survival, as well as marine. When we have smolt data, we're eliminating that uncertainty. We know -- we have a better starting point because we're further ahead in the life history. And we can -- now we just have uncertainty from the moment they leave the system that they're being measured in, the downstream migration, and then the ocean life history phase, that survival uncertainty.
So the one stock where we have a really long time series for smolt data is Chilko. And Chilko

is an indicator system for Fraser sockeye. It's the one stock where we have a really long time series of smolt data, and also adult return data. So what we can do with that stock is partition total survival into freshwater -- freshwater survival and marine. So when we have annual events or we're looking at what's going on overall in Fraser sockeye survival, we look to Chilko to give us an indication of where is this -- say, for example, 2009, that was a really -- an event where survival was extremely poor, you can look to Chilko to give you some indication of where that mortality occurred to start narrowing down the questions that you're asking on what occurred in 2009. So Chilko is our indicator stock that we go to because we can -- we can look at what freshwater survival was like, and marine survival, and see where that occurred.

Chilko is our only indicator stock for Fraser sockeye with that long-time series of smolt data. We also have Cultus where we have smolt data. But Cultus is a unique stock in its own rights, and the time series is very -- it's not a complete time series through time. There's a lot of missing years, and it is not an indicator stock, per se. So Chilko is our only indicator stock.

And back to your question, Wendy, is that in a perfect world it would be better to have more indicator stock data to give us a better handle on more than one stock in regards to being able to figure out if there's a survival breakdown, where is that occurring, in the freshwater or the marine environment. And Chilko is one stock out of 19 telling us part of the story, but you'd probably want a few more indicator stocks to give you an idea of is this globally across all sites. So from an indicator stock perspective, in a world of unlimited resources it would be beneficial to have more indicators stocks.

And but we do have other juvenile data, like as I mentioned Friday, that is useful for providing us with some indication of whether freshwater survival trends or tracking in other stocks, it's just not the smolt to the end of the freshwater life history phase.

Q Thank you. You talked a little bit about uncertainties in that answer, so I wanted to move to the next question which is on that topic. What are some of -- I take it, first of all, that there are uncertainties in run size forecasting. What are some of those uncertainties. Can you describe them in general terms?

A Yes. With any model in the world of modelling, whether you're forecasting Fraser sockeye or you're forecasting the weather, or global climate change, there's always going to be uncertainty in regards to your observations that you're using to seed the model. So for example, for Fraser sockeye we use escapement data, as well as recruitment data as our core data. And there's always some uncertainty around those escapement estimates. They're not -- you never have a perfectly accurate estimate, except in a few cases where we have fences and you're -- you're assessing the system with 100 percent accuracy, you're counting every single fish that goes through, so you know that it's 100 percent precise. It's a -- it's perfect system.

But a lot of the escapement enumeration programs don't employ fences because they can't. It's usually a barrier to placing a fence on a lot of the systems because of water levels, flows, et cetera. So they use a range of methods to enumerate on the spawning grounds, from mark-recapture studies or visual surveys from helicopter flights, et cetera, and there's going to be uncertainty in the core data we're using from that perspective.

The same with the -- that's the escapement data, but the same with the recruitment data, which is catch plus escapement. You'll have the escapement uncertainty, as well as uncertainty in the catch estimates, because catch is assigned to the different stocks through assessing catch and doing some analysis on the animals being caught in the fisheries, and assigning them based on a sample to the different stocks. So there can be uncertainty in that, as well. So that's just classic observation error in the models.

The other kind of error in the models is the -- or uncertainty in the models is associated with uncertainty and variability in inter-annual survival. So we use different models to explain recruitment. So brood year escapement,

environmental variables, but there's always going to be a certain component of that inter-annual variation and survival that we cannot explain. And that is also a component of uncertainty in the models, the variation in recruitment over time.
And the model forms themselves are part of the uncertainty, given, you know, you're exploring a lot of different forms of models that are capturing stock recruitment dynamics in different ways, so there's uncertainty in the model form that you're using, as well. So I would say those would be the key uncertainty elements to the forecasts.
Q What about uncertainty in future survival. Is that an uncertainty that comes into play as well, or is that captured in something you've already described?
A Yes. It was captured in -- that we explain a lot of the variability in the stock recruitment, or we can explain a portion of the variability in what we see every year in terms of recruitment from a certain spawner abundance, but there's a certain component of that's unexplained. So there's uncertainty in future survivals for Fraser sockeye.
Q Okay. So that could be uncertainties about what happens in the marine environment, uncertainties about what happened in the freshwater environment, that kind of thing?
A That's right.
Q Okay. All right, thank you. So that's very helpful background. I want to look at the models that are being used, and I know that there's been a change made to the model in 2010, so I think to just put that in context we'll look first at the 2009 -- or what, how forecasting was done prior to 2010 and then move into the 2010 changes. So the first place I want to go is the paper prepared by Al Cass, Michael Folkes and others, which is a Science Advisory Secretariat document prepared in 2006, and that's in Tab 2 of your binder in front of you, and it's CAN002926, and it's called "Pre-season run size forecasts for Fraser River sockeye for 2006". Have you got that?
A Yes.
Q Okay. Are you familiar with that paper?
A Yes.

Q Okay. Now, as I understand it, this document basically outlines the models that were used to develop the forecast for 2006 and up until and probably including 2010 to some extent; is that right?
A That's correct.
Q Okay. If you turn to page 2 and 3 of that document, page 3 and 4 describe these two models, broad-based model descriptors, naïve models and biological models that you reviewed earlier.
A Mm-hmm.
Q Okay. And section 3, which is on page 2, describes the methodology and it says that there's these three steps, first you:

> 1) choose the candidate forecast models depending on data availability;
>
> 2) perform a retrospective analysis for each stock...
>
> 3) evaluate model performance by comparing the retrospective forecast with the abundance [observed]...

And then:

> 4) identify the "best" forecast model...and present forecasts as posterior distributions of returns...

So I just want to go through those methods. I'd just first say that's still the method that was used up until 2010?
A That's correct.
Q And I'll come to 2010 later, but I understand that this was still part of what was done in 2010, in any event?
A Yes, that's correct.
Q Okay. But I'll come to 2010 in a minute. Okay. So if you can just explain what does that mean, the first step in the method, to:

> Choose the candidate forecast models depending on data availability.

What is involved in that step?

A We have a suite of models that we have in our toolkit of models that we use for forecasting. so it's a range of biological models and naïve models. And particularly for the biological models we can, as we talked about earlier -- typically we use stock recruitment data for the 19 forecasted stocks, and that's escapement and recruitment data. For some stocks we have juvenile data, so what this first point is pointing out, that we would also explore the adult escapement data with the recruitment data for the biological models. But if they have -- if there is juvenile data associated with it, we'd layer on the juvenile -- using the juvenile data as predictor variables. So, and that can't be done for all stocks because not all stocks have juvenile data. So there are some stocks that we can incorporate juvenile data into.
The same with jack data. Jack data generally doesn't come in, we don't have it available in time for the forecasting process. Cultus is one stock where we do have jack data available because it's a fence and we get that data in-season, so we use jack data for Cultus specifically.
And environmental variables are -- can be used for the forecasted stocks -- the 19 forecasted stocks when we're using biological models can be included as well.
So that's generally what number 1 is meaning, that we've got a toolkit of models. Depending on whether we have juvenile data or not, not all stocks can be modelled using juvenile data if it doesn't exist. So we just select the suite of models for each stock that could be explored, limited by the data that's available.
Q So for any given stock you could run a variety of models on that stock, if the data is available?
A Yes, and we would.
Q Okay. So the next point is to:

> Perform a retrospective analysis for each stock...

What is involved in that process?
A For every stock we have this toolkit of models that we -- can be used for that particular stock. And then the next step that we do to select the

top model is to conduct retrospective analysis, and that is essentially taking the first half. So we have a 50-year stock recruitment time series for stocks, generally speaking, they're not all the same length, but say generally 50 years. We break that time series in half and use the first half of the time series to seed the models, whether they're biological models or naïve models, and then for the second half of the time series we start to create a time series of forecasts. So we sequentially for the second half of the time series generate a forecast, and then update that data point into the first half of the time series, and then for the next year, generate a forecast. And we keep going through, updating the data behind and generating forecasts. So we have -- we'll end up with a whole time series for the second half of the time series of forecasts. And we can compare those forecasts to the true returns.

The models that have the smallest difference between the forecasts and the true returns, are -- perform better in retrospective analysis. So we look at the performance of the models and compare how each one is doing through time compared to the true return time series. And we create a ranking for all the candidate models for a particular stock, and then we're ranking them, based on this retrospective analysis, from 1 to total number of models that exists.

So that's retrospective analysis for ranking. And should I move on to...

Q Yes. I'm going to go through each of those methods or processes. so if you want to just carry on, that's fine.

A Yes. It just flows in.

Q Yes.

A Yes. So we have the ranking for each stock of the suite of candidate models that we've used. And from -- in the 2006 paper, what was done was the top-ranked model in that, ranked from the retrospective analysis, is actually used for the forecasting, for that annual forecast.

Q So that's the step 4, the "best" forecast model is that top-ranked model?

A That top-ranked model.

Q Okay.

A And that was used for 2006.
Q In doing that work has -- have you found, or has the Department found that one model performs better than others across all stocks? Like, is there one ideal model that works for all the stocks better than anything else?
A There is not one model that performs optimally across all stocks, and even across one stock through time. So generally if you look at a forecast table, there will be a range of different models being used to generate forecasts for different stocks. And not one model comes out as being superior to any of the other models. And this is similar to results done by Dr. Randall Peterman's group in a paper by Haeseker in 2008. He's using the same methodology as the Department of Fisheries and Oceans is using to rank models and compare performance. So they're using the retrospective analysis approach we use, as well. And in that paper they, similarly to us, have not found a single model that outperforms all the other models. There's not one that rises to the surface as the ultimate forecast model.
And in some cases, interestingly, both from our perspective and from Dr. Peterman's perspective, is that naïve models can sometimes perform better than biological models. So there are cases where naïve models that may just be a time series average, performs better over time than a biological model that may include the brood year escapement in -- and the relationship between brood year escapement and recruits in a biological model. The naïve models actually might perform better for certain stocks. So you'll see in the forecast tables certain naïve models for certain stocks have performed better.
Q Okay.
A So -- yes.
Q Sorry, I was just going to say if we turn to page 11 of the document that you have in front of you, which is actually CAN page number 15, this is just an example of all the different stocks that you have -- you talked about earlier, with the different run timing groups, and then the forecast models that were determined to be the best for each of those stocks under the column "Forecast model"; is that correct?

A That's correct. This is for the 2006 paper.
Q Right. And you can just see there's a wide range of, as you say, the Ricker model, which is a biological model, on Bowron compared to the TSA, which is a non-parametric model for Fennell.
A Right.
Q Okay. Have you looked at how environmental variables improve model performance? I know you have said that that does go into the biological model work. Does it -- have you found that it improves model performance?
A We've looked at a variety of environmental variables that include sea surface temperature and Fraser discharge, ocean indices, such as the Pacific Decadal Oscillation, that is really just tracking sea surface temperature anomalies in the broader North Pacific. So we've looked at a bunch of different variables. And although for some stocks, in some retrospective analysis years, like in some years when we're conducting retrospective analysis, environmental variables can help improve the forecast performance, it's not a significant improvement in terms of the performance or in terms of the forecast you get.
     So generally when you look at the forecasts with just a Ricker model, just a biological model with no environmental variable, and then if you look at a Ricker with a sea surface temperature covariate that we've explored, even though the sea surface temperature covariate may slightly improve forecast performance, you won't see a huge difference between the forecast. It's only slightly tweaking the forecast, but it isn't having a large impact on the overall forecast. And there isn't one environmental variable again that performs best for all stocks.
     So basically from a quantitative perspective, the environmental variables haven't significantly improved the forecast for all the variables we've looked at. And likely that's because single environmental variables, such as sea surface temperature or even the broad ocean indices are oversimplifying the complexity of the survival mechanisms, in both the freshwater and the marine environment, this, working together to influence total survival for Fraser sockeye. So using a single environmental variable, quantitatively

hasn't been -- hasn't given us any answers, in terms of making big differences to the forecast approach.
MS. BAKER: Thank you. The Al Cass paper, "Pre-season run size forecasts for Fraser River sockeye for 2006" should be marked as the next exhibit, please.
THE REGISTRAR: Exhibit number 351.

EXHIBIT 351: CSAS Research Document 2006/060 "Pre-season run size forecasts for Fraser River sockeye for 2006", A. Cass, et al

MS. BAKER:
Q Now, as I think we've already said, the method that we've just reviewed that's described in the 2006 paper was used in 2007, 2008 and 2009; is that fair?
A That's correct.
Q And once you -- I take it you didn't -- there wasn't a CSAS document prepared in each of those years because there weren't significant changes made to the model, you were simply applying the model that was described in this paper?
A There is, just to correct, or to clarify that, there is a CSAS paper - and CSAS is the Canadian Science Advisory Secretariat - report is produced annually and it's a SAR.
Q Sorry, that's what I was going to get to. There wasn't one of these research documents prepared in those 2007/'08/'09?
A That's correct.
Q But there was a Science Advisory Report prepared for each of those years, which produces the results of your model runs and your forecast for use in the -- in the Department?
A Yes.
Q Okay. So those have already been marked as exhibits in the hearing. The 2009 one is Exhibit 340.
Okay. Well, it didn't come up in colour, so you're going to -- I hope we don't lose too much data as a result of that. But this is the document that was prepared in the 2009 year by you and your group?
A I should clarify. It is prepared by myself and my colleagues and my collaborators, but it is also

the synthesis of -- the synthesis of the Salmon Subcommittee for the CSAP process, which is the Canadian Science Advice-Pacific review process that DF has to review papers annually. So the actual author of these Science Advisory Reports is not myself, but it is the Department of Fisheries and Oceans, and it includes all the consensus from these meetings based on what we present and it's a consensus from the committee on -- that is placed into this document. So the actual author is Fisheries and Oceans.
Q Okay. And the committee that you're referring to is the Salmon Subcommittee of the Centre for Science Advice-Pacific?
A That's correct.
Q Okay. And that document is the document that's intended to be used for forecast information for the 2009 year.
A That's correct.
Q And who uses this document?
A This would be used both -- well, by a range of users. It is placed on the Fisheries and Oceans, or on the CSAP -- CSAS, Canadian Science Advice Secretariat website. So once it's published it's placed on the website so it's available for public consumption. So anyone can use it for any purpose. In terms of formal processes, the information in the document is used formally by the Fraser Panel process in the fisheries planning process. It's used internally -- yeah, I guess it can just be used by anyone.
Q I'd like to move now to the changes that were made to the model in 2010. First of all, in 2010 there were changes made that were extensive enough that another research document was prepared; is that right?
A Yes.
Q Okay. And that document should be at Tab 4 of your binder, and the CAN reference I think is CAN185610 -- I hope that's right. Okay.
THE COMMISSIONER: So did we mark the last exhibit --
MS. BAKER: Oh, the last exhibit was already marked.
THE COMMISSIONER: Yes, 240?
MS. BAKER: 340.
THE COMMISSIONER: 340, yes.
MS. BAKER:
Q Okay. So this document was authored by you, along

with Catherine Michielsens from the Salmon Commission, E.J. Porszt, I'm not sure --
A Yes.
Q -- where this person's from, and Mr. Al Cass, or Dr. Al Cass.
A Yes. It's -- the authors are myself, Dr. Catherine Michielsens from the Pacific Salmon Commission, Erin Porszt from DFO and Al Cass from DFO.
Q Okay. And why was this document required in 2010? Why were changes made and why did it go into this form of document?
A We had presented a Science Advisory Report in -- through the normal course of action in November, as we typically do present them, and in -- for the 2010 one, we presented at the CSAP process and the Salmon Subcommittee had determined or assessed or concluded that there was -- there had been enough -- there were sufficient changes to the 2010 document that we were presenting as a Science Advisory Report, that it required a research document format, and the changes --
Q And what's the significance of it going to a research document format?
A A research document is much more intense in terms of the analysis that goes into the report. It is, as you can see, this actually has authors that include myself and Dr. Catherine Michielsens and Porszt and Cass, and so this is a research document, more detailed. It also is now going through a more formal review process. In addition to the Salmon Subcommittee, there are two -- generally two formal reviewers placed on it. It's similar to in some ways a Masters defence or a Ph.D. defence, or a publication in the primary literature, where you're actually getting formal reviews for this. So the document gets sent to formal reviewers. In the case of this document, we had Dr. Randall Peterman, as well as -- so from Simon Fraser University, as well as Dr. Chris Wood, as formal reviewers.
So in the case of a research document, it goes through that formal review process. Those reviewers provide comment, as well, on the day of the CSAP meeting. For example, Dr. Randall Peterman attended the CSAP proceedings, and provided comments throughout that, as well, in

addition to his formal written comments. And as well there's a Salmon Subcommittee present, typical of the Science Advisory Reports, as well, where all the people present, including internal and external to the Department experts. Technical experts on forecasting, as well as Fraser sockeye attend and it's essentially a defence of the paper by the authors to the Salmon Subcommittee that also includes the two formal reviewers, and it includes internal and external. So it's -- it's a step up from the Science Advisory Report in terms of the formality of the review process. And as I said, it's very similar to other review processes that involve Masters, Ph.D., or primary literature publication.

Q And was there something that -- like what happened to generate the need for this. Like, what were the changes -- why were the changes made?

A For Fraser sockeye we'd seen productivity declines for these stocks for some time. We'd been reporting on them even in the -- these forecast documents starting in the 2006 paper, perhaps earlier, I just haven't scrutinized them to date, but they -- for this meeting. So we'd been observing these declines in productivity. And in 2009 we also saw an extremely low productivity event, the lowest productivity we'd seen on record. But we'd still seen these persistent declines in productivity.

So for the 2010 forecast we wanted to present alternative hypotheses for future survival for Fraser sockeye. Typically we'd been using the long-term average, so the full time series to forecast returns, so the full stock recruit time series. And in the 2010 forecast we wanted to present alternative assumptions about future -- about the survival of Fraser sockeye in this paper in light of declines in productivity.

