

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



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

Public Hearings

Audience publique

Commissioner

L'Honorable juge /
The Honourable Justice
Bruce Cohen

Commissaire

Held at:

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

Monday, August 22, 2011

Tenue à :

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

le lundi 22 août 2011



Errata for the Transcript of Hearings on August 22, 2011

Page	Line	Error	Correction
85 to 89	41 to 21	DR. JOHNSON answering	DR. STEPHEN answering

APPEARANCES / COMPARUTIONS

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

APPEARANCES / COMPARUTIONS, cont'd.

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

APPEARANCES / COMPARUTIONS, cont'd.

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

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Vancouver, B.C. /Vancouver
(C.-B.)
August 22, 2011/le 22 août
2011

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6 THE REGISTRAR: The hearing is now resumed.

7 MR. MARTLAND: Mr. Commissioner, I am appearing, Brock
8 Martland, M-a-r-t-l-a-n-d, with me is Jennifer
9 Chan and Kathy Grant. Ms. Chan is my counsel as
10 well for the Commission on the Disease hearings;
11 Ms. Grant for the Aquaculture hearings to follow.

12 As we begin today, I'd like to take just a
13 brief moment to acknowledge the passing this
14 morning of the Honourable Jack Layton, the Leader
15 of the Opposition, who of course made a most
16 meaningful contribution to Canadian public life.

17 I also had a note that Mr. Taylor wished to
18 address you on one brief point as we start the
19 day.

20 MR. TAYLOR: Mr. Commissioner, Mitchell Taylor for the
21 participant Canada, and with me is Jonah
22 Spiegelman. Also behind me at the far back is
23 Jeff Miller. He's a law student, and I am seeking
24 leave if he might be at the front, Mr.
25 Commissioner.

26 THE COMMISSIONER: Yes, of course, Mr. Taylor, that's
27 fine.

28 MR. TAYLOR: Thank you.

29 MR. MARTLAND: Mr. Commissioner, by way of a few brief
30 remarks as we start today. We begin, of course,
31 the hearings on the topic of disease, which run
32 for three-and-a-half days, then they're followed
33 by hearings on the topic of aquaculture. We've
34 made a schedule change, we communicated that
35 Friday, with respect to the second disease panel,
36 Dr. Kristi Miller and Dr. Kyle Garver, adding a
37 half day from that panel, but taking that half
38 day, if you will, from the Project 5 panel, which
39 is the Commission's Reports on Aquaculture. So in
40 the short we will have Drs. Miller and Garver
41 running Wednesday, and then until noon on
42 Thursday, at which point we'll start with the
43 Panel 5 evidence.

44 I also want to say at the outset, as
45 Commission counsel we're grateful to all
46 participants' counsel for their assistance. We
47 have a schedule in the next three weeks or so that

1 is ambitious. It reflects our preference, but
2 also the preference of participants to have a
3 number of important witnesses as opposed to only a
4 select few. Of course, the trade-off in that
5 equation is that counsel must be focused and
6 disciplined in their questioning, and I'm grateful
7 to them in taking that approach and agreeing to
8 respect the time allocations.

9 I can say at the outset I will be perhaps
10 making myself a bit of a pest to my colleagues in
11 reminding them of the time. I'll be asking them
12 through these hearings to cede the floor when
13 their time is finished, and to understand that if
14 they don't, they'll be using the next lawyer's
15 time, and that if there are outstanding questions,
16 if somehow they have not asked an important or a
17 vital question at the start of their questions,
18 that they look to address the Commission at the
19 end of the hearing and to see if there's time at
20 that point, rather than carrying on and pushing
21 our schedule.

22 On that, Mr. Commissioner, we're in a
23 position to begin the first panel of experts, Drs.
24 Michael Kent and Dr. Craig Stephen, both of whom
25 have prepared technical reports, Dr. Stewart
26 Johnson and Dr. Christine MacWilliams from DFO.

27 If they might be affirmed, please, Mr. Registrar.
28 THE COMMISSIONER: Put on their microphones, please.

29
30 STEWART JOHNSON, affirmed.

31
32 MICHAEL KENT, affirmed.

33
34 CHRISTINE MacWILLIAMS, affirmed.

35
36 CRAIG STEPHEN, affirmed.

37
38 THE REGISTRAR: I'm sorry, I need your names.

39 DR. KENT: Michael Kent.

40 THE REGISTRAR: Yes.

41 DR. JOHNSON: Stewart Johnson.

42 DR. STEPHEN: Craig Stephen.

43 DR. MacWILLIAMS: Christine MacWilliams.

44 THE REGISTRAR: Thank you. Counsel.

45 MR. MARTLAND: Thank you.

3

PANEL NO. 55

In chief on qualifications by Mr. Martland

1 EXAMINATION IN CHIEF ON QUALIFICATIONS BY MR. MARTLAND:

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Q I'll begin, if I might, with number 4, and I'll be referring as we move through this to lists -- to, sorry, documents on our list of proposed exhibits. And Dr. Kent, I'll begin questions of you. First of all, I hope you'll recognize on screen your c.v., sir?

DR. KENT: Yes.

10

11

12

Q And just -- there we go, you see the red light on the microphone.

DR. KENT: Yes, I do.

13

14

MR. MARTLAND: Thank you. And if I could ask this be marked as the next exhibit, please.

15

16

THE REGISTRAR: Exhibit number 1448.

17

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EXHIBIT 1448: *Curriculum vitae* of Michael Kent

20

MR. MARTLAND:

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Q I will briefly, to confirm your background, sir, you are a professor in the department -- Departments of Microbiology and Biomedical Sciences at Oregon State University and also you are the author of Technical Report 1, which we'll be addressing in a moment, a report for this Commission.

28

DR. KENT: Yes, that's correct.

29

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Q I understand that you hold a Ph.D. in Comparative Pathology from the University of California Davis from 1985, an M.Sc. in Biology from San Diego State University from 1981, a B.Sc. in Fisheries from Humboldt State University from 1977 and that your research interests include fish diseases and parasitology.

36

DR. KENT: Yes, that's correct.

37

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41

Q Your laboratory conducts studies of diseases related to both wild and cultured fish populations, including the pathological and physiological effects of population on salmonid fishes in mountain lakes; is that true?

42

DR. KENT: That's correct.

43

44

45

46

47

Q And is it correct that you've served as a co-advisor to a number of graduate students, indeed some of those students will be appearing here as witnesses, one of whom is Craig Stephen, as well as Dr. Sonia Saksida?

4

PANEL NO. 55

In chief on qualifications by Mr. Martland

Ruling on qualifications

1 DR. KENT: That's correct.

2 Q And on the basis of this -- I should also ask
3 this. You have a background, having worked for
4 the DFO; is that correct?

5 DR. KENT: Yeah, that's correct. I worked with them
6 from 1988 through 1999 and cumulated my -- my
7 career with them as Head of the Fish Health
8 Section, which I became Head of the Fish Health
9 Section in 1997.

10 MR. MARTLAND: Thank you. On the basis, Mr.
11 Commissioner, of the c.v. and this witness's
12 qualifications, I'll ask to have him qualified as
13 an expert specifically with respect to fish
14 disease and parasitology, please.

15 THE COMMISSIONER: Thank you.

16 MR. MARTLAND:

17 Q Now I'd like to have document number 5, please,
18 brought up, Mr. Lunn. You'll see in a moment, Dr.
19 Kent, your report, which I referred to a moment
20 ago.

21 DR. KENT: Yes, that's my report.

22 MR. MARTLAND: I'll ask this be marked as the next
23 exhibit, please.

24 THE REGISTRAR: Exhibit 1449.

25

26 EXHIBIT 1449: Cohen Commission Technical
27 Report 1 - Infectious Diseases and Potential
28 Impacts on Survival of Fraser River Sockeye
29 Salmon, February 2011
30

31

MR. MARTLAND:

32 Q And I believe there's a corrections or errata
33 sheet that associates with that document. I may
34 touch on it very briefly, but if I might ask, Mr.
35 Lunn, if you could put that on the screen. And
36 that's just two things about page 20, but first of
37 all the second word there was misspelled, it
38 should have been "*salmonsitica*", and secondly that
39 the ranking that's described in the table on page
40 20 doesn't correlate to what the text of your
41 report says. It should have been "moderate"; is
42 that correct?

43 DR. KENT: That's correct.

44 MR. MARTLAND: And I'll ask this sheet please be marked
45 as the next exhibit.

46 THE REGISTRAR: Exhibit 1450.

47

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PANEL NO. 55

In chief on qualifications by Mr. Martland

1 EXHIBIT 1450: Errata sheet for Cohen
2 Commission Technical Report 1, undated
3

4 MR. MARTLAND:

5 Q Dr. Johnson, I'll ask Mr. Lunn next to please
6 bring up number 1 on our list of documents. And
7 I'll ask, I hope my easiest question, which is do
8 you recognize your c.v.?

9 DR. JOHNSON: That's my c.v.

10 MR. MARTLAND: If this might be the next exhibit,
11 please.

12 THE REGISTRAR: Exhibit 1451.
13

14 EXHIBIT 1451: *Curriculum vitae* of Stewart
15 Johnson
16

17 MR. MARTLAND:

18 Q With respect to your background, you head the
19 Aquatic Animal Health Section of the Salmon and
20 Freshwater Ecosystems Division in the DFO's
21 Pacific Region Science Branch, and in that
22 capacity, sir, I understand that you oversee the
23 work of various DFO staff investigating or
24 monitoring aquatic pathogens and diseases, a list
25 that includes again a number of folks who are
26 testifying, Dr. Christine MacWilliams, who is on
27 the panel today, as well as Dr. Kyle Garver and
28 Dr. Simon Jones; is that correct?

29 DR. JOHNSON: Yes, I do.

30 Q You hold a PH.D. in Biological Sciences from Simon
31 Fraser University from 1991, an M.Sc. in
32 Biological Sciences from Dalhousie in 1986, and a
33 B.Sc. in Biological Sciences from the University
34 of Victoria from 1978; is that right?

35 DR. JOHNSON: Yes, that's correct.

36 Q In addition, you've completed post-doctoral
37 training, both at the University of B.C. and
38 Stanford University, and I understand that among
39 other positions, you served as an external
40 reviewer on DFO Pacific Science Advice Review
41 Committee, as a science advisor on the Genome BC
42 project called "Genomics in Lice and Salmon", as
43 well as having been a past chair of the PICES
44 Working Group on Environmental Interactions of
45 Marine Aquaculture; is that right?

46 DR. JOHNSON: Yes, that's correct.

47 Q Your major research interests include diseases,

6

PANEL NO. 55

In chief on qualifications by Mr. Martland

Cross-exam on qualifications by Mr. Taylor (CAN)

Ruling on qualifications

1 immunology, physiology, and the husbandry of
2 aquatic animals, including research on host
3 pathogen interactions involving what I'll be
4 calling through the hearings, Mr. Commissioner, I
5 expect, *Leps*, but the proper name is
6 *Lepeophtheirus*, I take it, *salmonis*?

7 DR. JOHNSON: Yes, that's correct.

8 Q And *Aeromonas salmonicida*.

9 DR. JOHNSON: *Aeromonas*.

10 Q *Aeromonas*.

11 DR. JOHNSON: *Salmonicida*.

12 Q All right. And apart from the pronunciation, I
13 hope those facts are accurate, sir?

14 DR. JOHNSON: Yes, they are.

15 MR. MARTLAND: I'll ask to qualify Dr. Johnson as an
16 expert in aquatic animal diseases, immunology and
17 physiology.

18 MR. TAYLOR: I agree with that so far. I have a
19 further question, if I may.

20

21 CROSS-EXAMINATION ON QUALIFICATIONS BY MR. TAYLOR:

22

23 Q Dr. Johnson, are you knowledgeable in
24 parasitology?

25 DR. JOHNSON: I am knowledgeable in parasitology,
26 especially as it pertains to studies of sea lice.

27 Q And is that of long standing, that is, you've been
28 knowledgeable in that area for many years?

29 DR. JOHNSON: My Ph.D. thesis was the first major
30 studies on *Lepeophtheirus salmonis* that were
31 conducted.

32 MR. TAYLOR: And therefore in addition to what Mr.
33 Martland has proposed, I think that Dr. Johnson is
34 an expert in parasitology, as well, as it pertains
35 to fish.

36 MR. MARTLAND: Unless counsel has an objection to that,
37 I don't have a difficulty with that formulation
38 being added.

39 THE COMMISSIONER: Very well, thank you.

40

41 EXAMINATION IN CHIEF ON QUALIFICATIONS BY MR. MARTLAND,
42 continuing:

43

44 Q And I'd like to have number 7, please, brought up
45 on screen, simply just to complete our
46 understanding, and I don't expect to be asking you
47 questions about this. But I hope once it's

1 righted, you'll see that this an organizational
2 chart with respect to on page 1, the Salmon and
3 Freshwater Ecosystems Division, on page 2 you'll
4 see the Molecular Genetics -- I'm sorry, Mr. Lunn,
5 I've made this challenging. But again, once in a
6 moment I think you'll see the Molecular Genetics
7 and the Animal Aquatic -- sorry, Molecular
8 Genetics organizational chart, and then on the
9 third page in a moment, I expect you'll see the
10 Aquatic Animal Health Section is that right?

11 DR. JOHNSON: Yes, that's correct.

12 Q And this accurately describes the Department's
13 structure with respect to these divisions or
14 branches?

15 DR. JOHNSON: Yes, it's the most up-to-date version.

16 MR. MARTLAND: I'll ask this be marked as the next
17 exhibit, please.

18 THE REGISTRAR: Exhibit 1452.

19
20 EXHIBIT 1452: Organizational Charts of DFO
21 Salmon and Freshwater Ecosystems Division,
22 May 2011
23

24 MR. MARTLAND:

25 Q Dr. Stephen, I'll move to you next and have a look
26 at number 2 on the list of exhibits, sir, which I
27 hope will be your c.v.; is that correct?

28 DR. STEPHEN: And it's a "Highlights" of my c.v., yes.

29 MR. MARTLAND: And if I might ask that this be marked
30 as the next exhibit.

31 THE REGISTRAR: Exhibit 1453.

32
33 EXHIBIT 1453: *Curriculum vitae* Highlights
34 Specific to the Cohen Commission Mandate of
35 Craig Stephen
36

37 MR. MARTLAND:

38 Q You serve as a Professor in the Faculty of
39 Veterinary Medicine and the Faculty of Medicine at
40 the University of Calgary, and you're the Founding
41 Director and President of the Centre of Coastal
42 Health, which is an independent non-profit
43 organization that conducts research primarily in
44 the areas of public health and fish and wildlife
45 health; is that right?

46 DR. STEPHEN: That's correct.

47 Q And you're the primary author of Technical Report

8

PANEL NO. 55

In chief on qualifications by Mr. Martland

Ruling on qualifications

In chief by Mr. Martland

1 1A, which we'll look at in just a moment.

2 DR. STEPHEN: Yes, correct.

3 Q You hold a Ph.D. in Epidemiology and a Doctor of
4 Veterinary Medicine from 1987. The first Ph.D.
5 from 1995, the doctorate from 1987, both from
6 University of Saskatchewan?

7 DR. STEPHEN: Correct.

8 Q Your doctoral work focused on emerging diseases in
9 fish populations, and your research interests
10 include aquatic animal health assessments, and
11 surveillance in the ecology of emerging diseases?

12 DR. STEPHEN: Correct.

13 MR. MARTLAND: If I might ask on the basis of this
14 witness's, at least highlights from his c.v. as
15 well as his background, that he be qualified as an
16 expert in veterinary epidemiology with a specialty
17 in the ecology of emerging diseases and
18 surveillance of aquatic animal health and disease.

19 THE COMMISSIONER: Yes, very well. Thank you.

20 MR. MARTLAND:

21 Q And if I might have number 6 brought up, please,
22 on the screen in front of you, it's got the same
23 cover, I suppose, but, Dr. Stephen, you'll
24 recognize that as being your report?

25 DR. STEPHEN: Yes, I do.

26 Q And it focuses, and we'll obviously be speaking
27 about this, but it focuses on the question of
28 salmon enhancement facilities and disease vis-à-
29 vis Fraser sockeye?

30 DR. STEPHEN: Correct.

31 MR. MARTLAND: I'll ask this be marked as the next
32 exhibit, please.

33 THE REGISTRAR: Exhibit 1453.

34 THE COMMISSIONER: I think it's 1454.

35 THE REGISTRAR: I'm sorry, 1454.

36

37 EXHIBIT 1454: Cohen Commission Technical
38 Report 1A - Hatchery Diseases, July 2011

39

40 MR. MARTLAND: And, Mr. Lunn, I know I have you moving
41 fast and furious on a Monday morning, but I'd like
42 to move to number 3 on our list of documents. Dr.
43 MacWilliams, you'll recognize that as being your
44 c.v.?

45 DR. MacWILLIAMS: It is.

46 MR. MARTLAND: I'll ask this be marked, please, as an
47 exhibit.

August 22, 2011

1 THE REGISTRAR: Exhibit 1455.

2

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EXHIBIT 1455: *Curriculum vitae* of Christine
MacWilliams

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MR. MARTLAND:

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Q And, Dr. MacWilliams, you served both as a Fish
Health Veterinarian for DFO Salmonid and
Enhancement Program, as well as the Laboratory
Animal Veterinarian for DFO Pacific Region Science
Branch, and your responsibilities include
coordinating fish health disease investigations,
providing management recommendations on disease
prevention, mitigation and therapeutic
intervention, educating salmonid enhancement
facility operators on biosecurity, and conducting
surveillance for fish pathogens of concern; is
that right?

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DR. MacWILLIAMS: That is.

19

20

Q You hold a Doctor of Veterinary Medicine from The
Atlantic Veterinary College from 2000, an M.Sc. in
Salmonid Pathology, also from the Atlantic
Veterinary College from 2008, and a B.Sc. in
Biology from the University of PEI from 1989; is
that right?

21

22

23

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DR. MacWILLIAMS: That is correct.

26

27

Q And your past research have included infectious
salmon anaemia virus, ISAV, as well as *Leps*?

28

29

DR. MacWILLIAMS: It has.

30

MR. MARTLAND: I'd like to have Dr. MacWilliams
qualified, please, as an expert with respect to
veterinary sciences with a specialty in fish
health, please.

31

32

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THE COMMISSIONER: Thank you, Mr. Martland.

34

35

EXAMINATION IN CHIEF BY MR. MARTLAND:

36

37

Q Now, I'll begin my -- just to, I hope, forecast a
sense of my questions, I plan to focus my first
questions on Dr. Kent and your report, sir, but in
doing that, I'll certainly be turning to the other
witnesses for comments on some general and
specific points, and then I'll spend some time
addressing Dr. Stephen's report.

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44

Dr. Kent, if I might start at the outset -

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and this is a theme, Dr. Stephen, I'll pick up

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with you as well - about, with respect to, if you

1 will, challenges to having the amount of
2 information and data that you wish to have to do
3 this report, you offered a comment to the effect
4 that your report was significantly hampered by the
5 lack of scientific research on disease. And, Dr.
6 Stephen, I think you've made similar kinds of
7 comments with respect to limitations that may have
8 hindered or hampered your work in your technical
9 report.

10 I'll pause just to be clear that these are
11 both technical reports, itself being, if you will,
12 a technical term, Mr. Commissioner, in that
13 they're commissioned by this inquiry and prepared
14 for the purpose of this inquiry with a view to
15 asking specific questions relating to Fraser
16 sockeye.

17 I'd like to at a general level engage on this
18 question of the known and the unknown, and having
19 as much as we can some understanding of the
20 significance of the unknowns with respect to
21 pathogens and disease.

22 Dr. Kent, first, that's a long preface, and
23 I'll spend less time talking from here forward.
24 But first, I understand that you hold the view
25 there's limited research on diseases and wild
26 stocks in contrast to captive stocks whether in an
27 aquaculture facility or hatchery or similar
28 facility.

29 DR. KENT: Yes, that's correct.

30 Q Could you comment on that and explain that, why
31 that's the case.

32 DR. KENT: Sure. Historically, not only within the
33 Pacific Region of DFO, but in general on -- in
34 research on salmonid diseases, most of the
35 emphasis has been directed towards investigations
36 on disease phenomena and within hatcheries or
37 captive populations. And since, you know, or I'd
38 say probably 50 years ago, would fish -- the field
39 of fish disease for 50 or 70 years ago, you'll see
40 the reports were mostly on infectious diseases and
41 others in hatcheries. With the emergence of
42 salmon farming I would say really taking off about
43 20 years ago, now we're starting to see a lot of
44 information, studies on diseases affecting salmon
45 in net pens and other captive private aquaculture
46 operations. In comparison, there's relatively
47 very little done on diseases of wild salmonids.

1 Parasites, there have been parasite surveys,
2 and even some pathogen surveys just documenting
3 the mere presence or absence, and even less so the
4 pathological changes at an individual level. But
5 as far as population studies, impacts of diseases,
6 infectious diseases, parasites, viruses, bacteria
7 at a population level with salmonids has been very
8 minimal. Other fishes, it's been done with
9 herring in Europe and also Alaska, et cetera.

10 There's a lot of difficulties that we can --
11 we can get into talking about why particularly
12 salmonids, wild salmonids are particularly
13 difficult to investigate. Be that as it may,
14 there's -- compared to other fields of fish
15 diseases, there's very little on impacts of
16 parasites and other infectious agents at a
17 population level, let alone an individual level
18 with salmonids.

19 Q Maybe I can pick up on the point you just made and
20 without maybe having the overview level of answer,
21 why is it so hard to obtain that information, why
22 it has been hard to do the work vis-à-vis wild
23 stocks.

24 DR. KENT: Sure. There's two reasons. One is that
25 many of the methods that we use for investigating
26 the impacts of disease and chronic infections, et
27 cetera, at a population level require sampling the
28 same population and knowing that it's the same
29 population over multiple time periods. It's quite
30 difficult with salmon. For example, they start
31 out in freshwater as subpopulations. They may
32 emerge out as smolts, then they would become one
33 population. They go into the ocean, and tracking
34 the same -- the identical population in the ocean
35 is extremely difficult. And so what would happen
36 would be is that you find a prevalence of a
37 particular pathogen or lesion, et cetera, collect
38 it in your own fish, then you look at sockeye
39 salmon or another species of fish, whatever, a
40 year later, how do you know, it would be very
41 difficult to say that it's the identical
42 population. And we're not just saying
43 genetically, but actually the true population.

44 So that's the main -- one main challenge with
45 salmonids.

46 Secondly, many of these species are
47 protected, and therefore you don't have a -- you

1 have a limited number of samples that are
2 available to you, and many of the methods that we
3 use in fish diseases become more robust when we've
4 got large sample sizes. So, for example, with
5 herring, we can do a lot of these epidemiological
6 investigations, because you can get thousands of
7 fish from more or less the same population, and
8 that's very difficult with salmon.

9 Q Is there a difference in the amount of research in
10 the field as opposed to in the laboratory,
11 relating to salmonids?

12 DR. KENT: Yes. Yes, sir, I just described the
13 difficulties of reliability of doing this
14 fieldwork, and so it does allow us to do -- on the
15 lab side there's a lot more solid information, in
16 my opinion, from lab studies, but it only pertains
17 to the labs, lab work, and this is mostly -- most
18 of these lab studies have been directed towards
19 pathogens that one observed, and this is observed,
20 associated with disease in captive fish.

21 So in a lab study there is more empirical
22 data, but then relating these findings from a lab
23 situation to what's going on in the actual field
24 situation is difficult, because we know that that
25 environmental -- fish being cold-blooded animals
26 and living in water are very tied to environmental
27 conditions within the water. And changes in
28 environmental conditions, temperature, et cetera,
29 can greatly affect the pathogenesis of an
30 organism.

31 So if you do a confined study, a well-defined
32 study in the lab under certain conditions under
33 certain temperature, you have to apply that to
34 what that pathogen is doing in the field with
35 extreme caution.

36 Q Dr. Johnson, to pick up on that point, is it the
37 case that a finding in the lab tells us something
38 or only a limited -- limited understanding of what
39 may be happening in ocean water.

40 DR. JOHNSON: You can learn many things from laboratory
41 studies, but as Dr. Kent mentioned, it's very
42 difficult to take -- to relate studies in the
43 laboratory to what would happen in the population,
44 in the wild population. For example, you can
45 study things such as how pathogens invade the
46 host. They have great detail in the laboratories.
47 And you can study how the host, at least under

1 those laboratory conditions, responds to the
2 pathogen.

3 One area that the laboratory work is, is that
4 in general most of the laboratory studies we've
5 done have been single pathogen studies. So we
6 really haven't sort of gone to this concurrent
7 infection. Most fish carry multiple pathogens.
8 So that's another limitation. But so the
9 laboratory studies have a place in investigations
10 of salmon diseases, but they do not replace the
11 sorts of field studies that Dr. Kent was talking
12 about.

13 Q But there are challenges in studies that involve a
14 particular stock and whether those conclusions
15 apply more generally to the species?

16 DR. JOHNSON: There are stock-specific differences in
17 susceptibility to some pathogens. Now, the -- and
18 I would also say that within a stock there could
19 also be family-specific differences. So when you
20 have -- if you do a comparative susceptibility, or
21 you -- susceptibility of a particular stock of
22 chinook salmon to a pathogen, it's not necessarily
23 comparable to another stock. I don't know if I've
24 answered that very well, but...

25 Q No, I think I have your point. Is it the case
26 that there is -- as I hear part of what you're
27 describing, then there's really a challenge,
28 although the laboratory may give insights about
29 particular fish, or what the mechanism is on an
30 individual level, one of the challenges is really
31 then zooming back and having -- trying to have
32 some understanding, whether you can get an
33 understanding at a population level.

34 DR. JOHNSON: Yes, that is the major challenge, and an
35 understanding in an environment, as Dr. Kent
36 mentioned, that varies widely and has a
37 significant impact on the fish and how they
38 respond to these pathogens.

39 Q Dr. Kent, are there also challenges with respect
40 to our understanding about the geographic
41 distribution of pathogens, about what's going on
42 in the marine environment, for example, two
43 possibilities?

44 DR. KENT: Yes. these are both -- both challenges.
45 They're not as, in my opinion, I would say not as
46 difficult as the previous challenges that we just
47 discussed. So basically it is correct, is when

1 you, if you did a survey on one population of the
2 profile, of the suite of pathogens that may occur
3 in these fish, you can't automatically apply that
4 to other populations. There are geographic
5 boundaries of pathogens. Often pathogens that are
6 -- have intermediate hosts are defined by the
7 distribution of their intermediate host, not by
8 the -- not by the species of fish. For example,
9 we have a very common pathogen down in Oregon and
10 Washington called *Nanophyetus* that causes salmon
11 poisoning in dogs. That's -- that's directed by
12 the distribution of a snail, so it's not by
13 distribution of salmonids. It will affect any
14 salmonid, but it does not occur in B.C. because
15 the snail host does not occur in B.C.

