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 Ramon Filgueira, PhD affirmed on February 19, 2024

I affirm and give evidence as follows:

1. I am Ramon Filgueira, PhD of Hubley, Nova Scotia. I am an Associate Professor in the Marine Affairs Program of the Faculty of Science at Dalhousie University.

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) Dr. Peter Cranford attached as Exhibit A to his Affidavit affirmed on January 18, 2024 and filed in this proceeding by the Intervenor Region of Queens Municipality (the **"Cranford Report"**); and

   (b) Inka Milewski attached as Exhibit A to her Affidavit affirmed on January 15, 2024 and filed in this proceeding by the Intervenor Group of 22 Fishermen (the **"Milewski Report"**).

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

6. My response to the Cranford Report and the Milewski Report is attached as **Exhibit A**.

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

AFFIRMED before me in Halifax, Nova Scotia on February 19, 2024.

[redacted]

A Barrister of the Supreme Court of Nova Scotia

[redacted]

Ramon Filgueira, PhD

DAVID A. BARRY
A Barrister of the Supreme Court of Nova Scotia

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

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

[redacted]

A Barrister of the Supreme Court of Nova Scotia

DAVID A. BARRY
A Barrister of the Supreme
Court of Nova Scotia

Rebuttal to the Reports of Inka Milewski and Dr. Peter Cranford

Ramon Filgueira, PhD

February 19, 2024

1. At the request of Kelly Cove Salmon (**"KCS"**), I have received and reviewed the report of Inka Milewski which is attached as Exhibit A to her Affidavit affirmed on January 15, 2024 and filed by the Intervenor the Group of 22 Fishermen (the **"Milewski Report"**) and the report of Dr. Peter Cranford attached as Exhibit A to his Affidavit affirmed on January 18, 2024 and submitted by the Intervenor Region of Queens Municipality (the **"Cranford Report"**) regarding the potential expansion of KCS's operations in Liverpool Bay. Ms. Milewski's work focuses on the potential effects of farming on lobsters and the potential benthic effects caused by organic loading. Dr. Cranford also focuses on benthic effects, particularly on the current methods to assess those potential effects.

2. In this report, I provide my opinion on the Milewski Report and the Cranford Report. In the following paragraphs, I will summarize my major conclusions, which I have outlined around two themes: "aquaculture-lobster interactions" and "organic loading". I conclude the report with a brief summary and a reflection on aquaculture regulations and monitoring.

(1) Aquaculture-lobster interactions.

3. The work in Port Mouton (Loucks et al. 2014 and Milewski et al. 2018) has fundamental scientific flaws. Some of them were highlighted in Grant et al. (2016). While Milewski et al. partially addressed the spatial issue by inferring the differences to the Port Mouton area as a whole rather than on a specific zone of Port Mouton, and by considering the potential effect of temperature in their analyses, there are still significant weaknesses that impede the authors from implying causality on the potential lobster-farm interactions.

4. The authors state that Capture Per Unit of Effort (**"CPUE"**) accounts for differences in effort between regions and years; however, the authors do not know the total effort of the fishery, which is crucial for using CPUE as a reliable metric. The information about the fleet was not disclosed by Loucks et al., but Milewski et al. state:

> *Approximately 40 boats, with a crew of 2−3 fishers per boat, land lobster in Port Mouton Bay. We recruited up to 15 boats and ~30 fishers (depending on the year) who had fished full or part-time in the bay to participate in this study.*

5. Engaging a part of the fleet would not be an issue if all boats operated in the same way (number of hauls per boat) and the total number of boats was known; however, based on data from their Table 1 (see below), it is evident that the number of hauls per boat is not constant over time (and probably changes across boats) and consequently the total effort is unknown. Not knowing the total effort of the fleet invalidates the use of CPUE as the different effort over the years, and not the farm, could impact catches.

Table 1. Adapted from Milewski et al.

