2023 NANFA RESEARCH GRANT REPORT

FRESHWATER MUSSEL SHELLS AND *NOTURUS* MADTOMS IN ONTARIO: A RARE OPPORTUNITY FOR THE CONSERVATION OF TWO AT-RISK GROUPS

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INTRODUCTION

The madtoms, genus *Noturus*, are a large and diverse group of freshwater catfishes endemic to the eastern portions of the United States and Canada. Many species have highly restricted ranges and are significantly specialized for their habitats. This, combined with their secretive nocturnal habits and low tolerance for adverse water conditions, makes them a poorly understood and vulnerable group. In Ontario, five species are known. Of these species, two—the Stonecat *N. flavus* and the Tadpole Madtom *N. gyrinus*—are widespread. The status of another, the Margined Madtom *N. insignis*, is disputed as it is currently unknown whether this species has an extremely limited and fragmented Canadian range, or if it has simply been introduced (Government of Canada 2015). The two species that remain—the Brindled Madtom *N. miurus* and the Northern Madtom *N. stigmosus*—are restricted to the southern parts of the province, including much of the Carolinian zone, and generally rarer. The Northern Madtom, especially, is considered to be one of the rarest fish in Canada and is listed as Endangered in Ontario (Government of Ontario 2014c). These tiny catfishes make up half of the basis of this study.

The other half of this study is represented by the vast assemblage of freshwater mussel (Unionidae) species that inhabit the streams and rivers of Ontario alongside the madtoms. Like the madtoms, these mussels are under-studied and, also like many species of madtoms, they are very sensitive to alterations in their aquatic habitats. In fact, it is believed that a staggering 70% of North America's freshwater mussel species are either officially listed as threatened/endangered or in decline (Salerno et al. 2018) In Ontario alone, 19 species are designated species at risk (Hayward et al. 2022). Nine of these are endangered just like the Northern Madtom. The associations and inter-relationships between these two entities, however, do not end there; they go far deeper.

The idea for this study came from an observation made by the author in 2020 while assessing populations of freshwater mussels in the Thames River, a prominent aquatic feature of south-central Carolinian Ontario (the life zone in southern Ontario characterized by a rich biodiversity). The species targeted in the survey were the Mapleleaf *Quadrula quadrula* and the Three-horn Wartyback Mussel *Obliquaria reflexa*; these species are listed as special concern and as threatened, respectively (Government of Ontario 2014a,b). Though several living Mapleleaf specimens were quickly located, the most significant observation of the day, at least for the purposes of this study, was still to come. A large, dead mussel shell had just been plucked from the sandy river bottom and was being held up to identify it. Upon being opened to observe the interior structures, an adult Brindled Madtom slid out from inside the shell (Figure 1). The relationship between mussels and some larger catfishes, where the fish spread the mussel's parasitic larvae, which have attached to their fins or gills, is well known (Howard 1913; Steingraeber et al. 2007). A relationship between catfishes (specifically, madtoms) and dead mussel shells, however, has been less frequently examined, indeed to the point where it was unclear to the author whether such an interaction had ever been previously recorded. The answer as to why the fish was inside the shell seems obvious in hindsight; however, it is clear that the shell would provide an excellent hiding place and a good source of physical protection. It made perfect sense that a small, vulnerable fish such as a madtom would take shelter in such a tailor-made sanctuary. And if one species of madtom would use such a shell for shelter, could not others do so? How widespread was this behavior? Preliminary research revealed a 2020 study done by Jacob Brumley and