16 Q With respect to pathogens, I wonder if it's also
17 the case that there's limited research with
18 respect to whether there's a baseline, or a
19 baseline understanding of endogenous pathogens in
20 terms of their prevalence, in terms also of
21 identifying those pathogens.

22 DR. KENT: Yes, that's true, and from personal
23 experience and -- and I can speak more broadly,
24 not just to say my situation but others, I feel
25 this is important to obtain this baseline
26 information. But this is not -- sometimes it's
27 very difficult to get this type of work funded
28 because it's not mechanistic, or as one would see
29 it as not as much hypothesis driven, it's just
30 data collection that could be used, that is a
31 basic important foundation to determine if a
32 change over time has occurred, if this pathogen
33 occurred previously, or present.

34 For example, the pathogen distribution in --
35 occurs in wild fish before salmon farming. We
36 don't have that information because the surveys
37 weren't done, or in regions where salmon farming
38 does not occur, that type of solid well-funded
39 large studies on the distribution of pathogens.
40 It's generally not done.

41 Q I wonder then if I, having covered a few aspects
42 of this question with respect to the limitations
43 on the research and the data, if you will, if I
44 can move, Dr. Kent, to your report and in
45 particular, Mr. Lunn, using Dr. Kent's report, at
46 page 24. And I apologize, I didn't make the note
47 that I have in front of me on the exhibit number.

1 MR. LUNN: That's 1449.

2 MR. MARTLAND: 1449, thank you.

3 Q On page 24, and we'll see this in a moment, but
4 ultimately, Dr. Kent, if you could have a look
5 indeed at the last sentence before the
6 "Recommendations" subheading, and you express,
7 after referring to Peterman:

8
9 ...we cannot conclude that a specific
10 pathogen is the major cause of demise to the
11 Fraser River sockeye salmon. However,
12 pathogens cannot be excluded at this time as
13 adequate research on the impacts of disease
14 on this population has not been conducted.
15

16 DR. KENT: That's correct.

17 Q Dr. Stephen, we'll come back to addressing this in
18 more detail, but, Dr. Stephen, I wonder if I might
19 ask you in relation to your report addressing
20 hatchery disease interactions, could you comment
21 on these limitations. Could you comment, as well,
22 on the limitations that you identified in your
23 report. Of course, the report speaks for itself,
24 and, Mr Commissioner, some of what I'll do today,
25 it doesn't -- and I hope not overly ambitious in
26 trying to communicate all of the fine detail of
27 these reports that are now in evidence before you,
28 but that is a preface remark, Dr. Stephen.

29 DR. STEPHEN: Certainly. I can certainly reinforce the
30 concerns or comments that Dr. Kent and Johnson did
31 of the challenges of working with the population,
32 and this is true for terrestrial wildlife as well
33 as aquatic wildlife, of trying to understand the
34 true distribution impact of diseases. There's a
35 dearth in the literature for that, largely as Dr.
36 Kent said, because most of our funding has been on
37 mechanistic research, as opposed to population-
38 based research.

39 From my risk assessment perspective for the
40 report that I did, a critical element of risk is
41 to identify that in fact has been exposure, and
42 we've had very little work in general, looking at
43 the exposure of free-ranging species to pathogens
44 of particular sources, and part of that comes
45 back to the challenges again, as Dr. Kent
46 mentioned, of tracking populations, but also of
47 tracking and finding the pathogen in the

1 environment.

2 I think another important deficit in the
3 science side is the focus we've had has been on
4 disease, as opposed to health. And the broader
5 capacity for that population to be resilient and
6 to thrive in the face of challenges like disease.
7 So the fish health world has really been a fish
8 disease world. So I think those are the main
9 science concerns.

10 From our report's perspective there was some
11 challenges in being able to validate local data,
12 so our report had to be somewhat broad and generic
13 because of the time constraints that was imposed
14 upon us.

15 And finally, the last one is that we don't
16 really have systematic surveillance, in my
17 perspective, of hatchery reared and wild fish. We
18 have periodic surveys. We have some surveillance
19 for specific pathogens, but overall health
20 surveillance is lacking. So our understanding of
21 even the distribution and abundance within the
22 full populations is challenging at this time.

23 Q Dr. Johnson, you made a point with respect to co-
24 infection, Dr. Stephen just described a disease as
25 opposed to health kind of a contrast, I suppose.
26 Could you comment on whether the research -- to
27 some extent does the research or does our
28 understanding reflect a focus on specific
29 pathogens as opposed to asking sort of stepping
30 back kind of questions about co-infection, about
31 the interplay of different factors.

32 DR. JOHNSON: I think to date the vast majority of the
33 research that's been done on diseases of fish has
34 been related to a specific pathogen. I cannot
35 think of any papers off the top of my head where
36 they've actually studied multiple infections in
37 fish.

38 Q Thank you. Dr. Kent, I'd like to move back to
39 your report. Your report, again which is now in
40 evidence, offers a subjective risk assessment with
41 respect to a variety of pathogens and diseases.
42 And before going into discussing at least some of
43 those specific pathogens, I'd like to spend a few
44 minutes with respect to how you went about your
45 analysis. And I think a pretty logical way to
46 start that discussion is asking you about how you
47 approached the concept of risk in your report. So

1 if you could comment in the context of this
2 report, which you were asked to do, how you went
3 about defining and using the concept of risk in
4 your report.

5 DR. KENT: Sure. And I think there's somewhere in my
6 report we could find that early on.

7 Q Probably page 2, at least in one part.

8 DR. KENT: Okay.

9 Q If that's helpful to you to have in front of you.

10 DR. KENT: Sure. But I can speak without seeing this.
11 So in preparing this report, based on my scope of
12 work, I was told to provide a ranking system on
13 the potential infectious agents as to how they
14 could impact sockeye. So this would be a ranking
15 of impacts, and I basically use this -- in this
16 context I use the term "risk". And Dr. Stephen
17 may want to expand in this as a -- in the field of
18 epidemiology, risk may mean something slightly
19 different.

20 So we're talking about risk as basically
21 potential for impact, and we use that
22 interchangeably in my particular report. The use
23 of the term risk in Dr. Stephen's and other
24 reports may be used a bit differently.

25 And as I outline in here, basically a high
26 risk pathogen would be one that is known to be
27 virulent or pathogenic to salmon in general, and
28 likely pathogenic or documentedly pathogenic,
29 highly pathogenic to sockeye. So that would be
30 one criteria. And the second criteria to fall
31 within the high risk scenario would be as a likely
32 scenario where sockeye salmon in B.C. in general
33 and Fraser River sockeye in specific would be
34 exposed or infected by that. Moderate would be --
35 low, I'll just talk about low risk. Low risk is
36 the opposite. Documented or to be, or based on --
37 documented or suspected to be low, not very
38 virulent, or very unlikely to be infecting sockeye
39 salmon, particularly Fraser River sockeye salmon.
40 And then the midrange would be intermediate to
41 that.

42 And certainly there's a lot of subjectivity
43 in that. These are my -- my rankings. I see that
44 it doesn't fall, that much of the pathogens that
45 I've ranked in the high risk area does not differ
46 much from other recent reports on this -- on the
47 Fraser River sockeye, but I did not basically use

1 these other reports to come up with my ranking.
2 These are mine, done independently. It just
3 clicks it out, well, it's just the way it is, is
4 that it actually matches up with some of these
5 other reports more or less.

6 Q Dr. Stephen, Dr. Kent alluded to you perhaps
7 having a different understanding of the meaning of
8 risk in epidemiology. Could you comment on that
9 as well as how that concept of risk was used for
10 your report?

11 DR. STEPHEN: Well, it's not just in epidemiology, per
12 se, but also in a lot of our environmental impact
13 work, as well as in international trade, risk
14 assessment is fairly well defined as having a few
15 components. One being in fact understanding the
16 acceptable threshold, to judge against your
17 findings to determine if something is acceptable
18 or not. Secondly, to have an adequate or
19 certainly complete understanding of the hazards,
20 in this case the infectious agents that reside in
21 the population, or to which your population of
22 concern would be exposed. The third level, then,
23 of course would be exposure to actually be able to
24 document that the population of concern has been
25 exposed to that hazard. And then finally the
26 capacity for any steps, whether they be management
27 or legislative or otherwise to mitigate against
28 those risks.

29 So we followed that framework for our risk
30 assessment and tried to accumulate information and
31 data around each of those four points to determine
32 if in fact risk could be measured in the hatchery
33 scenario.

34 Q I'd like to turn, please, Dr. Kent back to your
35 report and to first of all on the very first page
36 of the report after, I think, the preface, which
37 is Roman numeral lower case "i", and you'll see on
38 the second or third line, and I'll read it out:

39
40 At present, there are no direct links between
41 a specific pathogen and sockeye salmon
42 survival at a population level in British
43 Columbia.

44
45 You make a comment, and I'll flip on a few pages
46 to page 1 to read this.

47 DR. KENT: Yeah, I agree with that. I do agree with

1 that.

2 Q I thought you might.

3 DR. KENT: Yes.

4 Q Page 1 we'll see that after citing a number of
5 articles, about seven or eight lines down, you
6 write:

7

8 ...there have been only a few infectious
9 diseases that have been shown or implicated
10 to cause significant mortality in wild salmon
11 in British Columbia...

12

13 DR. KENT: That's correct.

14 Q Is it the case if you were describing your
15 research or findings to a non-scientist or a
16 layperson, is there a smoking gun here?

17 DR. KENT: In my opinion, I don't see a smoking gun for
18 the present situation. As I said, there are some
19 pathogens like the *Ichthyophthirius multifiliis*
20 that has been described associated with pre-
21 spawning mortality in sockeye up in the Babine
22 system, et cetera. So there's specific examples
23 where -- where there is, quote, a smoking gun in a
24 particular population. But there at present there
25 is no -- there's no scenario like that for -- for
26 the populations of sockeye salmon that we're
27 looking at in this particular exercise.

28 Q I'll paraphrase to ask this question, but at one
29 level I understand you to really suggest that the
30 conclusion here, if you will, is that the first,
31 rather than the second among these two examples,
32 the conclusion I read you as reaching is that the
33 evidence doesn't show this, but that's different
34 than the stronger conclusion of saying it's not
35 happening. We know that's not the case.

36 DR. KENT: It's option one, yes, that the evidence that
37 there is -- the evidence does not show this, based
38 on the data that we have. No. And so therefore
39 we cannot say that there is not an infectious
40 agent, or other disease phenomenon, and that's
41 kind of an important role in the survival of
42 sockeye salmon, and we just do not have any hard
43 evidence to support that at this time.

44 Q And in the absence of that evidence, how much
45 comfort do you take from it not having been
46 proved, per se?

47 DR. KENT: What do you mean, as (indiscernible -

1 overlapping speakers).

2 Q (Indiscernible - overlapping speakers). Do you
3 have a concern that this may be happening but it's
4 not been proven or documented, per se.

5 DR. KENT: Yes. I think it's worthy of investigation.
6 Simply to not move forward on investigations on
7 the impacts of diseases on salmon, sockeye salmon,
8 because we do not have any firm evidence at this
9 time would not be prudent to do that. So does
10 that clarify my answer?

11 Q I think it does. Dr. Johnson, do you have an
12 answer on that question or on that point?

13 DR. JOHNSON: I would agree with Dr. Kent on that
14 point. But I also suggested there still is a need
15 for us to know exactly what is happening with
16 respect to the pathogens that we already know
17 exist in sockeye salmon, because I don't feel that
18 that's been adequately addressed. So we know that
19 these animals evolved with a variety of pathogens.
20 They could become -- they could carry these
21 pathogens. They can go through their life quite
22 happily carrying these pathogens without disease.
23 We don't know what triggers disease.

24 So I think that if there is to be more work
25 done, it needs to both consider those things that
26 we know, and the possibility that there is
27 something new.

28 Q You make a distinction between carrying a
29 pathogen, but it's not at the point of being a
30 fatal or a disease even, for that matter. That's
31 an important distinction. I wonder if there are
32 misconceptions that you come across with respect
33 to disease. Do people that you -- whether that's
34 within the Department or perhaps even more
35 broadly, are there misunderstandings on how
36 disease operates for salmon?

37 DR. JOHNSON: Well, I don't think it's just for salmon.
38 It's for all animals and human beings, as well.
39 That it's not uncommon to find animals or fish
40 within a population that carry pathogens and they
41 show no signs of disease. However, given the
42 appropriate environment conditions and that, what
43 can become a natural association with a pathogen
44 can become unbalanced and you can see the
45 development of disease. So I guess the take-home
46 message is that the presence of pathogens does not
47 necessarily mean that there will be a disease or a

1 disease outbreak within an individual or within a
2 population.
3 Q Dr. Kent, your report, I think only touches on
4 this briefly. But there's certainly been public
5 concern with respect to the prospect or
6 possibility of the arrival in this province of ISA
7 or infectious salmon anaemia, in particular. I'd
8 appreciate knowing of work you've done on ISAV and
9 also on any comments you have to make with respect
10 to the risk it may present, or the effect it may
11 have if it does arrive for Fraser sockeye.
12 DR. KENT: I have not done -- I've essentially done no
13 research on ISA virus, infectious salmon anaemia
14 virus. I worked on another virus, the salmon
15 leukemia virus that was associated with a disease
16 that in the fish farm community referred to it as
17 marine anaemia, so there's been some confusion
18 between ISA virus, which has been called marine
19 anaemia in other parts of the word, and Dr.
20 MacWilliams could probably expand on that, because
21 she did a lot of work on that.
22 So as far as what we refer to, particularly
23 the ISA virus, a well-defined virus and well-
24 defined disease, to my knowledge has never
25 occurred in British Columbia. It occurs in other
26 parts of the world and can cause a serious disease
27 in salmonid fishes. But to my knowledge at
28 present, and reviewing the documents that were --
29 that I had an opportunity to review, I see no --
30 and testing for ISA virus, I've seen none of that.
31 But I think Dr. MacWilliams can expand on that
32 much more than I can.
33 Q Dr. MacWilliams, I'd ask you to do that, please.
34 DR. MacWILLIAMS: Could you repeat the question,
35 please.
36 Q Sure. I'm looking to have -- well, let me in fact
37 ask you to pick up on a point that was just made.
38 And with respect to ISAV and marine anaemia, are
39 they the same thing or different?
40 DR. MacWILLIAMS: No, they're not.
41 Q Could you explain that, please.
42 DR. MacWILLIAMS: I can't actually tell you much about
43 marine anaemia because I've never worked on that
44 one, and I haven't seen it or diagnosed it.
45 Q And you've worked on ISAV, then?
46 DR. MacWILLIAMS: Yes, I did that during my Master's
47 thesis work. And infectious anaemia virus is --

1 has just been shown to cause natural infections in
2 marine farmed Atlantic salmon. Under experimental
3 conditions they have -- certain labs, including
4 mine, have been able to experimentally infect
5 using a high dose of a very pathogenic strain of
6 the virus and cause disease in other species. In
7 my case it was rainbow trout or *Oncorhynchus*
8 genus.

9 And but work done on Pacific salmon has shown
10 that Pacific salmon are relatively resistant to
11 the disease. You can infect them with a high dose
12 of a strain in very unnatural conditions in a
13 laboratory, and you can -- but most Pacific salmon
14 species, they weren't able to cause disease. They
15 were able to just have application of the virus,
16 but the fish did not actually get sick.

17 So it is important to note that Atlantic
18 salmon are the only species that have ever shown
19 natural infection in a wild environment.

20 Q You refer to work having been done for Pacific
21 salmon. Do you know if that includes sockeye
22 particularly, or which species were used for that
23 work?

24 DR. MacWILLIAMS: I can't confirm sockeye has been
25 worked on, no.

26 Q Okay. Let me move, Dr. Kent, I'd like to have Mr.
27 Lunn bring up pages 19 and 20 of your report. And
28 just to first, we've made a correction to the
29 second of those two pages, page 20, where I
30 suppose something was overbilled, *Cryptobia*
31 *salmositica* was given a "Severe" but that was
32 really a typo. Dr. Kent, you in your report, in
33 the text of your report placed it in the moderate
34 category.

35 DR. KENT: Yes, that's correct.

36 Q All right. And we've entered a document to that
37 effect. You've also described the risk level that
38 you've used for this report. It is, and I think
39 your answers suggest that you are being modest in
40 acknowledging that there's some limitations or
41 there's an in-built subjectivity to this kind of a
42 ranking system. It's very helpful as a talking
43 point but of course this can't be the final word
44 on the risk level forever and ever with respect to
45 Fraser sockeye; is that the case?

46 DR. KENT: Yes, certainly.

47 Q Are there challenges to ranking chronic or sub-

1 lethal diseases?

2 DR. KENT: Yes. The challenges would be, I think I can
3 kind of follow up on what Dr. Johnson was just
4 talking about. I would only see three categories
5 of the impacts of pathogens. One would be
6 basically almost commensal, with very little
7 impact at the host level and maybe no, often no
8 impact at a population level. So talking about
9 the host and individual organism then, we're
10 really -- we're not too concerned about one salmon
11 dying from a disease. We're talking about impacts
12 at the population level. So let's talk about it
13 at both of those levels.

14 So you could have no impact at a population
15 level, and at a host level or an individual level
16 and a population, and you could have some that are
17 -- that may be an acute virulent disease that
18 would be -- cause a severe impact on an individual
19 level, but the prevalence of that pathogen is so
20 low that it's not really impacting the population.

21 Let's talk about chronic diseases. So as
22 many of these chronic infections, parasites often
23 fall into this, the chronic diseases like
24 bacterial kidney disease, many animals are
25 infected at a low level with these, or if you look
26 at them histologically, you did a pathology
27 examination, you would find that, yes, there are
28 lesions. How is that, but the fish appears
29 totally healthy, and that fish may live its entire
30 life healthy.

31 But there can be other, and this is the line
32 of work that we do in our lab is looking at other
33 endpoints other than just the fish appearing
34 morbid. Do they grow, do these chronic infections
35 slow their growth or affect smoltification? Other
36 studies look at the effects of chronic infections
37 on fecundity, the number of eggs that are
38 produced, so how it affects spawning.

39 So there's a lot of these indirect impacts of
40 these chronic infections that if they are
41 prevalent can impact a fish at a population level,
42 but that an individual level they seem like
43 they're not really causing much problem, because
44 the fish would appear totally normal.

45 Was that probably it's a kind of a convoluted
46 answer, but that's some of the challenges of
47 chronic infections is that they may have other --

1 the term "chronic", that means the fish is going
2 to be infected with this particular pathogen its
3 entire life and maybe at some stage in its life,
4 it could actually have an impact on its survival.

5 Q Dr. Johnson.

6 DR. JOHNSON: I would like to just add that with
7 respect to a chronic infection, a good example
8 from sockeye salmon may be *Myxobolus arcticus*,
9 which is a parasite which resides in the brain of
10 most if not all Fraser River sockeye salmon.

11 Q Mm-hmm.

12 DR. JOHNSON: And studies out of Alaska done many years
13 ago have shown that in situations where this
14 parasite in the brain is very abundant, although
15 the fish look normally healthy outside, they do
16 see that there's some level of reduced swimming
17 performance. So that would be, I think, a good
18 example of a chronic disease of sockeye salmon.

19 And just to add a bit onto Mike's commensals,
20 it could be commensal or opportunistic. There are
21 things within the environment that normally don't
22 cause disease in fish, which under -- given bad
23 enough conditions for the fish can become a
24 problem, and I can't think of a good example
25 offhand, but I would say probably some of the
26 fungi that occur naturally within the environment.

27 Q What does "commensal" mean?

28 DR. JOHNSON: Well, I would say commensal is living in
29 association with but not -- I don't know the
30 proper parasitological definition offhand, but
31 probably living in association with but not
32 necessarily causing a great deal of harm. I mean,
33 just through the association there is some harm or
34 damage or some cost to the host. So it's not a
35 benign relationship.

36 DR. KENT: Yeah. Well, I guess we would often think of
37 commensals as living happily together, you know,
38 and basically a bacteria in our gastrointestinal
39 tract would be a good example. They're living off
40 some of our nutrients that they're considered --
41 that we're eating, but at the same time they're
42 not causing severe disease. And that's what Dr.
43 Johnson was trying to think of an example, there's
44 many examples in human medicine. Many of us are
45 aware of the infection called *Giardia*, giardiasis,
46 where lots of people are infected with it, and
47 basically are totally normal. So those people

1 with that particular organism the *Giardia* organism
2 that you get when you're camping, et cetera, would
3 be a commensal. And then under certain
4 circumstances, many of them are unknown, the
5 genetic predisposition of that person, or having
6 some other underlying stress or disease, they
7 could flip over it and become a pathogen and
8 actually cause detriment to the host.

9 Q Dr. Kent, is there, when you describe these
10 limitations on the research and the knowledge --
11 and our understanding on some pathogens, is there
12 a potential that one of these that may be put in a
13 low risk category here is put in the low risk
14 because of the lack of information about it, as
15 opposed to saying that you've reached a conclusion
16 that's simply not of concern.

17 DR. KENT: It's the lack of information, and I could
18 just kind of pick some of these low -- I'm just
19 looking right off the top of these tables, like
20 VEN, the viral erythrocytic necrosis virus. I
21 don't -- that's been known for a long time. It's
22 supposed to cause -- I mean, it's recognized as a
23 pathogen in herring. Salmonids are susceptible.
24 My work with salmonids, I've never seen any severe
25 disease caused by it, but no one has been out
26 looking at -- to my knowledge, and maybe Dr.
27 Johnson and others can expand on that.

28 But doing blood smears on wild-caught sockeye
29 and, I mean, we're doing that and this infects the
30 blood cells. And suddenly you saw a very high
31 prevalence and a severe -- high prevalence, lots
32 of animals infected, and then it's a severe
33 infection, that would mean high levels of
34 erythrocyte blood cells infected, you'd say well,
35 this would jump out of the low category and be put
36 into the -- to the high category. And what I mean
37 by high category, it's not proven to be that, and
38 it would be high on the priority to do further
39 investigations on what that particular pathogen
40 was doing to the host at -- both at an individual
41 level and at a population level.

42 So a lot of these low organisms are ones that
43 are not known, are not documented to be virulent,
44 but that doesn't mean that they have been shown
45 not to be, with experimental studies, that they
46 have not been empirically shown not to cause
47 disease.

1 And particularly as other colleagues have
2 mentioned, under a certain environment, because
3 then you'd want to be more particularly interested
4 in my understanding is what's going on in the
5 marine environment. So you'd have to do these
6 challenge studies in the lab with a marine -- a
7 marine phase fish, and sockeye. And frankly,
8 because sockeye salmon are not reared a lot in
9 captivity, most of the work done in lab studies
10 have been done with other species than sockeye
11 salmon.

12 Q Dr. Johnson, you nod to that last point at least?

13 DR. JOHNSON: Yes, I agree with that, and I think
14 Mike's point that even these pathogens which are
15 in his low risk category, under the appropriate
16 environmental condition, food limitation, or
17 whatever, has the potential to cause disease
18 within an individual and possibly within
19 populations.

20 Q Maybe I can now move through some of the specific,
21 and I'll be addressing, I think there's a total of
22 six pathogens or diseases Dr. Kent, that you
23 ascribed or put in the high risk category; is that
24 right?

25 DR. KENT: I can't recall, but I mean that sounds about
26 right, as far as the number that I put into that
27 category.

28 Q Okay. Well, hopefully my counting was okay.
29 Let's move through with first of all, IHN.

30 DR. KENT: Okay.

31 Q Infectious hematopoietic necrosis virus?

32 DR. KENT: Yes.

33 Q And for all of these, I'll just simply add what I
34 won't be doing here is trying to have you explain
35 the life stage, where whether in marine or
36 freshwater, where these pathogens may be located
37 or found, and so on. That's set out in your
38 report. I wonder if I might pick up on the
39 question of IHN by using, Mr. Lunn, a different
40 document - so we can perhaps keep this on deck,
41 I'll certainly be coming back - number 11 on our
42 list of documents.

43 And I think, Dr. Johnson, I may in fact ask
44 these questions of you. You'll see Kyle Garver's
45 name is there. He's coming later this week. But
46 he works for you, Dr. Johnson, and I may be taking
47 a shortcut, but I'd like to ask you. I take it

1 you're familiar with this document, and indeed may
2 have been involved in it?

3 DR. JOHNSON: Yes, I'm familiar with the document and I
4 was somewhat involved with it.

5 Q All right. What is this document in brief?

6 DR. JOHNSON: This is a document that Kyle was asked to
7 put together for a workshop that was held by the
8 Pacific Salmon Commission. I didn't attend the
9 workshop myself. But he was asked to sort of
10 discuss what pathogens are known to affect sockeye
11 salmon and to provide a bit of insight into some
12 of the longer-term studies that they've been doing
13 on sockeye salmon for specific pathogens.

14 Q It says at the top: "Hypothesis: Diseases in
15 freshwater and marine systems are an important
16 contributor to the Fraser sockeye situation".
17 That's really posing the question as opposed to
18 giving the answer. Is that a fair description?

19 DR. JOHNSON: Well, I think that this is providing
20 information that could be related to that
21 hypothesis.

22 MR. MARTLAND: I'd like to ask this be marked as the
23 next exhibit, please.

24 THE REGISTRAR: Exhibit 1456.

25

26 EXHIBIT 1456: Garver, Hypothesis: Diseases
27 in freshwater and marine systems are an
28 important contributor to the Fraser sockeye
29 situation, June 2010

30

31 MR. MARTLAND:

32 Q If we look at page 3, we're speaking about IHN
33 prevalence rates. And I'd like to, if Mr. Lunn's
34 able to bring up those two graphs that are in the
35 figure on the upper left-hand side. He's very
36 adept at zooming in and out, so I know we'll have
37 those there. With respect to those prevalence
38 rates that are set out, first of all, Weaver Creek
39 and Nadina River are both spawning channels; is
40 that right?

41 DR. JOHNSON: I know that Weaver is, and, yeah, Nadina
42 is also a spawning channel.

43 Q All right. And Dr. MacWilliams, I'll just
44 confirm, do I have that right?

45 DR. MacWILLIAMS: That's correct.

46 Q Thank you. This document suggests first of all
47 that we see very different bars, if you will,

1 reflecting the different years, and the prevalence
2 rates over time of IHNV. That seems to suggest,
3 first of all, significant variability year-to-
4 year; is that fair?

