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No Undertakings given

Wednesday, November 13, 2013
Upon commencing at 9:30 a.m.
THE CHAIRMAN: Good morning. Welcome back. We will reconvene with the Consumers Association and their witness on sturgeon.
Mr. Williams?
MR. WILLIAMS: Good morning members of the panel, Mr. Chair. I would suggest that we have Dr. Peake introduce himself and then Ms. Johnson can affirm or swear him in.
Stephan Peake: Sworn
DR. PEAKE: My name is Stephan Peake, I'm associate professor at the University of New Brunswick in Fredericton.
MR. WILLIAMS: Members of the panel, there should be two documents related to Dr. Peake's presentation. One is an updated curriculum vitae, and the other is a powerpoint. And I will express on behalf of my clients my apologies, we, in terms of preparing the powerpoint, we started preparation yesterday, and Dr. Peake made some subsequent reordering of his powerpoint, so the numbers, the page order that appears on your powerpoint may not necessarily accord with what you see in his presentation. So

I apologize for that. And we make the offer, we weren't anxious to redo 50 copies, but if there is a feeling, anyone who would like us at the break to provide a revised version, we would be more than happy to. And you will accept my apologies.

THE CHAIRMAN: As long as you can direct us to the right page number, no problem.

MR. WILLIAMS: Dr. Peake, if I could just direct you to section 2.3 of your curriculum vitae? Am I correct in suggesting to you that your primary area of research relates to the determination and mitigation of anthropogenic impacts upon fish?

DR. PEAKE: Yes, that's correct.

MR. WILLIAMS: And is anthropogenic a fancy word for human made, or man made or woman made?

DR. PEAKE: Yes, that's true, that's a fair definition.

MR. WILLIAMS: And in terms of the work that your recent graduate students have been performing, would it be fair to say that a considerable focus has been the ecology and aqua-culture of lake sturgeons, the effects of sedimentation on fish and invertebrate

communities, and fish passage over dams and through culverts?

DR. PEAKE: Yes, that would be fair to say.

MR. WILLIAMS: I just want to turn you for a moment to section 4.2 and 5.1 of your curriculum vitae. And Dr. Peake, am I correct in suggesting that section 4.2 highlights the research that your undergraduate or graduate students have been undertaking under your direction?

DR. PEAKE: Yes, that's correct.

MR. WILLIAMS: And you have kindly underlined some of the areas of research that are most relevant to this proceeding and your evidence in this proceeding?

DR. PEAKE: Yes.

MR. WILLIAMS: And likewise in section 5, you have flagged your peer reviewed articles that have been either accepted for publication or published in referee journals. And again you have underlined, not all of your sturgeon work, but some of the key pieces relating to this proceeding. Would that be fair?

DR. PEAKE: Yes, that would be fair.

MR. WILLIAMS: Dr. Peake, how many summers, if any, have you spent in Manitoba examining issues related to lake sturgeon?

DR. PEAKE: It would go back to my graduate work starting my masters degree in the mid '90s, so probably 15 years or so. I wouldn't say that every single one of those years was focused entirely on sturgeon, but from the point of my masters on, there was almost always a sturgeon focus to my research, at least a couple of sturgeon projects. And towards the end of that, so from the early 2000s to the late 2000s, sturgeon was my primary focus in Manitoba. So I was here for probably 14, 15 summers, right from spring until fall, and sturgeon was either a minor, or in a lot of cases a major component of my research.

MR. WILLIAMS: I note that you quite cleverly avoided being here for the winters.

DR. PEAKE: I did actually spend a couple of winters here, but that was enough for me at the time.

MR. WILLIAMS: Keeping in mind both your research and peer reviewed articles, can you describe your research and experience, if any,

with stocking in large northern impounded river systems?

DR. PEAKE: Yes. I mean, if large impounded northern systems would include the Winnipeg River, that's where most of my hands-on sturgeon work has occurred, so Winnipeg River fitting that description. As far as stocking goes, we did one fairly intensive field project on stocking with one PhD student over the course of three or four summers.

MR. WILLIAMS: Okay. And could you describe your research, if any, in understanding the habitat of age zero lake sturgeon ecology, as well as juvenile lake sturgeon ecology in the context of large northern impounded river systems?

DR. PEAKE: Yes. So in the Winnipeg River we did quite a bit of work on juvenile and young-of-year, age zero lake sturgeon. So I would say probably seven years at least in the field. One PhD student and at least two other graduate students at the masters level, along with several undergraduate students, so there was a large component of my work focused on juvenile and young-of-the-year ecology.

MR. WILLIAMS: And could you describe

your research, if any, into the operation of lake sturgeon hatcheries?

DR. PEAKE: Yes. Specifically, we were doing quite a bit of work on age zero lake sturgeon, and whether we could improve hatchery success, and so probably ten years of raising sturgeon at a small experimental facility in Manitoba. So it wasn't always direct research on stocking, but we were always raising fish in the hatchery for use in our other experiments, and at the same time there was one PhD student focused specifically on improving the techniques for sturgeon aqua-culture.

MR. WILLIAMS: And in the course of your work and your years of experience in terms of lake sturgeon in Manitoba, would you have had occasion to have any interaction with the Grand Rapids hatcheries or other hatcheries in Manitoba?

DR. PEAKE: Yes. The first Manitoba hatchery that I had experience with, I actually stayed at the Whiteshell hatchery during my masters degree. They were raising sturgeon there at the time. And I had the opportunity to observe their techniques and do some research on those. So that's where it started in the Whiteshell. And

subsequently, before I was able to raise my own fish, we would get them from Grand Rapids. So there was a fair amount of interaction with the Grand Rapids folks in the '90s, I would say from, not so much in the -- late '90s to late 2000s, we were always interested in whether they had fish available for us to use, because it was fairly difficult for us to get our own juveniles to work with. So I would say indirect, but a reasonable amount of interaction with the two main Manitoba hatcheries.

MR. WILLIAMS: And would you have had any occasion to have interaction with the Wild Rose Hatchery in Wisconsin?

DR. PEAKE: Yes, in the mid '90s, I went down to observe how the folks down at the Wild Rose Hatchery raised their fish, because I was interested in working with sturgeon aqua-culture, and that was the place to go at the time. So I visited the site, I spoke with the main individual that ran the hatchery, and he provided advice on how to maximize survival and some of the procedures that were needed.

MR. WILLIAMS: Dr. Peake, we will get to your powerpoint in just a couple of seconds,

but would it be fair to say that most of your research projects in Manitoba have been funded wholly or in part by Manitoba Hydro?

DR. PEAKE: Yes, that would be accurate.

MR. WILLIAMS: And in terms of Manitoba, would it be accurate to suggest that your primary area of research has been the Winnipeg River?

DR. PEAKE: Yes, that would be accurate.

MR. WILLIAMS: Are you aware of any peer reviewed research relating to lake sturgeon on the Nelson River system?

DR. PEAKE: No, I'm not aware of any peer reviewed lake sturgeon papers from the Nelson River.

MR. WILLIAMS: In terms of the lake sturgeon cycle, Dr. Peake, can you describe any areas in the peer reviewed literature where, in your view, there are knowledge gaps relative to other life stages?

DR. PEAKE: Yeah. I would say that in the past, the juvenile life stage, so in the first year of life, young-of-the-year, has been, I would

say, the most under examined part of the life history, primarily because they are difficult to study. And that's been -- that knowledge gap has been increasing in the past few years with a lot of research coming out of the northern United States. And I would say that currently the knowledge gap is still with juvenile and young-of-the-year fish, and mainly directed at the areas where it is most difficult to work, which is northern latitudes in large deep rivers where it is very difficult to find them, just because they are so small and the water is cloudy and deep.

So we were able to find out a lot of information, thanks to the work that was supported by Manitoba Hydro on the Winnipeg River. And the knowledge around that life stage has been greatly enhanced by that, but I think there is still a lot of work to do on even more northern rivers and other rivers in the northern range of the species.

MR. WILLIAMS: And in terms of any other knowledge gaps, can you comment upon if any relate to age zero?

DR. PEAKE: Specifically age zero, I would say the ability of hatchery reared age zero fish to integrate into a population after its been

stocked, especially in the northern rivers, there hasn't been -- done very little work in Canada on very quantitatively assessing survival rate of age zero fish, post hatchery reared age zero fish that were stocked out in the fall or the spring. So that would be an area of interest.

MR. WILLIAMS: In terms of general sturgeon management, are there any, in your view, any knowledge gaps that you would identify in the peer reviewed literature?

DR. PEAKE: Yeah. Again, I would reiterate in terms of management with hatchery stocking being a popular management tool, again, there is data from the U.S. and that data is a good foundation, but the conditions up here are quite different. And so if hatchery stocking is being used as a management tool, I think there is lots of room for additional study up here.

Another problem with sturgeon management is upstream and downstream migration, trying to get sturgeon upstream past migratory obstructions, and getting them safely downstream past the same, is an area that received a lot of attention but we haven't gotten very far in coming up with good solutions for that.

MR. WILLIAMS: Finally, could you describe comparatively the state of research in terms of large northern impounded rivers as compared to research in more southern or smaller river systems?

DR. PEAKE: Yes. It is much easier to work in water that's a couple of feet deep and in a river that's maybe 20 yards across, or 20 metres across. It is just much easier to operate under those conditions, it is much easier to track fish, it is easier to catch them. So it is not surprising, and there is a lot of interest in the United States for bringing sturgeon back and filling in the knowledge gap. So there has been a lot of research effort on sturgeon in the northern U.S. because it is relatively easy to work there. There has been quite a bit of work.

There is some really fundamental differences in, when you move from a river like that to a river like the Nelson or the Winnipeg, it is much more difficult to work in. We are talking 100 feet deep as opposed to three or four feet deep, very dark water, very cold water, different winter conditions, different productivity of the rivers. So I think that's

probably why I would say that the research, the foundational research that's been done on the Winnipeg River is great, but there really needs to be more work done on the northern rivers to really get an idea of the differences between those two areas.

MR. WILLIAMS: Thank you, Dr. Peake, for your patience, and please feel free to walk us through your powerpoint. I may rarely interrupt, and certainly I think you would invite the members of the panel, if they chose to ask questions as you make your presentation?

DR. PEAKE: Yes. Yes, please feel free to stop me if you want anything clarified or you have a question.

Okay. So I will just get started here. By way of an outline, I was recently reminded that it has been a couple of weeks or so since we've been talking about lake sturgeon. And there is a fair amount of terminology, we have already got into that, you have heard terms like young-of-the-year, and juvenile, and age zero.

So I just would like to start off by reviewing lake sturgeon life histories, some of the terminology. And as I do that, as I take you

through the life cycle and just familiarize you, or refamiliarize you with the terms, I would like to comment on my opinion of the general vulnerability of each of the life stages to mortality, under a variety of conditions.

I would then like to get into my concerns. I will say at this point, reading over the impact assessment, I thought it was generally well done, and I just had a few, in some cases the devil is in the details, and there is just a few concerns that I have, and I'm hoping those concerns will be constructive.

My first concern is related to the sturgeon stocking program as proposed.

My second concern is specifically related to how hatchery lake sturgeon will be marked prior to stocking.

My third concern is in respect to the feasibility and, therefore, the associated risk associated with creating and maintaining juvenile sturgeon habitat at the proposed site.

My fourth concern is related to adult lake sturgeon that may be moving downstream and becoming entrained at the dam, so going over spillways and through turbines at the facility.

So that's the outline, and we will get started with a quick review, hopefully, of lake sturgeon life history.

So as I mentioned and as everybody knows here, I'm sure, lake sturgeon have several different life stages. And I put "stages" in quotes because some of the stages are very defined, very definite, everybody would agree that, you know, that a yolk sac larvae is a yolk sac larvae. Some of the stages are a little more fuzzy in terms of the definitions and what exactly constitutes what.

So I will give you what my sort of definition of these stages are. And each of the stages in a lot of cases have unique behavioral patterns, they have unique vulnerabilities, and they often have unique dietary and habitat requirements. So we will go into this, and I will refer to this cycle, this life cycle. And at the top I have, we will start with spawning adults, and I just want to, whenever the slides are up, the context of the life cycle is defined in the middle of the circle. So in this case I'm assuming that the theoretical population that we are talking about here is healthy. So there is

good representation of all of the life history, or of all of the year classes, there is plenty of juveniles, there is plenty of sub adults, there is plenty of spawners. And I'm also assuming that the habitat is relatively pristine and there is plenty of it for all of the stages.

So given that context, if we start in the spring with the spawning adults, the males and the females will come upstream, often to a rapids or a migratory obstacle. And I should also say that along the bottom there is a very general key as to -- the colour of the box is my assessment of the relative risk of mortality or recruitment failure of that stage. And so green at the top would represent a low probability of recruitment failure, and red would be a higher one, in very subjective terms.

So assuming that the population is healthy, we would assume there is lots of spawning adults. So the box is green in this case because we wouldn't expect -- we would expect the spawners to be there in good numbers. So what happens is in the spring the females would come up to the spawning grounds, and we are again assuming that the spawning grounds are suitable. They would

broadcast eggs. And the females carry many hundred thousand eggs at a time. They would broadcast the eggs over the substrate, and the males would come and expel milt or sperm over the eggs. And they expel it into the water, and so fertilization of the eggs is simply a chance meeting of egg and milt in the water column.

And if all goes well, what you end up with in the next stage is a fertilized egg. And I would say that just, you know, just by nature of the fact that the eggs and the milt are released just sort of haphazard into the water, there is going to be cases where fertilization doesn't occur just because things didn't meet up properly. So I would characterize the mortality risk at that point as moderate. There is going to be definitely a fair number of eggs that don't become, that don't become fertilized.

If the eggs do become fertilized, they tend to get very sticky and they will adhere to the rock substrate that's a vital part of the spawning habitat. They will go into crevices and fissures in the cobble and the rock, and they will stick to those spots and continue to develop. As they develop they hatch out into what we refer to

as yolk sac larvae. The reason they are called yolk sac larvae is because they are fish larvae, but they have a yolk attached to them, not unlike a baby bird might have. And they feed on that yolk sac during further development. So at that point they don't need external food.

At this point, even in the best of situation, they're fairly vulnerable to predation, they are hidden down in the crevices, but they can be eaten by things. So I would say the risk of failure between the egg and the yolk sac larvae is fairly low, just because they are protected down in those rocks. And also one of the advantages of northern locations is that the water temperature at that point is fairly low, and that reduces things like fungal infections and that kind thing. So we would expect fairly good survival from the egg to the yolk sac larvae.

The yolk sac larvae, as I said, will remain in the substrate feeding off the yolk sac and eventually turn into larvae. Larvae is a sturgeon that has completely used up its yolk sac, it has developed a complete digestive system, it is ready to start feeding. So it is going to leave that protective habitat where it has been

and it is going to drift passively downstream for a few days. So at that point it is fairly vulnerable to predation. It is now out in the open. And in a lot of cases, because it could feed off the yolk sac, it didn't need a complete digestive system. And if there were problems with development of that system along the way, that's where some of these fish are going to drop out. So I would say moderate chance of mortality at that point.

And so as I mentioned, these guys will come out of the substrate, drift, hopefully they will find suitable habitat downstream and they will settle out on that habitat and begin what is called exogenous feeding. So when they are feeding off the yolk sac, that's called endogenous feeding. And then they need to switch to very small zooplankton, but they actually need to capture and consume these guys.

So the next point is fingerling, this is occurring from late spring -- sorry, go ahead.

THE CHAIRMAN: This may be where the slides got changed. In our copy at the larvae stage it is red, which is high. Now there it looks to be moderate high on the screen. Which

would be correct for the larvae?

DR. PEAKE: This would be correct.

THE CHAIRMAN: The one that is on the screen?

DR. PEAKE: The one that is on the screen, yes. I apologize for any inconsistencies. I would say in general, almost across the board, what you see on the screen is, if there is any disagreement, this copy would be the accurate one.

THE CHAIRMAN: Thank you.

MR. WILLIAMS: And Mr. Chair, that may be why, at least for the board records, we should have a revised version, and that would be our suggestion, again, with apologies.

THE CHAIRMAN: No problem.

DR. PEAKE: Okay. So, as the larvae start to feed, they again need to start off with -- they are very small at this point, they need to find small zooplankton to eat. But as they grow, they can't continue to be eating these very small animals and expect to grow at any decent rate. So throughout this period they are consistently having to find and adapt to larger prey so that they can grow out properly and become a fingerling.

A fingerling, up here in Manitoba, a fingerling would actually be the size of your finger, so maybe 15 centimetres or so. And they would reach this size in the fall, probably September type time.

So, because there is a lot going on with fingerlings, because they have to transition to the new food, because they have to continually adapt to larger food, I would say that there is a relatively high risk of mortality at this stage. So throughout the time when they are feeding exogenously over the summer, a fair number of these fish are going to drop out of the population, and what is going to be left are the well adapted fish that are very good at finding food, very good at competing with other fish for that food. And this is how natural selection works.

So I think the main bottleneck, even in a healthy population with pristine habitat is going to be the transition from larvae to fingerling. Once that happens, these guys will remain in the nursery habitat. There is a fair amount of site fidelity in juvenile sturgeon and young-of-the-year. So they tend to, wherever they

settled out, they tend to stay there. And again, they are transitioning to larger prey in the attempt to grow as much as they can over the summer, so that they can face the tough conditions of the winter as well as possible.

So the next point worth mentioning is a yearling fish. This is a fish that in the spring, it is approximately one year old. It would be approximately 25 to 30 centimetres long. And I put this in a low mortality risk category, just because if the fish that have gotten past this tough time at getting to the fingerling stage have already found the habitat they need, they have already adapted to food, and really all they are doing now is growing out. They are getting bigger to the point where they are less susceptible to predation. And so things are looking pretty good for them at this point.

They need to survive that first winter to become what we refer to as sub adults. Sub adults have very hardy, they have very few predators. They are essentially large juveniles. They are not sexually mature yet, but they may have moved out of the juvenile area, and so their behaviour changes a little bit and they are quite

a bit larger. So these would be fish that would be in the 60 centimetre, 60 to 80 centimetre range. And again at this point they may have moved out of nursery habitat.

So I think this is a reasonable representation of the life history in a healthy population. And you will notice a few things. The first is that the probability of going from one box to the other might be fairly high, but when you make a jump, I guess, so from here to here you are going to get lots of survival. From here to here you are going to get lots of survival. But if you consider these to be sort of critical points with probabilities of survival, individual probabilities of survival, when you go all the way through each of these, you have to multiply the risks associated with this. So if you wanted to assess the probability of an egg going right through the cycle and back to a spawning adult, that probability would be extremely low because you have individual probabilities along the trajectory that are not working in the favour of the egg.

And this is normal. I mean, this is the reason why a sturgeon carries 700,000 or

800,000 eggs, because it figures that even if I get less than one per cent survival, that less than one per cent is going to be the strongest, the fittest, and there is still going to be enough there to keep the population steady, assuming that the population numbers are high enough to maintain the critical numbers.

So the other thing I would say too is that this might be a reasonable representation of a situation that existed in a lot of Manitoba rivers a couple of hundred years ago, before there was any human activity on the rivers.

Now, that is not the case anymore. Obviously, humans do impact rivers. And so if we think about how this picture might have changed, and how it might relate directly to the Keeyask area right now, based on the studies that have been done there, I would say from my interpretation of the reports that I was provided with, I think one of the keys difference right now would relate to the number of spawning adults that are there. It seems like there is a very low number of spawning adults. So I would change the risk, the failure, the recruitment failure from green in a population where there is lots of

spawners to red, simply because there doesn't seem to be that many adult fish in spawning condition showing up at the proper spawning sites. So that's one change I would make.

And the rest are less dramatic. They are really based on what seems to be, the habitat there seems to be a little bit depleted, a little bit impacted, not severely, but enough to suggest that some of these life stages, the mortality risk would be upgraded a little bit. So I would say that the yolk sac larvae are probably a little more vulnerable, the yearlings are probably a little more vulnerable, and the sub adults would be a little bit more vulnerable. But the most dramatic impact seems to be at the spawning adult stage.

So then if we were to, and I know there is no one proposing this, but if the Keeyask facility was to get developed and if we were to look at what would be happening post-project without any mitigation, there would be a further loss of spawning habitat, and it would put pressure on the entire system, there would be a lot of potential habitat degradation. So with the loss of spawning habitat, we would probably have a

pretty bleak picture in terms of the early life stages. And if there wasn't enough young-of-the-year habitat and juvenile habitat, we would have problems there, and maybe less so at the sub adult stage because they are very hardy. But -- again, no one is suggesting this happened -- but obviously it points out the need for some sort of mitigation if we are going to put a facility there.

And this brings us to the Partnership's suggestions in terms of the mitigation policy, the cornerstone of which appears to be hatchery supplementation and habitat remediation, which I think are good ideas.

In terms of the sturgeon stocking, which again is one of the cornerstones of the plan, I think lake sturgeon stocking in general is a reasonable means of mitigating losses that might occur at Keeyask. It is a great way to bolster the existing population that's been depleted for a variety of reasons. So I, in general, I think it is the way to go.

Now, again, just for the sake of getting everybody up to speed, it is probably worth going through the life cycle again very

quickly and showing where the vulnerabilities change when you keep the juvenile fish in the hatchery. So obviously their vulnerabilities are different because, it is much different, the hatchery environment is much different and they are not subjected to things like predation. So we would expect their vulnerabilities and risks to change in a hatchery program.

So, very quickly, if you are going to raise sturgeon, you are going to need eggs and milt, so fish in spawning conditions are collected. And I should point out there has been -- that the context of this in the middle is in the context of a fall fingerling stocking program. So in this case the sturgeon would be reared throughout the summer and stocked as fingerlings in the fall.

And the other thing I would say is that my interpretation of the risks are based on the literature that's come from the southern part of the range, so the northern U.S. And that's where most of the information is. So at this point I will use that information in my assessment of risk.

And so down there, there is some

interesting behavioral differences between sturgeon down there and here. And one of them is with the spawning adults on the Wolf River and various places, the adults will actually come -- you might have seen pictures of this -- the adults will come right up against the shore, they will be splashing around in like six inches of water as they are trying to expel their eggs. And for hatchery workers that are trying to collect eggs, it is simply a matter of walking down to the shore and dipnetting them out of the water. So it is fairly easy and the chances of not being able to collect eggs down there is very low. So I have that in green.

At this point the hatchery worker will physically mix the eggs and the milt in a jar so that the exposure of the eggs to the sperm is very concentrated and the probability of fertilization is very high. And so you are going to get some eggs that are just not -- they are just not formed correctly and they won't fertilize, and so you are going to get some loss at this point. But for the most part, you are going to get a very high fertilization rate because it is being done artificially, I guess, is the best way to put it.

Once we get to the yolk sac larvae, once we get our fertilized eggs, we take them back to the hatchery and put them in jars, and they roll in these jars for a week or so until the yolk sac larvae will hatch out. And I would say that the mortality between the properly fertilized eggs and the yolk sac larvae is fairly high down there as well. For the most part, unless there is a problem with the eggs or a problem with the milt, if everything is good and the mixture went well, you are going to get a fairly high success rate at the hatch. When they come out and they are fed these things called brine shrimp, so they need to be weaned on to brine shrimp once they have absorbed their yolk sac. And the people down south at the Wild Rose have this down pretty well. So they will introduce these tiny little brine shrimp into the tanks and the fish will start eating them. And the risk of mortality at that point, at least in that hatchery, is fairly low.

At some point, though, just like in the wild, the fish need bigger food and less costly and labour intensive food. And what is often used is frozen prepared bloodworm that you can put in there. And in some cases actually down

south they can actually convert them over to a dry commercial trout based feed. We don't tend to do that up here because it is very difficult. But at least getting them on to bloodworm is fairly simple and the mortality rate is relatively low at that point.

Now, it is at this point that the hatchery would stock the fish out. And down there because the water temperatures are quite warm and they have a long season and the spawning occurs early, the fingerlings are really -- they are not the size of your finger, they are more likely to be 25 centimetres in length. They would be stocked out in the fall. And because of the latitude, there would still be a good portion of fall left when they are stocked out, and so the rivers wouldn't be terribly cold, they would still be fairly productive and there would be a fair amount of food at this point.

So they do have to survive the first winter, but they are not being stocked into really harsh conditions right away. So there is some data on survival of fall stocked fish down there and it is fairly good. So I have that in yellow. And then assuming that the habitat is good down

there, you are going to get good survival at the sub adult stage.

