NOVA SCOTIA AQUACULTURE REVIEW BOARD

IN THE MATTER OF:	*Fisheries and Coastal Resources Act*, SNS 1996, c 25
	- and -
IN THE MATTER OF:	An Application by KELLY COVE SALMON LTD. for a boundary amendment and two new finfish aquaculture licenses and leases for the cultivation of Atlantic salmon (*Salmon salar*) – AQ#1205x, AQ#1432, AQ#1433, in Liverpool Bay, Queens County

Affidavit of Brian Glebe, PhD affirmed on February 19, 2024

I affirm and give evidence as follows:

1. I am Brian Glebe, PhD of Bayside, New Brunswick. I am the President of Briden Consultants Ltd. which provides management, scientific and technical consulting services for aquaculture. I am a fish physiologist and salmonid aquaculture research scientist, and I held the position of Aquaculture Research Scientist with the Department of Fisheries and Oceans before my retirement from that position.

2. I have personal knowledge of the evidence affirmed in this affidavit except where otherwise stated to be based on information and belief.

3. I state, in this affidavit, the source of any information that is not based on my own personal knowledge, and I state my belief of the source.

4. I have received and reviewed the following affidavits and reports:

   (a) Jonathan W. Carr attached as Exhibit A to his Affidavit affirmed on January 19, 2024 and filed in this proceeding by the Intervenor Protect Liverpool Bay Association (the **"Carr Report"**); and

   (b) Dr. Edmund Halfyard attached as Exhibit B to the Affidavit of Dr. Edmund Halfyard affirmed on January 19, 2024 and filed in this proceeding by the Intervenor Protect Liverpool Bay Association (the **"Halfyard Report"**).

5. Kelly Cove Salmon (**"KCS"**) has requested my independent expert opinion in response to the opinions expressed in the Carr Report and the Halfyard Report.

6. My response to the Carr Report and the Halfyard Report is attached as **Exhibit A**.

7. My CV is attached as **Exhibit B**.

AFFIRMED before me virtually on MS Teams with Dr. Glebe in Bayside, New Brunswick and me in Halifax, Nova Scotia, on February 19, 2024.

[redacted]

David A. Barry
A Barrister of the Supreme Court of Nova Scotia

Brian Glebe, PhD

6. My response to the Carr Report and the Halfyard Report is attached as **Exhibit A**.

7. My CV is attached as **Exhibit B**.

AFFIRMED before me virtually on MS Teams with Dr. Glebe in Bayside, New Brunswick and me in Halifax, Nova Scotia, on February 19, 2024.

David A. Barry
A Barrister of the Supreme Court of Nova Scotia

[redacted]

Brian Glebe, PhD

KCS Application re AQ#1205X, AQ#1432, AQ#1433 in Liverpool Bay, Queens County

This is **Exhibit A** referred to in the Affidavit of Brian Glebe, PhD affirmed before me on February 19, 2024.

David A. Barry
A Barrister of the Supreme Court of Nova Scotia

To: Nova Scotia Aquaculture Review Board
2024-02-19

Dr. Brian Glebe
President

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In the matter of: An Application by Kelly Cove Samon Ltd. for a boundary amendment and two new finfish aquaculture licenses and leases for Atlantic salmon in Liverpool Bay, NS.

I have been asked by Kelly Cove Salmon Ltd. to provide my expert opinion on the reports of Mr. Jonathan Carr and Dr. Ed Halfyard in respect to the impact of Kelly Cove's proposed expansion of its operations in Liverpool Bay on wild Atlantic salmon.

In order to provide context for my expert opinion in respect of the impacts on wild Atlantic salmon, I have also reviewed the affidavit of Dr. Kurt Samways, which was prepared in support of Kelly Cove Salmon's application.

