Proceedings of the 2021 Canadian Freshwater Mollusc Research Meeting: December 7 – 8, 2021, Burlington, Ontario

Todd J. Morris, Kelly A. McNichols-O'Rourke, Margaret N. Goguen and Scott M. Reid

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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.

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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.

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Editors:
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ABSTRACT

Morris, T.J., McNichols-O'Rourke, K.A., Goguen, M.N., and Reid, S.M. (Editors). 2022. Proceedings of the 2021 Canadian Freshwater Mollusc Research Meeting: December 7-8, 2021, Burlington, Ontario. Can. Tech. Rep. Fish. Aquat. Sci. 3455: vii + 37 p.

The fourth biennial Canadian Freshwater Mollusc Research Meeting was held virtually using the Microsoft Teams platform on December 7-8, 2021. The meeting was jointly hosted by Fisheries and Oceans Canada and the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry. The research meeting included 31 platform presentations and was attended by 141 individuals.

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, species at risk, threats, outreach and education, conservation genetics, and habitat. Attendees from seven Canadian provinces (AB, SK, MB, ON, QC, NB, NS), three American states (NY, MI, OH) as well as the city of Nelson in New Zealand represented federal departments, provincial/state agencies, academic institutions, environmental consultants, non-governmental organizations, naturalist groups, zoos, museums, and interested citizens. There was an emphasis on building relationships to promote future collaborations and research opportunities.

RÉSUMÉ

Morris, T.J., McNichols-O'Rourke, K.A., Goguen, M.N., and Reid, S.M. (Editors). 2022. Proceedings of the 2021 Canadian Freshwater Mollusc Research Meeting: December 7-8, 2021, Burlington, Ontario. Can. Tech. Rep. Fish. Aquat. Sci. 3455: vii + 37 p.

Les 7 et 8 décembre 2021, la quatrième réunion biennale de recherche sur les mollusques d'eau douce du Canada a été présentée virtuellement via la plateforme Microsoft Teams. Au cours de la réunion, organisée conjointement par Pêches et Océans Canada et le ministère du Développement du Nord, des Mines, des Ressources naturelles et des Forêts de l'Ontario, 31 présentations orales ont été données devant 141 participants.

L'objectif de la réunion était de rassembler les malacologistes canadiens afin qu'ils échangent à propos de leurs recherches passées, récentes et en cours sur les mollusques d'eau douce. Parmi les sujets de discussion figuraient la situation et la répartition, les espèces en péril, les menaces, la sensibilisation et l'éducation, la génétique de la conservation et l'habitat. Les participants de sept provinces canadiennes (Alberta, Saskatchewan, Manitoba, Ontario, Québec, Nouveau-Brunswick et Nouvelle-Écosse), de trois États américains (New York, Michigan et Ohio), ainsi que de la ville de Nelson, en Nouvelle-Zélande, représentaient des ministères fédéraux, des organismes provinciaux et d'État, des établissements universitaires, des consultants en environnement, des organisations non gouvernementales, des groupes de naturalistes, des zoos, des musées et des citoyens intéressés par le sujet. La réunion visait principalement à établir des relations qui pourraient déboucher sur des collaborations et des possibilités de recherche futures.

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 to 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 MOLLUSC RESEARCH MEETING ORGANIZING COMMITTEE

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

Program Schedule: Tuesday, December 7, 2021
All times are in Eastern Standard Time (EST)

10:00-10:20	**Introductions and welcoming address**	
Session 1: Status & Distribution		
10:20-10:40	Platform 1	**Summary of St. Clair Region Conservation Authority sampling of freshwater mussel populations in the Sydenham River** C. Paterson and N. Drumm
10:40-11:00	Platform 2	**Studying a unique community of freshwater mussels in North America in the underwater caves of the Upper Ottawa River** A.L. Martel and J. Heinerth
11:00-11:20	Platform 3	**Historical impacts causing the decline of freshwater mussels and current efforts to delineate remaining populations – Upper Niagara River, Erie and Niagara Counties, New York, United States** A.K. Benshoff and M. Filipski
11:20-11:40	**BREAK**	
11:40-12:00	Platform 4	**Species distribution modeling for native freshwater mussels in the Detroit and St. Clair rivers** S.S. Keretz, D.A. Woolnough, T.J. Morris, and D.T. Zanatta
12:00-12:20	Platform 5	**Identifying Brook Floater presence in rivers within Nova Scotia** M. Lachance and D. Roberts
12:20-12:40	Platform 6	**Unionids in Middle Creek at Bishops Mills: 28 years of erratic monitoring** F.W. Schueler
12:40-13:40	**LUNCH**	
13:40-14:00	Platform 7	**Recent additions to the knowledge of freshwater mussel fauna in Saskatchewan** I.D. Phillips
Session 2: Species at Risk		
14:00-14:20	Platform 8	**The shelf of shame: handling uncertain records** M.N. Goguen and T.J. Morris
14:20-14:40	Platform 9	**Population demographics, reproductive life history and conservation threats of *Lampsilis cariosa* in Nova Scotia** K. White, A. Penney, L. Douglas, E. McPhee-Tomko, and D.I. MacNeil
14:40-15:00	Platform 10	**Thames River monitoring – The good, the bad and the TBD** K.A. McNichols-O'Rourke, M.N. Goguen, K. Wright, and T.J. Morris
15:00-15:20	**BREAK**	

15:20-15:40	Platform 11	**Pond rearing of *Lampsilis fasciola*, *Ptychobranchus fasciolaris* and *Epioblasma triquetra* to investigate feasibility of broodstock development** C. Wilson, K. McNichols-O'Rourke, J. Pierman, and P. Johnson
15:40-16:00	Platform 12	**How successful is translocation for freshwater mussel species at risk in southwestern Ontario?** C. Febria, L. Damphousse, and R. Macneil
16:00-16:20	Platform 13	**Freshwater fish and mussel biodiversity hotspots for conservation priorities in southwestern Ontario** A. Mohamed, D.A.R. Drake, T.J. Morris, and N.E. Mandrak
16:20-16:40	Platform 14	**An integrative framework to predict the presence of species-at-risk mussels in New Brunswick** M.A. Gray, S.A. Cusack, D.M. Greeley, E.B. Noël
16:40-17:00	Platform 15	**How much effort is enough? The role of detectability in species at risk sampling** T.J. Morris, M.N. Goguen, and K.A. McNichols-O'Rourke
17:00-18:00	**DISCUSSION ROOMS Status & Distribution Species at Risk**	

Program Schedule: Wednesday, December 8, 2021
All times are in Eastern Standard Time (EST)

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10:20-10:40	Platform 17	**Toxicity of bisphenols in developing embryos of the freshwater snail *Planorbella pilsbryi*** È. Gilroy, C. Venier, and R. Prosser
10:40-11:00	Platform 18	**Using wild-caught freshwater mussels as bio-indicators for microplastic accumulation downstream of municipal wastewater treatment plants in the Grand River watershed** E. Robson, E. Weir, K. Kidd, R. Prosser, P. Gillis, J. Bennett, and J. Salerno,
11:00-11:20	Platform 19	**Mussel assemblages in four reservoir lakes on the Tittabawassee River (Lake Huron drainage, Michigan USA) after 2020 dam failures** A.M. Laszlo, D.A. Woolnough, and D.T. Zanatta
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11:40-12:00	Platform 20	**Evolution of new zebra mussel (*Dreissena polymorpha*) populations in Massawippi and Memphremagog lakes in Quebec** I. Picard, M. Gérin, and A. Orjikh
Session 4: Outreach & Education		
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Session 5: Conservation Genetics		
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14:00-14:20	Platform 24	**Genetic diversity maintenance in captive-reared *Lampsilis fasciola*** N.M. VanTassel and D.T. Zanatta
Session 6: Habitat		