Q And just to -- just to flag, if you can turn to page 29 of the document. I'm not sure what the CAN reference number is, but 29 on the document itself -- 29, sorry. Okay. This starts, there's a series of pages where the declines are graphically presented, and I'm not going to spend any time on this, I just wanted to flag that's what these graphs are showing, the returns over time and the decline on some, but not -- not all.

A That's correct. There is -- most of the forecasted, the 19 core forecasted stocks have been exhibiting systematic declines in productivity. There are a few stocks such as Weaver, Late Shuswap, that have not been exhibiting systematic declines in productivity, as well as Harrison, in contrast, that has been exhibiting systematic increases in productivity.
Q All right. So you were faced in 2009 with the lowest returns ever and that caused you to go and have a look at how you were putting assumptions into the model, or whether there was other assumptions that could be made to improve your -- your forecasting outputs; is that fair?
A It was -- the declines that we'd seen systematically over time and 2009, as well, that led to the -- exploring the forecast methodology in a different way.
Q Okay. And what was the change that was made in the 2010, what was the new assumptions that were put in?
A For the 2010 document we included three different alternative assumptions about survival of Fraser sockeye, and that, when I say survival, includes from the egg stage all the way through to the adult return stage. So we included three different scenarios that reflect different assumptions about the survival experienced by fish returning in 2010, starting from when they were in the gravel, all the way through to their adult return.
The first productivity scenario that we included was long-term average productivity. And that methodology to produce that forecast table was identical to past methodology that has been used. So it's using the full time series in the context of forecasting to generate the forecasts. So there's nothing new with the recent -- the Long-Term Average first case productivity table.
The differences in the forecasting methodology occurred in the second and third cases, which are the Recent Productivity forecast, which assumes that recent productivity is what -- what we're using. It's the assumption that recent productivity is what's going to persist through to 2010, is the second assumption. And the third assumption or the third forecast table is if 2009,

which was the lowest productivity on record for most of the Fraser sockeye stocks, if 2009 repeats itself, it is the forecast that we would expect -- the return that we would expect to see in the third forecast is if 2009 productivity repeated itself through to 2010.

The specific changes for the second forecast that I just mentioned, the Recent Productivity, I'll go through that because -- I'll go through the last two cases where the forecast specific methodologies changed.

In the second case, the Recent Productivity forecast, the major changes in that were the inclusion of three new models. What we've called the RS4 year, which is recruits per spawner in the last four years, the RS8 year, which is the average recruits per spawner in the last eight years, and the Kalman filter Ricker model. And these three models are using -- they're using as predictor variables the brood year escapement, which -- what we use for Fraser sockeye is effective female spawner abundance, which is females multiplied by their spawner success, how successfully were they -- how successfully were they as spawners in terms of their percent spawn in terms of their eggs present in their carcasses. So that's what we're using as a predictor variable for the three new models.

The RS4 year is simply taking that brood year escapement and multiplying it by productivity in the four last years, or the last eight years. so RS4 year, RS8 year. The Kalman filter Ricker model is using the Ricker model form, but it's -- classically models use the full time series, and in a Ricker model there's a parameter for the productivity of a stock. And when you're using the full time series, that model is parameterized using the full time series. So from the high productivity period all the way down to the low productivity period, that's typically what's used, and if we used a Ricker model in the Case 1 "Long-Term Average" forecast, it would be using a productivity that reflects the full time series.

What the Kalman filter Ricker model does is focus that productivity parameter on the more recent time series, which has been lower in terms of productivity. So typically if stocks had been declining, the Kalman filter Ricker model would produce a lower forecast because it's picking up that lower productivity in a biological model context, and that model is based on work by Catherine Michielsens as well as collaboration with Randall Peterman, Dr. Randall Peterman from SFU who has published work on the Kalman filter model and describes the importance of using such models, given in light of -- when you see shifts in productivity.

So those would be the three new models that we've used in the second case, which is the Recent Productivity. They're models that specifically pick up Recent Productivity.

Now we still used all our full suite of candidate models for each stock. We just added these three new models, and we've run them through a retrospective analysis, that I've described earlier, to compare which models perform better. The other difference with that second case, which is the Recent Productivity forecast scenario, is that we look at the performance of all of these models over the recent time period, so in the last eight years. So rather than taking the full retrospective period, which is the second half of the time series, we're only using the last eight years. Because productivity's declined, we want to see if certain models are performing better, more in the recent period. And so that would be a departure from the first case scenario, where we're using the full retrospective time series to rank the models.

The other difference between the second case and the case we -- the first case, so the recent productivity versus the long-term average, is that five-year-old recruits -- typically when we're generating forecasts, we generate forecasts for the four and five-year-old recruits, and then by assigning age proportions to those recruits, we add them together to get the total forecast. So typically for the Long-Term Average Productivity forecasts, we would just run the two recruitments through the model and get the recruitment, and then do those calculations.

In the case of the Recent Productivity, because the five-year-olds in this -- the Fraser sockeye are four and five-year-old fish, so we're generating forecasts for four and five-year-olds, and adding them together, because we expect four and five-year-olds to return. In the case of the five-year-olds, they would have been from the same adult spawners. They would have entered the ocean at the same time as the four-year-olds that returned in 2009, so in the previous year. And we know from any of those stocks that previous year was the lowest survival on record for a number of the stocks, lowest productivity on record. So for the five-year-old component, for the Recent Productivity forecasts we used the preliminary productivity from the previous year, from 2009, knowing that these five-year-olds experienced all the same survival conditions, so likely they will be equally coming back on similar productivities.

We used preliminary productivity from 2009 to forecast the five-year-old component of the total forecast. And what that means is essentially because it's the lowest productivity on record, it's even lower than the recent four years. If you're generating a forecast for the five-year-olds, it will be much lower, given it's the lowest we've ever seen on the Fraser sockeye record for most stocks. So the five year -- there was a difference in that five-year-old component, as well, for the Recent Productivity forecast.

Model selection was the same for Recent Productivity forecast, where you would rank the models and select the top models to generate forecasts.

And the final forecast scenario, the third one, was what if 2009 repeats itself. And so we say the same productivity we saw in 2009 repeating itself in 2010, what would we see in terms of returns. So that was the last scenario where we took preliminary productivity again from 2009 and we applied it to both the four-year-olds and the five-year-olds. So in Case 2 we only used 2009 productivity for the five-year-olds, because we know they encountered the same survival conditions, but for the what if productivity in 2009 repeats itself, we just applied the productivity we saw in 2009 to generate forecasts for 2010 returns, based on the brood year escapements for 2010.

So it's -- it's the assumption that if 2009

repeats itself, this is what we would see and we presented it in the third forecast table.
Q Thank you. It's complicated --
A Yes.
Q -- so I appreciate you going through it. With those three different case studies, as you've described them, you then went through the same forecasting exercise that you had done in the years previous, or as you've described as modified, but you created a forecast for each of the stocks, for each of those cases; is that right?
A That's correct.
Q Or run-timing groups, I guess, in some cases.
A Yes. And I should -- there was one thing I wanted to elaborate on when you were referring to the 2006 methodology. One thing that we started to do differently is instead of just choosing the top-ranked model to generate the forecast, we compare -- because in the ranking process, it's an important thing to bring up, because you're asking about changes. And one thing we layered on from the Cass et al paper, and this is a lot of -- from advice from other and from different meetings, from a lot of input from the Pacific Salmon Commission, we -- we compare the forecasts that are produced for not just the top model, but the top-ranked models and compare the actual forecasts being produced. Because sometimes performance between the first-ranked model and the second-ranked model can be very small, so we want to see if the forecasts are telling us something different using a different model form. So we go through a whole process of evaluating how for each stock the top models --
Q Okay.
A -- forecast.
Q Okay. So you do the mathematical modelling and you come up with your best estimate of a forecast for each of the different 19 stocks in most cases, and/or the run-timing groups. The Case 3 you only had run-timing groups for; is that correct?
A That's correct.
Q Okay. So without getting into that minutiae for right now, that -- those forecasts were then presented in the 2010 research paper on page 41 in a graph or a figure that shows sort of the

aggregated information put together using the different models. So we have, if you can turn to page 41, which is 47 in Ringtail, I think, and it's not in colour, but hopefully you can describe what's on that.
So this document, as I understand it, the first graph, which says "A. All Stocks", puts all of the different run-timing group aggregates together and it shows the total run size forecast using "1. Long-Term Average Productivity", which is sort of the old method.
A Mm-hmm.
Q And then "2. Recent Productivity", which is Case 2 that you just went through. And then "3. Productivity Equivalent to 2005 Brood Year", which is the Case 3 study that you described.
A That's correct.
Q Okay. And then it's broken down below into each of the run-timing groups that same function, so you've got the calculations done for the Long-Term Average Productivity, the old method, the Case 2 and the Case 3. Okay. So can you just explain, like, what's being shown on these -- on these bars, what's -- is this -- this is a probability distribution, I take it.
A Mm-hmm.
Q Can you explain how that is to be read?
A These are plots to graphically display the probability distributions of the forecast table, and it's communicating -- this table is -- this figure is specifically communicating the random stochastic uncertainty in the forecast that deals with what I described earlier in terms of observation error, what's called variability in returns from one year to the next, so the width of that horizontal bar is describing the uncertainty from those two elements. And in addition it's also -- these figures are describing uncertainty in regards to your different assumptions regarding productivity for Fraser sockeye under the three different scenarios. So under the assumption that long-term average productivity will persist into 2010, whether recent productivity is going to persist through to 12010, or whether productivity equivalent to the 2005 brood year, which means productivity that we saw associated with the 2009 returns, which was the lowest on record, whether

that will repeat itself through to 2010. So there are three alternative assumptions about what we might expect to see in terms of productivity for Fraser sockeye.
So the width -- the width of those horizontal bars are describing -- yeah, I'm just repeating myself.
Q So that's -- okay. So just in lay people's terms, if we look at the Long-Term Average Productivity, the first, grey bar would show what, the ten percent probability?
A Yes, the left-hand component of all those bars which is dark grey on the left-hand side of all the graphs is the ten percent probability level.
Q Okay. And then you move into the black bars and there's a white separator at some point on that bar. That's -- is that the 50 percent probability mark?
A That's correct. So these are the probabilities extracted from the forecast table and they're describing the probability of a return coming in at that return abundance, or below. So the 25 percent probability level would be describing a probability of being at that run size, so there's a one-in-four chance that the return would come in at or below that specified run size.
Q Okay.
A So you're right, Wendy, the white bar is the 50 percent probability level.
Q And the numbers on the -- on the "x" axis, those are numbers of fish, right, like the --
A Total returns.
Q Total returns.
A Yes.
Q Okay. So if we look at the Long-Term Average Productivity bar for 2010, you are predicting, I take it, if we take the grey bar right out to the right-hand margin, that there is a 90 percent chance that the -- sorry there was a 10 percent chance that the run would be 40-plus million or less. Is that how we read this?
A A 90 percent probability that it would be at 41 million or less.
Q Okay. Oh, sorry, yes.
A Yes.
Q I don't know why I keep getting these --
A Oh, it's --

Q -- probabilities reversed, but someday I'll get it. All right. And then the next line, "Recent Productivity", there are some arrows pointing to the different dividers on this graph. Can you tell me why that is?
A The arrows were communicating the exercise we just went through in identifying the -- the break points between the 10, the 25, 50, 75 and 95 percent probability levels, and these probability levels are extracted from the actual three different tables. So it's those colour breaks that are identical in terms of what probability level they're representing on the three different scenarios for your assumptions about -- the assumptions about productivity for Fraser sockeye.
Q And is there a reason why the Case 2, "Recent Productivity" is highlighted in that way that the arrows are pointing to that bar and not one of the other two bars?
A I was just trying -- we were trying to select the -- the easiest one to illustrate that example.
Q Okay. The 2010 return, did it actually come in within any of the forecasts that were produced for the 2010 year, the actual return for 2010? Is it -- does it show, does it fall within any of these probabilities we see on the graphs?
A It's very preliminary, the return results, so they haven't been finalized yet. But for 2010 the return I think was around 35 million. So it would fall within the probability distribution for the Long-Term Average Productivity scenario. But that is looking at the total.
Q Yes.
A Yes. So it does.
Q Okay. I mean, the Commission has heard at public hearings that the 2010 forecast was inaccurate and that caused various problems. Do you consider that the 2010 forecast was inaccurate, based on the work that you did?
A The -- well, I guess, when you're looking at these probability distributions, they are describing the total distribution. The actual return does -- if you look at -- break it down by stock, we don't have all the final details for all the stock breakdowns, but the -- these probability distributions are describing the -- I guess using the word "inaccurate" is probably not what I would

describe it as. These forecasts are describing the range of uncertainty and our knowledge based on these different assumptions about future survival, and what the returns came back at, particularly for certain stocks, particularly Late Shuswap and the Early Summer Shuswap group came in on the higher end of the probability distribution. Other stocks came within the probability -- came in some cases below the 50 percent probability level for the Long-Term Average, sometimes above. So there's lots of variability in productivity for the returns that we saw in 2010.

So what these forecast scenarios are doing is placing those returns in the context of the different assumptions about future productivity and providing a measure of where those actual returns are falling out in regards to long-term, recent or 2005 brood year productivity. So they were on the map in terms of long-term average productivity. So what the forecasts are telling us is that for a lot of stocks, the 2010 returns were well above average for the case of Late Shuswap, but they're also telling us for some stocks, because you have to go through the complexity of all the stocks that exist, that some stocks were below average in terms of long-term average productivity. So we use the forecast to -- as a sort of map to place the returns in the context of the different productivity scenarios.

MS. BAKER: Okay. Mr. Commissioner, I wasn't keeping a very close eye on the clock, and I see it's already almost 20 after 11:00. Did you want to take a break here?
THE COMMISSIONER: Yes.
MS. BAKER: Thank you.
THE REGISTRAR: The hearing will now recess for 15 minutes.

(PROCEEDINGS ADJOURNED FOR MORNING RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: Hearing is now resumed.
MS. BAKER: Can you just turn your mike on? Thanks.

EXAMINATION IN CHIEF BY MS. BAKER, continuing:

Q So I'd like to go back to the 2010 research

document and actually, could I have this marked as an exhibit, just for reference?
THE REGISTRAR: Exhibit number 352.

EXHIBIT 352: Pre-Season Run Size Forecasts for Fraser River Sockeye Salmon in 2010

MS. BAKER:
Q If I can ask you to turn to page 44, which I think is 48 in the Ringtail numbers -- sorry, 50. Apparently I can't count.
This table sets out - and let me just back up for a minute. You did a table that sets out the results of your bottle runs for each of the three cases, correct?
A Yes.
Q So I'm just going to, in the interests of time, go to case 2. I understand case 2 is what was ultimately recommended for the 2010 forecast; is that right?
A The -- yes. I'll just elaborate on that. It was the CSAP Salmon Subcommittee had put that forward as the forecast with the greatest weight of evidence, the most plausible forecast. So Case 2 was in light of recent low productivity put forward as the most plausible; however, the first and the third case were still considered within the realm of possibility. We just had the greatest weight of evidence put forward for case 2.
Q Okay. So with that in mind, I think I'll just focus on case 2 for today's hearing, just to review it. So this document or this page of the document, I should say, sets out your forecast results using that recent productivity analysis that you described earlier?
A That's correct.
Q Okay. And again, on column A it sets out all the different stocks within the run timing groups, including the miscellaneous stocks?
A Yes.
Q And then the next Column B, this sets out the different models that you use to create the forecast, the ones that were most appropriate for those stocks?
A That's correct.
Q All right. And then what do the tables C, D, E,

F, G and with the nice colours, what does all that describe?
A Those columns are setting the stage or providing background for the forecasts. And for the models being used, the -- the Brood Year escapement is a key input to a lot of the different models and the Brood Year escapement, so Column C has BY and then in brackets (06) and then underneath EFS and that's Brood Year 2006 effective female spawners, so that's the predictor variable that we use in most models.
Q So if I can just stop you for a minute --
A Yes.
Q -- those show the parent generation for the four-year-old returns; is that right?
A Yes. That's correct.
Q Okay.
A The parental females from -- for the fish returning in 2010. That's correct.
Q As four-year-olds?
A As -- sorry.
Q And then the one beside it is the same but is it for the five-year-old numbers?
A Yes.
Q Okay. And then what do the colours mean, yellow, red and green?
A Based on time series averages for each individual stock, we created a distribution and -- a distribution of Brood Year escapement or in the case of Columns E and F, a distribution of productivity in the last -- oh, productivity on the time series and a distribution of returns, and we broke that into three categories, whether it was below average, which it would -- below the time series average, so we would colour code it red if the Brood Year escapement or the productivity or the returns are average, we'd colour them yellow in this table. And if they're above average, they'd be coloured green.
So we're using this as a tool, a ground truthing tool, as well as a tool to give you an idea of how the returns are -- what are driving the returns we would expect. So in this forecast scenario, because we're looking at recent productivity, I wanted to -- we wanted to highlight in Column C, in particularly Column C, which is the driver, that most of the Brood Year

escapements for most of stocks as a starting point for what we expect to see in the future was generally a lot of the stocks were yellow or green. So they were either average or above average in terms of their Brood Year escapement, so at the very starting point in the forecasting process, the number of parents that were around in most of the systems was actually average or above average. So things were good from that perspective, starting out.

There were four stocks that were below average, so Bowron, Late Stuart, Quesnel, Weaver were four stocks that had below average Brood Year escapements so they're starting out, out of the starting blocks, a little bit behind everything else for those individual stocks, given their own individual long-term time series for escapements. So that's part of the story when you're generating a forecast.

The other parts of the story, the five-year-old component, the contribution of the five-year-old parents, the parents that are producing five-year-olds in 2010 are playing a very small role in this forecast, because we were assuming that productivity associated with these five-year-olds is identical to the four-year-olds that came back in 2009, so the lowest productivity on record for most stocks because the five-year-olds came from the same parents as the fish that returned in 2009 and they hit the ocean at the same time as those fish hit the ocean in 2009, so they experienced almost identical survival conditions. The only difference is they spent one additional year in the ocean.