Background of Dr. Brian Glebe: I attained a PhD in genetics and physiology from McGill University followed by a 45-year career in both Atlantic salmon conservation and farming. I was part of the science team that experimentally (in the 1970s) grew the first Atlantic salmon in sea cages in North America. Subsequently, I evaluated multiple stocks for farming attributes and selected the Saint John stock, which is now the farming standard in Atlantic Canada and Maine. I assisted the first commercial farmer, Art MacKay, with the development of his farm on Deer Island. His first harvest was in 1979. It was not long after that the first commercial harvest occurred in Nova Scotia (1984). I managed a collective genetic improvement program for three salmon generations for the major farming companies.

Resume of Dr. Brian Glebe: Enclosed.

Publications of Dr. Brian Glebe: Over 70 of my publications are available at:

https://www.researchgate.net/profile/Brian-Glebe

As Dr. Kurt Samways acknowledges the Nova Scotia Southern Upland salmon population native to the Mersey River (closest river to the proposed salmon farm development) is considered extirpated, that is, has ceased to exist. No salmon have been present in the Mersey River since 2008 due to low pH and competition from invasive bass.

Dr. Halfyard similarly documents the Medway River as very acidic, in the pH range of 4.8 to 5.0. For context, on a logarithmic scale, a pH of 4.8 is 200% more acidic than 5.0. Numerous scientific publications (including my own “Fertilization success and sperm motility of Atlantic salmon (Salmo salar L.) in acidified water” indicate that salmon reproduction is seriously limited under these conditions.

https://www.sciencedirect.com/science/article/abs/pii/0044848684900310

The pH effect is both direct and indirect (as shown by increased toxicity of aluminum which occurs naturally in the water). In a recent communication with T. Goff (former manager of the DFO Mersey Fish Culture facility, now permanently closed) he reported that the hatchery fry mortality was 30% at pH 5.0 and 100% at 4.8. This would seem to indicate the river is no longer viable for a salmon run.

In addition, this river has flow control structures (of which there are over 500 in the province) which would impede the migration of salmon. Flow control structures also warm the water which is conducive to invasive species, which are more tolerant of temperature extremes and low pH. This would seem to indicate the river is not viable for a salmon run.

Numerous predatory smallmouth bass have invaded the watershed. Dept of Fisheries (now DFO) was responsible for much of the spread of invasive bass we see today (Page 141. J. Catt 1949 The Canadian Fish Culturist):

https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/171231_1949.pdf

From New Brunswick to Nova Scotia invasive bass are prevalent in most salmon rivers. The Mersey River and other local rivers have substantial smallmouth bass populations, which would likely displace more cold-water species such as salmon and trout. Bass populations thrive in the lower pH water.
In New Brunswick, the Magaguadavic River is another example of the impact of invasive bass on salmon. Mr. Carr reviews and acknowledges this bass prevalence in most regional salmon rivers in his own paper: Jonathan W. Carr and Frederick G. Whoriskey. 2009. “Research Document 2009/074 Atlantic Salmon (Salmo salar) and Smallmouth Bass (Micropterus dolomieu) Interactions in the Magaguadavic River, New Brunswick.”

https://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2009/2009_074-eng.htm

However, Mr. Carr appears to downplay the importance of invasives contributing to population declines and extinctions. Instead, he focuses on salmon farm escapes interbreeding with wild fish as the root cause of wild salmon declining. There are no confirmed reports of farm escapes interbreeding with wild fish in southwestern Nova Scotia rivers. In fact, very few escapees have been observed in regional rivers. In another publication, where Mr. Carr is listed as a co-author (Matthew R.J. Morris, Dylan J. Fraser, Anthony J. Heggelin, Frederick G. Whoriskey, Jonathan W. Carr, Shane F. O'Neil, and Jeffrey A. Hutchings. 2009. "Prevalence and recurrence of escaped farmed Atlantic salmon (Salmo salar) in eastern North American rivers"), it states that rivers in the vicinity of Liverpool Bay (the Mersey, Medway and LaHave rivers) have had only two farm escapees recorded.

