Proceeding of the 2017 Canadian Freshwater Mollusc Research Meeting: November 8-9, 2017, Burlington, Ontario

Editors: T.J. Morris[1], K.A. McNichols-O'Rourke[1] and S.M. Reid[2]

[1] Fisheries and Oceans Canada
Great Lakes Laboratory for Fisheries and Aquatic Sciences
867 Lakeshore Road
Burlington, ON
L7S 1A1

[2] Aquatic Research and Monitoring Section
Ontario Ministry of Natural Resources and Forestry
Trent University – DNA Building, 2140 East Bank Drive
Peterborough, ON
K9J 7B8

2018

Canadian Technical Report of Fisheries and Aquatic Sciences 3246

Fisheries and Oceans Canada | Pêches et Océans Canada

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of Fisheries and Oceans Canada, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in the data base *Aquatic Sciences and Fisheries Abstracts*.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page.

Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457-714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715-924 were issued as Department of Fisheries and Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. II n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques de Pêches et Océans Canada, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications à part entière. Le titre exact figure au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la base de données *Résumés des sciences aquatiques et halieutiques.*

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre.

Les numéros 1 à 456 de cette série ont été publiés à titre de Rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de Rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de Rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Canadian Technical Report
of Fisheries and Aquatic Sciences 3246

2018

Proceedings of the 2017 Canadian Freshwater Mollusc Research Meeting: November 8-9, 2017, Burlington, Ontario

By

Editors:
T.J. Morris[1], K.A. McNichols-O'Rourke[1], and S.M. Reid[2]

[1] Fisheries and Oceans Canada
Great Lakes Laboratory for Fisheries and Aquatic Sciences
867 Lakeshore Rd., P.O. Box 5050
Burlington, ON
L7R 4A6
Email: Todd.Morris@dfo-mpo.gc.ca, Kelly.McNichols-O'Rourke@dfo-mpo.gc.ca

[2] Aquatic Research and Monitoring Section
Ontario Ministry of Natural Resources and Forestry
Trent University – DNA Building, 2140 East Bank Drive
Peterborough, ON
K9J 7B8
Email: Reid.Scott@ontario.ca

Cat. No. Fs97-6/3246E-PDF ISBN 978-0-660-24425-9 ISSN 1488-5379

Correct citation for this publication:

Morris, T.J., K.A. McNichols-O'Rourke, and S.M. Reid (Editors). 2018. Proceedings of the 2017 Canadian Freshwater Mollusc Research Meeting: November 8-9, 2017, Burlington, Ontario. Can. Tech. Rep. Fish. Aquat. Sci. 3246: viii + 26 pp.

PREFACE

The second biennial Canadian Freshwater Mollusc Research Meeting was held at the Canada Centre for Inland Waters in Burlington, Ontario on November 8-9, 2017. The meeting was jointly hosted by Fisheries and Oceans Canada and the Ontario Ministry of Natural Resources and Forestry with support from the Freshwater Mollusk Conservation Society. The workshop included a plenary, 29 platform presentations, and one poster presentation. The meeting was attended by 78 individuals (56 in person and 22 via WebEx).

The objective of this meeting was to bring together Canadian malacologists to share past, current, and ongoing research on freshwater molluscs. Topics of discussion included status and distribution, life history, conservation genetics, species at risk, threats, propagation activities, and outreach actions. With representation from the Pacific to the Atlantic, attendees came from seven Canadian provinces (BC, SK, MB, ON, QC, NB, NS) and four American states (IL, MI, NE, NY) and represented federal departments, provincial/state agencies, academic institutions, environmental non-governmental organizations, naturalist groups, zoos, museums, and interested citizens. There was an emphasis on building relationships to promote future collaborations and research opportunities.

PRÉFACE

La deuxième réunion bisannuelle consacrée à la recherche sur les mollusques d'eau douce du Canada a eu lieu au Centre canadien des eaux intérieures à Burlington, en Ontario, les 8 et 9 novembre 2017. La réunion a été organisée conjointement par Pêches et Océans Canada et le ministère des Richesses naturelles et des Forêts de l'Ontario, avec le soutien de la Freshwater Mollusk Conservation Society. L'atelier comprenait une séance plénière, 29 présentations de plateformes et une présentation d'affiches. 78 personnes ont participé à la réunion (56 en personne et 22 par de WebEx).

L'objectif de cette réunion était de rassembler des malacologistes canadiens pour discuter des recherches passées et en cours sur les mollusques d'eau douce. Parmi les sujets abordés, mentionnons l'état et la répartition, le cycle biologique, la génétique de la conservation, les espèces en péril, les menaces, les activités de propagation et les mesures de sensibilisation. Représentant des ministères fédéraux, des organismes provinciaux et des organismes d'État, des établissements d'enseignement, des organisations non gouvernementales de l'environnement, des groupes de naturalistes, des zoos, des musées et des citoyens intéressés du Pacifique à l'Atlantique, les participants étaient originaires de sept provinces canadiennes (C.-B., Sask., Man., Ont., QC, N.-B., N.-É.) et de quatre États américains (IL, MI, NE, NY). L'accent a été mis sur l'établissement de relations afin de promouvoir de futures collaborations et des possibilités de recherche.

EDITORS' COMMENTS

These proceedings contain all of the abstracts that were presented at the research meeting. The abstracts were reviewed in a limited capacity and formatted by the editors. They were not sent for external review. Questions or comments relating to their content should be directed to the authors of each abstract and not the editors. The views and statements contained in these proceedings are those of the speakers and are neither condoned nor rejected by the editors. Any use of trade names or products does not constitute endorsement or recommendation for use.

REMARQUES DES ÉDITEURS

Le présent compte rendu contient tous les résumés ayant été présentés lors de la réunion de recherche. Les résumés ont été révisés en partie et formatés par les éditeurs. Ils n'ont pas fait l'objet d'un examen externe. Les questions ou les commentaires liés à leur contenu devraient être envoyés aux auteurs de chaque résumé et non aux éditeurs. Les points de vue et les affirmations exprimés dans ces comptes rendus sont ceux des conférenciers et n'ont été ni approuvés ni infirmés par les éditeurs. L'utilisation d'une marque de commerce ou d'un produit ne constitue nullement une forme d'approbation ou de recommandation de son utilisation.

CANADIAN FRESHWATER MUSSEL RESEARCH MEETING ORGANIZING COMMITTEE

Dr. Todd J. Morris	Fisheries and Oceans Canada
Kelly McNichols-O'Rourke	Fisheries and Oceans Canada
Dr. Scott M. Reid	Ontario Ministry of Natural Resources and Forestry

TABLE OF CONTENTS

PROGRAM AGENDA: Wednesday, November 8

Time	Title	Author(s)
12:00 –13:00	Registration and Poster set-up	
13:00 – 13:20	Introductions and welcoming address	Todd J. Morris
Platform 1 13:20 – 13:40	The lost Mussels of Pelee Island	Kelly McNichols-O'Rourke, Alex Meilutis, and Todd J. Morris
Platform 2 13:40 – 14:00	2016-2018 Southern Quebec Mussel Survey: New population of the endangered Hickorynut, *Obovaria olivaria*	Philippe Blais
Platform 3 14:00 – 14:20	Brailing the Plantagenet Reach: Not catching anything where there may not be anything to catch	Frederick W. Schueler and Ryan Robson
Platform 4 14:20 – 14:40	Toronto Zoo and Freshwater Mussel Conservation: Five year field study and public campaign	M.K. Whibbs and C. Lee
14:40 – 15:00	Break	
Platform 5 15:00 – 15:20	Historical (1880s) and Current Communities of Native Freshwater Mussels in the Rideau River: an Anthropocene legacy of dams, urbanization, and invasive species	André L. Martel, Noel Alfonso, Arielle Vary-O'Neal, and Jacqueline B. Madill
Platform 6 15:20 – 15:40	Exploring Ontario Nature's first riverine reserve: The Sydenham River Nature Reserve	Meg Sheldon, Kelly McNichols-O'Rourke, and Todd J. Morris
Platform 7 15:40 – 16:00	A simplification of the St Clair delta mussel fauna: What happened to our refuge?	Todd J. Morris, Kelly McNichols-O'Rourke, and Clint Jacobs
Platform 8 16:00 – 16:20	Quagga and Zebra Mussels in British Columbia	Lora Nield and Marina Beck
Plenary 16:20 – 17:20	The impact of Dreissena on native unionid bivalves in Europe and North America: lessons learned	Lyubov E. Burlakova