5 DR. JOHNSON: Yes. The graphs do demonstrate the
6 highest amount of variability between year-to-
7 year. The other thing these graphs demonstrate is
8 that there's not always a good relationship
9 between the prevalence of IHNV in adults and the
10 -- in the fry that came from those adults. So it
11 just shows that it's very difficult to predict,
12 based on IHN levels in the adults whether there'll
13 be any IHNV detected in the fry.

14 Q It also would seem to be, and I appreciate these
15 may be two snapshots as opposed to running film,
16 but it would seem to be that from these snapshots
17 of understandings we see potentially very
18 different pictures in a given year as between
19 those two spawning channels. I think the best
20 illustration is the earliest years, which would be
21 about 1988 or so.

22 DR. JOHNSON: Yes.

23 Q Quite high levels at Weaver Creek and relatively
24 lower at Nadina.

25 DR. JOHNSON: Yes. And I think that this is what you'd
26 expect to find if you were to go out and monitor
27 wild populations, a high level of variability
28 depending on where you collected the fish, and
29 very high levels of variability between years.

30 Q And at a broad level would you offer your view on
31 what sorts of insights or broader conclusions we
32 can draw from these, I used the word "snapshots".
33 I don't know if you'd agree that's the way to look
34 at this. But is this something that we can
35 transpose or extrapolate out to a broader
36 understanding of Fraser sockeye?

37 DR. JOHNSON: As I said, I think this really points out
38 a lot about the actual difficulties that we would
39 face if we tried to do a more complete assessment
40 of Fraser River fish, rather than -- it shows that
41 based on the way this monitoring program has been
42 conducted, is that we can't predict whether the
43 fry will have high or low levels of IHNV based on
44 the adults that have returned, their condition.
45 So I think it's better to be used as a point, and
46 I think the point that Kyle was making in this
47 paper was that there's high level of variability

1 between these two systems, and a high level of
2 variability between years just illustrates how
3 difficult it is going to be to get a handle on
4 pathogen loads within the various stocks of Fraser
5 River sockeye salmon.

6 Q And I wonder to complete this picture with respect
7 to IHN, there's a new document that was not on
8 our list of documents, but it was received in the
9 recent production by Canada, the CAN number is the
10 Ringtail number, it's described from Canada's
11 production 490137. And in fact, Dr. Johnson, this
12 morning I asked you, I showed you this document
13 just to confirm, and I think what you'll see, and
14 I'll -- Mr. Lunn will be finding that document in
15 a moment. But as he goes to it, I think what it
16 may give us is the IHN prevalence -- IHN
17 prevalence rates, again for Weaver and Nadina, but
18 also adding the more recent results, including
19 from 2010.

20 DR. JOHNSON: And I think if I remember -- oh, there's
21 the graph. Sorry. Yes. This is the actual data
22 on which that original document was -- the
23 original document was actually written from this
24 data.

25 Q Mm-hmm.

26 DR. JOHNSON: Again what it shows is that within any of
27 these systems, including the Okanagan River, which
28 of course isn't part of the Fraser River, but the
29 prevalence of IHN in adult sockeye can range
30 widely from, you know, zero percent up to, I don't
31 know, what's the highest, 52 percent in some
32 years. And there's really no discernible pattern
33 over time.

34 Q Is that an alarming number, 52 percent, or does
35 that simply -- we need to -- it strikes me that
36 the most recent number is the highest. But it
37 doesn't, as you suggested, perhaps it just simply
38 confirms the unpredictability.

39 DR. JOHNSON: 1987 had 38 percent. I think that all of
40 these field studies are going to be somewhat
41 influenced by the time that when these samples
42 were collected. So, I mean, these studies have
43 been done year after year. They go on a field
44 trip to the river, and the field trip is, you
45 know, timed to try to capture the same portion of
46 the run every year. But basically some years the
47 fish are early, some years they're late, and so

1 you may be capturing -- it's not to say that these
2 prevalences are set in stone. So if you go and
3 the fish have just arrived on the spawning
4 grounds, you may find ten percent. If you go back
5 after they've spawned, or just prior to their
6 spawning, that could have increased, or it could
7 have decreased, if those individuals that are
8 carrying the virus fell out of the population.

9 So I think that there is a bit more
10 variability there in with respect to what time
11 these fish are actually sampled.

12 MR. MARTLAND: Before I forget to do it, Mr. Registrar,
13 if I might ask this be marked as the next exhibit,
14 please.

15 THE REGISTRAR: Exhibit 1457.

16
17 EXHIBIT 1457: IHNV prevalence rates in
18 Fraser River sockeye salmon data, undated
19

20 DR. KENT: I could expand on what Dr. Johnson just
21 said. And we're conducting a study on pre-
22 spawning mortality in chinook salmon on the
23 Willamette River down in Oregon, and we see
24 dramatic differences in pathogen burden based on
25 how long the fish have been in the river, and
26 therefore that reflected on that would be what
27 time of the season en-route migration or even at
28 -- that the fish were examined.

29 So I just would have to agree with what he
30 was saying there, that not only variation in year,
31 these variations could be described by geographic
32 differences, but also I think that's a very
33 important point, about the time of the run that
34 the fish are looked at. And you say, well, we're
35 going to try to deal with that situation by
36 collecting the fish on September 1st, or whatever
37 every year, but then the problem is the runs vary
38 from year to year. And so it may be late in the
39 run or early in the run, depending on the year.

40 Q Is it the case, Dr. Kent, that not much is known
41 about -- we have some information from Weaver and
42 Nadina, but beyond that we have an absence of
43 information or data about other sockeye spawning
44 areas?

45 DR. KENT: That's my understanding. I think others
46 from DFO might be able to expand on that, but
47 there is limitations, that's one concern, but then

1 also if we get back to the marine environment,
2 there's very limited information on how -- we're
3 talking about the impacts of IHN on fry fish and
4 relationship to spawning adults. I mean, maybe
5 take a step back a little bit, is that the virus
6 is known to be maternally transmitted, and that's
7 why there's a lot of work looking at correlations
8 between disease in the fry of the following year
9 correlating with brood stock. As Dr. Johnson
10 pointed out, these correlations do not -- do not
11 hold up, and this has been well-recognized for a
12 long time.

13 I understand that there is some new
14 information on well, basically what we -- if we
15 talk about IHN as a potential impact on the marine
16 -- fish as they are in the marine phase, there's
17 been some transmission work that was run by Garth
18 Traxler, a former DFO scientist, and others
19 showing that the larger sockeye salmon when
20 they're in the marine environment are much less
21 susceptible to the IHN virus. But I understand
22 that there's -- that there's some variability in
23 the strains of IHN and that some of them may be
24 more pathogenic to the marine phase salmon. But
25 that's new information that's not been published,
26 and so I can't really expand much more on that in
27 that area.

28 Q Dr. Johnson, yes.

29 DR. JOHNSON: Yes, I'd like to just make one point
30 there. There's only, as I understand, one
31 genotype of IHN in sockeye salmon in British
32 Columbia. These other studies which have used
33 these other genotypes was in a laboratory study,
34 so these are not naturally occurring genotypes. I
35 may stand corrected on that. There also has been
36 some studies on Alberni Inlet sockeye salmon, on
37 IHN studies there. But those have been somewhat
38 limited, and were conducted quite a while ago.

39 Q If we move back to the Technical Report 1, you'll
40 see in the high risk notation is given, if we move
41 down that page a little, under "Bacteria" to
42 "Vibrio", and under that "Aeromonas", which I
43 mispronounced earlier, which causes furunculosis.
44 Dr. Kent, do you have any comments beyond what's
45 set out in your report about those two bacteria
46 and their potential to have a significant effect
47 on Fraser sockeye?

1 DR. KENT: I put *Vibrio Anguillarum*, cause of vibriosis
2 in the high risk category, because -- potentially
3 high risk category, because we know that it's
4 ubiquitous in the marine environment and under
5 certain conditions it can be highly pathogenic.
6 To my knowledge there's been very little work on
7 survey of *Vibrio* in post-smolt sockeye, that's
8 sockeye that have just recently entered seawater.
9 Other species of salmonids they have found it in.

10 So it is one of potential -- it's generally
11 thought in the scientific community that *Vibrio* is
12 associated with environmental -- the prevalence of
13 the bacterium in the ocean is associated with
14 environmental conditions, and then the fish being
15 stressed. Those two combinations together would
16 result in a high level of disease in them. And
17 fish are going through a fair amount of stress
18 when they first go from seawater -- freshwater to
19 seawater as smolts. So that's why I put that one
20 in the high category.

21 *Aeromonas salmonicida*, the cause of
22 furunculosis, well-recognized as an important
23 disease in captive fishes, and highly pathogenic,
24 that's why we would put it, and, you know, that
25 would be one that would, if it occurred, if the
26 pathogen occurred in sockeye salmon, in my
27 opinion, it would be likely to cause significant
28 disease.

29 I'm not aware of any experimental studies
30 done with sockeye with this bacterium, but I'm --
31 based on what we know on the historical
32 specificity and ability to cause severe disease in
33 a number of salmonid species, I would suspect that
34 sockeye salmon would be highly susceptible to it.

35 Q Dr. Johnson.

36 DR. JOHNSON: I'd just like to add a little there.
37 It's not that people haven't wanted to do
38 experiments with sockeye salmon, they just happen
39 to be extremely difficult to maintain in the
40 laboratory. And that's a key thing with the
41 laboratory studies is that when you're taking
42 these animals, a wild animal, out of their natural
43 environment, putting them into the laboratory,
44 introducing them to a foreign food source, then
45 you've got to wonder what -- what effect is this
46 having on their stress level and how does this
47 impact your results.

- 1 I guess the other problem with sockeye is
2 they often have IHN, which when you bring them
3 into the laboratory can cause problems in the
4 laboratory environment, just simply through the
5 stress of them being taken from the river and then
6 contained in tanks.
- 7 Q Let me turn now to BKD, if you see at the bottom
8 of that page 19, *Renibacterium salmoninarum*, which
9 I think I read as *R. sal*, is that shorthand for --
- 10 DR. KENT: Sure, that's fine.
- 11 Q All right. That's going to be easier for me. So
12 I may use that and perhaps shouldn't be using BKD.
13 which is in fact the disease caused by that
14 bacteria, if I have that right.
- 15 DR. KENT: That's right. The disease is called
16 bacterial kidney disease, and we refer to it as
17 BKD, and the bacterium that causes it is *R. sal*.
- 18 Q In your report you make reference to sockeye being
19 particularly vulnerable to *R. sal*, and as it
20 causing acute to chronic severe systemic disease
21 which can result in death between weeks and months
22 following infection.
- 23 DR. KENT: That's correct.
- 24 Q Dr. MacWilliams, you have dealt with BKD in the
25 context of work on salmon enhancement facilities.
26 I may return to discussing that more when we move
27 to Dr. Stephen's report, as well. Do you have
28 comments on the immunological impact and the
29 increasing disease susceptibility in surviving
30 fish from *R. sal*?
- 31 DR. MacWILLIAMS: In my experience *Renibacterium* more
32 likely causes a chronic progressive lifelong
33 infection that gets worse over time. The bacteria
34 is very slow growing in culture and in my
35 experience it is also slow growing within a
36 population from the exposure and infection, it can
37 take months before you'll actually see any
38 clinical signs of disease with this pathogen.
39 When you do see signs of disease it can be causing
40 acute mortality at that point, but the chronic,
41 slow developing nature is part of this pathogen.
- 42 I'm, sorry, I forget the rest of the
43 question.
- 44 Q No, that was -- that covers me some distance. I
45 wonder if I could ask --
- 46 DR. MacWILLIAMS: Oh, sorry.
- 47 Q Go ahead.

1 DR. MacWILLIAMS: I remember. Part of it also is
2 because *Renibacterium* actually infects the host's
3 immune cells, having this as a concurrent -- or a
4 concurrent infection can make any animal, any fish
5 more susceptible to other diseases, because it's
6 kind of modulating its immune response.

7 Q And you in your answer described it from your
8 experience. Maybe you could just help us
9 understand, where is it that you're seeing *R. sal*,
10 and what's the context? How is it, can be seen,
11 so to speak?

12 DR. MacWILLIAMS: Well, it's an endemic pathogen in
13 British Columbia in all Pacific salmon species.
14 So we pretty much see it everywhere.

15 Q And is it in the context of work on hatcheries and
16 salmon enhancement facilities that you were coming
17 across it in your work?

18 DR. MacWILLIAMS: Yes, we see it in enhancement
19 hatcheries, we see it in the research stocks that
20 are derived from wild populations, we see it in
21 wild fish kills, oftentimes it's detected as an
22 incidental finding if there is another cause of
23 disease, but it can be a primary pathogen, as
24 well.

25 Q Mr. Lunn, if we move back to Dr. Kent's report in
26 about the middle of page 20, under the "Protozoa",
27 Dr. Kent, you list *Ich*, which you've said in full,
28 and I won't try and do so, but it's also known as
29 white spot disease. We see that is listed as a
30 high risk pathogen. I think you indeed singled it
31 out earlier, and I wonder whether is that pathogen
32 a particular concern for Fraser sockeye?

33 DR. KENT: It would be a concern --

34 Q I'm sorry, and your microphone, thank you.

35 DR. KENT: I'm sorry. It would be a particular concern
36 as a cause of en-route and pre-spawning mortality,
37 adult fish coming back and it's been documented by
38 Dr. Traxler and a few others to actually be
39 associated with severe disease in fish that have
40 returned to freshwater spawn. It would not be a
41 problem in the marine environment at all, because
42 actually that's a treatment that they use for
43 treating this parasite is salt, so this would not
44 even be on the radar as far as a cause of disease
45 in the marine environment. But certainly when
46 waters are the right temperature, around 15 to 20
47 degrees, that this parasite can cause devastating

1 mortality when fish are in a rather confined
2 situation such as when they come back into spawn
3 and spawning channels in close proximity to each
4 other.

5 MR. MARTLAND: Mr. Commissioner, we're getting close to
6 the break time. I wonder if I might close off on
7 the last of the six high risk category pathogens
8 and then suggest we move to break, if that's
9 agreeable.

10 Q With respect, Dr. Kent, if I could take you to
11 page 15 of your report, and the second and third
12 paragraphs are discussing *Parvicapsula*, which is
13 again listed in the high risk category. We see
14 under that "Risk. High" paragraph, you make the
15 comment that:

16
17 ...this is one of the few pathogens that have
18 been documented to occur in a high prevalence
19 in Fraser River sockeye salmon.
20

21 Then just to step back one paragraph, you make the
22 comment that:

23
24 DFO had an active research program
25 investigating this parasite in sockeye salmon
26 until around 2003/2004. At this time, sea
27 lice became a major concern in the Province,
28 and fish health research efforts were
29 diverted from [*Parvicapsula*] to study sea
30 lice.
31

32 DR. KENT: That's correct.

33 Q Is there -- when there's a diversion of efforts,
34 is there a sense in which that may reflect whether
35 it's public interest or political interest, or the
36 allure or appeal of addressing particular
37 concerns? Is that part of in your view what's...

38 DR. KENT: All of the above, and I can say with working
39 for 12 years -- 11 years with DFO, and there's a
40 frustration with scientists in that they'll be
41 working on a project and it does not come to
42 completion or significant progress because of
43 pressure from political reasons and others that
44 scientists - when I was there, maybe things have
45 changed now - are directed to with their limited
46 resources redirect their resources to the, if I
47 should say, the disease of the day that has become

1 popularized in the media. And so that that's my
2 -- what I, as you see here, this is I conducted a
3 one-day interview in December with various
4 scientists at DFO and this is my interpretation
5 from the interview with Dr. Jones on why the work
6 was not continued with *Parvicapsula*. They had
7 some excellent work going on with that and then I
8 saw that it didn't continue on from the early --
9 from about ten years ago.

10 Q Dr. Johnson, I wouldn't have thought this to be
11 the case, but do some fish diseases have sex
12 appeal? Do sea lice or their...

13 DR. JOHNSON: Do sea lice have sex appeal? No. I'm
14 just going to add a little to that. There have
15 been papers published after that and Dave
16 Patterson and that have continued to work on
17 *Parvicapsula*, especially as how it affects host
18 physiology. So I wouldn't say that DFO was out of
19 it. Simon had a program where they were observing
20 for it in rivers. The more they looked, the more
21 they found. And at that time sea lice became a
22 concern as expressed by a variety of different
23 groups within British Columbia.

24 I guess in support of my group, one of our
25 main roles is to provide science-based advice for
26 managers. And so we have to be somewhat
27 responsible to questions which are posed to
28 managers, and that can have an impact on, you
29 know, longer term research programs.

30 So in the case of when sea lice were
31 identified as a potential issue on wild fish,
32 there was money made available that was outside of
33 our program, and every people, such as Simon and
34 myself when I came, took advantage of that money
35 to provide this advice.

36 Q You mentioned Simon, I'll just for the sake of the
37 record confirm you're speaking about Simon Jones.

38 DR. JOHNSON: Yes, Dr. Jones, sorry.

39 MR. MARTLAND: I don't mind the informal, but I just
40 want to be clear who we're speaking about. Mr.
41 Commissioner, if I might suggest we move to the
42 break.

43 THE COMMISSIONER: Mr. Martland, just before we do, I
44 wonder if I could just ask just a couple of brief
45 questions following on the answers that the panel
46 has given this morning.
47

1 QUESTIONS BY THE COMMISSIONER:
2

3 Q And this may be a complete non sequitur and you
4 can certainly be frank with me and tell me if I'm
5 in another realm. But in the human or mammal
6 world or animal world, we hear of disease sweeping
7 through a population, it might be SARS or some
8 other kind of let's call it epidemic that comes
9 and goes. And we hear from the health officials
10 that we're okay now: it came, we've dealt with
11 it, it's gone. Within the populations of fish
12 that you're addressing, could it be that a disease
13 would come and go in that way to a population
14 without the scientists being aware of that
15 happening, or would there always be telltale signs
16 of that kind of experience having happened, so
17 that you could then determine whether more
18 research needs to be done.

19 The other question I have for you is whether
20 the research you've been explaining, that needs to
21 be done, would have to be done on all salmonids in
22 order to make some sense out of what is happening
23 to a particular population, for example, sockeye.

24 DR. KENT: I can respond, and then maybe my colleagues
25 might want to add to it, and particularly your
26 first question, Mr. Commissioner. You bring a
27 very -- the analogy certainly could take place
28 where a disease could sweep through a population.
29 In humans we could almost -- it's more confined
30 and generally we don't -- so that humans are a
31 little bit more confined. But the big problem,
32 the big difference would be is if it's a disease
33 like an acute viral disease, devastating viral
34 disease swept through a population, we'd have
35 dying humans, or sick humans at the hospital that
36 we could document this.

37 Unfortunately in the ocean when a fish dies,
38 it just disappears. And so we don't have the
39 opportunity, particularly with salmonids in the
40 ocean, to find dying fish. They're just not
41 available. We have these phenomena like the VHS
42 virus, there's a viral disease that has swept
43 through the Great Lakes. In a confined lake
44 they're able to document actually dying fish.
45 Dying sockeye salmon out in the ocean would be
46 very difficult to encounter. In fact, you could
47 have, in my opinion, you could have conceivably

1 very large numbers of fish dying, due to a new
2 viral disease or other pathogenic phenomenon, and
3 not detecting it. That's my -- like, that's
4 basically my thoughts on that, and probably my
5 colleagues might have something else.

6 DR. JOHNSON: No, I generally agree with what Dr. Kent
7 just said. There have been occasional IHNV
8 outbreaks and other parasite outbreaks in sockeye
9 stocks, which when they've occurred in freshwater
10 and especially occurred in association with
11 spawning channels where we have people actually on
12 the ground, that they've been actually able to
13 document them. But even in the freshwater
14 environment when we have, you know, the Fraser
15 River watershed the size of Germany, there's a lot
16 of places which are terribly inaccessible, and we
17 simply don't have the people on the ground to make
18 those sorts of observations.

19 DR. STEPHEN: I think, Mr. Commissioner, you've brought
20 up a very important point to recognize that there
21 are analogies to things like SARS. And I think
22 I'd get you to reflect on mad cow disease, bird
23 flu, and wearing my public health hat, our
24 capacity to predict precisely when a human
25 epidemic is coming is pretty bad. I mean, BSE,
26 mad cow was going to wipe us all out, if you
27 recall, then we had very few human cases. Even
28 our early models of HIV were very wrong, and this
29 is in a situation where we have excellent data on
30 a large number of people, with tests and all those
31 sorts of things, and the public health response is
32 beginning to abandon this concept of prediction to
33 this concept of readiness and resilience, and how
34 do we in fact forecast the unforecastable in an
35 area we have a lot of money and a lot of data.

36 So when we add the challenges that have been
37 brought up this morning with salmon, our capacity
38 to identify specifically it will be this stream
39 this year is very limited. To find general causes
40 that might make a population more susceptible to
41 disease, we can talk in those generalities. But
42 prediction is very challenging in a population
43 that is under very little oversight and watching.

44 DR. JOHNSON: And I'd then follow up on your second
45 question, Mr. Commissioner. So we can learn lots
46 from research done on other salmonid species. So
47 we can learn a lot of very general things about

1 fish. We can learn what is the nature of their
2 stress response, how do they respond to elevated
3 water temperatures. But we would need to do these
4 particular studies on sockeye salmon to actually
5 set the limits of their tolerance. So I think we
6 could learn lots and we can learn lots about how
7 even from Atlantic salmon, how they respond to
8 pathogens, what immune system functions are up-
9 regulated when they're challenged with BKD. And
10 those should probably be the same in sockeye
11 salmon. So we can learn very basic things. But
12 for a particular -- for sockeye salmon and even
13 probably for different populations of sockeye
14 salmon, we would really need to actually do these
15 studies on those fish.

16 THE COMMISSIONER: Thank you very much, Mr. Martland,
17 and thanks to the panel for those answers. Thank
18 you.

19 MR. MARTLAND: I wonder if I might suggest if we're
20 able to do a ten-minute break to hold to our
21 schedule, I'd appreciate that. Thank you.

22 THE COMMISSIONER: Certainly, thank you.

23 THE REGISTRAR: The hearing will now recess for ten
24 minutes.

25
26 (PROCEEDINGS ADJOURNED FOR MORNING RECESS)
27 (PROCEEDINGS RECONVENED)

28
29 THE REGISTRAR: Hearing is now resumed.

30
31 EXAMINATION BY MR. MARTLAND, continuing:

32
33 Q Thank you. Dr. Kent, we were looking through your
34 report and I don't have any particular part to go
35 to within the report, but I wonder if you could
36 touch on -- indeed, I wonder if I should do this.
37 Let's go to page 7 of Dr. Kent's report, please.
38 And you'll see that there's reference to what's
39 titled "The Putative Novel Virus" which describes
40 Dr. Kristi Miller's, who's going to be testifying
41 later this week and her work with respect to what
42 I take to be termed the mortality-related
43 signature.

44 Dr. Kent, I wonder if, as I say to you, to
45 preface this we'll be hearing from her and
46 learning much more about her work. Could you
47 comment from your point of view as you go through

1 this subjective risk analysis for Fraser River
2 sockeye for a host of different pathogens or
3 diseases, where does Dr. Miller's work on this
4 mortality-related signature fit in or does it fit
5 in?

6 DR. KENT: Well, it doesn't really fit in because my
7 directive was looking at infectious agents and
8 this is a host response. I think I -- a simple
9 analogy would be if you found a -- you're looking
10 at a certain lesion or change, I know that there's
11 -- looking at recent documents they're starting to
12 get some evidence of a parvovirus as associated
13 with this infection, but at the time that I
14 prepared this document it was very -- it really
15 didn't pertain because this is looking at a
16 pathological change, if you will.

17 Now we used to do pathology more by looking
18 at histological changes in the organs, but now we
19 have these molecular methods and this would be, in
20 my opinion, somewhat equivocal to that of Dr.
21 Miller-Saunders and her colleagues are equating a
22 certain type of pattern and gene expression that
23 has been known in the literature to be associated
24 with a virus disease. So this is indirect
25 evidence. It's not really direct evidence of a
26 pathogen based on the data that I was able to
27 review and so it really kind of fits outside of
28 the box and that's why I put this as unknown.

29 Q Dr. Johnson, from your point of view, do you have
30 a perspective on -- or view on where this research
31 fits in with other research?

32 DR. JOHNSON: Well, Dr. Miller's research, the Fish
33 Health Group has been providing samples for her
34 research from 2010 and 2011 survey work. I'm not
35 going to speak to Kristi -- Dr. Miller's research,
36 mostly because I'm only familiar with it as what's
37 been presented to us at staff meetings and that so
38 I'm not intimately familiar with what her
39 laboratory group has been doing.

40 Q Number 14 on our list of documents, Dr.
41 MacWilliams, I'd like to ask you about this,
42 please. I won't spend time going through this
43 document but I take it this is a document that you
44 authored, Dr. MacWilliams, that really addresses
45 Dr. Miller's work on this mortality-related
46 signature; is that correct?

47 DR. MacWILLIAMS: Yes, it is.

1 Q Do you know when it dates to, either specifically
2 or generally?

3 DR. MacWILLIAMS: It was early in 2009 and it was the
4 first that I'd seen anything of Dr. Miller's work
5 and it was a research summary that was in response
6 to the Fraser River sockeye declines.

7 Q Was this document provided to Dr. Miller? Or did
8 you provide it to Dr. Miller?

9 DR. MacWILLIAMS: I don't know. I forwarded it to Mark
10 Saunders and I don't know if she has seen it or
11 not.

12 Q And what was the purpose of this document?

13 DR. MacWILLIAMS: I was just from my perspective as a
14 veterinarian asked -- pointing out areas where
15 some of the interpretations being made and the
16 assumptions being made were perhaps speculative or
17 perhaps -- I thought some of the interpretations
18 were over-reached and that just some more caution
19 in experimental design should have been done.

20 MR. MARTLAND: I'll ask this be marked, please, Mr.
21 Registrar, as the next exhibit.

22 THE REGISTRAR: Exhibit 1458.

23

24 EXHIBIT 1458: MacWilliams, Update on Science
25 Review 2009

26

27 MR. MARTLAND:

28 Q On the topic of sea lice, Dr. Kent, in your report
29 where does sea lice fit in? Was it something that
30 you looked at or didn't?

31 DR. KENT: I did look at it some. I saw from the
32 reviews of my document -- of this report that I
33 prepared that others -- some people wanted me to
34 expand on that a lot -- much more. There's a lot
35 of papers out there. It's a very controversial
36 issue as far as the impact of sockeye -- of sea
37 lice on wild salmonids in B.C. and particularly
38 pink salmon.

39 I put this as a lower priority. The main
40 reason, you know, subsidate it, when you say
41 we're doing this subjectively and deciding which
42 disease we're going to emphasize and not, I could
43 have filled this whole report based on the time
44 and allocation that I was given just on the
45 discussion of sea lice.

