MDOT Mussel Relocation at Nottawa Creek – M60/66, St. Joseph County



Prepared by: Peter J. Badra Michigan Natural Features Inventory P.O. Box 13036 Lansing, MI 48901

For: Michigan Department of Transportation Lansing, MI

March 8, 2021 (Addendum 2022)

Report Number 2021-01

Extension

MICHIGAN STATE





Suggested Citation:

Badra, P.J. 2021. MDOT Mussel Relocation at Nottawa Creek – M60/66, St. Joseph County. Michigan Natural Features Inventory Report No. 2021-01, Lansing, MI. (Addendum 2022: One Year Post Relocation Survey)

Cover Photos: Inset left, Mucket (*Actinonaias ligamentina*) and inset right, Ellipse (*Venustaconcha ellipsiformis*) a species of special concern tagged and relocated from the M60/66 bridge site in Nottawa Creek, St. Joseph County; Background, Nottawa Creek at the M60/66 bridge crossing looking north from the bridge site transect A.

MSU is an affirmative-action, equal-opportunity employer. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, gender, gender identity, religion, age, height, weight, disability, political beliefs, sexual orientation, marital status, family status or veteran status.

Copyright 2021 MSU Board of Trustees

Acknowledgments

Financial support for this project was provided by the Michigan Department of Transportation. Joe Rathbun, Ashley Cole-Wick, and Charlotte Brennan provided valuable assistance with field surveys. Ashley Adkins, Sarah Carter, Brian Klatt, Mike Monfils, Deb Richardson, and Nancy Toben provided essential administrative support.

Introduction

The goal of this project is to minimize potential impacts of a planned M60/66 bridge repair on native unionid mussel species at the Nottawa Creek crossing. Surveys were performed to document the native mussel community present at the bridge site and to identify a suitable relocation site upstream and nearby the bridge site. A complete search was made at the bridge site and all live unionid mussels found were tagged and moved to the relocation site. Survey and relocation methodology followed guidance provided in Michigan's Mussel Survey Protocols and Relocation Proceedures (Hanshue *et al.* 2019). A follow-up survey is planned for approximately one-year post relocation to monitor the status of relocated mussels and help assess the success of the relocation.

Nottawa Creek flows into the St. Joseph River (Lake Michigan drainage) with a watershed encompassing 92.5 square miles (59,196 acres). The M60/66 bridge site is located 860m upstream from the confluence with the St. Joseph River; township 5 south, range 9 west, section 29; St. Joseph County. The center of the area of direct impact is N42.01023 W85.38820. The Nottawaseppi Huron Band of Potawatomi Indians Reservation is located within the Nottawa Creek watershed in the southwest corner of Calhoun County. Land use within the watershed is 68 percent agricultural, 13 percent forested, 10 percent wetland, and 9 percent nonfarm lands. Pollutants in the watershed include excessive sediments and nutrients, pathogens, and pesticides (Matousek 2020). There are four dams on the mainstem of the creek. A history of dredging, channelization, draining of wetlands, and removal of large woody cover has had long-term impacts on the Nottawa Creek ecosystem. These including increased erosion and sedimentation, altered hydrology (increased flashiness), reduction in shading from natural riparian vegetation, and loss of fish cover such as log jams (Gunderman 2013). Sources of excess nutrients in Nottawa Creek include livestock and waterfowl access to the stream, leaking septic systems, fertilizer and pesticide runoff from non-agricultural lands, and erosion and runoff from roadsides (Williams 1998).

There is a 1930 occurrence record for ellipse (*Venustaconcha ellipsiformis*, species of special concern) 2.5km upstream of the Nottawa Creek - M60/66 site, and a pre-1940 occurrence record for snuffbox (*Epioblasma triquetra*, federally endangered) in the St. Joseph River near the confluence of Nottawa Creek. These occurrence records originate from the University of Michigan Museum of Zoology Mollusk Collection. In 2001, two empty snuffbox valves were found 5.3km downstream of the Nottawa Creek - M60/66 site in the St. Joseph River. Also found at this site in 2001 were live mucket (*Actinonaias ligamentina*), Wabash pigtoe (*Fusconaia flava*), fluted-shell (Lasmigona costata, species of special concern), and black sandshell (*Ligumia recta*, state endangered), and shells of elktoe (*Alasmidonta marginata*, species of special concern), purple warty-back (*Cyclonaias tuberculata*, state threatened), and round pigtoe (*Pleurobema sintoxia*, species of special concern) (Badra and Goforth 2001).