So this is a situation I think that represents what is happening down there. And I think at this point, though, there is -- well, I might -- if I can just back up? I think one, if I have one criticism about what I read, it is that the expectations of the Partnership and the Proponents seem to follow this assessment of mortality risk in general, and it is different, I guess, than what I experienced when I was raising fish, and my interpretation of what was going on at the Manitoba hatcheries while I had, you know, while I was interacting with them.

So what I would like to just mention is that, from my knowledge base, there really isn't the track record of consistently successful sturgeon production in Manitoba as there is down in the States. It is essentially really difficult to raise sturgeon here, it is incredibly labour intensive, it requires -- they require 24 hour care. They are very prone to inexplicable die-offs. So I would say that in my experience sturgeon rearing in Manitoba, certainly in the work that I have done and what appears to have

happened in the hatcheries, at least in my interaction with them, it has been fraught with difficulties. Despite a lot of effort, a lot of expense, survival rates have been quite variable from year to year, ranging from very good to zero in some cases. Depending, you know, there might have been a year where you just couldn't get eggs and milt because the weather was horrible or the fish weren't available, so right off the bat you were beat before you even got started.

The other troubling thing was that there was never a really good indication of reasons for good and bad outcomes. When you had a good outcome, you felt really great about it, you thought, wow, I have got this figured out. And then the next year for absolutely no reason the fish would just die en masse with no apparent indication of why. So it is -- it can be, I know myself and my students have lost a lot of sleep and hair and everything else trying to raise sturgeon in any consistent manner.

So, if we move away from the southern experience and I update this picture in terms of my experience in Manitoba, things change a little bit. And the first change that I would say

happens at the adult point, the fish here don't just swim up to the edge of the shore and wait to be netted out, they tend to be a little more difficult to catch. And in the -- it was, there was a time when it was just luck of the draw. If you happened to net a fish in spawning condition, then you got lucky, and otherwise you didn't. There has been some movement towards using hormones to induce ovulation in fish that are caught, and this has certainly made things a little bit easier. But I would suggest, I guess, that just the inherent, the potential for not being able to catch the fish in the right condition, perhaps for the hormone not to work, perhaps for human error or equipment failure, that there might be slightly higher risk in Manitoba of not getting gametes at all, not getting eggs or milt at all.

Once the eggs are collected, at this point it is fairly easy, so I don't see any need for changes at the egg or the yolk sac stage. But I would change things slightly at the larvae point.

At the Wild Rose Fish Hatchery, people seem to be very, very good at converting their

fish over to brine shrimp and bloodworm. And our experience, my experience has been, and I think it has been reflected in a lot of cases at the other Manitoba hatcheries, is that the sturgeon are not happy switching foods, they are not very -- there is going to be a loss at the initial stage when they are being weaned on to brine shrimp, and you are going to lose a fair number, you can expect to lose a fair number of fish at this point. So I would say it would be more of a moderate risk. And then just when you get them on brine shrimp and you need to switch them over to bloodworm, it is another opportunity for these guys to say, we are not going to do that, and then you will often lose a bunch more fish at that stage, they simply won't convert over to the new diet. So I would say that it would also be moderate mortality risk, in my experience, in Manitoba at this stage.

So then one of the key differences -- one of the similarities here is that I'm also proposing in this case to be stocking the fish out at the fingerling stage. And I think there is a key difference here between the Manitoba experience and the southern experience. And the key difference is related to the latitude

difference, so the climatic differences that are apparent. And also in the biology of the fish, the fish here are adapted to the cold climate more and their tolerance for warmer water is less. So there is some differences with respect to the condition of the fish at the time of stocking. And I also am a little bit concerned about the relative lack of data, of really good, hard data from Manitoba, or really anywhere in Canada for what we can expect in terms of survival rates once the fish are stocked and they are faced with their first winter.

So based on those things, and I will elaborate on my reasoning in a second, but based on those concerns I would actually say that there is, in Manitoba there is a fairly significant mortality risk for fall stocked fingerlings making it through the winter. And again, I will elaborate on that in a second.

Once the fish are in the rivers and surviving, then I don't expect there to be a problem at the sub adult range.

So I guess my experience, when I say Manitoba experience maybe I should have put Steve Peake's experience, but that is what I'm drawing

from and that's how I would characterize vulnerability for hatchery fish in Manitoba.

So, I would just, I guess whenever we have thought in my lab, whenever we thought we have figured out sturgeon rearing, we have always been humbled. So I guess I would suggest that there be caution and perhaps a temperament of expectations with respect to the ability of a new hatchery to consistently, year in, year out, produce really good numbers of fish for stocking efforts, just because of all of the uncertainties and all of the risks associated with all of those different groups. And you know, things can happen, even under the best operating standards and the best people, accidents can happen, things can happen that can cause failures.

I would again caution that, just because we, in a lot of cases we didn't, we couldn't understand why we were losing these fish, we couldn't understand why the fish were just dying off for various reasons. And so because we could never really link conclusively cause and effect, I would never say that research shouldn't be done, but I would say that it is a great idea to research those issues and try and get a handle

on what is causing the deaths, but I'm not sure if that research will completely alleviate the situation. It is just like, the life history of sturgeon is such that most of them die in the wild, most of them die, and so that's just the way it is. And the ones that survive are the strongest ones. So to expect that all of them, or that large numbers are going to live, and that research and effort alone is going to change that may not be something that's realistic.

I would say there appears to be little or no evidence that fingerling lake sturgeon that are stocked into northern latitudes, so I would categorize that as pretty much anywhere in Canada, if they are stocked in the fall there is not a lot of evidence to suggest specifically that those fingerlings are able to survive the winter conditions in reasonable numbers. There is some anecdotal accounts, there is some work on the Assiniboine that suggests that fish are surviving, but there hasn't been a really sort of robust analysis of where those surviving fishes come from. The fish that have been stocked in the Assiniboine have been various life stages, right from yolk sac larvae up to large juveniles. So it

is impossible to say whether the fish that are recaptured by fishers in that system came from fingerlings that were stocked in the fall or other fish that were put in there at different points.

At this point I would say that there is, with the lack of evidence out there, there is some evidence from our Winnipeg River studies that suggest that fall stocked fish may have difficulty finding sufficient food to maintain their body weight. And to my knowledge this isn't -- there isn't enough data there to be very strong in this assertion. It is not publishable at this point, it is based on a lot of work, but not a lot of data. But that doesn't -- and there is trends there that are showing this. And the two trends are, number one, that the wild fish in the fall, the fish that are already in the rivers, the vast majority of them have empty stomachs, suggesting that there isn't much resource for even the fish that are already adapted to those situations. So these fish are not eating, there's not a lot of food for them. And what they are doing is they are hunkering down and hoping that they have enough energy reserves on board to get them through the winter and to the point where they can

start feeding actively again in the spring. So even the wild fish are, for the most part, not feeding.

Now, we stocked some fall fingerlings in the Winnipeg River in the fall. These were 15 centimetre fish. We put them in the river and then we immediately started fishing for them. We fished for them for two or three weeks, and we were able to recapture them over about a two-week period. And for the most part, what we saw, what we were hoping to see is an increase in their growth, or at least a maintenance of their weight. And we did not see that, we tended to see a drop, a fairly precipitous drop in their weight, suggesting that they weren't able to find the food that they needed to maintain their body weight.

We stopped being able to catch them after a couple of weeks, which doesn't mean that they were all dead at that point, it might have been that they had just dispersed, but we didn't see any indication in the ones that we did recapture that they were maintaining their body weight. So there is a suggestion there, and I want to be very careful about how much emphasis I put on this, but there is a suggestion there that

those fish may have had trouble finding food.

And then we put in a fair amount of effort the next spring to recapture these fish, and again, I will say that we were fishing for very small fish in a very small system. We didn't expect to recapture a lot, but we recaptured zero, none, despite a fair amount of effort. That doesn't prove that they weren't there, but it is suggestive that they may not have been.

And now in contrast to that, we did have some success in showing that if you stocked out the larger fish, the yearling fish, if you stocked them -- if you kept them over the winter, grew them out a bit to about 25, 30 centimetres, stocked them in the spring when conditions were improving and food was becoming more abundant, that they were better able to survive and thrive after being stocked. So we were able to recapture stocked yearlings and show that they were growing. So it shouldn't be too surprising to suggest that a yearling stocked fish is going to have a better probability of integrating into the population than one in the fall.

So I would first say that it seems from the documents that I read that there is a

fair amount of reliance on the data coming out of the northern U.S. when it comes to dealing with survival rates of fish right through, and especially with respect to stocking success. I would say that, I would recommend anyway that the stocking program focus on yearlings. So if possible, to the largest extent possible, keep the fish over the winter, stock them out in the spring when we have some demonstrated success, and probably the best chance of success. And if there is any stocking at all in the fall, I would suggest that only the largest -- even in the hatchery, all of the fish aren't the exact same size, the ones that are best able to compete with their buddies are the bigger ones. And I would say if there is going to be any fall stocking, it should be that say 10 per cent of the largest fish that are stocked out. I say that because they are large and potentially they have developed better competitive ability, they might be the most likely to survive.

And they will also be able to carry implanted PIT tags. I apologize, I lost the slide just before this where it shows you what a PIT tag is and defines a PIT tag as a passive integrated

transponder. I will show you a picture of one in a second. But it is a small uniquely coded tag that can be put into the fish. And the largest of the fish in the fall would probably be big enough to take one of these tiny little 8 millimetre tags.

MR. WILLIAMS: Dr. Peake, if I could stop you for a minute and actually get you to back up two slides to the one that discusses the need to use caution in extrapolating survival rates. If I could get you to go back to the basis for your conclusions that conditions are considerably more difficult in the northern rivers as compared to the southern, sir?

DR. PEAKE: Sure. I mean, if I were to expand on that, I would say that the southern rivers -- when the people are getting the hatchery fish, they are getting them a month, sometimes more, earlier than we get them here. So their spawning fish are releasing eggs in April, late April, whereas ours are late May, early June. So they get a head start in the hatchery. The fish down there are able to tolerate higher temperatures. So when I talk to the folks down there they say, yeah, if you want big fish, all

you have got to do is crank the temperature up to 23 degrees and feed them lots, and they grow right out. The problem is, if I crank the temperature past 21 degrees, all my fish die because they are not adapted to that warm temperature. So you can not grow fish in Manitoba at the same rate as you can down there, because they can't tolerate those warmer temperatures.

The other difference is that fall here is not necessarily equivalent to fall down there. And so down there they are stocking large fish that have grown well over the summer into a system that's still productive and will be productive for a month or more, gives the fish a bit of a chance to adapt. Here you are tending to try and get these things as big as possible, there is a tendency to want to push the release date later, and even at that point the fish are half the size, half the length and probably a quarter of the weight of the fish down there. And now you are putting them into a situation that is very harsh in terms of the availability of prey. And if it can be said, and I'm fairly confident this is the case, if it can be said that essentially what these fish now are doing are using their energy

reserves that they have on board to essentially wait out the winter. The fact that the winter here is going to be arguably longer and more severe than it is down there, they are going to have to use their already smaller energy reserves to last a longer period of time, and perhaps a harsher period of time, before the spring comes and they can start feeding and bulking up.

This is what I mean by the conditions here are more difficult and more challenging for the fish over their first winter. Does that answer your question?

MR. WILLIAMS: Thank you.

DR. PEAKE: Okay. So, as I mentioned, if the sturgeon are, if the remaining sturgeon, so if we were to stock out the top, the largest fish in the fall, if we wanted a fall stocking program, we wanted to, perhaps, you know, make some space in the hatchery, we could get rid of some of the largest fall fish, equip them with these uniquely coded PIT tags so that we could monitor the survival of those fish and evaluate the fall stocking program to give us some data on fall stocking effectiveness at this latitude, that would provide some really good information. I

would say the rest of the fish, if possible, could be held in the hatchery and grown out to the yearling size, and stocked out in the spring when I think they have a much better chance of survival.

So if you did that, this is the expectations, or my interpretation of the expectations for a fall fingerling stocking program. And if you moved away from a fall fingerling stocking program towards a yearling -- spring yearling stocking program, I think you would be able to change this high risk event to a much lower risk event, just based on my anticipation that the larger fish would be able to survive better being stocked into much more hospitable and much more productive water.

So assuming that habitat isn't limiting, assuming the habitat is there, then we would end up with something that looks like this in terms of realistic expectations. And you know, I think we can't do much better than this, to be honest. If we can, then fantastic. I think, I'm not usually a pessimist, 12 years of raising sturgeon will turn you into a pessimist, but I really hope that we can improve the stocking

success, if we can reduce the mortality rate and if we can get lots of years of great hatches and great survival, that's fantastic. If we can stock them out as yearlings and increase those populations, then great. But I think this is a balanced expectation for what we can expect.

MR. WILLIAMS: Dr. Peake, I want to just stop you here because this is where the disconnect between the paper and the powerpoint, and it is all fine, but if you could go back one slide and show your expectation if there is a primary reliance upon the fall stocking?

DR. PEAKE: Yes.

MR. WILLIAMS: Just walk us through that a little slower.

DR. PEAKE: Sure. This is the picture that we built a few minutes ago, about my interpretation of the risk if sturgeon are kept in the hatchery until fall and stocked out as fall fingerlings into what I consider fairly harsh conditions that exist up here. It is based on the fact that the fish are small, the fact that the conditions are tough, and the fact that we just really don't know, we don't really have a good handle on what we can expect the survival to be.

In my opinion, if we are going to start with the southern experience, if it is going to go either way, it is going to go towards a higher risk of mortality.

MR. WILLIAMS: Now, if I could just stop you here, I think it is the right slide but you have got the wrong name in the middle, it looks like it is the spring.

DR. PEAKE: Yeah, I meant to show you that one there, this slide right here.

MR. WILLIAMS: Yeah.

DR. PEAKE: Now, the reason why it is still there is just because I wanted to, in advancing I just wanted to bring everybody's attention to the fact that now I'm talking about spring. I didn't want to do two things at the same time. I'm changing the context in this slide, and in this slide I'm changing my opinion of their vulnerability.

Okay. So if we change over to a spring yearling stocking, assuming the habitat is there, just by virtue of the fact that the fish are larger, they have more energy reserves, they don't need to get through a tough winter, and presumably there is food there, I think you are

going to very significantly reduce the risk and the uncertainty associated with the stocking program.

MR. WILLIAMS: Thank you.

DR. PEAKE: So I will move on from stocking to marking. And marking fish is a cornerstone activity in fish management. I spend a lot of time and effort marking fish because we need to evaluate if what we are doing is working or not. And to do that, we need an idea of when fish were stocked, and some of the basic, some of their basic biology and how that biology has been changing between the time when we release them and the time we caught them.

So I agree with what the Proponents have said in terms of making it a priority that all stocked lake sturgeon are marked, I think that's absolutely essential. I think to stock completely unmarked sturgeon into this system would be a mistake, and so I agree with that assessment.

And the reason why the sturgeon need to be marked is so that the stocking program can be assessed quantitatively, and so that we can adaptively manage the population to say, okay, we

don't need to stock any more, or we can scale back the stocking effort, or it needs to be increased. All of those questions that are going to come up are going to need good, hard data to guide the proponents as they manage the population.

The other reason is because I think it is important, and I agree with the proponents in their assessment that it is a priority to be able to distinguish hatchery reared fish from the wild ones that are currently there. We don't want -- there is a lot of very precious genetic diversity locked up in the wild population. They are different fish. The wild fish have been through the natural process of natural selection, whereas we have kind of circumvented that process a little bit in the hatchery, so there may be difference in behaviour, in vulnerability. We don't want the hatchery fish outcompeting the wild fish and decreasing that storehouse of genetic diversity. So there is a lot of -- and also being able to distinguish wild from hatchery fish is going to allow us to very carefully manage the population in the future. So if we see the wild population coming up, that tells us one thing. And if we see the wild population declining and the hatchery

coming up, that tells us something else. And it gives us information that is going to be needed to adaptively manage the population.

However, and despite that, I think that there is a range of ways to mark fish, and that's been outlined by the proponents. And in my opinion, most of those ways of marking are not ideal. I think the best way to do it is with these passive integrated transponders. I think all sturgeon that are released in the Keeyask area should be equipped with PIT tags, and that is going to allow the best management of the population afterwards, and it is going to give us the really key data that we need.

So some of the drawbacks that exist with the other non-PIT tag methods are that the fish need to be -- need to be altered, injured, I don't want to be dramatic but I will call it maimed, prior to release or upon recapture.

So one example of that, you will see with this fish it has a fin right here, and on the other side that fin has been cut off, and so notwithstanding any sort of ethical or animal care issues, it is not a mark that's going to be unique to that fish, it is going to be all of that year

class out of hatchery will have that mark on it. So the exact fish isn't unique. And I will get into why I think it is important that each fish have a unique mark on it. But, essentially, all it tells you is that's a hatchery fish. And the particular fin that's taken off might give you a indication also of when it was stocked. But the problem is it is not a really -- there is some subjectivity involved in identifying it. If you catch a fish and it has got a fin that's a little bit, half off, or maimed, or maybe it has grown back, there is some subjectivity associated with identifying it as a hatchery fish.

An example of a tagging procedure that requires killing or maiming the fish after recapture is a coded wire tag. These are used a lot for pacific salmons, where there is tons of fish and it is no big deal to kill them to retrieve these things called coded wire tags that are implanted in the nose. But I don't think at this stage we are in a position where we can sacrifice a lot of the fish that have gone through the hatchery process, made it through the difficult procedure of integrating into the population, only to be sacrificed as part of the

monitoring program. So I think those techniques are not ideal to be honest. And all of the techniques that only identify individuals, they don't identify specific individuals, but a group of individuals, they suggest an approximate release time, they identify the animal as being hatchery reared, but they do not provide really good information on establishing what I call critical population parameters. And an example of those would be growth rate. So without the unique marks, you can get a very rough idea of growth, but because growth is a rate, you need to know how much growth has occurred, but you also need to know how long a period that growth has been. And if you can't really pinpoint with very good accuracy how old that fish is, then you have real trouble coming up with those numbers.

Another type of marking, this is called visible implant elastomer tagging, it is an inert plastic material that's inserted under the skin. It is, again, it is not a unique code that's going to be unique to individuals, and it tends not to last for very long.

So any of the proposed procedures that don't last essentially through the life history of

fish are going to be, it is going to make it difficult to distinguish those fish from wild fish, and so you are not going to achieve your goal of being able to separate wild and hatchery reared fish in the long term.

So I think PIT tags are the way to go. They are -- this is what a PIT tag looks like. I had another picture next to a coin and it would give you an indication of how big they are, they are quite small, they are about 8 millimetres long. They are definitely, in serious marker catch or in hatchery valuation programs, this is the tag that's used. Every single fish gets a unique code that can be referenced later to establish when the fish was stocked, how much it weighed when it was stocked out, and how much it weighed when it was last captured. So every single fish has a unique code, when it is stocked out it weighed this, we caught it in year 2 and now it weighed this, we caught it again in year 5 and now it weighed this. And there is no question as to how old it is and there is no question as to how much it grew.

I can tell you that we used these tags on a research program, and before we started using

them on the Winnipeg River, we found, our results lead us to a certain conclusion about the health of that population. And then once we started integrating the PIT tags into it and collected a lot of recapture data, the actual truth about the health of that population was pretty much the opposite of what we thought. So our ability to look at something like very accurate growth rate helped us to overturn a previous conclusion that was based on information that we didn't have, because we didn't have unique codes. So it can be really that important.

The other advantage of PIT tags is they are inert, there is no battery, they last indefinitely. So theoretically the fish could have it for its entire life span. They are relatively inexpensive, and the tags can be interrogated by simply waving the detector across the fish when you catch it in the boat, there is no stress, there is no injury to the fish, you just wave the reader across the fish and you instantly find out whether it has a tag or not.

So I would suggest that all stock lake sturgeon be equipped with PIT tags prior to release. I would also suggest that no hatchery

fish are reared -- no hatchery reared fish should be placed in the system without one of these PIT tags. And I guess I would point out that this would preclude -- if this was adhered to, there wouldn't be any stocking of larval fish such as in this picture, they are just too small to take a tag like this. So I wouldn't recommend releasing unmarked larval fish, or any fish that weren't big enough to take one of the PIT tags.

I think it wouldn't be a bad idea, we did this in our Winnipeg River studies to double tag fish. And the consultants that work for Hydro know all about this. So essentially you attach a PIT tag, also it is called a floy tag, and there is an example in the picture. You can see the red external tag with a number on it. What this does is it allows you to determine PIT tag loss rates, which are fairly low but it is good thing to know. It also allows people that are fishing in the system, when they catch a tagged fish and they read the number, they can call up somebody, report the number, and add to the data base in terms of what is the post collection.

Yes?

MR. SHAW: Is the use of PIT tags more

expensive than the other options?

DR. PEAKE: In some cases, I guess it depends on whether you define expense solely in terms of money, or also in terms of time. The PIT tags are in the neighborhood of five or six dollars a piece, and once they are implanted, it is very quick to interrogate them and you get that data very quickly.

With the other tags, the initial marking is less expensive, but in some cases you have to send away tissue samples to get analyzed for the presence of chemicals that you might have dipped the fish in. There are, if you just went with floy tags alone like that, without the thing that -- floy tags are cheaper but they don't -- there is a tendency for them, as the fish grows, for them to get lost. So I would say if you take into consideration all the benefits of the PIT tags versus the cost, there is not even, there is nothing comparable. There is cheaper ways to do it, but you don't get the information you need, I guess is how I would put it.

MR. SHAW: Thank you.

DR. PEAKE: So, I would like to move on to habitat. Habitat remediation and creation

is the other cornerstone of the proposed mitigation program. I think it is a necessary component. I think I agree with pretty much everything in terms of the fact that we need to be -- we need to provide suitable habitat for all of the life history stages. So I would say the proponents rightly anticipate that juvenile habitat may be a limiting factor in establishing viable and self-sustaining populations.

If you remember back to those life stages, failure at any point along that trajectory can result in complete failure of that year class. And the habitat, if there is not the habitat that's there, you can get that failure, and juvenile habitat is particularly critical for the life stage.

So the Proponents have indicated that juvenile habitat might be limiting in the area, and they have proposed that it could be built so it will be created in the same way that spawning habitat will be created, to augment what is already there, and with the goal, with the goal that should be there, and that's to avoid life history bottlenecks.

I would say in response to that, I've

never -- I think it is a great experiment, I think it is very ambitious, but I'm a little worried about it only because, to my knowledge, juvenile egg sturgeon habitat has never been created in a large river anywhere that I know of, anywhere in the world. And I think plans to do that are, again, laudable, but I think the process in general needs to be considered as experimental. And when it is experimental, it is difficult in my mind anyway to predict the probability of success with any certainty. Because definition, it really is an experiment, it is a very complex thing to do. And I would simply like, if I was asked I would simply not be able to predict in any meaningful way what the probability of success of that endeavor might be.

I can say just off the top of my head that I would expect it to be much more difficult to maintain than say spawning habitat, because we are talking about a sandy substrate that's needed for young-of-the-year, and that sandy substrate will be highly vulnerable to changes in flow. So, for example, if the flow in the river were to decline and there were suspended sediment in that flow, that fine sediment would start to fall out.

And if it fell out on top of the sand, then it would effectively -- it would have the potential to effectively ruin that habitat because now you have got silt where you used to have sand. And if sand and the insects that inhabit that sand are what the young are needing, then that could impact the quality of that habitat.

And by the same token, if there was a flow increase, because sand is fairly small and light, if the flow would increase there is a chance that habitat, even if it was in good shape, could just get completely blown out. I think it is hard to argue that sand is something that is not very vulnerable to those changes.

And I'm reminded actually of some work that I did up in Northern Manitoba, at Churchill, where we were building a rock weir, out of huge boulders the size of cars, and we needed to provide fish passage. So there was very intricate designs about where all of the boulders should be placed so that they would provide the resting pools for the fish. So they were in there with these big machinery placing these giant car size rocks just so, so everything was right. And we came back to evaluate it the next year, and the

ice had just demolished all of these rocks that you wouldn't think could ever be moved by anything.

I'm not trying to be dramatic, but it is an example of where we are trying to engineer something, and nature says, yeah, right, that's just not going to happen.

I think, again, I think it is a great experiment, I think it is going to be challenging. And it is not just a matter of trying to get the sand to stay there, the sturgeon don't care about the sand, they care about the things that they want to eat that grow in the sand. So not only is it an engineering problem to keep the sand there, but there is uncertainty associated with the probability of the right type of invertebrate community to invade that habitat. Juvenile sturgeon are fairly picky when it comes to the food they will eat. From some of the studies we have done, there is three or four types of, broad types of invertebrates that they prefer. And they tend not to eat other things that might be there, even if they are there. Not only that, the juvenile sturgeon have to be able to find this habitat. They also have been to be willing to use

it. And you would think inherently that if they do find it, and that they -- you would think that they would be able to find it and you would think that they would be willing to use it, but some of the stuff that we have done, some of the work we have done on the Winnipeg River would suggest that sturgeon don't always act in their best interests, just some of their inherent hard-wired behaviours will actually work against them.