14:20-14:40	Platform 25	**Characterization of Snuffbox (*Epioblasma triquetra*) populations, microhabitat, and surrounding unionid communities in Michigan** S.M. LaValley and D.A. Woolnough
14:40-15:00	Platform 26	**Biodegradable tracer particle to model the dispersal of larval mussels** C. Farrow, L.T. Lim, and J. Ackerman
15:00-15:20	**BREAK**	
15:20-15:40	Platform 27	**Buffering success: assessing the effect of riparian vegetation buffers on juvenile unionid mussel habitats** A. Lu and J. Ackerman
15:40-16:00	Platform 28	**Temporal dynamics of freshwater mussel larvae** S.L. Smodis, T.J. Morris, and J.D. Ackerman
16:00-16:20	Platform 29	**One shell orientation to rule them all? The effects of hydrodynamic forces on the orientation of freshwater mussels** E. Sabeti-Mehr and J.D. Ackerman
16:20-16:40	Platform 30	**Unionid species at risk and benthic macroinvertebrate community biomonitoring reveal complementarity in support of watershed-scale restoration** R.A. Eveleens, T.J. Morris, D.A. Woolnough, and C.M. Febria
16:40-17:00	Platform 31	**Predicting mussel species at risk distributions in southwestern Ontario rivers using spatial distribution models and the Aquatic Ecosystem Classification method** S.M. Reid, A.H.M. Bell, A. LeBaron, B.J. Schmidt, and N.E. Jones
17:00-17:05	**Closing Remarks**	
17:05-18:00	**DISCUSSION ROOMS** **Threats** **Outreach & Education** **Conservation Genetics** **Habitat**	

Platform Presentation Abstracts

Platform 1: Summary of St. Clair Region Conservation Authority sampling of freshwater mussel populations in the Sydenham River

Craig Paterson and Nicole Drumm

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The East Sydenham River, situated in southwestern Ontario, supports some of the richest species diversity in Canada. The river and connecting lands provide habitat to an array of fishes, birds, mammals, reptiles, and amphibians as well as 34 freshwater mussel species. The Sydenham River is currently known to be inhabited by 12 of 15 freshwater mussel species in Ontario that have been assessed as at-risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), including globally threatened species. In 2020, a 2.5 km reach of the river was sampled using two survey methods to gather data on species distribution and abundance. The study area was dissected into five blocks, each 500 m in length. Within each block, ten 1 m^2 quadrats were excavated by hand to a depth of 15 cm and a 4.5 person-hour timed-search using tactile searching was conducted. Each live mussel was identified, measured, photographed, sexed (where applicable) and released; shells and valves were identified and returned to the river. A total of 1,140 live mussels were detected representing 23 different species, including 60 individuals representing eight different species at risk (SAR). Kidneyshell (*Ptychobranchus fasciolaris*), Northern Riffleshell (*Epioblasma torulosa rangiana*), and Rainbow (*Villosa iris*) were the most commonly detected SAR representing 27%, 25%, and 17% of all live SAR sampled. Amongst the 180 SAR shells and valves detected, Rayed Bean (*Villosa fabalis*) and Salamander Mussel (*Simpsonaias ambigua*) were the most commonly detected representing 66% and 16%, respectively. Whereas live Rayed Bean (*V. fabalis*) and Salamander Mussel (*S. ambigua*) represented 8% and 2% of all live SAR detected, respectively. All species detected during the 2020 sampling completed by the SCRCA were known to occur within the Sydenham River. Although freshwater mussels in the Sydenham River have been well studied over time, the 2020 survey sites had minimal existing data on species richness and abundance, providing a unique opportunity to explore a large, contiguous segment of this diverse and remarkable river system.

Platform 2: Studying a unique community of freshwater mussels in North America in the underwater caves of the Upper Ottawa River

André L. Martel[1] and **Jill Heinerth**[2]

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The Ottawa River is the location of the longest and most complex underwater cave network discovered to date in Canada -- a fact largely unknown to most Canadians. These caves are underground extensions of the main channel of the Ottawa River with tunnels running under the mainland and through Islands of the Paquette Rapids, adjacent to Allumettes Island (QC) and the town of Westmeath (ON). The first written mention of the presence of underwater caves or large underground river channels in the Ottawa River is in the field journal of explorer and geologist Sir William E. Logan, during his 1845 survey of the Upper Ottawa Valley while paddling at the Paquette Rapides, next to Allumettes Island. On 28th August 1845, Logan wrote ‘’…*The first thing that struck my attention was the appearance of the Ottawa at one place where it boils up from under a solid bank, with a breadth of 50 yards and a depth which I could not ascertain: but McNaughton thinks that one third of the river comes out*…” (source reference: Charles H. Smith and Ian Dyck, 2007, in their book entitled: William E. Logan’s 1845 survey of the Upper Ottawa Valley. Mercury Series History Papers 54. Canadian Museum of Civilization). Starting in July 2019, underwater cave diving aimed at specifically examining the freshwater mussel fauna (and other aquatic species) found inside the cave network was conducted by cave diver Jill Heinerth. To our knowledge this is the first study on freshwater mussels living in caves. The habitat comprises cave tunnels of 2 to 5 m wide, 1.5 to 3 m high, with cave walls and ceilings commonly covered by sponges (summer conditions), and with moderate to strong water current (dependent on season and discharge of the hydro dam located ca. 100 km upstream). Following 32 cave dives totalling 69 hours of diving work, hand collected specimens as well as underwater photographs and video footage to date reveal five species of freshwater mussels living inside the Gervais and Three Island Caves network. Mussel species include, by decreasing order of abundance, live and empty shells of the species Eastern Elliptio (*Elliptio complanata*), Plain Pocketbook (*Lampsilis cardium*), Hickorynut (*Obovaria olivaria*) and Black Sandshell (*Ligumia recta*), as well as empty shells of the Triangle Floater (*Alasmidonta undulata*). Mussels predominantly prevail in areas of fine sediment deposition, where current eddies occur at the turning portions of cave tunnels, or inside cave channel expansion chambers where water current is reduced, with densities commonly 10-100 ind. / m^2. Fishes observed include Northern Pike, Lake Sturgeon, Smallmouth Bass, Logperch, as well as schools of unidentified cyprinids, some of which are the presumed hosts required to sustain mussel reproduction and stable populations inside the caves. Future research on this unique community includes documenting further regions of the caves, determining mussel population density, studying the ecology of mussel species, including the fish-mussel linkage for species such as Hickorynut, and its presumed host, the Lake Sturgeon.