So we're making an assumption that these five-year-olds -- I put it there just as a gauge for how the five-year-old contribution is doing, so in terms of red and green, but in a way they're not playing a big role in the forecast, because the five-year-olds are being forecast using the very low productivity that we saw in 2009, because we expect them to be hit similarly by that low productivity. So the four-year-olds, Column C, is really driving the total return as a predictor variable.

Then in Column E and F -- so there's three key factors that determine how many fish you might expect to see. The first is how many parents do you have - so that's the Brood Year escapement - and how many parents are you starting out with. The second important variable is the age structure which I've just described, so what is that? How old are they when they return? So Fraser sockeye mostly are going to return as four-year-olds, so we're really focused on Column C.

The third important thing is the survival. So if you know how many parents there are and you know survival, you've got your answer. So what Column E and F are describing are the recent productivities for Fraser sockeye. So the last eight years, Column E is productivity in the last eight years and F is productivity in the last four years. And again, we're colour coding these productivities in the last four years and the last eight years relative to the time series, and if the recent productivities are below average, they're coloured red --

THE COMMISSIONER: Just ask you a question?
A Yeah.
THE COMMISSIONER: I'm -- I'm trying to follow the four and five-year split.
A Okay.
THE COMMISSIONER: Do the models take into account that -- you mentioned 2009 is the lowest productivity year on record.
A Yes.
THE COMMISSIONER: Right. Do the models build into their calculation a factor for perhaps the 2009 year showing up in 2010, along with the 2010 expectation in terms of returns? So if there was some reason that we don't know of why there was a delay for more than the usual number of sockeye --
A Mm-hmm.
THE COMMISSIONER: -- in other words, they didn't come back in the four-year span but for some reason that we don't know --
A Mm-hmm.
THE COMMISSIONER: -- there was a cause for this delay --
A Mm-hmm.
THE COMMISSIONER: -- so that more came back along with what was expected for the 2010 year, so you get this --
A Mm-hmm.

THE COMMISSIONER: -- now, you know, the bookend. We have an extreme low return --
A Mm-hmm.
THE COMMISSIONER: -- with an extreme high return.
A Mm-hmm.
THE COMMISSIONER: How do the models adjust for those -- you talked about uncertainties earlier around --
A Mm-hmm.
THE COMMISSIONER: -- environmental factors and so on.
A Yeah.
THE COMMISSIONER: But just in terms of other kinds of factors that may be playing, do the models take any of that into account or are they, as you say, giving a very low weight attached to the five-year?
A Now, that's a really good question and I'll explain in response to that. It's a very good question because people -- that was coming up in public spheres, scientific spheres, with the low returns in 2009, was there the possibility that those four-year-olds just delayed and were returning as five-year-olds. With the forecasting process, we're using the past to predict the future. And in the past - and we did look at this intensively - was -- we've never really seen that kind of response in the age four and five age structure. It's never been seen before where there's a massive signal where you see a massive shift in age proportions.
So generally speaking, for most Fraser sockeye stocks, the age four component makes up about 95 percent of the total age structure. And throughout time for most of those stocks, that age structure doesn't vary. If it does, it's very little.
We've never seen on the time series for any stock -- and I'll explain one exception after I finish this part, is that we've never seen a shift like that. So even though that was out there as a hypothesis, looking at our historical data which is what we use to forecast and move forward into the future, we've never seen that kind of delay in the five-year-olds that would create a surplus in the next generation. So what you are suggesting -- or what your hypothesis would have been would be we would expect, instead of the usual 85

percent in 2010 of age fours, we might see 85 percent age fives because they've all come back from the previous year. But because we use the past to predict the future, we've never seen that for the Fraser sockeye stocks except for one exception, and I'll explain that.

And we're using the past to predict the future. We wouldn't build that into the models. We would still use the classic age proportions that we've seen on the historical time series. So there's no -- that would be an event that would be outside of our range of understanding, so we couldn't incorporate it into our models because we've never seen it before. So it's a hypothesis. If it came true, it would have been very interesting and it would have added to our time series and it would add more knowledge for future hypothesis-building, but for the current year, we didn't have any evidence that that's occurred ever.

Harrison, I'll just explain, is one interesting stock. You've probably heard about it already throughout the testimony. Harrison sockeye are three and four-year-old fish and they're unique because all other stocks spend an additional year in the fresh water after they emerge from the gravel, so they rear in a lake and then after that year of rearing in a lake, the migrate to the ocean, so they've got a longer freshwater life history; whereas Harrison sockeye, when they emerge from the gravel, they shortly after that emergence are migrating to the ocean. There's some -- some research that shows that they rear in sloughs along the way, but not for very long.

Harrison sockeye, as a result, have a different age structure. We call them three-sub-ones, four-sub-ones, because they only have that one year in the gravel, and in reference to your question about age structure, Harrison do fluctuate wildly from one year to the next from three-year-olds to four-year-olds, so they're the only stock where we see that kind of fluctuation in age structure.

And there's some linkage with Harrison delaying a bit more in the marine environment when pinks are out there, as well, so a hypothesis could be that Harrison are out in the ocean, the same time as pinks. They have a similar life history to pinks because pinks also migrate to the ocean right away. They don't rear in the fresh water, so they're presumably competing for the same food resources in the ocean.

And because Harrison is competing with this large abundance of pink - and this is a hypothesis, not fact - but they could be competing for the same resources out there in pink years and as a result they need an extra year in the ocean before they can return. So in pink years, we do see a slight delay in migration on Harrison sockeye, meaning that in pink years, we do see a slightly greater four-year-old proportion than three-year-old proportion, 'cause Harrison are three- and four-year-olds.

But they're the only stock we've ever seen anything like that for, evidence that their age structure dramatically shifts from one year to the next. So to answer your question, we haven't built that into the forecast because we've never seen it before. So that would -- that's an interesting hypothesis and, of course, people were curious to see whether the age structure in 2010 was going to be flipped around and that would have been really fascinating, but we didn't see that and it does map onto what we've seen historically. We've never seen that kind of flip-flop in age structure delay.

THE COMMISSIONER: So where in the model do I see the five-year factor being considered?

A The age proportions?

THE COMMISSIONER: Right.

A When we're generating the forecasts, so say for -- I'll just start -- say with the biological model, we'll generate -- we'll take the Brood Year escapement, so we have a relationship between Brood Year escapement and recruitments, so say simply -- we've got Brood Year escapement and recruitment and then we've got sort of a model going through and you draw up -- so you say your Brood Year escapement is 10,000 fish and just putting it simply, say there was just a straight line, like a linear regression straight line. You just map up on your X-axis --

THE COMMISSIONER: Oh, I see.

A -- and you map across. So then you go, okay, there's 10,000 fish. That maps onto 20,000 recruits. And we use the word "recruits" to describe the number of fish that comes back from that parental generation and those recruits include four- and five-year-olds.

And so what we do is we take -- that's why the two columns, C and D, are in there. We would take Column C, so say for Early Stuart we would take the 15,900 in this -- say this RS4 year - this is recruits per spawner in the last four years - multiplied by Brood Year escapement. We would multiply that Brood Year escapement in 2006 brood year, which leads to four-year-olds, but what we're doing is we're generating a forecast for total recruits coming from those parents.

So from 2006 four years later there would be four-year-olds coming out of that and five years later there would be five-year-olds coming out of that, but we're just generating a forecast for the total four and five-year-olds from that, and we only want the four-year-old components from that, so we multiply the total recruits that we get from that Brood Year escapement by the proportion of four-year-olds we see on the time series.

So say for Early Stuart it's 85 percent four-year-olds, we would take for Brood Year '06 15,900. We would get a recruitment from that and multiply that by the proportion of four-year-olds, and that gives us the four-year-old component of the forecast. And it's -- stock recruitment tables, you have to flip your mind around from returns and recruits. Because a parental generation -- it's like your offspring will grow up -- some of their babies will be mature at four years and some a year later at five. So all the recruits coming from this Brood Year escapement are coming back in 2010 and also in 2011, but we only want the component that's coming back in 2010 from those parents.

And then the 2005 Brood Year, flipping that a little bit, there -- that Brood Year escapement is 51,000. What we would do is we'd multiply the 51,000 by recent productivity. That's now the year before, the 2005 Brood Year. This parental generation would be producing again offspring in four years later and five years later. And because this is the '05 Brood Year, they would have produced four-year-olds in -- the previous year, in 2009, and they would produce five-year-olds in 2010. So what we're doing is we're taking that Brood Year escapement, multiplying it by the productivity, and we'll get a total recruitment for those parents. Their kids came back four years and five years later, but we in this case only want the five-year-olds coming back because the four-year-olds came back in 2009. So we're multiplying that by the five-year-old proportion, which would be the inverse of the four-year-old component, so a small percentage, like around 20 percent of the total run -- or 20 percent of the total age proportion.

So each of these Brood Years are producing offspring four and five years later and we're taking that total and assigning only the four-year-olds coming back and the five-year-olds coming back and then we add those two numbers together to get the total. And it's -- that's where the age proportion comes in.

THE COMMISSIONER: Right.

A Yeah.

THE COMMISSIONER: Thank you.

A Okay.

MS. BAKER:

Q Okay. Thank you. Then if we look at the table, we continue to look at the table, it shows in H and I the mean run sizes for all cycles and then for the 2010 cycle; what is that describing?

A The mean run sizes place the forecast distribution in the perspective of what we've seen historically on average. There's Column H is across all the cycles, so Fraser sockeye have -- they're four-year-old fish, 85 percent of the -- each stock is generally four-year-olds, so we usually describe Fraser sockeye on -- using cycles.

So it's not that they're completely independent of one another, but each four-year cycle since they come back in four years is almost a unique population so there's parents, their offspring come back four years and four years and four years, so they're forming their own, perhaps, productivity pattern or their own like cyclic abundance, there's some cycles are more abundant than others. So we, in addition to looking at all

the cycles, all four -- all years combined, we also look at the specific cycle that we're looking at.
So, for example, Late Shuswap in 2010 is dominant. It's on its dominant cycle, so that's once in every -- once every four years Late Shuswap comes back at the largest abundances across all cycles, so that's why it's important to compare the forecast distribution to also the cycle average, which tells you specifically anything unique. Some stocks don't exhibit differences in cyclic -- cycle line abundances, and other stocks, Late Shuswap is the key example that comes back at much larger abundances once every four years. So those two are for reference to the forecast, so you can place the forecast in Column J to N in the context of the cycle average and then Column I specifically is used to place Column L, which is the 50 percent median probability level in the context of how the 50 percent probability forecast is doing relative to average, which is the colour coded Column G.
Q Okay. So in simple terms, all cycles means every single cycle without distinguishing on a cycle abundance basis, just what the mean is.
A Yeah.
Q And then 2010 cycle is looking at the 2010 year, 2006 year, 2002 year and so on back in time and looking at the means just on that cycle line?
A That's correct.
Q Okay. And then Columns J, K, L, M, N, these describe the different probabilities that you would expect running those models and these are the probabilities that we were looking at previously on page 41 on your horizontal bar graphs, correct?
A That's correct.
Q All right. Okay. Then that -- I think that's probably enough for me on that document. Probably enough for everybody on that document. It's a great document, but it's pretty dense.
The contact -- once that work had been done, you created a SAR document which you described earlier. That's Exhibit 341 for the 2010 year. Okay. And as you had described just after the break, I had said to you well, case number 2 is what was recommended and you indicated that it was

put forward, all three cases were put forward in the SAR but the highest probability table or case study was 2 and that's given the most highlight in this document. If we turn to page 8 that sets out the table that we just reviewed minus a couple of the columns. That's right?
A Yes.
Q Okay. And then if we turn to the next page, this sets out some summary information on the other two case studies, the long-term average and the productivity equivalent to the 2005 Brood Year, correct?
A Yes.
Q Okay. Did you -- do you think that there was value in performing these three different case studies using these different assumptions? Was that a useful exercise?
A Yes. I would say that producing three different tables for our different assumptions about Fraser sockeye survival through to 2010 was a valuable exercise.
Q And why is that?
A The -- the three tables have been useful, particularly -- well, they're useful for framing out the uncertainty in the forecasts -- in the return in 2010 associated with our forecasts, both from, as I'd mentioned earlier, by presenting the probability distribution from the ten to the 90 percent probability level, it's describing that uncertainty in the models, the process, the observation error, et cetera, within the models, but we're also presenting the uncertainty in these three tables regarding future survival. So whether we expect 2010 to return at recent productivity, aligned with recent productivity, long-term average or whether we expect 2009 to repeat itself.
The usefulness of the tables laid out this way, if we had just presented the recent productivity table or we just continued on with the long-term average productivity table, the advantage of these tables was to place the returns that we saw coming back on these as maps, so particularly with greater stock detail. So these SARs, particularly for the long-term average productivity, there was more detail for the individual stocks on -- in the research document

for 2010 versus what's in this table we've simplified, because this is a communication document and we were really putting forward the recent productivity forecast, but the research document is also used during Fisheries planning processes, so they would have the greater detail, as well.

So when stocks are returning, it enables us to place on these maps where these stocks are falling out, so often in -- we've heard a lot in the press, fix a real focus on 50 percent probability levels and they're being communicated often as deterministic single point estimates, but these forecasts are actually describing the range of uncertainty we're seeing both as I'd mentioned in process observation error, as well as in different assumptions about future survival. So what they're used as or what we can use them as is a map to place the stocks as they're coming in onto these different probability -- these different assumptions about survival and it gauges right away where we're at.

So in the case of stocks, we had recommended since we'd seen productivity in recent years had been quite low, we made assumptions that the greatest weight of evidence was that we'd expect to see that in the future but what we started to see with the stocks as they were returning was, in fact, they were coming in closer to the long-term average than they were the recent average. So even though the greatest weight of evidence was on the recent productivity, we weren't saying that these other scenarios couldn't happen because we actually don't have indicators telling us which of these scenarios could happen. We just felt that the past, immediate past, would predict the future better than the historical time series.

So as the run started coming in, we started placing them on these maps, realizing that Early Stuart was coming in greater -- so that's the first run-timing group to enter the Fraser watershed, and that group started coming in at the high end of the recent productivity scale. And but when you place it on the long-term average productivity scale that uses the whole time series, not just the recent productivity, it started referencing where that stock is actually falling in reference to a long-term average. So that one roughly was coming in around 100,000. I don't -- they're not final numbers yet, but you can see that it places it between the 25 and the 50 percent probability level on the long-term average productivity table. So it's actually closer to long-term average than it was recent productivity. That's the first stock to enter the Fraser watershed.

Then -- there's overlap between all these four run-timing groups, but it's starting to give an early sign that things might have been better throughout that life history of Fraser sockeye from the egg stage all the way through to the adult return. There was some signs that Early Stuart was coming back better than the low productivity we'd seen in recent years. And as other runs started coming in, we don't necessarily have the detailed stock breakdown, but we have aggregates of stocks depending on how fine of a genetic analysis we're doing on the returns as they're coming in, because we don't get down specifically in season to specific stocks. But there were signs that particularly the Shuswap run was coming in much better than expected, and that's the Early Summer Shuswap run, so it's occupying some of the same habitat that the Late Shuswap, which is the Adams run, which was the massive run in 2010, that run in the Early Summer component, we started seeing signals that that was falling out high in the long-term average productivity table.

There's a lot of nuances to the individual stocks, so often we do fixate on a single number, like the 2009 forecast; 10.6 million is a number that's used over and over again but really you've got to focus on the nuances of the forecast tables amongst all the stocks and the probability distribution. In 2010 the value of these tables are is being able to place the individual stock groupings you have as they're coming in right away onto a map that's telling you what productivity was like for the individual stocks.

And we always hear -- we over-simplify it a lot. We'll say 2010 was a bonanza year; 2009 was a crappy year or a bad year. But there's actually nuances to the stocks that you can see within the forecast tables. So, for example, 2010 was really great for the Shuswap run stocks, so Late Shuswap, which was the Adams, which we knew even from the start was going to drive the forecast. We hadn't seen productivity declines for it, so in fact, even in the recent productivity forecast, we weren't -- the forecast in the recent productivity versus the long-term average for Late Shuswap wasn't too different, because we hadn't seen productivity declines for Late Shuswap, which was the driver of the 2010 forecast. It's actually had very stable productivity over time, relative to all the stocks that have been showing these declining trends.

And so based on our recent knowledge, as well as our historical knowledge for Late Shuswap, we didn't expect to see a real drop in abundance for Late Shuswap. We didn't expect to see lower productivity. And if you look at the two tables, especially in the research document for Late Shuswap, you won't see a big difference between Late Shuswap for the long-term average productivity table and Late Shuswap for the recent productivity table. They both have very similar forecasts because we didn't see declines in productivity.

So that was interesting about 2010 and these three tables, because Late Shuswap, which again we expected to return at high abundances, actually turned at really high abundances. It was -- I believe they probably came out at the 90 percent or above the 90 percent probability level, so we're at the tails of the distribution. So they were actually, based on this kind of system of map -- or just kind of placing them on the map of the three forecast tables, you could tell right away that Early Summer Shuswap were coming back at -- on the long-term average, even above average. And but you could also see that other stocks, even Early Stuart -- 'cause when we say 2010 was a gangbusters year, Early Stuart actually didn't -- it was better than recent productivity, but based on the long-term average, it was still below average.

And there's other stocks that are below average, so it's important when we're looking at the forecasts to really focus on the complexity of the forecast tables, not default to just a single number like 10.6 million. And these tables, the real benefit is that perspective, that even in season people -- science, scientists and people using the information in season to manage the fisheries could start switching their attention to the long-term average productivity table. They started seeing signals and they had a table right in front of them that would say if things are above average now, this is what we're looking at more than this recent productivity, and they could clearly say that we weren't experiencing what we saw in 2009.

So we -- fairly early on, I'm sure the -- that was out of the realm. People were starting to think okay, we're not going to see 2009 again. And then you started seeing that it is actually better than recent productivity, so it's more on the long term. But amongst all those stocks, there's still nuances, which is always important to keep in mind. The same for 2009, there's a lot of nuances to the returns.