So, an example is that the juveniles tend to be very site -- they have very strong site fidelity. So in the nursery area where they drifted out on, they will stay there for many years growing. And even if that habitat declines in quality, or there is so many fish, and we saw this in the Winnipeg River, there is so many fish that there is not enough food to go around, if there is more habitat a couple of kilometres downstream, or a few kilometres downstream, they won't say to themselves, this habitat isn't good, I'm going to look for better stuff, they won't do that. They will stay in the nursery habitat that they have chosen, to their detriment, and we demonstrated that on the Winnipeg River. If that's the case, then we might run into a

situation where the fish are just unwilling to move to new habitat, even though it is there.

And I'm getting close to finishing, and I have been droning on for a long time here.

So if we go back to maybe our best case scenario, in terms of reducing mortality risk with our spring yearling stocking program, again, I want to emphasize that this is the case if habitat is not limiting. But at this stage when we are talking about putting in engineered habitat, I think we are introducing additional risk and uncertainty into this chain. And if we think of this life cycle as a chain, I think we are weakening considerably this link right here. We are adding a bunch of uncertainty and probability that has to be taken into consideration.

In my mind, and this is purely subjective, the addition of that uncertainty, and just the difficulty that creating young-of-the-year habitat is going to be, I think has to affect the vulnerability of the transition from yearlings, even though they are stocked at yearlings, the transition of yearlings to sub adults, at least one level. So they are going

from a low to moderate risk, to a moderate to high risk. And I actually think that's fairly conservative. Anyway, I will leave you with that.

So I think the Proponent should consider the placement of juvenile habitat a worthwhile experiment, no more, no less than a worthwhile experiment. Something that would be great to do, I would be very interested and curious about how that would go. And I think if it worked, it could be something that could help a lot of other places that are facing this problem. But certainly have little -- treat it as an experiment and have little to no expectations with respect to success. And based on those low expectations, have some sort of back-up plan if the placement of the juvenile habitat is unsuccessful and existing habitat is unsufficient.

My final comment.

MR. WILLIAMS: Dr. Peake, just before -- it is Byron over here -- just before you leave this area. If we can go back to the two big cornerstones of the Hydro mitigation proposal, those being stocking and remediation of young-of-the-year habitat, if you could at a high level compare the certainty you have with those

two approaches as compared to Hydro, or the Partnership, excuse me?

DR. PEAKE: Okay. I think my expectations of the risk associated with being able to grow large numbers of hatchery fish consistently are slightly more pessimistic than the Proponent's, not greatly, and I don't think that point is a huge issue.

I think my expectations of survival in a fall stocking, a fall fingerling stocking program is considerably -- would involve considerably more risk than I saw in the documents that I was provided with in terms of the Partnership's expectations.

And I'm a little more, I'm quite a bit more incredulous about the chances for success of creating stable viable habitat for juvenile, for young-of-the-year and juvenile fish. I think if you look at it as a purely engineering exercise alone, I think, I'm not a -- I'm not an engineer, a Hydro engineer or anything like that, I'm only going based on what I have seen, but I think anyone would agree that it is a difficult task to put sand somewhere and expect it to stay there.

From a biologist's perspective, I also

know enough to say that it might be difficult to get the right invertebrates to inhabit that. And then, again, sturgeon have a bad way of getting in their own way for survival. And so all of those things combine to make my interpretation of the risk as quite -- well, quite risky, but for the most part just uncertain. I'm actually uncomfortable even assigning a specific probability to it, because there is just so much uncertainty with the entire thing. I see it as an experiment and I would be very curious to see what the results are going to be, but I would really not like to predict.

And I know the Partnership has been asked to make those predictions, so that's perhaps why that has been done. If their predictions for the success of that are moderate, low to moderate, I believe, I remember, I would say that in my opinion that would be optimistic. But, again, there is just a lot of uncertainty, so it would just be my opinion.

MR. WILLIAMS: Thank you.

DR. PEAKE: So the last point, and I will get through this pretty quickly, is on entrainment. So entrainment is when a sturgeon

that's in the reservoir comes to the upstream side of the dam and moves down through the dam, either via the turbines or over the spillways. The plan has been to design the spillways and the turbines in a way that provides little or no protection against actual entrainment of lake sturgeon or other species. And I think this was done on purpose, I'm not criticizing, I'm not saying this as a criticism, it just seems to be a fact.

Normally, or if it was the intent to keep fish out of the intakes, then there would be a screen placed on there that had fairly small spacing that would keep fish out. The Proponents have chosen rather to let the fish go through the turbines and design, use a turbine design that minimizes mortality through the intakes and provides an acceptable survival rate of that occurrence. And so I guess I wouldn't call it -- I wouldn't call that provision of safe passage, I would call it mitigation of the effects of entrainment. So that's fine.

But I would say with respect specifically to lake sturgeon, the comprehensive studies that have investigated the probability of lake sturgeon entrainment at the proposed facility

in relation to proper -- in relation to population size don't seem to be there. In a lot of cases it is just going to be straight luck whether the fish are going to find themselves down there. There isn't really a key downstream component to the sturgeon life history. They are just going to sometimes find themselves there. So the probability that a sturgeon is going to encounter the upstream side of the dam, it seems to me is going to relate to how many sturgeon are there. So to take, I guess, a snapshot of the situation right now and use that to predict how many fish are going to interact with the dam is a good start. But I think there is some more work to be done on that, as the population changes. And some of the work that has been done, and it has been done in the right way, I'm not criticizing it, but some of the general tendency has been to take very small sample sizes of what is there and track them, track those tagged animals and see what they do. The numbers are fairly small, and perhaps more work needs to be done there.

Comprehensive studies investigating the probability of lake sturgeon injury and mortality relative to fish size also are lacking.

And that's not surprising. The best way to figure out whether a fish is going to get injured by a turbine is to put it through a turbine and see what happens. And that has been done. The problem is you just can't do that with sturgeon, and that's why that data doesn't exist.

But the general rule is that vulnerability, no matter what the turbine design is, the general rule is that the bigger the fish, the more likely it is going to have an interaction with the turbine, and generally those interactions are not positive.

There don't seem to be too many studies that investigate the probability of lake sturgeon becoming impinged on the racks that protect -- that keep large fish out of the turbines, relative to flow rates and fish size. So the largest fish, the largest sturgeon, and perhaps you could say the most important and precious ones, the ones that are so critical to spawning, may not be able to fit through the spacing of those racks. And so I didn't see too much information on hard numbers about the probability of these large sturgeon becoming impinged on the trash racks relative to the range

of flow rates that are expected, and relative to the size of the fish that are there.

And then once, if we get impingement events, there haven't been very many studies, and you know, this is a failing on the scientific community I guess, is that once the fish becomes impinged on the screen, what is the likelihood that it is going to get itself off there, and what is the likelihood that it is just going stay there until it dies? And this information is lacking.

I can say that I have spent a lot of time watching fish become impinged on screens, and one of the things that I know -- and watching sturgeon in particular become impinged on screens -- is that once they are flat against a screen, the only way they will come off is if the flow that's pushing them against that screen is reduced dramatically, and when that happens, they can fall off the screen and they can swim away. But as long as that flow is maintained, they are not coming off of it and the mortality is going to be there.

Even if the flow, even if that flow is within their swimming performance capability, as defined in the literature, that does not in any

way mean -- just because they are capable of it from a swimming performance perspective does not mean that they are going to be able to get off that screen. Simply because the act, the action of jumping off that screen and getting out of that flow doesn't translate into the ways that swimming performance is measured.

I would just say that, in general, I would like to see plans and the feasibility of these kind of studies. And I wasn't privy to the decisions and the discussions around all of this, but there doesn't seem to be a lot of studies done to address these issues.

And I would say, I don't know how much this has been done, I don't even know how feasible it is, but it would be nice to have monitoring systems and programs that are ideally not involving small sub samples of the population that are tagged with one or two transmitters. These systems might be investigated and carried out where possible at spillways, trash racks and turbine outlets through the life of the project, and as sturgeon numbers increase. So a little more direct measurement of the impact of entrainment, and not just on tagged fish, but on

any sturgeon that might appear there. So that maybe some more thought given towards, instead of letting large sturgeon go through and take their chances, possibly doing small things to prevent entrainment. So decreasing slightly the trash rack spacing, I know that has other implications, but it might be worth looking at again. The racks can be angled so that it is easier for the fish to get off. There are such things as behavioral deterrents. I know that there is a fairly small literature on deterrence for sturgeon, but something like that might be looked into.

And with the idea to minimize injuries and maximize protection for the large lake sturgeon, they are the ones that I'm concerned about. I believe that small sturgeon going through the turbines will survive in large numbers and in the percentages that are outlined by the Proponents, but I'm concerned with really large lake sturgeon that get through the racks, and even more concerned with the largest lake sturgeon that end up on the screens.

So just a summary, just very quickly in summary, I would say that lake sturgeon are difficult to rear, in my opinion. And you can get

complete or partial year class failures, and these can occur at several points between initial egg fertilization and the end point, the end goal when the fish are integrating into the population. There is many, many opportunities, each with a varying degree of risk along that trajectory, and failure at any point along there can have dramatic effects.

I would love to see the results of the juvenile habitat creation efforts, but I think it is clear that it introduces additional risk and uncertainty into that already fragile chain of events.

It is my opinion that hatchery lake sturgeon should be, all of them should be equipped with individual unique codes. I don't have any stock in PIT tag companies, I don't care what marking technique is used, but I think that each fish that is released should have an individual unique code, so that we can get really good at growth -- or that they can get really good growth data and have the best possible data for their adaptive management plan that's going to occur over the next 20, 25 years.

And I just think that more

consideration should be given to safely preventing downstream entrainment of large lake sturgeon at spillways and intakes. I know it is a complicated issue. There is pressure from all sorts of places to provide downstream passage. My personal opinion is that downstream passage is not something that's needed by lake sturgeon for their life history. The plan is to physically move them upstream so my -- just off the top of my head is why not eliminate or very much minimize the number of fish that go downstream, and protect the genetic variation by moving fish, physically moving fish downstream as well as upstream, and then you can manage both movements, instead of managing the upstream movement, the upstream passage, and then just letting the downstream passage take care of itself and let it go unmonitored.

So that's it for today. I appreciate your attention.

MR. WILLIAMS: Thank you. Depending on the break time, Dr. Peake is certainly ready for cross-examination.

THE CHAIRMAN: Thank you. We will take a break for 15 minutes, come back at 11:20,

please?

(Proceedings recessed at 11:04 a.m.
and reconvened at 11:20 a.m.)

MR. WILLIAMS: Just before I turn Dr. Peake over to my learned friend, Mr. Bedford, I will just indicate, again, in terms of the printed version that was my mistake and I apologize for that. We will make sure that we get an updated electronic copy filed with Ms. Johnson. And also there have been some specific requests for revised paper ones to make sure that the colour coding is correct, and we will certainly make those available to the Commission and to any others. Perhaps people can approach me at lunch if they want a revised version and I will be happy to arrange it. Again, my apologies.

THE CHAIRMAN: Thank you, Mr. Williams. Mr. Bedford?

MR. BEDFORD: Good morning, Dr. Peake.

DR. PEAKE: Good morning.

MR. BEDFORD: My name, as you just heard, is Doug Bedford. I'm one of the younger lawyers assisting the Keeyask Hydropower Limited Partnership.

DR. PEAKE: Okay.

MR. BEDFORD: I read your paper, I watched the presentation, as we all have. You are clearly cautious about the use of hatcheries in Manitoba. My understanding of hatcheries generally, and certainly those in Manitoba, is that if you don't clean the tanks, the fish are likely to die?

DR. PEAKE: Yes, I would agree with that.

MR. BEDFORD: And if you don't feed the fish the correct food, they are likely to die?

DR. PEAKE: Yes, especially in the case of lake sturgeon, I would agree with that.

MR. BEDFORD: And if you don't chop the bloodworm small enough for the lake sturgeon, they can't get it in their mouths and they can't eat it and they will die?

DR. PEAKE: Yes, absolutely.

MR. BEDFORD: If you don't feed them at the right time, they die or they don't do well?

DR. PEAKE: Correct.

MR. BEDFORD: And if you don't have well-trained staff, or enough staff, the tanks don't get cleaned properly and the fish often don't get fed properly?

DR. PEAKE: Yes, I accept your premise, if you have an untrained staff who are handling the fish improperly, that will be sufficient to result in mortality, no doubt.

MR. BEDFORD: And all of those things were problems that were experienced at the Grand Rapids Hatchery, were they not?

DR. PEAKE: I have no knowledge about the training and the competency of the staff at Grand Rapids. I do know that when I was there, they worked 24 hours a day, the tanks were clean, I never questioned the ability of the Grand Rapids staff to raise the fish. So I will state unequivocally that I don't know about their backgrounds, I don't know about their training, I wasn't there to see how they did you all of their work. But I didn't see anything while I was there to suggest either incompetence or neglect.

MR. BEDFORD: When you were there, as I recall Mr. Williams' question to you, you said the late 2000s, you meant precisely 2008 to 2010?

DR. PEAKE: Sorry, could you repeat that?

MR. BEDFORD: Mr. Williams asked you in the opening question and answer about Grand

Rapids hatchery and when were you there, and your reply was "late 2000s." Precisely you meant 2008 to 2010?

DR. PEAKE: I actually meant -- I meant from approximately 2000 to approximately 2008, so not just 2008, and definitely not 2008 necessarily to 2010, approximately early 2000s, perhaps 2003 to about 2007, 2008. The reason being at those times we had -- we were less dependent on Grand Rapids Hatchery for providing fish to us and, therefore, we didn't have a lot of, we didn't have as much contact with them in the late 2000s.

MR. BEDFORD: And I also noticed that on one of your slides, lake sturgeon stocking, the cut-off date on the slide was 2010. So I concluded that that was one of the reasons that the cut-off date was 2010, is that that's more or less the date that your direct experience in Manitoba ended?

DR. PEAKE: That's the time when my experience at the Grand Rapids Hatchery ended. And I would go so far as to say that it ended some time in the late 2000s, between 2008 and 2010. My presence in Manitoba carried on a little bit past

there, I would say pretty much -- we pretty much finished up 2010, 2011, around that area. So, yes, I had very little exposure at all to the Grand Rapids Hatchery past 2008. I would definitely concede that point, yes.

MR. BEDFORD: And so it is important for all of us to know that the Grand Rapids Hatchery, since you were last there, is now under new management, and the foregoing problems that we've walked through have been corrected?

DR. PEAKE: I'm happy to hear that. I would just say that if those corrections have resulted in dramatically increased survival rates consistently over that period of time, I think that's great. I think the more fish that are available for stocking, the better. So I'm perfectly willing to concede that if you guys have fixed the problem, then I believe you. It has just not been in my experience. I testified to what my experience was, and not only at Grand Rapids, but my experience raising sturgeon for eight, nine, ten years. I consider myself relatively competent, and the student who was working on the fish spent unbelievable amounts of time cleaning and doing things properly. So I

don't think that my experience relates entirely to Grand Rapids, it is to my own personal experience as well, not to say that whatever has been found at Grand Rapids wouldn't have benefited me as well. But I'm not privy to that information.

MR. BEDFORD: I'm told that you worked in Manitoba some years ago now with a Ms. Cheryl Klassen?

DR. PEAKE: That's correct.

MR. BEDFORD: And I saw, in fact, in your paper references on pages 2 and pages 3 to work that you did with Ms. Klassen. She was a student and you were, in effect, supervising some of her work?

DR. PEAKE: That's correct, co-supervising in her PhD, supervising in her masters degree.

MR. BEDFORD: And I noticed as well that Mr. Williams quite helpfully on your CV underlined in particular Ms. Klassen's contributions to this field of knowledge?

DR. PEAKE: Yes, absolutely unquestioned.

MR. BEDFORD: Ms. Klassen tells me that lake sturgeon survival is very much related

to the experience of the individual caring for them. And I gather you have no problem agreeing with that?

DR. PEAKE: I think the two are definitely related, yes.

MR. BEDFORD: Ms. Klassen also tells me the work that she has done over the last decade in Manitoba, some under the auspices of the University of Manitoba where she did graduate work, that in doing that work she has never had a survival rate of zero. And when she told me that, I had to conclude that your references to a zero survival rate must be with respect to some unhappy occurrence in the Province of New Brunswick, not Manitoba?

DR. PEAKE: That's not true. I mean, lake sturgeon don't exist in New Brunswick, I have never done any work on the lake sturgeon in New Brunswick. However, there was certainly work done before Ms. Klassen's involvement. There were times when our survival rate was zero because we were unable to get -- the people at Grand Rapids were unable to get eggs from adults, and so we didn't have any to start with. And I would essentially equate that to a survival of zero,

because we started with zero and ended with zero.

I don't have all of the records on the survival rates. I would not argue that while Cheryl was there, we might not have had a survival rate of zero, but we certainly had survival rates from the egg to the fingerling that were single digit numbers. I don't know that for sure, but I would say that we had near zero survival from egg to fingerling in certain years, despite I will say Ms. Klassen's incredible amount of work, and I would say considerable experience and dedication towards the fish.

And so I think just the fact that we had those survival rates with her at the helm is actually an indication of how difficult it is to raise -- we found it to raise fish, despite competent people and a lot of work.

MR. BEDFORD: I know from reading the references in your paper, and also from speaking to Ms. Klassen, that her involvement began 2002, 2003?

DR. PEAKE: I don't know the exact dates, I have lots of students. I know that Cheryl started off I think as an undergraduate, so I wouldn't dispute those dates.

MR. BEDFORD: And I'm sure it will no doubt boost your confidence and that of Mr. Williams and his client when I tell you that Ms. Klassen now works for my other client with respect to lake sturgeon, my other client being Manitoba Hydro.

DR. PEAKE: I did hear that. I haven't been aware of that for a long time, but I think that's fantastic, and I think that Ms. Klassen, I am very happy for Ms. Klassen and I think she will be an asset to your client. And it definitely reduces my concerns with her there as opposed to her not being there. I think she is very good at what she does.

MR. BEDFORD: On page 2 of your report you observe and I quote:

"Almost no solid data on overwinter survival rates of stocked lake sturgeon in Canada."

I'm sure you recall writing that?

DR. PEAKE: I can't be sure of the exact wording. I don't have the slide right in front of me now. I would prefer to find it so I could --

MR. BEDFORD: It is not in the slide,

it is in your paper.

DR. PEAKE: I understand, okay.

MR. BEDFORD: Page 2.

DR. PEAKE: Could you indicate what paper that is and then just reread that? Because when you read it the first time, I was trying to think of where that was coming from.

MR. BEDFORD: It is a paper that bears the title, "A Report Prepared by Stephan Peake, PhD for the Manitoba Clean Environment Commission Hearings 2013." I know you must recall that.

DR. PEAKE: Yes, I can recall that. Thank you.

MR. BEDFORD: Again, I'm drawing from page 2 --

MR. WILLIAMS: Mr. Bedford, would you mind if I approached Dr. Peake?

MR. BEDFORD: Of course not.

DR. PEAKE: Okay. Could you just repeat exactly where on page 2 that is, just to speed up my ability to find it?

MR. BEDFORD: Okay. The words that I'm quoting were, and I quote:

"Almost no solid data on overwinter survival rates of stocked lake

sturgeon in Canada."

Now, where precisely and which sentence you find that on page 2, you look and I will look.

Do you see the paragraph that begins with the words "once reasonable"?

DR. PEAKE: Yes, I see that.

MR. BEDFORD: Count down seven lines, and you will see the sentence:

"There is almost no solid data on overwinter survival rates of stocked lake sturgeon in Canada...",

And the sentence carries on. I was quoting the first part of your sentence

DR. PEAKE: Yes, I do see that now, thank you.

MR. BEDFORD: And as I know from listening to you, and also from listening to Mr. Davies and Dr. Schneider-Vieira, who is sitting beside me, there is work currently being done with respect to lake sturgeon in this country. Correct?

DR. PEAKE: I'm sure there is work being done with respect to lake sturgeon in this country. I'm sure there is.

MR. BEDFORD: So it is not going to surprise you to learn, although I think you already know, that there are now four studies in Manitoba which confirm overwintering of lake sturgeon?

DR. PEAKE: I wasn't aware of those from the information that I was provided. And I guess specifically in the wording that you are directing me to, I was specifically referring to the survival of fingerling lake sturgeon that are stocked in the fall, and not any other group that might be being looked at. So while there might be survival having been shown for yearlings or other groups, that may be the case, but I'm not aware of any data from peer reviewed publications or anything like that that give numbers to overwinter survival of lake sturgeon fingerlings stocked in the fall.

MR. BEDFORD: You referenced in passing one of the four studies, and that's the one that was done earlier this year on the Assiniboine River in Manitoba. So you are familiar with that one?

DR. PEAKE: I'm not familiar with the study. I'm familiar with the fact that lake

sturgeon -- lake sturgeon have been sporadically stocked into the Assiniboine River at various stages in various numbers at various times, most of them not being tagged in any way, shape or fashion. So I am aware that lake sturgeon have been stocked in the Assiniboine River. I'm aware there has been some reports of recapture by fishers. But I have no knowledge as to whether -- I have seen no data to conclude that the fish that are caught, that were caught by the fishers came -- were originally stocked fingerlings in the fall when they were put in the Assiniboine River.

MR. BEDFORD: Sturgeon were extirpated from the Assiniboine River?

DR. PEAKE: Yes, they were.

MR. BEDFORD: So any sturgeon that I might find there this afternoon would clearly originate from stocking, would they?

DR. PEAKE: They absolutely would, but they might have come from large juveniles that were stocked in there, they may have come from small juveniles stocked at various points. Again, I think, my understanding of the Assiniboine River is that it is just sort of the spot where excess sturgeon are put safely, because it is extirpated

there is no reason to worry about an existing sturgeon population there to mess up. So my experience with the Assiniboine, which is limited to only what I've heard from other people, is that that's the spot to put hatchery lake sturgeon if you want to essentially give them somewhere to go.

I'm not aware of any comprehensive scientific program that's involved tagging and recapturing and reporting to specifically determine where the fish that are being captured by fishers came from originally and at what life stage.

MR. BEDFORD: A study done earlier this year, 2013, in the world of academia is at best going to find its way into a peer reviewed journal, two, maybe three years from now?

DR. PEAKE: I'm not aware of that study. Is it Assiniboine River?

MR. BEDFORD: No. My observation is that the time lag between the scientist doing the studies and everyone reading about the results of the studies is generally two to three years. It takes that long to write your work, submit it to a specialist journal, and for the journal to ultimately decide to publish it?

DR. PEAKE: Yeah, I would agree there is a delay in publishing scientific data. There is a process, the peer review process takes time, the publication process takes time, so two to three years is not unreasonable.

MR. BEDFORD: Now, given your answers a few moments ago, can I conclude that you in fact are not personally familiar with the two studies done on overwinter survival of lake sturgeon on the Nelson River, one study in 2012, a second study earlier this year, both of which found in 2012, three quarters of 91 sturgeon that were stocked in the river were recaptured and released, and in 2013, three quarters of 152 sturgeon stocked were found and released and had clearly overwintered?

DR. PEAKE: Excuse me, I'm not aware of that. I was listening carefully to determine when those sturgeon were stocked, and you didn't mention at what stage or at what time of year they were stocked, so I can't speak to that. But you are right, I'm not aware of that research.

MR. BEDFORD: And a fourth study, I mentioned that there were four, a fourth study done again this year on Pipestone Lake, which

found the same results for overwintering.

MR. WILLIAMS: Mr. Bedford, just for clarification and in fairness to the witness, your -- especially since he has not seen these reports, are you suggesting that these are the stocking of fall fingerlings?

MR. BEDFORD: The answer to Mr. Williams' question is, fingerlings and yearlings, the primary point being that they overwintered successfully, and a large percentage of them appear to have overwintered successfully. But I appreciate the fact that Dr. Peake is not personally aware of these studies, so I will move on.

MR. WILLIAMS: No, Mr. Bedford, just so I'm clear, just for the premise of your question, is the premise that there was a combination of yearlings and fingerlings stocked? Just so I understand, in fairness to the witness, because of course his evidence is focused on the survival rate of fingerlings.

MR. BEDFORD: And I'm told it was a mix of fingerlings and yearlings.