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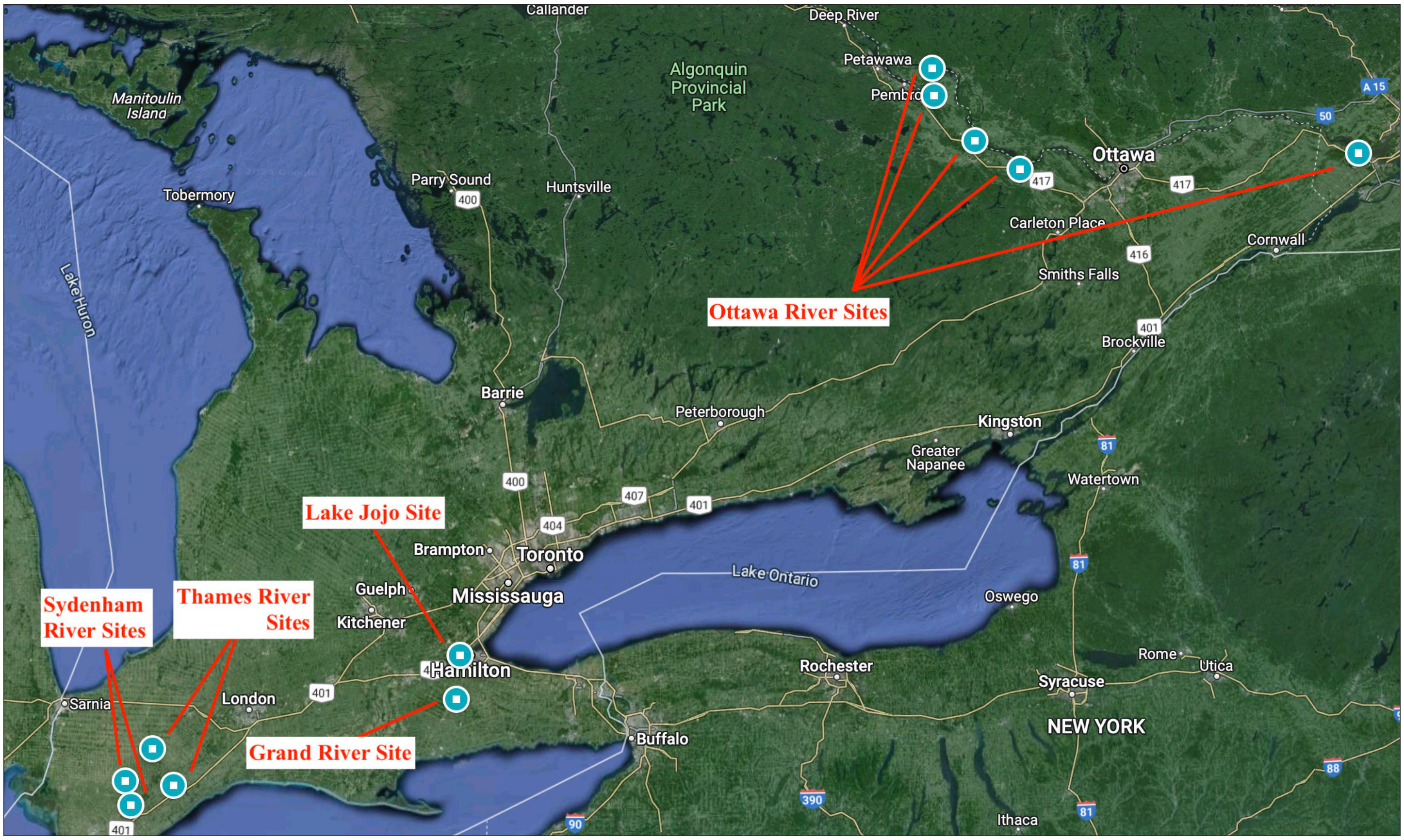

Figure 1. Locations surveyed for madtoms in southern Ontario.

Philip W. Lienesch in Kentucky (Brumley and Lienesch 2020) where they observed madtoms in the Green River using dead mussel shells as cover. They predicted that madtoms would be more willing to utilize mussel shells for cover than other objects such as the river's rock substrate. The results of their study supported their prediction. Furthermore, they postulated that, since mussel shells appeared to play such a vital role in the life history of these madtoms, declines in mussel populations could thus affect madtom populations as well.

But no such study (extensive or otherwise) had been performed in Ontario; so, it was impossible to say if this behavior was widespread here as well. And, if the results of the Lienesch and Brumley study held true in Canada as well, then it is possible that declines in the populations of native mussels here could also account for reductions in the populations of local species of *Noturus*. The central question of this study is then a logical next step: Could the loss of native mussel populations in Ontario be affecting populations of *Noturus* by removing potential homes and/or shelter from their environment as is hypothesized to be occurring in Kentucky?

Figure 2. Brindled Madtom captured at the Alvinston site in 2020.

In order to address this question, and due to a limited budget and lack of a research team, it was necessary to reduce the study to one, far simpler component, which would hopefully act as a steppingstone allowing more research to be done in the future. The more fundamental question was then as follows: **Do the madtoms of Southern Ontario (namely the Stonecat, Tadpole, Brindled, and Northern madtoms) make significant use of mussel shells for shelter in Ontario as they do in Kentucky?** Answering this question would allow for the establishment of a more robust understanding of potential interactions between madtoms and mussels in the province and would provide a jumping off point for assessing whether or not a reduction in freshwater mussel populations and consequently in accumulated dead mussel shells in southern Ontario rivers is a heretofore under-appreciated threat to *Noturus* populations. After all, without knowing whether the behavior recorded at the Thames River in Ontario in 2020 and in the Green River in Kentucky is widespread or commonplace, speculating further will likely be counter productive. The point of this study is not to answer with any certainty whether a loss in what will hereafter be termed "habitat mussels" is affecting populations of at-risk madtoms. Answering that question would require a far longer-term study and likely a budget far greater than a single grant could support. This study instead was designed to provide results and data that can support future research. It is hoped that the results of this study and any that may follow may help us gain a deeper understanding of the larger role of freshwater mussels in the aquatic ecosystem.