Methods

The area of direct impact (ADI) for the planned M60/66 bridge repair in Nottawa Creek is an area 18m wide by 35m long, centered on the bridge. The downstream buffer zone is an 18m wide by 7m long area extending downstream of the ADI (Figure 1.) Property owners with land adjacent to the M60/66 bridge site, as well as the river reach upstream of the bridge were contacted by letter to describe the nature and timing of planned field work and provide contact information if they had questions or concerns. One landowner stopped by the field site while surveys were taking place to talk about the project. Fieldwork took place from October 2nd to 15th, 2020. Personnel included two MNFI staff and one retired aquatic biologist.



Figure 1. The area of direct impact (red) and downstream buffer zone (yellow) at the M60/66 bridge site. Figure provided by MDOT.

Semi-quantitative Surveys

Transect surveys were performed at the bridge site and potential upstream relocation site to characterize the unionid mussel communities at those locations (Figure 2). These surveys took place between October 2nd and 7th, 2020. Two, one meter wide transects running from one side of the stream to the other, parallel to the bridge were established at the bridge site. The first (transect A) was placed six meters downstream of the downstream edge of the bridge abutment (Figure 3) and the second (transect B) five meters upstream of the upstream edge of the bridge abutment (Figure 4). At the potential relocation site, the downstream transect (transect A) was located 228m upstream of the northern edge of the bridge at N42.01177 W85.38676 (Figure 5) and the upstream



Figure 2. Location of transects for the initial survey of the area of direct impact (yellow) and potential relocation site (blue), and area mussels salvaged from the bridge site were relocated to (red square).

transect (transect B) was located 274m upstream of the northern edge of the bridge at N42.01166 W85.38623. Tactile and visual methods of detection were used to search each transect for live mussels and shells. Stream substrate within transects was excavated 5-10cm down by hand to help ensure buried mussels were not overlooked. Approximately 3-10 minutes of search effort was spent per square meter during transect surveys. A longer search time per square meter (6-10min.) was required in areas with firmly embedded pebble sized rock than what would normally be spent. Deeper holes down to 25cm were occasionally excavated into the substrate to help confirm that live mussels were not being missed.

Glass bottom buckets were used to facilitate visual detection. A full-face mask with snorkel and drysuit were used in the deeper section of each transect at the bridge site to facilitate surveys in areas that were between 50cm and 70cm deep. Live individuals were identified to species and placed back into the substrate anterior end down (siphon end up) in the immediate vicinity of where they were found. Shells were also identified to species and returned to the river. The number of live individuals of each unionid mussel species was recorded at each transect. Length measurements were made on all live individuals found. The presence of Gastropods, Asian



Figure 3. The east half of transect A at the M60/66 bridge site, looking north.



Figure 4. Transect B at the M60/66 bridge site, looking east.



Figure 5. Transect A at the relocation site, 228m upstream of the M60/66 bridge, looking north.

clams (Corbicula fluminea) and zebra mussels (Dreissena polymorpha) were noted if found.

Habitat data were recorded to describe and document stream conditions at the time of the surveys. Substrate within each transect was characterized by estimating percent composition of each of the following six particle size classes (diameter): boulder (>256 mm); cobble (256-64 mm); pebble (64-16 mm); gravel (16-2 mm); sand (2-0.0625 mm); and silt/clay (<0.0625 mm) (Hynes 1970). Woody debris, aquatic vegetation, and eroded banks were noted when observed. The percentage of the search area with pool, riffle, and run habitat was estimated visually, and a rough measure of current speed was made.

Relocation

A thorough search of the salvage area (ADI plus downstream buffer) was performed using tactile and visual means of detection. The entire ADI and downstream buffer were searched starting at the downstream end working upstream. The top 5-10cm of substrate was swept away and raked through with surveyor's hands. Deeper holes down to 25cm were occasionally excavated into the substrate to help confirm that live mussels were not being missed due to being buried deeper than 5-10cm. SCUBA gear was used to survey areas of the ADI and downstream buffer that were deeper than approximately 70cm. A guideline running parallel with the current was used to track progress while searching the substrate using SCUBA. A drysuit and full-face mask with snorkel were used in areas that were between approximately 50cm and 70cm deep. Glass bottom buckets were used in areas less than approximately 50cm deep. A total of 18.6 person hours were spent searching the 756m² area (ADI and downstream buffer) for an average of 1.5 minutes search time per square meter. The salvage survey and relocation took place October 8th and 15th, 2020.