Platform 3: Historical impacts causing the decline of freshwater mussels and current efforts to delineate remaining populations – Upper Niagara River, Erie and Niagara counties, New York, United States

Adam K. Benshoff[1] and **Mark Filipski**[2]

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[2]*NYS Department of Environmental Conservation, Niagara River RAP Coordinator.*

The Niagara River is an important binational waterway that connects Lake Erie to Lake Ontario. At the beginning of the 20th century, various chemical and steel industries began to alter the shoreline landscape of the river. By the 1970's, the decline of the areas' industrial and manufacturing facilities left behind sediments contaminated with toxic chemicals and pesticides. After several years of coordination and development, the U.S. Niagara River Area of Concern (AOC) Habitat Restoration Plan was finalized in 2019. The U.S. Fish and Wildlife Service (USFWS) New York Field Office and New York State Department of Environmental Conservation (NYSDEC) began discussions to conduct assessments and potential restoration of sentinel native mussel species representing the lower-level food chain within the Niagara River aquatic ecosystem in support of the U.S. Remedial Action Plan (RAP) for the Niagara River AOC. Based on historical museum records, the Upper Niagara River once boasted a diverse mussel assemblage, however, in the last 20 years, only 22 sites have been assessed for freshwater mussel presence / absence resulting in the collection of 10 live species. Previous survey efforts have occurred in nearshore habitats due to pre-construction surveys associated with nearshore project installations. Offshore riverine habitats have been largely excluded from surveys for a multitude of reasons and inherently exhibit a knowledge gap in the extant mussel distribution within the Upper Niagara River. Efforts began in 2020 to develop standardized methods that could be followed to determine occurrence, abundance, distribution, and assemblage characteristics of extant mussel resources in nearshore locations where live mussels were collected, as well as offshore habitats. In the spring of 2021 those methods were field tested using qualitative searches and linear transects (*n*=15) placed perpendicular to river flow with a focal emphasis on offshore habitats. Surveys resulted in the collection of six live species and 12 additional species collected as dead shells only, including federally endangered Snuffbox (*Epioblasma triquetra*). Efforts will continue in spring of 2022 to further evaluate freshwater mussel resources in the U.S. portion of the Upper Niagara River.

Platform 4: Species distribution modeling for native freshwater mussels in the Detroit and St. Clair rivers

Shay S. Keretz[1], Daelyn A. Woolnough[1], Todd J. Morris[2], and David T. Zanatta[1]

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Native freshwater mussels (Bivalvia: Unionidae) were seemingly pushed to extirpation following the introduction and establishment of dreissenid mussels within the St. Clair–Detroit River system of the Laurentian Great Lakes region. Unionids have been considered extirpated from the Detroit River since 1998 and, although unionid populations have been found in the St. Clair delta, the state of unionids in the St. Clair River main channel remains unknown. To assess the potential remnant unionid populations in these rivers, the Detroit and St. Clair rivers were surveyed in 2019 and 2021, respectively, using a mixture of stratified random, historical, potential refuge, and model-selected sites (n = 56 Detroit River sites and 51 St. Clair River sites). Data collected from the Detroit River in 2019 and MaxEnt were used to create unionid species distribution models, which chose the model-selected sites for sampling the St. Clair River. A total of 220 live unionids representing 11 species were found among 5 sites in the Detroit River and a total of 14 live unionids representing 9 species were found among 7 sites in the St. Clair River. Live unionids found in the St. Clair River were found at all site types except the model-selected sites (n = 6), with randomly selected sites representing 4 of the 7 sites where unionids were present. The model developed from the Detroit River dataset failed to be predictive for unionid presence in the St. Clair River. Updated species distribution models using data from both the Detroit and St. Clair rivers will be created and additional surveys to assess the models will occur in both rivers in summer 2022. Additional analyses are pending in an attempt to further our understanding of native mussel distributions in large river systems, which can contribute towards unionid conservation and management in the future.

Platform 5: Identifying Brook Floater presence in rivers within Nova Scotia

Marie Lachance and **Desirée Roberts**

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As part of The Confederacy of Mainland Mi'kmaq (CMM) – Mi'kmaw Conservation Group (MCG) multi-year projects (2017-2023) funded by Fisheries and Oceans Canada (DFO), a commitment was made to collect information on the population distribution, relative abundance, morphological variation, and critical habitat of the Brook Floater (*Alasmidonta varicosa*). This involved the sampling, identification, and measurement of brook floater found in rivers of Nova Scotia, with emphasis on the Shubenacadie/Stewiacke watershed, near Millbrook and Sipekne'katik Mi'kmaw Communities in Mi'kma'ki. Since 2017, a total of 36 different sites have been surveyed with 15 of these sites surveyed each year over a period of three or more years. Live brook floater specimens were found at 11 sites with 7 sites having repeated brook floater presence over the years. Through these multi-year projects, many partnerships have been established, particularly with DFO and with Cape Breton University (CBU). DFO has provided MCG with training and funding, while CBU has been an important partner in data sharing and in a collaborative project involving environmental DNA analysis to assess brook floater presence. These partnerships enabled MCG to build enough capacity and experience to successfully participate in collaborative efforts to gather and share information on brook floater presence/absence locations and size structures, as well as involving Mi'kmaw communities in freshwater mollusc research, monitoring, and outreach activities. This presentation highlights MCG's monitoring and research efforts on brook floater over multiple years, and MCG's experience in building partnerships and collaborative networks in freshwater mollusc conservation and research.

Platform 6: Unionids in Middle Creek at Bishops Mills: 28 years of erratic monitoring

Frederick W. Schueler

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Middle Creek in North Kemptville is a low order tributary of the Rideau River, surveyed along 220 m of rubble / bedrock riffles through brushy woods from 1993 to 2021, from the site of a sometimes beaver dam, past the site of a 19th Century mill dam (44.87360°N 75.70511°W), to the bridge of a village street. This is a shallow gradient stream which ceases to flow in droughty summers, with a fish fauna constrained by anoxic water in many winters. Surveys were conducted at various dates and levels of flow, by collecting shells and noticing living mussels. Species encountered were *Pyganodon grandis* and *Elliptio complanata* from the beginning of the survey period, and *Lasmigona compressa* since 2006. Results will be discussed in relation to drought, predation, beavers, and other factors.

Platform 7: Recent additions to the knowledge of freshwater mussel fauna in Saskatchewan

Iain D. Phillips

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Little monitoring or assessment of mussel populations have been conducted in the waterbodies of Saskatchewan since the foundational freshwater distribution surveys provided in the works of Arthur H. Clarke in the early 1970's and 1980's, leaving a gap in current knowledge about the characteristics of the freshwater mussel assemblages there. Over the past fifteen years, however, many projects conducted by the Water Security Agency and its stakeholders have included the freshwater mussel assemblage in prairie waterbodies of Saskatchewan for endangered species monitoring, biomonitoring, and food web ecology producing range extensions, revised distributions, a greater understanding of mussel-specific stressors, and their position in regional food webs. Revised distribution ranges for *Ligumia recta* and *Lampsilis ovata* indicate greater western expansion than previously known. Further, stable nitrogen isotopes have provided additional insight into their response to wastewater effluent, as well as their role in food-webs across the rivers of Saskatchewan. These observations are forming a baseline understanding of the threats freshwater mussels face in Saskatchewan, but also opportunities to better manage surface water for their conservation in the future.