Year	Hauls	Boats	Hauls/Boat	Stage	T
2007	5779	7	826	Feed	NA
2008	5238	12	437	Feed	4.97
2009	10230	15	682	Feed	5.03
2010	13045	14	932	Fallow	7.79
2011	11597	12	966	Fallow	5.98
2012	11717	13	901	Fallow	6.89
2013	8558	11	778	Feed	6.55
2014	6957	10	696	Feed	7.14
2015	3914	7	559	Fallow	2.3
2016	5868	8	734	Fallow	4.47
2017	5865	8	733	Fallow	5.6

6. A second issue concerns the limited period to evaluate the interactions, the last two weeks of May:

> *During the spring portion of the fishery (last 2 wk of May), lobsters are known to migrate into Port Mouton Bay as water temperatures increase.*

7. As temperature changes from year to year, the phenology of the lobster migration is expected to change. Beyond temperature, other large-scale variables could impact the assessment carried out in such a small temporal window. Therefore, limiting the sampling to two weeks introduces uncertainty in the analysis. A more robust approach should integrate the whole fishing season.

8. Beyond these fundamental aspects, the data published by Milewski et al. has inconsistencies. For example, the figure posted below from the supplementary materials includes 5 data points for the feeding stage despite the authors only having data for 4 data points during that stage. Similar inconsistencies appear in other figures.

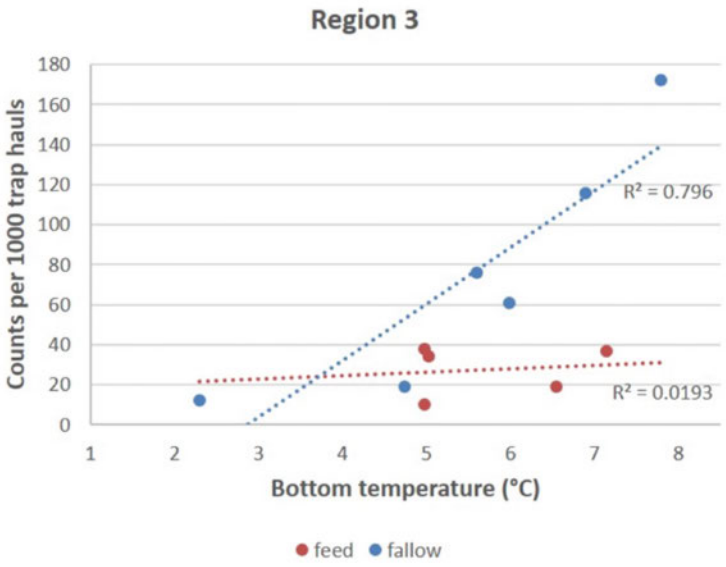

Figure 2. Extracted from Milewski et al. supplementary information

9. The conceptual flaws and inconsistencies suggest that the work carried out in Port Mouton cannot be used to infer any effect of the farm on the lobster fishery. My analysis does not imply that these effects cannot exist, but it indicates that if they exist, they cannot be proven with the studies by Loucks et al. or Milewski et al.

(2) Organic loading

10. The Cranford Report strongly focuses on regulations and, in particular, on the issues of the ion-selective electrode potentiometry (S^{-2}_{ISE}) method as a monitoring tool. I cannot agree more with Dr. Cranford that the UV spectrophotometry method (S^{-2}_{UV}) is better for that purpose. I also want to note that I cannot provide a rigorous scientific opinion regarding the bias of the S^{-2}_{ISE} based on the data presented by Dr. Cranford in Figure 3. A type II linear regression analysis would be needed to evaluate if the slope and intercept of the regression differ statistically from 1 and 0, respectively, which would inform about the agreement of both methods and the accuracy of the S^{-2}_{ISE} method. I think that it is important to note that based on the figure below, the S^{-2}_{ISE} does not seem to have a strong bias toward always predicting lower sulfide values as the number of samples in the figure is well balanced above and below the diagonal (green dashed line). No matter what, based on the work published by Dr. Cranford, it seems that the precision of the S^{-2}_{ISE} is lower, and the S^{-2}_{UV} method is superior.