PROGRAM AGENDA: Thursday, November 9

Time	Title	Author(s)
Platform 9 8:00 – 8:20	Feeding in recently metamorphosed freshwater mussels	Josef D. Ackerman and Rakesh Mistry
Platform 10 8:20 – 8:40	Effect of porewater flow on juvenile unionid feeding	Victor Fung and Josef D. Ackerman
Platform 11 8:40 – 9:00	Selective Feeding of Freshwater Mussels: Implications for Resource Partitioning	Katherine Tran and Josef D. Ackerman
Platform 12 9:00 – 9:20	Is the clearance rate response to increased total suspended solids plastic in juvenile unionids?	Shaylah Tuttle-Raycraft and Josef D. Ackerman
Platform 13 9:20 – 9:40	The Sins of the Father: Multi-generational effects of copper on the freshwater snail *Planorbella pilsbryi*	R. K. Osborne, P.L. Gillis, R.S. Prosser, and D. Bowes
9:40 – 10:00	Break	
Platform 14 10:00 – 10:20	Assessing the toxicity and risk of salt-impacted winter road runoff to the early life stages of freshwater mussels	Patricia Gillis, Quintin Rochfort, Kirsten Exall, Rodney McInnis, and Ryan Prosser
Platform 15 10:20 – 10:40	Risk posed by pesticides to native freshwater mussels in the Great Lakes Basin	Joseph Salerno, Emily Holman, Patricia Gillis, Paul Sibley, and Ryan Prosser
Platform 16 10:40 – 11:00	Facultative parasitic ciliated protozoa, *Tetrahymena glochidiophila*, influences glochidia viability in freshwater mussels	Ryan Prosser, Joseph Salerno, Jim Bennett, Denis Lynn, and Patty Gillis
Platform 17 11:00 – 11:20	The Effects of the Mactaquac Hydro Generating Station on Freshwater Mussel Assemblages in the St. John River, New Brunswick	Emma Lippert
Platform 18 11:20 – 11:40	Fantastic Beasts and Where to Find Them: Mussel surveys, caging, and wastewater in the Grand River	C. J. Bennett, J. Salerno, E. Hayward, R.S. Prosser, H. Khan, E. Burton, S. James, Q. Rochfort, A. Leadbetter, C. Metcalfe, and P. Gillis

Time	Title	Author(s)
Platform 19 11:40 – 12:00	Environmental DNA (eDNA) is as sensitive as quadrat sampling for detection of unionid species at-risk	C.A. Currier, T. J. Morris, C. Wilson, and J. Freeland
12:00 – 13:00	Lunch – poster session	
Platform 20 13:00 – 13:20	Conservation genetics of North American *Margaritifera margaritifera* (Bivalvia: Unionida: Margaritiferidae)	David T. Zanatta, Bernhard C. Stoeckle, Kentaro Inoue, Annie Paquet, André Martel, Ralph Kuehn, and Jürgen Geist
Platform 21 13:20 – 13:40	Population structure, genetic diversity, and colonization history of the Eastern Pondmussel, *Ligumia nasuta*, in the Great Lakes drainage	Mariah W. Scott, Todd J. Morris, and David T. Zanatta
Platform 22 13:40 – 14:00	Evaluating research progress for aquatic species at risk in the Great Lakes basin, 2004-2016	D.A.R. Drake, K. Thiessen, T.J. Morris, M.A. Koops, T.C. Pratt, S.M. Reid, and N.E. Mandrak
Platform 23 14:00 – 14:20	Can Adaptive Cluster Sampling Improve Ontario Mussel Species at Risk Monitoring?	Scott M. Reid, Anita LeBaron, and Todd J. Morris
Platform 24 14:20 – 14:40	A meta-analysis of the relationship between habitat condition and mortality in freshwater molluscs and fishes	Georgina Braoudakis, Dominique Lebrun, Andrew Drake, Marten Koops, Robert G. Randall, and Todd J. Morris
14:40 – 15:00	Break	
Platform 25 15:00 – 15:20	Outcomes of the Mussel Relocations and Monitoring Events	Gina MacVeigh
Platform 26 15:20 – 15:40	An Update of Fish Culture Sections Efforts to Culture ‘At Risk” Mussels	Christopher Wilson and Kevin Loftus
Platform 27 15:40 – 16:00	Implementation of Brook Floater (*Alasmidonta varicosa*) conservation measures in Canada	Fabiola Akaishi, Ree Brennin Houston, Mary Sollows, Donald McAlpine, Francis LeBlanc, and Nellie Gagné
Platform 28 16:00 – 16:20	Federal recovery planning, research information gaps, and outreach for aquatic (fish/mussel) species at risk in Ontario.	Amy Boyko and Shelly Dunn

Time	Title	Author(s)
Platform 29 16:20-16:40	Guidance for Freshwater Mussels in the Okanagan	Lora Nield and Greg Wilson

POSTER SESSION

	Authors	Title
Poster 1	Understanding Host Fish and Habitat Requirement Helps to Locate a Vast Population of the Rare Hickorynut Mussel (Unionidae) in the Ottawa River	André L. Martel and Jacqueline B. Madill

PROGRAM ABSTRACTS

Plenary - The Impact of Dreissena on Native Unionid Bivalves in Europe and North America: Lessons learned.

Lyubov E. Burlakova

Great Lakes Center, SUNY Buffalo State, Buffalo, NY 14222. Email: burlakle@buffalostate.edu

Invasive byssate bivalves *Dreissena polymorpha*, the zebra mussel, and *Dreissena rostriformis bugensis*, the quagga mussel, are spreading in Europe during the last 200 years and in North America during the last three decades. Colonization of waterbodies by *Dreissena* has caused dramatic declines in native freshwater mussels, especially in Unionidae. Both European and North American experience suggest that the highest unionid mortalities are recorded during the rapid dreissenid population growth followed by local unionid extirpation or coexistence, however it is still unclear what factors are essential for native mussels' survival. The first unionid "refuges" were found in Great Lakes a few years after *Dreissena* introduction, and ongoing studies revealed a suit of conditions that allow dreissenids and unionids to co-exist. Critical evaluation of factors that aid or prevent unionid coexistence with dreissenids can provide an opportunity for unionid conservation on both continents that are still being invaded by dreissenids.

Platform 1 - The Lost Mussels of Pelee Island

Kelly A. McNichols-O'Rourke[1], Alex Meilutis[2], and Todd J. Morris[1]

[1]*Fisheries and Oceans Canada, Burlington, ON, Canada, L7S 1A1. Email: Kelly.McNichols-O'Rourke@dfo-mpo.gc.ca*
[2]*Ministry of Natural Resources and Forestry, 659 Exeter Road (4th Floor), London, ON, N6E 1L3*

Pelee Island is one of nine Canadian Islands that make up the Township of Pelee and represents the most southern point in Canada. It is home to a large number of rare plant and animal species. Historical records indicate that over 25 species of mussels were found in the nearshore Lake Erie areas surrounding Pelee Island. No formal surveys had occurred on the island therefore, our objective was to complete a mussel species inventory of Lake Henry in partnership with Ontario Parks. Lake Henry is located in Lighthouse Point Provincial Park on the north tip of the Pelee Island. In 2016, 21 blocks were surveyed for three person hours each. Each block was 50 m x 50 m in size (2,500 m^2) and surveyed by a four-person crew in wetsuits using tactile methods and mussel scoops. A total of 544 individuals representing seven live mussel species were observed. Densities in each block ranged from 0.0008/m^2 to 0.03/m^2 in the 17 blocks where live mussels were found. The most abundant and common species throughout the lake was the Threeridge with 414 individuals observed at 76% of blocks. The

Mapleleaf mussel, which is a species of Special Concern in Ontario, was the second most abundant (74 individuals) and common species, occurring at 13.6% of blocks. A single Pink Heelsplitter was also found. Shells of an additional four species (two of which are considered species at risk) were also observed during the survey. Although there has been a large decline in the number of mussels in Lake Erie surrounding Pelee Island, native mussel species continue to survive in Lake Henry. The results of this survey provide information that leads directly into recovery strategies and action or management plans.