Platform 8: The Shelf of Shame: handling uncertain records

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Malacologists are sometimes presented with records that, although appearing valid, seem to be inconsistent with what is known of the species: unusual or disjunct range extensions, habitat mismatches, or inconsistencies with host distributions. Despite the uneasiness surrounding these records, their validity cannot be dismissed as the specimen has been verified and locality information can be provided. We are left to wonder if the specimen was overlooked in a sample bag from a previous day's sampling in another river or may have been dropped by a hiker or paddler exploring Ontario's many scenic rivers. These records typically stand out as abnormalities and occupy a place of uncertainty on the "*Shelf of Shame*". The repercussions of an uncertain record extend beyond just puzzling experts when a Species at Risk (SAR) is in question. SAR occurrences can impact management decisions such as species assessments, the delineation and protection of important habitats, restrictions on development and instream works, and may lead to costly administrative processes. When records can be successfully investigated and other individuals found, some measure of resolution is obtained and the original record can be taken off the Shelf of Shame. However, when no further evidence of the species can be found, the question remains of how to handle the original record. In 2019, Fisheries and Oceans Canada completed surveys throughout Muskrat Creek and a portion of the Teeswater River to investigate an unusual record of the Endangered Fawnsfoot (*Truncilla donaciformis*) that was reportedly collected live in Muskrat Creek in 2005. After extensive qualitative and quantitative surveys, no evidence of Fawnsfoot was observed. While it can be assumed with high certainty that there is not currently a Fawnsfoot population in Muskrat Creek, the 2019 surveys do not provide any satisfying clarity on the source of the original animal nor the history of Fawnsfoot in this river. To date, the Fawnsfoot record remains on the Shelf of Shame and is an example of how uncertain records can lead to extensive effort that results in little further clarification. This record and others on the Shelf of Shame serve as reminders of the importance of accurate data collection and good sampling practices to avoid potential distribution errors and effects on management decision.

Platform 9: Population demographics, reproductive life history and conservation threats of *Lampsilis cariosa* in Nova Scotia

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Yellow Lampmussel (*Lampsilis cariosa*) occur along the Northeast Atlantic Slope of North America from Georgia to Nova Scotia. They are considered threatened and declining throughout much of their range in the United States. Listed as of "Special Concern" federally in Canada, they are found in only two provinces: New Brunswick and Nova Scotia. Yellow Lampmussel are designated as "Threatened" in Nova Scotia and until recently were thought to be limited to the upper Sydney River and two small connected lakes (Blacketts and Gillis) in the Sydney River watershed. The discovery of a second Nova Scotia population at Pottle Lake in 2015 prompted an extensive search of waterbodies in the region and the location of a third population at Forresters Lake in 2015. In collaboration with three levels of government, indigenous groups, and recreational anglers we did extensive sampling of all three Nova Scotia populations to fill knowledge gaps associated with population demographics, reproductive life history, and conservation threats. Filling these gaps is essential for developing effective management plans and predicting how the species will respond to management strategies intended to mitigate threats. Our sampling revealed that Yellow Lampmussel density was low in all three Nova Scotia populations at 0.45-0.95 mussels/m^2. Life history and reproductive characteristics were similar across populations with maximum age estimated at 25 years. The minimum age of females becoming gravid and displaying mantle lures was four years, with females brooding glochidia through spring and fall. Sex ratios were significantly male-biased in all three populations. White Perch (*Morone americana*) was the only fish species found to host Yellow Lampmussel glochidia. The recent illegal introduction of Chain Pickerel (*Esox niger*) into Blacketts Lake poses a major threat to White Perch in the Sydney River watershed. We found no evidence of recent Yellow Lampmussel recruitment in Blacketts Lake suggesting this population may be in jeopardy.

Platform 10: Thames River monitoring – The good, the bad and the TBD

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The Thames River in southwestern Ontario was once home to 35 species of freshwater unionid mussels. At least 30 of these species currently remain including 10 that are considered species at risk (SAR). To monitor this important freshwater mussel community, 12 index stations were established throughout the watershed by Fisheries and Oceans Canada. To date, each site has been surveyed twice with the initial surveys completed in 2004/05 and 2010 and the first monitoring events completed between 2015 and 2017. Sites were surveyed using 1 m^2 quadrats and a systematic sampling design with three random starts. A total of 2,029 live individuals representing 27 species (8 SAR) were observed during the initial surveys and 7,369 live individuals representing 28 species (8 SAR) were observed during the first monitoring events. Between the initial surveys and the first monitoring events, significant increases or increasing trends in average site density and average site species richness were observed throughout most of the watershed. Similar results were also seen for SAR densities. These differences suggest that positive changes are occurring within unionid populations in the Thames River; however, survey conditions or design limitations could impact these results. With only two data points, more information must be collected to determine if these results are a true reflection of the Thames River unionid story and if this information can be used to inform SAR conservation and management.

Platform 11: Pond rearing of *Lampsilis fasciola, Ptychobranchus fasciolaris* and *Epioblasma triquetra* to investigate feasibility of broodstock development

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Building off previous propagation activities, the Ontario Ministry of Northern Development, Mining, Natural Resources and Forestry's Fish Culture Section now rears a variety of freshwater mussel species and year classes year-round in a pond using submerged system (SUBSY) adapted from a design used by the Alabama Aquatic Biodiversity Center. This presentation will provide an overview of the pond rearing design and maintenance activities, summarize current holdings (species, quantities, sizes) and provide an update on rates of maturation by year class and implications for the feasibility of establishing broodstocks and/or ark populations.

Platform 12: How successful is translocation for freshwater mussel species at risk in southwestern Ontario?

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Freshwater mussels (Unionidae) serve as critical structural and functional links for aquatic food webs and are effective bioindicators, but unfortunately large numbers of species are declining globally, with many in Canada federally listed as species-at-risk (SAR) (Bolden & Brown, 2002). Restricted in dispersal ability due to their sessile nature, Unionidae are incredibly vulnerable to human activities such as river infrastructure projects like bridge construction, culvert replacements and earth moving activities adjacent to waterbodies (Pires et al., 2021). Therefore, translocation efforts involving freshwater mussel populations are commonly conducted as a mitigation response under the federal *Fisheries Act* and *Species at Risk Act* under which freshwater mussels are protected (Species at Risk Act, 2002). Since the Mackie et al. (2008) protocol, practitioners have been required to follow standard practices to ensure translocation success; however, little to no follow-up has been done to assess the effectiveness of this practice. Here we seek to understand why mussels remain at some sites but migrate from others, or if essential host fish are present at a relocation site for continued reproduction, using the Argyll Bridge relocation project as a launching point for our research. The Argyll project is the largest known mussel translocation effort to date in Canada and is situated in the town of Caledonia, in the Grand River watershed and traditional Territory of Six Nations and Mississaugas of the Credit First Nations. Here we describe our team, partnership network and research approach to be undertaken. Embedded in our knowledge co-production process, we will integrate data syntheses, apply a space-for-time gradient study design and revisit a select number of sites to assess “success” of previous projects. This holistic approach aims to better inform decision making and policy. The presentation is also an invitation for collaborators and knowledge holders to engage our team about known translocations, available datasets to be included in our study and in engaging Indigenous ways of knowing nature.

Mackie, G., Morris, T.J., and Ming, D. 2008. Protocol for the detection and relocation of freshwater mussel species at risk in Ontario-Great Lakes Area (OGLA). Can. Manuscr. Rep. Fish. Aquat. Sci. 2790: vi +50 p.