It's not -- in 2009, almost every stock was bad, poor productivity, amongst the lowest on record. But Harrison was still an exception in 2009, so when you look at the full forecast table, you could see Harrison actually came in above the -- above average in terms of its productivity.

And even within these probability levels, stocks aren't all coming in at the same kind of -- within their forecast distribution, so although we do a summation at the end, it's really important, especially for management purposes, I think, as well, to make sure you focus on the stocks and the run-timing groups. And it's a long answer to why those three tables are important.

Q Thanks. Do -- can the run size forecasts be updated after the SAR has been developed? Are changes made?

A Changes can be made to the forecast all the way up to when they're being used. It's only -- it would be the best practice, which is what we do, that if new information comes to us or there's revisions that we need to make to the forecast, we will -- we can do it all the way up to when it's being used. So changes could be made to the forecast. The paper itself wouldn't change because it's a published document with a number associated with it and it's published on the CSAS website, so that would never change, but there could be changes to the forecast itself. It's possible that you could make changes and there would be processes if the forecast changed.

I know we made a revision to the Early Stuart forecast in 2009, I believe, and that revision came in light of new revisions to our escapement time series for the Brood Year, so the parental generation. There was revision to the numbers from the data that we were using and it had a big effect on the forecast. So we didn't -- oh, at the time, actually, the forecast paper hadn't been put online, so we were able to make it within the document. But if the document had been published and that change occurred, we would still put that change through public channels and through processes, so the Fraser Panel, for example, that deals with in-season management of Fraser sockeye would get an update as soon as we had that information available to update them on changes we'd made to the forecast. So it's best practice to -- if there is a chance, we wouldn't sit on it and not inform the people who need to know to make management decisions.
Q Okay. This is a question I've asked a couple of other witnesses who have been here. There are uncertainties, as you've described, with pre-season forecasts and then there's differences between the pre-season forecasts and what's observed in season. So given those uncertainties and the differences that are observed when the runs return, are these forecasts valuable? Are they worth generating?
A Well, when you say differences, we should clarify that there are -- in most years the returns fall within the forecast distribution. So they're not different. They're just falling within the forecast distribution at a different probability level.
Q Okay.
A And your question was...?
Q Was are they a useful thing to do? Are they providing useful information or do they just create confusion and is it --
A Mm-hmm.

Q -- 'cause we certainly hear a lot of people stating that the forecasts are unreliable, that they're inaccurate and is that a problem with the communication or is that a problem with the forecasting information you're providing?
A I would say it's a problem with communication. Even the terminology "inaccurate" is inaccurate. You wouldn't say the forecast is inaccurate. You would -- the return is just falling within the probability distribution lower or higher than the 50 percent probability level. But people are often fixated, especially -- because it is complicated. I can't remember all these numbers in this table, so it's much easier to remember 10.6 million than the complexity of this table. So the -- I know where I'm going. I just have to...
So -- so, yeah, it becomes a problem with communication. There's a lot of wording that's used to describe the forecasts, especially in light of 2009 where people are fixating on the 10.6 million number. And it's really over-simplifying the forecast as it's presented in terms of the probability distribution, the uncertainty we have associated with the forecast and the fact that DFO never expects the 50 percent probability level to be what will return. That's a mid-point in the probability distribution and we actually have a one-in-two chance that the run will come in above or below that actual value. So that value isn't a deterministic DFO expects 10.6 to come back. We actually expected a range from 3.6 to 36.6 or whatever the range was, roughly in that range, to come back, and that's our probability distribution.
And we also say we expect -- the forecasts are used to say well, we expect a return to come back, say, at the 25 percent probability level, so for -- I'm not sure if we're -- if we just move back on the -- to the previous page for Table 1. Thank you.
The 10 percent probability level, say, for -- or the 25 percent probability level for Early Stuart, say, is -- there's a one-in-four chance that we would expect that the return would come back at 26,000 or less, given the environmental conditions that this particular table is

associated with. So given recent productivity, we would expect that 26,000 fish would come back or less, given recent productivity. So there's a lot of statements you're making when you're talking about the forecasts. We're not saying DFO expects 11.4 million to come back. We're saying for Early Stuart, there's a range of probabilities based on our range of experiences we've seen in the recent productivity; that under the assumption of recent productivity we expect a one-in-four chance that it'll come back at 26,000 or less, a three-in-four chance that it'll come back at 66,000 or less.

So with the forecasts, it's -- those kind of words -- we're getting back to communication. It's been highly over-simplified in how it's been communicated broadly to the Canadian public and how it's been picked up as a point estimate. And it's also being -- 'cause it's a complex issue. It's very -- like I said, memorizing this table would not be -- it might be humanly possible for some people but most people not, so you tend to simplify and say we expect 10.6. But this table is just describing our -- we're always using the past to predict the future and this assumption in Table 1 is given recent productivity, this is the range of returns we would expect to see if this productivity persisted into the future.

So I'm -- that's the first part of your question is just explaining the communication disconnect in how the tables are actually quite complex, they are explaining the uncertainty given your assumptions so in previous years for 2009 we just had the long-term average table. That was the only table we were using. And in that for a particular model we would be saying we would expect a one-in-two chance that the run would come back at 10.6 million. Given the environmental conditions we've seen on the historical time period.

If environmental conditions go off what we've seen in that historical time period, then of course the forecast -- the return is actually going to come outside of the range of probabilities that we assign because we've never seen it before. So the past is used to predict the future and we're trying to communicate what the past is informing us in terms of the uncertainty with the forecasts and the nuances between the different stocks.

So there has been a real over-simplification of the forecasts that have -- and misuse of terms like "inaccurate" or "completely wrong" or those kind of terms. The forecast is actually quite informative to tell you that right away it's what we're seeing in 2009 is actually completely different from what we've ever seen historically. It is amongst the lowest productivity or is the lowest productivity on record for a lot of stocks. So when something is outside of your historical range of understanding, you're not going to pick it up in these types of models because they're forecasting the future based on what we've seen historically. So that's the communications part of your question.

But the other part of your question is are these useful and I think that they are useful from multiple perspectives. I already described why they're useful from the perspective of placing returns in the context of the forecast and I think in the case of 2009 it was a very useful tool and unfortunately, the message that got out was a little backwards. You know, it was all this -- people being upset that the forecasts were wrong and in fact, what the message is is that based on our historical understanding of Fraser sockeye population dynamics, 2009 was very strange. We'd never seen it before.

So the real message, unfortunately, got missed a little bit with how it was being communicated and it should have been wow, something really exceptional happened in 2009 because it's falling at the extreme end of our probability distribution. So there was something like a one-in-one-hundredth chance that we would have seen that total return, given our range of understanding of Fraser sockeye stocks. So that's the communication issue and the usefulness of the forecast is to do that to place the returns that we see in the context of what we've historically seen.

So 2009, we saw 1.3 million. We could place it on that range where we said 3.6 -- the range, using current probability levels, we'd say the ten percent probability level we expected 3.6, all the way up to the 90 percent probability level where we expected something like 37.6 and, in fact, the run came in below the ten percent probability level at 1.3 so right away, we're getting a signal that what we're seeing is outside of our historical range of understanding.

And then when we started post-season looking at productivity data, you start recognizing that for a lot of stocks, the productivity was amongst the lowest on record for the time series or was the lowest for most stocks, not Harrison. Harrison was for 2009 returned at reasonable abundance, a good abundance. But that's again the nuances of the data and not all stocks' productivity was the lowest on record. So there's a lot of variation in the data.

So the forecasts are useful from that perspective, placing the returns in the perspective of what have we seen historically. They're also useful -- they're the best we have as a tool for pre-season and early in-season management. These models are through the retrospective analysis process are the best-performing models that we have currently available to forecast Fraser sockeye returns and they do characterize the uncertainty, as well as -- characterize the uncertainty of what we might be -- expect to see given assumptions. So in previous years' forecasts, we only had the long-term average productivity tables, so our assumptions were always this is the probability distribution we expect to see given productivities are similar to long-term average. If they're outside of that, then they're going to be outside of what we've seen historically.

So for pre-season planning, early in-season, for run -- early in-season run size models, I know they use the pre-season forecasts as a tool to help as a starting point for what we're seeing -- what we expect to see. As in-season data becomes more and more available, these pre-season forecasts start dropping off in terms of their usefulness as inputs into the model, but they're still useful from a qualitative perspective to place you on the map as to where you are.

And as I'd mentioned, they are amongst the best models globally, especially this past year.

We were using models like the Kalman filter Ricker model which are -- very few people globally would use that model. It's very current and up to speed on very recent methodology that Dr. Peterman was developing in regards to picking up recent productivity trends, so in our recent productivity table we try to stay sort of ahead with new models and new methods, so -- and then we do the retrospective analysis to pick the best models, so they are our best starting point. They're better than just pulling a number out of the air or making a rough guess as to what you think might be coming next year.

So those are the two benefits. And there's one more, just from a purely scientific -- from a scientific biological perspective, biologists and scientists are always playing around with models in the perspective of forecasting and understanding how it describes the current state of understanding about population dynamics for an organism. So for Fraser sockeye we have a bunch of models and these all in different ways describe our understanding of population dynamics for that model and every year we're re-evaluating our assumptions about how well we understand this animal and evolving and trying out new modelling techniques and it's not just within this world that's input into management, but scientists are developing models.

So you'll see in state-of-the-ocean reports published by DFO but that include scientists throughout the world -- I'd say largely U.S., Canada, who are publishing different forecasts for different salmonids or different stocks and they're all playing around with different hypotheses for what is influencing Fraser sockeye survival. So models, in a way, are exploring hypotheses for Fraser sockeye survival. So biologically, scientifically, they're a useful tool for describing our current state of understanding of survival, exploring and adapting and evolving.

So those are the three key reasons why forecasts are important.

Q Thank you. And then just one area I wanted to cover briefly with you. Dr. Beamish of DFO Science has done work recently in the marine environment in the Strait of Georgia, looking at juveniles in the Strait of Georgia. Had you or have you considered whether his work or other similar marine studies could be used in forecasting?

A Yes. We quantitatively have used a variety of variables in the models which I described earlier, so in the biological models we can use a variety of environmental variables and this is going to segue into your question, but the -- it sets the stage for it. Quantitatively, we tried sea surface temperature, we've tried Fraser discharge, different individual variables, and they generally haven't improved the forecast. They do little tweaks to the forecast but they don't give us the answer. They aren't the solution to explain all the variability in the stock recruitment relationship, so that we perfectly can predict Fraser sockeye using sea surface temperature. In fact, they only tweak it minorly and it only tweaks it for some stocks in some years. But we haven't found a single environmental variable.

And likely the reason for that is that Fraser sockeye have such a complex life history that they -- from their individual rearing lake, where they're in the gravel, there can be environmental conditions in the gravel, flood events that scour the eggs, all the way downstream during their downstream migration there can be mortality, especially as they're transitioning into the ocean, there can be mortality. They hit the Strait of Georgia, there can be mortality. They migrate fast along the continental shelf and out into the North Pacific and then they're mingling around there for another year before they return. So it's this huge massive special temporal scale on which we're trying to understand what is driving survival.

So in our models when we're quantitatively trying to put in environmental variables like sea surface temperature, it's only one spot and it's in their whole life history that covers freshwater all the way to marine and it's asking a lot of a sea surface temperature variable that does try to -- sea surface temperature isn't just the temperature alone, but it's often influencing different zooplankton compositions, different food quality for the fish or just the temperature itself, so it is trying to integrate a number of variables into a single one. But at the same time, it probably is over-simplifying or not quite capturing the problem, because it's in time and space. You could measure sea surface temperature, but maybe you're not measuring it in the right spot at the right time, or maybe it's synthesized over a broad space, so that it's so complex to just take individual variables and look at it quantitatively. So that's why there's been a lot of challenges trying to find the one variable or a couple of variables or a composite of variables that work quantitatively. So it's a big question with Fraser sockeye.

Other forecasts, other -- other salmonids that have been forecast have better success with incorporating environmental variables so, for example, on the West Coast of Vancouver Island there will be Coho stocks that migrate out and they stay local on the coast of Vancouver Island, so unlike Fraser sockeye, these animals are in the freshwater, so there's that element of uncertainty in their survival, but then they're hitting the ocean and staying very local. So you can do very strategic sampling in time and space because you know where they are. You can even sample the animal because they're right off the coast and you know they're going to stay there for their whole marine distribution.

And I know that there are certain individuals like Dr. Ron Tanasichuk has been doing some forecasting quite successfully because he's working on stocks that you have a better handle on where they are. Their ocean distribution is a lot more localized versus Fraser sockeye that are hitting the Strait of Georgia and very rapidly, except for Harrison, that's unique again, but all the other stocks are hitting the Strait of Georgia and generally from research data from Dick Beamish and Marc Trudel, who do the high sea salmon and Marc Trudel does -- Dr. Marc Trudel does high sea salmon and Dr. Dick Beamish does the Strait of Georgia. They've been finding they migrate rapidly through the Strait of Georgia. They migrate along the continental shelf out through the Aleutians and then they're hanging out in the North Pacific. So there's -- through time and space, they're covering a big geographic area, so I'm just pointing out the complexity of their life history and why those individual variables haven't worked very well.

So in segueing into 2009 and recognizing that individual variables aren't working well, we did look at a report card and we could refer to that now if you wanted to. It's -- it's a qualitative way of describing a range of indicators for Fraser sockeye. So rather than just looking at sea surface temperature in Entrance Island off the coast of Nanaimo, we've integrated a bunch of these different variables in a report card, which is commonly used, it's being used by the U.S. Government, as well, doing report cards on environmental variables that you think will influence sockeye or the animal that you're studying's survival.

So we qualitatively looked at that. I can explain it in the 2009 report on page 16.

Q This is in the SAR?
A That's in the SAR.
Q So that's Exhibit 340.

THE COMMISSIONER: Ms. Baker, I note the time. I'm not sure when you had planned to break for lunch.

MS. BAKER: Well, this was my very last question, so if she could finish this answer, then I'll be finished, if that's possible. It's up -- obviously, we'll break if you want to break, but...

THE COMMISSIONER: Okay.

MS. BAKER: Continue?

THE COMMISSIONER: I don't know how long her answer's going to be, but that's fine.

MS. BAKER: Pardon? Okay. If you get really hungry, just...

Q I mean, I did want to focus on the work that Dr. Beamish is doing in the Strait of Georgia and whether that's been incorporated in.
A Okay. The answer I'm giving will be --
Q Okay.
A -- it would be good to --
Q Okay. So that you were looking --
A I'm giving you a bigger answer than what you've asked, if you're really focused on -- but you did frame your question as in Dick Beamish and others, so...

Q Yes. Okay.
THE COMMISSIONER: Ms. Baker, I think we -- I think we will take a lunch break now.
MS. BAKER: Okay.
A Okay.
THE REGISTRAR: Hearing is now adjourned until 2:00 p.m.

(PROCEEDINGS ADJOURNED FOR NOON RECESS)
(PROCEEDINGS RECONVENED)

EXAMINATION IN CHIEF BY MS. BAKER, continuing:

MS. BAKER: Can you turn your mike on, Ms. Grant? Thanks.
Q So you were in the middle of answering a question about marine areas. I'd asked about Dr. Beamish's work and you were giving some background on marine impacts.
A So I had finished up the last pre-lunch session by describing why, quantitatively, the variables we'd been using haven't been effective to date due to the complexity of the marine survival issues for Fraser sockeye and how complex their migration is from the fresh water to the marine environment, and why, for some salmonids who remain more close off -- off the coast of -- west coast of Vancouver Island, for example, and remain local using single environmental variables. Those are a lot easier because you know where they are, they remain in a fixed area, and they don't have as broad migration. So that was from the quantitative perspective why perhaps these single invariables that we've been trying to use quantitatively haven't been helping us too much in regards to improving the forecast.
So in light of that, starting in 2009 -- and we'd been thinking about this for a while, particularly through engagement with scientists in the U.S. and other scientists working on salmonids that use the Pacific Ocean as a rearing ground for juvenile -- their juvenile stages. We'd been looking at this kind of red light/green light report card for qualitatively looking at environmental indicators for Fraser sockeye similar to what they do in the U.S. for some Chinook and Coho stocks in the U.S. that migrate

out of the Columbia. They have some good red light/green light indicators for their stocks that have been somewhat effective in their forecasting approach.

So we were deciding that if these single variable quantitative variables weren't going to work, we were going to go in this more qualitative realm. This will lead into your specific questions.

This is a table, Table 5, in the 2009 Science Advisory Report of the report card that we produced for some key environmental indices, or that we thought would influence Fraser sockeye, particularly in the marine environment. Every year DFO has annual State of the Ocean meetings and they produce research documents out of that. I believe it's a research document, not a Science Advisory Report, although I could be wrong.

But it's a pretty thick document where they invite scientists and people -- and biologists and oceanographers working on environmental indicators in the ocean environment to these meetings every year, and this includes scientists from both within the Department and outside of the Department. It's a very good document for summarizing ocean conditions within the Strait of Georgia and North Pacific, conditions that are -- animals will be experiencing, whether it's Fraser sockeye or Chinook Coho stocks from the west coast of Vancouver Island.

So this table is our attempt at synthesizing and integrating some of the key indicators that we think would influence Fraser sockeye in a broader perspective than a single environmental variable, and we were using this in addition to comparing performance with single quantitative variables to help describe the state of the ocean in a particular ocean entry year.

So this table is organized with on the top line there's "Ocean Entry Year" is highlighted, so that's the year -- generally it's thought -- the main hypothesis in regards to marine survival is that it's early ocean survival that influences the marine survival component of Fraser -- or of animals when they enter the ocean. It's that early first part of their life history that's most important for influencing total mortality in the marine environment, so we're focusing in on the ocean entry year which is two years after their brood year.

So two years after the parents spawn, the eggs are deposited in the gravel, they come out of the gravel, spend a year in fresh water and then migrate to the ocean. These would be the conditions experienced by fish stocks.