Platform 2 - 2016-2018 Southern Quebec mussel survey: new population of the endangered hickorynut, *Obovaria olivaria.*

Philippe Blais

President Regional Environment Counsel Montérégie; President Vigile Verte; Advisory counsel Board member CNC Quebec. Administrator Project Canunio on iNaturalist https://www.inaturalist.org/projects/canunio QC.CAN. Email: redgarter@videotron.ca

Obovaria olivaria was designated 'Endangered' by the COSEWIC in 2011 and is currently designated 'of special concern' in Quebec and Ontario, but does not currently benefit from any legal protection from either federal or provincial governments. Like so many other North American unionids, the species has suffered severe declines and state-level extirpations in much of its former range in both Canada and the US, in parallel with the equally dramatic decline of its main fish hosts, the lake and shovelnose sturgeons. It has also suffered losses from the dreissenid invasion. Our three year unionid survey of the Champlain Sea lowlands area (a qualitative, informal sampling protocol) turned up some new occurrences of this rare species, the largest of which was found in the L'Assomption River, a Saint-Lawrence tributary North of Montreal. Only a few shell records where previously known from that watershed, prior to 2001. Preliminary searches have turned up some encouraging data concerning this newly discovered population besides its size, notably some obvious signs of strong and sustained recruitment rates. Deeper, main river channels, the preferred habitat of the species, have not yet been surveyed for these sites. This 'hiding in plain sight' discovery illustrates all too well the great gaps in unionid distribution still badly in need of filling in Quebec and South-Eastern Ontario. Additional sampling measures such as substrate and deep water searches should ideally be undertaken to properly evaluate the exact extent and density of this hickorynut mussel population, which could be among the largest and healthiest populations in North America.

Platform 3 - Brailing the Plantagenet Reach: Not catching anything where there may not be anything to catch

Frederick W. Schueler[1] and Ryan Robson[2]

[1]Fragile Inheritance Natural History, 4 St-Lawrence Street Bishops Mills, RR#2 Oxford Station, Ontario K0G 1T0. Email: bckcdb@istar.ca
[2]South Nation Conservation, 38 Victoria Street. P.O. Box 29, Finch, Ontario K0C 1K0. Email: RRobson@nation.on.ca

A brail is a frame that drags beads or hooks across the bottom of a waterbody, so that when Unionids clamp shut on a bead or hook they're jerked out of the substrate, and can be brought to the surface for exploitation or study. Fred had been suggesting that a brail was needed to sample the deep clayey water of the South Nation River since 2001, and when, in 2015, the Board of the South Nation Conservation [Authority] allocated funds for committee-initiated projects, Fred's suggestion that their project be the construction of a brail was accepted by the Fish & Wildlife Committee. The South Nation isn't a pool-and-riffle river, but, like many other rivers in Ontario & Quebec and across the prairies, has a bed made largely of glacially deposited silty clay, running in an alternation between deep reaches and limestone sills. Most of what happens in the river happens in the deep reaches, and the only way to sample them for Unionids is with a brail. Ryan took on the construction of the brail, basing it on internet descriptions and using material on hand. The brail was tried out in *Dreissena*-infested deep lower reaches of the river while doing the annual hoop-netting for fish in August, and the brail was run by us and Shaun Crook, on 8, 10, and 11 August. We'd found fresh *Potamilus* and *Leptodea* shells (one each) on the shore, but have no idea of the density of Unionids out in the stream. These sessions were about an hour long, conducted after the day's hoop-netting was done. On the first two days we went along pretty smoothly with the throttle at its lowest setting, using sonar to avoid obstacles, going 1.5-2.5 km/h, but we didn't catch anything except fishing gear. On the third day we tried to move more slowly by drifting with wind and current (no movement), slowly pulling in the brail by the rope, and then trying the trolling speed of the motor going upwind, 1.2 km/h, and we finally snagged a 2 metre branch coated with minute juveniles of *Dreissena polymorpha*. We concluded that we were not catching any Unionidae here and terminated the trials. The next step is to use the brail in a reach of the river where we know Unionids are abundant.

Platform 4 - Toronto Zoo and freshwater mussel conservation: five-year field study and public campaign

M.K. Whibbs and C. Lee

Toronto Zoo, Scarborough, ON. CAN. Email: mwhibbs@torontozoo.ca, clee@torontozoo.ca

For five years Toronto Zoo has actively conducted field surveys following systematic sampling methodology to document freshwater mussel populations in the inland tributaries of Lake Ontario. Concurrently, the Zoo has initiated and developed a dynamic public campaign called 'I am Important! I am Protected!' to promote awareness and conservation of native freshwater mussel species and support field research. Field surveys have yielded significant data including habitat features and water quality parameters as well as the presence of seven native mussel species in watersheds from Credit River in the west to Lynde Creek in the east and the Kawartha Lakes. Statistical analysis is underway on this five-year data set to establish a baseline of mussel population status in the region. Data collected through the newly launched *Clam Counter* app for iOS and Android English/French, developed in partnership with Fisheries and Oceans Canada, further supports field research into freshwater mussel distribution in Canada and is promoted through the Zoo's 'I am Important! I am Protected!' public campaign.

Download *Clam Counter* for free and bring your Android or Apple device to the meeting. Participants will be introduced to this bilingual field tool as we walk through key features of the app and highlight new features in the works for the 2018 field season.

Platform 5 - Historical (1880s) and Current communities of Native Freshwater Mussels in the Rideau River: an Anthropocene legacy of dams, urbanization, and invasive species

André L. Martel[1], Noel Alfonso[1], Arielle Vary-O'Neal[2], and Jacqueline B. Madill[1].

[1]Zoology Section, Malacology, Research and Collections, Canadian Museum of Nature, Gatineau, QC, & Ottawa, ON. Email: AMARTEL@mus-nature.ca
[2]Biology Department, University of Ottawa, Ottawa, ON.

Earliest records for native freshwater mussels of the Rideau River watershed deposited at the Canadian Museum of Nature date back to 1882. The first specimens were collected upstream of Rideau Falls in the then small town of Ottawa, formerly called Bytown, at the time of the Ottawa River timber trade. 15 unionid species based on museum records and modern field surveys point to the Rideau River watershed as the richest river system for unionid mussels in Eastern Ontario. Primary stressors impacting the unionid fauna, in chronological order, have been: dam and weir construction (canal), urbanisation, and invasive species. Most recently, the introduced zebra mussel (1990s) has contributed to the steep decline of the unionid fauna across the entire river system. Our team has annually followed the demography of this invasive mollusc along the river since its discovery in 1990 until 2015; this included measuring zebra mussel settlement on live unionid shells. We conducted the first detailed surveys of unionid mussels (time search and quadrat methods) in 1998-2001 before the zebra mussel severely impacted the unionid-rich riffle habitats located upstream. Since then, the zebra mussel has continued to spread, impacting not only deep-water impounded habitats but also the rich unionid communities in the shallow riffle habitats. The same unionid sites were re-examined in 2016. Unionid mussels have been nearly extirpated because of zebra

mussel fouling, with abundances at many locations declining by 90%. The remaining small populations of unionid mussels are primarily found in refugia areas, which are shallow habitats near or within macrophyte beds with suitable, mixed loose substrates, generally wetlands and connecting backwaters. Unionid refugia provide some hope for the long-term survival of native freshwater mussels in the Rideau River system.

Platform 6 - Exploring Ontario Nature's first riverine reserve: the Sydenham River Nature Reserve

Meg N. Sheldon**,** Kelly McNichols-O'Rourke, and Todd J. Morris

Fisheries and Oceans Canada, Burlington, ON, Canada, L7R 1A1. Email: margaret.sheldon@dfo-mpo.gc.ca

Officially launched in 2017 by Ontario Nature, the Sydenham River Nature Reserve is a 193 acre land area in southwestern Ontario which includes a 2.5 km stretch of the Sydenham River. Although the Sydenham River is well studied and the mussel community above and below the nature reserve is well documented, this specific reach had never been inventoried. A three day survey of the entire reach was completed by Fisheries and Oceans Canada in 2017 to assess the freshwater mussel community. The site was split into five 500 m long blocks, in which a 4.5 person-hour timed-search survey and 10 1 m^2 quadrat excavations were completed. A total of 1691 animals, representing 24 species, were observed during the surveys, including seven Species at Risk (SAR). A total of 1456 animals representing 21 species, including 128 SAR (8.8% of all individuals) of six species, were found during the timed-search surveys. An additional 235 animals were observed during the quadrat excavations of which 25% were SAR (60 individuals; six species). Mean overall site density of the reserve was 4.7 (± 0.68) mussels/m^2. While the abundances and densities observed were typical and expected of the Sydenham River, the variation in these estimates among the five blocks was higher than anticipated. Results of this intensive reach survey indicate that the "point survey" technique generally used in freshwater mussel surveys may be useful for calculating species presence and density estimates at a specific site; however it may not be possible to use these data to extrapolate accurate estimates of the mussel community in surrounding stretches of river. The "reach survey", while time consuming and limited by river access, provides a better understanding of reach variability as well as the freshwater mussel community throughout the river.