Dr. Peake, you have got your report in front of you still, if you turn to page 3? You

discuss the survival rate of fall lake sturgeon fingerlings that were stocked in the Winnipeg River. Do you see that?

DR. PEAKE: Yes.

MR. BEDFORD: And you note that in the period 2009 to 2011, there were "no spring recaptures whatsoever."

DR. PEAKE: My copy doesn't have page numbers on it. I'm wondering if by page 3 you are including the title page? I'm not seeing --

MR. BEDFORD: No, not including the title page.

THE CHAIRMAN: Can you tell us just where you are on that page?

MR. BEDFORD: I will in a moment.

DR. PEAKE: On page 3, I'm not seeing what you are referring to. I'm seeing reference to early studies conducted by Dr. Barth on juveniles. I'm not seeing a reference to the marking, the stocking program, the experimental stocking program that you referred to?

MR. BEDFORD: Page 2, my mistake referencing page 3, comes from reviewing initially your draft report, and then looking at the final report and using the final report today and not

the draft report.

DR. PEAKE: Yes, I do see that now. Thank you.

MR. BEDFORD: Again, Mr. Sargeant, page 2, the paragraph that begins:

"Once reasonable numbers of hatchery lake sturgeon are available...",

and you must count down nine lines.

THE CHAIRMAN: Thank you.

MR. BEDFORD: Now, again, you wrote, Dr. Peake, that in the period 2009 to 2011, with respect to the Winnipeg River studies that there were:

"...no spring recaptures whatsoever."

And I can tell you that I'm told that you are entirely correct with respect to the spring of 2009, but I'm also told that there was a recapture in the summer of 2009.

Were you aware of that?

DR. PEAKE: You know, now that you mention it -- I mean, this is data that wasn't, as far as I can remember, part of the thesis. It was just kind of random information that was being brought in sort of as time went on. I do vaguely remember something along those lines, but I also

remember it being pretty subjective. I remember when it was brought in there was some uncertainty as to the mark, whether the mark was a -- it wasn't a fish that was tagged with a passive integrated transponder, if I remember correctly it was a fish that was marked either with a, I believe, it might have been fin clipped, and there was a lot of uncertainty with respect to whether it was actually a marked fish or just a fish that had an abnormality on its fin. But I guess even if I were to, even if it had been one of our fish, which I don't believe we were able to with a lot of certainty determine. I guess I would say that one fish, the next number out of the thousands that we released would still support I guess my concern that the survival rate would be fairly low for those fish.

MR. BEDFORD: And I'm told that more of these fingerlings that were stocked in the fall of 2008 were caught in the fall of 2009. Were you aware of that?

DR. PEAKE: I was not aware of that.

MR. BEDFORD: And I'm told that even more of them were caught in the spring of 2010. I conclude you weren't aware of that either?

DR. PEAKE: I was not aware of that, no.

MR. BEDFORD: Are you at all familiar with the work being done by Dr. Gary Anderson at the University of Manitoba?

DR. PEAKE: I am aware of Dr. Anderson. I have known Dr. Anderson a long time. I'm not fully aware at this point of the scope of his research. I know he is doing work with Manitoba Hydro on various issues.

MR. BEDFORD: Now I'm told that my client, and more particularly the consultants who have the same area of expertise that you do, heartly endorse your recommendations for use of PIT tags. But as I think you've mentioned in passing, PIT tags are not suitable for marking fingerlings, because the fingerlings are simply too small.

DR. PEAKE: It is possible for the fingerlings to be too small. If they are -- I think they could accept PIT tags, the largest of the fingerlings in a good growth year would be able to accept the new 8, the smallest 8 millimetres tags that are available now. And perhaps the smaller, or the average and the

smaller than average fish might have trouble carrying those tags, I would agree with that.

MR. BEDFORD: Certainly larval sturgeon are way too small to take a PIT tag?

DR. PEAKE: That's correct.

MR. BEDFORD: But Dr. Gary Anderson at the University of Manitoba has developed a technique to mark even larval sturgeon and certainly fingerlings with an isotopic signature. You are familiar with that?

DR. PEAKE: I'm familiar with the fact that he is doing that. I am familiar with the basic idea of that technique, but I have not seen any of his data.

MR. BEDFORD: Page 5 of your report and I will pause to make sure I have the right page number this time. If you turn your attention to young-of-the-year habitat, you walked us through a bit of that in your presentation as well. And I note that at the beginning of your testimony this morning when Mr. Williams asked you some questions on the subject of young-of-the-year habitat, your answer to Mr. Williams was that there is a "increasing" knowledge gap in this area. And I suggest to you that you no doubt

misspoke, and you meant that now in the year 2013 there is a "decreasing" knowledge gap with respect to our understanding of lake sturgeon and young-of-the-year habitat?

DR. PEAKE: Yes, I would agree with that. I clearly would not say that the knowledge gap for young-of-the-year is increasing, it is decreasing as more people are becoming interested in the subject, and it is decreasing as more people work on it. And that's the way it is supposed to work.

MR. BEDFORD: Now one of the concerns that you had in the presentation about artificially creating young-of-the-year habitat is repeated on page 5 of your paper towards the bottom of the long paragraph that's there. And I quote:

"There are almost certainly significant engineering challenges associated with placing sand and keeping it in place in a constantly changing hydraulic environment."

Have you found that?

DR. PEAKE: Yes, I found it.

MR. BEDFORD: But I would like to

suggest to you that there really are not significant engineering challenges to doing this, if one uses either the tremie method, or the slurry method for placing sand on the bottom of a river?

DR. PEAKE: Yes, and I'm the first person to admit I'm not an engineer. I'm not a fluvial hydrologist. I'm not any of those things. I have worked in water most of my career. And my assessment of the feasibility of creating a stable sand habitat is completely based on that knowledge that I have gained over the years. And, you know, if a fluvial engineer told me that it was as easy as pie, I would still be skeptical because it just doesn't -- keeping sand clean in a river that's constantly changing just seems like a very difficult thing to do for me. It just seems that way for me. So that opinion is based on my understanding of the dynamics of rivers and sand, and admittedly that opinion is based on experience and not any sort of education or training.

MR. BEDFORD: You are rather like me on this topic. When I first heard this, I guessed or imagined that this must be a very challenging thing for humans, engineers to do, take sand and

put it on the bottom of a flowing river. I have since been educated and I gather, as you have admitted, you are not engineer and this is not something that you have actually tried to do?

DR. PEAKE: That's correct. And I guess I would say that I don't consider it a great engineering challenge to place sand on the bottom. I would more say it is much more difficult to ensure that that sand stays where you put it, and isn't covered over by silt or transported elsewhere, based on changes in the flow in the river.

MR. BEDFORD: So to meet that challenge, I'm told one will be using one to two millimetre grains of sand and not finer sand which might indeed drift or move; heavier sand, thicker grains, it is not probably going to move as you fear?

DR. PEAKE: Yeah, I mean, I just remain skeptical of that and I have no other reason than -- I have no basis for feeling that, just based on experience, I will be very interested to see how this experiment turns out. As I said, if the proponents are able to put sand and keep it there and keep it from being covered

by sediment, I think that will be a great advance to sturgeon mitigation strategies, and I'm really looking forward to seeing the results of that work.

MR. BEDFORD: And I'm also told that the chosen site for creating this artificial lake sturgeon young-of-the-year habitat is a reach of the Nelson River where the flows in the river do not vary hour by hour or day by day, they are in fact stable. Which is another, I'm told, good fact to support the conclusion or prediction that this artificial habitat is not going to move away. Are you familiar with that, or are we once again beyond your particular area of expertise?

DR. PEAKE: No, I mean, I would say again that during this whole discussion, that I don't have formal training on this subject, but I do have a lot of experience in the field. And I would say that it makes perfect sense to put that habitat in an area of stable flow. I don't -- I don't see really how you can keep flow that stable in the face of things like changing water levels and changing levels of precipitation. But if it can be done, then I think, you know, if it can be done, then I think you will be successful. I just

have healthy skepticism because I have seen, again as I mentioned in the presentation, I've seen nature move things that were many magnitudes of size larger than a one to two millimetre grain of sand, several kilometres away from where it was put, against the calculated models that were produced by very educated and very intelligent people. So that's the basis of my skepticism and I hope I'm wrong.

MR. BEDFORD: Now, I think as you noted in passing, if the expectation is that this will be appropriate breeding ground for -- not breeding ground, but feeding ground for young-of-the-year sturgeon, one needs more than simply sand at the bottom of the river. Presumably they would be there to eat and there has to be something for them to eat. So I rather suspect that you are familiar with the fact that there are abundant studies that do show, I'm told, that invertebrates will colonize artificial substrate samplers in about six to eight weeks. So in effect, once the engineers get the sand down there in the right grains and in the right reach of the river, within six to eight weeks there will be a meal for young-of-the-year sturgeon.

DR. PEAKE: I would also say that I'm not a specialist on invertebrates. I think just from working with some of the projects where we've raised -- we have tried to colonize invertebrates to feed sturgeon, that if you put the proper substrate in, that there will be colonization by invertebrates. But there has been cases too where that hasn't been the case for us, and so I just pointed it out as another potential uncertainty.

MR. BEDFORD: I have returned to page 5 of your paper. You will probably remember using this phrase. Mr. Williams used it, but he used it differently than you do, so the two of you can sort out over the noon hour perhaps which is which. I'm looking about five lines up from the bottom of page 5. And you write that:

"The Cornerstone of the mitigation strategy is the infusion of young-of-the-year fish through stocking."

And I would like to suggest to you that if there is a cornerstone, your term, for my client's strategy on this topic, it is to stock a variety of life stages of sturgeon and not simply young-of-the-year?

DR. PEAKE: Okay. I guess my definition of young-of-the-year is any sturgeon from the yolk sac larvae up to a fish that's approximately a year old, and so I thought that had encompassed the range of fish sizes that had been planned to be stocked. If I'm mistaken, then I'm not sure where -- where that is in the reports that I looked at.

MR. BEDFORD: Thank you. Those are all of my questions.

DR. PEAKE: Thank you.

THE CHAIRMAN: Thank you Mr. Bedford. Mr. Bedford, during your cross-examination you mentioned four specific reports. You also referred to evidence about 2009, 2010 catches. I don't know if those are in those four specific reports. But could those reports and that evidence be provided to the Commission?

MR. BEDFORD: I anticipate that they can, but I will review that with my client over the noon hour.

THE CHAIRMAN: Thank you. Okay. First up among the participants. Pimicikamak.

MS. KEARNS: I don't have any questions. It was very helpful, thank you.

THE CHAIRMAN: Thank you, Ms. Kearns. Manitoba Wildlands.

MS. WHELAN ENNS: Thank you, Dr. Peake for your presentation. And Mr. Chair, I have about the same number of questions as yesterday. I think it is probably eight or ten.

There aren't specific slide numbers on these, but they are pretty much from the sequence of your presentation. And I wanted to ask you if we heard correctly that you made a comment about 200 years ago before there was any human activity on Manitoba rivers.

DR. PEAKE: Yeah, I mean, obviously I can't speak directly to what Manitoba rivers looked like 200 years ago, but I would -- my thoughts on suggesting that 200 years ago there were good populations and good habitat is anecdotal. But, you know, if sturgeon a couple of hundred years ago tended to be -- my understanding is that they tended to be quite plentiful throughout their range, large and in large numbers, and because people weren't impacting them at a large scale, that they were there in good numbers and also that their habitat could be considered pristine.

MS. WHELAN ENNS: Are you aware of the first -- I'm on human contact and since -- the first significant human, post human contact use for sturgeon in Manitoba other than food?

DR. PEAKE: Could you clarify as to whether the use was by First Nations people or by people that --

MS. WHELAN ENNS: Settlers. And the two questions in terms of the 200 year question and this one somewhat go to together and I think have some importance for the proceedings and the Partnership.

DR. PEAKE: Okay. If I were to -- I don't know with 100 per cent certainty. If I were to make an educated guess what sturgeon were used for, other than food by settlers, it was either, because they were so plentiful, either as cord wood to burn and keep themselves warm, or as at an industrial level I know that the swim bladder was used to clarify beer, I believe, the isinglass. That would be my two sort of educated guesses.

MS. WHELAN ENNS: Good educated guesses. The reason for the 200 year question is because the human use, including settlers or colonial use and others in Manitoba, is more like

400 years. And this question about a non-food use of sturgeon goes directly to the situation sturgeon are in now in Manitoba, and also in Canada, which is obviously your specialty. So what I was getting at is we did use them as fuel, including in the older than or farther back than 200 years use of the riverways, so all of the river boats used them as fuel.

I wanted to also ask you then -- and thank you for the reference in terms of Aboriginal people's use. This is an area that may have come up in your work in Manitoba with respect to river and lake sturgeon. And I would like to ask you whether there is any specific things you've learned or applied in your analysis and your work with sturgeon in Manitoba, based on First Nations use, interest in and being impacted in terms of the lack of sturgeon?

DR. PEAKE: That's a very good question. I'm trying to -- I'm the first to admit that my research has tended to focus on generating numbers and hard data like a lot of scientists do. I had the pleasure and opportunity to work with some First Nations representatives on the Winnipeg River when it was come time to collect spawning

males and females. And it was clear that there was traditional knowledge on the system and I can remember learning that at one point the -- like, I can remember commenting on how big the fish were and the gentleman was saying that, you know, that in his experience and long ago they grew to be twice as big as the biggest ones that are there now.

So I think with respect to making recommendations based on the knowledge that I've gained, and it is admittedly fairly limited, unfortunately, I haven't had a lot of interaction with the First Nations folks on the river. But that -- that their knowledge of sturgeon and the system goes back far, far longer than mine, and I certainly respect it, and I would certainly take any information that they had as valuable and try and integrate it into my sort of more numbers driven work. So, I'm sorry, I can't come up with anything really specific, but --

MS. WHELAN ENNS: Thank you very much. The next question has to do with water temperature.

DR. PEAKE: Yes.

MS. WHELAN ENNS: So the region of

Manitoba or of Canada or the Nelson River flows and where the Keeyask Generation Station is intended is a region that already is showing and will have greater increase in temperature due to climate change than, for instance, southern Manitoba. So the question is, in that context, have you considered what an increase of 1 degree in water temperature in the Keeyask Lake and in the Nelson River adjacent, what effect that will have on the sturgeon?

DR. PEAKE: Could you clarify whether you mean a 1 degree average increase in the water temperature or an instantaneous 1 degree increase at a certain point?

MS. WHELAN ENNS: Average. Then also in all seasonal temperatures.

DR. PEAKE: Okay. So in my experience when -- I'm always surprised when I hear big effects happening when there is only a single degree change in the average, but what is not apparent to get that single degree, there is times when the water temperature is several degrees higher than normal, and when you average that out it tends to be a low number, but the actual exposure on a shorter time scale can be larger.

There is several aspects of sturgeon biology that are sensitive to temperature. The one is -- and in some ways when you are thinking about vulnerability, this is where you can look down at the southern places and see what happens, see what they are facing because it is even a bigger deal down there. And one of the vulnerabilities with a higher water temperature is a greater chance that the developing eggs are going to be attacked by fungal infections. Even in the hatchery it is important to keep the water temperature low or you are going to have a bloom of fungus that's going to take over and cause a lot of mortality at the egg level.

At the mid-summer temperatures when they get very warm and the water temperature is increasing -- I don't have any direct data or experience on the Nelson River, but I can say that on the Winnipeg River there are certain temperature thresholds, because when we have been raising fish we have just been using water from the Winnipeg River, and it typically is at the same temperature as the water that's in the river. And when it -- in particularly hot summers there was a lot of mortality of the juvenile fish when

the water temperatures increased beyond approximately 20 to 21 degrees, and when that happened the only way that we could keep the juveniles from dying off was to artificially cool the water.

So the tolerance of, particularly the juveniles, they have an upper lethal temperature limit that will be higher at -- that will be lower, excuse me, at higher latitudes. And so you can expect that the Nelson River fish are adapted to what has traditionally been the temperature regime on the Nelson River, and that increases beyond what is their upper lethal limit will result in death, especially in the juveniles. I would say that the older fish are more resilient and would be better capable biologically of dealing with the higher temperature regimes.

I would say that there is two life stages that would be particularly vulnerable to increased temperature, and that would be the egg and the larva to fingerling stage.

MS. WHELAN ENNS: Thank you very much. If I have missed this in the presentation tell me right away. But the discussion about yearlings is the reason for this question, because it is

obviously an overwintering but it is longer life time before release and so on. Are there, in your experience or in your analysis, are there risks in terms of invasive species and -- well, life and mortality for sturgeon once they are released?

DR. PEAKE: I think it is a difficult question to answer concisely because it depends on the nature of the invasive species. Some invasive species, it is theoretically possible for invasive species to have a negative impact on one fish or some sort of organism, and even a beneficial effect on another. So I would say that in general invasive species, the tendency is to try and avoid that situation, and I think it is possible, certainly possible that an invasive species could have a negative impact on sturgeon, especially if this species is out-competing them for their critical resources at critical points in their life history. At the same time, I think that it really does depend on the nature of the invasive species, and that some would have impacts and some would have no impacts.

MS. WHELAN ENNS: Thank you very much. Last topic, if you will, and the question has to do with sturgeon being endangered and being

listed. I wanted to ask you to give us an idea of the steps, from a scientific point of view, the steps to in fact have arrived at the Nelson River main stem population of sturgeon being listed.

So would you tell us whether this process starts with COSEWIC, which is the committee on the status of endangered wildlife in Canada, and what the situation is right now for sturgeon with respect to the Federal Species at Risk Act and also how long that takes?

DR. PEAKE: You know what, I honestly wish I could answer that question fully for you. I tend -- I have tended in the last few years, because it -- to answer one part of your question it seems to take a very, very long time. And I can remember being -- hearing about the potential listing as endangered, I can remember hearing that a number of years ago. And because it has been taking so long, I honestly haven't been following the process as it has been going through the steps in Manitoba. I know there were some delays in coming up with a recovery plan, which I think is part of the process. But I honestly, and I really should know this whole process better than I do, but I don't think that I know it clearly enough to

take a stab at presenting it. And I honestly don't know exactly where in the process we are on that. I will say that if they do end up being listed, either Federally or otherwise, that what can and can't be done to them will probably become much more narrow, and may have an impact on the mitigation plan, but it is difficult at this point to, I think -- I guess we have to work under the setting that we have right now, which is that I believe they are not listed at this point, they are being considered, and it seems to have been the case for a very long time.

MS. WHELAN ENNS: So given then -- and thank you. Given the potential time lines, and your comment just now that if we get to a point, and it has been going on since 2006, if we get to a point then where sturgeon are listed under the Federal Species at Risk Act, would there then need to be some thought, a look at what the mitigation and restocking practices have been, what is going to be allowable?

DR. PEAKE: I think if that happens there will definitely need to be some thought on that. I think that what, if anything, that will need to happen is there will be more stringent

rules about what can and can't be done to sturgeon specifically in relation to the risk of harming or killing one that the -- even the mitigation strategy takes, and so if the mitigation strategy is such that there is, I guess, a conceivable or a reasonable risk that a sturgeon or a number of sturgeon might be injured or killed by that, it might be difficult to continue with that, and there may need to be discussion about how the process can be adapted to bring that risk within -- bring that risk within acceptable levels with respect to that legislation, so yes.

MS. WHELAN ENNS: Thank you. Thank you very much, Dr. Peake, and thank you, Mr. Chair.

THE CHAIRMAN: Thank you, Ms. Whelan-Enns. Peguis?

MS. GUIRGUIS: We have no cross-examination. Thank you, Mr. Chair.

THE CHAIRMAN: Thank you. Okay, Fox Lake Citizens.

MR. McLACHLAN: I have maybe seven or eight questions. Should we do that before lunch?

THE CHAIRMAN: Well, let's see how it goes.

MR. McLACHLAN: Okay. Thank you very much for your presentation, Dr. Peake, it was very illustrative and easy to understand. I have a few questions.

THE CHAIRMAN: Would you introduce yourself.

MR. McLACHLAN: My name is Stephane McLachlan, and I'm a prof at the University of Manitoba. I was hoping to get you to expand a little bit on some your observations. As you noted a number of times, Manitoba Hydro is quite optimistic about the role, both in terms of restocking and also around habitat creation, so most of my questions focus on that.

We heard earlier, and I'm sure you have read, that they are quite optimistic that by taking over the hatcheries that they will address a number of shortcomings that you have experienced and that you have shown quite clearly.

So my first question is despite this idea that the tanks can be cleaner, and perhaps that the feeding can be more effective and that the training can be more effective, do you see there being inherent difficulties in kind of growing these fish, that despite the best efforts

that there will still be difficulties that are encountered, and can you expand on those a little bit more?

DR. PEAKE: Yeah. I mean, I think that hatchery, when you are raising fish in a hatchery there is the temptation to maximize your survival rate, and you do that by doing things like having trained people keeping things very clean and sterile. I don't completely -- I know it was suggested that perhaps the troubles that we were having and the troubles at Grand Rapids were the result of that, and I -- I respectfully don't completely agree with that statement. I think that the people working with the sturgeon had done so for many years. They were good at what they did. The tanks were kept clean. And in spite of that there was mortality. And in some ways I'm not sure why that should be surprising, because if you look at sturgeon in the wild, they are living in completely unsterile conditions with mud every where. They live in sediment and they don't live in sterile environments that are cleaned and they are not hand fed. So as a result a lot of them die, and that's just how nature works.

So I think when you are trying to get

60, 70 per cent survival out of a group of animals that normally and naturally experience a survival rate that's closer to one or two per cent, that you shouldn't be surprised that it is difficult to do that. And I -- again, I hope I am being overcautious about it because I really think the idea of stocking fish and bringing the Nelson River populations back up using that technique is the way to go, and I think that -- I really hope it works. And I guess I'm -- my experience just, you know, for the years that we worked on it, and the blood, sweat and tears that we went through, is just tempering my ability to sort of just believe that it is a matter of clean tanks and personnel experience.

MR. McLACHLAN: And do you have any experience say with the Rainy River Hatchery in Manitou?

DR. PEAKE: I don't have experience with that hatchery.

MR. McLACHLAN: If not direct experience, are you familiar with their success rates at all?

DR. PEAKE: The only thing I know about the Rainy River system has been told to me,

so it is completely hearsay and anecdotal. But what I have been told is there is actually a pretty good population of sturgeon in the Rainy River system, I could be wrong about that but that's just my impression. And to be honest, because of that I didn't really know there was a lot of stocking going on. So the short answer to your question is I'm not terribly familiar with their stocking program and their success.

MR. McLACHLAN: Okay. Thank you. And I have done a bit reading, even though it is not my area of direct expertise about these on site stream side hatcheries that are sometimes advocated. Can you talk a little bit about the strengths of that perhaps as a complimentary approach, how they might be used in such kind of endeavour?

DR. PEAKE: The first time I saw that, and I think I know what you are referring to is folks down in the U.S. that had the idea that sturgeon were imprinting on their habitat, that juvenile sturgeon would somehow imprint on the water, like the water quality and the chemistry of the water, so that the idea was that if we take them and put them in hatcheries with sterile water

or water that they are not familiar with, that might hamper their ability to integrate into the population. So the idea was to create small hatcheries in trailers that could be deployed to the actual rivers where the eggs and the milt were being collected, so that the water used in these hatcheries could be pumped straight from the river through the system and then back into the river. I thought it was an interesting idea.

I do remember thinking that, although, perhaps it makes -- perhaps it is a reasonable hypothesis that sturgeon might imprint on particular water chemistry, I had never seen any evidence to that. And I do remember wondering, I do remember thinking that if it was me I might seek that evidence before I spent a lot of time and effort generating those type of hatcheries. They are fairly expensive and they tend to be fairly small and produce a fairly low number of sturgeon. I think the numbers for fall fingerlings were in the order of 300 or 400 fish. So I think -- I'm not sure if it is the most efficient way to raise sturgeon. I'm not completely convinced that the premise of the whole endeavor, i.e., the imprinting on water chemistry

has been shown with enough solidity to make me want to go out and get one of these things. So I guess that's sort of the sum of my thoughts on those things.

THE CHAIRMAN: Dr. McLachlan, I think we won't get through your questioning before lunch break, so we will take the break now and come back at 1:30, and you will be back in the chair.

MR. McLACHLAN: Okay, perfect, thank you.

(Proceedings recessed at 12:30 p.m. and reconvened at 1:30 p.m.)

THE CHAIRMAN: We will resume the cross-examination of Dr. Peake. Dr. McLachlan for Fox Lake Citizens is in the chair.

Dr. McLachlan?