All live mussels detected within the ADI and downstream buffer zone were placed in mesh bags and kept in the water at the edge of the creek until that portion of the search area was completed. Live individuals were carried upstream to the relocation site (10min walk) and placed back in the water. Each live individual of all unionid mussel species was dried with a towel and tagged with a polyethylene shellfish tag on each valve. Hallprint FPN 8mm x 4mm "Twin" glue-on shellfish tags were attached using cyanoacrylate glue. These tags are coded so that, for example, one valve has tag A001 attached and the other valve B001. A photo was taken of each tagged mussel. Mussels were planted approximately half-way into the substrate at the relocation site. Mussels were placed in an 14m² area centered at N42.01173 W85.38678, approximately 228m upstream of the northern edge of the M60/66 bridge. Measurements to a landmark were also made to more precisely document the location where mussels were placed. The center of the relocation area is 14.8m, bearing 38°, from the largest sycamore tree on the southern stream bank, south of N42.01173 W85.38678.

Results

Semi-quantitative Surveys

A total of eight mussel species were detected in the two transects searched at the bridge site, including three species of special concern. However, only one live mussel was found, a Wabash pigtoe (*Fusconaia flava*) (Table 1). All other species were represented by empty shells. A total of five mussel species were detected in the two transects at the relocation site. All five species were represented by live individuals, including one species of special concern (Table 2). Photographs representing each mussel species are provided in Appendix A. Lengths of all live mussels found in transects searched at the bridge site and potential relocation site are given in Table 3.

The one species found live in the bridge site transects (Wabash pigtoe) was also found live in the relocation site transects. An additional three species were found live in the relocation transects that were only represented by shell in the bridge site transects, including ellipse (*Venustaconcha ellipsiformis*) a species of special concern. A fourth species found live in the relocation transects was not found in the bridge site transects. No dreissenid mussels were observed at the bridge site or potential relocation site. Numerous live Asian clams were noted at both the bridge site and potential relocation site, as well as several rusty crayfish (*Faxonius rusticus*). Other species observed incidentally were rainbow darter (*Etheostoma caeruleum*, Figure 6), blackside darter (*Percina maculata*), and grass pickerel (*Esox americanus vermiculatus*).

The substrate was occasionally was excavated down to approximately 25cm to search for any mussels that have been deeply buried due to the surveys taking place late in the season. No live mussels were detected at these depths within the substrate. Live mussels were found buried just below the surface of the substrate or exposed to some degree to the water column. This increased confidence that mussels were not going undetected because of relatively cold water and air temperatures. Substrate was very similar at the bridge site and relocation site, being a mix of cobble, pebble, gravel, sand, and silt. All five substrate size classes at the bridge site were also present at the relocation site. Cobble and silt were the least prevalent components at both the bridge and relocation site (Table 4). On the east bank of the creek at transect A at the bridge site there were many chunks of asphalt embedded in the bank above water's edge and extending into the water a few meters. The proportion of pool, riffle, run habitat was different between the bridge site and relocation site. These differences in stream morphology between the sites appear to be, at least in part, due to the effects of increased stream current around the bridge piers. Scour around the piers causes pool habitat to be created under the bridge and riffle habitat to be created on the upstream side of the scoured pool, just upstream of the bridge (bridge site transect B).

Water visibility was high (approximately 2m) though limited light under the bridge reduced visibility to around 0.5m (Figure 7). Water pH and conductivity taken at the relocation site was 8.09 and 254µS. Water temperature

at the bridge site was 8°C (46.4°F) on October 2nd and on October 15th. Minimum air temperature recorded was 7°C (44.6°F) taken on October 15th. Other physical habitat characteristics are given in Table 5.

The relocation site has several of the recommended attributes of potential mussel relocation sites listed in the Michigan Freshwater Mussel Survey Protocols and Relocation Procedures (2019). It is upstream and within the same river reach as the bridge site, the mussel community present at the relocation site indicates it would support mussels relocated there from the bridge site, the stream habitat is similar, it is free of disturbances for the foreseeable future, and no dreissenid mussels were present.