We did a lot of -- we've done a lot of work over the years working -- liaising with the State of the Ocean group that pulls together all these environmental indicators from Canada and the U.S., scientists that pull these ocean indicators together to help explain some of the Fraser sockeye forecasts. Within that, you'll have different scientists' own forecasts. When I've described earlier the usefulness of our particular forecasts, those, in conjunction with other scientists' forecasts all are different hypotheses or different ways of exploring what factors are controlling Fraser -- or influencing Fraser sockeye survival. In the State of the Ocean, it's -- the factor is particularly focused on the marine environment.

THE COMMISSIONER: Perhaps you can help me with this. On Table 5, it says [as read]:

> For 2009 returns, most sockeye, age four, spawned in 2005.

So you're talking about all of the stocks, the 19 stocks?

A That's right. It's the summary for most sockeye.

THE COMMISSIONER: Okay.

A And given the larger age four -- since most sockeye are four-year-olds. In 2009, most of the sockeye would have come from spawners in 2005.

THE COMMISSIONER: But you're talking about all the 19 stocks?

A That's right. In general.

THE COMMISSIONER: In general, okay. And it says:

> And migrated to the ocean in 2007.

You're talking about all of the sockeye stocks, the 19 stocks, in general?

A In general, yes.

THE COMMISSIONER: So what I'm trying to understand is that these indices or conditions that you're talking about, you're assuming that they would have impacted all of the stocks in the same way because the results -- you explained this morning just before the noon break, that there are different results for the different stocks --
A Mm-hmm.
THE COMMISSIONER: -- in terms of the return of four-year-old sockeye.
A Mm-hmm.
THE COMMISSIONER: But you're assuming here that all of these conditions would impact in the very same way?
A Yes. I think this is just a tool to holistically describe if there's something extreme going on or if we're in a transitional period, it's more of a broader indicator, understanding that there'll be nuances within the stocks. There'd be no way to tease apart an individual report card necessarily for all the individual stocks, and again, this is just focused on the marine environment. So each stock will have unique environmental conditions in the freshwater environment as well. So the fresh water will also be driving --
THE COMMISSIONER: So they -- I hope I get this right. So in 2007 when they migrate to the ocean, the stocks that came from the 2009 brood --
A Mm-hmm.
THE COMMISSIONER: -- are out there with the stocks that are going to be coming back in 2010; is that correct? There'll be three years as opposed to the four years from 2009?
A Yes. They would -- there would be mingling amongst the different years.
THE COMMISSIONER: Okay. So the conditions that you're considering would be impacting -- I'm just asking -- the 2009 --
A Mm-hmm.
THE COMMISSIONER: -- as well as the 2010 returns.
A That's correct, yes.
THE COMMISSIONER: Okay.
A So for the case of the last -- the one that you were referring to, 2007, that led to 2009 returns. This table I'm - as you reiterated - really saying that, for most sockeye -- most sockeye are four-year-olds, most of them who returned in 2009 hit

the ocean in 2010. But you're correct that in 2010, some of the five-year-olds from this same ocean entry period from 2007 would have experienced the same environmental conditions.
     That links back to your earlier questions about age-proportions. When I was describing how five-year-olds -- I applied a similar mortality productivity rate to the five-year-olds in 2010 as those experienced by four-year-olds in 2009. It's for that exact reason that you just asked your question in that they all experienced the same ocean conditions. They entered the ocean the same time, the five-year-olds who returned in 2010 would have also hit the ocean in 2007, similar to the four-year-olds that returned in 2009.
THE COMMISSIONER: Right.
A   So they're out there at the same time.
THE COMMISSIONER: So if there was an extreme condition, marine condition that would have impacted the 2007 sockeye, is it not fair to assume that that would have impacted the 2010 run as well?
A   It would impact the five-year-old component. So for -- and that's -- we did take that into consideration.
THE COMMISSIONER: Okay.
A   So, yes, you're absolutely right that what happened in 2007, independent of this graph even, 'cause this graph is not explaining what actually happened in 2007 because we saw really poor productivity, but that poor productivity experienced by the four-year-olds that returned in 2009 is the same environmental conditions in the marine environment that the five-year-olds in 2010 would have encountered.
THE COMMISSIONER: Okay.
A   They comprise a much smaller component of the total, but they still would have been an influence which is why we took that into consideration.
     So with this table, we were trying to qualitatively describe some of the key environmental variables that include some of the larger ocean indices. Some of you might have heard of things like the PDO, which is the Pacific Decadal Oscillation, which is broad indices for the North Pacific, basically describing sea surface temperature anomalies in the North

Pacific. If it's warmer -- if it's a warmer PDO, it's generally assumed that it's poorer conditions for salmon and Fraser sockeye.

Then there's a bunch of physical conditions that are more specific localized sea surface temperature, upwelling kind of indices, as well as biological conditions such as the prey availability.

This State of the Ocean Report really outlines this from Dr. David Mackas's work from the Institute of Ocean Sciences where he's looked at the west coast of Vancouver Island and looked at the shifting composition of zooplankton, and how, during warmer years, the warmer water copepods move up from the southern climates into our waters. These copepods tend to be larger and energetically less good than the colder water species that are typically here.

It's like eating -- when the warm water years hit and these warm water copepods come up, it's like eating a hamburger and French fries and coke, versus eating, in normal cold years, a salad with a well-balanced meal. So the fish in the warm years are getting this poorer food quality. David Mackas has been tracking this on the west coast of Vancouver Island so we included that as well.

There isn't as much copepod information in the Strait of Georgia. I know that they're working on compiling -- piece together a time series from a bunch of different sources, but for the purpose of this, all we had was the west coast of Vancouver Island.

So we colour-coded again similar to the forecast table where we were trying to rank these in terms of whether these environmental conditions were average, below average or above average, so green, good, good for salmon survival; red, poor; and yellow is kind of average for salmon survival.

I guess what I want to point out about this graph is that there's a lot of variability in terms of survival and how it actually links up, even with these broad different indices and how that top line is Chilko marine survival, just as an indices of overall marine survival for Fraser sockeye. That was the one indicator stock I mentioned earlier.

In 2005, all the indicators - and if you read the State of the Ocean Report the DFO publishes compiled from all these scientists - ocean conditions were generally poor for survival conditions and 2007 was actually a poor year for marine survival for Chilko as well as for productivity amongst stocks. So we kind of thought we were onto a somewhat right track because indicators were lining up somewhat telling us things were bad in 2005, and they really were bad.

In 2006, we started seeing a transition. When we went to the State of the Ocean meeting, we got all this information that ocean conditions were improving, we're seeing more transitional. However, we were still recommending more conservative probability levels on the forecast given it being transitional. It's unclear which indices are driving it, but we were transitioning. We did also see, in 2006, an improvement in Chilko marine survival, so we were seeing this turn-around in 2006 of improving marine survival conditions.

Then we went to the 2007 State of the Ocean, and from most indicators now, it was like intermediate in terms of some of the conditions, or really good. Of course, there's always, like, exceptions where certain things retrospectively you can look back and go, oh, that was saying things weren't great. But when you look at it holistically, the general message from that meeting was things were looking pretty good in 2007.

So we were thinking, going into the 2009 return year, that things were good. There are -- so a lot of this is extracted from the State of the Ocean Report. There's other individuals -- as I'd mentioned earlier the value of forecasting is playing around with -- exploring different hypotheses for what is driving survival for Fraser sockeye. We do that within our own forecasting process. It's part of that exploration.

But Dick Beamish, Dr. Beamish, as well as Skip McKennall, Dr. Jim Irvine, all these other scientists are also exploring different hypotheses for survival. At the time of the 2008/9 forecasts, I know Dr. Beamish's work was in very preliminary stages. He was focused on September catch-per-unit effort when you look at the State of the Ocean Report, and he recognized in later State of the Ocean Reports that those were -- September CPUE after he did some DNA analysis, realized that all those fish that he was sampling in September were Harrison sockeye, which Harrison have so many unique things about them. They're doing very unique things in terms of their life history in terms of their survival. They're improving in survival whereas all the other stocks are going down.

So at the time of the 2009 forecast, I know certain hypotheses are -- certain pieces of hypothesis development were in the preliminary stages, so for certain scientists, such as Dick Beamish, his stuff was very early. It wasn't until later on that he started getting the DNA back and realizing that he wasn't even using the right time period from his surveys. He was -- September CPUE to try to forecast total sockeye. So he made a statement in the State of the Ocean Report from the 2007 -- '06 or '07 State of the Ocean Report about conditions and what they expected, but it was a work in progress and it's being developed.

So we did explore his work amongst all the other environmental variables that were being considered, but recognized that it was a work in progress. It hadn't actually produced the right forecast for 2008, so it wasn't a hypothesis that we were going to move forward on and place a great weight of evidence on in moving into 2009, when the bulk of the evidence suggested that indicators were good. All these scientists are working and developing their hypotheses further and it's a work in progress. But we definitely every year explore environmental indicators quite extensively.

MS. BAKER: Thank you. I have no other questions for Mr. Grant, but I know that Canada has some questions. Should we move to Canada or did you want to follow-up on anything with the witness before we do that?

THE COMMISSIONER: No, that's fine. Thank you, Ms. Baker.

MR. TAYLOR: Mitchell Taylor, Mr. Commissioner. In my questions, for Mr. Lunn's benefit, I expect to refer only to Exhibit 340 which is the 2009 forecast, and Exhibit PPR-5 which is the Harvest Management Practice and Policy paper.

CROSS-EXAMINATION BY MR. TAYLOR:

Q Ms. Grant, in answering the question that the Commissioner posed to you about mid-morning today, you referred to -- I think I heard you say 95 percent of the returns in a given year would be the four-year-olds, and I think I heard you say at another point, 85 percent, and then at one point you referred to 20 percent five-year-olds in a given year. Can you just explain or elaborate on is there a number, is there a range, or which of those numbers would be the four versus five ratio on average?
A Yes. For clarification, there is a range, so I don't have the exact range in front of me, but it would be pretty small, and it probably would range from 80 to 95 percent or 99 percent even, so the key message I was trying to get across was more they make up -- the four-year-old component makes up a significant component of the run. I was not recollecting the same every time I mentioned it, but it was -- what I was trying to get across was that it was -- it makes up a range from probably what I just described.
Q All right.
A A pretty large component with exceptions -- for example, Pitt -- Pitt sockeye is one exception where the five-year-olds make up much larger component than that. But I was trying to describe just a general range and wasn't being consistent.
Q All right. Thank you. And the large percentage you're referring to is the four years (sic), I take it?
A That's correct.
Q In that same area of your evidence, or picking up on that, will DFO know with regard to the 2010 returns what percentage or roughly what percentage were five-year-olds or the ratio between four and five?
A DFO does have preliminary return results for Fraser sockeye by stock. I can't speak to specifics. I wouldn't recollect it all perfectly, but there were no surprises in the returns in

terms of age composition, so we didn't see, in the 2010 returns any anomalies in regards to having a greater than normal age five proportion in the return distribution.
Q You also mentioned in that same area of your evidence pink years. Just for clarity, can you explain what years are pink return years and what years are pink out-migration years?
A Pink return years are odd years for the Fraser system.
Q And outgoing?
A And it would be even years for outgoing, so they would spawn and the fry would emerge from the gravel and they would migrate to the ocean in even years.
Q Thank you. Now, is there something you can point to, to link or tie the 19 stocks that are forecasted as against the conservation units that exist for Fraser sockeye?
A Yes. In the 2009 report --
Q The Forecast Report?
A The Forecast Report, I believe.
Q Which is Exhibit 340.
A Table 1 and 2 in that report.
Q On page 6 and 7. And if you could just explain what this is telling you or how you see a relation or what is the tie?
A Okay. Holtby and Ciruna in 2007 published a first-cut at the conservation units for all Pacific Region salmonid stocks that -- and in this table, in the forecast table, in light of the Wild Salmon Policy and moving forward into the future, we wanted to align the stocks that we forecast, so the 19 forecasted stocks including the miscellaneous stocks that we forecast, and link them to the CUs from the Holtby and Ciruna paper.
So what we did in the second column of Table 1 is list, next to every stock, the numbers that are associated with the conservation units that are listed on Table 2. So we'll use Bowron for an example, the first stock in Early Summer. Bowron has, in the CU list in Table 1, the number 3. And then when you go to Table 2, that Bowron stock is associated with the Bowron Early Summer conservation unit. So we're just lining up what stocks go with what conservation units. In some cases you can see, like for the example of Bowron,

that the stock lines up exactly with the conservation unit. So they're the same thing. They're looking at the same thing.

Other ones such as Fennell and Raft are North Thompson stocks, and Fennell and Raft together add up to the Kamloops Early Summer conservation unit, so that's an example of where two different stocks in our forecast table are equivalent to one CU, so it's a little different.

Then there's other CUs such as -- I'll just pick another one, like Chilko, for example, in the Summer run, so the first stock in the Summer run timing group. On Table 1, they include CUs 13 and 14. So they're an example of a CU that -- a stock in the forecast table that's associated with two CUs, so they include Chilko Early Summer and Chilko Summer as a conservation unit.

So just to summarize, there are some cases where there's perfect correlation between the stock and the conservation unit. Other cases where two stocks amount to one CU, and other cases where two CUs equal one stock.

Q All right. Is that sort of information or tie in the 2010 forecast?

A We don't include it in the 2010 forecast. We are -- there is a work in progress, a paper that's being published, and we're in the process of working through conservation units and so we haven't included an update in the 2010 forecast.

Q Do you know if it'll be in the 2011?

A The 2011 forecast, that's what I meant.

Q It's not in it?

A No.

Q All right. Now, I'd like to ask you a couple of questions about a document that's referred to as a Policy Practice Report. It's Policy and Practice Report number 5. That's coming up on the screen, and if we go to page 81 of that document, and specifically paragraph 212. I have a question for you.

You'll see under "a.", it says -- well, I'll read all of it, but:

> Key to pre-season planning are:
>
> a. Pre-season forecast for each run timing aggregate.

Do you have anything that you want to say about that statement?
A Sorry, Mitch, can you repeat what -- are you onto --
Q Number "a." there.
A Oh, "a.", yes, okay.
Q Is that accurate --
A Yes.
Q -- or is there anything that you'd like to say?
A The only clarification we would -- or I would ask is that for pre-season planning, it would be clarification on whether these -- I would assume that pre-season forecasts would include our abundance forecasts that I'm involved with as well as the diversion and run-timing forecasts that were the responsibility of another DFO employee, but those three kinds of forecasts would be included. So it might be just requiring clarification on whether that wording encompasses the three different kinds of pre-season forecasts.
Q So that would be diversion, run-timing and abundance?
A Yes.
Q Then if you go to a couple of pages over to paragraph 225, and I'll give you a moment to read it if you like, but if you could have a look at that and tell the Commissioner whether you have anything to say about what's stated in that paragraph.
A Yes. This paragraph would -- if reworded, would capture the changes in methodology more appropriately. As written, it's a little unclear that the changes made to the methodology don't apply to all three productivity scenarios. So I would recommend a change that would involve saying something like for the 2010 forecast, it included three -- so you would pull out the presentation of the forecast as three different productivity-based results and three different tables. We'd probably change the wording of that to the presentation of three different forecast tables using three different assumptions of sockeye productivity, and not turn that into a number 2, but switch it into -- significant changes include that statement, as I'd worded it, and then a period, and the -- the long-term average productivity table, the first case, was identical to methodology we've used in

the past.
Changes were made to the methodology specifically for the long -- recent productivity case 2, and productivity like the 2005 brood year, case 3. So those were the only two cases where methodological changes were made. So it's --
Q So it's all as you described earlier this morning.
A It is. So it's just a little more complicated than it is -- or not complicated, but it just needs to be switched around so that it -- this sounds like changes were made to every forecast scenario.
Q All right. Okay. Anything else about that paragraph that you want to pick up on?
A Well, I would be specific that the retrospective analysis conducted over the last eight years was specific to the recent productivity forecast table, and the same with the use of models like the common filter, and I would say use of models like the Kalman filter, Ricker model, if we're using an example. And again, that's specific to the recent productivity forecast table.
For both the recent productivity forecast table and the productivity like 2005, the last point applies to both of those.
Q All right. Can you briefly describe the collaboration that accompanies the work that you do in forecasting?
A Yes. We, over the years, have done significant collaboration with our colleagues within the Department of Fisheries and Oceans, so, for example, Al Cass -- Mr. Al Cass is foundational to the forecasting process, and we've -- we work as a team in collaboration with other people with similar expertise within the departments, so we would collaborate significantly with individuals like Al Cass who has a legacy of forecasting and is foundational to the forecasting process.
We would also engage other individuals within the Department who have expertise. We collaborate also outside of the Department with individuals who have expertise in forecasting and Fraser sockeye, so, for example, the Pacific Salmon Commission has been extremely helpful in the forecasting process from Mike Lapointe's input over the years on just his incredible understanding of the animal and the brood year

escapements, returns. He understands the data. He always is extremely helpful and we collaborate extensively throughout the forecasting process with Mike Lapointe.

Also Dr. Catherine Michielsens we have also collaborated extensively with. She's a Bayesian statistical expert and has provided us with lots of advice and assistance in the forecasting approach. She is a lead author on the 2010 Forecast Paper and assisted with the 2009 forecast.

We've also engaged Dr. Randall Peterman with forecasting approaches, trying to stay on the cutting edge of models that are available. So I worked with Dr. Randall Peterman taking one of his courses on risk assessment, as well as working with him directly on the forecasts. We did a lot of collaboration when it came to using the Kalman filter, Ricker model, which was one of his forecasts that looks at shifts in productivity over time versus just looking at average productivity. So we've collaborated with him there.

Dr. Randall Peterman was also a reviewer of our 2010 forecast paper, and agreed with the methodology and felt that we were using cutting edge methodology that's available in the field.

We also -- I mean, the collaborations go on and on 'cause I've already talked about the environmental conditions where we've collaborated extensively or engaged scientists on ocean conditions, freshwater conditions, as well as our operational programs. Within my division in Stock Assessment, I'm the analytical arm whereas we have a Sockeye Operational Group as well. We would engage extensively on them on the data, issues like that. So there's a lot of collaboration when it comes to the forecast.