DR. McLACHLAN: Thank you.

Okay. My next question had to do with site fidelity. And in your presentation you indicated that sturgeon don't always behave in ways that are in their best interest. I was just wondering, is this common in nature? Is it something that's atypical?

DR. PEAKE: Typically animal behaviour

will be directed at minimizing energy expenditure and maximizing the likelihood of survival. That's how nature works. It's not that common to see an animal acting against that. And when you do, it's typically a maladaptation. And I think, I mean specifically what you are referring to is that sturgeon, with respect to site fidelity, the juvenile sturgeon will, once they have picked a habitat to live in, they will stay there for several years if not many years, and feed in that area. And their movements are very limited within quite, like it's quite -- I mean, even over the course of four or five years, the total area of movement would be within a couple of kilometres, even though there's nothing keeping them from moving upstream, or actually just drifting downstream, they expend energy to stay in those nursery habitats.

Now, you would expect that if that habitat was very good, but in the case of the Winnipeg River, there was a very heavy concentration of juveniles in the nursery habitat. And because of that, there was a lot of competition for resources and there wasn't enough food to go around for all of the fish that were

there. And you would expect an animal to, in the face of overcrowding and limited resources, you would expect them to fan out and look for better habitat. And that just didn't occur in our studies on the Winnipeg River. So the fish were actually expending energy to stay in a patch of habitat that couldn't support them, even though there were patches downstream that they could get to, without expending energy, that would result in an increase in their growth rate and survival.

And so I think it's essentially a maladaptation in sturgeon that's related to the fact that they probably, and this is completely a hypothesis of mine, but obviously they don't know what's downstream and they are -- in the past when populations were much higher, it may have been that it was detrimental to move downstream because there were already lots of fish in juvenile habitat down there. So moving downstream would invade that habitat and cause overcrowding of that habitat. So it may have just been that over time, they developed the behaviour that they should stay where they are, even if the conditions are difficult there.

And they essentially don't realize

that that situation may have changed. And so they are doing what they have always done, and that's expending energy, staying where they are, remaining with having high fidelity towards that.

DR. McLACHLAN: And so you described that well in the Winnipeg River. Is it likely that the same phenomenon will occur in the Nelson?

DR. PEAKE: That's a difficult question for me to answer without data. I think from what I saw in the reports done by the consultants, that they are finding sturgeon in habitat that I would have expected them to find it in. And so I guess what I would say is, there's nothing to indicate to me that their behaviour there would be any different, but that will remain to be seen, I think. And if it is the case, it will be an important consideration in the management of the species.

DR. McLACHLAN: And so you anticipated my next question.

So, first of all, if that is indeed the case, then it seems to make sense to be cautionary about that, in what ways might it make them vulnerable to disturbance associated with this particular project?

DR. PEAKE: Right. Well, the vulnerabilities are for fish that have, for lack of a better word, imprinted on a certain area or certain piece of juvenile habitat, if there is better habitat, either created, or created through engineering or created naturally, if they are, if they also exhibit high site fidelity to the place that they have imprinted on, it's unlikely that they would naturally move to that area, even though it was better. So they might continue to prefer to stay in suboptimal habitat.

The other issue is that if there is habitat created, and it's good habitat, and the fish are stocked in it and they actually do find it and use it, if that habitat becomes unsuitable through a change in the flow regime or whatever, it is possible that as the habitat degraded, that those fish that were there would not move out of that area and they would continue to exist in poor habitat.

So those are a couple of things that I'm sure the folks that are planning this have on their minds. But it's something that could impact the management of things afterwards.

DR. McLACHLAN: Perfect, thank you.

At one point in your presentation, you talked about kind of perhaps the desirability of carrying fish downstream as well as upstream. Can you kind of expand on that a little bit?

DR. PEAKE: Sure. Lake sturgeon have a definite upstream component, so I think upstream passage is something that really should be considered at a hydro facility, or any development that results in a migratory barrier. And that's been done here and I think it's been done properly. I have spent a lot of time trying to figure out how to get sturgeon to voluntarily move through engineered fish ladders and such that are typically used for salmons and other species. And we have, essentially the scientific community has had almost no success with that.

And so at this point, it's really come down to, if downstream passage -- or if upstream passage, excuse me, is considered vital, then really trapping and transporting them over, according to a schedule and a regime that is not going to harm them, is done in a way that is creating that mix of genetic variation that the movement results in, is really the only feasible way at this time to achieve the goals of upstream

passage for lake sturgeon.

So I guess on the other side of the coin, downstream passage to me doesn't seem to be quite as important. It's not, to my knowledge, it's not a requirement of any of the life history stages, and it's kind of incidental. The fish just finds itself near the dam, it's investigating an area along the bottom, it gets caught in flow that's heading towards something that it can't get out of and it ends up being impacted.

I think from a genetic perspective, you can't just constantly move fish upstream. If your goal is to maintain genetic diversity, you need to have some mixing of the other direction as well. But because it's not quite as critical to the life history, and because moving them downstream, either through turbines or over spillways, however much you design the facility to minimize impacts, there will be impacts. There will be entrainment and there will be injuries and mortalities associated with that. And I guess I just wonder if the acceptance of that risk and that mortality rate is really worth it, given the fact that they don't really need to go downstream anyway.

And if you are carrying out a program that's moving fish upstream, I guess I just wonder why you wouldn't expand that program a little bit to move some fish downstream, and use some methods to try and prevent sturgeon from being entrained, which isn't a new thing. There is plenty of dams out there that have had that goal in mind to reduce the probability of entrainment. So I think there's probably strategies out there that could be used to do that, and the movement could be facilitated by a trap and transfer program.

And if it's there anyway, then, I don't know, it just seems to me to be a good way of controlling. If we're going to control things, let's control everything. To me, it's one thing to control the upstream passage, but if there's no controls on the migration of fish coming in, it's actually difficult to predict how many fish need to be moved upstream when we don't know how many are coming through downstream, and whether we are moving too many. It's just difficult to plan the entire thing. And I think that if the overall plan was to be looked at again, and if I were at the table, I would be suggesting something along those lines.

DR. McLACHLAN: Do you see that as especially important given -- and we have heard from various presenters how few old fish there are in this system, and if it's particularly those old large fish that are most vulnerable?

DR. PEAKE: Yes. It's the fish that are going to go through the protective racks, are going to be a range of small fish, which are going to theoretically have a low mortality, right up to fairly large fish, that are still going to go through but their survival rate is going to be considerably less. I'm the first to admit that there hasn't been a lot of data where sturgeon specifically have been put through turbines. But, again, the general rule is the bigger the fish, the more chances of an encounter. And so the larger fish are going to be injured. And then the even larger fish, which are even rarer and arguably even more important, are going to be -- have the potential to become entrained on the racks if there is no means, or there's no effort into either reducing approach velocities or carrying out some sort of -- or putting, installing some sort of hardware that makes it easier for them to escape if they become impinged,

or makes it more unlikely that they are going to become impinged.

And I guess to end with that line of thought, the other thing that I would be encouraging is some means of monitoring those protective trash racks, and not just on tagged fish, but in general. So that it can be determined exactly how many fish are becoming impinged on there, and how long they are staying, whether they are able to get off and that kind of thing.

So, yeah, I think.

DR. McLACHLAN: In your kind of expert informed opinion, when you look at the various mitigation strategies, are those responses adequately reflected in what you have seen in terms of either the presentations, or in terms of the documents, to protect those very rare, big, old fish?

DR. PEAKE: Can you repeat the question?

DR. McLACHLAN: So, again, I mean, there is a number of different mitigation strategies that the proponent has suggested, right? Do you think those mitigation strategies

adequately address the concern that you just brought up in terms of high levels of mortality for those large, very rare fish.

DR. PEAKE: Yeah. I wouldn't say that we can expect high levels of mortality for those large fish. I think that the probability that a large fish will encounter the upstream side of the dam is actually on the low side. However, those that do are going to do one of two things. They are either going to go through the racks and take their chances with the turbines, and there will be an associated probability of injury and mortality with those, or they are going to -- I should say there's actually three possibilities -- they are going to be able to avoid that being impinged on that screen and they will go off, or they will be impinged -- I guess there is going to be four possibilities -- they will be impinged and they are able to remove themselves, or they will be impinged and they won't be able to.

My experience with sturgeon and other fish is if they do become impinged, there's a very high likelihood that they will not be able to escape from that.

And so overall, I think that the

likelihood of injury and mortality for large fish on the upstream side, due to entrainment, in the grand scheme of things is relatively low. But I guess I question why, if it was me, why would I accept even a low probability when there's probably a good -- it could be designed to keep them out of there completely and get them down a different way.

DR. McLACHLAN: Okay, thank you.

In your slides 3 and 4, you indicated kind of the existing situation. So this is your, you know, all of your life history, your cycle of life histories. And then you indicate a healthy population and a pristine habitat, and the Keeyask area pre project. And then finally, on page 5, you talk about the post project, assuming that there was no mitigation.

DR. PEAKE: Yeah.

DR. McLACHLAN: And obviously there's a lot more red in the latter.

Now, given all of the kind of caution that you have indicated around some of the optimism within the proponent's presentations, we're not assuming no mitigation. But if you were going to create another slide which indicated kind

of, rather than optimism, pessimistic, so assuming that kind of the hatchery production wasn't as successful as they are hoping that it will be, assuming that the habitat creation wasn't as successful as people were hoping it to be, within that range that we always anticipate as scientists, again not assuming no mitigation, but assuming kind of much less successful or optimist mitigation strategies, can you take me through and tell me what you think kind of those boxes would look like?

DR. PEAKE: Can you bring up slide 29, please? Okay. This is my interpretation of the vulnerabilities and the risks with Keeyask pre-project. I think that if the proposed mitigation strategies were put in place and they didn't work, I wouldn't -- I mean, I don't expect that if things aren't working that the proponents are going to just throw up their hands and say, okay, we gave it a shot, we're not doing anything anymore. My impression was that it's an adaptive management process. If they see things not working as they go, then they would change things to make them better.

So I certainly don't think at any time

would there be anything like that slide with all the red on it. And my guess is that at worst it would look like this slide right here. I think it's difficult -- it's difficult for me to imagine a situation where despite the best efforts of some really smart folks, that things would actually get worse. And so I think in kind of a worst case scenario, I think the population would continue to flounder as it is now and remain at kind of depleted numbers. I think that's probably as bad as it could get, assuming continued effort to mitigate.

Does that answer your question?

DR. McLACHLAN: A little bit.

Just in your experience, despite the best intentions of mitigation, is it your experience that sometimes we actually create more harm than good around some of these populations with sturgeon, lake sturgeon in this case?

DR. PEAKE: I think that's a possibility. And then certainly the probability of that would increase in a situation where you had development that occurred without any sort of -- without a lot of regulatory input, without a lot of genuine interest in the people that are

operating the facility to really manage the population. Honestly, I don't think that's the case here. And I would say as well that there has been occasions, like a couple of the systems that I have worked on in the Winnipeg River were just -- there wasn't much consideration given to sturgeon to begin with. And you know, it just, it worked out that the area downstream of the generating station turned out to be pretty decent spawning habitat, and with really no ongoing mitigation, the population did really well.

So, again, I hesitate, I think honestly that with a Partnership that is genuinely concerned about the resource, which I believe they are, and the amount of knowledge that the group working with them has, again, I think it's really -- I think it's very unlikely that things would get worse than this, to be honest.

DR. McLACHLAN: So you spoke earlier in response to Mr. Bedford, when you were looking at the Assiniboine River, in the sense of that being a good situation for restocking because they had been extirpated, so in a sense it was less likely to "mess up"; right? I guess that's what I'm trying to get at. So you're saying there's

little likelihood that we can mess things up despite our attempts to mitigate possible harm?

DR. PEAKE: I should qualify that. I don't necessarily think that it's good that the Assiniboine was extirpated. I think it makes it easier to stock fish there, because one of the big concerns about stocking sturgeon is that you're not bringing in fish with -- you're not endangering a population that exists there that has a unique genetic makeup.

So, I mean, this was the reason why we're not trucking sturgeon from the Winnipeg River up to Keeyask to bolster those populations, because we want to maintain the genetic integrity of that population.

When a system is extirpated like the Assiniboine River, that's certainly not a good thing. But from the perspective of stocking, it makes things easier because you don't have to worry about that anymore, you can essentially bring fish from anywhere because you're creating a population from scratch.

If your question is, am I concerned about sturgeon on the Nelson River becoming extirpated despite the best efforts, I would not

say it's impossible, but I would say that as long as there is work going on there, good work on the monitoring and the adaptive management, I think the risk is low.

DR. McLACHLAN: And finally, and this is my last follow-up question to that, you've got a situation that we have a species that shows high site fidelity. We've got populations or subpopulations that are separated in space, and perhaps not much movement among them as a result and so we would anticipate that there would be genetic variability among those subpopulations. Would one of the mess-ups, if you like, be if we become too dependant upon, you know, our restocking, say because the mitigation strategies around habitat creation aren't successful, then is there a chance that it will kind of homogenize the variation among those subpopulations?

DR. PEAKE: Yes. I'll go back and say that it's unlikely that you'd see unique genetic populations between dams, because it tends to take a long time for that to become established. But certainly what you have mentioned, the possibility of the genetic variation, the amount of genetic variation that exists within that region becoming

diluted by the fact that a lot of the fish that are coming in are coming from the same parents, which is not the way it normally happens in nature.

And I guess I think that's why, for that reason, it's important to protect the wild fish that are there, and that's why it's important to monitor the health of the wild population, as well as the hatchery population. Because if it starts to show, if you start to see that that wild population is all of a sudden starting to decline, that would be something that you would need to adapt to and figure out why that's the case, and try to protect the genetic diversity that you have in those. And so if you lost all the wild fish and it became completely a stocked population, you would definitely lose genetic diversity.

Now, I don't know at what point that would become a problem, but it would -- I mean, I'm not a geneticist but there's certain minimum genetic variability that's needed to ensure a healthy population and things like mutations and that kind of stuff creeping in, but it's not really my area of expertise.

But, in general, it's a valid point

and it's a good reason why the wild fish should be protected and monitored very closely.

DR. McLACHLAN: Okay. Perfect. Thank you.

THE CHAIRMAN: Thank you, Dr. McLachlan. I think one or two of us panel members have some questions. Mr. Yee?

MR. YEE: Thank you, Mr. Chair.

I just have one question for you, Dr. Peake. In your paper, you talk about the year of the young in juvenile habitat. And in particular, you noted that the year of the young juvenile sturgeon habitat must consist of coarse sediment sand but must be relatively free of fine sediment.

I wonder if I can get a better understanding of how important sedimentation is, given there's going to be a fair amount of erosion created by the reservoir and there will be a higher level of sedimentation, how will this impact this habitat?

DR. PEAKE: I think that the stage -- the developmental stage that's most vulnerable to sedimentation would be the larvae and the young, maybe up to the yearling. Beyond that, the fish get fairly -- assuming that the substrate

conditions are conducive to growing the right invertebrates, there becomes more flexibility in terms of what they can tolerate.

I think if the nursery areas that the young of the year are inhabiting are infiltrated with fine sediment, I think that would have a negative impact on their well-being and their survival.

But I guess if the habitat, if the coarse sand habitat is there and it's stable, it tends to be because the flow is strong enough to keep that fine sediment from settling. So if there's shoreline erosion that suspends those fine particles, as long as the flow is sufficient to keep it from settling out on that sand, it will just wash over and it shouldn't have a big impact on that sandy substrate.

So, again, it emphasizes the importance of, if habitat is going to be created, it really needs to be in water that's not going to fluctuate a lot in terms of flow. And as long as that's not the case, the amount of sediment that comes in from other sources becomes a little less critical, as long as it will drift over it rather than settle out onto it.

MR. YEE: Thank you.

THE CHAIRMAN: Dr. Peake, I have two or three questions that bounce around a little bit.

This morning, Mr. Bedford mentioned isotopic markings. Can you explain a little bit what they are and what your opinion is of them?

DR. PEAKE: Sure. Yeah, stable isotopes are, I'm not an expert in stable isotopes, I have worked with them a little bit. And what the strategy is with respect to using stable isotopes to mark larval fish, or very small fish, is that you would feed them food that contains an abnormal mix of -- and forgive me if I get this wrong, if there's any chemists in the building or whatever -- but essentially elements can exist at different isotopes -- well, there's different isotopes. And the relative amount of each isotope is fairly consistent in nature. And so what happens is that the whole process is based on the premise that you are what you eat. So if you are eating this normal range, this normal ratio of isotopes, you have a normal background isotopic signature that reflects the food in the environment.

Now, if the sturgeon are reared on food that contains a different ratio, then their body tissues will not match that of the background. And so the idea is go ahead and do this and have that mark on their bodies, throughout their bodies. And then when they are recaptured, you can take a tissue sample and analyze it and see which isotopic signature you get, the one from the background or the one that was put in at the hatchery?

I have two concerns with this. My main concern is the same as the concerns with all of them, it's not a unique signature, it's not a code that's unique to individual fish. It is going to, at best it is going to show you what is hatchery fish and what is a wild fish, and perhaps give you a rough idea of when that fish, of how old that fish was.

So in that sense, the only advantage of that is that you can, like even the fin clipping and the other things you can't really do on larval fish, they are just too small and too fragile. It's something you can do on the very smallest fish.

The other concern that I have, other

than the fact that I'm losing my voice, is that when you release the fish, again, you are what you eat. So your fish that's 10, 15 centimetres long, and you have this different isotopic signature, you start to eat and you become very large, and that isotopic signature is diluted by consuming a lot of the other signature. And what you have to do is you have to do a long-term study on how long that isotopic signature remains with the fish, and when it eventually disappears, which it will. And you also -- it's very complex in that the fish will eat something and it will lay that molecule down somewhere in its body. But then it will also, it doesn't stay there forever, it will come off and be shed into the environment. And it's a complex process. And in order to figure out exactly when, how long that signal will last, you would have to do a 10, 20 year study every year showing how that signal is attenuating over time. And there just hasn't been time to do that. And so I'm not sure how there could be a lot of confidence as to when, how long that mark could theoretically remain in place and be detectable. So those are my two main concerns with isotopes.

THE CHAIRMAN: Thank you.

Now, you talked a fair bit about fish getting entrained on the trash racks. And you mentioned, although I don't think you gave any detail about diverting them away from the trash racks. We have done a bit of preparation for this and seen some methods. How could you keep the fish away from the trash racks?

DR. PEAKE: There's a few, there's some trash rack designs out there that are on an angle relative to the incoming flow. That's one way of doing it, so that the fish is kind of directed along the screen and then out of the area of influence. So that's one of the ways that it can be done.

Controlling the velocity at the screen is another way. So if the velocities are -- and there's lots of trade-offs with this. Like as soon as you decrease the bar spacing, then velocity will change and presumably increase, and you'll lose head differential. And so there's a lot of give and take with this. But there are ways to flat out block sturgeon from, most adult sturgeon anyway, from going through into the turbines, and that is to reduce bar spacing. And that's obviously going to have impacts on other

species because you might start keeping the adults of the other species out.

So, theoretically, you could bring the spacing down a little bit, you could angle the racks. You might look at -- this isn't a new problem, so other utilities have dealt with this -- you might look at behavioural things that cause a negative reaction in fish. So bubble curtains, strobe lights, that kind of thing are all things that would -- electricity, electrical currents, that kind of thing. So there are things out there. I don't think there's anything that's perfect.

But the thing is, it's not a new problem, and so you wouldn't have to invent that wheel if you decided philosophically to go down that path.

THE CHAIRMAN: And I take it from your comments this morning that you don't particularly favour sort of the downstream outlets, like a cut in a dyke that might open up to I guess a big water slide or something?

DR. PEAKE: Well, I think what you are describing sounds a bit like a spillway to me.

THE CHAIRMAN: Yeah.

DR. PEAKE: So I don't think it's a horrible idea. I think there's challenges associated with it, trying to -- there tends to be a shying away. Essentially any water you put through that is going to be water lost to the generating station, so you're going to want to minimize that loss. And by definition, that means that the opening to that type of structure would be fairly small. And so to get sturgeon to find that area and then go down the ramp would be, I think would have a fairly low chance of working in any sort of sustained manner.

I think you'd be better off to either move them physically or let them go over the spillways, keeping in mind that there can be injuries with that as well. And somehow, again, this is difficult, but somehow sort of monitoring or getting an idea of how many fish are moving downstream over spillways.

THE CHAIRMAN: Thank you.

You talked a fair bit about hatcheries and some of the problems in the past at hatcheries. The Partnership or the Proponent has talked about the possibility of building another hatchery in the Keeyask area. Do you have any

thoughts on that? Are there advantages, or might it divert the skill level of -- if you have just one hatchery, like expanding Grand Rapids, you could concentrate more skilled people there. Were any of these legitimate concerns?

DR. PEAKE: I think the opportunity, if a new hatchery is going to be built at the facility, there's an opportunity to bring in some controls, things like temperature control, things like treating the water, you know, and disinfecting the water and this kind of thing, all these things that might help with survival and that might be easier with a new facility.

I know Grand Rapids in the past has had trouble with water temperature, and specifically, if I remember correctly, trying to get water temperatures up to a point where the fish were growing at a reasonable rate. And so temperature control might be, you know, easier in a new hatchery to do something like that.

It reduces risks associated with transporting fish if the fish are right there ready to go.

I'm just sort of brainstorming, but I would also think that it might be difficult to get

really highly trained staff to a new facility that's fairly remote, and especially when it's only a seasonal type thing, so there might be some issues along those lines. It's difficult for me to comment on the likelihood of that.

But I think that the people to ask about that would be the people working at Grand Rapids Hatchery. They have been there for a long time. If it was me, I would be soliciting their opinion as to whether they could do a better job at their facility with an upgrade, or the whole process could be better done at a facility directly and specifically designed to raise lake sturgeon.

THE CHAIRMAN: Thank you.

Now, the Partnership has sort of boldly predicted that, after Keeyask, sturgeon will be better off. Now, you've sort of brought out a couple of provisos, one that you believe would be that if they release yearlings in the spring, if they are successful in developing juvenile habitat, if they can meet those two, and I don't know if there are other provisos, do you think that they might be able to improve the stock of sturgeon in the Nelson River?

DR. PEAKE: Yeah, I think the answer to that is yes. I think if the plan is such that there is an influx of hatchery raised fish that are able, whenever they are stocked, I think it's -- I think the time to do it where it's least likely to fail, and best in terms of marking the fish because they are large enough to take the pit tags, I personally think that's the time to do it because I think it's going to maximize, even though keeping them in the hatchery over the winter might expose them to some slightly additional risk of mortality, I think for the most part, if we figured out how to get them to a fingerling stage, well, then to get them from a fingerling to a yearling should be the least challenging part of that whole process.

And so I think stocking yearlings in the spring is the best way to give them the highest chance of surviving. And if there is, if the habitat is there, enough of it is there to support them, whether it has to be created or not. If it's there and if we get a good survival rate with the yearlings, I do think the population will, you will start to see it over time, it will increase, assuming that there's no other sort of

unforeseen things going on.

THE CHAIRMAN: But there are, as you have said, a number of uncertainties?

DR. PEAKE: There are a lot of uncertainties. And when you look at all the uncertainties when you want to go -- because you have to go the whole way, I mean, you have to go from an egg all the way around to a fish that is successfully integrated into the population, and that is a really long road with a lot of bumps in it along the way. And if you get 99 percent of the way and you have a failure, like there's no second prize really. The whole chain is only as strong as its weakest link. And if that link breaks halfway through or two-thirds of the way through, it has a big impact on the population potentially.

THE CHAIRMAN: Thank you, Dr. Peake.

Mr. Williams, anything further with Dr. Peake?

MR. WILLIAMS: I have no redirect, Mr. Chair. You took my only question of redirect, so I thank you for that.

I do want to thank on behalf of CAC Manitoba, Dr. Peake, for your work. We are

prepared to call Dr. Schaefer when we have the direction from the board, Commission.

THE CHAIRMAN: In a minute or two. Dr. Peake, thank you very much for your time today and for the preparation of these documents.

DR. PEAKE: I enjoyed it. Thank you for the opportunity.

Before we go to Dr. Schaefer, Mr. Bedford, anything on the reports that we inquired about before noon?

MR. BEDFORD: Yes. I am reminded that one of the four has actually been filed. It's part of one of those Federal Government DFO TAC answers. And the other three, I'm assured we can provide you when we recommence this hearing a week and a little bit from today.

THE CHAIRMAN: Thank you.

Mr. Williams?

MR. WILLIAMS: I'm going to ask Dr. Schaefer to come up, and if I might be excused for just one second, Mr. Chair, while he sets up?