STUDY SITES

For this study, 11 river sites in four different southern Ontario watersheds and one isolated small lake (Figure 2) were sampled from May to August 2023 (with one extra day of sampling performed previously in October 2022). The sites were chosen for their accessibility and for their location within river drainages with the largest and most diverse assemblages of both freshwater mussel species and madtoms.

1. **Sydenham River (two sites):** This river is well-known as having the greatest diversity of freshwater mussels anywhere in the country (Metcalfe-Smith et al. 2003) and has significant populations of the Brindled Madtom and Stonecat. It also used to be home to the Northern Madtom, although it is probably extirpated (Government of Canada 2016).
2. **Thames River (two sites):** Like the Sydenham, the Thames once contained a massive assemblage of freshwater mussels, historically containing somewhere around 34 species, although it is now much more degraded than the Sydenham, having lost about one third of its mussel population (Metcalfe-Smith et al. 1999). It is one of the few rivers in Ontario, however, still known to host the Northern Madtom.
3. **Grand River (one site):** The Grand River is less diverse in mussel species than the Sydenham and the Thames but still contains very large populations, including some rare species such as the Threehorn Wartyback (Goguen et al. 2023).
4. **Ottawa River (five sites):** The Ottawa River, being far larger, deeper, and more northerly than any of the other waterways examined, presents distinctly different assemblages of both mussel and madtom species. Brindled and Northern madtoms are not found here, but Stonecat are, and Tadpole and Margined madtoms, which generally do not occur in the other watersheds, can be found in the Ottawa and its tributaries (personal experience). Many of the species of mussel found in the Carolinian Rivers are also absent here, but they are replaced by other at-risk species such as the Hickorynut *Obovaria olivaria* (LeBaron et al. 2018) and the Elephantear *Elliptio crassidens* (personal experience). In addition, the clarity of the water is much greater here than at the other three rivers, making underwater surveying in the area much easier.
5. **Lake Jojo (one site):** In addition to the aforementioned river sites, Lake Jojo, in Dundas, Ontario, was also surveyed. The trip to this site was primarily meant to investigate the status of a transplanted population of the provincially-threatened Lilliput Mussel *Toxolasma parvum* (Campbell 2022), but an eye was kept open for the possibility of any madtoms in the area. The site is a shallow, highly silty small lake with a thick layer of mud/clay as its substrate. The lake tapers to a small, sandy creek at the west end, and its water clarity is much increased compared to the rest of the lake.

Figure 3. Stonecat captured at the Thamesville site in 2022.

SAMPLING TECHNIQUES

A variety of sampling techniques were employed across the sites. Due to highly variable conditions across these sites such as depth, water clarity, and substrate, not all of these techniques were applicable at every site. The four major sampling strategies employed were as follows:

6. **Snorkeling:** Snorkeling at the study sites was one of the first methods attempted in this study. The idea was to slowly crawl along the bottom of the river or stream in the shallower riffles, carefully and methodically looking for any species of madtom and inspecting large dead mussels on the bottom by slowly lifting them up and determining whether a *Noturus* or other organism was sheltering within.
7. **Camera Trapping:** In order to overcome both the issue of poor water clarity and the possibility of scaring potential subjects by snorkeling, the idea was proposed to leave an underwater camera in a promising location, facing towards one or more large mussel shells on the bottom found in situ with good potential to provide shelter for madtoms.
8. **Dipnetting:** A "last resort" technique, it was hoped that by dipnetting, it might be possible to scoop up large shells along with any potential occupants before they were able to flee. This was, after all, how the Stonecat in the Thames originally observed by the author was discovered.
9. **Visual Surveys:** A blanket method that would be the easiest to employ, but it would consequently provide the least amount of hard data. Any observations made in or out of the water from a position not immersed in the water fall under this category. It was hoped that at sites with water too turbid to survey effectively by snorkeling, looking down from above the water and walking slowly upstream may have been a viable alternative. In addition, examination of shells at the river margins or on the immediate shoreline would be used to assess the viability of mussels in the area as shelter/habitats.

RESULTS

Only two madtoms were observed throughout the entire study: both were Stonecats (Figure 3), both were found at the Thamesville site, and both were caught by dipnet. None were observed during visual surveys, snorkeling surveys, or camera trapping. It is unknown if the two specimens caught were utilizing mussel shells as shelter at the time of capture. Mussel shells of sufficient size and orientation for providing adequate shelter/habitat for madtoms were observed at virtually every location, however, and at several of these sites other species of fish or invertebrates were observed to make use of the shells. Around 23.5 hours were spent on-site surveying across the study locations.