Q All right. Thank you. Now, bearing in mind the uncertainties and variables and all of what you've said in your evidence so far, can you say in your assessment how good is the forecasting that's done for Fraser sockeye using the processes and methodology you've described?

A Relative -- in the world of forecasting, I think through, again, Dr. Randall Peterman's reviews and others reviewing our methodology, our methodology that we use for Fraser sockeye is at the -- it's using the best available tools that are available to us for the world of Fraser -- for sockeye -- forecasting salmonid stocks. Not only that, we're even on the cutting edge by incorporating models like the Kalman filter, Ricker model, that had been recently introduced by Dr. Peterman, by incorporating time-varying productivity parameters within our models.

So I think it would be generally accepted that the modelling approaches we've used, and Randall Peterman would agree based on his comments at the review of our 2010 research document, that our methodology used is very good -- like it's at the cutting edge of what is available in the scientific community.

Q All right. Thank you. Is there anything else by way of information or points that you think are important for you to make about forecasting for the Commissioner or to the Commissioner other than -- beyond what you've already testified to?
A I'm just going to think for a moment.
Q Okay.
A I think we've covered the key points. There's nothing.

MR. TAYLOR: Thank you. Those are my questions.
MS. BAKER: Thank you, Mr. Commissioner. I believe the next up is Mr. Leadem for the Conservation Coalition.
MR. LEADEM: Leadem, initial T., appearing as counsel for the Conservation Coalition.

CROSS-EXAMINATION BY MR. LEADEM:

Q I want to begin by thanking you, Ms. Grant, because before you gave your evidence, a lot of forecasting was incomprehensible to me, and I've gained some understanding. I can't pretend that I understand Bayesian probabilities, nor do I think I ever will, but at least I have some appreciation for what it is that you do, so I thank you for coming.

I want to reflect on the Wild Salmon Policy and some of the work that you've done. You alluded to a paper that's presently in the works, and I wonder if we can just take a quick look at Exhibit 184, Mr. Lunn, please.

Are you the same S.C.H. Grant as author -- main author on this paper?
A Yes.
Q And my understanding is that this particular paper which deals with benchmarks for Fraser River sockeye conservation units was reviewed last fall, was it?
A It was reviewed in the spring of this past year, I believe. Yeah, this past spring.
Q Okay. It went through the CSAP process, did it?
A Yes, it went through the CSAP. I'm just switching gears mentally now from forecasting.
Q All right. I'll give you a moment to reflect on it, because --
A Yeah, just --
Q -- my information is that this went through the CSAP process sometime in November of 2010.
A Yeah, I'm mind-blanking on when -- when we -- when it went through the CSAP process, but it did go through the formal CSAP process and it's a research document similar to the 2010 Forecast Paper in the type of document that it is.
Q And my understanding is that the paper is presently under review. I just wanted to get an updated status on it.
A Yes. This draft, this exhibit draft that you have is prior to the CSAP process, so the Science Advice Process within DFO, and it was a day -- it was a two-day CSAP process, so this paper was what all the formal reviewers that included, again, Dr. Randall Peterman, Mr. Mike Staley and a third reviewer as well. So there was three formal reviewers as well as the CSAP Salmon Subcommittee, which included Dr. Carl Walters being present, Dr. Catherine Michielsens and a room full of technical experts.

So this paper is what all those reviewers, the formal ones and the people present in the room would have seen. But coming out of that meeting are recommendations from the formal reviewers as well as from the CSAP process, and it does not encapsulate any of that at this point in time. So there will be changes made to the methodology, our approaches, and this will be published in the spring of this year.
Q All right. That answers my question. I just simply wanted an update on it.

A Okay. Okay.
Q Earlier today, you gave evidence about the forecasting and about incorporating environmental variables within your forecasting, and you -- I think you listed a couple of them. One was sea surface temperature, another one was Fraser River flow. I was wondering if you would also give some consideration to incorporating water temperature in the Fraser as an environmental variable in forecasting.
The reason I asked that is that last week we heard from Mr. Lapointe who gave evidence and highlighted that environmental variable as a key factor in survivability of the fish as they're migrating upstream. Would that be something that you would want to consider as an environmental variable? Can you factor that into your modelling exercises?
A Yes, we could factor that variable into the modelling exercises. One of the challenges with incorporating just that single variable is that when you consider the life history of Fraser sockeye, in fact, a lot of the mortality -- the bulk of the mortality occurs probably from the egg stage when you consider billions of eggs are laid. From the time they emerge from the gravel, a lot of mortality occurs in that stage.
A lot of mortality is thought to occur -- one of the key hypotheses for survival of salmonids is that -- or fish, in general, is generally they're most vulnerable when they're smallest and youngest, so they're more vulnerable to mortality mechanisms like predation and starvation. It's also thought -- so in the freshwater environment, it would be a lot of mortality occurring early on in the freshwater environment, as well as that transition into the marine environment.
It's thought that the bulk of the mortality -- this is a hypothesis -- that a lot of the mortality would occur early on, because when they hit the marine environment, they're their smallest and they're more vulnerable to predation because they're not able to swim as fast. The bigger you are, the faster you can swim. Also to tolerate periods of less food availability, if you're bigger, you have greater energy stored. So usually it's thought that early on, when you first

hit the ocean, you're most vulnerable to mortality.
So part of the downstream migration, there could be considerable mortality as they're migrating down as juveniles as well as when they first hit the ocean, the Strait of Georgia early on along their migration, along the Continental Shelf.
So getting to your question, it's thought that most of the mortality - and when we cue in on mortality mechanisms and environmental variables, we're cued in on variables that would be drivers of that early marine ocean entry or downstream migration elements.
The variable that you're describing, definitely we know through work of -- you're going to hear from David Patterson and others working on environmental conditions and how they influence returning salmon and influence mortality of the returning salmon. They can play a big role in mortality, but in the grand scheme of the sockeye life cycle, it's generally thought that it's this early ocean entry period or juvenile period in the fresh water that's driving recruitment variation.
So it's a part of the puzzle. But using it, again, as a single environmental variable probably would explain very little of the total variability in salmon survival.
Q That's helpful. Thank you.
A Okay.
Q I want to end up by contrasting the 2009 return and the 2010 return, because those were the two returns that you spoke most in terms of your evidence. Do I have it right that the 2010 return, you can describe it as being a bonanza, but mostly due to the Late Shuswap, the great runs of the Late Shuswap that we saw last year; is that right?
A Yes. I would characterize it -- I don't have, again, all the preliminary data in front of me and it's not an exhibit and it is preliminary. But you are correct that preliminary returns are suggesting that the drivers of the abundance in the 2010 returns were the Late Shuswap which is comprised -- like the big part of that run is the Adams run as well as -- even the Early Summers, the Scotch Seymour component, which are Shuswap-

rearing fish as well. So it appeared that the Shuswap-rearing fish, both in the early Summertime component and the Late time component did pretty well.

Of course it was Late Shuswap that was the bulk of the abundance in 2010, and it was also the stock that -- we haven't seen persistent declines in productivity on their time series, unlike other stocks that have been declining. Like Shuswap has been kind of stable in terms of its productivity.

So in terms of our recent productivity forecast, it actually wasn't too different for Late Shuswap than the long-term average, because productivity hasn't systematically declined for Late Shuswap.

Having said that, even so, like Shuswap, when you place it on the map of the long-term average forecast table, it's still falling out at the high end of the probability distribution, so it's -- on top of it not having exhibited any declines in 2010 in productivity, it appears to have exhibited increased productivity in the 2010 returns. So no doubt that Late Shuswap was driving those returns.

Q But that same abundance pattern, you did not see emerge with other stocks or other conservation units. I mean, those conservation units - and I know the results are still preliminary - but those conservation units, such as Cultus, and some of the other conservation units, they still remain flat or in decline; is that right?

A No, that is incorrect. Again, I don't have all the data in front of me, but I know that for a lot of the other stocks in 2010, there's a few that if you place them on the long-term average productivity -- they did better than recent productivity, so we -- we had put that forward as the most -- the greatest weight of evidence was the recent productivity, second case. A lot of the stocks we switched over, if you want to compare them, you switch over to how they compare to the long term time series.

Late Shuswap was extremely on the high end of the probability distribution, so I suggest their productivity is really good. But a lot of the other ones were still showing average, above average productivities. And then there was several showing below average. So Early Stuart is

one example of one that was -- I believe the return was in the 100,000 range, so it was slightly below the long-term average.
     So there was nuances amongst the stocks in terms of how they were doing. Cultus was one that actually didn't do -- it did okay this year. It was a good return, I know, back to the fence. We were seeing something like 10,000 fish, so it was on -- it wasn't -- productivity was not as bad as the recent productivity we've seen, even for Cultus.
Q   But going now to 2009, that was, as you say, an anomaly because we saw most of the stocks, with the exception of the Harrison and potentially some of the Late Shuswap showing a very marked decline; is that fair?
A   Yes. In 2009, we saw a more consistent signal of below-average productivity across all stocks except for Harrison, in that return year. In the 2009 return year, Harrison was one of the exceptions.
     Of course, there's variability in terms of whether it was the lowest. For most stocks it was amongst the lowest productivity we'd seen on the time series, but there was variation amongst the stocks.
MR. LEADEM: Thank you. Those are my questions.
MS. BAKER: Mr. Commissioner, the only other counsel to ask questions would be Brenda Gaertner.
MS. GAERTNER: Mr. Commissioner, I only have a few questions of this witness, and I share the gratitude that was expressed earlier by Mr. Leadem.

CROSS-EXAMINATION BY MS. GAERTNER:

Q   Could we turn to Exhibit 340? I just want to pick up on the transition from the way the forecasting has been done over the 19 stocks and the way we're moving into the conservation units. I noticed from the evidence that you gave at Table 1 on page 6 of the actual document, I noticed when I looked at the comparison of the 19 stocks, and then I looked at the conservation units, that the predominant aggregate that -- bear with me as I use layman's terms -- that could be dis-aggregated is the Summer runs. Is that -- is that a fair

observation? It looks like the group of Summer runs are the ones that have the most groupings of the conservation units. Have I read that right?
A Yes, they would -- based on what you're saying, that is correct. They have multiple conservation units within them, more so -- like that run timing group would have more multiple conservation units within an individual stock than the other -- than, generally speaking, than the other run timing groups.
Q And so the work, in terms of moving from the 19 stocks into the conservation units, whatever number we end up with, could well be served to start focusing on the Summer runs. If we started to -- if we had to priorize where we could get the best bang for our buck in terms of dis-aggregation -- getting more information about the conservation units, beginning to gather more information over time in terms of conservation units, that if we began to focus, particularly in the aggregate of the Summer, that that would be a useful thing?
A I think for clarification, you're -- just because the conservation units are aggregated with a particular stock doesn't mean we don't have -- oh, maybe that's what you do mean. Dis-aggregating the recruitment time series.
Q That's right.
A Well, I know a holistic -- like an answer to your question is that that is definitely, from my understanding, what we're working towards. The Pacific Salmon Commission is responsible for creating the stock recruit time series, pulling together all the data from DFO's escapement work as well as catch work. I know that that's something that the Pacific Salmon Commission was working towards, the possibility of being able to, as you put it, dis-aggregate the stock recruit time series so that you could look at individual conservation units. But that's a work in progress.
Q Great. All right. So I have read that chart somewhat accurately. Perhaps my next question could just flow from that 'cause I am curious on how we can begin to do the work of moving from the 19 stocks into the conservation units. I'm wondering if I've heard your evidence correctly today, is that we could -- you could begin to

develop forecasting models for those conservation units. You're lacking the long-term numbers for that, so you're lacking long-term escapement numbers for some of those conservation units, but you could begin to develop, relatively soon, the more recent numbers on those conservation units; is that correct?
A I would characterize that somewhat differently. The Wild Salmon Policy -- I call it the Wild Salmon Policy toolkit that Holt et al had published in 2009 -- I believe, describes a number of tools that can be used for Wild Salmon Policy stock status work. Within that toolkit were things like trends over time, so escapement trends over time as a tool for assessing status for a lot of these conservation units.
So, for example, Late Stuart has Takla/Trembleur, Summer and Stuart Summer as two separate CUs incorporated into it. I'm just going to cross-check this. Yeah, so it's 15/16, Stuart Summer and Takla/Trembleur Summer. Our escapement time series does dis-aggregate, like we enumerate our spawning ground assessments so that we have separate estimates for Takla/Trembleur and the Stuart Summer. So those two CUs, we could do stock status work on the CUs independently using different metrics.
Q So you could actually provide the forecasting on those two already.
A What I'm saying, the Wild Salmon Policy tools --
Q Not the benchmarks on it. So let's stick to -- if I'm confusing things, please let me know --
A Okay.
Q -- but if -- when it comes to just the forecasting work that you're doing, do you have --
A Oh, okay.
Q -- the forecasting tools to give us forecasts for both the Late -- for both of the conservation units in the Late Stuarts?
A Well, on one hand, we would, for some of the CUs, because we could use what we're calling non-parametric models, so you could use -- because we can split out for Late Stuart, as an example, the brood year escapements into the two conservation units. You could use the two different brood year escapements for the two different conservation units multiplied by recruits per spawner, time

series average or -- you could look at variance of that kind of model because we can separate for a few of these CUs the escapement time series.

We wouldn't necessarily at this exact point in time be able to use all the biological models, depending on where we're at for separating out the recruitment time series, so where our spawning ground assessments do provide fine enough resolutions to separate into individual CUs, it's our recruitment information, which is the catch component of escapement plus catch, so the escapement part we could partition. But the recruitment part, which is partitioning catch into the separate CUs, would be an ongoing -- it's part of an ongoing process, and it hasn't been -- I'm not sure where we're at with that, but it's not something, at present, we'd be able to do. It's a work in progress.

But there would be certain models we could use by CU.

Q I somewhat think it would be unfair for me to ask you which of these you could do. Which could you do a forecasting model right now?

A Well, the challenge with answering that question would be that this is -- this CU list is from Holtby and Ciruna's 2007 paper, and we're in the process of updating that current list. So these CUs wouldn't necessarily be the final CUs. That's a work in progress as well that we'd be finalizing with the April report.

So it would have to probably wait until we had all the final CUs to put into that table, because I -- there would be a lot of -- not a lot, but there'd be changes to what you see here. So to go through one by one could be -- it might be misleading, given that the conservation unit isn't finalized.

Q Okay. I'll move on, and not press that point with you at this time.

I'm curious. The chart that you called the report card, short Table 5 of this same document at page 15, I don't see it in the 2010.

A Oh.

Q Is there a reason for that? Did I miss it?

A No, you didn't miss it. The reason we didn't include it in 2010, we're still tracking the state of the ocean environmental conditions, staying in the loop on what's going on environmentally. But given the indicators that we had selected had not captured the survival conditions that we saw in 2010, being that -- or, no, I should go back to the 2009 return year.

Because this suite of environmental variables had indicated to us that the environmental conditions were good, so if you look at that last circled column on this chart, that was the 2009 returns for most of the sockeye that returned in 2009 as four-year-olds. All those environmental indicators that we had selected, and from the State of the Ocean report, had broadly said -- or indicated that ocean conditions were good. IN fact, the returns in 2009, as we all know, were amongst the lowest productivity on record.

So whether these aren't capturing either the environmental conditions in the ocean or we're missing something in the freshwater environment early on, we felt it wasn't informative given it was disconnected with what actually occurred in 2009, so we decided not to publish again in 2010 the state -- this information, and instead reference State of the Ocean Reports, but not specifically provide this, given it disconnected for 2009.

Q Okay. That's helpful, thank you. I take it from the evidence you've provided us so far that it's your thinking that taking any one particular environmental variable is not helpful in forecasting, and that there -- so far. So far it's not helpful.

I want to turn your mind to the issue of cumulative impacts which is sort of the opposite way of saying that, that there's a lot of impacts along the way, a lot of impacts in addition to global temperatures, which is what I take to be the primary indicators that are being used right now, temperature for water -- or water temperature or water flow as a result of icepack melting.

So there are a lot of other cumulative impacts. Just take urbanization at the mouth of the river, for example. Are there models that are being developed or considered, either in British Columbia or in the world, that you're aware of, that would help us to begin to include in any of the forecasting, anything that we're doing, these

cumulative impacts that salmon are responsive to?
A There -- I'm sure there are. I'm not necessarily --
Q You're not aware of any of the cumulative impact models?
A I can't speak to any specifically, so, no.
Q Okay. I was hoping you could turn our minds to certain ones that might be helpful to us.
All right. Then the last area of questions I have is just around the whole issue of communication and uncertainty and I thought your evidence this morning to be particularly helpful, especially the expression a lot of people focus or fixate on a number.
A Mm-hmm.
Q So I have -- given the broad range of users of things like the CSAS paper, the public, the managers and the harvesters, do you have any recommendations on how we can communicate better the purpose of forecasting and what you're doing here and - it's a twofold question - and the implications of those uncertainties to those that are reading them?
A I think that's -- I mean, communicating uncertainty and communicating the forecast is definitely something we're constantly working on and playing around with, so it's one of the reasons why we, I think in the 2010 forecast, started presenting the three different cases in those horizontal bars that were presented on page 41 on the 2010 research document by Grant et al.
Q Yes, I remember those.
A Okay.
Q So that's one of your ways --
A So we are playing around with different communication -- ways to communicate the uncertainty in the forecast, and that table, as we were walking through, was communicating both uncertainty in -- the stochastic random uncertainty and observation error, process error, model -- that kind of thing in the forecast distribution as well as forecast -- presenting uncertainty in regards to our assumptions about survival of salmon, whether -- for Fraser sockeye we expected 2009 to repeat itself, or we expected long-term average.
So we were playing around with different

tools for communicating this complex sort of uncertainty in a simple form. The idea is that once you walk through it once, the next time you see it, you'll know right away what that's communicating, so it's -- the hard step is just walking through and explaining. But once you have it, you get a grasp of what you're communicating.