Platform 7 - A simplification of the St Clair delta Mussel fauna: What happened to our refuge?

Todd J. Morris[1], Kelly McNichols-O'Rourke[1], and Clint Jacobs[2]

[1]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON, Canada. Email: Todd.Morris@dfo-mpo.gc.ca, Kelly.McNichols-O'Rourke@dfo-mpo.gc.ca
[2]Walpole Island Heritage Centre, Walpole Island First Nation, Walpole, ON, Canada, Clint.Jacobs@wifn.org

Since 1999 the Canadian waters of the St. Clair delta have been known to possess a rich and diverse freshwater mussel fauna including many species which have since been listed under the Canadian *Species at Risk Act*. As these waters are found in the relatively undisturbed wetlands of Walpole Island First Nation it was hoped that they would act as refuge for many species from the impacts of dreissenids and other pollutants. In 2003, Environment Canada established a network of index monitoring sites within this area and these sites were resampled by Fisheries and Oceans Canada in 2011 and again in 2016 to investigate the status of this refuge. Sites were sampled by snorkelling along predefined transects until a mussel was detected. Once detected, the location was marked and a circular plot (65 m^2) was searched with the location of the animal at the centre of the plot. All animals were collected, identified, measured and all dreissenid mussels were enumerated and removed. Each transect was searched until 10 plots were assessed or until the transect reached the shore. Dreissenid burden (# of dreissend mussels/unionid) has declined steadily over the study period at all sites while unionid density (#/m^2) within the circular plots initially declined between 2003 and 2011 but has rebounded in 2016 to equal or exceed 2003 levels at most sites. However, unionids have become more patchy with the average number of plots/transect declining from 26 in 2003 to only 14 in 2016 resulting in an overall reduction in the number of unionids found within the study area from 814 in 2003 to 674 in 2016 (18% decline). Although overall species richness has remained relatively stable between 2003 (19 species) and 2016 (18 species) there has been a shift in dominance with *Lampsilis siliquoidea* representing 66% of all individuals in 2016 compared with only 33% in 2003. Four of the seven species at risk found in 2003 were not detected in 2016 calling into question the potential for the delta to act as an ongoing refuge for many species.

Platform 8 - Quagga and Zebra mussels of British Columbia

Lora Nield[1] and Marina Beck[2]

[1]Senior Ecosystems Biologist, Ministry of Forests, Lands, Natural Resource Operations and Rural Development. Email: Lora.Nield@gov.bc.ca
[2]Invasive Mussel Program Coordinator, Ministry of Environment.

In this presentation you will hear British Columbia's approach to managing for Quagga and Zebra Mussels including: status of mussel, high risk vectors for invasion, legal tools

implemented, and on the ground actions taken. In addition, L. Nield will present on the successes, challenges, and learnings from what has been done to date.

Platform 9 - Feeding in recently metamorphosed freshwater mussels

Josef D. Ackerman and Rakesh Mistry

Physical Ecology & Aquatic Science, Department of Integrative Biology, University of Guelph, Guelph, ON. CAN. Email: ackerman@uoguelph.ca

The early life history of unionid mussels is not well understood and our understanding of the factors that affect their feeding are limited. We examined the suspension feeding rates (i.e., clearance rates, CR) of *Chlorella vulgaris* by recently metamorphosed juvenile *Lampsilis siliquoidea*, *Lampsilis fasciola*, *Villosa iris*, and *Ligumia nasuta* under ecologically relevant flow conditions in a recirculating racetrack flow chamber system. The range of velocities examined was determined experimentally using a permeameter containing riverbed material (63 um to 6.5 cm diameter) in which juvenile mussels are thought to reside. The CR of the juvenile unionid species increased linearly with algal flux (flux = velocity x concentration) and with the age (or size) of the mussels. These results provide insight into potential threats to the growth and survival of unionid juveniles by factors that limit the concentration and/or velocity of porewaters upon which they feed. They also provide new insight into the feeding abilities of recently metamorphosed juvenile mussels, which will contribute to our understanding of their habitat requirements and assist in the conservation of this imperiled taxon.

Platform 10 - Effect of porewater flow on juvenile unionid feeding

Victor Fung and Josef D. Ackerman

Physical Ecology & Aquatic Science, Department of Integrative Biology, University of Guelph, Guelph, ON. CAN. Email: vfung@uoguelph.ca

There is a need to understand the early life history of endangered unionid mussels, such as nutritional requirements, to develop conservation and restoration strategies. In particular, we do not know what juvenile mussels feed on in their natural habitats. We exposed recently metamorphosed juvenile *Lampsilis siliquoidea* (3–4 weeks old) to interstitial water and river water in a racetrack flow chamber under different ecologically relevant flux conditions to examine the effect of algal flux on selective feeding. Interstitial water was collected through piezometers installed in the river bed where juvenile mussels reside. Mussel clearance rates (CR) were measured through a calibrated fluorometer and flow cytometry was used to determine specific algal taxa CR. Mussel CR increased with algal flux in both interstitial and river water, but CR in interstitial waters were higher. Differences between clearance rate may be due to differences in algal composition and particle concentration in river and interstitial waters.

Ultimately, this study should provide information on suitable potential reintroduction sites with algal taxa and flow conditions required by juvenile unionid mussels.

Platform 11 - Selective feeding of freshwater mussels: implications for resource partitioning

Katherine Tran and Josef D. Ackerman

Physical Ecology & Aquatic Science, Department of Integrative Biology, University of Guelph, Guelph, ON. CAN. Email: ktran13@uoguelph.ca

The feeding of three co-occurring freshwater mussel species (*Ptychobranchus fasciolaris, Quadrula quadrula* and *Potamilus alatus*) in the Sydenham River at Florence, ON was examined under static and ecologically relevant flow conditions. Experiments were designed to examine the change in algal composition (clearance rate (CR) and feeding electivity) following a feeding experiment in a recirculating flow chamber and an aerated tank to determine whether (1) the *CR* of mussel species will vary under different flow conditions and (2) if co-existing mussels feed selectively and/or partition algal resources. The *CR* calculated based on the change in chlorophyll *a* concentration revealed differences in the feeding ability between mussel species where *P. alatus* had a significantly higher *CR* than *Q. quadrula.* Water samples collected at the beginning and end of each feeding experiment were analyzed using the flow cytometer and 9 algal taxa were identified in the river water. Higher feeding was observed under flowing conditions across all the mussel species examined using natural seston from a turbid river. High *CR* was also found for some algal taxa, where higher feeding was observed on four of the nine algal taxa under flowing conditions. All three mussel species selected for larger particles within a 28-35 µm size fraction, while rejecting smaller particles (12-19 µm). While mussels did not appear to partition resources by size, there was evidence that different mussel species are capable of selectively feeding on different algal species. This study suggests that the maintenance of mussel diversity within the same river may be facilitated by resource partitioning, and also raises questions about conclusions from static testing.

Platform 12 - Is the clearance rate response to increased total suspended solids plastic in juvenile unionids?

Shaylah Tuttle-Raycraft and Josef D. Ackerman

Physical Ecology & Aquatic Science, Department of Integrative Biology, University of Guelph, Guelph, ON. CAN. Email: stuttle@uoguelph.ca

The relationship between total suspended solids (TSS) and suspension feeding is complex. Recently, the effect of TSS on adult unionid clearance rate (CR) and gills were found to vary with the source population of the mussels. The source of this variation

may be related to the TSS concentrations of the source rivers, however the mechanism (i.e. genetic vs. phenotypic plasticity) is unknown. Juvenile *Lampsilis siliquoidea* from the Thames River were transformed in the laboratory and maintained in river water on shaker tables. Half of the mussels also had river sediment (50 mg L^{-1}; 0-63 µm) added to the water. At 4-weeks old, juveniles were placed into the wells of a 12-well cell culture plate for one hour, in one of six TSS treatments (0 – 25 mg L^{-1}) and CR were calculated and compared. Although both rearing groups experienced monotonic decreases in CR as TSS concentration increased, the river water + TSS group was less affected. Specifically, the CR was higher than the control (i.e., water only) group in all TSS concentrations except the no sediment control (0 mg L^{-1}). Understanding if the response to TSS is plastic, at least during early stages of juvenile development, has implications for mussel relocation and reintroduction. These preliminary results suggest that the conditions of the intended reintroduction site should be included in propagation strategies.