46 Some work that's been done at DFO
47 demonstrated that the sea lice are most damaging

1 to fish smaller -- for smaller fish and the
2 sockeye go out in the ocean at somewhat - maybe my
3 colleagues can correct me on that - I think
4 somewhere around eight or ten grams, at a size
5 when they would be much more resistant to the
6 damage of sea lice. Sea lice have occurred on
7 salmonids for a long time and based mainly on that
8 knowledge and review of the literature, I put this
9 -- and the limitations of time that I had to
10 prepare this report, I put this as a lower
11 priority than some people might have. If you're
12 just going to -- if you were going to review the
13 -- conduct a report based on the number of
14 citations, the sea lice would have been much
15 higher, but as I said, for the reasons I just gave
16 you there is that the sockeye are larger when they
17 enter the sea water. They're only going to be
18 infected in sea water and therefore I gave less
19 emphasis to the sea lice than some others.

20 Also, I know that there's going to be four
21 other -- three or four other reports on the
22 interactions of salmon farming with the potential
23 demise of wild sockeye and I know that that issue
24 -- the issue of sea lice and it's relationship to
25 sockeye salmon will also be addressed in those
26 reports.

27 Q And on that note, I'll just confirm indeed we do
28 have a number of other reports and indeed, the
29 panel specifically on sea lice that will be coming
30 within the next few weeks.

31 Dr. Stephen, I haven't taken you to your
32 report in any great detail. With the time
33 limitations, I don't plan to do this in great
34 detail. You've commented a little bit about the
35 report and the work that you've done. I wonder if
36 I could look to ask about your report but in the
37 course of doing so engage both you and Dr.
38 MacWilliams with respect to the operation and
39 oversight of hatcheries and salmon enhancement
40 facilities. I suppose salmon enhancement
41 facilities is the safest, broadest term; is
42 that...?

43 DR. STEPHEN: I think that would work for today, yes.

44 Q All right. First with respect to your findings,
45 I'd like to read out from page 4 of your report,
46 this is within the executive summary of your
47 report --

1 MR. LUNN: Sorry, Mr. Martland...?

2 MR. MARTLAND: I'm sorry. This is from Dr. Stephen's
3 report and it's Exhibit 1454.

4 MR. LUNN: Thank you.

5 MR. MARTLAND:

6 Q If you look in the middle of the page at the
7 paragraph that begins:

8
9 We could not determine...

10
11 It reads:

12
13 We could not determine if diseases present in
14 salmon enhancement facilities (hatcheries or
15 spawning channels) present potential for
16 serious or irreversible harms to Fraser River
17 sockeye salmon. Limitations in scientific
18 understanding, lack of ongoing surveillance
19 of wild and cultured fishes, and deficits in
20 data provided to us --

21
22 I'll pause to say this is in the context of the
23 disclosure -- an application and disclosure of
24 information to the commission from salmon
25 enhancement -- from federal and provincial SEPs in
26 the province.

27
28 -- deficits in the data provided were the
29 primary reasons for our inability to make
30 specific cause-effect conclusions and to
31 qualitatively or quantitatively assess risk.

32
33 Is that really the key finding that you make is
34 effectively a conclusion that we can't say?

35 DR. STEPHEN: I think that's the most important
36 conclusion of the report, yes.

37 Q And you describe in your report the method you
38 use, but I take it that conclusion we can't say is
39 true both with respect to what the literature says
40 but secondly, as I alluded to with respect to what
41 the data that were provided say to you?

42 DR. STEPHEN: Yes, we took two approaches of trying to
43 look at the literature and then look at the
44 facilities' specific data and we had the same
45 challenges in both approaches.

46 Q At page 2 if we flip back two pages, and we just
47 go down to really the next part there's a

1 paragraph beginning:
2

3 We know of no...
4

5 And I'll read it out:
6

7 We know of no legal fish health standard that
8 establishes an acceptable level of fish
9 pathogen risk for enhancement operations
10 except for legislation dealing with the
11 exclusion of foreign or exotic disease from
12 Canada. A single standard for acceptable
13 exposure cannot currently be defined as the
14 capacity for individuals and populations to
15 cope with a disease is context specific and
16 would be affected by things such as the
17 pathogen, host species, life stage, habitat
18 quality, water temperature and many other
19 factors.
20

21 You go on to write:
22

23 A health standard of no infectious or
24 parasitic micro-organisms or diseases in
25 Fraser River sockeye salmon is unattainable
26 because; infection and disease are normal in
27 wild fish populations and a variety of
28 infectious agents are ubiquitous in aquatic
29 environments or common in cultivated or wild
30 fishes.
31

32 Could you comment on those points that you make,
33 please?

34 DR. STEPHEN: I think that the importance of that is
35 again, when I outline what we do for risk
36 assessment, the first star for me is to understand
37 what risk target we're going for. A lot of
38 disease in the past - and animal health has been
39 zero or some - and if we think of foot and mouth
40 disease, one case of foot and mouth disease in
41 Canada would be unacceptable. So a lot of our
42 legislation on animal diseases have been based on
43 trade and barriers to trade. Finding one animal
44 would be enough to have a barrier to trade. But
45 when we look at some of these other diseases,
46 there's obviously ecological considerations,
47 economic considerations and social considerations

1 as well and if we can't have a zero or present
2 perspective for managing a population, we need to
3 think about what would be reasonable when we look
4 at the risk to say have we met that threshold of
5 acceptability.

6 Again, and I was a little bit shy in putting
7 in we know of no legal standard because we
8 certainly aren't lawyers by any means, but when we
9 look at the legislation for this and other
10 projects, I think things like, you know, the
11 **International Boundary Waters Act** or some of those
12 sort of things talk about prevention and movement
13 of pathogens, but nobody says it's okay to have
14 one percent or five percent or two percent, and so
15 we have no management standard against which to
16 work. And because, as you've heard from the other
17 panellists say today, pathogens and diseases are
18 part of normal systems. We really can't have a
19 zero.

20 So this is the very first challenge we had
21 when trying to assess the risk and if there was an
22 acceptable risk by saying what external standard
23 can we use for acceptability.

24 Q In terms of the -- I wonder if I can just use a
25 metaphor and tell me if it works. When we think
26 about the impact on wild salmon I think you're
27 saying two different things. First of all, we
28 don't have -- my analogy, I suppose, to carpentry.
29 We don't have the things that we want to measure,
30 but more than that, the measuring tape is not
31 standardized. I may be able to -- you were
32 talking about not having a standard against which
33 to assess or understand risk. Is that that sort
34 of a complaint, as well?

35 DR. STEPHEN: Well, let me just clarify. It's not that
36 we don't have a standard. There's multiple
37 standards with different perspectives, so -- and I
38 don't want to suggest which would be more correct
39 at this point. But there are definitely different
40 measuring tapes out there and as you've heard
41 earlier, especially if you want to measure health
42 and well-being of salmon, going out and counting
43 pathogens is insufficient to really measure that
44 and that's been the focus of most of the fish
45 health work. So this is why we've got this
46 deficit of knowing where to measure and the tools
47 to measure and then having a variable measurement

1 tape, to use your analogy.

2 Q What did you conclude with respect to the
3 screening for disease at enhancement facilities?

4 DR. STEPHEN: I think that we can see at enhancement
5 facilities, there's a number of ways they look for
6 diseases. One is in response to problems which I
7 think is a significant part of their work, where
8 the hatchery managers might recognize there's a
9 problem that they might need investigation or
10 medication or support from their veterinarian.
11 There's other times when they have some programs
12 to specifically look at some pathogens such as you
13 heard earlier bacterial kidney disease. There are
14 some screening done on brood stock where they will
15 catch things other than just those diseases and if
16 we talk about the provincial hatcheries, as well
17 as the federal ones in that case, they will look
18 at some pathogens.

19 I could not find evidence of systematic
20 ongoing population surveillance so all individuals
21 are sampled in a random, systematic way, so it
22 tends to have -- focus on particular conditions
23 and in not all cases are animals tested for all
24 possible pathogens, which is a very reasonable
25 approach for utilization of resources.

26 Q Dr. MacWilliams, do you have comments of the
27 sufficiency of the current level and approach to
28 disease screening for federally overseen
29 enhancement facilities?

30 DR. MacWILLIAMS: Sorry? Could you ask that again?

31 Q Do you have a view on the sufficiency of disease
32 screening at enhancement facilities? Is the
33 disease screening that goes on now all that it
34 could or should be?

35 DR. MacWILLIAMS: We are -- the level of screening is,
36 in my opinion, it is sufficient. We do probably
37 not miss any disease outbreaks. We screen for
38 bacterial kidney disease in watersheds that we
39 know the pathogen is present at a higher level
40 than normal and we are -- do also have a range of
41 management steps to intercede and try to mitigate
42 against so we can work toward lowering it --
43 lowering that disease within those watersheds. We
44 have similar programs in place for IHN virus in
45 sockeye stocks where we are doing annual screening
46 of the brood stock and also have a number of
47 management practices in place to specifically

1 address that pathogen, virus-free water source,
2 compartmentalization of sockeye only to those
3 sites, or -- and if multiple sites,
4 compartmentalization between those stocks. So we
5 do have a number of processes in place for
6 management of the diseases that act to limit the
7 number of -- limit the disease risk.

8 We also have in the last few years done some
9 pre-release screening at major facilities only and
10 we're hoping to go further toward that in the
11 future. So with our management policies in place,
12 yes, I think that our screening and our disease
13 efforts are sufficient.

14 Q In the perfect world are there things like
15 vaccinations or prophylactic measures that could
16 be used more rigorously or regularly across
17 enhancement facilities?

18 DR. MacWILLIAMS: Definitely. I'm not saying that we
19 couldn't do better. We absolutely could.
20 Specifically speaking to vaccinations, we are very
21 limited in that the majority of our fish, the
22 pinks, chum and sockeye, which are the vast
23 majority of fish that we release, are normally
24 leaving our facilities in a .2 to one-gram size.
25 There are no effective vaccines for that size of
26 fish. The immersion vaccines become effective
27 after two grams in size. The injectable vaccines
28 you can start giving them at ten grams in size but
29 they are more efficacious if they're given later
30 and give longer protection if they're given to
31 fish that are more in the 20- to 30-gram size. So
32 there are -- we are constrained by what's
33 available in a commercial vaccine and also by the
34 life stages and the size of fish that we release.

35 Q If I could bring up the top of page 3 please, Mr.
36 Lunn, from this report. Dr. Stephen, in your
37 report you make reference to having documented --
38 this is four lines down - cases where fish with
39 known or suspected infections were released from
40 salmonid enhancement operations into fish-bearing
41 waters. That really gets us to a question around
42 whether that occurs, why that would occur. It may
43 seem to someone surprising that fish that were,
44 for example, BKD-positive were released into the
45 wild given, for example, what Dr. Kent has told us
46 about the risk level from BKD for sockeye.

47 Could you comment - and I've got one or two

1 documents I can take you to or you're welcome to
2 go to in answering. Dr. MacWilliams, could you
3 please address that question?

4 DR. MacWILLIAMS: Yes, the enhancement hatcheries do
5 periodically release fish that are known to be
6 carrying pathogens. Specifically, bacterial
7 kidney disease is one that we on our hot zones
8 occasionally if the pathogen is detected during
9 rearing, we will treat with antibiotics and we
10 will do a pre-release screening of the population
11 and try to determine a population level prevalence
12 of that pathogen. And if our tests indicate that
13 the population is too high, we will cull that
14 population as opposed to release.

15 But a zero tolerance doesn't work with that
16 pathogen in that it is endemic and we -- at any
17 site we are taking up to 30 percent of the
18 escapement for our rearing, and of those -- so if
19 the pathogen is high in prevalence in a certain
20 year, we're only taking three out of ten fish that
21 are in the system. The other seven are naturally
22 spawning but the fish that we take in we are
23 disinfecting the eggs, we are taking the results
24 of our screening and managing with our egg
25 segregation culling program the female that test
26 high positive. Their eggs are removed from the
27 facilities and destroyed. And we also provide
28 optimal nutrition, do predator control, so we're
29 trying to give them the best chance they have. If
30 we still see a disease outbreak in our yearling
31 production of bacterial kidney disease then we can
32 manage through therapeutants and also we do risk
33 assessment prior to release. But having a zero
34 tolerance and saying we're not going to release
35 any is not possible.

36 Other instances where we may release fish
37 with disease would be after parasites,
38 costeotrichina (phonetic), that are normal skin or
39 gill parasites that are also endemic pathogens,
40 ubiquitous in wild circumstance and we release
41 them with some -- some assurance that sea water is
42 somewhat curative because it's one of the
43 modalities used to treat them. So as they're
44 migrating out, there is a risk that they are going
45 to pass that horizontally to other freshwater
46 stocks, but that that exposure will decline in the
47 estuary and beyond.

1 And the only other circumstance I can think
2 of where we may release disease-positive fish is a
3 number of our facilities will do sea pen rearing
4 and in the sea pens once they're in the sea pens
5 to keep them and treat them and hold them for a
6 period of time to ensure the treatment was
7 effective and go down that road, it becomes
8 somewhat questionable in terms of their -- the
9 biological needs of the fish to actually get
10 going. So in a sea pen circumstance, the rule is
11 -- rule of thumb is normally that if any sign of
12 mortality, regardless of what the cause is, we let
13 them go. We consider them once they're in the sea
14 pens to already be essentially wild fish and we
15 let them go as soon as possible to prevent any
16 horizontal transmission between the population and
17 -- but if we're doing that with a suspicion of
18 disease at a very low level of mortality or
19 morbidity, we're also requesting that they get a
20 sample to the lab so that we can confirm what
21 they're dying of or what they're looking sick from
22 before we release them.

23 Q To better understand the approach of the
24 department and your approach on, in particular,
25 this question of BKD ourselves, if I could look to
26 number 10, please, Mr. Lunn, on our list of
27 documents and this I won't take you through it,
28 but I take it this is quite a -- from your
29 perspective probably an articulation of the
30 rationale for how it's indeed titled, the specific
31 pathogen control plan for any bacterium at B.C.
32 Federal enhancement hatcheries and affiliates.
33 This really articulates the approach that's taken?

34 DR. MacWILLIAMS: It does.

35 MR. MARTLAND: If I might ask this be marked as the
36 next exhibit, please?

37 THE REGISTRAR: Exhibit 1459.

38
39 EXHIBIT 1459: Specific Pathogen Control Plan
40 for, at B.C. Federal Enhancement Hatcheries
41 *R. sal* and Affiliates
42

43 MR. MARTLAND:

44 Q And as a shorthand number 8 on your list of
45 documents it describes the six categories of
46 results from the ELISA or ELISA test for BKD or *R.*
47 *sal* and I won't have you explain that, but that is

1 the test that's used for BKD?

2 DR. MacWILLIAMS: For screening of the adult brood,
3 yes.

4 Q Okay. And this is a document number 8 on our list
5 of documents that dates the September 29, 2010
6 from you to a manager -- I'm sorry, just at least
7 John Willis recipient.

8 DR. MacWILLIAMS: He is the manager at Snootli Creek
9 hatchery.

10 MR. MARTLAND: If I could ask this be marked as the
11 next exhibit, please?

12 THE REGISTRAR: 1460.

13
14 EXHIBIT 1460: Memo from C. Williams to J.
15 Willis et al re Broodstock Screening results
16 - Lakelse Sockeye dated September 29, 2010
17

18 MR. MARTLAND:

19 Q And I take from the description here that it's not
20 simply a "yes" or a "no" test.

21 DR. MacWILLIAMS: No. No, the levels of the pathogen
22 within the brood stock follow a continuum from
23 negative to very high levels and we put in the
24 categories you can see there of negatives or low
25 level of detection. Those fish are considered
26 suitable for yearling rearing programs. The low
27 positives we consider those to be suitable for fry
28 release and so they won't be held for a year at
29 the facility, and the moderate positives and high
30 positives are ordinarily destroyed. The high
31 positives, the cut-off of greater than .06, should
32 note that, you know, the highest value we've seen
33 in our ELISAs is an OD value of greater than
34 three. So we're still on the conservative end and
35 I believe that we are -- we manage this pathogen
36 and disease comparable to how it's managed in all
37 Pacific Northwest hatcheries of our neighbouring
38 states, as well.

39 Q And I wonder, Dr. Stephen, do you have comments on
40 whether you see a risk remaining or a risk arising
41 from a practice that -- or an approach that
42 permits the release of fish as you've just heard
43 described?

44 DR. STEPHEN: Well, I mean, I'll take you back to the
45 earlier question about the most important
46 conclusion, which was the inability to actually
47 determine what risk is because of the challenges

1 of understanding if an exposure occurs. And so to
2 sort of speculate on this particular disease and
3 this situation is challenging. Certainly as you
4 heard earlier, this idea of additional stressors
5 being added to populations is never desirable,
6 whether it's a pollutant or a pathogen or a
7 habitat change, but with the information available
8 you can't specify if this truly increases risk
9 against background levels due to the inability to
10 see if these fish truly interact in transmission
11 to each other.

12 Q I'm noting the time and I'll need to speed along
13 to a conclusion, so I'll look to now move to
14 number 12 of our list of documents. Dr. Johnson,
15 I'll perhaps direct this question in the hopes
16 that you may have looked at or have some
17 familiarity with it. It bears a date stamp of
18 July 5, 2011. Indeed, I'm just told that it is
19 already an exhibit, which I hadn't made a note of
20 so I'll find that exhibit number in a moment.
21 This document is given to the deputy minister with
22 respect to providing information about work that's
23 been done to understand what happened for Fraser
24 sockeye in 2009 and perhaps more generally with
25 the decline over time.

26 What I'm most interested in - and it's
27 Exhibit number, we think 1364 - we'll pick up on
28 that and confirm in a moment.

29 I'd like to go to page 3 of the memo, which
30 may be page 4 of the PDF document. There's four
31 -- you'll see in this passage that there's four
32 factors that are classed as being most likely that
33 led to sockeye mortality at the scale observed in
34 2009: low food abundance in the Strait of
35 Georgia; low food abundance in the Queen Charlotte
36 Sound and Gulf of Alaska -- skipping to number 4,
37 toxic algal blooms in the Strait of Georgia and
38 then back to number 3, disease.

39 With respect to the disease description
40 that's given there, doing this awkwardly, but
41 before I forget to do it, it's Exhibit 1371 is the
42 correct exhibit number. This is already an
43 exhibit. With respect to the advice that's given
44 there on disease, do you have any concerns or
45 comments on that advice?

46 DR. JOHNSON: I think that this whole issue of the role
47 of pathogens may have played in the decline is all

1 related to the other three factors which are
2 listed here. So what the document is essentially
3 saying is that we know that there are many disease
4 -- many pathogens present in sockeye salmon and we
5 know that factors such as low food abundance,
6 possibly toxic algae blooms can affect how these
7 pathogens would impact sockeye salmon, so that's
8 why I think disease has stayed in there. There's
9 also, of course, the interesting work that Dr.
10 Miller's done with her genomic signatures which
11 suggest that a fairly large number of the fish
12 showed this signature. But it also does note that
13 the actual pathogen responsible for that signature
14 hasn't been determined.

15 And on an earlier statement I should correct
16 that we are doing some other work with Dr. Miller.
17 Dr. Garver is now working with Dr. Miller on doing
18 some parvovirus challenge work with sockeye salmon
19 so I'm sorry, I forgot to mention that.

20 Q With respect to the work that the DFO is involved
21 in now and indeed that you're intimately familiar
22 with, Dr. Johnson, we understand that that
23 includes a research program to examine the health
24 of Fraser sockeye in the Strait of Georgia and
25 that although that work is ongoing to date, it has
26 not revealed that there's been, I gather,
27 histology testing - and my note was 250 fish at
28 this point. That may have changed. I don't know
29 if it's a moving target. Could you comment though
30 as to the state of that work and what results, if
31 any, you have to this point?

32 DR. JOHNSON: Okay. In 2010 it was -- well, we
33 basically came up with a program to approach
34 sockeye salmon health more from an overall health
35 perspective rather than simply doing more surveys
36 for disease. So the goal of this program is to
37 integrate with our fisheries biologists, fisheries
38 ecologists, the disease staff, Dr. Miller's group,
39 to come up with an overall assessment of health
40 status of Fraser River sockeye starting in the
41 lake, throughout their period of migration through
42 the Strait of Georgia. So we received three years
43 of funding. The first field season was in 2010
44 and that year we also received some support for
45 marine harvest for some of the ship time, and some
46 work from the salmon foundation, Dr. Riddell's
47 group.

1 So in each of these years, we have done
2 large-scale surveys of sockeye salmon throughout
3 the Strait of Georgia at up to 70 to 80 different
4 sites ranging from the mouth of the Fraser River
5 right to through Johnstone Strait. We've also
6 collected fish in 2010 at the mouth of Chilko Lake
7 where we take advantage of the fact that there's a
8 counting fence that we can actually obtain
9 samples. And this year in 2011 we also added
10 sampling of fish in the lower river, just
11 immediately before they leave the strait.

12 And on these fish they're receiving a
13 complete health assessment. 2011 we've included
14 things such as water chemistry -- well, 2010 have
15 water chemistry, but in 2011 we've also done toxic
16 phytoplankton sampling with associated surveys, so
17 I'm seeing this as a real sort of change away from
18 just sort of everybody doing their own thing and
19 trying to bring everybody's expertise. Like we've
20 sort of -- Kyle -- Dr. Garver is doing the
21 virology work and we're using recognized and
22 validated diagnostic tests, as well as a lot of
23 histopathology and all of the results of the 2010
24 survey were presented in this -- at this workshop,
25 which was the April 14th workshop that DFO hosted
26 for the staff. I don't know what else...

27 MR. MARTLAND: So I appreciate that answer. Mr.
28 Commissioner, I dare not run long and then be
29 telling my colleagues to conclude on time, so I'm
30 going to conclude my questions there. I have a
31 note that Canada, Mr. Taylor, has 80, eight-zero,
32 minutes.

33 MR. TAYLOR: Thank you. So by my count then I have 20
34 minutes now and then 40 minutes after lunch.
35 Sorry, 60 minutes after lunch.

36
37 CROSS-EXAMINATION BY MR. TAYLOR:

38
39 Q I'm going to start and do similar to what Mr.
40 Martland did, that is, to ask questions about
41 technical paper 1 and then move from there to
42 technical paper 1A and my questions on report 1
43 will primarily but not exclusively be of Dr. Kent
44 and Dr. Johnson and 1A of Dr. Stephen and Dr.
45 MacWilliams. But please, panellists, if you have
46 something to say in answer to a question, even if
47 I haven't specifically directed to you, I'd be

1 most pleased to hear from you.

2 My first question is going to be general of
3 Dr. Kent and Dr. Stephen and I'll take each of you
4 in turn. Dr. Kent, how long were you given to do
5 the work that then resulted in your delivery of
6 your paper to the commission, approximately?

7 DR. KENT: Oh, I would say approximately six months, as
8 far as the timeframe, as far as the amount of
9 hours devoted to it, is that right?

10 Q Well, I suppose hours are important --

11 DR. KENT: Yes.

12 Q -- over a course of time but it's the timeframe
13 that I was mainly interested in. Just in terms of
14 hours, we don't need to account for your hours, as
15 such, but were there other things in your work
16 life that were impinging during the six-month
17 timeframe that would have prevented you getting at
18 this in any significant way?

19 DR. KENT: Well, I'm a full-time faculty member at
20 Oregon State University and my research and
21 teaching responsibilities there so I worked mainly
22 in the evenings and weekends on this particular
23 project.

24 Q All right.

25 DR. KENT: And we can go back and calculate that
26 basically I would say it was somewhere around 24
27 days of -- 24 eight-hour days, my guess, is --

28 Q That's fine.

29 DR. KENT: -- about that.

30 Q Like many academics, I take it then that this was
31 an extra piece of work beyond your regular
32 university teaching and as you just said, so you
33 spend your evenings and weekends doing this for
34 this particular commission.

35 DR. KENT: That's correct.

36 Q And did the timeline that you were working under
37 contribute to and limit in any way the amount of
38 data that you were able to bring in and, in turn,
39 assess and analyze for this work?

40 DR. KENT: I don't think so. I was given a large
41 amount of documents, grey literature documents,
42 pathology reports from -- through the commission
43 from DFO and I felt that I had adequate time to
44 assess them. I reviewed a lot of these documents.
45 I don't feel that my report was compromised by the
46 amount of time that I was given. It's not like
47 there -- in other words, I don't believe that

1 there's a big body of literature, large body of
2 literature out there that I just didn't have the
3 chance to review that would have been pertinent
4 and changed my overall conclusions on the report.
5 Q All right. Thank you. And in addition to data
6 and information that you got from DFO did you get
7 some from the Province of B.C. as well through the
8 commission?

9 DR. KENT: I believe so.

10 Q So in sum then, you feel you had quite a good
11 collection of data as to what's available and you
12 had the time to assess it?

13 DR. KENT: The only compromise in my time would be that
14 at the very -- a number of documents came in -- I
15 teach a course back in Maine ever summer and I was
16 teaching it last week and I actually made sure
17 that we didn't have a conflict with this. And a
18 number of documents came in just a few days ago
19 that I haven't had an opportunity to review those.

20 Q All right. Dr. Stephen, I have the same questions
21 of you for your quick answer to that. How long
22 were you given to do the work that then resulted
23 in the delivery of your report to the commission?

24 DR. STEPHEN: I'm thinking of February to middle of
25 July. That allowed us a start on the literature
26 review right away but there were more delays in
27 getting some of the hatchery-specific data and,
28 most importantly, it came in about 3500 PDF files
29 rather than a database, so we had to spend a lot
30 of our time just re-entering and cleaning the
31 data. So it did cause some time crunches, without
32 a doubt, and didn't allow us to go to local
33 facilities and validate things or ask follow-up
34 questions that we might have liked in a more
35 timely and thorough examination.

36 Q All right. And with that are you saying that
37 there's some gaps in what you were able to take in
38 and analyze?

39 DR. STEPHEN: Well, like Dr. Kent, I think that we got
40 the literature covered off quite well. I think
41 that to me when I look at -- when I go and do
42 field data, I always like to go and talk to the
43 people who generate those data, make sure that
44 they've understood our request that we've got all
45 the information that we need, so I can give a
46 level of confidence that I've actually seen
47 everything and I didn't have a chance to do that,

1 so the answer to your question is I can't tell you
2 if there are gaps or not.