AN OBSERVATION ON INTERACTIONS BETWEEN THE LAKE SPONGE *SPONGILLA LACUSTRIS* AND THE EASTERN ELLIPTIO *ELLIPTIO COMPLANATA*

At both the Westmeath Site and the Sandbar Site, Eastern Elliptio was found encrusted with Lake Sponge (Figure 4), one at

Figure 4. Lake Sponge on Eastern Elliptio.

Westmeath, and three at Sandbar. The first mussel consisted of a dead shell, while the latter three were all alive. These observations raise several questions: does Lake Sponge encrust only the Eastern Elliptio? What is the relationship between the sponge and the mussel? Is it commensal, parasitic. or beneficial? Several studies, including those by Ricciardi et al. (1995) and Lauer and Spacie (2004), recorded that freshwater sponges would encrust and outcompete introduced Zebra and Quagga mussels in the Great Lakes, but no study appears to have made similar observations regarding the interactions between native mussels and the sponges. A potential investigation of this observation might be fairly cost-effective and relatively simple. A comparison of size and growth patterns in live mussels with and without encrusted Lake Sponge would begin to inform whether or not the sponges are having any kind of effect on the mussel's fitness, and more intensive surveying would be sufficient to discover if any other species are selected by the sponges as "hosts." There is certainly much to be learned here, and potential for an informative and unique study abounds.

CONCLUSIONS

No madtoms were observed using mussel shells at any of the 11 surveyed sites. This may seem to support the idea that habitat shell use by madtoms is not widespread. When taking into account the fact that only two madtoms were captured in total (both Stonecat, and both at the Thamesville site), it becomes clear that the central question of this study, "Do the madtoms of southern Ontario make significant use of mussel shells for shelter as they do in Kentucky?" can regrettably not be answered one way or another at this time. However, several other observations made during the course of this study are able to fill in some of the peripheral picture, so to speak. At the Alvinston, Florence, and Caledonia Sites, multiple crayfish, as well as stonefly, beetle, and caddisfly larvae, were found inside mussel shells, showing that the use of such shells as shelter for adult and developing invertebrates is widespread at these sites. In addition, at the Alvinston Site, Johnny Darter *Etheostoma nigrum* were observed laying eggs inside mussel shells. And, at the Caledonia Site, either a darter species or a Round Goby *Neogobius melanostomus* was observed to shelter inside a habitat shell by the Camera Trap. Again, this does not say anything about these species' preference for using shells or other forms of cover, but it shows that the use of habitat shells is occurring in some capacity.

Regardless of the shortcomings of this study, the author's hope is that their efforts will provide a knowledge base for future research. Valuable data on the presence and absence of mussel and fish species at the 11 sites has indeed been obtained, and this data can be put to use in future, more extensive projects. Future researchers will be able to look to this study for reference regarding potential sampling sites or techniques, and they will be able to use this report to foresee and address complications such as heavy turbidity. The possibilities are endless. If nothing else, the results of this study have certainly provided the author with a far greater understanding and appreciation of the riverine habitats he investigated than he ever thought he could have. This study is far from over; the author would like to continue it, and this project should provide a good starting point for future research.

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Figure 5. Cut strips of salmon drying. (Photo by Jeff Chen)

learned the mending process and the proper knots to use while they made a new set net for use in the Educational Fish Net Fishery, a program permitted through the Alaska Department of Fish and Game.

Early the next morning, one of the Village elders set the Educational Fish Net during low tide in the Cook Inlet in Eklutna's designated fishery site. In the early afternoon the net was checked, and the fish were harvested; a nice mix of Coho and Sockeye was captured (Figure 4). An elder taught her method of fish cutting and taught how to brine, smoke, and dry the catch (Figures 5 and 6). The meat was stripped, brined, and smoked along with the backbones, and the heads and eggs were set aside to make a traditional fish-head soup, which was served with lunch the following day. After several days of smoking and drying, the strips and backbones were taken home by participants and donated to elders.

Figure 6. Salmon drying and being smoked. (Photo by Jeff Chen)

CONCLUSION

NVE's 2023 Culture Camp was a great success, and the salmon activities were extremely well-received. It was our most well-attended Camp to date, averaging approximately 60 participants per day. The youth participants came away with increased knowledge and appreciation for salmon and the cultural significance they have for the Eklutna People. It was a great opportunity to connect both youth with elders and the past to the present. We thank NANFA for awarding the Gerald C. Corcoran Grant funds to help facilitate these educational activities, which will be continued and expanded into the future.

If you would like to learn more about the Eklutna River and the ongoing effort to restore flows to save the salmon, please visit eklutnariver.org, and consider pledging your support and raising awareness to this important effort.

(Mussels and Madtoms, continued from page 10)

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