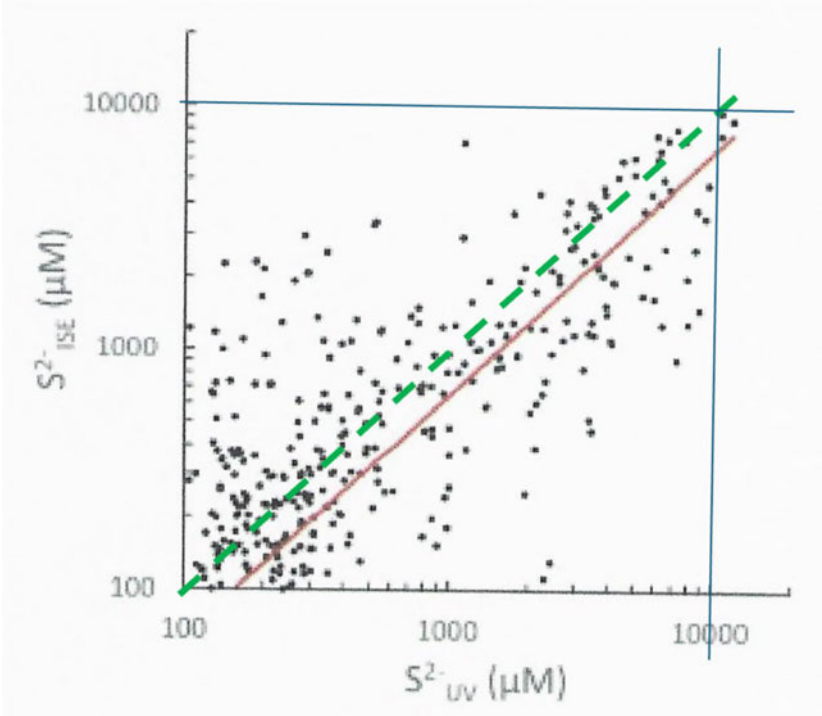

Figure 3. Adapted from Dr. Cranford's report. The green dashed line represents a perfect agreement between both methods.

11. Dr. Cranford also suggests new thresholds to link free sulfides with other "Ecological Quality Status" (Figure 6 in the Cranford Report). Although the figure comes from Cranford et al. 2022, the calculation of the thresholds comes from Cranford et al. 2020. The figure below, from Cranford et al. 2020, represents the relationship between AMBI (the AZTI Marine Biotic Index), a well-known index for assessing benthic impacts, and the values of free sulfides measured with the $S^{-2}{}_{UV}$ method. The r^2 of the relationship is 0.399, which indicates that free sulfides only explain ~40% of the variance of AMBI. Based on Cranford et al. 2020, it is also difficult to determine the selection of the chosen regression as Table 3 only indicates that the "best-fit equations" are plotted, and the methods do not indicate the criteria to select the best model, only that "dynamic curve-fit algorithm in SigmaPlot" but to the best of my knowledge, the user ultimately determines the model. Given the dispersion of the data and the logarithmic scale, choosing a different regression model could heavily impact these thresholds. Despite these nuances, it is crucial to consider this uncertainty to establish thresholds as sulfides only explain 40% of the variance. In fact, based on that low r^2, the use of sulfides, independently of the method, could be challenged as an indicator of the benthic status.