3 Q All right. Thank you. Now, my next few questions
4 are of any and all panel members so jump in as you
5 see fit. And they have to do with all species
6 using the Fraser River system. They're all using
7 the same water, of course, and you've spoken some
8 of this, something of this, various of you, and we
9 may have some more, but there's pathogens in the
10 water, both fresh and ocean, at all times and
11 quite a number, as I understand it. And we have
12 some species that seem to be doing quite well and
13 other species not doing so well and there's some
14 decline in the sockeye stocks which, of course, is
15 what led to and what this commission is about.
16 But pinks, for example, are doing quite well and
17 there are some other species, as well.

18 So any of you have a comment or explanation
19 as to why it is using the same water with the
20 various pathogens that all of the fish would be
21 going through and/or living with, why some species
22 are doing better than others? Does anyone want to
23 take that on?

24 DR. KENT: If I can speak in generalities, the fish
25 have different -- we're talking about -- let's say
26 -- I assume you're talking like different species
27 of salmon; is that correct?

28 Q Well, no, not only salmon but other fish too.

29 DR. KENT: Okay.

30 Q But mainly salmon, I would think.

31 DR. KENT: One explanation for a difference as it
32 relates to pathogen is we see dramatic differences
33 in host susceptibility and susceptibility based on
34 the species of salmon. That's one explanation.
35 And a second explanation - this is just some very
36 general - they have different -- the fish have
37 different life histories. Pink salmon go out in
38 the ocean immediately. Sockeye salmon are going
39 to spend the first year or whatever in fresh
40 water. So they have very different life histories
41 and very different susceptibilities to different
42 pathogens. So you can't -- a sockeye salmon is
43 very different than a pink salmon in a lot of
44 ways. That's my general comment on that.

45 Q And, in fact, risk is very life-stage dependent,
46 isn't it?

47 DR. KENT: Yes.

1 Q And so - and we'll come to the other panel members
2 in a few moments, but continuing with Dr. Kent, so
3 in humans, you can sometimes think of the very
4 young and the very old as being particularly
5 susceptible to even such things as the common 'flu
6 that those of us who are in between young and old
7 may not be so much vulnerable to; is the same true
8 of fish?

9 DR. KENT: Yes, the same is true. There would be
10 certain vulnerable life stages. One is fry, as
11 Dr. MacWilliams pointed out that the very little,
12 very young fish, you can't vaccinate them because
13 they don't have a competent immune system. So one
14 very critical stage would be the very young fish.
15 Second very critical stage is during
16 smoltification. There's a high energy demand and
17 often fish are more vulnerable to diseases when
18 they're going from fresh water to sea water, and
19 also during that stage you're seeing a whole suite
20 of new pathogens that they've never encountered in
21 their life. They've spent their life in fresh
22 water and they have developed immunities, certain
23 freshwater pathogens, et cetera, and now they're
24 in the sea water and seeing a whole suite of new
25 pathogens. So that's a vulnerable stage.

26 The third very vulnerable stage would be in
27 returning fish. Pacific salmon species are
28 destined to die when they return to fresh water to
29 spawn, except for steelhead, steelhead trout, they
30 can survive multiple years. So when a returning
31 salmon comes back to fresh water, again it's
32 seeing a new -- they've been in the marine
33 environment for one, two or three years depending
34 on what species they are and now they're coming
35 back into fresh water and again seeing a whole
36 bunch of -- a whole suite of pathogens that they
37 haven't seen for a long time, if you will, in
38 their life. And more importantly, and probably
39 the biggest driving factor is that their immune
40 system, they stop feeding and their immune system
41 becomes severely compromised when they come back
42 as adults.

43 So expanding, you know, that's basically the
44 three phases that fish are -- that salmonid fish
45 are -- where they're much more susceptible to
46 infectious diseases.

47 Q All right. Thank you. Other panel members, do

1 you have a comment on explaining why or how some
2 species - and we can largely address salmon, pinks
3 for one, why some are doing so well and others
4 not, even though they're all living with the same
5 pathogens? Resistance, of course, is one thing.

6 Dr. Johnson, do you have anything to say on this?

7 DR. JOHNSON: Yes. I think I'll add a little to what
8 Mike said. I think that we should look at the
9 fact that there are pink salmon doing quite well
10 in the Fraser River and work towards developing a
11 better understanding of how they relate to
12 pathogens in comparison to sockeye salmon, for
13 pathogens such as sea lice, for example. And I
14 think that we could probably learn a little from
15 that.

16 But I do agree with Mike, is that we need to
17 assume that there are differences in their
18 susceptibility to pathogens and there may be
19 differences due to the different sort of life
20 history stage they're at when they enter sea
21 water. But I think that it would be very
22 interesting, and I'm not sure of the exact
23 relationship between sockeye and pink salmon with
24 respect to, say, BKD. I know that BKD can be
25 quite common but which is more susceptible,
26 sockeye or pink, I don't know that. But I think
27 that information could be -- some of that
28 information could be found and it might be very
29 interesting to consider when you're talking about
30 the role of diseases in sockeye salmon.

31 Q Dr. Stephen, did you want to add to this?

32 DR. STEPHEN: I think I can just reinforce it. It's
33 the same -- you've asked the difference between
34 species. I think you just have to look outside
35 our windows here and look at the difference
36 between the same species of people and different
37 life histories, different challenges, different
38 patterns depending on where you live, your
39 socioeconomic status. Similar things happen in
40 animals, so even within one group of sockeye
41 salmon, depending on where they reside in the
42 lake, I think there was some work done by Leo
43 Margolis years ago where if you caught Kokanee at
44 one depth versus another depth, they'd have a
45 different parasite suite because they're looking
46 at different parts of the food chain.

47 Now add on the fact you have different

1 species, I don't think you can assume that their
2 ecologies are the same, so their timing of their
3 exposures, their susceptibilities and their
4 capacity to handle those would be the same. And
5 now when we go out to other species, whether it's
6 sturgeon or river otter, that complexity gets even
7 more abundant.

8 Q All right. Thank you. Dr. MacWilliams, do you
9 have anything you want to add?

10 DR. MacWILLIAMS: The only thing I can think to add
11 would be that not only life stage but the life
12 stage and the life history when they leave fresh
13 water, all those timing issues are going to also
14 depend on how much pathogen exposure they're going
15 to come in contact with. So it is very complex
16 and whether or not they have concurrent infections
17 or whether or not they have any adequate
18 nutritional play and all questions of the host
19 immunity with the environmental questions of --
20 and the pathogen questions, those very complex
21 interactions taking place.

22 Q All right. I wonder if we might turn to Canada's
23 document Tab 3, which is a PowerPoint
24 presentation. Thank you. Dr. Johnson, this is
25 something you prepared, I think, isn't it?

26 DR. JOHNSON: Yes, this was prepared for the April
27 workshop that was held on the factors related to
28 potential causes of sockeye declines.

29 Q Okay. And I think there's been reference to that
30 April workshop and you're speaking of April 14/15
31 of this year, are you?

32 DR. JOHNSON: Yes, I am.

33 Q Just very briefly, 'cause for immediate purposes
34 that workshop isn't the focus, but can you just
35 very briefly let the commissioner know what was
36 that workshop so he can get this in context?

37 DR. JOHNSON: The workshop brought together a variety
38 of DFO scientists who were working -- who work in
39 the different areas which were proposed as being
40 possible factors related to both the rather
41 disastrous decline of sockeye salmon as well as
42 long-term declines. It was basically an
43 opportunity for everybody to get together and to
44 provide an update on where they were at with
45 respect to the research that they were doing and
46 how they thought -- they may have changed --
47 whether they'd changed their opinions or not.

1 The piece that we're seeing here was done
2 primarily as an introduction to allow staff
3 members who were not knowledgeable about diseases,
4 so it covers many of the things that we talked
5 about today, the importance of the environment and
6 things like that in interactions with -- between
7 hosts and pathogens. It also provides us with a
8 bit of an overview of the survey work that's been
9 done in the Strait of Georgia.

10 MR. TAYLOR: All right. Could this be marked as the
11 next exhibit, please?

12 THE REGISTRAR: Exhibit 1461.

13
14 EXHIBIT 1461: PowerPoint presentation -
15 Introduction to Pathogens, Diseases and Host
16 Pathogen Interactions of Sockeye Salmon
17

18 MR. TAYLOR:

19 Q If you turn to page 2 - and this is a question for
20 all of the panel and I'll give you a moment to
21 look at that, but there's a statement that Dr.
22 Johnson has set out in his deck here and
23 presented, as you've heard, in April, that covers
24 some of what we have heard from you over the
25 course of the morning in a compendious form. I
26 think you can ignore the handwriting on that
27 particular page. I don't quite know what it
28 means, but for present purposes, just leave it --
29 put it to one side.

30 Do each of the panel members agree with
31 what's set out there? And Dr. Johnson, we'll just
32 take it that you do agree, of course, because you
33 wrote it, but do the other panel members agree
34 that that's a good compendium of pathogens and
35 their existence and relationship to disease and
36 that being multi-factoral?

37 DR. JOHNSON: I would agree. Maybe I'd add a little
38 bit on item 2 is:

39
40 Pathogens have co-evolved with their hosts.

41
42 That's assuming that they're not exotic pathogens
43 that the host has never encountered in their --
44 previously.

45 Q Yes, thank you. That's a good point. And the
46 pathogens you were looking at are endemic to B.C.,
47 aren't they?

1 DR. KENT: Yes. They're -- all the pathogens I've
2 looked at are endemic to B.C., from my review of
3 the literature, et cetera, to conversations I've
4 -- there's no indication that I have that there is
5 an introduced pathogen involved with this
6 scenario.

7 Q All right. Thank you. Dr. Johnson, it looks like
8 you have something to add.

9 DR. JOHNSON: Yes. And this presentation was only on
10 the endemic pathogens.

11 Q Right. Thank you. Dr. Stephen, Dr. MacWilliams,
12 is this a good account for what it's covering
13 there?

14 DR. STEPHEN: Yeah, I think it's a very general model
15 for how disease is multi-factoral. And to add to
16 the point too, I guess my only other caution there
17 is to make sure we don't always assume that co-
18 evolution means they come to benign co-existence,
19 because that's not always the case.

20 Q Okay. Thank you. Dr. MacWilliams?

21 DR. MacWILLIAMS: I think it's a reasonable generalized
22 model, absolutely.

23 Q Then if you look at page 4, it speaks to
24 challenges to quantifying disease impacts and Dr.
25 Kent, in particular, you spoke to that before.
26 And I've got two questions of the panel. One is
27 probably relatively easy to answer and the other
28 might take a bit longer.

29 The first question is whether this is a good
30 compendium of the challenges that exist and the
31 second question has to do with concurrent
32 infections which you'll see in the final bullet.
33 But taking them one at a time, is this a good
34 compendium to the challenges? Dr. Kent, you spoke
35 of this before, so if you have anything to add, by
36 all means; otherwise, we've got your evidence from
37 before.

38 DR. KENT: This is the first time I've seen this, so
39 I'm just reading this through right now.

40 Q All right.

41 DR. KENT: Yes, I agree with all those statements.

42 Q Okay. And Dr. MacWilliams?

43 DR. MacWILLIAMS: I agree with the statements, however,
44 I think it's also missing -- I'm assuming this is
45 referring to disease impacts in wild populations
46 and I don't think that this discusses the
47 difficulties in the sampling wild populations and

1 getting random samples or in getting sufficient
2 numbers. Yeah, I just think it's missing the
3 difficulties of actually surveilling wild
4 populations.

5 Q All right. Dr. Stephen, is this a good
6 compendium, perhaps with the addition that Dr.
7 MacWilliams has just put in?

8 DR. STEPHEN: I think I can agree that these are all
9 definitely challenges for infectious disease
10 research. We make clear they're talking about
11 infectious diseases and I agree with Dr.
12 MacWilliams of the other challenges, as well.

13 Q Now, in terms of concurrent infections, and you
14 wrote this, Dr. Johnson, so I'll ask the question
15 and then I guess it might be appropriate if we
16 break for lunch and you can think about -- all of
17 you can think about the question over lunch. But
18 with the reference there to concurrent infections,
19 and bearing in mind that one or more of you spoke
20 earlier about the studies that have been done so
21 far generally involve single pathogens, concurrent
22 infections is both a reality and adds a huge
23 complexity to this whole equation in terms of
24 trying to find out what impact a given pathogen
25 might or what contributing impact a given pathogen
26 might or might not have, doesn't it?

27 MR. TAYLOR: So I'll leave that question and if it's
28 agreeable, Mr. Commissioner, we can stop now for
29 lunch and come back.

30 THE COMMISSIONER: Thank you, Mr. Taylor.

31 THE REGISTRAR: Hearing will now adjourn till 2:00 p.m.

32
33 (PROCEEDINGS ADJOURNED FOR NOON RECESS)

34 (PROCEEDINGS RECONVENED)

35
36 THE REGISTRAR: Hearing is now resumed.

37
38 CROSS-EXAMINATION BY MR. TAYLOR, continuing:

39
40 Q Thank you. Before lunch I left the panel with a
41 question that essentially had to do with their
42 being studies so far or most of the studies being
43 on single pathogens, one or more of you have
44 spoken of concurrent infections and I suggested in
45 a question that that adds a huge complexity to
46 trying to isolate the contributing factor that
47 might be associated with any given pathogens and I

1 left that question with the panel to consider, so
2 now is your opportunity. Who wants to start?

3 DR. KENT: There are a handful of studies with
4 salmonids on co-infections and their interactions.
5 I can just think of a couple that come to mind
6 from my geographic area in Oregon. As I mentioned
7 in one of my earlier statements about a parasite
8 that's very common and somewhat pathogenic to
9 salmon called *Nanophyetus*. It's a worm. Some
10 work done by NOAA fisheries showed that fish that
11 were infected with this worm were more susceptible
12 to the vibriosis. That's one example that I could
13 think of. And recently I had a student that just
14 completed his Ph.D. and his papers are in press or
15 have been published on multiple -- the
16 interactions of multiple parasite infections in
17 coho salmon. So that's -- I'm sure that's biased
18 towards my geographic area and my lab, but those
19 are a couple of examples that I can cite.

20 Q What I'm really thinking of and getting at here is
21 that in order -- when you have co-infections or
22 concurrent infections, rather, in order to
23 understand what is the contributing factors, if
24 any, of a given pathogen it's usually complex
25 because of the inter-related concurrent nature of
26 the infections that are at play; is that right?

27 DR. KENT: That's correct. I totally agree.

28 Q And do the other panel members all agree with
29 that?

30 DR. JOHNSON: I agree with that statement.

31 Q Listening to the evidence -- I'll take the lack of
32 anyone else saying anything as agreement unless
33 you speak up and that's fine.

34 DR. STEPHEN: Well, I'll speak up then.

35 Q All right. You speak up.

36 DR. STEPHEN: Well, I think -- I mean, your attempt to
37 characterize complexity is simplistic.

38 Q All right.

39 DR. STEPHEN: These are hugely complex on some levels
40 when you're getting down to mechanisms, and we're
41 only talking about the interaction with pathogens
42 and pathogens. You're not looking at interactions
43 of pathogens with pollutants, for example. Some
44 work was done in Oregon, I believe, years ago
45 looking at the impacts of pollutants on
46 susceptibility to pathogens. And the question of
47 complexity comes back to describing individual

1 mechanisms of disease versus population impacts.
2 So I absolutely agree these are complex systems
3 and I just wanted to make the addition that it's
4 to our detriment if we only think about pathogens
5 in these sorts of equations.

6 Q Okay. Dr. MacWilliams, you're nodding or
7 indicating you have something to add?

8 DR. MacWILLIAMS: Just agreeing.

9 Q All right. You agree with -- okay. Thank you.
10 Listening to the evidence that's gone on so far
11 today, as I hear it and the take-away I get from
12 it and from the papers that we've seen is this.
13 There are pathogens. Some are identified as high-
14 risk, but at the same time we rarely see outbreaks
15 of disease in captive fish, whether they be farms
16 or enhanced, and therefore, a take-away that one
17 can have is that pathogens while they exist and
18 can cause disease, can also be successfully
19 managed and are, in fact, being successfully
20 managed. So I put that out and ask the panel if
21 they can speak to that point as to disagreeing or
22 elaborating on it.

23 Dr. Stephen?

24 DR. STEPHEN: I was just going to ask us for you to
25 clarify what your marker of success is. When you
26 define these are successful, how are you defining
27 that?

28 Q Well, it's nothing magic but simply that you don't
29 see catastrophic events occurring hardly ever.
30 Does that help?

31 DR. STEPHEN: It does help and I guess that's an
32 important distinction because as you heard with
33 Dr. Kent earlier, there's many things other than
34 catastrophic effects that pathogens can do.

35 Q Mm-hmm.

36 DR. STEPHEN: And in a lot of wildlife disease
37 literature, the non-catastrophic are probably
38 those that have the more population regulating
39 effect. You know, that and fewer eggs produced
40 per female, that less energy they get up the dam,
41 so I think that's -- so I wanted to see if you're
42 talking just about catastrophic or the full suite
43 of potential pathogen effects?

44 Q Well, catastrophic may be too strong, but a result
45 that is seen as a problem, a big problem. The
46 long and the short of what I'm putting to you is
47 that while there are pathogens and there can be

1 disease, that pathogens could be managed. That's
2 the point.

3 DR. MacWILLIAMS: I'd like to describe the biosecurity
4 measures that are used for enhancement fish.

5 Q All right.

6 DR. MacWILLIAMS: In captivity. And so the principles
7 of biosecurity, there's three main tenets and one
8 is that you want to keep pathogens out of your
9 facility, one is if they do happen to get in, then
10 you want to prevent them from spreading, and the
11 third is the efforts that you do to keep your
12 population as healthy as possible and reduce their
13 susceptibility to the pathogens having a
14 deleterious effect.

15 So to keep pathogens out in the enhancement
16 facilities, we will choose our brood stock for the
17 sites that do BKD management, they go beyond this,
18 which you'll note from other documentation, but
19 every fish, every brood fish that is looked at is
20 examined. If the female looks reasonably healthy,
21 she'll -- they'll collect eggs from her. If the
22 eggs look unusual or if the ovarian fluid is
23 bloody or cloudy, those eggs would be discarded.
24 So the initial surveillance comes right at the
25 start for every brood fish.

26 And brood fish for enhancement hatcheries, we
27 do use wild returning brood fish. They're
28 probably the biggest risk to our facilities
29 because they do carry a certain pathogen load
30 that's higher than normal circumstance. Beyond
31 that we also do egg disinfection, we'll do egg
32 fungus prophylactic treatments for the sites that
33 have egg fungus issues, depending on their water
34 quality. We'll do -- use well water or pathogen-
35 free water for incubation for the most vulnerable
36 life stages.

37 In preventing disease from spreading, we do
38 daily surveillance. Those fish are looked at and
39 fed every day. If there's an issue, it's often
40 detected. Usually the first sign you'll see that
41 something is going on in the population in terms
42 of illness is that the feeding response is lowered
43 and if the feeding response is lowered, the fish
44 aren't breaking surface in response to feed, then
45 the fish culturists are experienced. They're not
46 casual observers. They're experienced enough to
47 know that's a problem and they increase how

1 they're looking at the fish.

2 Any sick fish on the edge of the population
3 or are going back against the screen, not able to
4 hold their position in flowing water, are culled.
5 The on-site people do examinations of those culled
6 fish and we have thresholds in place that if the
7 mortality or morbidity rate reaches a certain
8 threshold, they are expected to contact the fish
9 health professionals. And there is a hierarchy
10 that they contact. Fish culturists will go to
11 their manager, go to their community advisor, go
12 to their support biologist, contact me or the fish
13 health technicians at the biological station
14 directly.

15 So there is a response in place. And we also
16 will practice separation of stocks so our brood
17 stock holding will be separate from our incubation
18 with foot baths and disinfection stations in
19 between. Separate classes, separate species will
20 all have specific areas. Unfortunately, we aren't
21 able to have dedicated staff for each unit. The
22 same people do the husbandry and care for all
23 levels of animals on facility; however, their
24 traffic flow patterns will be designed or
25 determined to follow the course from the most
26 susceptible populations. You work in incubation
27 first and go to your general population. If you
28 have diseased animals, known diseased animals,
29 you'll do those at the end of the day or your
30 brood stock at the end of the day. So there's
31 traffic flow patterns so that you're not -- I'm
32 unlikely to spread disease from one marine
33 container to another.

34 They also have disinfection measures in place
35 where they use the known disinfectants at the
36 appropriate concentrations for any materials that
37 come in contact with fish or possibly diseased
38 fish especially. And those are routinely applied.
39 And for keeping fish healthy and lowering their
40 susceptibility we optimize nutrition as best we
41 can. We limit handling events. Our animals --
42 they're used ponded into the only container
43 they're going to be reared in. It will be
44 shortened, so instead of going into a long raceway
45 with very small numbers of fish, they'll go into
46 just a subsection of the same raceway and as they
47 grow, more space will be allotted to them, so we

1 control our densities because low and high
2 densities can both be stressors causing aggression
3 among fish to try to develop hierarchies.

4 So there are many management practices in
5 place to help prevent disease exposures and
6 consequences at culture facilities.

7 Q All right. And in addition to that, there's you.
8 You're the veterinarian to the Salmon Enhancement
9 Program, as I understand it. Can you just, while
10 we're at this, briefly explain your role and your
11 involvement or contact with the various
12 facilities?

13 DR. MacWILLIAMS: Okay. Well, I work out of the
14 Pacific Biological Station and --

15 Q In Nanaimo?

16 DR. MacWILLIAMS: Yes. And in addition -- or I
17 indirectly supervise two fish health technicians
18 who do the diagnostic lab work for the hatcheries
19 and also for DFO Science. And in response to a
20 disease investigation or a disease suspicion call,
21 the first decision would be on whether or not it's
22 deemed appropriate to do a site visit or else have
23 the facility send fish directly to us. And we
24 advise on sample size, we do diagnostic test
25 selection based on what we expect. We also do --
26 run the surveillance program for bacterial kidney
27 disease, that specific management program. We do
28 pre-release screening on the stocks that have been
29 identified as high risk of having disease on
30 release. What else do we do? I provide treatment
31 and recommendation advice.

32 Q All right. Now, the commissioner has heard in a
33 previous round of evidence the breakdown, if you
34 like, of the various facilities that exist that
35 broadly speaking can be grouped into major
36 facilities on the one hand and community
37 facilities in the other and you're familiar with
38 that, of course. The major facilities are the DFO
39 hatcheries and spawning channels, right?

40 DR. MacWILLIAMS: Yes.

41 Q And I'll have the number slightly off but there's
42 about 22 or so of those in B.C.?

43 DR. MacWILLIAMS: Correct.

44 Q And then you have the community facilities which
45 are just what their name might imply, community-
46 operated, run at a local level and generally
47 speaking quite small?

- 1 DR. MacWILLIAMS: That is correct. Well, some of the
2 community and some of the community economic
3 development programs are mid-level facilities that
4 do release large numbers of fish.
- 5 Q All right.
- 6 DR. MacWILLIAMS: But, yeah.
- 7 Q Are those ones involving First Nations?
- 8 DR. MacWILLIAMS: Some are, yes.
- 9 Q Okay. Now, the major facilities, the DFO
10 facilities, in addition to yourself in Nanaimo,
11 the major facilities have professionals on site,
12 fish culturists or such you call them?
- 13 DR. MacWILLIAMS: Yes.
- 14 Q And would there be one or more at each of the
15 major facilities?
- 16 DR. MacWILLIAMS: There would be more than one.
- 17 Q And those people are responsible for the fish
18 health management plan and operations at the given
19 hatchery?
- 20 DR. MacWILLIAMS: In concert with their manager and,
21 yes.
- 22 Q And yourself?
- 23 DR. MacWILLIAMS: Yes.
- 24 Q What staff of that nature would the community
25 facilities have, if any?
- 26 DR. MacWILLIAMS: The community facilities will all
27 have fish culture staff, with fish culture just
28 being the people who do the daily husbandry and
29 care. And the community programs will also have
30 an assigned community advisor which is a DFO staff
31 person who also is there to provide them advice
32 and technical support and as a liaison to myself
33 and the enhancement support operations group out
34 of the Regional Headquarters.
- 35 Q All right. And just almost finally on this point
36 for the moment, are you aware of the approximate
37 number of fry that the hatcheries in the aggregate
38 in British Columbia put out each year?
- 39 DR. MacWILLIAMS: The last few years it's been around
40 300 million.
- 41 Q And as compared to the number of fry that would be
42 generated through the natural spawning, what kind
43 of number would that be?
- 44 DR. MacWILLIAMS: I have no idea.
- 45 Q All right. Dr. Johnson, if I could return to you
46 for a moment. At the bottom of page 2 of Dr.
47 Kent's report which is Exhibit 1449, Dr. Kent

1 refers to -- yes, thank you. At the bottom of
2 that page, Dr. Kent divides the pathogens into two
3 categories: those that cause acute disease and
4 rapidly kill; and secondly, pathogens that cause
5 chronic infections which are only heavy infections
6 that are associated with sickness or death. That
7 is, you only have a real problem if you've got
8 heavy infection.

9 Do you see a third category?

10 DR. JOHNSON: Yes. I think we actually had a bit of a
11 discussion on this earlier when we were discussing
12 commensals, chronic and acute pathogens or
13 opportunistic. So in Dr. Kent's report here,
14 there really wasn't sort of the focus on the
15 commensal -- well, that's the group that I believe
16 is missing is the commensal or opportunistic
17 pathogens, but that may be simply my -- a
18 difference in definition from what Dr. Kent had.

19 Q Okay. If you couple that with -- that is the
20 point about commensal and I think you're bringing
21 into play the environmental factors there, are
22 you?

23 DR. JOHNSON: Well, yes. As we discussed earlier,
24 there are a variety of organisms within the
25 environment that under the right environmental
26 conditions can result in the disease situation.
27 Normally these organisms wouldn't even be
28 considered a pathogen, but under particular
29 conditions they can become pathogenic and I think
30 Dr. Kent provided a very good example from humans,
31 which is the *Giardia* that many people carry.

32 Q All right. I want to pick up, Dr. Johnson, on
33 something that was part of the evidence this
34 morning and fairly briefly and that is the role of
35 science in responding to the requests of fish
36 managers. As you understand it, fish managers set
37 priorities that then translate into science work
38 and research that's done and fish managers have
39 many priorities that they're looking at or reasons
40 why they might want to have you study this or
41 that; is that correct?

42 DR. JOHNSON: Yes, that's correct.

43 Q And with that do scientists have any ability to
44 decide for themselves or science as a branch to
45 decide what it's going to work on?