https://cdnsciencepub.com/doi/10.1139/F08-181

The Medway River, 20 kilometers distant from Liverpool Bay, has an annual wild run numbering fewer than 100 grilse (a salmon that has returned to fresh water after a single winter at sea) and large salmon. . This watershed also has an abundance of bass. The main stem has a pH range 0f 4.8 to 5.0 as outlined in the Dr. Halfyard affidavit, a range that would likely significantly impede successful salmon spawning. However, some tributaries are well buffered and have higher pHs. These tributaries appear to have refuge parr populations which may be contributing smolts in support of the limited adult return. More significantly, there appears to be significant numbers of precocious (mature) fish among these parr (as reported by the Fish and Game Association). These mature parr could possibly be considered a gene bank for the unique genetic signature of this river strain. There is an opportunity for this river to support a smolt to adult supplementation (SAS) and fry stocking program using marine conservation cages. This successful approach for endangered inner Bay of Fundy river strains in New Brunswick is being supported by Kelly Cove Salmon and implemented by a consortium of NGOs, First Nations, and government agencies. Dr. Samways is an established expert in this technique for successful salmon enhancement. In his affidavit, he indicates Kelly Cove's willingness to support a marine conservation approach to rivers in the vicinity of Liverpool Bay.

LaHave River, 60 km distant from Liverpool Bay, has an annual run of slightly more than 100 grilse and salmon. The river is well buffered and has water quality conducive to salmon reproduction. The dam has a

fishway where migratory fish including salmon can be enumerated. The fishway enables the LaHave to be used as an Index River in DFO surveys. This river is ideally suited for a marine conservation approach to aid in stock recovery. An Invasive smallmouth bass population appears to be the greatest impediment to stock recovery. Similarly, this strain could be used in augmentation of the Medway strain numbers. Sperm from Medway precocious parr could be used to fertilize SAS eggs from the LaHave to perpetuate the unique genetic integrity of a Medway recovery program.

Without extraordinary mitigation measures, it would appear to be impossible for farm escapees and wild salmon to spawn in the Mersey and Medway watershed. Restoration may require liming for pH control combined with hatchery supplementation such as SAS. Without a listing of these river populations as endangered, mitigation supported by DFO is highly unlikely. Historically, DFO closed all but two (the Mactaquac NB and Coldbrook NS hatcheries) of the original 22 Maritime Fish Culture Facilities for budgetary reasons just prior to the general salmon population declines. Only Kelly Cove currently has the infrastructure and financial resources to support a local salmon recovery program, especially for the Medway River, that could be modeled after the successful Inner Bay of Fundy program supported by Parks Canada and others in New Brunswick.

As Dr. Samways correctly points out “the extirpation of the Mersey River population of Atlantic salmon is the result of many causes including the acidity of the Mersey River, the presence of dams and flow barriers along its course and high populations of invasive fish predators. Until these causes for the extirpation of salmon in the Mersey River have been addressed, efforts at restoring the wild salmon populations in the Mersey River would be extremely challenging. “

A cause-and-effect relationship between salmon farm escapes and the decline of local wild populations is very difficult to establish. There is no evidence for such a relationship in Nova Scotia. The Magaguadavic River salmon population in NB is often cited (erroneously) as showing this relationship. Mr. Carr, in his affidavit, attempts to use this river as an example of a population decline due to a wild stock interbreeding with farm escapes entering the river. Since 1992 the ASF has euthanized over 3000 farm escapees (determined by appearance and scale characteristics) at river entry. Only 10% of the farm escapees were maturing individuals and the remaining immature fish would not have spawned. Had the immature fish not been killed, speculation is that they may have offered a unique sport fishing opportunity.