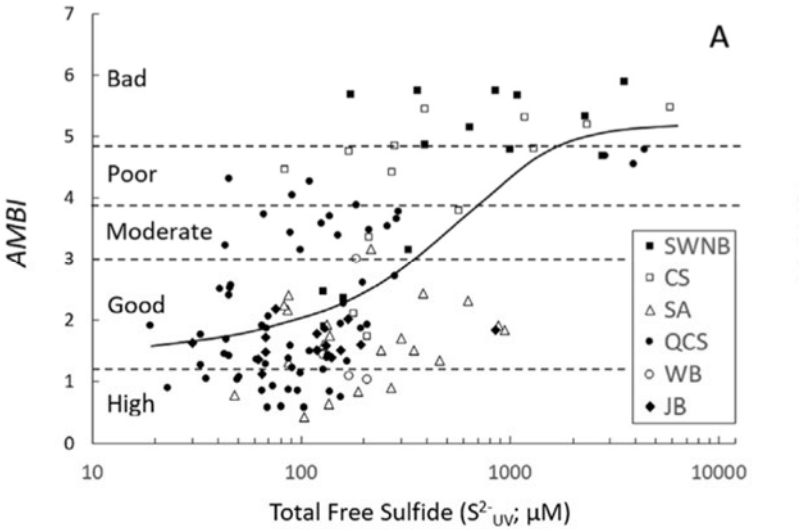

Figure 4. Figure 7a From Cranford et al. 2020. A 200µM sample can range from excellent status to bad, highlighting the challenge to correlated both metrics

12. Dr. Cranford also stated that “State-of-the-art numerical modelling methods employed worldwide specifically to address the regulatory requirement to predict contours of the depositional footprint of BOD matter have consistently failed to match observations of benthic organic enrichment and community impacts”. Again, as an ecosystem modeller, I cannot agree more, models have failed, but models have also provided excellent results. As George Box stated, "All models are wrong, but some are useful".

13. What is interesting from my perspective is that after recognizing the complexity of predicting organic deposition and the plethora of variables that could impact these predictions, Dr. Cranford extrapolates from a study in Scotland (Fox et al. 2023) to estimate the extension of the hypoxic area in Liverpool Bay. Although Dr. Cranford states that this is a “first order calculation”, Dr. Cranford compares that calculation with the estimations from Aquamodel, a state-of-the-art modelling platform used and validated in many aquaculture sites across the world (http://www.aquamodel.net/) which includes bathymetry, water circulation, and farming practices among others. Therefore, Dr. Cranford’s estimation of the hypoxic/anoxic area of “68 football fields” should be considered in the context of that extrapolation and uncertainty, as all points made by Dr. Cranford to criticize models can also be applied to his calculations.

(3) Summary

14. The uncertainty in Loucks et al. and Milewski et al.'s studies do not allow for inferring any effects on lobster CPUE caused by the Port Mouton farm. As stated above, this does not imply that these effects cannot exist, but they cannot prove it with their data. Regarding benthic loading, Dr. Cranford raises interesting points regarding the method to determine sulfides, regulations in general, and the constraints of mathematical models. At the Liverpool Bay level, Dr. Cranford's educated guess of the impacted area could be challenged by multiple reasons, as discussed above. Again, this assessment does not imply that ecosystem-level impacts driven by organic loading will not exist in Liverpool Bay, but the estimations from Milewski and Dr. Cranford cannot prove those effects.

15. This final paragraph is probably beyond what is relevant for the ARB as they need to make decisions in the context of current regulations, but I think that it is important to understand my position. As with every human activity, aquaculture will have some effects on the environment, and we have the duty of ensuring that these activities are done in a sustainable fashion. Using the best knowledge that is available to make decisions and robust monitoring are crucial to ensure that goal. This monitoring should be holistic and include all sources of knowledge, from sulfides using the best methods we have, to fishers' observations who deploy traps close to aquaculture sites. It is also important to consider the system as a whole, recognizing that sustainability includes ecological, social and economic pillars. We must also acknowledge the complexity of managing these social-ecological systems and the inherent uncertainty that affects these systems, from stochastic events to climate change. For these reasons, I strongly believe that all right-holders and interest-holders should be part of the conversation and that transparency and effective communication are critical to reducing that uncertainty.