Platform 13 - The Sins of the Father: Multi-generational effects of copper on the freshwater snail *Planorbella pilsbryi*

R.K. Osborne [1], P.L. Gillis[2], R.S. Prosser[3], and D. Bowes[3]

[1]*University of Waterloo, Department of Biology, Waterloo, ON, Canada. Email: rkosborne@edu.uwaterloo.ca*
[2]*Environment and Climate Change Canada, Aquatic Contaminants Research Division, Burlington, ON*
[3]*University of Guelph, School of Environmental Sciences, Guelph, ON*

Traditional toxicological testing can be limited to assessing the risk posed to an organism at only one life stage or portion of its life cycle, and tend to only assess the immediate, observable effects caused during exposure. This can be due to the time and resources required to maintain an exposure through a full life cycle, especially for larger or long-lived organisms. In order to better understand whether these partial-life span tests are representative of long term and population scale effects of chronic contaminant exposure, we used the freshwater snail *Planorbella pilsbryi* to conduct a two-generation study on the effects of copper in a pulse exposure scenario. The test involved an initial seven day exposure of the parent generation to sub-lethal Cu concentrations, followed by allowing exposed parents to lay eggs in clean water. Eggs were then allowed to hatch and develop in clean water, and the resulting juvenile snails were exposed to Cu for 72 hours to establish an acute Cu LC50 for juveniles hatched from each original parent treatment. By comparing the LC50s, we determined that the level of parental Cu exposure influenced the sensitivity of naïve first generation juveniles to Cu. Our study found that the LC50 for Cu of naïve juveniles laid by non-exposed parents, 29.25 ug/L Cu 95%CI [22.17-36.32 ug/L Cu], was significantly higher than the LC50 of naïve juveniles born to parents who were exposed to copper, 11.57 ug/L Cu 95%CI [3.71-19.43 ug/L Cu]. In addition to copper sensitivity, several other sub-lethal endpoints were monitored (such as egg mass production, egg viability, and time

to hatching) but none were significantly influenced by parental exposure to copper. These results suggest that despite minimal difference in parent reproduction and first generation development, parental exposure caused increased sensitivity of the first naïve generation of juveniles and supports continual investigation of multi-generational toxicity studies with snails for use in risk assessment.

Platform 14 - Assessing the toxicity and risk of salt-impacted winter road runoff to the early life stages of freshwater mussels

Patricia Gillis[1], Quintin Rochfort[1], Kirsten Exall[1], Rodney McInnis[1], and Ryan Prosser[2]

[1]Aquatic Contaminants Research Division, Water Science and Technology Directorate, Environment and Climate Change Canada, Burlington, ON, Canada. Email: patty.gillis@canada.ca
[2]School of Environmental Sciences, University of Guelph, Guelph, ON

In temperate regions where road salting is used for winter road maintenance, the level of chloride in surface waters has been increasing. This is a concern for freshwater mussels, because many species, including Species at Risk have ranges limited to southern Ontario, Canada's most road-dense region. While early-life stage freshwater mussels are known to be sensitive to salt, the toxicity of winter road runoff had not been examined. This study examined the acute toxicity of winter road runoff (14,400 mg Cl/L) to glochidia and newly-released juvenile mussels. To characterize responses in different receiving environments, acute sensitivity was examined in waters of different hardness. The effect of chronic exposure (28 d) to runoff was also assessed using 7-12 month old mussels. The 48-h EC50s for *Lampsilis fasciola* glochidia exposed to road run-off dilutions were similar in moderately hard (~100 mg $CaCO_3$/L; EC50 7.8% runoff, 1177 mg Cl/L) and very hard synthetic water (~250 mg $CaCO_3$/L; EC50 7.0% runoff, 1032 mg Cl/L). The 96-h EC50s for <1 week old *L. siliquoidea* were 13.8% runoff (2276 mg Cl/L) in moderately hard water and 20% runoff (3159 mg Cl/L) in very hard water. These effect concentrations correspond with previously reported chloride toxicity, indicating that chloride is likely the driver of toxicity in road-runoff rather than other compounds (metals, PAHs). The 28 day LC50 for 7-12 month old mussels was 10.6% runoff (1810 mg Cl/L) in moderately hard water. Toxicity data from the current study, the literature, and concentrations of chloride in ON surface waters were used to conduct a probabilistic risk assessment of chloride to mussels. The assessment indicated that acute toxicity of mussel early-life stages during April-November is unlikely to occur, however there is a lack of data for the winter months when the majority of salt-impacted road runoff occurs. In addition, the risk assessment exercise revealed that chronic exposure to elevated chloride could pose a risk to juvenile mussels and that further investigation is warranted to ensure that these sensitive organisms are protected.

Platform 15 - Risk posed by pesticides to native freshwater mussels in the Great Lakes basin

Joseph Salerno[1], Emily Holman[2], Patricia Gillis[2], Paul Sibley[1], and Ryan Prosser[1].

[1]*School of Environmental Sciences, University of Guelph, Guelph, ON, Canada. Email: joseph.salerno@canada.ca*
[2]*Aquatic Contaminants Research Division, Environment and Climate Change Canada, Burlington, ON.*

Canada supports 55 of the approximately 300 Unionidae species found in North America, with 40 species found within the Great Lakes Basin. Freshwater mussels contribute important ecological functions to aquatic systems. The water filtered by mussel assemblages can contribute to improved water quality and the filtered material deposited in sediment provides a link between pelagic and benthic food webs. In addition, mixing of sediments by burrowing mussels can improve oxygen content and release nutrients. However, nearly 70% of global freshwater mussel species are listed as either endangered, threatened, or in decline. In Ontario, 28 species are in decline or in need of protection. Even though freshwater mussels are considered extremely sensitive to contaminants, little is known about the risk pesticides pose to the most sensitive life stage: glochidia. *Villosa iris*, rainbow mussel, is currently listed as "endangered" under the Species at Risk Act. A potential risk to the recovery of freshwater mussel species is the presence and persistence of pesticides in the Great Lakes Basin. Acute (48 h) toxicity tests were performed with *Villosa iris* glochidia to determine the effect on viability following exposure to azoxystrobin, boscalid, metalaxyl, myclobutanil, carbaryl, clothianidin, imidacloprid, thiamethoxam, malathion, chlorpyrifos, flupyradifurone, and cypermethrin. The study found that glochidia were relatively insensitive to the pesticides tested and LC_{50}s ranged from 594 to >17400 ug/L. All neonicotinoid LC_{50}s were greater than the highest concentration tested. The pesticides tested likely represent a *de minimis* risk to the viability of glochidia in Ontario streams where pesticide concentrations were considerably lower than those tested in this study.

Platform 16 - Facultative parasitic ciliated protozoa, *Tetrahymena glochidiophila*, influences glochidia viability in freshwater mussels

Ryan Prosser [1], Joseph Salerno [2], Jim Bennett [1], Denis Lynn [3], and Patty Gillis [1]

[1]*Aquatic Contaminants Research Division, Environment and Climate Change Canada, Burlington, ON, Canada. Email: prosserr@uoguelph.ca*
[2]*School of Environmental Sciences, Guelph, ON*
[3]*Department of Zoology, University of British Columbia, Vancouver, BC, Canada*

A number of studies have documented species of ciliated protozoa residing in the mantle cavity of freshwater mussels (e.g., *Conchophthirus* sp., *Trichodina* sp.). Cilizated protozoa have even been found living in the gill water tubes of mussels (*Conchophthirus acuminatus*). These previous studies have described the relationship between the

ciliated protozoa and mussels as mainly commensal. When performing toxicity tests with the glochidia from fatmucket mussel (*Lampsilis siliquoidea*) from Missouri, we observed the presence of a ciliated protozoan. These mussels were cultured in the laboratory and then moved to a pond as juveniles to develop into adults. The presences of protozoa seemed to coincide with a rapid decrease in the viability of glochidia (i.e., ≤ 24 h). A series of experiments were performed to determine whether the presence of the protozoan was the cause of the decline in glochidia viability. Glochidia were removed from the cultured fatmucket mussels, and plain pocketbook (*Lampsilis cardium*) and wavy-rayed lampmussel (*Lampsilis fasciola*) mussels collected from the wild in Ontario, Canada. The glochidia were examined under the microscope for the presence of the protozoa. The protozoa were only observed in the glochidia of fatmucket mussels. The glochidia of the three species had a viability of > 90% at 0 h. Pocketbook and wavy-rayed lampmussel glochidia were infected with protozoa from the fatmucket glochidia. The mean viability of pocketbook and wavy-rayed lampmussel glochidia not infected remained ≥ 89% after 72 h of incubation. The mean viability of fatmucket, pocketbook, and wavy-rayed lampmussel glochidia infected with protozoa declined to 17.9, 4.1, and 9.6%, respectively, after 72 h. The cell density of protozoa with the infected glochidia increased significantly over ~48 h of incubation and then declined as the viability of glochidia decreased below ~25%. Initial analysis of the protozoan DNA indicates that the protozoa belong to the genus *Tetrahymena*.