There never was a natural wild stock in the Magaguadavic River. DFO planted hatchery-grown Saint John smolts to start the run after a fishway was constructed around the historically impenetrable waterfall at the river mouth. Also, escapees from the three commercial hatcheries in the Magaguadavic watershed (also growing Saint John genetic stock provided by DFO) contributed to the so-called wild run. In summary, the Magaguadavic spawners have always been a run of Saint John River genetic origin returning home, irrespective of hatchery or farm source. The presence of bass was likely the major contributor to the decline. There is no similarity to a possible genetic relationship between wild and farmed salmon in the Liverpool area.
In my opinion, the Board should disallow this unrelated comparison to a NB river as immaterial evidence for this adjudicative hearing.

Similarly, Mr. Carr's comment in his affidavit that traces of European genes found in the Big Salmon River wild stock (Inner Bay of Fundy) may have resulted from "illegal use" of European stocks by commercial salmon farmers. This statement is both highly speculative and likely untrue. The intent appears to unduly discredit salmon farming in general. Public Maine State and Canadian DFO Maritimes (Introductions and Transfers) databases show many permits for legal European salmon entry. At one time, 50% of legally farmed salmon in Maine were either pure European or Saint John hybrids, with the balance being pure Saint John stock. With more recent policy changes by the governments, farmers are now restricted to the use of Saint John stock on both sides of the border. There were escapes, and not recognizing international borders, farmed European salmon very likely strayed from the Gulf of Maine into the nearby Bay of Fundy. Also, it is not uncommon for wild European salmon to stray into Maritimes and Newfoundland waters and presumably spawn with wild Canadian salmon. Further information is available in my two most relevant papers on the subject: Brian Glebe. 1998. "Salmon Aquaculture Breeding Programs: History and Future" and Brian Glebe. 2006. AAC Bulletin 106-12. Page 20. "Introduction of Exotic Salmonids to Aquaculture in Eastern Canada and Maine."

https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/244621.pdf

https://aquacultureassociation.ca/wp-content/uploads/bsk-pdf-manager/2017/09/Bulletin-106-12.pdf

I have firsthand knowledge of the Magaguadavic River salmon population dynamics as the operator of one of the forementioned commercial hatcheries in the watershed. Similarly, I am on record as an importer of European genetic stock for commercial farming in Maine and for research purposes in New Brunswick and Prince Edward Island.

What is conspicuous by its absence in the affidavits is reference to Kelly Cove's improvements in salmon husbandry over the last decade. These improvements have had a genetic containment effect. We often associate improved salmon physical containment with modern engineered mooring systems and cages with stronger netting. However, the greatest threat to wild salmon is not the absolute numbers of fish escaping but the number that are capable of breeding and these are the maturing grilse among the immature population. Artificial lighting has been recently employed to dramatically reduce grilsing by as much as 90% in the cultured Saint John stock. This photoperiod control method I developed is being widely used to reduce the numbers of grilse in cages. Escaped grilse have the highest likelihood of interbreeding with wild fish:

https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/346785.pdf

Production of very large smolts (over 500 g) in land-based recirculation aquaculture systems (RAS) spend less time in the sea cages before a harvest weight is attained. Less time in the ocean means less chance of escape. Kelly Cove has a RAS hatchery under design for construction in Centreville NS.

Finally, advanced genomic breeding for reduced grilsing is being successfully carried out at the new Kelly Cove breeding centre in New Brunswick.

Unfortunately, there is no way to sterilize salmon without side effects on production. Dr. Alan Youngson from Aberdeen Scotland produced the first triploid salmon which are sterile. I followed his lead with the first triploid salmon produced in North America in the early 1980s. Triploids have been found to be slower growing, less resistant to disease and more susceptible to low oxygen environments. They can and are being grown commercially but not without more risk than growing diploid Saint John stock salmon. Norway has stopped the farming of triploids for the moment due to these concerns. Better methods for salmon sterilization are being developed and strains will be available for farming within the decade. The greater risk of disease among triploids could potentially be a greater concern for the welfare of wild salmon.