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

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

[redacted]

A Barrister of the Supreme Court of Nova Scotia

DAVID A. BARRY
A Barrister of the Supreme Court of Nova Scotia

RAMÓN FILGUEIRA
CURRICULUM VITAE (February 2024)

Dalhousie University, Marine Affairs Program
Halifax, Nova Scotia, Canada
[redacted]

Current Position

2021 – present **Associate Professor (tenured)**
Dalhousie University, Marine Affairs Program (Halifax, Canada)

2018 – 2026 **Professor Tier II (1111 Forskningssjef – 20% position)**
Institute of Marine Research, Benthic Resources and Processes (Bergen, Norway)

Previous Positions

2016 – 2021 **Assistant Professor (tenure-track)**
Dalhousie University, Marine Affairs Program (Halifax, Canada)

2016 **Research Scientist** (casual position)
Fisheries and Oceans Canada, Centre for Aquaculture and Environmental Research (West Vancouver, Canada)

2015 **Research Scientist** (casual position)
Fisheries and Oceans Canada. Gulf Fisheries Centre (Moncton, Canada)

2012 – 2015 **NSERC Visiting postdoctoral fellow, Canadian Government Laboratories**
Fisheries and Oceans Canada, Gulf Fisheries Centre (Moncton, Canada)
Advisor: Dr. Luc A Comeau

2008 – 2012 **Postdoctoral scholar**
Department of Oceanography, Dalhousie University (Halifax, Canada)
Advisor: Prof. Jon Grant

Education

2002 – 2007 **PhD in Marine Sciences**
Department of Ecology and Animal Biology. Universidad de Vigo, Spain
"Feeding behavior of *Mytilus galloprovincialis* (Lamarck, 1819) under trophic conditions of Galician Rias". *Cum laude* (Highest degree honour in Spain)
Supervisors: Dr. MJ Fernández-Reiziz and Dr. U Labarta

2000 – 2002 **Graduate diploma in Advanced Research**
Department of Ecology and Animal Biology. Universidad de Vigo, Spain.
"Biology of Organisms and Ecosystems". Supervisor: Dr. BG Castro

2000 – 2002 **Master diploma in Environmental Management and Sustainability**
Universidad de Valencia, Spain

1994 – 1999 **BSc in Marine Sciences**
Universidad de Vigo, Spain

Awards & Scholarships

2015 Prix d'Excellence (Fisheries and Oceans Canada's most prestigious award) as member of the Aquaculture Carrying Capacity Team
2012 – 2015 NSERC - Visiting Fellowship in Canadian Government Laboratories
2010 – 2013 Ángeles Alvariño Fellowship (Xunta de Galicia) – Declined in 2012 –
2010 – 2013 JAE-Doc (C.S.I.C.) Postdoctoral research contract – Declined –
2008 – 2009 Juana de Vega Postdoctoral Fellowship
2004 – 2007 Caixanova Predoctoral Scholarship
2003 Xunta de Galicia Predoctoral Scholarship
2002 Institute of Marine Research (C.S.I.C. – I.I.M.) Predoctoral Scholarship
2001 Insuiña S.L. Research Grant

Teaching Experience

2020 – present	MARA 5009 Integrated Coastal Zone Management (Masters, Dalhousie University)
2016 – present	OCEA 4401 Marine Management I (Senior Undergraduate, Dalhousie University)
	OCEA 4402 Marine Management II (Senior Undergraduate, Dalhousie University)
	MARA 5003 Marine Science and Technology (Masters, Dalhousie University)
	Annual guess lectures in MARA 5021 Fisheries Management and ENVI 5505 Biophysical Dimensions of Resource and Environmental Management
2010 – 2011	**Lecturer, Dalhousie University**
	Subject: "Environmental Impact in Marine Ecosystems"
2009 – 2010	**Lecturer / Teaching Assistant, Dalhousie University**
	Subject: "Environmental Impact in Marine Ecosystems"
2000	**Postgraduate course in education**
	Instituto de Ciencias de la Educación. Universidad Complutense de Madrid.