46 DR. JOHNSON: I think that both the senior managers, as
47 well as fish managers, do listen to the Science

1 staff when they do propose new areas of up-and-
2 coming importance for disease studies. And most
3 Science staff have other projects which may or may
4 not be funded by DFO which is usually more along
5 the lines of things which they are personally
6 interested in, as well. So the overall --
7 although the overall goal of Science is to provide
8 science-based advice to senior management, there
9 is lots of opportunity to work on other things and
10 lots of opportunity to obtain funding from other
11 groups and other agencies such as NSERC to do
12 other projects.

13 Q All right. I want to turn, if I may, to Tab 4 of
14 Canada's binder of documents. This is a paper
15 that you and others authored, Dr. Johnson. It's
16 up on the screen now. Are you familiar with that
17 paper?

18 DR. JOHNSON: Yes, I'm familiar with this paper.

19 Q Now, this is about sea lice, which is not the
20 topic for today, but it is a topic upcoming. I'm
21 not going to ask you about sea lice as such, but I
22 want to be sure that we have this paper before the
23 commissioner. This was the paper done in 2007,
24 was it, by you and --

25 DR. JOHNSON: Yes.

26 Q -- either Mr. or Dr. Wagner and Fast?

27 DR. JOHNSON: It's both Doctors Wagner and Fast who are
28 post-docs, as well as Dr. Fast was a post-doc of
29 mine and Dr. Wagner is a consultant I believe in
30 Vancouver.

31 MR. TAYLOR: Okay. Could this be the next exhibit,
32 please?

33 THE REGISTRAR: 1462.

34
35 EXHIBIT 1462: Paper entitled Physiology and
36 immunology of *Lepeophtheirus salmonis*
37 infections of salmonids - by Wagner, Fast and
38 Johnson
39

40 MR. TAYLOR:

41 Q And just so that we understand what this paper is,
42 is it a review of the literature and state of
43 knowledge at that time at least about sea lice
44 infections?

45 DR. JOHNSON: It's a review of the literature knowledge
46 at that stage of time for this one particular
47 species of sea louse. So there are multiple

1 species of sea lice in B.C. waters that can be
2 found on salmon.

3 Q All right.

4 DR. JOHNSON: This is all on *Lepeophtheirus salmonis* or
5 *L. salmonis*.

6 Q And the other main species is one that begins with
7 "C" which I will try to --

8 DR. JOHNSON: *Caligus clemensi*.

9 Q -- pronounce. Sorry?

10 DR. JOHNSON: *Caligus clemensi*.

11 Q Thank you. And in writing this paper, did you
12 apply your knowledge and expertise to it to give
13 your best and full assessment of the pertinent
14 literature to that date?

15 DR. JOHNSON: Yes, we did.

16 Q Now, you also address in the paper as I read it
17 some cautions about how results from different
18 studies are difficult to compare to the different
19 methodological approaches and variable species and
20 species-specific susceptibility to infection and
21 if you look at the end of the right column on the
22 first page, which is page 176 of the publication,
23 under that heading "Limitations of Laboratory-
24 Based Studies" and then over the page to the first
25 text part of the left column, I think you'll see
26 that, but you seem to be setting out there what I
27 said, that is, you have to be careful in how you
28 take the results from different studies; is that
29 right?

30 DR. JOHNSON: Yes. The original goal of this paper was
31 to try to review all of the literature and to try
32 to get it so we could actually make direct
33 comparisons. During that review, it became very
34 obvious that there was so many differences between
35 different studies that it is extremely difficult
36 to make meaningful comparisons between studies.
37 For example, some studies used infection methods
38 that resulted in copepods being on the gills,
39 which are not a normal place for copepods. But
40 yet those data are often used to talk about
41 impacts on the host.

42 So this sort of puts together all the things
43 we sort of observed when we were trying to come up
44 with an overall level of sea lice that would be
45 detrimental to a host and all of the problems that
46 we sort of encountered in trying to do that.

47 Q All right. And then it appears that in the upper

1 left quadrant of the page we're on -- yes, we're
2 there now where it says "Box 1", which is when you
3 look at the actual article a slightly different
4 colour, I think, of background.

5 DR. JOHNSON: Yeah.

6 Q The upper left quadrant, those are some, if you
7 like, tips that you have set out as to how people
8 might structure a study so as to make for either
9 less inconsistency or better compatibility study-
10 to-study; is that right?

11 DR. JOHNSON: Yeah. And that's not -- you know, I
12 think we could use this sort of list for a wide
13 variety of pathogens, including sea lice and
14 different species of sea lice. We've talked today
15 about, you know, actually understanding what is
16 normal. I think that's a huge -- what is the
17 normal condition of the host? That's really
18 critical to understanding any impact of any
19 pathogen on the host.

20 We also need to know what we actually want to
21 measure and the appropriateness of the types of
22 measurements that we're doing. And we need to
23 have a consistent and proven mechanism by which we
24 report on, say, the numbers of pathogens present.
25 There's a variety of ways that you can do it. But
26 it needs to be something that you can compare.
27 And we've also talked about that -- how in this
28 case we talked a bit about how the age structure,
29 just because you have a sea louse on a fish
30 doesn't mean that it will have the same impact --
31 well, the different developmental stages of sea
32 lice and the host have different levels of impact.
33 So...

34 Q Okay. If we return to Dr. Kent's paper, Exhibit
35 1449, and page 6, he deals there with I'm going to
36 simply say the initials, but it's three-quarters
37 down, rather than trying to say the words of the
38 pathogen, IPN virus. Do you have some comment on
39 the inclusion of that virus in this paper?

40 DR. JOHNSON: Well, as far as I know, infectious
41 pancreatic necrosis virus has not been reported in
42 British Columbia, but I could stand to be
43 corrected.

44 Q All right. And Dr. Kent, in the paper, refers to
45 rarely documented. Do you know of any
46 documentation of that in British Columbia, Dr.
47 Kent?

1 DR. KENT: I'm -- I can't recall a specific document.
2 I seem to recall that it had been isolated one
3 time, IPN-like viruses have been isolated from
4 rainbow trout. I don't know the specifics of
5 that. There are a number of IPN viruses are a
6 group of viruses and I don't know if it was --
7 what strain was actually found, so I can't really
8 expand on that any more than that.
9 Q But it's on the strength of what you've just said
10 that it got into this paper, which seems to be a
11 fairly, if you like, tenuous --
12 DR. KENT: That's right.
13 Q -- tenuous basis?
14 DR. KENT: Right. So it's either rare or not at all.
15 I do recall some report of it occurring in
16 salmonids. I can't think of the specific
17 document. So I'm just going by memory at this
18 point.
19 Q All right.
20 DR. KENT: Maybe Dr. MacWilliams, do you know of any?
21 This is much older literature. We're talking
22 going back 20 or 30 years. It certainly, if it
23 occurs, it's a very rare event.
24 Q All right. So would it be fair to change your
25 paper from rarely documented to if it occurs it's
26 very rare?
27 DR. KENT: I would be okay with that.
28 Q All right. And Dr. MacWilliams, Dr. Kent was
29 turning to you and you, I think, shook your head,
30 but so that the record gets your answer, what do
31 you say about this virus and whether you have any
32 knowledge of it in B.C.?
33 DR. MacWILLIAMS: I'm not aware of the detection of IPN
34 in B.C.
35 Q All right. Dr. Kent's paper at page 8 deals with
36 salmon leukemia virus and I think I understand
37 that that goes by another name called marine
38 anaemia; am I right or wrong on that?
39 DR. KENT: Yes. You're right and wrong, so --
40 Q Thank you.
41 DR. KENT: -- that's typical of the way science works.
42 So marine anaemia was a name that was put -- one
43 of the manifestations of this condition called
44 plasmacytoid leukemia, like a lot of other
45 leukemias and related diseases result in its most
46 severe forms results in the host becoming anaemic,
47 lacking red blood cells. And hence the fish show

1 pale -- some of the fish will show pale gills and
2 a term that early on when fish farmers were noting
3 this disease and veterinarians working with it, it
4 was just a name that was applied in the
5 vernacular, calling it marine anaemia. It's not a
6 very specific term and Dr. MacWilliams might be
7 able to correct me, but I seem to recall very
8 early on when the ISA disease, infectious salmon
9 anaemia, came around some people referred to it as
10 a marine anaemia, as well, too, and hence we
11 really try to get away from using that term,
12 marine anaemia, because it was not specific and it
13 was also a lot of confusion resulted between this
14 and infectious salmon anaemia, which causes severe
15 anaemia.

16 So the more appropriate term is plasmacytoid
17 leukemia and this is where we associate it with
18 this particular retrovirus.

19 Q All right. Dr. MacWilliams, did you want to add
20 anything to that?

21 DR. MacWILLIAMS: I concur.

22 Q Okay. Now, you call it in your paper salmon
23 leukemia virus, Dr. Kent, but is it the case that
24 there's a big question whether it's a virus?

25 DR. KENT: It's not really -- there's not a big
26 question if it's a virus. The question would be
27 is what the relationship of the disease. So we're
28 going back about 20 years now before we had the
29 sophisticated molecular methods that we could to
30 pull out sequences, et cetera. So we identified
31 -- this is working with a virologist, Dr. Bill
32 Eaton at that time, with Malaspina College and
33 working -- myself as a pathologist and working
34 with a virologist so this is really work that he
35 did as far as defining the virus. He used methods
36 that you basically differentiate -- purifying
37 material and differentiating and then running an
38 assay called reverse transcriptase and at that
39 time that was probably one of the better tools
40 that we for identifying the presence of
41 retroviruses and we also found viral particles
42 that were consistent with retroviruses.

43 Third, we were able to transmit the disease
44 with cell-free filtrates in the laboratory, so
45 there were some pretty good evidence that there
46 was a virus there. We didn't have as -- we've
47 heard this term earlier today, quote the "smoking

1 gun". We weren't able to - Koch's postulates,
2 that is, grow the virus in culture - reinfect fish
3 and cause this leukemia-like condition.

4 It's well-known in the literature that retro
5 -- one of the -- retroviruses may cause -- many
6 infectious leukemias or related diseases are
7 caused by retroviruses. But the problem is is
8 that retroviruses are very common in animals and
9 many retroviruses occur in animals that do not
10 cause any disease. Many of these are endogenous
11 retroviruses that basically are incorporated in
12 the genome and are not causing any disease. So
13 it's a more complicated answer than saying that we
14 did not find a virus. We found a virus, but
15 definitively if that was the cause of the disease,
16 we didn't achieve that.

17 Q All right. I rather understand that in you, Dr.
18 Kent, and in you, Dr. Stephen, we have two of the
19 leading experts on this. You've done an awful lot
20 of the writing between the two of you on salmon
21 leukemia; am I right on that?

22 DR. KENT: I think so.

23 Q All right. You don't have to be modest.

24 DR. KENT: Okay.

25 Q And you agree, Dr. Stephen?

26 DR. STEPHEN: Yes, I do.

27 Q And do you have anything to add to what Dr. Kent
28 was just saying?

29 DR. STEPHEN: If I can maybe expand a little bit on
30 what he was talking about. I think that the --
31 it's important to distinguish between the findings
32 of some of the molecular work on something like a
33 retrovirus versus saying this particular disease
34 is caused by this particular thing. I think Dr.
35 Kent will mention that I think in your own
36 experience, Mike, as well as others down in the
37 States are finding a very similar, if not the
38 same, disease with different organisms.

39 My research found that you could find marine
40 anaemia or plasmacytoid leukemia in situations
41 where there were other chronic inflammatory
42 diseases. And, in fact, if I took the diagnostic
43 slides to five different pathologists, the
44 agreement between those pathologists was worse
45 than flipping a coin and they had a hard time
46 distinguishing between this being a cancer and
47 chronic inflammation.

1 And again as Dr. Kent suggested, there are
2 endogenous retroviruses and there's alternative
3 hypotheses about this virus maybe, you know, that
4 the animals are undergoing chronic inflammation
5 that allows this virus to replicate that maybe
6 didn't start it off; yet when you take that virus
7 and then inject it into the belly of a fish in an
8 experiment, which would be a very artificial way
9 of doing it, it was able to cause the disease. So
10 I think that it's very important to distinguish
11 the pathology that they call plasmacytoid leukemia
12 with these various potential causal pathways that
13 cause that pathology.

14 Q What I think I'm hearing from both of you, and you
15 two are amongst the leading experts as I
16 understand it and writers on this, is that there's
17 considerable uncertainty about this and no one is
18 able to tie it to any disease so far. Is that a
19 fair summary?

20 DR. KENT: Yes. As far as the so-called -- the salmon
21 leukemia virus described by Bill Eaton and myself
22 as a co-author, I just explain the associations of
23 that and Craig, I thought, expanded on this -- Dr.
24 Stephen expanded on this quite appropriately. I
25 don't see any disagreement with what he's saying.
26 And even added to that, this -- we're talking
27 about cases that we obtained in the early -- late
28 1980s, early 1990s. As time went on, I'm going to
29 follow up on some of the things that Dr. Stephen
30 just said, there is a condition. It's a
31 diagnosis, plasmacytoid leukemia is a presentation
32 of cells and that could be caused by more than one
33 agent, just like anaemia being caused by more than
34 one agent. And, in fact, the later cases were
35 more commonly associated with a parasite,
36 *Neucleospora salmonis*, which we originally found
37 in Washington State.

38 And, in fact, it was my former major
39 professor at UC Davis was working more on the
40 "parasite theory" and we talked quite frequently.
41 He was trying -- it was this attempt to say well
42 it's got to be caused -- this particular
43 histological manifestation has got to be caused by
44 one -- it's either the virus or the parasite. And
45 we never really had that argument. It's a very
46 convoluted story with this and so that's
47 basically, I think, we've summarized it.

1 Hopefully it's not making things too complicated,
2 but that's basically what the story is. It's a
3 complicated ideology and the proliferation of
4 immature blood cells can be caused by a number of
5 different things.

6 So just like I think the easiest thing to
7 say, well marine -- something that causes anaemia,
8 multiple things are caused by anaemia. So we
9 can't even state if the salmon leukemia virus --
10 is there some evidence of it as a cause of a
11 plasmacytoid leukemia, it does not rule out other
12 agents causing this type of lympho-proliferative
13 disorder.

14 Q All right. Thank you. Moving along, Dr.
15 MacWilliams, you spoke at the beginning of this
16 afternoon about some of the protocols and fish
17 health management practices that are in place in
18 enhanced facilities to guard against and ward off
19 disease from pathogens. Are there -- let's take
20 the major facilities first. Are there operating
21 manuals and protocols written down in place in
22 those facilities?

23 DR. MacWILLIAMS: Yes. All the major facilities do
24 have fish health management plans as a condition
25 of licence.

26 Q And what sort of things would those fish health
27 management plans cover? You've said a number of
28 things that are done. Is that all in the manual?

29 DR. MacWILLIAMS: Yes. All of the biosecurity
30 practices are in that manual. You can think of a
31 fish health management plan as basically a
32 biosecurity document. So that each plan has a
33 number of standard operating procedures for gamete
34 collection, brood stock selection, disinfection,
35 what have you.

36 Q All right. What about the community facilities,
37 what do they have by way of manuals or
38 instructions or that sort of thing written down?

39 DR. MacWILLIAMS: The community facilities have a --
40 it's a small booklet with biostandards for culture
41 rearing and some on how to do egg disinfection,
42 how to do egg fungal treatments, densities and
43 loading for the various species, so they also have
44 a booklet that's very concise, but outlines the
45 basics for fish culture for enhancement
46 facilities.

47 Q And do they have -- do the community facilities

1 have access to the things that would go into a
2 major facility's fish health management plan? Can
3 they access that?

4 DR. MacWILLIAMS: Yeah. The CAs have all been given a
5 copy of the template for the fish health
6 management plans and we've done a couple of
7 workshops on writing SOPs or standard operating
8 procedures for the CADPs to encourage them to
9 start writing down their own procedures of what
10 they do in developing their own set of SOPs for
11 operations.

12 Q You referenced a few moments ago to conditions of
13 licence, that is the major facilities have to have
14 fish health management plans as a condition of
15 licence. As I understand it , all major
16 facilities are licensed, are they?

17 DR. MacWILLIAMS: Yes, they are.

18 Q Is that true of the community facilities too?

19 DR. MacWILLIAMS: I'm not sure the state of the
20 community facilities but if they aren't, they will
21 be. And that would be a more appropriate
22 question, I think, for the 31st.

23 Q Okay. That's fine. And I'm not going to get into
24 the licensing here because you're quite right that
25 there's another panel on that, but the whole idea
26 of licensing of major facilities is new, is it?

27 DR. MacWILLIAMS: Yes. We've just been under licence
28 conditions as of December 2010.

29 Q All right. Now, I may be going out on a limb here
30 as to whether Mr. Lunn has the form of licence for
31 major facilities. If you do... Oh, thank you.
32 If you have a look at that, Dr. MacWilliams,
33 can you recognize that as being the form of
34 licence for major facilities at -- if I'm right,
35 it's a 21-page document and perhaps I should put a
36 copy in front of you.

37 DR. MacWILLIAMS: No, that is the template for the --

38 Q Do you recognize the first page?

39 DR. MacWILLIAMS: -- enhancement -- the major
40 facilities' licences, yes.

41 MR. TAYLOR: All right. May that be an exhibit,
42 please?

43 THE REGISTRAR: Exhibit 1464 please -- 63.

44

45 EXHIBIT 1463: Salmonid Enhancement Program
46 Aquaculture Licence 2010
47

1 MR. TAYLOR:
2 Q Now, Dr. Stephen, and when I read your report and
3 went to the recommendations section there was an
4 awful lot, 37 by my count. That appears to be
5 quite a shopping list of things, many good ideas,
6 but still an awful lot. Have you given any
7 thought to focusing and prioritizing your
8 recommendations?
9 DR. STEPHEN: Yes --
10 Q I think the -- sorry, just before I go to you,
11 they start at page 99 of Exhibit 1454. Yes,
12 Doctor?
13 DR. STEPHEN: Certainly. I think that what we
14 attempted to do was to give not just thematic
15 recommendations but some hopefully tangible steps.
16 So while it looks like many, you'll notice many of
17 them are sub-recommendations to go towards the
18 major goals.
19 Q Right.
20 DR. STEPHEN: I think if I had to summarize those and
21 distil them down, my first would be to get the
22 fish health programs working on fish health, as
23 opposed to their focus largely on pathogens and
24 disease and largely for some of the reasons we've
25 heard a bit of discussion on the panel today.
26 Q Now, just as you go through it and what you've
27 just said is an example, are you able to tie what
28 you just said to one of these numbers?
29 DR. STEPHEN: If you give me a copy of that, I
30 certainly could go through them so I can skim
31 through them if you'd like. But certainly
32 recommendation number 2 is -- speaks right to
33 that.
34 Q Yes. I will provide you with a copy of the
35 recommendations of -- Dr. Johnson has got one for
36 you there.
37 DR. STEPHEN: Thank you.
38 Q Page 99. It's just that it's going to help
39 everyone, I think, if when you speak you can tie
40 it to --
41 DR. STEPHEN: Absolutely.
42 Q -- one of your numbers. And you're quite right.
43 You've got 11 main recommendations with by my
44 count a total of 37 when you count --
45 DR. STEPHEN: Right.
46 Q -- all of the sub-points.
47 DR. STEPHEN: And the sub-points, as I say, were there

1 to hopefully give some sense of specific things we
2 can do. So you can see as I talk about starting
3 to think about health, we're talking about to do
4 that there are things that have to be done, like
5 making the management records available to people
6 like Dr. MacWilliams, like making sure there's
7 continuing education for folks, so they start
8 thinking about health protection and promotion.

9 Q All right.

10 DR. STEPHEN: So that would be certainly one that I
11 would go to that many of them could fall into
12 that.

13 I think a second major one which I believe is
14 under the research section -- let me just flip to
15 it one moment. That would be recommendation 8 I
16 think would be very important to think about what
17 is the management target that we're working for
18 for acceptable risk, which is why I was asking for
19 some clarification on your question about what
20 we're able to deem success. I think that would be
21 a very important one for moving forward and it has
22 only one sub-recommendation underneath there.

23 I think the other way I'd bring these
24 together is I would like to see leadership really
25 embrace and support a culture of research and
26 practice that's holistic and integrative. An
27 example of what Dr. Johnson brought up earlier, I
28 think, is a fantastic step forward where the
29 ecology folks and the water quality folks and the
30 fish pathogen folks are starting to work together.
31 And a number of our recommendations certainly deal
32 with that.

33 Q Just, sorry to interrupt, but that's the three
34 years starting in 2010 work that Dr. Johnson was
35 referring to, you mean?

36 DR. JOHNSON: Yes, I believe that's what he's referring
37 to. That's what I was referring to. A more
38 holistic approach.

39 Q Okay. I'm sorry, Dr. --

40 DR. STEPHEN: No problem.

41 Q -- Stephen. Go on.

42 DR. STEPHEN: And you can see recommendation number 3
43 talked to that, so that we're not segregating
44 salmon health by ownership or discipline. Sub-
45 recommendations on 3 speak to that particular one.

46 The last one that I have, many of the other
47 ones that I have are expansions on recommendation

1 of getting towards adaptive management, and
2 you'll see a number of the recommendations such as
3 having the capacity for applied research, so that
4 we can actually provide definitive evidence at
5 management plans or meeting or targets, that we
6 actually can manage and monitor, I should say,
7 wild fish so that we know that risk reductions are
8 being done. So while there are 37
9 recommendations, I think they would fall under
10 those major themes.
11 Q So I think, if I hear you right, you went 1,
12 recommendation 1, 8, 3, did I get that in what you
13 were going through just now?
14 DR. STEPHEN: 2 would be the one talking about focus on
15 health and resilience.
16 Q Or 2, 8, 3, sorry.
17 DR. STEPHEN: And 1 would be -- many of them would fall
18 under what would need to be done to do adaptive
19 management and let me just double-check the
20 number, 8 is the acceptable health standard would
21 be some priority, certainly.
22 Q Okay. Are you familiar, Dr. Stephen, with the
23 licence that major hatcheries now operate under
24 that we've just put in as an exhibit?
25 DR. STEPHEN: We were provided some copy of the Pacific
26 Aquaculture Regulations that talked about
27 licensing and we were provided one, I think, draft
28 of Big Qualicum Hatchery's and we focused only on
29 the fish health management plan with that.
30 Q Okay.
31 DR. STEPHEN: And it was no different than the other
32 versions of the fish health management plans we
33 were provided.
34 Q All right. Do those fish health management plans
35 then go some distance to meeting the kind of
36 recommendations that you're putting forward?
37 DR. STEPHEN: No. I think my recommendations more go
38 towards help bolster up our confidence that those
39 fish health management plans are meeting the goals
40 that we set out to get.
41 Q All right. Do you agree with the approach that's
42 being taken to now licence the hatcheries and put
43 conditions in the licence and put even more
44 stricture around the operations?
45 DR. STEPHEN: Sorry, you're saying "stricter" or
46 "structure"?
47 Q Well, both actually.

1 DR. STEPHEN: Okay. Well, it's important because I
2 think more structure is important, especially as
3 you've been alluding to with some of the community
4 facilities. The reason I thought it was
5 "stricter" is again because I don't -- I could not
6 uncover the evidence that they're not sufficient
7 as they are now. So that's why I wanted to make
8 that clarification.

9 Q All right. Now, Dr. MacWilliams, the licence
10 conditions and the protocols and so forth that
11 hatcheries operate under may be seen as not as
12 onerous as ones that salmon farms operate under;
13 is that something that rings true with you or not?

14 DR. MacWILLIAMS: Yes. The licences for the varying
15 levels, whether it's the finfish aquaculture,
16 finfish enhancement or the -- actually, the major
17 facilities, finfish enhancement or the public
18 involvement finfish enhancement, there are three
19 different levels -- or three different types of
20 licences and they are constructed to demonstrate
21 the differences between those practices and how
22 they operate and what their goals are. So the
23 licences for the enhancement programs are not as
24 detailed as the aquaculture industry licence but
25 it's a reflection of what we do and that we are
26 releasing fish as juveniles. We're not holding
27 them throughout their entire lives.

28 Q All right. And you're using native stocks to
29 start?

30 DR. MacWILLIAMS: Yes. And we also -- yes, native
31 stocks, native watersheds, and, yes.

32 Q As I understand it, a spawning channel or a
33 hatchery at bottom is taking the local fish and
34 putting them in your own facility as an egg to
35 then hatch to get a fry to then send out to the
36 same local environment again?

37 DR. MacWILLIAMS: Correct. Except I'd caution that a
38 spawning channel, you're not actually taking eggs.
39 You are just providing -- allowing them into a
40 habitat to spawn naturally.

41 Q Yes. Thank you. Now, at Tab 11 of Canada's book
42 of documents, there is a paper on ISA. Dr.
43 Johnson, you're familiar with that paper, are you?

44 DR. JOHNSON: Yes, I am.

45 Q And Dr. MacWilliams, you are, as well?

46 DR. MacWILLIAMS: I am.

47 Q Okay. Are you knowledgeable, Dr. MacWilliams, on

1 the research on ISA as regards Pacific salmon?
2 DR. MacWILLIAMS: I would be very knowledgeable up to
3 about 2006 and less so since then.
4 Q Okay. All right. This particular paper is at Tab
5 11 is one that is dated 2003, I think, by a -- is
6 it Mr. or Dr. Rolland and Mr. or Dr. Winton?
7 Either? Anyone? Can you answer?
8 DR. JOHNSON: It's Dr. Winton. I'm not sure about Dr.
9 Rolland.
10 Q All right.
11 DR. MacWILLIAMS: It would be Doctor. But Jill is not
12 Mr.
13 Q Okay. And what is the upshot or purport of this
14 paper? What's it about and what does it conclude?
15 DR. JOHNSON: Dr. Winton and Dr. Rolland did a
16 challenge in their Level 3 laboratory, which is a
17 very high secure environment, laboratory with a
18 very high level of biosecurity, where they
19 investigated whether a virulent strain of ISAV
20 would cause disease in Pacific salmon. They
21 tested, I believe, chum and chinook and coho
22 salmon and they used an artificial mechanism for
23 infecting them, that is, they actually took
24 virulent virus and injected these fish with it,
25 rather than -- thereby bypassing sort of the
26 normal route across the gills. If I remember the
27 paper correctly, although they were able to
28 generate disease in the Atlantic salmon both the
29 species, all of the species of *Oncorhynchus* were
30 -- did not develop disease, although I believe
31 there was some instances where they could isolate
32 virus from the fish at some point afterwards.
33 Q All right. Now, Dr. MacWilliams, you've mentioned
34 that you have knowledge up to 2006 on ISA. Did
35 you write a paper around about that time on it?
36 DR. MacWILLIAMS: I did.
37 MR. TAYLOR: Now, Mr. Lunn, do we have that paper
38 available?
39 MR. LUNN: Yes.
40 MR. TAYLOR: This is a paper that was part of a letter
41 that we sent in July to the various participants.
42 Q Is that your paper that you're thinking of, Dr.
43 MacWilliams?
44 DR. MacWILLIAMS: It is. Yes.
45 Q And when was that written?
46 DR. MacWILLIAMS: It was actually written in 2006 but
47 didn't get published until 2007.