THE CHAIRMAN: Absolutely.

MR. WILLIAMS: We're ready, Mr. Chair.

THE CHAIRMAN: Go ahead.

MR. WILLIAMS: I'd ask that

Dr. Schaefer introduce himself and then Ms. Johnson will help you with the swearing in.

DR. SCHAEFER: Yes. Good afternoon, my name is Jim Schaefer. I'm professor of biology at Trent University in Peterborough, Ontario.

Jim Schaefer: Sworn

MR. WILLIAMS: And for the panel, again there will be two documents. One is Dr. Schaefer's powerpoint and the other is a brief biography. And if we can turn to the biography for just a couple of moments, Dr. Schaefer, would it be accurate to say that your general expertise is as a conservation biologist and population ecologist with regard to northern mammals?

DR. SCHAEFER: Yes.

MR. WILLIAMS: And if we were to focus in on your expertise as it relates to the sedentary and migratory ecotype of caribou, I wonder if you can tell us a little bit about your work as set out on page 1, as a member of the science review panel in terms of Ontario boreal caribou recovery?

DR. SCHAEFER: Yes, I have been studying caribou now for almost 30 years. I began here as a graduate student at the University of

Manitoba. Along the way, in addition to my research activities, I was invited by the Minister of Natural Resource in Ontario to become a member of a small panel, a science review panel, to provide some critical review of the draft Ontario caribou recovery strategy. I was also shortly thereafter invited to become a member, and I am still serving as a member of the provincial caribou technical committee as well.

MR. WILLIAMS: Thank you.

And again, just in terms of how it may have informed your expertise, I wonder if you can comment upon your work in the 1990s as the senior wildlife biologist in Newfoundland and Labrador?

DR. SCHAEFER: Yes. Prior to my university appointment, I was for four years the senior wildlife biologist in Labrador with the provincial government, and caribou were the centre piece of our research and management efforts there, again, consistent with what Labradoreans were looking for.

MR. WILLIAMS: Can you tell us how many jurisdictions across Canada in which you have investigated the sedentary and/or migratory ecotype of caribou?

DR. SCHAEFER: Yes. In addition to Manitoba, I have worked and studied caribou in Ontario, Quebec, Labrador, the island of Newfoundland, some work in Nunavut as well.

MR. WILLIAMS: Okay. And in the course of your work, would you have come across circumstances where there would have been spatial overlap between the sedentary ecotype and the migratory ecotype?

DR. SCHAEFER: Yes, for certain. In both Ontario and Labrador, it was a common instance, for example, a regular instance in Labrador that we had intermingling of the migratory type with the smaller sedentary herds. Indeed, our management structure was set up to deal with that.

More recently, I had been collaborating with the Ministry of Natural Resources in Ontario. And again, there is great interest in the degree of separation and intermingling between those two ecotypes.

MR. WILLIAMS: Thank you.

And just to direct your attention to page 4 and 5 of your brief biography for a moment, as it relates to your expertise, I wonder if you

can describe the peer-reviewed work or the research you have done with regard to the issue of abundance and disturbance of caribou?

DR. SCHAEFER: Yes. As a population ecologist, we are often most interested in patterns of abundance, patterns of distribution, and the factors that cause those. And so a lot of our work on caribou reflects that. We have been interested greatly in habitat and how it reflects caribou abundance distribution. And more recently I would say as well the effects of human caused disturbances, hydroelectric developments, forest harvesting, for example, in Newfoundland and in Ontario.

MR. WILLIAMS: And just before we get to your powerpoint, it would be fair to say that you have done work in Manitoba. In terms of the specific caribou population that is of most concern in this hearing, you wouldn't have direct contact with that population?

DR. SCHAEFER: No, that's correct.

MR. WILLIAMS: Okay. Dr. Schaefer, please proceed with your presentation.

DR. SCHAEFER: Thank you very much. And good afternoon, Mr. Chair, and members of the

Commission. I am pleased to have this opportunity this afternoon to speak about caribou in light of the proposed Keeyask generation project.

What I would like to do is begin with an overview of the essentials of caribou biology. And I think that would provide us then with a springboard whereby we can assess the EIS and the potential implications of this project.

And needless to say, Mr. Chair, I would invite you and other members of the Commission to pose questions at any point during my presentation.

I think if we are going to choose one feature of this animal that's perhaps more prominant than anything else, it's space. Space is central to caribou conservation. And indeed, we identified two different ecotypes based on space. This animal is indeed as well the most mobile land animal on the planet. And I think the importance of space is neatly depicted here. This is some classic work by Kent Brown on the Red Wine Mountains caribou herd in central Labrador.

What you see here is a map of the distribution of 20 different radio collared females at calving time. What we see is a

disbursed distribution such that they occupy their entire population range at that time, some 25,000 square kilometres.

And for caribou, it's not just any space, caribou depend on old forest as well. Some evidence of this comes from my work with Dr. Bill Pruitt at the University of Manitoba, looking at the effects of a fire in 1980 on the east side of Lake Winnipeg. This was the Wallace Lake fire, it covered some 65,000 hectares.

What you see here are two maps. The hatched area depicts the outline of that fire. And the symbols that you see here, the triangles and the squares, are the distribution of caribou that we were able to determine during winter aerial surveys.

What we see four years after fire is that caribou tended to remain within the limits of that burn and, indeed, within their normal population range as we knew before the fire. But five years after the fire, we saw a shift in distribution to the northwest, into stands that were some 55 years old. And from that study, we concluded that forests need to be at least a half century old for them to be suitable as caribou

habitat. And there's been several studies since that time that have corroborated that finding.

One of the other interesting things we see about caribou is perhaps their most predictable behaviour is that site fidelity. This is a tendency to return to the same place. And we can take a look at the year in the life of one female caribou, again from the Red Wine Mountains caribou herd. This was a female we lovingly knew as RW93107, and she was captured in May of '93 near Grand Lake. We can follow her track over the course of the year. We see that she calved at a small unnamed lake in the eastern portion of that range, and then moved towards the south in the fall and bred. And then during the winter, she moved on top of the Red Wine Mountains, spent that time of year, essentially the entire winter with other members of her herd, where the snow was thinner and softer and the feeding was more favourable.

And then the following year, in a swift move but from a different direction, she returned to almost exactly the same site to give birth to a calf again.

And so we have noticed this for

caribous, they often remain faithful to their calving sites and often through their, what we would call their post calving sites as well during summer. It's a very common behaviour for caribou.

Another thing that we have learned about caribou is that they often avoid industrial disturbances. And the extent of the disturbances is often well beyond the strict bounds of the project.

This is some work I did with Shea Mahoney on the effects of the Star Lake hydro development in west central Newfoundland. And we looked at this as a before and after experiment. The response of caribou that we looked at was their distribution in the vicinity of the project. And so you see here on the horizontal axis, different distances that we put into classes, zero to three, three to six, six to nine, nine to 12 kilometres.

And on the horizontal axis, you see the proportion of animals, the percentage of animals that were in those different areas before construction, and then during and after construction.

What we note there is the dramatic

change, especially in the smallest distance class. In other words, before construction, about half the animals came within three kilometres of the project site. Once construction began and for two years later, that dropped by about 50 percent.

And there's some indication indeed of lower occupancy of caribou, as we say, out as far as six and perhaps even as much as nine kilometres.

And this is not uncommon that caribou show this kind of avoidance on the order of perhaps one to five kilometres from these kinds of industrial disturbances.

Another trend that we see that's shared worldwide is the trajectory of caribou populations. This is some put together by Liv Vors and Mark Boyce. And what we see is a rather sobering trend that about four out of five caribou populations around the circumpolar north now are declining. And this is more or less then a global trend.

I wanted to underscore today a milestone in our scientific understanding of this animal. And this is the identification of ecotypes. Distinction, not surprisingly, is based

on space.

We often, and caribou biologists often distinguish between what we call a sedentary and migratory ecotype. The labels there are to some extent based on the extent of movements of these two ecotypes, but really the defining characteristic is what females do at calving time. And so for sedentary caribou living in the midst of predators, they do what we call space out. They disperse into forests, into peat lands, onto islands, and they give birth to their calves in seclusion and in solitude.

On the other hand, migratory caribou do virtually the opposite. They tend to aggregate at calving. Typically, they will move north of tree line at springtime and concentrate on traditional calving grounds, often in their thousands, sometimes in their hundreds of thousands, and we call this spacing away.

Both of these behaviours we think are strategies to reduce the risk of predation of caribou, especially on calves. And so for female caribou living in the midst of predators, the sedentary ecotype, what we think they are doing is trying to make themselves rare, make themselves

scarce, difficult to find for wolves in particular.

On the other hand, migratory caribou respond to predation by moving away, distancing themselves from wolves, for example.

And this distinction is crucial, I think, because the two ecotypes differ dramatically in their population ecology. I must tell you there's a little bit of fluidity in caribou terminology. And so sedentary caribou are sometimes called forest dwelling caribou or woodland caribou or boreal caribou. On the other hand, migratory caribou are sometimes called forest, tundra, or barren ground, or coastal caribou. I think you'll find perhaps during my talk today, I use those terms interchangeably as well, but they do correspond fairly well with the labels that are used in the EIS of barren ground, coastal for the migratory ecotype, and resident for the sedentary ecotype.

So I'd like to begin then with the migratory ecotype. And I'd like to begin with a population I know fairly well because I studied it for several years. This is the George River caribou herd. And what we have here is one of the

best study populations in the world, I think. This is an estimate of population size of the George River caribou herd going back to 1954. And of course, we see dramatic changes here. The first estimate in 1954 was of just 4,700 animals, probably an underestimate because those are the first surveys ever. But what we see is dramatic growth up to perhaps three-quarters of a million animals. So at least a hundred fold increase in just a few decades. And then a decline more recently down to less than 28,000, so dramatic changes in numbers. And we think this is not atypical for migratory caribou to show these changes in abundance.

And with those changes in abundance, perhaps not surprisingly, we often see changes in occupancy or range expansion. This is a graph that I adapted from some of the work from Tom Bergerud, showing the distribution of George River caribou during that period of increase that we saw. What we think is typical for migratory caribou is they occupy what's called a core range. Regardless of the population size, they will always be found there. And in fact, when their populations are small, they will habit perhaps

just the core range.

What you see here are a number of years that are noted, where for the first time perhaps in generations people that were noticing caribou again.

So as the George River caribou herd grew during the 1960s, '70s, '80s, and even into the '90s, caribou range expanded across the entire breadth of that peninsula, some 700,000 square kilometres. And so not surprisingly, abundance and distribution are linked when it comes especially to migratory caribou.

And indeed we can put these two together. This is some very innovative work by Claud Morneau and Serge Payette at Laval University using evidence from tress, what we call dendrochronological evidence. So they were quite clever.

One of the things that happens when caribou migrate and move around is that they often leave a telltale sign of their presence, trampling scars, as we call it. So exposed roots of black spruce or tamarack, for example, will be damaged. And of course there's a date associated with that. So if you look at the left-hand side of this

graph, that cross-section there, we notice trampling scars that's I think noted as number one, that's from 1904. And there's another one, number four I think it is, yes, it is, from 1973. And so from that then, what these authors did was to do a survey across Quebec, Labrador and develop an index of abundance that takes us back even before our first surveys in the 1950s.

So if you take a look at this graph, there's the years, and you can think of the lines there as measure of abundance of caribou. What we notice, yes, since the 1950s, there is growth, so that corroborates our survey evidence that we had, that I showed you earlier. What it also shows, however, and indicates is that there is some evidence that caribou were also abundant at the end of the 19th century. And so we suspect that caribou numbers rise and fall over the course of decades, perhaps centuries. There's some interest in whether these are cycles, but changes in abundance are very common for migratory caribou.

Of course, we're interested in why.

Another metric that we have comes from the caribou themselves. This is some work by Serge Couturier looking at index of body size of

caribou, length of the mandible, length of the jaw of adult female caribou from the mid 1950s to more recently. And there's a decline there from 290 down to 270 millimeters. That doesn't sound like much, but that's a 7 percent decline over a couple of decades. And if we put these two graphs together, it gives us some reasonable evidence about why these caribou quit growing and why their numbers have declined.

We see the period of growth there from the 1970s to 1990s corresponds very neatly with the period of decline and body size. So the inference there, although there's some uncertainty, is that migratory caribou are likely limited by food, and summer food in particular. In other words, by going to the traditional calving grounds year after year after year, they escape the effects of predation, but eventually trample and overgraze their food.

I'd like to change now and focus on the sedentary ecotype, also known as the boreal population in Canada. And I think we can say quite bluntly that woodland caribou, sedentary caribou are in trouble. If we take a look at local caribou populations, woodland caribou

populations across the country, nearly half of them are declining. And the boreal population is considered a threatened species federally and, I believe, provincially as well.

The reason for this is widely acknowledged to be habitat loss. And essentially the consensus amongst caribou biologists is that when we disturb forests, say through forest harvesting or roads, we set into motion a slow, what I might call a slow tumbling of dominos. So young forest, for example, are more conducive to other deer species like moose and white-tailed deer. As a result of that, we get increases in predators like wolves, and then increases in the predation of woodland caribou.

And this can cause the decline and sometimes even the demise of local caribou populations.

Another milestone in our understanding of this comes from some work that was spearheaded by Environment Canada. And the key here is that they were able to link habitat condition to population condition. This graph depicts that quite well I believe. This is some work that was assembled from 24 different woodland caribou

populations across the country.

And on the horizontal axis, we note total disturbance. This is the proportion of the range that is disturbed by humans, so things like power lines, roads, cut box, for example, as well as fire.

And then on the vertical axis, you see something called mean recruit. Recruitment is very important to caribou populations. It's the addition of young animals to the adult population, so it's very closely related to population growth. Obviously, what we see here is a negative relationship. In other words, the more that a range is disturbed, the lower the recruitment.

We also know that for caribou populations to be stable, they need to have on order of about 25 or so calves per hundred females. That's how it's expressed in this graph, which gives us at least a rule of thumb that about a third, perhaps 35 percent of a range could be disturbed and still meet conservation objectives.

Indeed, I think Environment Canada generalized this relationship to consider the relationship between risk to caribou and habitat loss. And so this is also from the report.

Again, we have percent of total disturbance on the horizontal axis there from zero to a hundred. And then on the vertical axis, the risk to caribou, whether the range is self-sustaining or not. And it can be everything from very low to very high. And so there's a relationship between the degree of habitat loss and the risk of a caribou population disappearing.

Another crucial point in this approach is that we need to sum up all forms of disturbance, both natural and human caused. They need to be considered in aggregate.

MR. WILLIAMS: Before you leave this page, you noted that had we need to sum up all forms of disturbance. Leaving aside manmade or human made, or person made disturbance, in terms of natural disturbance, what are the biggest factors?

DR. SCHAEFER: The biggest factor, of course, is fire. We know the boreal forest is a fire prone ecosystem. And we also know, as I showed you some of our work on the east side of Lake Winnipeg, that fire causes short-term habitat loss, short term in the sense of half a century. So putting those two together is the means by

which we can assess the quality of caribou habitat.

MR. WILLIAMS: Thank you.

DR. SCHAEFER: And so conservation biology then is really focused on the recognition and understanding of what we call limiting factors, factors that determine or govern population growth. And therefore, I think, based on our understanding of these two ecotypes, if there are going to be detrimental effects of the project, they would likely exacerbate those factors.

And so with respect to migratory caribou, for example, I believe there is good reason to be vigilant with respect to heightened mortality from the project, either from drowning, or over harvesting, or from vehicle collisions. Nonetheless, I think if we accept that summer food, if we accept that summer food is the key limiting factor, I would anticipate that the population level effects of the project will be small and can likely be mitigated.

On the other hand, with respect to summer resident caribou, I believe there are some uncertainties that have important implications for

evaluating the project. And so in that regard, I have three questions I'd like to pose, and I will try to answer as well.

So my three questions are, do boreal caribou indeed reside in the project area? Is caribou habitat under-utilized? And third, what are the future prospects for caribou?

So let's consider the first question. Here's a map from the provincial recovery strategy which suggests a straight line northern limit to the sedentary ecotype in this province. I think this simply, at least for me, highlights our gap in knowledge. Rarely do we see this kind of straight line boundary and ecological systems. So what I'd like to do here is provide you with several lines of evidence that, in my view, suggest that indeed boreal caribou are likely to inhabit the project area.

And the first three are from the EIS itself. And so as described in the EIS, we have resident caribou that exhibit a dispersed calving distribution, harem breeding, and a low population density. Those are some of the defining features of the sedentary ecotype.

Second, the province does recognize a

historically resident population, the Nelson Hayes herd. And this is very similar to our experience in Labrador where, yes, the two ecotypes used to intermingle and overlap. And this kind of overlap with migratory caribou may cloud our ability to recognize the resident population, but the historic observations are indeed consistent with a sedentary caribou population in the area.

Third, local knowledge, as I understand from the EIS, also recognizes a local type of caribou. And this is very similar to my experience in Labrador where the Innu there, perhaps not surprisingly, also identified and recognized two types of caribou.

There's some additional evidence I'd like to bring to bear as well. And the first is the hypothesized northern limits of this ecotype. We call them woodland caribou. But really our understanding is it's not forests that limit their northern distribution. And the work that Tom Bergerud has done I think is quite compelling. He suggests that the northern limit of this ecotype is set by the ability or availability of open water at springtime. And why is that? It's thought to be important escape habitat for

caribou, female caribou with their calves.

If you take a look at a map from his book, if you take a look at Quebec Labrador there, the red line represents what we think is the northern limit of the distribution of sedentary caribou. And the coincidence there is with that of open water by June 15th. In other words, there is open water available on large lakes, which makes islands then refuges from predation and, therefore, this sedentary ecotype is able to exist under those conditions.

And if we extend that line westward, again, this puts the project area within the northern limits of the boreal ecotype.

And indeed, based on the available information we have from the project area, the timing of open water in spring places the project area within sedentary caribou range. In virtually every year, there was open water available by calving time in spring.

And indeed, here's a map from Janet Edmonds from a couple of decades ago. She placed the project area virtually coincident with the northern range limits of forest dwelling sedentary caribou.

We have some additional and recent evidence from the neighboring Province of Ontario as well. This is some work that was spearheaded by the Ministry of Natural Resources. This is based on the radio collaring and tracking of 131 adult female caribou in that province. And what you have here is a map of the distribution of calving for those animals between 2009 and 2011. This was some work done by my graduate student, Caitlin Wilson, at Trent University.

If you look at that map and look at those dots, I think two things are prominent. One is what we call disjunction. In other words, there is a geographic gap between the distribution. We see animals near the coast of Hudson Bay which would be migratory caribou, and then animals dispersed across the boreal forest, which we would consider to be sedentary caribou.

The other thing I think we can glean from this map is that those sedentary animals range about as far north as the southern edge of the Hudson Bay lowland, the gray area there. Again, if we extrapolate that relationship westward, that would also place the project area within sedentary caribou range.

Finally, we can also distinguish the ecotypes to some extent based on their shape and their size. I took this again from Tom Bergerud's book. If you take a look at the antlers, for example, you'll see a difference between typical migratory caribou antlers for males and typical sedentary caribou antlers. In general, sedentary caribou antlers have a slightly different shape to them. As you can see, they have more points or more tines, as they are called.

On the other hand, migratory caribou antlers tend to have fewer points, they have a higher arc, a higher top as well.

If you take a look at the graph below, this is the basis on which we can distinguish both males and females, which is of interest, but also the two ecotypes. And so if you just take a look at males in particular, those at the top end portion of that graph, we see that sedentary caribou are generally bigger in body length. So they are more out, the right hand portion of the graph. And on the other hand, migratory caribou tend to have relatively larger antlers for their size, they tend to be further or higher on that graph.

MR. WILLIAMS: Dr. Schaefer, just so I understand, how do I tell that it's a male sedentary caribou? Is it the triangles towards the right?

DR. SCHAEFER: Yes, that's right. So sedentary caribou are the triangles. If you look only at males, and I think they are circles, I'm trying to see from this distance. The open symbols represent migratory animals. So there's some ability to distinguish the two based on those measurements.

And so we have some photos from remote cameras of resident caribou in the area. And so I took this photo that was provided to me, and we don't know the body size, that's not possible to know. We don't have any scale for this photo. But I did measure the relative size of the antlers to the body size. And so if you do that, you measure those two, I came up with a ratio of .44, which is not unequivocal, but is again within the range of what we would expect for a sedentary caribou male.

And so on balance, using these different lines of evidence, I conclude it's more likely than not that boreal woodland caribou

inhabit the project area.

I think for us as scientists, the most compelling evidence would be a dispersed calving distribution of radio collared females in the springtime, and those data do not exist.

I'm going to say this, and try to get this across clearly, but I think we could say that the absence of evidence from the EIS should not be considered evidence of absence, if I can say that.

The second question I wanted to pose and try to answer is the idea of whether or not habitat is under-utilized. And we see this repeatedly in the EIS, that habitat is not limiting to summer cows and calves, that it appears under-utilized, and that if animals are displaced, they'll find suitable habitat elsewhere.

I think these kind of conclusions stem from their definition of habitat, which in the EIS is considered the place where an organism lives. And that's a fairly restrictive definition of what we would consider habitat. I think most population ecologists would agree with Caughley and Gunn's definition, a broader definition which suggests that habitat should be considered the

resources and the conditions that govern the presence, survival and reproduction of a population. So a much broader definition of habitat, one that's very close, in fact, to what we would consider a limiting factor, things that govern population growth.

If we accept that definition, and I think most population ecologists do, then we come to the conclusion that for sedentary caribou, space is habitat. It's pivotal to calf survival and predator avoidance.

Let me give you an example. We know very well that caribou inhabit islands during the summer, often go there singly. If we accept that broader definition then, then water is caribou habitat. They may rarely be in it, but it's absolutely crucial as escape habitat. So if we accept this broader definition, which I think conveys what habitat is for forest dwelling caribou, then space becomes habitat per se.

Here's some good evidence about that, again from Tom Bergerud, that shows us how important space is for population growth. This is kind of a complex graph, but what we see on the horizontal axis is caribou density. So we have

everything from very low density, less than .01 animals per square kilometre, so one animal per 100 square kilometres, that's very low density, up to .16. And the different symbols you see there are from nine different sedentary caribou populations.

On the vertical axis, you see recruitment again. This is expressed a little differently this time, but it's virtually the same measure. In this case, it's expressed as the percentage of calves to the total herd. So higher percentage of calves, higher recruitment. Clearly there's a negative relationship between those two. In other words, when caribou populations are dense, recruitment declines. And we know recruitment is very closely related with population growth.

The second thing we can glean from this graph is based on our knowledge about what is necessary for caribou recruitment for a stable population. And that's well-regarded by caribou biologists to be 15 percent calves. About 15 percent calves will have a growing population, below 15 percent calves, a declining population. And so if we look at the intersection of those

two, in other words we can convert 15 percent calves to a density of .06 animals per square kilometre.

Bergerud considered this a stabilizing density. In other words, if populations exceed .06 animals per square kilometre, population will decline. If they fall below .06 animals per square kilometre, the populations increase.

The implication here is that if we confine caribou to higher densities, recruitment is likely to decline, populations are likely to decline. The reason for this is likely again the importance of space, is that if caribou populations are dense, it's easier for predators to be able to find their calves and the calf survival declines. Scarcity is part and parcel of their biology.

Final question I'd like to pose are what are the future prospects for caribou in the area?

MR. WILLIAMS: Dr. Schaefer, on this point, you are focusing again on the sedentary ecotype?

DR. SCHAEFER: That's right.

MR. WILLIAMS: Thank you.

DR. SCHAEFER: Indeed it's acknowledged in the EIS that we are working already in a greatly altered region, and moreover, here's a quote from the document:

"...that a single large and/or severe fire could substantially alter habitat composition over the long term, which could alter many of the terrestrial environment predictions."

I agree with that.

On the other hand, what I would also suggest is that we not only need to monitor fire occurrence, but model it as well. Fires are bound to occur. What we need to understand is what the probabilities are and the consequences are for forest dwelling caribou as a result of fires.

Just underscore that indeed this is a fire prone ecosystem. We know that, as said in the EIS, as is noted in the EIS, that just six years account for about two-thirds of the area burned. And so here is another way of saying that it's in a graph, as scientists like to use, so I produced this graph.

Let me decipher this one for you as well. If we take each of the years and rank them

from smallest to largest in terms of the area burned, this is some years there are very few fires, no fires for example.

On the other hand, at the right-hand portion of the graph, some years like 1989 we had substantial areas burned.