Scientific Contributions

Papers in Refereed Journals

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Submitted Papers

108. Steeves L, Winterburn K, Coffin MRS, Babarro JMF, Guyondet T, Comeau L, **Filgueira R**. The combined effects of temperature and exogenous bacterial sources on mortality in *Crassostrea virginica* under severe hypoxia. Submitted to Estuaries and Coasts.
109. Sajid Z, Gamperl K, Parrish CC, Colombo S, Santander J, Mather C, Neis B, Holmen IM, **Filgueira R**, McKenzie CH, Souto-Cavalli L, Jeebhay M, Gao W, López-Gómez MA, Ochs C, Lehnert S, Couturier C, Knott C, Romero JF, Caballero-Solares A, Cembella A, Murray HM, Fleming I, Finnis J, Fast MD, Wells M, Singh G. An Aquaculture Risk Model to Understand the Causes and Consequences of Salmon Mass Mortality Events (MMEs). Submitted to Reviews in Aquaculture
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111. Krause G, **Filgueira R**, Ahmed N, Alexander K, Fanning L, Ferse S, Guchs N, Guillen J, Johnson T, Kaiser M, Kite-Powell H, Kreiss C, Lipton D, Marin S, Mikkelsen E, van den Burg S, Stead S, Villasante S. Regionalisation alone will not make marine aquaculture more sustainable. Submitted to One Earth.
112. Krause G, Weitzman J, Rector M, **Filgueira R**, van den Burg S, Dankel DJ, Olsen MS, Osmundsen TC. The Social Science of Offshore Aquaculture: Uncertainties, challenges and solution-oriented governance needs. Submitted to Frontiers in Aquaculture

113. Stockwell C, **Filgueira R**, Grant J. The effects of oxygen supplementation on farmed Atlantic salmon (*Salmo salar*) behavior using acoustic telemetry. Submitted to Aquaculture Research

Book Chapters

114. Brownscombe JW, Lawrence MJ, Deslauriers D, **Filgueira R**, Boyd RJ, Cooke SJ (2022) Applied fish bioenergetics. In Cooke SJ, Fangue NA, Farrell AP, Brauner CJ, Eliason EJ (Eds.) Conservation Physiology for the Anthropocene – A Systems Approach. Fish Physiology Series Vol 39A. Academic Press, Cambridge, MA. Pp 141-188. doi.org/10.1016/bs.fp.2022.04.004
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119. Álvarez–Salgado XA, Fernández–Reiriz MJ, Labarta U, **Filgueira R**, Peteiro LG, Figueiras FG, Piedracoba S, Rosón G (2009) Influencia do cambio climático no cultivo do mexillón das rías galegas. In: Pérez V, Fernández M, Gómez JL (Ed.) Evidencias e Impactos do Cambio Climático en Galicia. Xunta de Galicia. Consellería de Medioambiente de Desenvolvemento Sostible, pp 373-389. (ISBN: 978-84-453-4782-9)

Academic and professional service

University committees and boards

- Marine Affairs Program: Admissions committee (since 2017, chair 2021, 2022)
- Marine Affairs Program: Ethics committee (from 2018 until 2022, chair 2021, 2022)
- Marine Affairs Program – Chair of LTA Search Committee (2022)
- Dalhousie University – Biology – Instructor hiring committee (2018)
- Dalhousie University – FGS NSERC Masters Scholarship Committee (since 2018)
- Dalhousie University – FGS Killam Postdoctoral Fellowship Committee (since 2018)
- Dalhousie University – Decanal Review Committee for the Faculty of Science (2020)
- Dalhousie University – Decanal Search Committee for the Faculty of Science (2020/2021)
- Aarhus University – Research Professor Assessment Committee (2023)