Platform 13: Freshwater fish and mussel biodiversity hotspots for conservation priorities in southwestern Ontario

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Area-based conservation approaches require identification of priority areas for conservation, for which the biodiversity hotspots concept is well known. We applied a systematic hotspot approach to freshwater fish and mussel diversity at a sub-basin level in southwestern Ontario - an area characterized by the richest freshwater biodiversity in Canada and high intensity of anthropogenic pressures. We used three ecological criteria (i.e., irreplaceability, representativeness and vulnerability) in five templates (i.e., 3 proactive, 1 reactive and 1 representative) to prioritize sub-basins for alternative conservation strategies. We used comprehensive datasets of fish and mussel species distributions in the region to estimate irreplaceability (based on at-risk species diversity) and representativeness (based on native species diversity) of sub-basins, while the vulnerability (level of cumulative threats) was estimated based on intensity of human pressures (extracted from several national, continental, and global datasets) and invasive fish species richness in sub-basins. The prioritization of the sub-basins differed based on the conservation-strategy template. The high priority sub-basins identified by proactive 1 template (that only focuses on vulnerability) had the lowest diversity of both fishes and mussels and thus, offered limited biodiversity benefits. Interestingly, high priority sub-basins of reactive and proactive (2 and 3) templates can provide similar conservation value as they host similar diversity of at-risk fish and mussel species. The sub-basin prioritization in each template varied depending on whether a single taxon (i.e., fishes OR mussels) or a multi-taxon (i.e., fishes PLUS mussels) approach was used in irreplaceability and representativeness criteria. Not only is current protected area coverage inadequate (only 0.36% of study region), but the distribution of protected areas is not optimized with respect to proposed spatial prioritization for proactive conservation. Our findings indicate that proactive conservation approaches can maximize conservation gains across multiple taxa in contrast to commonly used species-specific reactive strategies.

Platform 14: An integrative framework to predict the presence of species-at-risk mussels in New Brunswick

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The New Brunswick Department of Transportation and Infrastructure (NB DTI) is partnering with researchers from the Canadian Rivers Institute (CRI) at the University of New Brunswick (UNB) to develop a science-based, weight-of-evidence (WOE) risk assessment framework to establish the presence/absence of species at risk (SAR) mussel species. The expected research outputs include: (1) using environmental DNA (eDNA) as a tool to map the spatial presence/absence of SAR individuals and characterizing biological communities at the mesohabitat scale, (2) developing effective freshwater mussel survey methodologies at the microhabitat scale; (3) connectivity mapping of freshwater systems in NB to map available freshwater SAR animal habitats at the macro-scale using LiDAR; and (4) an integrated framework incorporating the micro-, meso-, and macroscale outputs into a probabilistic model for the determination of risk to SAR across NB. This research program will produce a regional-scale, science-based, WOE risk assessment framework for freshwater mussels that can be applied to projects that can impact adjacent surrounding freshwater habitats. Beyond the regulatory and operational application, the outputs have implications for the conservation and restoration as mapping of suitable SAR habitat will directly aid in prioritizing SAR habitat restoration, i.e., informing where to invest habitat restoration efforts across NB. A science-based framework will help to expedite permitting and reduce delays for in-water works and construction activities.

Platform 15: How much effort is enough? The role of detectability in species at risk sampling

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How much sampling is required to confidently assess the occurrence of a species at a particular site is a difficult question to answer but one that is critical for the successful management of species at risk (SAR). Incorrectly declaring a SAR present at a site may invoke costly and time-consuming recovery measures (e.g., relocations) whereas an improper designation of absent may result in significant harm to individuals or populations, potentially jeopardizing the long term survival or recovery of the species. The likelihood of detecting a species, given that it is present at a site, is influenced by many things including the abundance of the species within the site and its detectability. Detectability is a direct result of the biology of the species (e.g., size, burrowing behaviour), the site characteristics (e.g., size, depth, turbidity, flow), the search effort and search methods, and the experience level of the survey team. During the 2021 field season we sampled 50 sites across the Thames and Grand river systems of southwestern Ontario in an effort to assess the detectability associated with traditional timed-search survey methods. Surveys were conducted using a 3-person crew and surveying for a total of 4.5 person-hours per site. Distance travelled by each surveyor was recorded and search efficiency was determined as the percentage of the total site area covered during the survey by the entire team. Search efficiency was highly variable ranging between 3 – 100% and was influenced by the overall site size, turbidity and depth (which also influenced the choice of search methods), and the total abundance of animals at a site. Combining search efficiency with species' biology allows for a determination of the likelihood of detection under a variety of real-word conditions.

Platform 16: Investigating contaminant exposure in freshwater mussels in the Athabasca Oil Sands region using a community-led approach braiding together Indigenous Knowledge and Western Science

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Oral history shared by the McMurray Métis and other Indigenous Knowledge holders in the oil sands region of Alberta indicate that the gathering and eating of freshwater mussels (referred to locally as clams), have historically been part of traditional cultural practices and are an important indicator of the health of the water. The McMurray Métis are known as the River People; the river is part of who they are just as they are part of the river. However, McMurray Métis Knowledge holders have noticed that clams are not nearly as abundant and widespread as they once were 20 to 40 years ago. Led by the McMurray Métis, in partnership with Alberta Environment and Parks and Environment and Climate Change Canada, we co-developed a framework to guide how Indigenous Knowledge and Western science would be ethically and practically situated in the research and then co-designed an investigation into the health of freshwater mussels in the oil sands region of Alberta. As a first step, the McMurray Métis decided to focus on using Indigenous Knowledge to find clams on the Athabasca and Clearwater rivers and to quantify potential contaminant levels (metals) in freshwater mussel tissue, sediment and surface water. Western science was used to support this line of questioning through place-based interviews and quantitative inquiry. Through our ethic of 'Learning Together' we touch on cultural impacts to McMurray Métis as a result of the decline of freshwater mussels in the region and show that the concentrations of numerous metals including aluminum, cobalt, nickel, and lead, were higher in freshwater mussel tissue, sediment and water collected from sites located on the bitumen deposits on the Clearwater River compared to samples collected off the bitumen deposit. While fewer samples were collected from the Athabasca River, metal levels in sediment and tissue were generally higher than those collected from the Clearwater River. Results from this research can be used to help better understand contaminant distribution and effects on aquatic health in the Athabasca and Clearwater rivers.

Platform 17: Toxicity of bisphenols in developing embryos of the freshwater snail *Planorbella pilsbryi*

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Bisphenol A (BPA) is a precursor to plastic polymers used in consumer products, including some food containers and packaging, adhesives and paper coatings. Increasing concerns about its endocrine activity and leaching from plastics have led to its ban from the production of baby bottles. BPA remains in use in other applications, while alternate products have also been developed, often with similar structure, and could pose comparable health hazards. These concerns are being addressed by the Chemicals Management Plan, a government initiative aiming to reduce the risks posed by chemicals to Canadians and their environment.

Over the last three years, research was initiated at Environment and Climate Change Canada to assess the effects of BPA and replacement products BPF and BPS on adult freshwater snails (*Planorbella pilsbryi*), in 96 hour assays. These studies indicated that BPA was the most toxic of the three compounds. A follow-up 28-day study was completed to assess the chronic effects of BPA in adult snails and the survival and hatching of embryos from the F1 generation grown in the presence of BPA. The results of this study revealed that the juveniles from the F1 generation were more sensitive than the adults from the F0 generation.

In the present study, we assessed the effects of BPA and three replacement products, BPF, BPS, and BPAF, to the embryonic development of the freshwater snail *Planorbella pilsbryi*, to determine whether replacement products are less toxic, and to compare the sensitivity of this life stage to juvenile and adult snails. In all three life stages, BPF and BPS were less toxic than BPA. In contrast, BPAF was more toxic than BPA, as also reported in the literature.

The effects of BPA on the development of snail embryos were observed at concentrations greater than those observed in the F1 generation issued from the chronic study, confirming that the increased sensitivity could not be explained by the life stage.