Conclusion

Responsible aquaculture development is not intrinsically counterproductive to the preservation and protection of native salmon and may in fact offer avenues to ward against looming extinction for some local populations.

Sincerely,

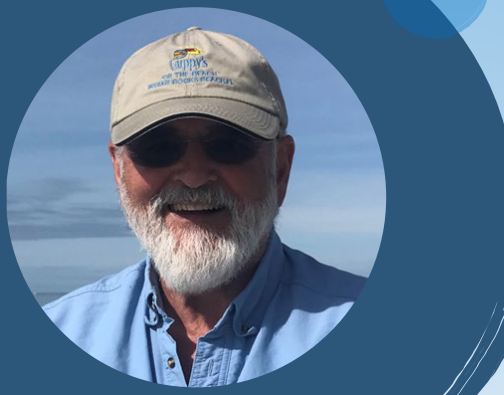
Dr. Brian Glebe

Enclosure(s): 1
Resume: Brian Glebe

KCS Application re AQ#1205X, AQ#1432, AQ#1433 in Liverpool Bay, Queens County

This is **Exhibit B** referred to in the Affidavit of Brian Glebe, PhD affirmed before me on February 19, 2024.

David A. Barry
A Barrister of the Supreme Court of Nova Scotia



Resume
Dr. Brian Glebe, Ph.D.

[redacted]
New Brunswick
Canada

[redacted]

[redacted]

Google Search Keywords for Publications: “Brian Glebe Atlantic Salmon” and “Brian Glebe Arctic char”

Expertise:

Salmon Aquaculture Production/ Genetics/ PhysiologyEducation

Years of Experience:40+

Professional experience:

Brian has had a distinguished career in Canadian science and business after earning both a PhD from McGill University in Montreal and a Bachelor’s Degree in Agriculture from the University of Guelph. As a Postdoctoral Fellow, he was part of the St. Andrews Biological Station team studying the performance of the first North American Atlantic salmon strains to be experimentally grown in open sea pens.

His past accomplishments include holding the position of Director of the Aquaculture Department (which he founded) of the Huntsman Marine Science Centre and instructor of the affiliated NB Community College Aquaculture Technicians Training Program, Director of the North American Salmon Research Centre (sea ranching and farmed salmon genetics), the Freshwater Production Manager for what was the largest Canadian salmon farming company at the time, and the Program Manager for the industry driven Atlantic Salmon Broodstock Development Program.
He has held adjunct professor positions with the Universities of Guelph and New Brunswick supervising graduate students, and teaching courses in Aquaculture and Ecology.

Brian retired from the Department of Fisheries and Oceans, where he held the position of Aquaculture Research Scientist.

Corporate executive experience includes VP Mariculture Products (salmon farming Maine) and President of Briden Consultants Ltd.

Briden was the largest supplier of Atlantic salmon seedstock to the early salmon farming industries in New Brunswick and Maine. Services have included genetic and physiologic consultation, the design, commissioning and operation of hatcheries. In Chile, Briden designed land-based salmon broodstock facilities for two major farming companies and continues to provide services for modern genomics breeding programs and for hatchery design support in Canada. Brian holds or has held numerous executive positions with community volunteer organizations and government bodies.

Brian is a well known fish physiologist and salmonid aquaculture research scientist with more than 70 publications and has presented new contributions to aquaculture science as an international speaker. His accomplishments have been recognized by the Aquaculturist of the Year award and the Atlantic Innovator of the Year award.

Experience Summary:

- Aquaculture Genetics
- Salmon Physiology
- Broodstock Management
- Hatchery Design, Commissioning & Management
- Fish health & Vaccines
- R & D Project Management
- Aquaculture Instruction
- Indigenous Economic Development
- Design and Development of aquaculture facilities utilizing advanced tools including BIM, GIS, 5D modelling, Conceptual, VR and Reality Mesh Visualization.