If each year contributed equally, in other words there was an equal likelihood of fire each year, that graph would follow that dotted blue line. And clearly it doesn't. And so it simply underscores that we're working in a fire prone ecosystem where some years contribute much more to the fire driven dynamics that we see.

And just underscore that the consequences for sedentary caribou would also be immense. It's acknowledged in the EIS that roughly 34 percent of the range is currently disturbed. And so based on Environment Canada assessment, this puts us in the low, but very close to the moderate risk category.

And so to get a better handle on these probabilities, I produced a model of future fire hazard, a simple stochastic, as it's called, or probabilistic model. And what I did was to base that on recent fire history. So the model was

based on fire history from 1979 to 2008, so based on a random draw. And then each year I allowed forest stands to mature as well by one year. So year zero was based then on the most recent history that we have, 2009, and it began with a total range disturbance of 33.9 percent, which is what is reported in the EIS.

And so I glimpsed 40 years into the future. And because this is a probabilistic model, I ran a thousand different replicas to get a handle on those probabilities.

Let me show you the results in graphical form. Here they are here. Again, let me decipher this for you. Essentially on the vertical axis, we are looking into the future. So we're beginning on the left-hand side and moving toward the right, 40 years into the future. And on the vertical axis, I have denoted here the different levels of risk for caribou from low, very low, at the bottom end of that axis to very high at the top. And so we begin at year zero at the blue dot, this is the present, and move forward 40 years.

First thing to note on that graph is that the spread increases over time, which makes

sense. As we move forward into the future, uncertainty becomes more and more prominent. And indeed the limits of those shaded areas represent 98 percent of all the outcomes. So it's a measure of the degree of increasing uncertainty as we move forward.

But we can also express those uncertainties as percentiles. And you see that on the right-hand portion of the graph. You can think of those percentiles as the probability or likelihood that the range will experience that much disturbance or more. And so, for example, after 40 years, the model suggests there's a 75 percent chance of ending up in the moderate to high category. We can even look more closely that there's about a 40 percent chance that we will end up in the high risk category. And then by deduction, a 27 percent chance of ending up in the low risk category.

I want to emphasize that these figures shouldn't be taken literally. But I do think they underscore that the project may occur in a much more disturbed landscape than at present. And therefore, the risk to caribou may, in a couple of decades may be in the moderate or even high

categories simply based on fire hazard.

And so I'd like to sum up my conclusions with a couple of points. The first is that, in my view, the project is being assessed in the face of two major uncertainties. One is the ecotypic designation of summer resident caribou. Are they members of the sedentary ecotype? I think although the evidence at hand suggests more likely than not that boreal caribou occupy the project area, I also think that some confirmatory observations are needed. And for scientists, we would use radio telemetry tracking. This could provide a very useful set of observations, confirm whether or not we had boreal caribou in the project area, and it would also help to resolve the second major uncertainty, which is the extent of the population range of those resident animals. Indeed, it's difficult to assess or evaluate the condition of a population range without knowing that extent.

And finally, I would also say that the project is planned to occur on a highly altered landscape. And the Keeyask project will, in all likelihood, exacerbate those habitat conditions to which forest fires impart additional uncertainty

and additional risk. Of course, what risk is acceptable is a societal decision, but I would also underscore that it's our experience that piecemeal approaches, if I might call them that, to forest management have represented a failure to conserve caribou in the past.

I thank you for your attention.

MR. WILLIAMS: Dr. Schaefer is ready for cross-examination. I don't know what's an appropriate time for a break. I'll leave that to the panel.

THE CHAIRMAN: Right now. So we'll take a break until 3:15.

(Proceedings recessed at 3:00 p.m. and reconvened at 3:15 p.m.)

THE CHAIRMAN: We'll reconvene. I'm going to put a little pressure on all of you this afternoon. Quitting time will be determined by the participants. I propose that unless this goes unduly long, I propose that we'll conclude the cross-examination today. So if you go on too long, some of your colleagues will be giving you the evil eye.

Mr. Williams?

MR. WILLIAMS: Can I just consult with

my witness for one second about a flight, sir?

THE CHAIRMAN: Oh, certainly.

MR. WILLIAMS: Ms. Craft, of course, is more on top of this than I am, 5:00 o'clock is his flight.

THE CHAIRMAN: His flight is at 5:00?

MR. WILLIAMS: He has to leave at 5:00.

THE CHAIRMAN: He has to leave here at 5:00?

MR. WILLIAMS: Obviously, Mr. Chair, if there's questions, we can change the flight.

THE CHAIRMAN: Let's hope we're out of here by 5:00, I don't want to be here that long. I might start throwing evil eyes too if it goes that long.

MR. BEDFORD: Good afternoon, Dr. Schaefer. I remember you from the Wuskwatim hearing.

DR. SCHAEFER: Yes, good afternoon.

MR. BEDFORD: I understand from the introduction that you made that your early work with boreal woodland caribou was in the Province of Manitoba?

DR. SCHAEFER: That's right.

MR. BEDFORD: And so I safely conclude that you are aware that to this day, neither Manitoba Conservation and Water Stewardship, nor Environment Canada, have identified boreal woodland caribou in the vicinity of the site of the Keeyask project?

DR. SCHAEFER: That's correct. I showed you the map of northern distribution as depicted in the recovery strategy.

MR. BEDFORD: And having read your paper, I am reminded that on page 4 you tell a reader, and I quote:

"Woodland caribou may be one of the most sensitive mammal species to human disturbance."

And on the same theme you tell a reader on page 6:

"Caribou have a negative response to human disturbance."

And you obviously illustrated that in the slide presentation.

DR. SCHAEFER: That's correct.

MR. BEDFORD: Now, before you arrived today, we have heard much evidence in this hearing that the footprint of the Keeyask project has been heavily disturbed by human development over the

past 30 to 40 years. You are aware of that of course?

DR. SCHAEFER: Yes, I am.

MR. BEDFORD: So help me out. Given the aversion of boreal woodland caribou to human disturbance, and given that they haven't been identified in this area by Manitoba Conservation and Water Stewardship, nor Environment Canada, why would boreal woodland caribou move into an area so heavily disturbed by human development?

DR. SCHAEFER: Two things. As I said earlier, hopefully I was clear on that, is that the absence of evidence which would constitute good radio telemetry information, for example, doesn't constitute the evidence of absence. In other words, just because we don't have evidence that woodland caribou are there doesn't mean they are not there. In fact, I showed you there are several lines of evidence that suggest, to me at least, that more likely than not they should, do inhabit the project area.

The other question I believe was with respect to the degree of disturbance. We should expect, I think in most cases, that there will be some avoidance of industrial disturbances. That's

been shown again and again in many instances.

MR. BEDFORD: Would not an equally valid answer to the question I just posed to you be that the regional, as opposed to the footprint, the regional terrestrial ecosystem in this area is not highly disturbed, and 99 percent of that regional terrestrial ecosystem lies outside the footprint area.

DR. SCHAEFER: I think I might be able to answer your question by looking at what unit we should be managing caribou, like boreal woodland caribou. And that's at the local population range. That's the basis of the Environment Canada approach, for example. And so key to that is to understand what the extent of that local population range is. In most instances, not all, but most instances it's determined by the extent of radio collared females over the course of a year or two. This is the approach the Ontario government is taking, for example. And without knowing that extent, it's then to some extent uncertain as to how we should be measuring disturbance, or over what scale we should be measuring disturbance. But it's absolutely crucial we manage at the local population range.

One would expect in this area that that would be on the order of 10 to 15 to 20,000 square kilometres. That would be about the right order of magnitude. But the limits of that, the boundaries of that would need to be determined empirically, that is with evidence.

MR. BEDFORD: Now, because I saw no mention of it in your paper, and I heard you make a statement during your presentation about radio collaring and the absence of it here, I have to conclude that you're not personally aware of the radio collaring that has been done of caribou in the Keeyask area by Manitoba Conservation and Water Stewardship?

DR. SCHAEFER: Yes. I guess looking at the EIS, I didn't see the kind of compelling evidence that would tell me that indeed we do or do not have boreal caribou in the area. I understand there's been some work by Manitoba Conservation on radio collaring of a caribou in the province. I am unaware of any in the Keeyask area per se.

MR. BEDFORD: Well, I'm told that two key conclusions drawn from the radio collaring of animals in the Keeyask area, these caribou in the

Keeyask area, are sedentary calving, and the same animals moving over a range of 41,000 square kilometres.

Now, accepting that those are the conclusions drawn by Manitoba Conservation and Water Stewardship from the collaring it did, can I suggest to you that if one discovers that these animals are ranging over 41,000 square kilometres, that that is a fact that tends to suggest that they are coastal or Pen Island herd caribou, given the extent of the range?

DR. SCHAEFER: I think the key point here is that when we're trying to distinguish migratory versus sedentary animals, the label suggests the extent of movement is the distinguishing feature. But that's not it. What's crucial is what the females do at calving time during the spring. If they show a dispersed calving distribution, regardless of the extent of movements, that would place them, in my mind, as sedentary caribou.

We had examples of that in Labrador where we had some animals that indeed did intermingle with the George River caribou herd. They had immense home ranges. And yet they

returned, they showed strong site fidelity, they returned to their same calving site that they had the year before, even though they were up along the Labrador coast well outside the population range. And indeed, in my experience, we have never seen a switch from one ecotype to the next. In other words, once an animal, once a female shows herself as a member of the sedentary ecotype, she seems to remain that for her lifetime, to our knowledge.

Similarly for migratory caribou, we have no evidence that they switch to sedentary behavioural strategy. So it seems ingrained in an animal to be one or the other. But the key point again is not the extent or the range, that's a very large home range that you suggested, but the key point is whether or not they show that dispersed calving distribution.

I might also say that we have some evidence from Ontario that the size of the home range tends to increase as one goes northward. So 41,000 square kilometres is very large, but I would suspect, even though we didn't compute that in Labrador, we probably had some females of approximately the same magnitude as well when they

over-wintered with the George River herd.

MR. BEDFORD: My recollection from reading the paper is that you tell a reader of the paper that the normal or expected home range for boreal woodland caribou is about 5,300 square kilometres.

DR. SCHAEFER: Yes, that's right. So that would be the normal. As I said, though, there are some cases where we had some home ranges in excess of that.

MR. BEDFORD: Some of our First Nation partners in this project have suggested to us that some of the caribou in the area are hybrids. Do you accept that that might be an explanation for these particular caribou, that they are hybrids, not boreal woodland caribou, not coastal Pen Island caribou, but a caribou that's got characteristics of each?

DR. SCHAEFER: That's an interesting observation. As a scientist, usually when we discuss hybrids, that's a genetic designation. It wouldn't surprise me there would be some gene flow, as we call it, between populations. As we know, from population genetics, it takes just a small number of immigrants into a population to,

how shall I say, to blur the boundaries genetically between different populations.

On the other hand, as I showed you from the graph, the map from Kaitlin Wilson's work, looking at the distribution of the 131 caribou across the province, there is a key geographic separation between those two ecotypes. As I said, we don't see any, at least in science we don't see any switching from one behaviour to the other. It's a key distinction.

MR. BEDFORD: A short while ago you showed us a picture apparently of one of these caribou in the Keeyask area. Everyone here will quickly remember the image. And you showed us some graphs comparing antlers and ratios of antler size to body length, as I recall, of the animal in the photograph and a barren ground caribou.

Can you tell me whether or not Pen Island Island coastal caribou show any differences in antler morphology between coastal and boreal woodland?

DR. SCHAEFER: If I understand your question correctly, it's that given the designation of coastal caribou, which I would interpret as a migratory ecotype, can we

distinguish those? As you can see from the graph, there's some overlap. And indeed, the one animal from which we were able to glean that information falls to some extent in the midst of either. So it's not unequivocal, as I said during my presentation, but it's certainly within the distribution that we would expect for a sedentary ecotype.

MR. BEDFORD: Some of the evidence given, I think it was a week ago, is that the current density of the moose population in this area is six animals per one hundred square kilometres, .06. I recall from reading your paper, you do an estimate that there will be a rate of increase of 2.9 percent per year of the moose population. And then you note, having presumably done the calculation, that in about 25 years, that moose population will double. Do you recall that part of your paper?

DR. SCHAEFER: Yes, I do.

MR. BEDFORD: And in rather simplistic reasoning, my understanding of the significance of an increase in moose is that that will naturally lead to an increase in predators, particularly wolves. And presumably if the wolves eat a number

of the moose, they will also then turn their attention to the caribou. Have I got that, in a very simplistic way, correct?

DR. SCHAEFER: That's the, I would say, almost consensus amongst caribou biologists, that the alternate prey, as we call them, moose in particular can, through predation, lead to the decline of woodland caribou, yes.

MR. BEDFORD: Now, I saw no reference in the paper, and this wasn't a main feature of the presentation, but I did not see it there either, any reference to the moose sustainability plan. So, in fairness to you, I'm concluding you perhaps have not seen that plan?

DR. SCHAEFER: No, I have not.

MR. BEDFORD: The moose sustainability plan, I'll tell you, has been developed largely in conjunction with our First Nation Partners. The objective of that plan is to achieve a stable moose population in the area. And without wanting to be too brutal about it, I understand a key element to the plan will be that the moose will be culled from year to year. So on the one hand, it's a happy thing that they are to stay where their population will otherwise increase. But

because of the concerns I have outlined and you have acknowledged, the objective will be not to allow that population to increase at the rate of 2.9 percent a year. Presumably you would endorse that sort of plan, that sort of thinking?

DR. SCHAEFER: Yes, I would.

MR. BEDFORD: Now, at page 11 of your paper and, of course, towards the end of your presentation, you have described for us an albeit simple model that you have developed to determine future fire occurrences in this area. In the appendix to your paper, and if you have it there you may wish to look at it, page 24, you tell a reader that you set an upper limit to the percentage of a burned area. I believe it's 17 percent. And you chose that because you found information in our materials, I know, that suggested that that was the worst year in the regional study area for fire.

My understanding is that you inputted this number into your model and then you asked the computer to run, as you said, 1,000 different scenarios. So one of the important inputs was the 17 percent calculation?

DR. SCHAEFER: Yes, 17 percent was

part of that, but the model was based on recent fire history. In other words, it was a random draw from the last 30 years of fire history that we had. Under the premise, I guess, that the best, or at least the best approximation we have of the future is the recent past.

MR. BEDFORD: And once again, the purpose of the number was you were seeking the annual area burned, and what was the worst year that we have records for showing annual area burned. Have I got that correct?

DR. SCHAEFER: Yes. Just to note that 17 percent, that was the upper limit. So I didn't allow for anything more extreme than what we have experienced. I believe that was 1989, when we had a large number of fires in the project area.

So, in that regard, I think the model was somewhat conservative. It doesn't mean that we can't have a fire larger than 17 percent. It's simply that I limited that to what we have experienced since 1979.

MR. BEDFORD: Okay. I have asked that the particular table from our materials be illustrated on the screen, and I'd like to walk you through something that I have observed about

the table and the number that you have used. This is not a good representation unless we can get the whole table on the screen. That's better.

Could we do a little better than that?

Dr. Schaefer, before we revisit the table, could you tell me how the numbers would change if the amount you used for annual area burned was less than what you used?

DR. SCHAEFER: How my model output would change?

MR. BEDFORD: Yes.

DR. SCHAEFER: If one would expect less disturbance.

MR. BEDFORD: Thank you. Now, if you'd look at the table, you could either use the copy that Ms. Pachal has circulated, or if your eyesight is a little better than mine, we can look at the screen. But on the left-hand side, you see burn year, and you chose 1989, of course, correct?

DR. SCHAEFER: I'm sorry, I missed your question.

MR. BEDFORD: If we look at the left-hand side column with the years, do you see that?

DR. SCHAEFER: Yes, that's right,

1989, correspondence was 17 percent.

MR. BEDFORD: And of course, what the table is illustrating for us is historical data showing burns over a 30-year period from 1979 to 2008, of course?

DR. SCHAEFER: That's correct.

MR. BEDFORD: So you chose 1989 as the year that was of interest to you for your model?

DR. SCHAEFER: No, that's incorrect. I used the full distribution that you see there. In other words, we don't know what the percentage burn next year will be. So the model chooses one of those years randomly. And because there's uncertainty about that, we run the model a thousand times to get a sense of the probabilities that result.

MR. BEDFORD: But the 17 percent, I see 17.3 percent associated with the year 1989. So when you wrote on page 24 in the appendix that you set an upper limit to the percentage burned at 17 percent, equivalent to the largest burn year, 1989, you didn't make up the 17 percent, you drew it from this table?

DR. SCHAEFER: That's correct. In other words, the model is perhaps I would say

somewhat conservative, because it's possible in future to have something worse than 1989, but I thought that would be a reasonable upper limit.

MR. BEDFORD: Would you look, please, now at the right-hand column that says area burned in hectares. And the last number in the table, you will see, as I do, as we all do, is 1,045,059 hectares. Correct?

DR. SCHAEFER: Yes, that's correct.

MR. BEDFORD: Now, that's the total area burned over 30 years, but that's not the total area of the regional study area, is it?

DR. SCHAEFER: Yes, that's correct.

MR. BEDFORD: So in order to find what proportion of the total study area was burned in 1989, one would have to take -- and if you go back to the year 1989 and run your finger over to the right-hand column, you would take 180,755 hectares, and divide that by the total area of the local study area, would you not?

DR. SCHAEFER: Yes, that's correct.

MR. BEDFORD: And the percentage that one arrives at, I'll tell you, is 6.1 percent, not 17 percent.

DR. SCHAEFER: Yes, that's correct.

So I just do want to underscore, though, that as I said, my model is very simple, and I don't think that the results should be considered literal. But I do believe it's important as part of the EIS to have done this modeling. In other words, the simple model that I present is simply a glimpse of the future, but I think there are much better ways of modeling this, and that should be done as part of the EIS, if we're going to understand what the implications are for the future.

MR. BEDFORD: Except by using 17 instead of 6.1 percent, your model reflects an area burned of three times greater than what actually burned historically?

DR. SCHAEFER: In that one year, that's correct.

MR. BEDFORD: And accordingly, I'd suggest to you, as I did before, I took everyone through the particular table and how you have used a percentage from it, the results of your modeling, as you have said earlier, ought to be less than what you have told us in the presentation and the paper?

DR. SCHAEFER: Yes, that's right. And I underscore again that the model itself is simple

for sure, but I think that kind of approach, that strategy would be a wise approach if we're going to understand what the implications are for the future.

MR. BEDFORD: Now, if for a moment we study history as opposed to the future, and we look again at the table that's in front of us, and we look at the regional study area column and the 30 years that are set out, one and then another one, my recollection is that in six of those years there was no fire at all. And in 24 of the years, there was some fires, but the fires varied greatly in the amount of hectares burned. That's obvious from looking at the chart. But we have historically no series of years where several years in a row we had severe extensive fires, do we? But your model results in having several years probabilistically looking into the future where you have severe fires. In effect, the historic record doesn't coincide with what your model produces?

DR. SCHAEFER: I'm not sure I would agree with that premise. One would have to do something called time series analysis, in other words one would look to the extent to whether one

could predict this year what would happen next year. And from what I see from the data, there's some tendency for a large fire year to be followed by another large fire year.

MR. BEDFORD: Could we now put back on the screen page 30 from your slide presentation? I don't know whether you control that or if someone else does, but if we can do that?

The quotation that you told us all readily during the presentation that you agreed with, and clearly is drawn from my client's filing, I'll remind you appears at page 2-131 of volume 1 of the additional terrestrial materials that were filed.

The concern I have with respect to your use of our writing as opposed to yours is that you left out the first part of the sentence, didn't you?

DR. SCHAEFER: I don't recall that, but I would be interested to read that again.

MR. BEDFORD: Well, I'm sure I have intrigued everyone's interest now. The first part of the sentence begins, and I quote:

"Although the project is not expected to create large accidental fires or to

alter fire behaviour,"

and now we can all read the balance of the sentence,

"...a single large and/or severe fire could substantially..."

So the concern I have is that you have taken out of context the sentence. The sentence is written in a part of the report that deals with a concern potentially about the project itself and the people working to construct it causing a fire that would not be caused otherwise naturally. And equally important, this isn't expected to happen.

DR. SCHAEFER: Let me underscore that the key to the conservation of forest dwelling caribou, as I said earlier, is that it's important to sum up all forms of disturbance, whether they are natural, human caused, or even unintended or unplanned. And so the point here is that, and I agree with the statement, despite the fact that the project may not increase the risk of fire, the important point to note is that the project may occur in a much more disturbed landscape than at present. And we need to understand what the current degree of disturbance is, as well as sum up other forms of disturbance, even those that are

unintended or unplanned.

MR. BEDFORD: You'll have to bear with me for one minute. Lawyers sometimes have too much paper to work with.

Dr. Schaefer, one of the things that I would never see, looking at the table that we were looking at a few minutes ago, the record of fires over 30 years, that it takes someone like Dr. Ehnes, or presumably someone like you to see when you look at a table like that, is that this particular area has been more disturbed in the past as a consequence of fire than it is today. Did you detect that when you looked at the table?

DR. SCHAEFER: No.

MR. BEDFORD: I'm told if you study the table, you have to go back to 1995 to find a year where the disturbance from fire equals what we see today. But if you didn't see the first observation, you won't have caught the second either.

DR. SCHAEFER: I think the important point here is that, yes, we expect that the degree of disturbance will fluctuate over time. I think it's good modeling practice to take that into account. In fact, the Ontario government has used

modeling like that to make sure that when it comes to woodland caribou in that province, they gauge the variability in the past to use it as a goal for variability in the future. And so it's no surprise to me that, yes, there will be some variability through time with respect to the degree of disturbance.

MR. BEDFORD: And I guess the fortunate thing then, that a simple person like me would conclude, is that if this area has been more disturbed in the past by fire, and yet we still have caribou there today, although we're not quite sure particularly what type of caribou they are, that caribou are hardy enough to endure fires?

DR. SCHAEFER: To some degree, I agree with that statement. It's really the extent and frequency of those fires that is important. It's no surprise, I would suspect, I would say that caribou are well fire adapted. But if the degree or extent of those fires is too severe, and we add on the cumulative disturbance from human caused sources, then we can get to a point where caribou populations are no longer sustainable.

MR. BEDFORD: Would you cast your eyes to the bottom of page 12 of your report and the

top of page 13?

And I have before me the second bullet point summarizing your second concern and conclusion. And I quote from your paper:

"Although the project contribution may be small, these disturbances in aggregate may propel the caribou population into the moderate or high risk categories."

Now, I know I have accurately read that to you.

DR. SCHAEFER: Um-hum.

MR. BEDFORD: Now, I suggest to you what you meant when you wrote that is that if indeed this particular local caribou type that we have been talking about is boreal woodland caribou, that they are the ones that you had in mind. You weren't suggesting to a reader that this project might propel the Pen Island caribou herd or one of the barren land caribou herds into a high risk category.

DR. SCHAEFER: Yes. Thank you for that clarification.

MR. BEDFORD: And thank you. I have no further questions.

THE CHAIRMAN: Thank you, Mr. Bedford.

First up, Manitoba Wildlands, Ms. Whelan Enns?

MS. WHELAN ENNS: Hello, Dr. Schaefer.

DR. SCHAEFER: Yes, hello.

MS. WHELAN ENNS: And welcome back.

Could you give us a quick overview, please, of woodland caribou in Canada and Manitoba and where, I'm going to use the regulatory term, but where under law they are protected, and how?

DR. SCHAEFER: Let me just say that federally, at least under the Species at Risk Act, caribou are deemed threatened, and that's been the case since 2000, I believe, when they were designated such under the Species at Risk Act. That means that a recovery strategy needs to be developed for them, and also there is a requirement to identify and protect habitat.

MS. WHELAN ENNS: And how about the Manitoba Endangered Species Act?

DR. SCHAEFER: I am less familiar with that and so I cannot comment, I'm sorry.

MS. WHELAN ENNS: Fair enough. I believe that it's about four years, maybe five years back since the sub species is listed as

protected here. Thank you.

DR. SCHAEFER: Yes, I do know that they are listed as threatened, I believe, in this province.

MS. WHELAN ENNS: Realizing that you have identified the summer risks and summer caribou -- now you are going to correct me in terms of types if I make a mistake, okay -- that your content was quite specific on that, and this goes to page 18 in your presentation.

Would you give us your opinion about whether there's any risk to winter food for the two types of caribou after a lake becomes a reservoir, in terms of those changes in habitat and those changes in the region?

DR. SCHAEFER: Yes, that's a good question. We know that winter food is important to caribou. It may not be limiting at the level of the population, but lichens in particular are seen as a crucial component of the caribou diet.