I know communication really interests myself, especially in light -- in the forecasting world. It's definitely a challenge in communicating complex information. As I was describing earlier today, why -- the forecaster beneficial (sic) -- and the miscommunication of the forecasts being a single number and not a probability distribution, and what these forecasts are really telling us, rather than the sort of misdirection on the forecast being wrong. Instead, they're actually telling us, flipping it around and saying, no, the forecasts are actually telling us that what happened in 2009 was at the extremes of our range of experience.

So I don't know -- like I don't have the answers. I know that we're working on it. I think just getting out there and being proactive and communicating it more might be helpful. I know we communicate it in management planning, and maybe it gets simplified somewhat -- not simplified there, but part of the miscommunication can be that we're putting certain probability levels into tables and people are -- then when it gets out to the public, they see the single number and they start to forget that there's a probability distribution associated with it.

So maybe there's improvements in how we're communicating in season from the Department and from the Pacific Salmon Commission 'cause we all release news releases throughout the season.

I think just being more proactive and getting out there and having even, you know, communicating like this to people and having people understand the complexity. But I think it's a bigger question for the Department also to tackle in terms of how communication can be improved.

Q Is it fair to say that the forecasting you're doing is forecasting a range of probabilities as distinct from providing forecasting of actual run sizes?

A Well, we're forecasting -- it's kind of like a combination, maybe, of those where we're presenting -- based on our historical understanding of the Fraser sockeye populations, we're forecasting the probabilities associated with different run sizes, so based on historically what we've seen. So which run sizes would be most probable given what we've seen historically, and which are becoming less and less probable. So moving from ten percent probability level, which is a 1 in 10 chance of seeing a run size up to a 90 percent probability. So it's kind of a combination of what you're saying.
Q One last question, which is I heard the complexity you have around communicating the uncertainties in the forecasting. I'm curious, what efforts do you make as someone who's responsible for generating these forecasts, to communicate the implications of those uncertainties to the managers, for example, the Fraser Panel. Is that work that you do, or do you rely on others to do it, or how does that get done?
A It would be a combination of myself -- I would be generally the presenter of the Fraser forecast and communicating the uncertainty for the Fraser sockeye forecasts at Pacific Panel Treaty meetings, so PST meetings. So annually, when we're in the pre-season planning mode, generally in February -- sometimes the January meetings -- which is post-season, if we have -- generally we'd have the forecasts done by then. I would be responsible for presenting at the Panel meetings.
We also have integrated management team meetings where I might present at. Others might present the forecast as well in different forms, because I can't be everywhere at once. Sometimes it's tasked to people who understand the forecasting methodology and who will present at other forums. So it's a combination of myself and colleagues who are also technical experts and understand the complexity of the data.
MS. GAERTNER: Mr. Commissioner, I just have one question of your counsel that I need to ask before I can complete this -- my questions if that's possible. I can either do that right at this moment or --
THE COMMISSIONER: Sure. I'll turn off my microphone.

(OFF THE RECORD DISCUSSION)

MS. GAERTNER: Those are my questions, Mr. Commissioner.
MS. BAKER: I don't know if Canada had any re-examination.
MR. TAYLOR: None.
MS. BAKER: No. Neither do I.
THE COMMISSIONER: I just had one quick -- I think you have a binder in front of you, Ms. Grant.
A Mm-hmm, yeah -- yes.

QUESTIONS BY THE COMMISSIONER:

Q Just to clarify for me, Tab 2, at least in my binder, is the CSAS document; is that correct?
A For 2006?
Q Yes.
A Yes.
Q I understood you to say that this document is not posted on the DFO website?
A This document would be posted.
Q It is posted? All right.
A It is.
Q And then the Tab 3 is the -- I think that's Exhibit 340, I'm not certain, but that's the Pre-Season Run Size Forecast for Fraser River Sockeye in 2009?
A Yes.
Q That's also posted?
A Yes.
Q So do I take it, then, that Tabs 4 and 5 similarly would be posted?
A Yes.
Q And do you have a counterpart at the Pacific Salmon Commission, or do you fulfil the role of advising on forecasting for both the DFO and the Pacific Salmon Commission?
A The forecasting responsibility for abundance forecasting for Fraser sockeye is DFO's responsibility, so we are ultimately responsible for producing it, so I would be the lead on the production of the Fraser sockeye forecast. But we collaborate and work with technical experts within the Department and outside, which is why we have Dr. Catherine Michielsens on the 2010 forecast as an author, because we've collaborated outside the

Department.
But the delivery would be on the Department for production of that forecast. But because we engage the broader scientific community, it can engage anyone out there who has the technical expertise that we want to engage, similar to any scientific paper that you write in the global community. You would engage colleagues and counterparts with expertise in other areas, so -- but the ultimate responsibility lies within the Department.
Q But all of the modelling work that you've been talking about all takes place within the DFO, not within the Pacific Salmon Commission.
A As I mentioned, because we collaborate with the Pacific Salmon Commission, there would definitely be modelling done by the specific Salmon Commission in working with us collaboratively to assist with the forecasts. So there would be modelling done by the Pacific Salmon Commission to assist with the forecast in a collaborative way. I mean, we're working together.
Q But are there -- are there documents similar to the ones that you've got in your binder from the Pacific Salmon Commission?
A Oh, no. No, they just collaborate with us on our documents because we're the ones responsible for it. So we're working together on this document. Right.
THE COMMISSIONER: Okay. Thank you very much.
MS. BAKER: We do have -- hopefully, our next two witnesses are here, so perhaps we can take a shorter afternoon break. I'd like to be able to get some substance out of the way within this afternoon, so...
THE COMMISSIONER: All right. Thank you.
THE REGISTRAR: The hearing will now recess for ten minutes.

(PROCEEDINGS ADJOURNED FOR AFTERNOON RECESS)
(PROCEEDINGS RECONVENED)

THE REGISTRAR: The hearing is now resumed.
MS. BAKER: Dr. Riddell, could you turn your mike on? Thank you. So Mr. Commissioner, we have a new group of witnesses to start, a panel dealing with run-size assessment, and this particular panel

will be dealing with hydro-acoustics. We have with us Mr. Mike Lapointe from the Salmon Commission, who has been sworn into these proceedings already, and Dr. Brian Riddell from Pacific Salmon Foundation, who is also been a witness already in the hearings, and perhaps they can just be reminded of their oath.
THE REGISTRAR: Yes, gentlemen, you are still under oath.
MR. LAPOINTE: Thank you.
DR. RIDDELL: Thank you.

MICHAEL LAPOINTE, reminded.

DR. BRIAN RIDDELL, reminded.

MS. BAKER: Thank you.

EXAMINATION IN CHIEF BY MS. BAKER:

Q Now, my -- my questions will be -- I'll try to direct them to the specific person who I'm asking them of. And my questions to begin with, for the most part, are directed to Mr. Lapointe. Currently there are two in-river hydro-acoustic programs operating in the Fraser, one at Mission and one at Qualark; is that right?
MR. LAPOINTE: That's correct.
Q And Qualark is just downstream from Yale, about 95 kilometres from Mission?
MR. LAPOINTE: I think that's about right. It's about a three-day swim. Brian and I were just sort of remarking, although there might be a little bit shorter distance. But it's about a three-day swim for a fish anyway.
Q Okay. Are both of these hydro-acoustic sites components of the in-season assessment program?
MR. LAPOINTE: Not in a formal sense. The Qualark program has been an experimental program. We did actually use Qualark, although it was not planned in 2010. It wasn't planned pre-season. But in a general sense, they'd just been conducted as a bit of an experimental program.
Q All right. And I'd just like to do a couple of clarifications in the Policy and Practice Report, as we go through. The first one is Policy and Practice Report Number 5 at page 72. You'll see

paragraph 184. The statement is:

> There are two in-river hydro-acoustic programs currently used to assess the abundance of migrating Fraser River sockeye in-season: one at Mission and one at Qualark.

I take it only the Mission one is officially used, although Qualark is, in fact -- it also does measure in-season abundance?
MR. LAPOINTE: That's correct.
Q Okay. Now, the data that is collected at Qualark, is it used in any way by the Fraser River Panel to manage the Fraser River sockeye?
MR. LAPOINTE: As I said, in 2008 and 2009, so the Qualark program has been operating for the last three years, it was used in an informal sense so there was regular in-season exchanges of that information within a fairly small group and it was used sort of informally. And in 2010, we did actually use the -- the Qualark estimates to actually adjust the Mission estimates. So informally, and then in 2010, that's the nature of how it's been used up until this point.
Q Okay. Is it expected that Qualark will become part of the official in-river run-size assessment program?
MR. LAPOINTE: It's possible. Right now, the future of continued operation at Qualark is in doubt.
Q And why is that? What's the concern?
MR. LAPOINTE: It's major -- mainly a funding issue. We're looking for alternative ways to fund the program and there is actually a proposal that's being written as we speak actually to look at an alternate funding source and we expect to hear probably sometime in February about the success of that particular proposal.
Q Right now, who funds the work at Qualark?
MR. LAPOINTE: Primarily DFO.
Q Okay. If this additional cost was added to the Salmon Commission -- Pacific Salmon Commission's budget, how would that work? What would be the impact?
MR. LAPOINTE: It wouldn't fit too well in the current funding climate. The approximate cost of Qualark, we've been informed by our colleagues, is about $300,000 a year, as an annual operating cost.

That doesn't include things like capital and equipment that are associated with the program. But that would represent about 7 percent of our annual secretariat budget, which is about $4 million, which is not a huge fraction of the total budget. But if you look at the fisheries management side of our budget, which is about a million of that four million, it's about 30 percent of that budget.

So the current climate, and I'm not trying to be negative about this, it's just the -- the countries are quite conscious about keeping their contributions constant. Both the United States and Canada both kick in 50 percent of the total budget so it's a $4 million budget, each would contribute $2 million. And so any increments above that, you know -- you know, quite legitimately are, you know, looked at very carefully and so it would be hard to push, in this case, approximately $150,000 per country easily through the budget process that we're going through right now.

Q Okay. Just another point in the -- in the PPR. I'll take you to it in a minute. First of all, the Mission system, is that a split-beam system?

MR. LAPOINTE: Currently at Mission, we're operating primarily split-beam transducers. We do have a DIDSON as well, but the primary estimation is by split-beam, that's correct.

Q Okay. And at paragraph 187 on the page you see on your screen, the PPR says that:

> The split-beam system can measure the speed and direction of fish moving upstream and/or downstream. It can also detect fish near the surface.

Is that correct?

MR. LAPOINTE: The first part of that sentence is absolutely fine. The second part of the sentence is kind of a yes-and-no answer. And I'll try to explain. Any hydro-acoustic piece of equipment has a blind zone associated with objects that are very, very close to the front of the -- of the equipment. So it doesn't matter whether it's split-beam or single-beam or whatever the technology is. DIDSON is not quite as susceptible

to this as the split-beam is. So we have two kinds of programs at the Mission site. One of them is a vessel where the equipment is looking downward into the water. And in that case, clearly, fish near the surface would not be detected within about the first metre or so. Now, the shore-based system is a system that looks out from the shore into the middle of the river. And that one is operated on a number of different aims, if you like. So you can picture a piece of equipment that's sort of vanning through the water column like this with a certain number of minutes at each aim. So obviously, when it's aimed towards the surface, if the fish are, you know, far enough away, it can detect those fish on the surface. So it's, you know -- it's a little bit complicated to suggest a rewording but that's how I'd characterize the situation there.
Q Okay, thanks. And one last correction in the PPR I just want to get out of the way. At page 74, paragraph 193, the statement here references four lines down:

> For Mission, there is a gillnet fishery downriver (at Whonnock) that provides information on species composition, test fishing at the Mission site itself and visual counts upstream at Hells Gate.

Is there also an additional test fishing site downstream of Mission that wasn't listed here?
MR. LAPOINTE: Yes, it's called the Cottonwood site and it's near the Deas Island Tunnel that you go through, the Highway 99 tunnel.
Q And what is that --
MR. LAPOINTE: It's primarily for stock composition.
Q Thank you.
MR. LAPOINTE: So the species composition being sockeye, pink, Chinook, Coho; stock composition being the individual components within the sockeye.
Q Okay. Thank you. I think those are all the points I wanted to raise in the PPR. So now I'd like to move to the Mission hydro-acoustic site. First of all, the Mission hydro-acoustic data is important for in-season run-size estimation; is that right?

MR. LAPOINTE: It's probably the single most important part of the in-season run-size estimation.
Q Okay. And the estimate of daily upstream migration collected at Mission is what we have heard many times referred to as the "Mission escapement"?
MR. LAPOINTE: That's correct.
Q Okay. And how does that data that's collected at Mission get used in run-size estimates?
MR. LAPOINTE: Perhaps -- maybe I could suggest a picture might be used here. We looked at some graphs last week in the Records of Management Strategy document and there's a set of them on page 170. I'm not sure what exhibit number this is.
Q That's Exhibit 330.
MR. LAPOINTE: And on page 170, just because -- I'm sure if I said, remember those graphs that we talked about last week, you might have a hard time recalling which ones I'm referring to. So these are the graphs that are used to display the daily abundance pattern of the different stocks. And in this case, they're shown relative to the forecast -- two levels of forecast, the median value and the lower value referred to as the "75p here. So the way that the Mission estimates are used is they're actually used to create that dark sort of jaggedy line, which in the top there for Early Stuart, shows a little bit of a peak around the 29th of July, for example. That's the graph that I'm referring to.
So the Mission data are used to generate that daily abundance pattern, along with any catches. So last week, we talked about this idea of a -- sort of a boxcar model with this train car that's about a day wide that has an abundance of fish on it. And if there's no fishing, then, as that abundance passes the test fisheries and it reaches Mission, then those two numbers, if everything's working well, should be fairly similar in terms of their estimates. But if there's a fishery that occurs between the two sites then there would be a removal. So obviously you want to account for the total abundance. So these graphs are intended to be the total abundance, not just escapement.
So it's the Mission data, which is the primary anchor. Any catches that might have

occurred between test fisheries in Mission that need to be added to the total run, that's primary -- the primary tool that's used to generate these graphs. The last six days, because those are fish that would have passed the test fishery but not yet reached Mission, would be test fishing base. So it would be nice to be able to kind of colour in the last six days of these graphs. But in the case of Early Stuart, by this date -- I'm not sure what the date is -- it looks like it's sometime in late July -- all the fish that would have been available to pass Mission would have passed. In the case of Early Summers and Summers, you see, are at different stages of the run.

So the concept is that you take these in-season daily reconstructions, what we call them, these bold solid lines and compare them to hypothetical run sizes with different timing and spread. And you're trying to ask the question, not just the forecast, but a whole range of them. And you're trying to ask, okay, which possible scenario of abundance and timing is most consistent with the data? And in our discussion last week, we talked about how you're more certain about that when you see the peak. So this is a very good example. You see the Early Stuart. If you've got the entire run in your sites, you could be pretty sure about finding some limited set of potential abundances that would be consistent with that.

If you look at the Summer run on the bottom, clearly there's going to be a whole range of potential abundances and timings that will be equally consistent with that little bit of data that we have. So Mission is the -- kind of the anchor for generating these curves.

Q And why -- why use Mission and not just the test fishing data that you're receiving six days prior to Mission?

MR. LAPOINTE: Well, the main issue is something I think I also referred to last week is that Mission is quite a large sample. We probably actually, in physical targets, detected Mission somewhere in the order of 10 to 15 percent of the actual number of fish going by. Test fishing catches represent somewhere around the order of half to -- half-a-percent to 1 percent. So it's a much smaller

sample. So the Mission data should be more precise and we believe more accurate just because it's a more -- it's a larger sample of what's going by.
Q All right. And near the Mission hydro-acoustic site, there are places where you do stock -- you collect samples for stock composition?
MR. LAPOINTE: Yeah, so the idea there is that the -- the total sockeye number comes from the combination of the acoustics and any species compositions. So in pink years, you'd have to parse out the pinks and the sockeye. But then you want to divide that total sockeye into the different stock groups at a minimum, the four sockeye management groups, so the Early Stuart, Early Summer, Summer and Lates. But then, as I think some of these other graphs in this document show, sometimes we're parsing out into finer units for different purposes. So you know, if the concept is you've got the total pie, which is the sockeye, and then the stock ID is splitting that pie into the different component groups.
Q Are the programs -- is the Mission program, I should say, reviewed by the PSA staff every year?
MR. LAPOINTE: Yeah, it's a routine part of our post-season work.
Q Okay. And who's part of that review? Which -- is it all PSC or are other people involved?
MR. LAPOINTE: We have both internal and collaborative reviews. The internal reviews are, you know, just our staff. The external or the collaborative reviews involve a group called the "Hydro-Acoustics Working Group", which is largely comprised of colleagues from DFO who have considerably acoustics expertise. So that kind of was borne out of more formal collaborations as a result of some of these reviews that have occurred in the past where there's been recommendations for improvements. And so we sort of kept that group together and we try to take advantage of their views in reviewing our programs.
Q All right. I'm going to show you a document, which is in Tab 4 of the binder you have in front of you. It's CAN065011.
MR. LAPOINTE: Okay, yeah?
Q Thank you. And these are Minutes of Hydro-Acoustic Working Group, HaWG.