Platform 18: Using wild-caught freshwater mussels as bio-indicators for microplastic accumulation downstream of municipal wastewater treatment plants in the Grand River watershed

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Microplastics, defined as plastic particles <5 mm in size, are ubiquitous in the environment, but less is known about how they enter and accumulate in freshwater food webs. Wastewater treatment plants (WWTPs) have been identified as a source of microplastics to rivers and the removal efficiencies of microplastics varies depending on the type of wastewater treatment. The Grand River watershed in southern Ontario acts as an ideal location to study microplastics, with approximately 1,000,000 people living within the watershed and 30 WWTPs releasing effluent into the river. We examined the occurrence of microplastics in caged *Lasmigona costata* exposed to wastewater effluent from the Kitchener WWTP. After 28 days of exposure, the hemolymph, gills, and digestive gland were removed for analysis. Microplastics were extracted and visually identified. This study provided insight into the accumulation, colour, and morphology of microplastics in freshwater mussels exposed to WWTP effluent. Building on this work, we are examining the occurrence of microplastics in wild-caught *L. costata* and *Actinonaias ligamentina* chronically exposed to wastewater effluent at additional WWTPs in the Grand River watershed. Water and sediment samples will also be collected for comparison to environmental concentrations of microplastics. This will provide a greater understanding of how WWTP effluent acts as a source of microplastics to rivers and the bioaccumulation of microplastics in wild-caught freshwater bivalves.

Platform 19: Mussel assemblages in four reservoir lakes on the Tittabawassee River (Lake Huron drainage, Michigan USA) after 2020 dam failures

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A known threat to freshwater mussels is habitat modification including fragmentation of river systems through dam infrastructure. In May 2020, a perfect storm of conditions involving a record rainfall event that contributed to a hydrologically saturated system, and existing dam infrastructure issues resulted in two dam failures in a four-reservoir lakes series within the Tittabawassee River watershed of central Michigan. These failures resulted in nearly complete dewatering of two lakes (Wixom and Sanford lakes, ~8 km^2 and ~6 km^2 pre-dam failures, respectively), where currently only the Tittabawassee River channel remains, and a 2.5 m drawdown was conducted to assist in dam repairs for the upper two reservoirs (Secord and Smallwood lakes, ~4.5 km^2 and ~1 km^2 prior to drawdown respectively). To examine the effects of the changes to this region, the non-profit Four Lakes Task Force, that is overseeing restoration of the dams and reservoirs, has initiated a multi-year study with Central Michigan University to examine mussel habitat including surveys of the four reservoirs. In summer 2021, surveys were performed in Secord and Smallwood lakes at >50 sites including completely randomized sites, historic sites (1980s), and/or tributary sites. Surveys were conducted using SCUBA and snorkel methodologies adapted to challenging logistics and conditions. Surveys also targeted areas immediately upstream and downstream of dams with at least 400 m surveyed downstream of each dam. Preliminary results from the Secord and Smallwood lakes indicate a patchy distribution of common lentic-adapted species and low species richness; >90% of >400 unionids collected alive were *Pyganodon grandis* (Giant Floater). Often, heavy biofouling by *Dreissena polymorpha* (Zebra Mussel) was evident as well as a large population of invasive *Cipangopaludina chinensis* (Chinese Mystery Snail) at several sites, especially Secord Lake. There was clear evidence of habitat alteration during the drawdown of the reservoirs. In summer 2022, we will begin formal surveys of Wixom and Sanford lakes. The results of our surveys and eventual modeling of mussel habitats will assist in guiding local, state, and federal agencies in how to restore these lakes while sustaining mussel assemblages and their habitat.

Platform 20: Evolution of new Zebra Mussel (*Dreissena polymorpha*) populations in Massawippi and Memphremagog lakes in Quebec

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Introduced in the Great Lakes 35 years ago, Zebra Mussels (*Dreissena polymorpha*) quickly invaded the St. Lawrence River, Champlain Lake and the Richelieu River in Quebec. Early prevention methods, including boat washing, seem to have limited its speed of spread in Quebec into other bodies of water, compared to the United States and Ontario where expansion had been faster. Zebra Mussels were first observed in Lake Memphremagog in 2017, and 2018 field surveys confirmed the presence of a well-established population in the north portion of this lake and in Lake Magog downstream. Densities were still relatively low with fewer than 5 mussels/m². Only Zebra Mussels were found. Following that discovery, a regional team was established including municipal, regional county, provincial and federal authorities, various specialists and lake associations. An action plan was set to monitor the new invasion (Memphremagog watershed and downstream), detect a potential introduction in susceptible areas (Massawippi watershed in particular), and take measures to limit the risk of introduction in new places (increase boat washing and other prevention and sensibilization measures). Zebra Mussel densities in Lake Memphremagog increased particularly in end of summer 2021 and a new population was confirmed in 2021 in Lake Massawippi on artificial substrates. This lake has optimal physicochemical conditions for Zebra Mussel in terms of pH, with values between 7.8 and 8.08, and calcium, with over 30 mg/L, raising concerns of a potentially more dramatic situation than in Lake Memphremagog where calcium levels are generally lower (only a small percentage of the lake area had values over the optimal 25 mg/L). An emergency survey was carried out by divers from various teams following the introduction with complementary eDNA analysis. This presentation will present the evolution of these introductions and recent results from various surveys. A discussion will be opened to attendees about future action to take and potential solutions to limit ecological and economic consequences of these introductions.

Platform 21: Toronto Zoo 2021 *Clam Counter* and freshwater mussel survey updates

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In September 2021, Toronto Zoo staff conducted timed-searches at five sites on the Rouge River and Little Rouge Creek. Quadrat surveys had been done at each site by Toronto Zoo staff in 2013 and 2014 as part of a five-year study of freshwater mussels in the inland watersheds of Lake Ontario. One new site was also surveyed in the lower Rouge River at Glen Rouge Campground. The objectives of these surveys were: 1. to compare results of two freshwater mussel survey methods (timed-searches vs. quadrat sampling) and 2. delineate the local upper boundary of Eastern Pondmussel distribution within Rouge Marsh. Over 100 individual mussels were documented at multiple sites; *Pyganodon grandis* and *Strophitus undulatus* were the most commonly encountered species while *Lasmigona compressa* was the least commonly found. A single *Lampsilis siliquoidea* was documented at the Glen Rouge Campground site. In addition to field surveys, Toronto Zoo continues to collaborate with Fisheries and Oceans Canada on the Clam Counter app. In the 2020 field season, 60 reports were submitted through the app including two SARA-listed species, *Lampsilis fasciola and Ligumia nasuta*. The 2021 field season saw a slight increase in reports submitted with a total of 66. Recent updates to app features including detailed instructions on photo submissions and improvements to map functionality have also been completed to improve the user experience and data accuracy.

Platform 22: Freshwater mussel programmes at the New Brunswick Museum 2020-2021

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The New Brunswick Museum (NBM) mollusc collection includes more than 2,000 catalogued freshwater mussel collections (~ 25,000 specimens), some dating to the 1890s or earlier, others as recent as 2021. Museum staff have engaged and partnered with members of institutions and communities to participate in the collection, identification, preservation and documentation of freshwater mussels in New Brunswick and elsewhere in the Maritimes. In spite of COVID-19 restrictions, NBM staff have been able to provide mussel identification workshops in support of university graduate programs, local watershed groups, and Fisheries and Oceans Canada-funded First Nations surveys, using the NBM collection as the basis for information and expertise. Programs have often emphasized freshwater mussel species of conservation concern in the region, mainly the Yellow Lampmussel, *Lampsilis cariosa*, and the Brook Floater, *Alasmidonta varicosa*.