The only experience I might draw on is from Labrador where the smaller reservoir, which is very large product of the upper Churchill development, did flood a large proportion of habitat for the Lac Joesph herd, as we called it,

a sedentary caribou herd in western Labrador. Obviously that was no longer good winter habitat, but I think it probably more importantly was no longer good calving habitat either, so we think the population declined as a result of that flooding.

MS. WHELAN ENNS: Thank you.

The EIS materials for this generation project refer to the creation of islands as part of the process of turning Keeyask Lake into a reservoir. These island are what's left and, of course, other islands are flooded and gone. So would you let us know what the likelihood is then of -- I am on both types here, and feel free to choose and correct me -- but what the likelihood then is of caribou in the reservoir area staying? And also whether these created islands are going to, in fact, provide adequate habitat and food sources that they would stay with?

DR. SCHAEFER: That's a very good question. Again, if I draw on our experience from Labrador, the Lac Joseph herd, the flooding that occurred as a result of the smaller reservoir did not seem to be adequate caribou habitat, likely because that remained frozen during the calving

season. So we know that open water is absolutely crucial for islands to be suitable as caribou habitat. Whether or not this project will produce more islands, more calving habitat, that's a very good question. I think there's some uncertainty about that. But I would say that there may be -- a marginal increase might be possible provided that the degree of disturbance in the vicinity is also not too strong.

MS. WHELAN ENNS: Thank you.

I want to ask you a couple of climate change questions as an ecologist, and feel free to improve on how I'm asking them.

The overarching question has to do with whether there's any studies, scientific work going on, projects you or your students have been involved in, in terms of effects of climate change in the regions in Canada where we have woodland caribou, more specifically then at the level in Manitoba where this region and the Nelson River is. Is there work going on? Has there been any conclusions?

DR. SCHAEFER: Again, that's a very good question. I think we can draw on a few lines of evidence there. One is the work that we did

with Dr. Bill Pruitt at the University of Manitoba. I think that's fairly well-established now that forest fires, at least for 40, 50 years result in a loss of caribou habitat. My understanding of the literature, I'm not a climate scientist, is that the climate change we are likely to experience in the coming decades is likely to cause an increase in the extent or frequency of fires. And so to some degree, that is not good news for forest dwelling caribou.

MS. WHELAN ENNS: Thank you.

Does the combination then of fires due to increased patterns and climate change, and the habitat loss from industrial development, and again in a region with a lot of projects in it, is there a multiplier here, if you put the climate change in with the habitat loss, is there a noticeable increase in risks or mitigation needed?

DR. SCHAEFER: I would say it's not necessarily a multiplicate of one but an additive of one. Again, the Environment Canada model I think is very clear in that in order to understand habitat loss, we add up all the forms of disturbance, whether they are from seismic lines or road or dams or whatever. And so as part of

that model too is fire. I think they used 40 years as the threshold, so anything less than 40 years was considered disturbed. Industrial disturbance as well, as far as we know, may be permanent loss. That's a huge area of uncertainty, but to this extent there's no evidence to discount that.

MS. WHALEN ENNS: Thank you.

You used a map from the Manitoba Government 2005 woodland caribou strategy, page 20 on your presentation. Is it, to your knowledge, an updated province-wide woodland caribou strategy since 2005?

DR. SCHAEFER: Not to my knowledge, no.

MS. WHELAN ENNS: Did you participate in the work for the woodland caribou recovery strategy? I think it's about two years old, that's for some of the herds in Manitoba?

DR. SCHAEFER: No, I did not participate in that.

MS. WHELAN ENNS: Okay, thank you.

I have another, page 23, another reservoir question, and it goes to trying to keep up on the significance of open water patterns and

water as habitat for caribou. So water that is a reservoir, and in the process of becoming a reservoir, does it add risk or change patterns for either of these types of caribou?

DR. SCHAEFER: Again, another good question for which there is some uncertainty.

Our experience in Labrador again is that based on the satellite collaring of George River caribou that used to come into the small reservoir area, I never once saw an animal cross that reservoir based on satellite telemetry. I'm not sure why that was. It may have been that ice conditions were just not suitable to crossing. I also heard suggestions that it might have been the number of dead trees that had built up on the shoreline was a barrier to those animals. There is some uncertainty about that, but Labrador would suggest there's a negative effect on the distribution of movements even on migratory caribou.

MS. WHELAN ENNS: Thank you.

Here we're dealing with, in terms of the information in the EIS, a flooding pattern or a known flooding pattern that may take, you know, six, seven, eight years after operation of

generation station. So the next question then would be, is that period of time, and to get to maximum flooding and to reservoir and so on, comparable to the projects that you have worked on, and the ones you are mentioning in terms of woodland caribou and getting to a reservoir.

DR. SCHAEFER: The only, perhaps the most direct experience I can suggest is the Star Lake hydro development, which construction took place I believe over one year, and then we looked at the distribution of caribou during that one year, as well as two years post construction. And there is no difference. In other words, what we saw was some reduced occupancy, some avoidance of the area that seem to be at least over two years to be consistent even once construction was complete.

MS. WHALEN ENNS: Thank you.

This is definitely not a scientific question. I'm thinking about ungulates generally in Manitoba and trying to phrase this. But would you say that woodland caribou and the types of caribou we have in Manitoba are historically moving north?

DR. SCHAEFER: Historically moving

north, meaning I presume, and I'm going to presume in your question, meaning receding from the south?

MS. WHALEN ENNS: Yes, in terms of loss of habitat in human use, and then basically moving up the province?

DR. SCHAEFER: This is something we have noticed virtually across all of eastern North America, is that there is range recession, range collapse as we call it. Some people interpret that as a migration northward. It's not really. It's really a systematic loss of populations over the last century or so.

In Ontario, for example, one of the things that I quantified some years ago was to take a look at this rate of range recession in Ontario, and we noted it was occurring at 34 kilometres per decade northward, from 1880 to 1990, which underscores for me that the disappearance of caribou, as I say, is a slow motion crisis. It's going on at an almost imperceptible rate. But when we look over the long term, it's something that is very clear to us.

There's some evidence I believe in this province as well, there was a population near

the Whiteshell, if I recall, that's disappeared. Less so, which is encouraging I think, I'm going to put it in a non-scientist way, I think Manitoba has an opportunity that provinces like New Brunswick, Nova Scotia, PEI have lost. And I think Alberta is, many populations are in very dire straits there as well.

MS. WHELAN ENNS: Are there species that are usual, and perhaps actually essential, in the habitat that woodland caribou use, also moving north?

DR. SCHAEFER: Sorry, I'm sorry, could you repeat that question?

MS. WHALEN ENNS: Thinking about range areas, large regions of the province where there's woodland caribou in moderate habitat health, certain species would, I would assume, then are likely to be in that same habitat. So my attempted question then is, whether in your estimation there are other species moving north at the same time and/or with woodland caribou?

DR. SCHAEFER: Absolutely. There's lots of evidence, birds and butterflies, for example, are showing poleward shifts in their distribution, and that's well-documented in the

literature.

I might say we might expect, although there's no documentation of this, that boreal sedentary woodland caribou may be moving north as well. That would be my expectation. If the climate is warming, we could expect earlier breakup, that would allow for some northward expansion of range as well. Probably more modest than what we're seeing in the range recession to in the south, which is certainly human caused, we know that. But I think it would be my expectation that sedentary caribou should be showing some modest northward range expansion as well.

MS. WHELAN ENNS: Thank you.

Do you know of any independent study or review of effects from Manitoba Hydro's projects and system in Manitoba on boreal caribou? This is a little bit like a cumulative effects question. But as an academic, you may well know about either intent to study or reviews that have been done where there was independent academic work to review the impacts and effects on woodland caribou from our hydro system?

DR. SCHAEFER: I'm aware of some ongoing work in the province that I believe is

supported by Manitoba Hydro. At the moment, I know of no peer-reviewed publications resulting from that work.

MS. WHELAN ENNS: Thank you.

Done, thank you.

THE CHAIRMAN: Thank you, Ms. Whelan Enns.

Peguis First Nation, Ms. Guirguis?

MS. GUIRGUIS: Good afternoon, my name is Cathy Guirguis, I'm legal counsel for Peguis First Nation, and I have just a couple of questions for you today.

So you talked a bit about fire disturbance and the loss of habitat from that. So can you just give me an idea of what are the main causes of fire disturbances, just in general?

DR. SCHAEFER: That's a good question for which I don't have a complete answer, but obviously the sources are lightning and humans as well.

MS. GUIRGUIS: Lightning and human, okay, thank you.

And just based on something that came out in the cross-examination, there was that statement that's still on the screen, and the

first statement saying that the Keeyask project is not expected to increase the chance of fire. In the model that you actually use, though, you didn't actually consider whether there would be heightened risks or anything of that sort from the Keeyask project, or from the presence of the construction, or anything like that to contribute to higher risk of fire, correct?

DR. SCHAEFER: Yes, that's correct. So I just assumed a steady state. And again, I think the important point here is that we need to understand that simply because something is subject to chance, like fire, doesn't mean it's unpredictable, right? The key point in my view is that modeling is useful and that it allows us to put probability statements on the various consequences that may result.

I can give you a simple example. We can flip a coin right now, and you would know that a fair coin would be a 50/50 chance. If I flip it four times, of course, then the chance of having half tails, half heads is much more likely than having four heads in a row. And I think this is the intent. The model that I used is simply an indication that, indeed, you can use these kinds

of tools to gain some insight on likely consequences.

The other point, if I might make, is that my understanding of the key to boreal forest conservation is to buffer for uncertainties as they say. In other words, we want a margin of safety, so we don't foreclose on options and put ourselves into a box.

Fire may be unplanned, unintended, but we have enough information in the EIS to make an educated projection of what this landscape was going to look like in the next 20, 40 years, and we should plan for that.

MS. GUIRGUIS: Thank you. That's very helpful.

The other point also is some information that came out in the cross-examination by the proponent, which I think I just wanted to understand a bit better. I think that I understood your evidence that there is, you know, different concerns when it comes to sedentary and migratory herds, and we need to be concerned about the habitat loss for both, but one more than the other perhaps.

And so in the discussion of whether or

not there are hybrids there, if there's hybrid species like between the two -- I don't know if I'm using the proper terminology, sorry -- but if there's hybrids, that doesn't necessarily mean that there's then no concern about habitat loss with respect to those hybrids, is there?

DR. SCHAEFER: Yes, I think if I could grasp your question, habitat loss is a major concern especially for sedentary caribou. We know that's the driver, as goes habitat, as goes caribou, it's almost that simple. And so if there are sedentary caribou in the project area, I think the evidence leans that way, then we should in my view take that precaution to make sure that habitats and disturbance doesn't come to the point where they are put at risk.

MS. GUIRGUIS: And if there are hybrids, it's the same concern?

DR. SCHAEFER: Again, I think we can be fairly clear that there's a distinction between these two ecotypes. And caribou, in my experience, are either one or the other. They may range over large areas, 41,000 square kilometres, that's a very large home range, but that animal is either a migratory or sedentary caribou, and

that's fairly straightforward to determine. And yes, they may hybridize in a genetic way, but to my view, we need to classify them as one or the other because what limits them is so different. I think that distinction is key and I want to say again.

MS. GUIRGUIS: Okay, thank you very much. Those are all my questions.

THE CHAIRMAN: Thank you, Ms. Guirguis. Ms. Pawlowska-Mainville?

MS. PAWLOWSKA-MAINVILLE: Good afternoon, Dr. Schaefer. Good afternoon. I just have a few questions.

Dr. Schaefer, do you think that Aboriginal people are a reliable source for identifying caribou?

DR. SCHAEFER: Yes, I do.

MS. PAWLOWSKA-MAINVILLE: Thank you.

And do you recall reading in the EIS or in the First Nations environmental reports that First Nations do claim that there is woodland caribou in the region?

DR. SCHAEFER: Yes, I do recall that.

MS. PAWLOWSKA-MAINVILLE: Can you discuss maybe why you think there is a dissonance

that Manitoba Hydro in the EIS claims that maybe there is, maybe there isn't, and First Nations are sure that there is?

DR. SCHAEFER: I guess it strikes to the heart of the evidence that's being used. As I said, to some degree there's an absence of evidence, scientific evidence that would give us a definitive answer on that. On the other hand, my understanding of Aboriginal traditional knowledge, it's different domain of knowledge, and I would think that the people that frequent that land have a pretty good understanding of what they are seeing, and what they know is a difference between the two. It would not surprise me.

MS. PAWLOWSKA-MAINVILLE: Okay, thank you.

So in your experience, would you say that ATK, and local knowledge, Aboriginal traditional knowledge and local knowledge could and should be used as a reliable source of data on caribou?

DR. SCHAEFER: Yes, I think so. These are two different domains of knowledge, to my understanding. My own view is that I think they are complimentary. In other words, our science is

really good at things that occur over large spaces. We have satellite telemetry, GPS telemetry, remote sensing, but we consider long-term scientific data to go back perhaps 50, 60 years.

On the other hand, local knowledge is deep and, therefore, I think they are complimentary. My experience with regard to caribou in Labrador is we often come to the same conclusions too. I don't think we should be surprised at that, we're looking at the same system.

MS. PAWLOWSKA-MAINVILLE: So my other question is regards to human disturbance. You mentioned items such as fluctuations of water, maybe unstable ice conditions from hydro development, and roads and other things.

Would you say that electromagnetic fields from power lines from generating stations, and noise from those power lines and generating stations would contribute to be an additional disturbance for the caribou?

DR. SCHAEFER: That's a very good question. From what we know, noise indeed is important to caribou. Some of the work that was

done in Labrador on different sources in this case, low level flying jets, there's no surprise we can change caribou behaviour on that basis.

With regard to electromagnetic fields, I haven't seen any analysis of that. Although there is some evidence from another ruminant, another animal, cows, and they show a disorientation apparently with regard to how they lie down in the midst of power lines. So the mechanisms may be unknown, the avoidance though is fairly well-established in the caribou literature.

MS. PAWLOWSKA-MAINVILLE: Would you say that noise and electromagnetic fields could be a reason why caribou could get smart perhaps, and avoid that area?

DR. SCHAEFER: Yes. We don't know what the sensory change that occurs for caribou that keys them in on that. My guess, though, I surmise that the reason they move so far away is because they perceive these changes as risk of predation. And so edge effects, we often think of as a few tens or hundreds of metres, that's insufficient for caribou. If you're going to avoid an area because of high risk of predation, it's on the order of kilometres that needs to be

put between you and that risk. And that's why I think we see such a broad area of impact from industrial disturbances.

MS. PAWLOWSKA-MAINVILLE: Would you say that the power lines in the electromagnetic field could change caribou migration, or alter them?

DR. SCHAEFER: It's possible. We did note from the Star Lake hydro development, I didn't talk about that here, is temporary disruption of migration. How we assessed that was to take a look at the order of animals. And before construction, it was predictable. The animals that went first one year were often the first the next year. During construction, that order got shuffled, and we interpreted that as some temporary disruption or disturbance of those animals. The interesting thing is, once construction ended, they went back to that same order. And so we think that was probably sensory disturbance in that case, probably from the noise.

MS. PAWLOWSKA-MAINVILLE: Interesting. Thank you.

And you also discussed site fidelity. So one of the questions that we are discussing

with our group is if, for example, you have an island on which a certain number of caribou calve, and what do you predict will happen if that same island that caribou calve on will be diminished in its size to one-third or two-thirds?

DR. SCHAEFER: Space is important. And so a typical density for forest dwelling caribou is one animal per 16 square kilometres. And so having more than one animal on an island would be fairly rare, I would think. If the island gets diminished in size, it still may be suitable. It may depend on the degree of disturbance of that area. But, again, we're talking about space and the ability of those animals to find predator free space and space away from other caribou is absolutely crucial.

MS. PAWLOWSKA-MAINVILLE: Have you come across in the EIS a discussion about Caribou Island?

DR. SCHAEFER: Yes, I did, although I don't recall much of that discussion.

MS. PAWLOWSKA-MAINVILLE: That's fine. Thank you.

And my final question actually is, prior to hydro development in the 1960s, so the

caribou were said to be abundant in the area and the primary source of red wild meat for most of the First Nations. So I guess my question is, what changes to the subsistence economy do you see and the diets that will change with First Nations with further diminishment of caribou?

DR. SCHAEFER: If I recall from the EIS, there's some indication from local people that caribou have diminished in numbers, if I recall. That's in keeping with our scientific information. If there's disturbance in the area, we would expect fewer numbers of caribou.

On top of that, I would say for migratory caribou, as the populations decrease in size, they will decrease in their area of occupancy as well. So the George River caribou herd is likely now to retract to that core area, it's down to very low areas compared to three-quarters of a million. I would predict that in the coming years, if the Beverly Qamanirjuaq and Pen Island herds decline in numbers, that there would be fewer caribou in the area to be harvested, or available to be harvested.

MS. PAWLOWSKA-MAINVILLE: Okay. And then one final question that I actually skipped

over and didn't realize. Do you think that local knowledge or traditional Aboriginal knowledge is a good form of management of caribou?

DR. SCHAEFER: Yes, I think so. I think we should marshal all forms of evidence that we can that we think is reliable. Science as well as local knowledge, I think that would just be wise in my view.

MS. PAWLOWSKA-MAINVILLE: Thank you so much. Thank you.

THE CHAIRMAN: Thank you. Ms. Kearns?

MS. KEARNS: Thank you. Pimicikamak does not have any questions.

THE CHAIRMAN: Thank you.

MR. SHAW: On the subject of uncertainties, you say on page 12 of your report:

"Although the evidence at hand suggests that more likely than not boreal caribou occupy the project area, confirmatory observations are needed. Radio telemetry tracking of female resident caribou, example two years of observations, will not only provide those useful observations, it will also help resolve the second

major uncertainty, the extent of population range of resident caribou."

So I have a number of questions arising out of that. The first one is, what kind of resources would be required for that type of tracking or study?

DR. SCHAEFER: As I said, two years would be a good time frame over which it would occur. If we're going to look at site fidelity, for example, we'd need at least two calving periods over which that would need to happen. For the Red Wine caribou herd, for example, we would normally have about a dozen collars on that herd that we had over many years. In Ontario, they are planning for each population to have about 20 females with GPS collars. I don't know if you want me to get into costs of that?

MR. SHAW: That was my next question.

DR. SCHAEFER: My understanding, it's been a while since I purchased collars of that sort, but I believe they are about $5,000 per collar. And there will be, my estimation would be about an hour and a half of helicopter time to deploy each one.

Once you do that, then the systems are

automated, so you can monitor not only the whereabouts of caribou, but also their fate and get some estimate of survival.

MR. SHAW: Could you just give us some idea of the accuracy of the results?

DR. SCHAEFER: They are very accurate now. It's surprising, we can pinpoint an animal within a few metres. And the collars that are being used in Ontario, for example, get a location every five hours. And so this is very precise information.

What can be more important, though, is the number of animals that you collar. So you need to have, I would say at least a dozen, 20 would be better, to get a good representation of the extent of their range.

MR. SHAW: Thanks so much.

THE CHAIRMAN: Dr. Schaefer, I have a couple of questions. I'm definitely not a scientist, but why can we not determine the nature of these caribou by DNA evidence? Am I being over-simplistic?

DR. SCHAEFER: No. And my understanding of genetics is not that -- I should say I'm a population ecologist more so than a

population geneticist. My understanding, though, of some of the work that's being done at Trent University, my colleague, Paul Wilson, is that there's not a lot of clear genetic differentiation between the two. But as I said, that doesn't mean that they are not different demographically, which is what's really important in conservation biology.

The other point is that it takes very few immigrants or gene flow between populations to blur their genetic distinctiveness. So if we have one male that's mating with several females, as they would, that would tend to blur those distinctions.

On the other hand, I do know of some work from Labrador where, based on blood proteins, and yes, we could distinguish the Red Wine Mountains caribou herd from the George River herd, so it's a matter of degree.

THE CHAIRMAN: We have had some questions in this cross just about the study area used. And Manitoba Conservation hasn't defined a range area for the summer resident caribou, whichever kind they are. We don't have any telemetry. So was the study area that was used in

the EIS appropriate for determining or assessing the levels of disturbance?

DR. SCHAEFER: That's a very good question. I would say that it's on the right order of magnitude, if I could say that. In other words, we know from caribou populations elsewhere that near the northern limit of sedentary caribou range that 10 to 20,000 square kilometres, something like that, that would be a typical population range. But the exact limits of that range I think are important, because if we're going to apply the Environment Canada approach, which is very powerful tool and very useful I think, then it would be good to apply it in its full extent. In other words, to know what the local population range is, and then to be able to estimate the degree of disturbance after that point.

THE CHAIRMAN: Can you comment on what are the implications for the Partnership if the summer resident caribou are determined to be boreal woodland caribou?

DR. SCHAEFER: That's a very good question. I think it would mean precaution. As I said, our experience elsewhere is that if we look

at each development in isolation, then it's inadequate to conserve woodland caribou. We also know about the importance of habitat, we know about the importance of once habitat's disturbed, that the consequences are long term. Whatever we do or don't do now will likely have consequences for at least half a century, in my view.

So I think it's profound, not just the legal ramifications, of course, but just the conservation implications are quite large. And the reason, again, in my view is that what limits migratory caribou is so different than what limits forest dwelling caribou. If you misdiagnose or misidentify those animals, then you may mismanage them, I think.

THE CHAIRMAN: I think this is my final question, and I don't know if we can pull up slide number 17.

Now, here at the 35 percent disturbance area, and you've got an arrow pointing at range self-sustaining. I just want to clarify, and perhaps you might comment on it, at 35 percent, that doesn't mean that 100 percent of the caribou are going to survive, that means there's about a 60 percent chance of -- not

survive, but being self-sustaining. Am I reading that correctly?

DR. SCHAEFER: Yes. The categories there to some extent are labels that try to reflect the biology of the animal, and there's some uncertainty about that. But we do know that the level of recruitment for a stable caribou population, as I said, is very well known, 15 percent calves, above that growing, below that declining. And so the relationship between disturbance and recruitment gives us some indication then about the risks that we are facing. And these are Environment Canada labels based on, I was part of that, the science that went behind it. It's a continuum.

THE CHAIRMAN: It's a, sorry?

DR. SCHAEFER: It's a continuum, right. So if you step over 35 percent, you're not necessarily going to have a population that diminishes, but you start running more and more risk.

THE CHAIRMAN: So using this chart at 45 percent disturbance, the likelihood of being self-staining is 40 percent?

DR. SCHAEFER: Yeah, I think the P

lambda greater than stable -- that is a very strange label to that access -- it's the probability of a population that at least shows stability or zero growth, right, stable in numbers.

THE CHAIRMAN: Thank you very much.

Thank you, Dr. Schaefer.

Mr. Williams, any redirect?

MR. WILLIAMS: No. We just wish to thank Dr. Schaefer for his work.

THE CHAIRMAN: Well, you have all been very good. I'm quite surprised that we got through the cross-examination quite as quickly and as fully as we did.

I'd like to add our thanks, Dr. Schaefer, for your presentation today and for your paper, in preparation of the paper.

We do have some documents to be registered. Madam secretary?

MS. JOHNSON: Okay. Our first document is CAC number 12, that's Dr. Peake's paper. CAC 13 is Dr. Peake's presentation. Number 14 is his Curriculum Vitae. CAC 15 is Dr. Schaefer's brief biography. CAC 16 is Dr. Schaefer's caribou paper. CAC 17 is

Dr. Schaefer's presentation. And KHLP 63 is table 2D3. Thank you.

(EXHIBIT CAC 12: Dr. Peake's paper)

(EXHIBIT CAC 13: Dr. Peake's presentation)

(EXHIBIT CAC 14: Dr. Peake's Curriculum Vitae)

(EXHIBIT CAC 15: Dr. Schaefer's brief biography)

(EXHIBIT CAC 16: Dr. Schaefer's caribou paper)

(EXHIBIT CAC 17: Dr. Schaefer's presentation)

(EXHIBIT KHLP 63: Table 2D3)

THE CHAIRMAN: Thank you. Tomorrow we meet in the afternoon and the evening, so we're adjourned until 1:30 tomorrow afternoon.

(Adjourned at 4:31 p.m.)

OFFICIAL EXAMINER'S CERTIFICATE

Cecelia Reid and Debra Kot, duly appointed Official Examiners in the Province of Manitoba, do hereby certify the foregoing pages are a true and correct transcript of my Stenotype notes as taken by us at the time and place hereinbefore stated to the best of our skill and ability.

Cecelia Reid

Official Examiner, Q.B.

Debra Kot

Official Examiner Q.B.