MR. LAPOINTE: Right.
Q This is the group you were just talking about?
MR. LAPOINTE: Yeah, it's a catchy name so it works. Yeah, this is our group. And it varies. Like sometimes there will be some other folks than the ones listed on this -- this list of -- but those are the principal players in the group.
Q Right. And this is an example of the minutes that would be kept of that kind of a meeting, obviously?
MR. LAPOINTE: Yeah, sure. Yeah, that's a perfect -- good example.
Q All right. You said that this working group was put together following some reviews. Is this -- can you relate the year of those reviews to the creation of this group?
MR. LAPOINTE: Sure. So we've had reviews associated with 1992, which was a Pearce-Larkin review; 1994, John Fraser review; 1998 was an internal review largely within the Fraser Panel in reference to the very hot water we had in the Fraser River that year; 2004, Brian Williams review. Trying to think if I've missed any. I think that's -- those are most of them. And of course, standing committee, Brian?
DR. RIDDELL: 2004.
MR. LAPOINTE: Okay. So there was a standing committee review also in 2004, I believe.
Q And was this group created in reaction to all of those? I mean I wouldn't think so.
MR. LAPOINTE: Oh, no, actually --
Q No.
MR. LAPOINTE: -- this group is there all the way through --
Q Yeah.
MR. LAPOINTE: -- so there's nothing about the 2004 review that was unique relative to the past years except that obviously we had a lot more outside folks focused on what we're doing. But other than that, it's a routine thing. We meet -- whether we have a review or not, we meet.
Q All right. In 2004, you -- you met with -- I think this was following the Williams review? That's -- that's (indiscernible - overlapping speakers)?
MR. LAPOINTE: Well, I think the Williams review was still -- still meeting in the spring of that year,

as I recall, but I could be -- could be wrong. I seem to recall testifying in like May -- April/May of that year so this was prior to that, probably to lay out some work plans for input into that process.
Q All right. And the Williams review was instigated by some significant discrepancies, amongst other things, in 2004; is that right?
MR. LAPOINTE: That's correct.
Q All right. And discrepancies in the river portion in terms of what got on the spawning ground and what was recorded initially?
MR. LAPOINTE: Yeah, this item that we've been calling the DBE in my previous testimony is the topic of that review largely.
Q All right. And is that what was on the -- on the table for discussion during the working group meeting that I have put (indiscernible - overlapping speakers)?
MR. LAPOINTE: Yeah, it's on the table for discussion in every year. So one of the inferences we draw -- or one of the things we use to draw an inference about how we're doing is how well or not the upstream numbers coincide with what we might have expected based on our lower river hydro-acoustics.
MS. BAKER: All right. Could I have these minutes marked, please?
THE REGISTRAR: Exhibit Number 353.

EXHIBIT 353: Hydroacoustic Working Group Meeting (HaWG) - 14&15 Dec 2004 - Review of 2004 of Mission Hydroacoustic Program

MS. BAKER:
Q Okay. So this issue that's on the table, the bias or accuracy at Mission, can you describe what that issue is and how it was addressed in your working group?
MR. LAPOINTE: I'm trying to think of a specific recollection to 2004. We would have done our normal, routine review of the sampling schemes to see if there were any issues with equipment. You know, on sample, there is -- anything that we could think of that would be obvious from a sampling design perspective that could cause bias. In 2004, we probably looked for other sources of

causes for discrepancies. The big one in 2004 would have been the extremely warm temperatures. I think, in my recollection serves me right, I think there were something like eight or nine record daily maximums Fraser River temperatures set in that year; in other words, the warmest day -- temperature on this date in 60 years. There were like nine of those set in 2004. So in a general sense, though, you know, this program has been subject to fairly intense scrutiny over time. And in all of those reviews, including 2004, and in general, it's been not found that there's significant issues although we've always come out of those reviews with recommendations for improvements.

Having said that, accuracy is not that easy to address in a scientific sense. And the reason I say that is when you use a word like "accuracy" and there's quite a bit of misunderstanding, not only in the public but also in some technical discussions. What you're really saying is, how close is your estimate to what the true underlying population is? And the reality is, at Mission, we don't know what the true underlying population is and so the way we try to address the issue of accuracy is by drawing some sort of an inference. And you draw an inference from a number of different ways. One is to, again, look at your sampling design. Are there any elements of your sampling design, places you're not sampling, things like that, that could create some sort of bias?

But the other way that's been used and more commonly is to compare the Mission estimate to another estimate from somewhere else like Qualark or upstream or -- and that -- that is used to draw an inference. And I guess it's always important, as a scientist, to sort of thing about that and recognize that if that's another estimate, then that estimate could also not represent the true value. So you're caught in this dilemma of trying to look for some consistency in independent estimates and say, well, if it's inconsistent there's definitely something that could be wrong with one of them. If they're consistent, perhaps the impression is drawn that perhaps they're correct, which may be true. I mean the likelihood

of two independent things being wrong so it's a -- it's a real challenge at the Mission site and any other acoustic site to know what the true answer is. And so we're always trying to draw these indirect inferences based on either other estimates or looking at our program to see if there's anything faulty about the way we're sampling that could create a problem.
Q All right. So in terms of what you can do to assess accuracy or bias at the Mission site, you've talked about evaluating the sampling design as being one thing to be done?
MR. LAPOINTE: Yeah, and you could think about other ways in sort of an academic sense to do this. I'm not certainly recommending them. But so for example, when there's a large fishery in Area E, it tends to remove almost all the fish that are available on a daily block. So when we see a Mission estimate following a fishery that is a very low number, that gives us some confirmation that when there's a removal we've got a pretty handle on the estimate.
You could do the reverse experiment and get a daily abundance estimate at Mission and then try to remove fish upstream of it to try to get a sample of a day's migration. I mean these are things that could be done but it is very challenging. But we do use catch information, both above and below Mission, to give us an idea, okay, well, does that catch make sense relative to the number of fish that were available or the harvest rates that a fishery could -- could exert? So it's definitely kind of inferential, indirect, not really attacking the accuracy question in a pure scientific sense.
Q Right. So the issue about bias has been on the table for a number of years and it is something that you review every year?
MR. LAPOINTE: Yes, it's a routine part of our analysis in the post-season.
Q All right. And have any improvements been made over the last, say, five to ten years in addressing some of these concerns?
MR. LAPOINTE: Yeah, a number of them. The most notables would be moving to the split-beam technology from the single-beam technology. Single-beam technology is not capable of

discerning direction of travel or speed of travel, whereas split-beam is so we had, I guess, initiated from the 1994 review about a seven, eight-year program to bring those methods of split-beam technology to Mission. And so that was one of the main ones.

Another main one is to try to sample also from the shore. So we basically followed a model developed for Qualark when Qualark was first developed in its first -- first incarnation, I guess, in the mid-'90s to say, okay, if we can sample from the shore, a significant fraction of the abundance, that should be much more robust. And the reason it's more robust is that the -- when you have a boat that's moving, a couple of things happen. One is fish to react to a boat. I'm sure everyone can relate to the idea that if you have a boat with a motor on it and you're trying to sample fish, they're going to react to the motor. And we can detect evidence of this within about four metres of our boat. We've done some work on that.

The other one is that you're trying to get an estimate of the speed of travel, which is important for the estimation. And so if you have a moving vessel and moving fish, it can be really difficult to get an accurate estimate of the speed. So the reason to go to the shore-based system is you can get way more accurate estimates of speed of travel and direction of travel from the shore. So split-beam trying to sample from the shore, we have systems now on both banks, are two of the most significant improvements we've made in the last four or five years.

Q Thank you. And Dr. Riddell, do you have anything to add on this? You need to turn your mike on. Thank you.

DR. RIDDELL: Well, there's a couple of points. I want to support what Mike was saying about how you assess accuracy or bias and that. And really the only way you can evaluate that is with an independent estimate. And Mike stressed the consistency element. But we also have to recognize that each has independent sources of bias. You tend to be using a different tool or you're using a different location and that. So we do place a fairly high dependence on consistency between estimates and that. And we do look for -- if it's a three-day lag between Mission and getting up to Qualark and if we adjust for that, is there a strong correlation? And many of your documents you'll see have plots of returns over time overlapped and there's a very, very high correspondence and that. So it's a difficult thing to do. I think, as Mike just said, the Pacific Salmon Commission has made a very serious effort to work with other groups and improve their estimates over time. And as you will get to later, I guess, the -- the main emphasis for going to Qualark in late 2000 was really to try and tie down this issue of accuracy of the estimate and whether we can account for some of the repeated sort of differences in numbers that people talk about.

Q Okay. And one other problem that's been identified at Mission is the impact of pinks co-migrating with sockeye. Can you give us some information on that?

MR. LAPOINTE: Sure, that's correct. And we've already touched on this a few times, I guess, even when -- I think the first time I was here perhaps in October or November. But there's two components of this. The most important one to focus on is the -- is the sampling of the -- of the species that are migrating by. And we use test fisheries to obtain the sample. And what we've noticed with pink salmon, and it became very obvious in 2005 where we feel like we probably had a fairly significant bias in Mission during our in-season period, is that the test fishery that we use, and I'm speaking specifically about the Whonnock test fishery now, tends to catch a disproportionate number of sockeye relative to the overall migration of sockeye plus pink. Likely, that's due to differences in where these fish travel. Pinks tend to be quite near shore, sockeye more in the mid-channel areas, and this test fishery at Whonnock is more of a mid-channel sampling test fishery.

The second component that's not discussed too much but we may get into a little bit more when we talk about other tools, is that pink salmon, because they are shore-oriented and they can be quite abundant, you know, something like, you know, 15, 20 million runs are not uncommon of which a fairly significant fraction of that would end up in the Fraser River, they can, with the split-beam technology really swamp the technology in some ways, almost overwhelm the ability to discern individual targets. If you're looking at a signal from this kind of equipment, it would almost look like a complete black screen in some cases when the pinks are very abundant. So that means that there would be a tendency to have a low bias in the total salmon because the pinks would not be estimated that accurately.

But a high bias in the proportion of sockeye -- the high bias in the proportion of sockeye is what created the problem in 2005. And 2005 was an extreme case because of the extraordinary lateness of the sockeye run and also the early upstream migration of pinks; they seemed to be doing something similar to late-run sockeye. So it's the combination of the sampling, which you want to be representative of the overall migration that comes from the test fishery, and the acoustic challenges that pinks pose that give us a challenge on pink years, let's say.

Q And that problem, you described as being particularly bad in 2005?

MR. LAPOINTE: Yes, it was extraordinarily bad for the reasons I just -- just described in terms of the overlap in the two species.

Q And in 2007, did it continue to be a problem?

MR. LAPOINTE: You know, in 2007 and 2009, we managed to kind of finesse a solution that we have used historically to estimate the sockeye and, that is, to use the test fishery. You know, prior to 2005 and continuing since then, as I say, 2007, 2009, what we've used is the -- related the catch of sockeye in the test fishery to the abundance of sockeye at Mission prior to when the pinks show up, so to get that ratio of how many fish are associated with a particular size catch, how many fish in the total migration, how many sockeye. And that was used very successfully up until 2005 when there really wasn't a good strong period of abundant sockeye migration before the pinks showed up, that they basically showed up at the same time so we couldn't use that method in 2005.

But in 2007 and 2009, we did use that method

and it seems to have come out okay. I guess I would just say because people will know, especially about 2009, is that those were both two very low sockeye run years, very low, a million-and-a-half. I think '07 was in the same range. And so in that situation, you're not likely to over-sample the sockeye with a test fishery in the middle of the channel because there aren't many to begin with. So I wouldn't suggest that the -- the fact that we were able to, you know, finesse the method and use the historical approach in 2007 and 2009 is kind of like we've got it solved. I think it just happened to work out because there was a low abundance of sockeye. So we're looking at other ways around this issue and we can maybe talk about those a little bit later, if we get into that issue.
Q I'm going to --
DR. RIDDELL: Could I just add something?
Q Yeah.
DR. RIDDELL: I mean I think just for clarification, what Mike is really talking about is the -- you have annual variation because the Fraser sockeye abundance is in the cycles and that. Now, '09 was very exceptionally low and that was different from the expected cycle year but '08 was not and that was a low cycle year. And the major difference that really caused a lot of problems in recent years has been the earlier run timing of pink that then overlap with the later run -- or the late portion of the summer sockeye and the beginning of -- well, right through the fall sockeye --
MR. LAPOINTE: Yeah, thanks, Brian, that's great.
DR. RIDDELL: -- the late run. So you've got really two factors that the Commission really has to sort out. One is the abundance of sockeye that has a couple of reasons between years and the other is the recently abnormal run timing of pink salmon. And now, we could be looking at just enormous runs like '09 and expected for 2011 should be very big again.
Q Right. And have there been any solutions worked out for what's expected in 2011?
MR. LAPOINTE: Well, I received the forecast document in my email today and it was received under the agreement of confidentiality because it's subject to review at the PSARC meeting on February 4th.

So I'm not sure what the protocol is for divulging that at this particular forum but I have seen a number. The reason Brian is suggesting it would be large is that there is a number out there that's the juvenile out migration estimate from 2010 and it was somewhere in the order of billion fry, which was not double the previous largest but it was -- I think the previous largest was 600 million so...
Q This is pinks you're talking about?
MR. LAPOINTE: We're talking about pinks, sorry. Thank you. Yes, we're talking about pink salmon. So Brian's intuition about the potential for large forecasts comes from that very large out migration of the juveniles.
Q Right. So are you anticipating a problem then with the species composition issue at Mission this year?
MR. LAPOINTE: We anticipate having to address the problem again this year and we're trying to put some programs in place -- and I think that's what you were starting to ask me but I'm not sure -- to try to -- try to address it.
Q Yeah, so is fish wheels a project that is designed to address species composition?
MR. LAPOINTE: It wasn't specifically designed as that, as its sole purpose, but it is an option and so...
Q How does that work?
MR. LAPOINTE: Well, the issue is -- the solution to this in terms of the conceptual solution is quite -- quite obvious. And what it's going to involve is what we call a stratified sampling approach. And what I mean by that is it's -- since we understand from our test fisheries that the sockeye and the pinks are not distributed evenly across the river, that it makes sense to have samples of the species composition from the shore separate from the channel. So that's the idea of a stratified sample, talking about stratified and space across the river channel. And similarly match that up with stratified samples of the acoustics from our acoustic estimation. Now, it just so happens that our acoustic estimation has already got a built-in stratification. We have a system on each shore and a system in the channel. So that part is well -- well looked after. The challenge is to come up with a stratified sampling

of the species composition of which the fish wheel provided an opinion for the shore-based sampling of the species composition.

So the projects that we've talked about and, in fact, even implemented as a pilot in '09 were be to use the fish wheel as the shore-based sampler and Whonnock as the channel sampler for species composition. And we actually developed an estimate of pink salmon escapement in 2009 based on that method and actually came out to a number that -- well, it was about 15 million pink salmon, which happened to match up with the run-size estimate from the test fishing less the catch so because they agree, of course, we believe they're probably both right but that may not be true.

And the other method that we're talking about and have already tried, although we haven't had the test fishery operate for a long enough period yet, is to use a test fishery at the Mission site itself. We've engaged Sumas First Nation to do set nets near the short for the shore-based part of the species composition and then a drift gillnet upstream of Mission for the channel.

So those are the two kind of ideas we have for the species composition and the stratified sampling.

Q And I have a note here about near-shore estimates using DIDSON. Is that the system that you already described when you said you have a system on the shore and a system in the centre?

MR. LAPOINTE: No, that relates to the second part of the pink salmon challenge that we have, this issue of saturating the split-beam.

Q Mm-hmm?

MR. LAPOINTE: Turns out the DIDSON seems to be quite robust -- quite a bit more robust in terms of the -- the volume of fish that can be -- can be passed in the DIDSON without creating a problem with the estimation and we know this from our work at Mission and we also know from the work at Qualark, which has had a DIDSON the last three years, that the daily abundances -- and I won't be able to remember the maximum daily abundance off the top of my head, but you know, closer to a million fish per day seemed to be able to go past these -- these systems -- and remember, they're going to be split in two because there's one on each bank --

seemed to be -- be able to be handled. I mean it's tiring for the -- for the folks that are doing the estimation because they're actually physically clicking through some of these counts. But -- but it looks from a technology perspective, that's a real advantage that the DIDSON, among others, will offer us in solving this problem.
Q Okay. Is it fair to say that where we sit today that Mission doesn't provide a reasonable assessment of sockeye when pink salmon are there? I mean it doesn't sound like the problem's been completely solved.
MR. LAPOINTE: I mean I think it's sort of a yes-and-no answer. There are certain conditions, and Brian was helpful in bringing these up, related to the relative abundance of sockeye and pinks when it's going to be more of a challenge and when the pinks come in early where it's going to be more of a challenge than others. But we have three years, you know, just take the most recent three years. 2005 clearly very significant problem in Mission, you know, documented in our annual report, already come up in evidence already. We've talked about it. 2007 and 2009, you know, seems like we did reasonably okay. So it's fair to say that the problem definitely has not been solved. I think that's -- but can we say every year it will be a problem? It will depend upon what the fish -- what the fish do to us, I guess.
Q And what about you, Dr. Riddell? Do you agree that while there was -- there are some problems, it's -- we can still get reasonable estimates of sockeye at Mission when pink salmon are in the water?
DR. RIDDELL: Well, I think that -- well, Mike referred to the fish wheel as not really being one of the target benefits of doing that but there are a number of spin-offs from the Qualark program linked with the fish wheels and that. And I think that by actually investigating all the data that we have at the same time, the Commission has certainly found ways that, as Mike said, stratify the river, use other tools to get your best estimate, in particular strata, and then put that back together. We've only been able to really do that because we've had other people working with the Commission now using new tools and trying to

verify some of these things. So I think we'll be able to build on that and we'll be able to do a better job because the tools that we have looked at, particularly in post-season, really did fit quite well for 2007 and 2009.
Q All right. And just one last question on the pinks and then I think we'll stop for the day. What are the -- we've, of course, heard many times about the four run-timing groups in the sockeye system. Which of those run-timing groups are impacted by the co-migration of pinks?
MR. LAPOINTE: Primarily up until recent -- up until the pinks started coming in early was the Late run. But now certainly the Summer run and the Late run for sure and in some years if it's a very large pink run and they're very early, the back half of the early summer can also be impacted by this problem. The later part of -- later -- later time prior to the Early Summers, I should say.
Q So on pink years, it's a very significant portion of the sockeye --
MR. LAPOINTE: If the pink's --
Q -- run that's impacted?
MR. LAPOINTE: If the pinks migrate upstream early, it can impact, you know, almost all the run groups except for Early Stuart.
MS. BAKER: Okay. If it's convenient, I'll stop there for today.
THE REGISTRAR: The hearing is now adjourned for the day and will resume at ten o'clock.

(PROCEEDINGS ADJOURNED TO JANUARY 27, 2011, AT 10:00 A.M.)

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

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Pat Neumann
Registered Court Transcriber

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
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Diane Rochfort
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