1 MR. TAYLOR: Okay. And just to ensure we get all of
2 this tidied up, can we mark the paper that I was
3 at at our Tab 11 as the next exhibit, that's the
4 paper by Rolland and Winton, please?

5 THE REGISTRAR: That's Exhibit 1464.
6

7 EXHIBIT 1464: Relative resistance of Pacific
8 salmon to infectious salmon anaemia virus -
9 Rolland and Winton
10

11 MR. TAYLOR: I thought we had a 1464. Okay. I'm told
12 that's the correct number for this one.
13 And then next Dr. MacWilliams' paper that she
14 just referred to from 2006, Morphologic
15 description of infectious salmon ... and so forth,
16 may that be the next exhibit, please?

17 THE REGISTRAR: 1465.
18

19 EXHIBIT 1465: Morphologic description of
20 infectious salmon anaemia virus (ISAV)-induced
21 lesions in rainbow trout *Oncorhynchus mykiss*
22 compared to Atlantic salmon *Salmo salar* -
23 MacWilliams et al
24

25 MR. TAYLOR: It's not a tab, it's an attachment to a
26 letter from July that you all got. Thank you.
27 Q And Dr. MacWilliams, can you describe what you did
28 and what you concluded in that paper?

29 DR. MacWILLIAMS: We did take a highly virulent strain
30 of ISA from -- that had been isolated in an
31 outbreak in a New Brunswick aquaculture facility
32 and we amplified it through tissue culture and
33 injected it into peritoneally or within the
34 abdominal cavity of rainbow trout and Atlantic
35 salmon and we characterized the disease that we
36 saw there. And basically we were able to cause
37 mortality and disease in the rainbow trout and we
38 had chosen that species because it is of the genus
39 *Oncorhynchus*, the same genus as the Pacific salmon
40 species, and -- but fully understanding that
41 Pacific salmon species have demonstrated increased
42 resistance to the virus by previous researchers.
43 And whereas we were able to under these very
44 artificial circumstances create disease, it still
45 became apparent that the disease in Atlantic
46 salmon is -- in a natural setting ISA has only
47 ever been found in marine farmed Atlantic salmon

1 and with marine farmed Atlantic salmon on this
2 coast they are really a reasonable sentinel that
3 if the disease were to be here and be present, you
4 would see morbidity and mortality within that
5 population much sooner than in any other
6 population, using both my work and other
7 literature reviews.

8 Q So just to be clear, when you say within that
9 population, which population are you --

10 DR. MacWILLIAMS: The Atlantic salmon.

11 Q Atlantic salmon. And so if it was to show up in
12 B.C. are you saying that you would see it in the
13 salmon farms before anywhere else? Is that
14 your --

15 DR. MacWILLIAMS: I would expect so, yes. And there
16 has been ongoing surveillance previously in the
17 province during their regulatory efforts and the
18 auditing and surveillance program and I assume
19 that will be ongoing under -- with DFO and
20 fisheries aquaculture management.

21 Q And with that surveillance what's been found, if
22 anything?

23 DR. MacWILLIAMS: There has been no indication of ISA
24 or ISAV on this coast in B.C.

25 MR. TAYLOR: All right. Thank you. Those are my
26 questions.

27 MR. MARTLAND: Mr. Commissioner, I have next on the
28 list counsel for the Province of B.C. with 70
29 minutes.

30 MS. CALLAN: Mr. Commissioner, Callan, C-a-l-l-a-n,
31 initial T.E., appearing on behalf of Her Majesty
32 The Queen in Right of the Province of British
33 Columbia.

34

35 CROSS-EXAMINATION BY MS. CALLAN:

36

37 Q My first set of questions are for Dr. Stephen. A
38 hatchery that does not produce sockeye salmon is
39 less a risk than a hatchery that does produce
40 sockeye salmon; would you agree?

41 DR. JOHNSON: I don't think so, no.

42 Q Could you explain why?

43 DR. JOHNSON: Well, I think as you've heard, there's
44 many of the pathogens that are equally shared
45 amongst the different types of Pacific salmon and
46 so it would depend on their root of exposure to
47 begin with. Secondarily, being able to compare

1 risks is a challenging thing to do when we can't
2 describe risks, so I keep coming back to that.
3 And thirdly, it would also depend on the amount of
4 the different animals being produced, the
5 biosecurity of the facility and the release of the
6 waste if at times when species of concern are
7 going by.

8 Q So for part of your research you investigated
9 three facilities operated by the Freshwater
10 Fishery Society of British Columbia and
11 specifically the Clearwater Trout Facility, the
12 Fraser River Trout Hatchery and the Vancouver
13 Island Trout Hatchery.

14 DR. JOHNSON: That's correct.

15 Q The Vancouver Island Trout Hatchery is on
16 Vancouver Island?

17 DR. JOHNSON: Yes.

18 Q What are the chances of this facility's releases
19 directly or indirectly transmitting disease to
20 Fraser River sockeye?

21 DR. JOHNSON: Well, that can't be quantified on the
22 data that's available. The biggest challenge we
23 had with looking at the provincial facilities is
24 we were only able to get some anecdotal
25 explanations from Sherry Mead about the release
26 patterns, so we weren't able to map where they
27 released their fish to where that might overlap
28 with sockeye habitat. So we weren't able to tell
29 if that was going to be a situation where their
30 fish were released.

31 Now, Ms. Mead did tell us that they don't
32 release their fish into sockeye-bearing lakes or
33 take their brood stock from lakes with sockeye
34 salmon, so that would suggest there would be a
35 lower opportunity for exposure. And given that
36 they released their fish into lakes, it would
37 further reduce that likelihood.

38 Q Now, the Clearwater Trout Hatchery is in
39 Clearwater, British Columbia, that's halfway to
40 the Alberta border?

41 DR. JOHNSON: Yes, if I recall.

42 Q And this is the only hatchery that you
43 investigated that stocks Kokanee fish?

44 DR. JOHNSON: That I can't recall. I'd have to check,
45 but as I recall, yes.

46 Q In your opinion, what are the chances that Kokanee
47 release into -- by the Clearwater Hatchery would

1 directly or indirectly transmit disease to Fraser
2 River sockeye salmon?

3 DR. JOHNSON: I think my answer would pretty much be
4 the same for that Vancouver Island and the other
5 hatchery, as well.

6 Q Okay. And you would agree though that Kokanee
7 usually do not go into marine habitat or migrate
8 down the Fraser River?

9 DR. JOHNSON: By definition, they should be lake-bound
10 sockeye, yes.

11 Q So the only FFSBC hatchery in a Fraser River basin
12 is the Fraser Valley Trout Hatchery?

13 DR. JOHNSON: Correct.

14 Q Okay. And this hatchery releases cutthroat,
15 rainbow and steelhead trout?

16 DR. JOHNSON: I would have to confirm that with our
17 report which species they...

18 Q Okay. And your opinion on risk would be the same
19 as the other facilities?

20 DR. JOHNSON: Yes.

21 Q So if we could turn to page 3 of your report? And
22 if we look at the bottom paragraph. I'm just
23 going to read for us. It says:

24
25 All major DFO and FFSBC hatcheries have Fish
26 Health Management Plans that are intended to
27 support the goal of not releasing fish with
28 known infections. The Plans have not been
29 audited. There are inadequate resources to
30 allow fish health professionals to visit
31 enhancement facilities to help adapt Fish
32 Health Management Plans to local conditions,
33 audit their practices and develop ongoing
34 disease prevention programs.

35
36 I am advised by the FFSBC that they do have site-
37 specific standard operating procedures and site-
38 specific biosecurity checklists or self-audits
39 derived from a general fish health management plan
40 that addresses primary fish culture practices,
41 fish health monitoring, accurate and current fish
42 health records and diagnostic capability. Do you
43 disagree with my understanding?

44 DR. JOHNSON: That was not within the documents sent to
45 us and Ms. Mead told us that documents hadn't been
46 audited and when we compared the three fish health
47 management plans they had, they were pretty much

1 identical except for some background on the
2 individual facilities.

3 Q Okay. And those would be the three tabs at the
4 Province's book, the documents, Tabs 15, 16 and
5 17, are these documents that you reviewed?

6 DR. JOHNSON: I'd have to see what those tabs are. Do
7 you have the documents there?

8 Q I have --

9 DR. JOHNSON: Okay. The fish health management plan
10 documents, those are the ones we received.

11 Q So you have reviewed these documents?

12 DR. JOHNSON: I had Dr. Stitt for our team ran through
13 them all himself and we talked about those, yes.

14 Q Okay. And if we could turn to page 12 of Tab 15
15 of the Province's book of exhibits and
16 specifically s. 2.1. So this document says that:

17
18 FFSBC Management and the FHU Section Head
19 have undertaken biosecurity audits to
20 identify areas of opportunities to improve or
21 upgrade biosecurity systems. This audit was
22 conducted in the Spring of 2007.

23

24 Is this new information to you?

25 DR. JOHNSON: No, I think we note that in the report
26 that a biosecurity audit has been done, yes.

27 Q On page 57 of your report, you mentioned:

28

29 The fish health staff at both laboratories
30 did not appear to have regular access to
31 production records...

32

33 I'm advised by the FFSBC staff that this is
34 inaccurate and they have a database called PARIS
35 that gives them access to the information. Are
36 you in possession of any knowledge that would
37 indicate that PARIS system does not provide staff
38 with this information?

39 DR. JOHNSON: We were left with the impression with our
40 interviews with the fish health staff that they
41 had trouble getting that information regularly.

42 Q Okay. On page 53 of your report you mention that
43 hatchery staff do not manage any suspected
44 diseases on their own and instead are advised to
45 contact the fish health staff. You would agree
46 that bringing in fish health staff as soon as
47 possible when disease is suspected is a good or,

1 you know, correct --

2 DR. JOHNSON: Yes.

3 Q -- way to operate?

4 DR. JOHNSON: Yes, I would.

5 Q On page 42 of your report you state:

6

7 Modelling is used as a foundational tool in
8 ecology and epidemiology. However, disease
9 models have often been erroneous or imprecise
10 in their capacity to predict disease events
11 as was seen for foot and mouth disease in the
12 United Kingdom, the spread and impacts of Mad
13 Cow Disease (bovine spongiform
14 encephalopathy) and AIDS, as well as the
15 epidemiology of H1N1 influenza.

16

17 So my question is can you explain some of the
18 limitations of mathematical modelling and provide
19 just one or two examples related to disease in
20 fish?

21

22 DR. JOHNSON: Now, I'm not a modeller myself, so it'll
23 be a very broad overview and I guess what I'd like
24 to say is with models -- mathematical models have
25 been very informative for us to develop hypotheses
26 about how diseases might act. Some of the
27 population mechanisms that we talked about
28 earlier, they have given us some very good
29 insights into how we might attempt interventions
30 such as a vaccine or treatment trial and they are
31 used increasingly in public health to inform
32 disease control as we go along. But they have
33 constantly been challenged with the problem of
34 finding out, you know, next month at this place at
35 this time there will be this outbreak. And a lot
36 of that comes from the nature of - as was alluded
37 to earlier - the complexity of the systems and the
38 fact they're dynamic and changing. So I mean as a
39 broad overview, modelling, as I say, has been
40 very, very important in both epidemiology and
41 ecology for us to understand disease, disease
42 processes in populations, but they have had some
43 limitations in being able to predict specific
44 events.

44

45 MS. CALLAN: Okay. And Mr. Commissioner, I would like
46 to mark the exhibits at Tabs 15, 16 and 17 as the
47 next three exhibits.

47

THE REGISTRAR: Number 15 will be marked as 1466;

1 number 16 will be 1467; 17 will be 1468.

2 THE COMMISSIONER: And what are they, Counsel?

3 MS. CALLAN: These are the fish health management plans
4 of the Freshwater Fishery Society of British
5 Columbia for three facilities that were
6 investigated.

7

8 EXHIBIT 1466: Freshwater Fisheries Society
9 of B.C. - Fish Health Management Plan Fraser
10 Valley Trout Hatchery - November 2010

11

12 EXHIBIT 1467: Freshwater Fisheries Society
13 of B.C. - Fish Health Management Plan
14 Vancouver Island Trout Hatchery - March 2008

15

16 EXHIBIT 1468: Freshwater Fisheries Society
17 of B.C. - Fish Health Management Plan
18 Clearwater Trout Hatchery March 2008

19

20 MS. CALLAN:

21 Q Dr. Stephen, are you familiar with the Fish Health
22 Audit and Surveillance Program operated from the
23 Province between the years 2003 to 2010?

24 DR. STEPHEN: This is the audit program for...?

25 Q For fish health.

26 DR. STEPHEN: No, I didn't see -- I don't recall seeing
27 specific data from that for this.

28 Q Well, not for this, but are you aware of the
29 program generally in any of your dealings?

30 DR. STEPHEN: I'm -- again, I'm not sure of the name.
31 Are you referring to what was done for the salmon
32 farms by the Province or for the hatcheries?

33 Q No, for the salmon farms.

34 DR. STEPHEN: Oh, okay, then I have some awareness of
35 that, a passing awareness, yes.

36 Q Okay. You provided some assistance in developing
37 this program, I understand?

38 DR. STEPHEN: In the early days of development, yes, we
39 did.

40 Q Okay. You critically reviewed the program when it
41 was initiated?

42 DR. STEPHEN: Our group did, yes.

43 Q Okay. Can you provide me with a summary of your
44 input into the program?

45 DR. STEPHEN: Oh, you're stretching my memory but I'll
46 do my best. It was awhile -- I think initially we
47 were consulted on how might one be able to do some

1 representative and defensible surveillance for
2 disease patterns on salmon farms, given the
3 challenges of resources and the concerns about
4 confidentiality of the industry. So we worked
5 with the Provincial -- I believe it was Dr.
6 Constantine at the time to give them options about
7 how they might be able to gather some of their
8 surveillance data in a way that was hopefully as
9 representative as you can get within those
10 limitations.

11 Q Are you familiar with any other programs like it
12 for any other food animal production industries in
13 Canada?

14 DR. STEPHEN: I'm not aware of any ones that looked
15 generally at a broad suite of diseases. There are
16 a number of targeted programs in other sectors but
17 I'm not aware of other ones in Canada like that.

18 Q Okay. And how does the British Columbia Fish
19 Health and Auditing Surveillance Program as it was
20 run by the Province until 2010 rank against other
21 audit or surveillance programs in Canada with
22 respect specifically to comprehensive coverage of
23 disease in a food animal production industry?

24 DR. STEPHEN: Oh, we've never done that assessment so I
25 couldn't give you any evidence on that.

26 Q Fair enough. And you probably couldn't rank it
27 against other ones in those circumstances?

28 DR. STEPHEN: Well, I mean, in the very general sense,
29 I think it's a very useful and helpful program
30 that provides a significant amount more
31 information than we'll see for other reproduction
32 sectors. But that's in a very broad general
33 sense.

34 Q Fair enough. Now, the food and agriculture
35 organization of the United Nations website
36 provides the following definition for freedom from
37 disease and this is at the Province's Tab 4, and
38 specifically it's the third paragraph.

39 DR. STEPHEN: Okay.

40 Q Okay. And it says:

41
42 Generally speaking, accreditation of disease
43 freedom is possible when there is no
44 clinical, epidemiological or any other
45 evidence of disease or agent of disease
46 presence in an given period of time within a
47 given geographical area. To validate such

1 claims adequate surveillance systems must be
2 in place.
3

4 And I'll stop there.

5 DR. STEPHEN: Okay.

6 Q Okay. Would you agree that the British Columbia
7 Fish Health Auditing Surveillance Program as it
8 was in place until 2010 could provide the support
9 for the designation of freedom from disease.

10 DR. STEPHEN: I would have to look at the numbers of
11 the samples and how they were allocated before I
12 could answer that. Declaration of freedom from
13 disease is more complicated than this and, in
14 fact, the FAO doesn't hold the authority but the
15 OIE does and as you'll see in the following tab or
16 table there , there are some specific requirements
17 for specific diseases. And there's now a
18 significant shift towards doing scenario-based
19 assessment of freedom from disease, so you'd have
20 to have a significant amount of data before making
21 that decision.

22 Q Okay. And you're not aware of the data that the
23 Province was holding?

24 DR. STEPHEN: You would have to look at it in details
25 in terms of sample sizes, representation,
26 geographic distribution, all those sorts of things
27 before you can make that consideration.

28 Q Okay. And do you have any information on what
29 numbers would generally be required?

30 DR. STEPHEN: No. It depends on population sizes,
31 agreed-upon levels of confidence, all those sorts
32 of things.

33 Q So if we could turn to the Province's Tab 3 -- I
34 apologize. Sorry. The Province's Tab 2.

35 THE REGISTRAR: Did you wish to mark that Tab 4?

36 MS. CALLAN: Oh, yes. Actually, before we turn to
37 that, I'll mark Tab 4 for the record.

38 THE REGISTRAR: It will be 1469.
39

40 EXHIBIT 1469: Supporting Claims of Freedom
41 from Disease - UN FAO website extract
42

43 MS. CALLAN:

44 Q So this document summarizes the number of animals
45 tested by PCR for infectious salmon anaemia virus.
46 It also lists the publicly-available websites that
47 contain this information. This table shows tissue

1 from 4726 fish which have been tested as part of
2 this program over the last eight years and all
3 test results have been negative. Would you
4 consider these results to be sufficient evidence
5 that B.C. has demonstrated freedom from ISA?

6 DR. STEPHEN: I couldn't elaborate on my last question
7 -- or answer about the complexity of doing that
8 with just the numbers. It will depend on the
9 number of pens, the number of farms, the
10 prevalence. There's a whole bunch of things that
11 come into the concluding freedom from disease.

12 Q Okay.

13 DR. STEPHEN: Now, I can say that this is a significant
14 number of animals. We look at some of our ongoing
15 screening for endemic problems or food safety
16 issues that might be done federally, this is a
17 larger sample size than you'll see in a lot of
18 other ongoing monitoring programs. But adequacy
19 for freedom from disease would take some time to
20 calculate and figure out.

21 Q I'd like to ask you a set of questions based on
22 your expertise in epidemiology. You have provided
23 advice for the development of several disease
24 auditing, monitoring and surveillance programs
25 around the world?

26 DR. STEPHEN: We have, yes.

27 Q Is it a standard part of you advice to include
28 recommendations that source farm data be
29 identified and all disease and veterinary records
30 and that those records be made freely available to
31 the public?

32 DR. STEPHEN: No, not for all cases that we worked on.

33 Q Have you ever recommended that?

34 DR. STEPHEN: I couldn't say with certainty. I could
35 say with certainty if your objective -- the design
36 of a surveillance system always depends on the
37 objective. Sometimes we design things for
38 individual agencies, sometimes for provinces,
39 sometimes for nations. When you want a degree of
40 public transparency, the importance in our view is
41 to be able to demonstrate adequate representation
42 as opposed to identifying sources for attribution.
43 If your goal is for other monitoring for source
44 attribution, then you have to have information.
45 It's quite -- about the specific place. It's
46 quite common for agricultural monitoring systems
47 to not name the owner of the farm per se but give

1 it on a broader geographic basis and a lot of that
2 comes from, you know, freedom of information and
3 personal privacy legislation.

4 Q Would you recommend this?

5 DR. STEPHEN: For what purpose?

6 Q Well, would you recommend that farms be identified
7 by source or do you recommend that in surveillance
8 programs if there is disease that they do not be
9 identified by source and rather are just
10 identified by geographical area?

11 DR. STEPHEN: I think that it's important if you're
12 doing surveillance to control the disease that
13 somebody knows the source so that you can find it,
14 you can trace it back. I don't know that -- it is
15 not a matter of epidemiology to decide whether
16 that information is publicly available. That's a
17 public policy issue.

18 Q Okay. Would you agree that a program promising to
19 share farm-specific disease records with the
20 public might actually increase the chance that a
21 disease outbreak would go undetected and possibly
22 unreported?

23 DR. STEPHEN: Sorry? So you're saying do I agree that
24 if a system identifies individual farms it would
25 increase -- decrease the likelihood of detection?
26 It depends on how you're detecting the disease.
27 If you're requiring individuals to report, there
28 can be problems as we've seen with things like
29 avian influenza. Farmers are reluctant to report
30 because of the large penalty to being found
31 positive and we've seen submissions for poultry
32 drop precipitously in a situation like that. If
33 you're doing active surveillance where you have
34 your own staff going out and looking, then it
35 shouldn't have an effect.

36 Q Okay. Is there a generally-accepted worldwide
37 standard related to disease surveillance programs
38 in sharing of source farm information?

39 DR. STEPHEN: Not that I'm aware of.

40 MS. CALLAN: Mr. Commissioner, is this a good time for
41 the afternoon break?

42 THE COMMISSIONER: Yes. Thank you.

43 THE REGISTRAR: Hearing will now recess for ten
44 minutes.

45

46 (PROCEEDINGS ADJOURNED FOR AFTERNOON RECESS)

47 (PROCEEDINGS RECONVENED)

1 THE REGISTRAR: Order. The hearing is now resumed.

2

3 CROSS-EXAMINATION BY MS. CALLAN, continuing:

4

5 Q And one last question with respect to the fish
6 health auditing and surveillance programs. Can
7 you name a specific surveillance and auditing
8 program that does identify farm source?

9 DR. STEPHEN: Any species you're thinking of?

10 Q Yes.

11 DR. STEPHEN: Not publicly. Not off the top of my
12 head, no.

13 Q Okay. Can you describe the differences between
14 *Gyrodactylus* species and *Gyrodactylus salaris*?

15 DR. STEPHEN: Only very generally. I'm not a
16 parasitologist. I mean, perhaps you want the
17 parasitologist to answer that question.

18 Q Okay.

19 DR. STEPHEN: He'd be much better suited than myself.

20 DR. KENT: And Dr. Johnson might want to follow up.
21 I'll give my answer, and I'm sure Dr. Johnson
22 might be able to expand on that as well, too.
23 There are hundreds of species of *Gyrodactylus*.
24 They're pretty host specific, for the most part.
25 That means they're only going to occur on, you
26 know, on one genus of fishes or even particular
27 species. The vast majority of them are moderately
28 pathogenic, or -- are not that pathogenic and only
29 become pathogenic in captive situations when water
30 -- when the fish are crowded, et cetera.
31 *Gyrodactylus salaris* is quite a different story.
32 This one is pathogenic. In a unique situation it
33 was introduced from Sweden into Norway and the
34 Norwegian Atlantic salmon in that scenario were --
35 are highly susceptible to it and is associated
36 with actual disease and mortality and wild salmon
37 there, where most of the other *Gyrodactylus*, if I
38 was, as a fish disease diagnostician, if I found a
39 few *Gyrodactylus* species on a fish I wouldn't be
40 too concerned about it.

41 Q Okay. So essentially, it's fair to say, then,
42 that *Gyrodactylus* species is a general form of a
43 parasite that is not very virulent, but the
44 *Gyrodactylus salaris* is one variety of those
45 species that is very virulent.

46 DR. KENT: Virulent, yes, that's right.

- 1 Q And there's no diagnostic test that's available
2 for *Gyrodactylus salaris*, but there is one
3 available for *Gyrodactylus* species?
- 4 DR. JOHNSON: Okay, actually, as part of the National
5 Aquatic Animal Health Program, Dr. Abbott has done
6 a large survey of *Gyrodactylus* species in British
7 Columbia and actually in western Canada, and
8 *Gyrodactylus salaris* is mentioned in the appendix
9 that's associated with the **Health of Animals Act**,
10 and so there are now molecular diagnostic tests
11 developed which will identify that species from
12 all of the *Gyrodactylus* species.
- 13 Q And when was that developed?
- 14 DR. JOHNSON: Oh, over the last couple years.
- 15 Q Okay.
- 16 DR. JOHNSON: Year and a half.
- 17 Q And it's very uncommon for it to be tested in
18 Canada?
- 19 DR. JOHNSON: I haven't -- I don't really know. It's
20 not -- if it's -- if it is an issue of the CFIA,
21 if they're interested in it, then they will decide
22 on the testing regime.
- 23 Q Okay. And *Gyrodactylus salaris* has not been
24 identified in British Columbia waters?
- 25 DR. JOHNSON: To my knowledge, it hasn't.
- 26 Q Okay. If you could turn to report 2010-1100 of
27 the Freshwater Fisheries Society's case reports.
28 This is in the Conservation Coalition's book of
29 documents, and I believe it's Tab 1. If you look
30 to the second paragraph, it says:
31
32 Presumptive Findings: Bacterial Gill Disease
33 is causing mortalities...
34
35 Would you agree that that's the cause of death in
36 this particular case report?
- 37 DR. JOHNSON: I've actually, until this just -- this
38 exact moment, I've never reviewed this case
39 before. And I'm also not a veterinarian, so...
40 Can we scroll to the top, please?
- 41 Q So if we could just scroll up a little bit as
42 well.
- 43 MR. LUNN: This is the top of the page.
- 44 Q Yeah, it's under the Presumptive findings," so
45 it's in the body with the last paragraph.
- 46 MR. LUNN: What would you like me to enlarge?
- 47 Q Starting from "Presumptive findings".

1 MR. LUNN: That's where I was, and the witness asked me
2 to scroll up.

3 MS. CALLAN:

4 MR. LUNN: So I'm just trying to accommodate.

5 DR. JOHNSON: I don't know and...

6 DR. KENT: I can make a comment on this. So I guess
7 I'm reading the report, 30 out of 30 were positive
8 for bacteria consistent with the agent that causes
9 Bacterial Gill Disease, that's a reasonable
10 presumption. Bacterial Gill Disease is well known
11 to be associated with negative water quality
12 conditions. The diagnosis from this, what I'm
13 reading here, sounds reasonable. Dr. MacWilliams,
14 she probably deals with this kind of thing all the
15 time. She might want to expand on that.

16 DR. MacWILLIAMS: No, that looks fine. I just can't
17 read the bottom of the page where it mentions
18 *Gyrodactylus*.

19 Q Yes. If you'd scroll -- there is -- I'll get to
20 that. I'm advised by the Freshwater Fisheries
21 Society that a clerical error was made and the
22 test for *Gyrodactylus* species was inputted as
23 *Gyrodactylus salaris*, and I understand the
24 Conservation Coalition will be making some use of
25 this. So my question to you, because I'm advised
26 by the Freshwater Fisheries Society that this was
27 a clerical mistake is, based on your expertise
28 looking at this, is bacterial kidney -- or, sorry,
29 is Bacterial Gill Disease more likely than the
30 *Gyrodactylus salaris*?