Platform 23: Assessing effectiveness of a lab-verified qPCR assay for the endangered Snuffbox (*Epioblasma triquetra*) in a natural riverine environment

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In 2012, *Epioblasma triquetra* was the last species in the genus listed under the U.S. Endangered Species Act after status assessments reported a 60% reduction in its historic distribution. Traditional survey approaches estimating mussel population boundaries and sizes can be logistically difficult and time consuming due to patchiness, cryptic burrowing patterns, and low densities. Environmental DNA (eDNA) has been used to detect species at low density and can potentially be used to sample an area faster than traditional surveys. This study aims to determine if a species-specific qPCR eDNA assay is successful for field-collected samples, determine if there is a difference in detectability between benthic zone and surface water eDNA samples, and observe if seasonality influences eDNA detection rate. Water was collected from the Grand River watershed in Michigan, during fall 2020, spring 2021, and summer 2021. Sites sampled have variable *E. triquetra* densities, with some sites of unknown *E. triquetra* presence. At high *E. triquetra* density sites on the Grand River, differences in detection probability were tested by sampling surface water and water near the benthic/water interface. Fall 2020 results were not successful in detecting *E. triquetra* DNA from field samples. Due to the lack of field detections in fall of 2020, the assay was tested in a controlled (streambank) environment using field-collected *E. triquetra* in 19 L buckets during the spring of 2021 and summer of 2021. Water samples collected from a bucket with two live *E. triquetra* resulted in positive detections, lower density and control buckets (without live *E. triquetra*) did not result in positive detections during spring 2021, and we expect summer 2021 buckets to mirror these results with higher *E. triquetra* densities. Assays of spring 2021 and summer 2021 samples are still ongoing.

Platform 24: Genetic diversity maintenance in captive-reared *Lampsilis fasciola*

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In the last decade, our knowledge of genetic diversity and structure of numerous wild stock unionid species has advanced extensively, but there has not been the same advancement in our understanding of captive-bred unionids. Our previous study (VanTassel et al. 2021) on *Lampsilis fasciola* and *Ptychobranchus fasciolaris* found that genetic diversity was maintained in captive-reared offspring when at least seven naturally fertilized gravid females contributed to the brood stock. Here we compared the genetic diversity of another cohort of captive-reared *L. fasciola* juveniles (from 12 naturally fertilized gravid females) to the wild population. We also analysed the variability of genetic diversity among the 12 *L. fasciola* broods. Individuals were genotyped at seven microsatellite loci and SNPs were generated using RADseq. No significant differences were detected between wild and propagated *L. fasciola* based on genetic diversity metrics on microsatellites (allelic richness, rarefacted allelic richness, observed and expected heterozygosity, and inbreeding coefficient) using Kruskal-Wallis tests. Additionally, no significant differences were detected between *L. fasciola* families based on microsatellite genetic diversity metrics. Genetic structure analyses (PCA and STRUCTURE plot) support wild and captive-reared *L. fasciola* as one genetic population with some sub-structure by family group. We expect that SNP-based analyses will reveal more fine-scale structure between family groups, and that parentage analyses will show a pattern of increased genetic diversity with increased male contribution to a brood. These findings will guide best practices for unionid propagation and supplementation/reintroduction efforts.

VanTassel, N.M., Morris, T.J., Wilson, C.G., and Zanatta, D.T. 2021. Genetic diversity maintained in comparison of captive-propagated and wild populations of *Lampsils fasciola* and *Ptychobranchus fasciolaris* (Bivalvia: Unionidae). Can. J. .Fish Aquat. Sci. 78: 1312-1320

Platform 25: Characterization of Snuffbox (*Epioblasma triquetra*) populations, microhabitat, and surrounding unionid communities in Michigan

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Freshwater mussels (unionids) are among the most imperiled faunal groups in the world. North America has one of the most diverse unionid communities with over 300 species, but over 70 percent are listed as endangered, threatened, or special concern. The Snuffbox mussel (*Epioblasma triquetra*) has been extirpated throughout much of its historic range, with presence in rivers being reduced by over 60 percent compared to historic records. The Snuffbox mussel is federally endangered in Canada and the United Stated. Snuffbox still have a wide range, including the Great Lakes region, the Mississippi River and some tributaries, and parts of Appalachia. This project focuses on the Great Lakes region Snuffbox, specifically in Michigan. Surveys of Michigan's 11 known rivers with Snuffbox populations occurred in 2020 and 2021. Sites were surveyed using both timed-searches and species-specific quadrat excavation searches. Timed-searches provide data on community composition and density in the river reaches. Species specific quadrat searches quantified the unionids and substrate present in 1 m x 1 m around where live Snuffbox were found. Over 135 person-hours of searches turned up 158 Snuffbox (CPUE range = 0.06 – 11.67). Interesting trends in age and size classes, sex ratios, shell:live ratios, and community assemblages are presented. Data collected and analyzed for this project will increase knowledge on each population of Snuffbox in Michigan, provide feedback for status assessments, and aid in the management and effective surveying for Snuffbox. We present successful strategies that could be used for assessing rare unionid species found in multiple watersheds.

Platform 26: Biodegradable tracer particle to model the dispersal of larval mussels

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Freshwater mussels may be especially sensitive to changes to hydrology and riverbed morphometry because their juveniles are transported freely in the water column and must settle in viable habitat on the riverbed to recruit. Consequently, the physical processes determining where settlement occurs are important for recruitment but have received limited attention. Physical models are used to study hydrodynamically-mediated dispersal when it is not possible or appropriate to release live organisms or their propagules. Large quantities of particles are required, which has historically limited the application of microscopic physical models to non-biodegradable plastics. We developed a novel biodegradable and non-toxic physical model (alginate microbeads) with modifiable size and density. We specifically designed the microbeads to simulate the physical characteristics of juvenile unionid mussels to model their dispersal in the field. The microbeads were loaded with either a natural fluorescent pigment (riboflavin) and glycerol, or calcium carbonate, to aid with detection and add excess density. We released the microbeads at two sites, one at the Speed River, Guelph, ON, and one at the Grand River, Kitchener, ON. Microbead captures in drift nets and specially designed sedimentation traps revealed patterns of transport and entry into the riverbed. The decline in microbead capture rates with distance downstream correlated with negative exponential and power model predictions, which is consistent with dispersal studies on larval mussels and other taxa. Our work thus far has also found good correspondence between our microbead captures and the predictions made by a mechanistic model that accounts for turbulence. The physical model developed in this study provides an environmentally-friendly resource to study the dispersal of freshwater mussels and other aquatic organisms. This study informs management and conservation efforts on population augmentation planning, and how land use changes to river habitats may affect mussel dispersal.

Platform 27: Buffering success: assessing the effect of riparian vegetation buffers on juvenile unionid mussel habitats

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Freshwater Unionids are an ecologically important and imperiled family of mussels whose conservation is essential for protecting freshwater ecosystems. Conservation efforts aimed at unionids include best management practices (BMPs) such as the construction or preservation of riparian vegetation buffers. However, the effectiveness of vegetation buffers at conserving aquatic habitats has been equivocal, and the habitat requirements of unionids – especially juvenile unionids – are not well understood. This is unfortunate because juvenile unionids experience increased mortality in poor pore-water conditions characterized by low dissolved oxygen (DO), high ammonia, high turbidity, low hyporheic conductivity, and cyanobacteria/chlorophyte dominated algae communities which can be caused by anthropogenic nutrient and sediment inputs. Because riparian vegetation buffers have proven to be effective in attenuating nutrient and sediment loads, we are examining whether riparian buffers are effective at maintaining juvenile mussel habitat quality by conserving pore-water conditions.