Platform 17 - The effects of the Mactaquac Hydro Generating Station on Freshwater Mussel Assemblages in the St. John River, New Brunswick

Emma Lippert

Canadian Rivers Institute/Department of Biology. University of New Brunswick, PO Box 4400 Fredericton, NB, Canada, E3B 5A3. Email: emmalippert9@gmail.com

At approximately 675km long, the St. John River is located primarily in the province of New Brunswick, but also flows through the province of Quebec and the US state of Maine. There are over two hundred dams or water control structures within the St. John River basin. There are three major dams on the main stem – Grand Falls Generating Station, Beechwood Dam, and the Mactaquac Hydro Generating Station. The Mactaquac Aquatic Ecosystem Study (MAES) is a multi-year study organized by the Canadian Rivers Institute to assist NB Power in making science-based decisions and management plans related to the refurbishment of the Mactaquac Hydro Generating Station, the largest of the impoundments within the St. John River Basin. There are ten freshwater mussel species that appear in the St. John River, and yet very little research has been done on their populations. Baseline population and habitat data still need to be established. A better look at the effects of the three main dams on mussel assemblages will provide better insight into the health and status of the St. John River mussels as well as a starting point for further research.

Platform 18 - Fantastic Beasts and Where to Find Them: Mussel surveys, caging, and wastewater in the grand river

Bennett, C.J.[1], Salerno, J.[1], Hayward,.E[2], Prosser, R.S.[1], Khan, H.[1], Burton, E.[1], James, S.[2], Rochfort, Q.[1], Leadbetter, A.[1], Metcalfe, C.[2], and Gillis, P.[1]

[1]Aquatic Contaminants Research Division, Environment and Climate Change Canada, Burlington, ON. Email: jim.bennett@canada.ca
[2]Trent University, Peterborough, ON, Canada

The Grand River watershed in southern Ontario has historically supported a diverse and abundant community of freshwater mussels however recent studies have shown that mussel diversity has declined in this watershed. Although a number of factors are believed to be responsible for the decline of freshwater mussels worldwide, environmental pollution is considered to be one of the key contributing factors. In the central Grand River, the distribution of mussels, including Species at Risk (SAR) has been shown to be directly impacted by urbanization, including the effluents from wastewater treatment plants. The current study investigated whether a primary (lagoon) wastewater treatment plant on a tributary of the Grand River is affecting freshwater mussels downstream of the lagoon discharge. The goals of this study were to assess the numbers and diversity of the freshwater mussel population upstream and downstream of the wastewater lagoon and to determine whether surface water at sites along the Grand River and tributary were of sufficient quality to support early life stages of freshwater mussels, as well as adult mussel health and survival. Mussel populations at six sites on the Grand River and three on the tributary were assessed using timed visual searches. A total of 18 species of live freshwater mussels including three SARs (*Villosa iris*, *Quadrula quadrula*, *Pleurobema sintoxia*) were found. To assess the effects of treated wastewater on mussel health and survival, adult *Lasmigona costata* was caged (i.e. deployed) upstream and downstream during the lagoon release. The caging study will be completed in early November 2017 and will be followed by analyses of biomarkers of stress and bioaccumulation of contaminants in the exposed mussels. The impact of wastewater on glochidia was assessed by conducting acute (48 h) toxicity tests with diluted wastewater and undiluted surface water collected at the caging sites.

Platform 19 - Environmental DNA (eDNA) is as sensitive as quadrat sampling for detection of unionid species at-risk

C. A. Currier[1], T. Morris[1], C. Wilson[2], and J. Freeland[3]

[1]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, L7S 1A1. Email: charisecurrier@trentu.ca
[2]Ontario Ministry of Natural Resources and Forestry, Peterborough, ON, K9L 1Z8
[3]Department of Biology, Trent University, Peterborough, ON, K9L 0G2

Increasingly, environmental DNA (eDNA) tools are being developed to infer species presence from analysis of bulk samples, such as water. As the popularity of the method

grows, it becomes increasingly important to assess the strengths and limitations of eDNA detection. Detection probabilities can vary with target abundance or biomass, sampling design, life history characteristics, and environmental conditions. Although studies have shown eDNA to be effective for the detection of species-at-risk, work to evaluate the efficacy of eDNA for the detection of bivalves has been sparse. In this study, we developed, validated, and field tested species-specific markers for four freshwater pearly mussels (Unionidae). Field sampling was conducted at established mussel monitoring sites and wetlands with suspected target species occurrences in southern Ontario; species detections from eDNA and quadrats were compared to assess the efficacy and sensitivity of the eDNA tools relative to traditional sampling. The impacts of sampling depth and population density on eDNA detection probability were tested. Target species eDNA was detected at all sites where individuals had previously been identified from quadrat sampling; in addition, two species were detected at previously undocumented sites using eDNA. High species specificity of eDNA assays was achieved despite many sympatric confamilials. eDNA abundance correlated weakly with target species density, but water sampling depth had no effect on detection probabilities. Because of its low cost and high sensitivity, eDNA could complement traditional sampling by informing sampling design and increasing detection sensitivity. eDNA sampling has the potential to improve our knowledge of species distributions and population status through increased sampling sensitivity and coverage.

Platform 20 - Conservation genetics of North American *Margaritifera margaritifera* (bivalvia: Unionida: Margaritiferidae).

David T. Zanatta[1], Bernhard C. Stoeckle[2], Kentaro Inoue[3], Annie Paquet[4], André Martel[5], Ralph Kuehn[6], and Jürgen Geist[2]

[1] Department of Biology, Central Michigan University, Mount Pleasant, MI. 48859 USA. Email: zanat1d@cmich.edu
[2]Aquatic Systems Biology Unit, Department of Ecology and Ecosystem Management, Technical University of Munich, D-85354 Freising, Germany
[3]Institute of Renewable Natural Resources, Texas A&M University, College Station, TX 77843 U.S.A.
[4]Ministère des Forêts, de la Faune et des Parcs, Québec, QC G1S 4X4 Canada
[5]Malacology Unit, Research and Collections, Canadian Museum of Nature, Ottawa, ON K1P 6P4 Canada
[6]Unit of Molecular Zoology, Chair of Zoology, Department of Ecology and Ecosystem Management, Technical University of Munich, D-85354 Freising, Germany

Understanding the current genetic diversity and population genetic structure of imperiled species is necessary in order to characterize and evaluate population performance and persistence, which can guide management decisions. *Margaritifera margaritifera* (freshwater pearl mussel) occurs across western Russia, north and central Europe, and Atlantic drainages of northeastern North America (NA). Because of severe declines in many European populations, the IUCN has listed *M. margaritifera* as

Endangered, conversely NA populations are thought to be relatively secure. As such, the population genetics of *M. margaritifera* occurring in European rivers is relatively well studied while the population genetic structure of NA populations is not known. In this study, we investigated the genetic diversity and differentiation from 23 collection locations of *M. margaritifera* (645 individuals) from drainages of the Atlantic Ocean and the Gulf of Saint Lawrence in Canada and the U.S.A. Genetic diversity of NA populations calculated from nine microsatellite loci was relatively high. Mean allelic richness ranged from 2.87 to 3.71 alleles per locus, mean observed heterozygosity ranged from 0.40 to 0.59, and mean expected heterozygosity ranged from 0.45 to 0.60. Analyses of genetic structure indicated that a single panmictic population exists for North American *M. margaritifera*. Genetic differentiation (F_{ST}) among NA sampling locations was low at 0.033 with little evidence of isolation-by-distance. However, there was some evidence of substructure in some tributaries of the St. Lawrence River in Québec, Canada. In contrast to most European populations, the NA population of *M. margaritifera* has lower genetic differentiation and greater diversity, possibly indicative of fewer recent genetic bottlenecks and drift effects. Such information is essential for further evaluating the conservation status of North American *M. margaritifera*. Conservation efforts should incorporate knowledge gained from population genetic studies in order to successfully maintain genetic variation and ensure the evolutionary potential of imperiled species.