External committees and boards

- ICES Working Group on Social and Economic Dimensions of Aquaculture (ICES WGSEDA, chair)
- ICES Working Group on Ecological Carrying Capacity of Aquaculture (ICES WGECCA, member)

Editor duties

- Invited editor of Aquaculture Modelling special issue on DEB2023

Reviewer duties

- Certificate of Excellence in Reviewing – Journal of Sea Research 2013
- Journal review (47 Journals, 128 Manuscripts):
  Ambio, Aquaculture, Aquaculture Environment Interactions, Aquaculture International, Aquaculture Reports, Aquatic Biology, Biofouling, Cahiers de Biologie Marine, Conservation Physiology, Ecological Indicators, Ecological Modelling, Environmental Engineering Science, Environmental Modelling and

Software, Environmental Science and Technology, Estuaries and Coasts, Estuarine Coastal and Shelf Science, Environmental Pollution, Frontiers in Marine Science, Frontiers in Sustainable Food Systems, Global Change Biology, Helgoland Marine Research, Hydrobiologia, ICES Journal of Marine Science, Information Processing in Agriculture, Journal of Cleaner Production, Journal of Experimental Marine Biology and Ecology, Journal of Sea Research, Journal of Shellfish Research, Journal of Sustainability Science and Management, Journal of Visualized Experiments, Marine Biology, Marine Biology Research, Marine Ecology Progress Series, Marine Environmental Research, Marine & Freshwater Behaviour & Physiology, Marine Policy, Marine Pollution Bulletin, Natural Resources Forum - A United Nations Sustainable Development Journal, Nature, PLOS ONE, Proceedings of the Royal Society B, Remote Sensing of Environment, Reviews in Fisheries Science and Aquaculture, Revista de Biología Marina y Oceanografía, Science of the Total Environment, Scientific Reports, Sustainability.

- Proposal reviewer: NOAA Saltonstall-Kennedy, Sea Grant: Rhode Island, Sea Grant: New Jersey, Mitacs, Netherlands Organisation for Scientific Research, Croatian Science Foundation
- Book proposal reviewer: Wiley
- Book chapter reviewer: Good and Services of Marine Bivalves
- PhD Projects: IFREMER
- Fisheries and Oceans Canada reviewer: Canadian Technical Report in Fisheries and Aquatic Sciences
- Center for Independent Experts (CIE) Independent Peer Review:
    - Morris JA Jr., MacKay JK, Jossart JA, Wickliffe LC, Randall AL, Jensen BM, Bath GE, Balling MB, Riley KL. 2021. An Aquaculture Opportunity Atlas for the Southern California Bight. NOAA Technical Memorandum OS NCCOS 298. Beaufort, NC. 485 pp. doi.org/10.25923/tmx9-ex26
    - Riley KA, Wickliffe LC, Jossart JA, MacKay JK, Randall AL, Jensen BM, Bath GE, Balling MB, Morris JA Jr. 2021. An Aquaculture Opportunity Atlas for the U.S. Gulf of Mexico. NOAA Technical Memorandum NOS NCCOS 299. Beaufort, NC. 545 pp. doi.org/10.25923/8cb3-3r66

Professional networks

- Aquaculture Association of Nova Scotia
- Aquaculture Association of Canada
- European Aquaculture Society
- World Aquaculture Society

Conference organization

- Co-organizer of DEB2021: Forecasting in a changing world (School and Symposium). Virtual.
- Co-chair of session “Socio-economic Challenges for Sustainable Aquaculture in a changing environment” in Aquaculture Europe 2022. Rimini, Italy.
- Scientific committee of DEB2023. Baton Rouge, United States of America.
- Co-chair of session “Blue Carbon, mariculture and climate change mitigation and adaptation in the Subarctic and Arctic” in ESSAS 2023. Bergen, Norway.
- Co-chair of network session “Ecological carrying capacity of aquaculture” in ICES ASC 2023. Bilbao, Spain.