31 DR. KENT: It would depend on the severity of the
32 *Gyrodactylus* infection. And actually,
33 *Gyrodactylus* generally occurs on the skin, whereas
34 *Dactylogyrus* would normally occur in the gills, so
35 I'm kind of questioning that diagnosis as well,
36 too. But that aside, it's a numbers game with
37 parasite infections, regardless of the precise
38 diagnosis. Seeing a lot of numbers of monogenes
39 on the gills would also support water quality
40 conditions that were suboptimal so that seeing
41 gill monogeneans, presumably *Gyrodactylus* as I
42 report here, would not be surprising to see these
43 co-infections with Bacterial Gill Disease.
44 Sorting out which one is the primary cause and
45 which one is the secondary, that would be rather
46 difficult. I think I see 50 percent, if that's
47 what I'm seeing, 50 percent were infected with the

1 *Gyrodactylids*; the monogenes, a hundred percent
2 with the Bacterial Gill Disease, so probably the
3 Bacterial Gill Disease was more important at that
4 point.

5 MS. CALLAN: Okay. And Mr. Lunn, I provided you with a
6 document on the break.

7 MR. LUNN: Yes.

8 MS. CALLAN: Could you turn to the page -- the document
9 from the Freshwater Fisheries Society?

10 MR. LUNN: I don't have that as available
11 electronically. I only have your hard copy.

12 MS. CALLAN: Okay.

13 MR. LUNN: I can hand that up, if you'd like, or --

14 MS. CALLAN: I have copies, so I can hand that out as
15 well.

16 MR. LUNN: Certainly.

17 MR. MARTLAND: Mr. Commissioner, I just want to slow
18 down to this extent, that we're being handed
19 something in real time, but sometimes it's emailed
20 the day of. I don't know who's seen this and
21 whether counsel have seen it or can take a
22 position on the fly. Perhaps this is something,
23 if Ms. Callan is able, to leave this down the list
24 of questions. At least counsel receiving the
25 paper now will have the opportunity to lead it.

26 MS. CALLAN: My understanding is the Aquaculture
27 Coalition got a similar letter that sets out the
28 same information from myself. I have handed this
29 copy as well to the Conservation Coalition, as
30 well as the same letter that was sent to the
31 Aquaculture Coalition that sets out the
32 information.

33 I just want to clarify a mistake before it
34 gets brought up in cross, so I'm just trying to
35 anticipate my friends' crosses, and I wasn't aware
36 of this until I reviewed the documents that the
37 Conservation Coalition was relying on, on the
38 weekend.

39 I can leave this till the morning, though, if
40 that makes it easier. In the interim, I'd like to
41 mark Tab 1 of the Conservation Coalition's book of
42 documents as an exhibit.

43 THE REGISTRAR: Exhibit 1470.

44

45 EXHIBIT 1470: PARIS Fish Health Case
46 Details, Case 2010-1100 Diagnostic, for

1 Little Campbell River Hatchery, dated
2 February 14, 2011
3

4 MS. CALLAN: And I would also like to mark Tab 2 of the
5 Province's book of exhibits as well as the next
6 exhibit.

7 THE REGISTRAR: What tab was that again?

8 MS. CALLAN: Tab 2.

9 THE REGISTRAR: Tab 2 will be 1471.

10
11 EXHIBIT 1471: Publicly available PCR test
12 results for ISAV in British Columbia farmed
13 salmon from 2003-2010
14

15 MS. CALLAN:

16 Q If we could move onto another subject, and
17 tomorrow we'll revisit whether or not the letter
18 can be marked as an exhibit, Dr. Kent, you've
19 concluded that no specific pathogen is a major
20 cause of demise to the Fraser River sockeye
21 salmon?

22 DR. KENT: No, that's not -- I've concluded that we
23 cannot identify a specific pathogen to be the
24 cause of the demise of that. In making that
25 conclusion, based on the lack of data - I know
26 this may seem like splitting hairs - but I'm not
27 saying we've excluded the possibility that a
28 single pathogen is the cause of the demise of
29 sockeye salmon.

30 Q That's fair enough. I wouldn't want to put words
31 into your mouth. Prolonged changes in water
32 temperature either in freshwater or seawater can
33 be a significant factor to the demise of Fraser
34 River sockeye salmon?

35 DR. KENT: Well, I'm not a -- this is getting a little
36 bit outside my area, but that seems to be a
37 reasonable -- a reasonable statement, and that it
38 is well known that temperatures really do play a
39 very significant role on the proliferation of
40 pathogens in and outside of their host, as well as
41 immune status of the host, the salmon host. An
42 example would be, we always talk about temperature
43 affecting salmon and they have their cold water
44 species, they like to be in cool water. You can
45 have a situation where the waters are quite warm,
46 but in the absence of pathogens the fish are doing
47 relatively okay. If you add pathogen on top of

- 1 warm water, and then you can see problems with
2 that.
- 3 Q Would you agree that considerable differences in
4 virulence and lethality can occur when a pathogen
5 infects different salmon species or in different
6 environmental conditions and thus linking these
7 diseases with potential problems and wild sockeye
8 salmon should be made with some caution?
- 9 DR. KENT: Yes.
- 10 Q Now, I understand that lab studies can provide the
11 basis of a hypothesis. For example, if lab
12 exposure to ISAV kills Atlantic salmon but not
13 Pacific salmon, you can hypothesize that ISAV is a
14 greater risk to Atlantic salmon than Pacific
15 salmon; would you agree with that?
- 16 DR. KENT: I would agree with that.
- 17 Q Now, when you created your subjective levels of
18 risk, did you use a standard risk analysis matrix,
19 such as consequence times probability, or is it
20 more subjective?
- 21 DR. KENT: It was more subjective that, and as I said
22 at the beginning of our hearings today, I guess,
23 in retrospect, it would have been better to say,
24 "high impact/low impact/moderate impact" instead
25 of using the term "risk", because I was using the
26 term "risk" in a different context than
27 epidemiologists and some others might use it in.
- 28 Q Okay. So I'm going to move onto the topic of sea
29 lice for a few moments. Would you agree that *L.*
30 *salmonis* are marine copepods that are not found in
31 water below a certain salinity?
- 32 DR. KENT: That's my understanding, yes.
- 33 Q And that *L. salmonis* infection in pink salmon
34 causes mortality only in fish less than 0.7 grams
35 and when subject to high concentrations of lice?
- 36 DR. KENT: That's my understanding from review of the
37 literature. And actually, Dr. Johnson, if I'm
38 wrong, he's the expert on sea lice, so if he sees
39 I'm making an error, I would not be offended if he
40 corrects me or chimes in and expands on the
41 questions.
- 42 DR. JOHNSON: Yes, that 0.7 gram was based on the work
43 of Dr. Jones, who will be testifying on the sea
44 lice.
- 45 Q Okay. And if we could turn to the Conservation
46 Coalition's Tabs 17 and then 19, but we'll start

1 with 17. Would you agree that this is the
2 scientific paper that forms the basis of this?

3 DR. KENT: I believe so.

4 MS. CALLAN: Mr. Commissioner, can we mark this as the
5 next exhibit?

6 THE REGISTRAR: Tab Number 17 will be marked as 1472.

7

8 EXHIBIT 1472: Journal of Fish Diseases,
9 2008, Early development of resistance to the
10 salmon louse, *Lepeophtheirus salmonis*
11 (Kroyer), in juvenile pink salmon,
12 *Oncorhynchus gorbuscha* (Walbaum), by S.
13 Jones, E. Kim and W. Bennett

14

15 MS. CALLAN: And if we could turn to Tab 19, now.

16 Q Is this also authority for the same point?

17 DR. JOHNSON: Yes, I believe so, it is.

18 MS. CALLAN: Mr. Commissioner, could we mark this as
19 the next exhibit?

20 THE REGISTRAR: Tab 19 will be marked as 1473.

21

22 EXHIBIT 1473: Diseases of Aquatic Organisms,
23 Infection Threshold to estimate
24 *Lepeophtheirus salmonis*-associated mortality
25 among juvenile pink salmon, by Simon Jones
26 and Brent Hargreaves

27

28 MS. CALLAN:

29 Q Now, you would agree that when sockeye smolts are
30 doing their outmigration, they are substantially
31 larger than 0.7 grams and that generally they're
32 between 20 and 50 grams?

33 DR. KENT: They're way -- they're much larger than 0.7.
34 I'm not sure 20 or 50. That seems about -- I
35 would say around 20, just depending on the run, et
36 cetera. Maybe my colleagues can expand on that,
37 but somewhere around 20 grams. Yet, yeah,
38 basically 20 times the size of that 0.7 grams, at
39 least.

40 Q Would you agree that's a reasonable hypothesis
41 that *L. salmonis* is not a significant source of
42 mortality, then, for sockeye smolts?

43 DR. KENT: It's a reasonable hypothesis at this time,
44 that's why I put it at a lower -- I assigned it to
45 a lower impact or risk -- risk level. That was
46 based largely on that. Dr. Johnson has something
47 else to add to that.

1 DR. JOHNSON: Yeah, the majority of sea lice that had
2 been found on the sockeye salmon, onto the genus
3 *Caligus*, *Caligus clemensi*, so that's not -- *Lep.*
4 *Salmonis* is the least abundant of the different
5 species of sea lice found on sockeye in the
6 studies that I'm aware of and in our work on
7 Georgia Strait.

8 Q Thank you. In your experience with DFO in the
9 1990s, were you aware of situations in which sea
10 lice, and specifically *L. salmonis*, infested
11 Atlantic salmon in sea farms?

12 DR. KENT: I guess this would be for me. Yes, yes, I'm
13 aware of infestations. I'm not aware of any
14 catastrophic outbreaks to the -- for the farms
15 that I was working with, but certainly the work
16 that I was doing on farms, I would find sea lice
17 on farms. I can't give you -- at that time, there
18 wasn't much as interest in sea lice, and it was
19 more or less an incidental finding in contrast
20 that was what had been seen more or less around
21 the same time on the east coast.

22 DR. JOHNSON: I can remember one instance where there
23 was heavy enough lice load on fish in the Sunshine
24 Coast which necessitated the sea lice treatment.
25 Effectively, I stopped working on sea lice in B.C.
26 because it simply wasn't an issue. When I --
27 after I finished my PhD I went on and did other
28 things. There were always sea lice presences, as
29 Dr. Kent said, but they were at levels which
30 didn't cause any harm to the animals that were
31 being cultured.

32 Q So it's fair to say, then, that sea lice
33 infestation of farmed Atlantic salmon in the 1990s
34 was fairly common?

35 DR. JOHNSON: I would say that in the 1990s, based on
36 my recollection of being able to go to salmon
37 farms to collect sea lice, it was easier to find
38 sea lice on salmon farms in the 1990s than it is
39 now, because of the use of SLICE treatments.

40 Q Dr. Johnson, you published a scientific paper in
41 1993 on the efficacy of sea lice treatment on
42 Atlantic salmon, and this is at Provincial Tab 8?

43 DR. JOHNSON: Yes, that's my paper. Sorry, I was just
44 trying to look over my glasses to read it.

45 MS. CALLAN: Okay. If we could mark this as the next
46 exhibit.

47 THE REGISTRAR: 1474.

1 EXHIBIT 1474: Diseases of Aquatic Organisms,
2 Efficacy of ivermectin for control of the
3 salmon louse *Lepeophtheirus salmonis* on
4 Atlantic salmon, by S.C. Johnson and L.
5 Margolis
6

7 MS. CALLAN:

8 Q Was your research done in response to the
9 perceived need from the B.C. Aquaculture industry
10 because they had fish that were infested with sea
11 lice?

12 DR. JOHNSON: No, I -- this research sort of stemmed
13 out of my interest in possible routes of parasite
14 control, more as -- more related to the global
15 issue that was being experienced in other parts of
16 the world than in British Columbia.

17 Q And you'd agree that salmon, *L. salmonis*, in
18 British Columbia or the Pacific ocean waters is
19 genetically different from *L. salmonis* in the
20 Atlantic ocean?

21 DR. JOHNSON: If you look at the work that Dr. Ben Koop
22 and I -- and Dr. Jones is involved with, and he'll
23 be on the stand, there is good evidence that there
24 are considerable genetic differences or sequence
25 differences between the Pacific and the Atlantic
26 form of *Lepeophtheirus salmonis*.

27 Q Okay. Now, I'm just going to turn to an issue
28 with respect to sea lice in the 1990s. Several
29 scientific papers without access to provincial or
30 federal or farm sea lice data, for example,
31 Brendan Connors' 2011 paper, which is set out at
32 Provincial Tab 14, claim that sea lice
33 infestations of wild salmon began in 2001. In
34 contrast, another scientific paper that had access
35 to the provincial sea lice data published by Dr.
36 Marty in 2011 claimed that farm-sourced sea lice
37 probably infested juvenile pink salmon many years
38 before the pink salmon were first examined for sea
39 lice in 2001. Which one of these assumptions best
40 fits your experience with sea lice in British
41 Columbia during the 1990s?

42 DR. JOHNSON: As I mentioned, in the 1990s, sea lice
43 were always present on salmon farms at levels
44 which made it worthwhile going to the salmon farms
45 to collect sea lice. Now, it's extremely
46 difficult to do sea lice research in B.C., because
47 it's often difficult, unless you go to wild fish

1 when they're returning, to get sufficient sea lice
2 from a salmon farm to conduct any sorts of studies
3 on sea lice.

4 MS. CALLAN: Okay. If we could mark Provincial Tab 14
5 as the next exhibit.

6 THE REGISTRAR: 1475.

7
8 EXHIBIT 1475: Journal of Applied Ecology,
9 Coho salmon productivity in relation to
10 salmon lice from infected prey and salmon
11 farms, by Brendan Connors, Martin Krkosek,
12 Jennifer Ford, and Lawrence Dill
13

14 MS. CALLAN:

15 Q Dr. Johnson, have you read the paper, Sea Louse
16 Infection of Juvenile Sockeye Salmon in Relation
17 to Marine Salmon Farmers on Canada's West Coast?
18 This is set out at Provincial Tab 23.

19 DR. JOHNSON: Yes, I've read the paper by Mr. Price.

20 Q This paper suggests that sea lice levels on
21 sockeye were greatest closest to salmon farms;
22 would you agree?

23 DR. JOHNSON: I have a few issues with this paper and
24 the companion paper which dealt with pink and chum
25 salmon. It's very interesting, if you look at the
26 maps that they provide in those two papers,
27 they're essentially the same map, but sites which
28 are being identified as being highly impacted or
29 not impacted differ between the two papers. So
30 it's a bit unclear to me as to how they actually
31 assigned these -- whether the sites were heavily
32 impacted or not. And I also disagreed a bit -
33 this is based on my memory - of the exclusion of
34 one site, which was far away from the outside of
35 their range of salmon farms, because the sea lice
36 counts were abnormally high, according to those
37 authors.

38 The other thing that I worried about was the
39 fact that for their comparison they used fish that
40 were caught by a completely different method, if
41 I'm not mistaken, and fish from a completely
42 different environment which was, I believe, up
43 just south of the Skeena.

44 Q You were anticipating most of my questions.

45 DR. JOHNSON: Well, this is what I read into this paper
46 when I looked at it. I think it's really

1 important to compare this one to their other paper
2 on pink and chum.
3 Q Okay. So you would agree that this paper excluded
4 sockeye caught in outlier sites amongst the
5 Discovery Islands?
6 DR. JOHNSON: It excluded sockeye caught downstream
7 from a fish processing plant in only one of the
8 years that they studied it. And I'd like to say
9 that we do get similar sea lice counts on fish, on
10 sockeye salmon, in the Strait of Georgia, but
11 there's also -- we get some big sea lice counts of
12 fish caught from much further south than the
13 Strait of Georgia. But, of course, the work that
14 we're doing is in a different year than these
15 authors did.
16 Q Okay. Now, they say they had the furthest -- the
17 highest level of sea lice was furthest away from
18 the salmon farms?
19 DR. JOHNSON: If I remember correctly, it was the
20 furthest away, but downstream from a processing
21 plant.
22 Q Now, my understanding is actually upstream from --
23 DR. JOHNSON: Or okay, I'm sorry. I'm thinking down is
24 down a bit. Yes, upstream from the processing
25 plant.
26 Q Okay. And I understand their theory was that the
27 salmon processing plant was the cause of the
28 infection?
29 DR. JOHNSON: I believe that was the theory that they
30 proposed.
31 Q And it was approximately eight kilometres
32 upstream; do you agree with this suggestion that
33 the authors of the paper put out?
34 DR. JOHNSON: I have no knowledge about what the salmon
35 plant was processing, if anything, at the time the
36 study was done. And it would be interesting that
37 if it was -- needed to be excluded in one year,
38 why didn't it need to be excluded in the
39 subsequent year?
40 Q And you'd agree that it's highly unlikely that the
41 sea lice were actually swimming upstream eight
42 kilometres to infect the salmon?
43 DR. JOHNSON: I think that this whole study of this
44 area is -- needs to consider the fact that there
45 are tidal flows that go in both directions. And
46 if I remember correctly, from the physical
47 oceanographers, that these tidal flows cover this

- 1 whole area that these papers talk about in both a
2 north and a south direction. So this area is
3 actually fairly well mixed, although, as I
4 understand, the major direction of water is
5 northwards, but on the tidal changes you can have
6 water going kilometres south and then kilometres
7 back north. So I don't think that it -- it would
8 be very hard for me, as an individual, to say
9 which sites in this area were impacted from salmon
10 farms based on that high level of tidal mixing.
- 11 Q Okay. Now, I understand that the author also
12 compared with the north coast. Would you agree
13 that this comparison is quite weak because of the
14 differing salinity levels?
- 15 DR. JOHNSON: I was more concerned, if I remember
16 correctly again, that there was a switch in the
17 type of gear that was used. And in one of the
18 papers they did express some concern, I believe,
19 that some lice were potentially under-sampled. I
20 can't remember exactly where it is.
- 21 Q Okay. Now, if we could turn to Figure 3 of
22 Provincial Tab 23. Would you agree that it shows
23 sea lice levels were higher in 2008 than in 2007?
- 24 DR. JOHNSON: Figure 3? Okay. I'm sorry, I have a
25 hard time seeing with these multi-focal lenses.
- 26 Q Yeah, so if you actually look to the --
- 27 DR. JOHNSON: Yeah.
- 28 Q -- figure it says that the solid line is 2007 and
29 the dotted line is 2008.
- 30 DR. JOHNSON: It would appear to me that the levels
31 were higher in 2008, but I would like to point out
32 that the actual abundance that we're talking about
33 is extremely low, ranging from zero to 0.2 sea
34 lice per fish.
- 35 Q Okay. That's a very good point as well. Would
36 you agree that because the sea lice levels were
37 higher in 2008 than 2007, that means that the
38 outmigrating fish for the 2010 adult returns had
39 higher levels of sea lice than in 2008 adult
40 returns?
- 41 DR. JOHNSON: I can't say that that would be for all of
42 the fish which were outmigrating. For the fish
43 that they sampled, that would, to me, appear to be
44 the case. But if you'd gone out two weeks later,
45 I don't know what you would have found.
- 46 Q Okay. If we could turn, now, to the topic of IHN,
47 and my questions will be directed to Dr. Kent.

1 In your report, you state that sockeye smolts have
2 a high risk exposure to IHN in both freshwater and
3 marine environments, and this is set out on page
4 19 of your report?

5 DR. KENT: Okay.

6 Q Would you agree that sockeye, once they enter
7 seawater, are not as susceptible to IHN as
8 compared to when they're in the freshwater, as
9 smolts and fry?

10 DR. KENT: Yes, I would agree with both that as relates
11 to their size susceptibility, and probably -- and
12 certainly, from what we know about where IHN
13 concentrations of IHN in spawning grounds, et
14 cetera, I would assume that they're also going to
15 be exposed to less virus in the marine environment
16 than they would in freshwater. So they have two
17 things going for them in the marine environment;
18 they're larger at that time, and they're also
19 going to be less -- I would -- I'm not a
20 virologist - Dr. Garver could probably expand on
21 this - but I'm pretty confident that there's much
22 lower concentration of IHN virus in the marine
23 environment than there is in the freshwater
24 environment.

25 Q Now, on page 5 of your report you said Traxler, in
26 1993, showed that while field observation of
27 clinical disease is confined to fry, experimental
28 exposure of 20 gram sockeye salmon in seawater
29 result in low mortality than cohabitated with
30 infected fish?

31 DR. KENT: Yes.

32 Q Okay. Is that statement perhaps a tad bit
33 overstated, or...?

34 DR. KENT: Well, I could expand on that. It's
35 basically this gets back to some more discussions
36 earlier today about comparing lab studies to field
37 studies. What this does tell us is that larger
38 sockeye salmon are capable of becoming infected by
39 cohabitation with infected fish. I was actually
40 involved with the study, I think I'm a co-author
41 on this paper, where these are basically done in
42 marine tanks in much closer proximity with
43 infected fish than they would be in a wild
44 situation.

45 Q Okay. And certainly in those two experiments both
46 yourself and Dr. Traxler had one tank of injected
47 Atlantic salmon and one tank with injected sockeye

1 salmon, so actually infected by injection with
2 IHN?

3 DR. KENT: Right.

4 Q And they were put in there for -- with 25
5 uninfected sockeye salmon in each sample group, so
6 two tanks, and 25 uninfected sockeye with other
7 fish that had been injected with IHN?

8 DR. KENT: If I recall, that was going on 20 years ago
9 when we did this study, but I mean, I've written
10 some 200 papers on fish diseases, I'll try to
11 remember this one, but they -- that the donor
12 fish, I agree with you, that if I seem to recall,
13 that the donor fish were established by injecting
14 them with virus so that we would know that they
15 would be shedding a large a number of virus and
16 then cohabitated them with other fish.

17 Q Okay. And of all of the sockeye that died, there
18 was actually only one that died?

19 DR. KENT: Yeah, that seems to be -- that seems to be
20 consistent with my recollection.

21 Q Okay. And that would not be statistically
22 consistent with zero?

23 DR. KENT: I would imagine it's not statistically
24 different. Again, what I'm saying is what this
25 study showed is that sockeye salmon of this size
26 under extreme conditions one could conclude from
27 these lab situations, are capable of becoming
28 infected and dying from IHN.

29 Q Okay. Would you agree, then, that perhaps stating
30 it was a higher risk in saltwater should be
31 modified to moderate?

32 DR. KENT: Well, the reason why I -- and maybe I would
33 be fine with either way. This is a problem with
34 this subjectivity that we have here. I also
35 understand that there's some new work being done
36 at Pacific Biological Station, where they're
37 showing some variability in subtypes of, you know,
38 the type of virus and the strain of IHN virus that
39 occurs in B.C., that there is some variability,
40 even within that one single strain in the
41 virulents, so that would be one concern.
42 So one could conceive of the scenario of a much
43 more pathogenic virus in the marine -- IHN virus
44 in the marine environments. The IHN virus is an
45 RNA virus and these types of viruses are well
46 known to mutate very quickly and change in their
47 pathogenicity quite rapidly. So it's something

1 that I would put it on the high -- potentially
2 high impact to put it on the warning for, you
3 know, if I was going to direct people to be
4 looking at potential pathogens is to keep IHN on
5 the list for fishes in the marine environment.
6 Q Okay. And Dr. Johnson, do you agree with that
7 statement?
8 DR. JOHNSON: I agree that I think that IHN virus has a
9 -- could play a role in sockeye population
10 dynamics. I'm not sure about the rate at which it
11 mutates. As I understand it, there is only a
12 single genotype found in sockeye salmon at this
13 time in B.C., yeah. I should say in all of B.C.
14 DR. MacWILLIAMS: I would add that you mentioned there
15 may be work being done with different strains at
16 the biological station. That's not correct. The
17 only work that we're doing is with the endemic
18 strain in B.C. The areas of strain that's been
19 shown in Washington that's showing increased
20 virulents for steelhead populations, cultured
21 steelhead populations, but that's not a strain
22 that we have in British Columbia.
23 DR. KENT: Okay, thank you.
24 Q Would you agree, though, that Atlantic salmon are
25 much more susceptible to IHN than sockeye salmon?
26 DR. KENT: Yes, Atlantic salmon are much more
27 susceptible to IHN than Atlantic salmon -- I mean,
28 Atlantic salmon are much more susceptible than
29 sockeye salmon.
30 Q Perfect. There are a no reported cases of IHN in
31 salmon farms in the last five years, that you're
32 aware of?
33 DR. KENT: I think others that are actively working in
34 B.C. could respond to that better than I can.
35 DR. JOHNSON: As far as I'm aware, there's no reported
36 cases of IHN in salmon farms in British Columbia
37 in the last five years.
38 MS. CALLAN: I note the time, we're at four o'clock.
39 If the Commissioner wants to break for the day, I
40 can start again tomorrow.
41 THE COMMISSIONER: Thank you.
42 THE REGISTRAR: Ms. Callan, did you wish to mark your
43 Tab 23?
44 MS. CALLAN: Thank you for that, if we could mark Tab
45 23 as the next exhibit?
46 THE REGISTRAR: Yes, that will be 1476.
47

1 EXHIBIT 1476: Sea Louse Infection of
2 Juvenile Sockeye Salmon in Relation to Marine
3 Salmon Farmers on Canada's West Coast, by
4 Michael Price, et al
5

6 MS. CALLAN: And if we could also mark Provincial
7 Tab 7, which is the paper that we were talking
8 about, the IHN, as the next one?

9 THE REGISTRAR: 1477.

10
11 EXHIBIT 1477: Diseases of Aquatic Organisms,
12 Transmission of infectious hematopoietic
13 necrosis virus in seawater, by G.S. Traxler,
14 J.R. Roome, and M.L. Kent
15

16 THE COMMISSIONER: Which tab was that, I'm sorry?

17 MR. LUNN: Tab 7 was the last one --

18 THE COMMISSIONER: Of B.C.'s? Of their documents? All
19 right.

20 MS. CALLAN: That's right. It's the document entitled,
21 Transmission of infectious hematopoietic necrosis
22 virus in seawater.

23 THE COMMISSIONER: Thank you. We're then adjourned
24 until tomorrow morning?

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

27
28 (PROCEEDINGS ADJOURNED TO TUESDAY, AUGUST 23,
29 2011, AT 10:00 A.M.)
30
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34

35 I HEREBY CERTIFY the foregoing to be a
36 true and accurate transcript of the
37 evidence recorded on a sound recording
38 apparatus, transcribed to the best of my
39 skill and ability, and in accordance
40 with applicable standards.
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45 Pat Neumann
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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.

Susan Osborne

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

Karen Hefferland