To evaluate how vegetation buffers conserve juvenile habitats, we are comparing the pore-water conditions (water chemistry, hyporheic conductivity, and algal assemblages) in mussel beds located in good quality sites (intact vegetation buffers > 30 m on both banks and juvenile recruitment) vs. poor quality sites (fragmented vegetation buffers < 20 m on one bank) in the northern and eastern branches of the Sydenham River. Preliminary results indicate that there is lower DO and higher ammonia at the upstream edge vs. the center of mussel beds, but difference between pore-water conditions in good quality and poor quality sites is not as apparent.

Understanding the habitat requirements of juvenile unionids and the effectiveness of riparian vegetation buffers at preserving their habitats will help improve the understanding of unionid life history and guide future conservation efforts. Additionally, this research may provide a potential method of determining juvenile mussel habitat suitability by examining pore-water conditions.

Platform 28: Temporal dynamics of freshwater mussel larvae

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Freshwater mussels often live in multispecies 'mussel beds' (e.g., 24 sp. in sites in the Sydenham River, Ontario) where many of the mussels have been reported to use the same fish species as hosts for their parasitic glochidial larvae. Given the coupling of mussels and host fishes, the purpose of this study is to gain a better understanding of the early life history of mussels to help protect these imperiled organisms. We are examining the temporal dynamics of glochidia in the water column and the potential for partitioning of their 'host-fish' environment through differential timing of glochidial release among species. We hypothesized that glochidia from different mussel species are released at different times of the day to minimize potential competition for host fish. Glochidia were continuously sampled in the water column at 2-h intervals over ten 24-h sampling days (i.e., 120 x 2-h samples) using a custom rosette sampler in the Sydenham River from late August to September 2020. A total of 3,785 glochidia were collected from 17 mussel species; the vast majority of glochidia were *Eurynia dilatata* (Spike, 75 % relative abundance), followed by *Actinonaias ligamentina* (Mucket, 8.6 %), *Epioblasma triquetra* (Snuffbox, 2.8 %), and *Cyclonaias tuberculata* (Purple Wartyback, 1.7 %). The concentration of glochidia varied temporally, particularly at nocturnal (nighttime) and crepuscular (dawn and dusk) diel periods among sampling days. For example, there were clear peaks between 20:00 - 24:00 h solar time on different sampling days. Statistical analysis of the results is in progress. The results provide greater insight into the host-parasite relationship in freshwater mussels and may provide insight into the potential threats and mechanisms leading to mussel declines. Ultimately, this information will improve our scientific understanding of mussel reproduction and supplement Species at Risk (SAR) recovery, conservation and management plans.

Platform 29: One Shell Orientation to Rule Them All? The effects of hydrodynamic forces on the orientation of freshwater mussels

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Unionid mussels are a diverse group that play a pivotal part in aquatic ecosystems by providing a number of ecosystem services such as the improvement of water quality through their suspension feeding. Water flow has a significant role in the morphology, physiology, and orientation of freshwater mussels, particularly with their nutrition intake and reproductive practices. Unfortunately, excessive hydrodynamic forces can also be disruptive through the dislodgement of freshwater mussels from the benthos. This presentation focuses on how hydrodynamics affect the evolution and diversity of shell shapes of unionid mussels. Specifically, unionids have evolved in response to the hydrodynamic forces of lift and drag as well as shear stress in the benthos while carrying out their feeding and reproductive activities. It is likely that unionids change their orientation and how deep they embed themselves in mussel beds due the hydrodynamic forces in the environment. It is predicted that mussels with elongated shell shapes such as *Lampsilis siliquoidea*, will experience less hydrodynamic forces when oriented lower in the water column. These predictions were examined using computational fluid dynamic modeling of mussels embedded in sediments vs. exposed on the sediment surface at different vertical and horizontal angles and Reynold numbers (Re = length x velocity/kinematic viscosity), as well as inferences from field measurements in southwestern Ontario. Results indicate that the drag coefficient increases when *L. siliquoidea* oriented themselves higher in the water column, which would increase the force that they experience (drag force is directly proportional to the drag coefficient) and make them vulnerable to dislodgement. For example, the drag is ~4x larger for an embedded *L. siliquoidea* oriented perpendicular vs. parallel to the sediment surface at the highest Re (i.e., 60 cm/s), and is >6x larger for an exposed mussel in the perpendicular orientation. Exposed mussels experience ~2.7x more force than embedded mussels depending on the Reynolds number. These results provide a better understanding of the hydrodynamic forces that mussels experience in the nature, which is especially important given the increased severity of storms under climate change. Ultimately, it will assist with the development of conservation strategies for endangered SAR mussels.

Platform 30: Unionid species at risk and benthic macroinvertebrate community biomonitoring reveal complementarity in support of watershed-scale restoration

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Freshwater mussels are central to the health of river ecosystems through providing multiple ecosystem functions that influence co-occurring species and their habitats. However, human impacts have driven declines in freshwater mussel communities and possible solutions for their recovery are complex. Within Canada, conservation of imperiled species has focused on key regions such as the Sydenham River in the Laurentian Great Lakes Basin, with limited insight into the habitats or watersheds they reside in. Unfortunately, it is common that species specific information and the condition of the ecosystems remain siloed between data holders, limiting the potential impact of conservation measures and their impact. Here we examined federal and local mussel records, harmonized with our own survey effort, to explore patterns of mussel species co-occurrences and macroinvertebrate community assemblages. Significant differences were present between mussel communities in tributary and main stem sites. Benthic macroinvertebrate diversity metrics (e.g., family richness, %EPT) and specific indicator taxa were strong predictors of mussel species richness and the presence of imperiled mussel species. Our analysis suggests that mussel community data could provide insight into imperiled species occurrences and that monitoring benthic macroinvertebrate diversity may have additional applications to inform mussel conservation. The complimentary patterns of community composition observed support collaborative and holistic approaches to freshwater mussel conservation as part of broader ecosystem management efforts.

Platform 31: Predicting mussel species at risk distributions in southwestern Ontario rivers using spatial distribution models and the Aquatic Ecosystem Classification method

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By identifying relationships with abiotic and biotic factors, output from species distribution models (SDM) can help to identify the boundaries of aquatic species at risk critical habitat, direct inventories, and define the spatial units for long-term population monitoring. In this study, we tested whether SDMs can be developed from existing southern Ontario occurrence data for five mussel species at risk using MaxEnt software; a program for modelling species distributions with presence-only species records. Models were built using species presence and abiotic attribute data for the Ausable, Bayfield, Grand, Thames, and Sydenham rivers. Abiotic attributes included: channel slope, riparian and catchment forest cover, summer water temperature, surficial geology and upstream catchment area. Attributes were based on the provincial Aquatic Ecosystem Classification (AEC) scheme. Strongly supported distribution models were developed for all five mussel species, with 2 to 4 influential predictor variables being identified for each species. Predictors identified consistently across species as influencing habitat suitability were summer water temperature and upstream contributing area. Other informative variables (i.e. geology and tree cover) were only identified for more widespread species (e.g. Wavy-rayed Lampmussel). The number of informative predictor variables for rarer species (e.g. Fawnsfoot) may be limited by the small number of species records, which could be addressed through future inventories. Incorporating the influence of anthropogenic stressors and host fish availability would also improve MaxEnt models but does require the compilation of additional databases.

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