Platform 21 - Population structure, genetic diversity, and colonization history of the Eastern Pondmussel, *Ligumia nasuta*, in the Great Lakes drainage

Mariah W. Scott[1], Todd J. Morris[2], and David T. Zanatta[1]

[1]Department of Biology, Institute for Great Lakes Research, Central Michigan University, Mount Pleasant, MI. USA. Email: mariahwscott@gmail.com
[2]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON, Canada

The freshwater Eastern Pondmussel, *Ligumia nasuta*, has declined over the last few decades in abundance and distribution. Declines are likely the result of infestation by invasive dreissenid mussels and changes in habitat. The species is now considered imperiled across large portions of its distribution, especially in the Great Lakes region. In this study, the genetic diversity and structure of the remnant populations in the Great Lakes region were assessed using newly developed microsatellite DNA loci for *L. nasuta*. This understanding of remaining populations can inform future management projects and determine if the remnant populations have experienced a genetic bottleneck or founder effect. Emphasizing the Great Lakes region, samples (n=399) from 58 collection sites in 26 waterbodies were included in this study. Across this distribution of *L. nasuta*, eleven genetic populations were identified, with significant genetic differentiation among them. Genetic structure of the species was assessed, as genetic similarities among populations were compared and geographic routes of colonization and gene flow were evaluated. The Lake Erie drainage appeared to be the

initial colonization point from the Atlantic coast. The Great Lakes region represented a series of sequential colonization events from Lake Erie to the other Great Lakes proper and then to their respective inland lakes. Colonization events generally followed a pattern of loss of allelic richness and showed a lack of private alleles. Analyses found evidence of inbreeding in all but one population and evidence of past genetic bottlenecks or strong founder effects in all but four populations. This study deepens the understanding of the genetic past and present of this imperiled species.

Platform 22 - Evaluating research progress for freshwater species at risk in the Great Lakes-St. Lawrence river basin, 2004 – 2016

Drake, D.A.R.[1], Thiessen, K.E.[1], Morris, T.J.[1], Koops, M.A.[1], Pratt, T.C.[2], Reid, S.M.[3], and Mandrak, N.E.[4]

[1]Central and Arctic Region, Fisheries and Oceans Canada, Burlington, ON, L7S 1A1.Email: Andrew.Drake@dfo-mpo.gc.ca
[2]Central and Arctic Region, Fisheries and Oceans Canada, Sault Ste. Marie, ON, P6A 2E5
[3]Aquatic Research and Monitoring Section, Ontario Ministry of Natural Resources and Forestry, Peterborough, ON, K9J 7B8
[4]University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C 1A3

The Great Lakes-St. Lawrence River basin encompasses <4% of Canada's drainage area, but contains 52% of Canada's SARA-listed freshwater mussels - 10 species listed as EN, THR, or SC, plus 5 species assessed by COSEWIC, and 36% of Canada's SARA-listed freshwater fishes - 24 species as EN, THR, or SC, plus 12 species assessed by COSEWIC. Listed freshwater fishes and mussels occupy diverse ecosystems and habitat types, including deepwater and nearshore zones within large lakes; coastal wetlands and embayments; inland lakes and ponds; small and large tributary streams; and, other managed waterbodies (e.g., dyked wetlands, agricultural drains, canals, and channels). Species threats are equally diverse, encompassing biotic and abiotic effects at multiple spatial and temporal scales (e.g., altered flow regimes, landcover conversion, aquatic invasive species, agricultural effects). Given the conservation significance of the GLSLRB, we conducted a review of research progress for imperiled freshwater mussels and fishes to understand core research accomplishments – and outstanding research gaps – in the 15 years since the implementation of SARA. Research progress was evaluated based on a four-group classification scheme (population ecology, habitat science, threat science, and recovery science) and a five-point scoring system (1 = research not initiated through 5 = research complete). An expert workshop provided opportunities to identify new technologies to address key gaps. Results indicated that progress for both freshwater mussels and fishes has been greatest for population ecology and habitat science (mean scores, 2.85 and 2.50 out of 5), with certain sub-groups experiencing strong success (population ecology: genetic structure, species abundance, and species distribution research, 3.18, 3.14, and 3.0 respectively; habitat science: determining the distribution and abundance

of host species; 3.8). Threat science was less well studied (2.23), while recovery science (1.89) had prominent gaps related to captive breeding, experimental translocations, and related work (e.g., identifying candidate sites for reintroduction). Implications of the review include a renewed interest in threat- and recovery-based science for imperiled aquatic taxa in Canada, including the development of dose-response thresholds for key stressors and research to support species reintroductions. Moreover, results highlight the need for new experimental approaches to address key conservation challenges, such as experimental populations to evaluate threats that are difficult to observe in the wild.

Platform 23 - Can Adaptive Cluster Sampling Improve Ontario Mussel Species at Risk Monitoring?

Scott M. Reid[1], Anita LeBaron[1], and Todd J. Morris[2]

[1]Aquatic Research and Monitoring Section, Ontario Ministry of Natural Resources and Forestry, Trent University – DNA Building, 2140 East Bank Drive, Peterborough, Ontario, CANADA K9J 7B8. Email: reid.scott@ontario.ca
[2]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada

Watershed inventories and population monitoring are essential components of efforts to conserve and recover freshwater mussel diversity. Since 2002, a quadrat-based sampling protocol has been used to monitor the status, distribution, and demographics of mussel species at risk in southern Ontario rivers. However, low population densities, typical of most mussel species at risk, limit the effectiveness of the current protocol to support monitoring objectives. In this study, simulation-based methods (computer program SAMPLE) were used to evaluate whether adaptive clustering sampling could improve single-species monitoring. Census data for eight mussel species (including three species at risk) collected from two sites (Rawdon Creek and Sydenham River) with contrasting mussel assemblages were used. Sampling design performance was assessed based on the accuracy of density and occupancy estimates and sampling efficiency, over a gradient of increasing sampling effort. In all cases, adaptive sampling was less accurate and efficient than simple random sampling or systematic sampling with random starts. Improvements to the monitoring program will only be achieved by increasing the spatial coverage of the existing systematic sampling design.

Platform 24 - A meta-analysis of the relationship between habitat condition and mortality in freshwater molluscs and fishes

Georgina V. Braoudakis, Dominique E. Lebrun, D. Andrew R. Drake, Marten A. Koops, Robert G. Randall, and Todd J. Morris

Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, Ontario. Email: georgina.braoudakis@dfo-mpo.gc.ca, dominique.lebrun@dfo-mpo.gc.ca

Habitat condition can affect the productivity of freshwater species through its effect on demographic processes, such as mortality, growth, fecundity, and migration. However, there is often a lack of information on the nature of relationships between habitat drivers (e.g., dissolved oxygen concentration; extent of structure and cover) and demographic factors, making it difficult to understand the range of expected population responses due to habitat change. Moreover, when driver-response relationships are derived, they are often assumed to be linear, which can be at odds with expectations under ecological theory. Meta-analysis can be used to draw broad conclusions about driver-response relationships across a variety of species and ecosystems. In the absence of species or system specific information, general relationships derived using meta-analytical methods can increase our understanding of population responses to habitat change and inform management decision-making (e.g., extent of habitat necessary to achieve population objectives). To this end, we conducted a literature review of relevant observational, experimental and modelling studies, focusing on freshwater molluscs and fishes. From each relevant study, we extracted species-habitat information, and evaluated whether driver-response relationships were linear, non-linear, or non-significant, and the distribution of response types among classes of habitat drivers. We also noted co-variates affecting the prevalence of non-linearity in each study (e.g., sample size). We will present preliminary results of the literature review component of the mussel meta-analysis (e.g., number and type of relevant studies for each habitat variable). We will then present results of the fish meta-analysis, including the number relationships classified as linear, non-linear or not significant, and the distribution of these response types among habitat drivers.

Platform 25 - Outcomes of the Mussel Relocations and Monitoring Events

Gina MacVeigh

Natural Resource Solutions Inc. 225 Labrador Dr. Unit 1, Waterloo, ON N2K 4M8. Email: gmacveigh@nrsi.on.ca

Natural Resource Solutions Inc. has completed numerous relocations using the Protocol for the detection and relocation of freshwater mussels and the subsequent monitoring that occurs afterwards. Through these relocations and monitoring events we have

learned some lessons and questions have arose that we feel others may be interested to know about. The majority of the relocations have been driven by Wavy-rayed Lampmussel within the Grand River.

Platform 26 - An Update of Fish Culture Sections Efforts to Culture 'At Risk" Mussels

Christopher Wilson and Kevin Loftus

Ontario Ministry of Natural Resources and Forestry, Fish Culture Section. Email: christopher.wilson@ontario.ca, kevin.loftus@ontario.ca

This presentation will provide an update of MNRF Fish Culture Section's ongoing efforts to develop expertise in the propagation of 'at risk' mussels through the application and/or refinement of techniques developed by others and to develop an understanding of the associated infrastructure and operational (including labour) requirements. It will include: (1) a brief summary of progress to date with each of the four 'at risk' species; (2) a description of our 2017 program including efforts to improve the near-term survival of juvenile Snuffbox following drop-off; (3) a description of our efforts to improve the long-term survival of all of the mussel species under our care; (4) a discussion of the different culture systems that we are using, including mucket buckets, sediment pans, tubwellers, flupsys, subsy bubblers, and a variety of artificial steam (or river trough) systems; and (5) plans for the future.

Platform 27 - Implementation of Brook Floater (*Alasmidonta varicosa*) conservation measures in Canada

Fabiola Akaishi[1], Ree Brennin Houston[2], Mary Sollows[3], Donald McAlpine[3], Francis LeBlanc[1], and Nellie Gagné[1]

[1]*Department of Fisheries and Oceans (DFO)-Gulf Region, 343 Université Avenue, Moncton, NB E1C 9B6. Email: Fabiola.Akaishi@dfo-mpo.gc.ca*
[2]*Department of Fisheries and Oceans-Maritimes Region, Bedford Institute of Oceanography, 1 Challenger Dr., Dartmouth, NS B2Y 4A2*
[3]*New Brunswick Museum, 277 Douglas Ave., Saint John, NB E2K 1E5*

The Brook Floater (*Alasmidonta varicosa*) was added to Schedule 1 of the *Species at Risk Act* as Special Concern in 2013. At the 2016 Canadian Freshwater Mussel meeting an update on biological information currently available on the Brook Floater and an overview of conservation efforts and measures identified in the Draft Brook Floater Management Plan were presented. Here, we review progress made towards implementing conservation measures for Brook Floater.

Conservation and Indigenous groups in New Brunswick (NB) and Nova Scotia (NS) have been working on projects targeting the Brook Floater funded by the Species at

Risk Habitat Stewardship and Aboriginal Fund for Species at Risk Programs. Their efforts have documented new locations of occurrences and have fostered stewardship initiatives and public awareness of this relatively little known species. Gathering of Indigenous Knowledge on Brook Floater is also a key aspect for the project led by the Indigenous group. To improve survey effort, DFO-Gulf Science team, in collaboration with indigenous and conservation groups, received funding from the Genomic Research & Development Initiative to explore the use of e-DNA to detect the presence of Brook Floater in NB watersheds. In addition, an initiative between the New Brunswick Museum and DFO led to the delivery of two freshwater mussel identification workshops to indigenous and conservation groups helping them to build capacity in developing freshwater mussel studies. The focus of these workshops was on the Brook Floater, and a second Schedule 1 species, the Yellow Lampmussel (*Lampsilis cariosa*)..

This presentation offers an update on the continuing efforts of indigenous and conservation groups in monitoring and maintaining the Brook Floater and its habitat in NB and NS, as well as provide an overview of recent initiatives (e.g., the use of e-DNA to detect Brook Floater in watersheds of NB), the freshwater mussel identification workshop, and upcoming studies.

Platform 28 - Federal recovery planning, information gaps, and outreach for aquatic (fish/mussel) species at risk in Ontario

Amy Boyko and Shelly Dunn

Species at Risk Branch, Fisheries and Oceans Canada, Burlington, ON. CAN. Email: amy.boyko@dfo-mpo.gc.ca, shelly.dunn@dfo-mpo.gc.ca

There are currently 11 freshwater mussels listed on Schedule 1 of the *Species at Risk Act* (SARA) in the province of Ontario with four others under consideration for listing. The Species at Risk Program (SARP) has drafted recovery strategies for Threatened and Endangered species, which include the identification of critical habitat (CH). Management plans have been drafted or are in the process of being developed for Special Concern species. Research needs and information gaps, many of which are consistent with at risk mussels listed under Ontario's *Endangered Species Act*, have been identified in these recovery documents. Some information gaps include a lack of information on population distribution and structure, habitat requirements for various life stages, sensitivity of glochidia and juveniles to environmental contaminants, host fish confirmation, and methods for assessment and critical habitat identification in large, deep, river systems.

DFO species at risk outreach with potentially affected groups, agencies, industries, educators, and collaborators is adapted annually in response to current or emerging issues and new or proposed CH. Some funding programs that may be accessed to fill information gaps and implement recovery documents are also highlighted. DFO continues to explore a variety of outreach approaches to reach relevant stakeholders.

Platform 29 - Guidance for Freshwater Mussels in the Okanagan

Lora Nield[1] and Greg Wilson[2]

[1]*Senior Ecosystems Biologist, Ministry of Forests, Lands, Natural Resource Operations and Rural Development. Email: Lora.Nield@gov.bc.ca*
[2]*Aquatic Species at Risk Specialist, Ministry of Environment. Email: Greg.Wilson@gov.bc.ca*

This document has been prepared by Lora Nield and Greg Wilson by utilizing the existing guidance provided in the *Protocol for the Detection and Relocation of Freshwater Mussels Species at Risk in Ontario-Great Lakes Area (OGLA)* by G. Mackie, T. Morris, and D. Ming, 2008. Without that document this would not have been possible as it is key methodology used for this version with only slight modifications made to address the local management concerns and habitats.

This document is intended to provide advice to qualified professionals (QP) undertaking freshwater mussel surveys and relocations within the Thompson-Okanagan area. Freshwater mussels are among the most imperiled groups of organisms in the world (*Metcalfe-Smith and Cudmore-Vokey 2004;* Strayer et al., 2004; Lydeard et al., 2004), with only four to seven species in B.C (Gelling 2008, Nedeau 2009). There is currently one mussel species, Rocky Mountain Ridged Mussel (*Gonidea angulate*), that is listed as at-risk by the federal Species at Risk Act (SARA), and by the provincial government (Red Listed). The scope of this document is focused on action needed for Rocky Mountain Ridged Mussel conservation. If other mussel species are detected at a project site this document can be used as guidance; however, the level of mitigation required may be different depending on the species conservation status.

POSTER ABSTRACT

Poster - UNDERSTANDING HOST FISH AND HABITAT REQUIREMENT HELPS TO LOCATE A VAST POPULATION OF THE RARE HICKORYNUT MUSSEL (UNIONIDAE) IN THE OTTAWA RIVER

André L. Martel and Jacqueline B. Madill

[1]*Zoology Section, Research and Collections, Canadian Museum of Nature, Ottawa, ON, K1P 6P4. Email: AMARTEL@mus-nature.ca*

The Hickorynut mussel, *Obovaria olivaria*, is one of 55 Canadian native freshwater mussel species. It prefers deep-water habitats with strong water currents and occurs in only six rivers nationwide (status: Endangered). In Canada, the known host fish is the Lake Sturgeon, *Acipenser fulvescens*. The Ottawa River watershed has a rich freshwater mussel fauna with 21 species. Museum records point to this river as a prime

location for Hickorynut populations. The goal of this study was to demonstrate that by locating the best host fish habitat, and aligning such information with habitat preferences of the Hickorynut, we would be able to find a healthy population of this rare freshwater mussel. The Finlay Island Ecological Reserve area, in the Lac Coulonge reach of the Ottawa River, was identified as ideal for sturgeon and presumably for the Hickorynut. SCUBA diving surveys revealed the presence of 5 species of mussels with the Hickorynut being the second most abundant species in the area (0.73 indiv. m^{-2}, and 22% of total live mussel counts). The Lac Coulonge reach favors the Lake Sturgeon and the Hickorynut mussel as it still a 'wild' sector of the Ottawa River that is unobstructed, with free-flowing water and no dams.

ACKNOWLEDGEMENTS

The editors would like to thank all of the platform and poster presenters, and all of those who took the time to participant in this meeting. We thank Lynn Bouvier for her help with technical expertise. We also thank Meg Sheldon and Katherine Tran for their help leading up to and on the day of the meeting. Thanks to Dominique Lebrun and Noel Soogrim for reviewing this technical report.