Two of the three fish species observed during these surveys are known to be suitable hosts for five mussel species documented in this survey. Mussel species shown to have utilized rainbow darter and/or blackside darter in laboratory or field studies were compiled from the Freshwater Mussel Host Database (2017) (Table 6). Grass pickerel were not reported as hosts for any mussel species. There were no barriers to fish movement between the bridge site and the relocation site. It seems reasonable to assume that fish present at the bridge site could also be present at the relocation site.

Relocation

A total of 25 live mussels representing six species were found in the salvage survey of the ADI and downstream buffer. An additional four species were represented by empty shells only. Shells of the species of special concern round pigtoe and one shell of the state threatened purple wartyback were found during the salvage survey. The number of shells found was recorded for special concern and threatened species. Seven of the 25 live mussels found were ellipse, a species of special concern. No other live listed species or species of special concern were found in the ADI and downstream buffer (Table 7). Photos of all live individuals found in the ADI and downstream buffer are provided in Appendix A. Tag code, length, width, and thickness measurements of each relocated mussel are provided in Table 8. Water depth in the area the mussels were relocated to was approximately 45cm.

Scour of the substrate under the bridge has likely been preventing live mussels from persisting in the area on each side of the bridge pier. Though substrate composition was similar between the bridge site and relocation site, pebble sized substrate particles at the bridge site were more firmly embedded within the smaller sized particles than at the relocation site. This may have been an effect of the scouring taking place near the bridge piers. In addition to the potential future impacts at the M60/66 bridge site, the relocation site seems to be a more suitable location for mussels to thrive because of its less firmly embedded substrate and lack of scouring. A follow-up survey to locate tagged mussels is planned for September 2021 to try to determine the status of each relocated mussel and help assess the overall success of the relocation.

		Bridge Site - Transect A						_	Bridg	e Site	- Transe	ct B	
Common name	Species	# Live	RA	D	# Shell	RA	D	# Live	RA	D	# Shell	RA	D
Mucket	Actinonaias ligamentina				22	0.39	1.21				11	0.55	0.63
Elktoe (SC)	Alasmidonta marginata				1	0.02	0.05				1	0.05	0.06
Pimpleback	Cyclonaias pustulosa												
Purple wartyback (T)	Cyclonaias tuberculata												
Spike	Eurynia dilatata				19	0.33	1.04				6	0.30	0.34
Wabash pigtoe	Fusconaia flava	1	1.00	0.05	11	0.19	0.60				2	0.10	0.11
Plain pocketbook	Lampsilis cardium				1	0.02	0.05						
Round pigtoe (SC)	Pleurobema sintoxia												
Flutedshell (SC)	Lasmigona costata				1	0.02	0.05						
Strange floater	Strophitus undulatus				1	0.02	0.05						
Ellipse (SC)	Venustaconcha ellipsiformis				1	0.02	0.05				1	0.05	0.06
	Total # individuals and density	1		0.05	57		3.13	0		0.00	21		1.20
	# species shell	-			8			-			5		
	# species live	1			-			0			-		
	Area searched (m^2)	18.2			18.2			17.5			17.5		

Table 1. Numbers of live unionid mussels and shells (#), relative abundance (RA), and density (D, individuals/m²) recorded during transect surveys at the M60/66 bridge site. (T= State threatened, SC= species of special concern)

		Relocation Site - Transect A						Relocation Site - Transect B					
Common name	Species	# Live	RA	D	# Shell	RA	D	# Live	RA	D	# Shell	RA	D
Mucket	Actinonaias ligamentina	3	0.60	0.17	8	0.35	0.45				2	0.17	0.11
Elktoe (SC)	Alasmidonta marginata												
Pimpleback	Cyclonaias pustulosa							1	0.17	0.05			
Purple wartyback (T)	Cyclonaias tuberculata												
Spike	Eurynia dilatata	1	0.20	0.06	4	0.17	0.22	2	0.33	0.11	2	0.17	0.11
Wabash pigtoe	Fusconaia flava				5	0.22	0.28	3	0.50	0.16	6*	0.50	0.32
Plain pocketbook	Lampsilis cardium												
Round pigtoe (SC)	Pleurobema sintoxia												
Flutedshell (SC)	Lasmigona costata												
Strange floater	Strophitus undulatus												
Ellipse (SC)	Venustaconcha ellipsiformis	1	0.20	0.06	6	0.26	0.34				2	0.17	0.11
	Total # individuals and density	5		0.28	23		1.29	6		0.32	6		0.32
	# species shell	-			4			-			4		
	# species live	3			-			3			-		
	Area searched (m^2)	17.8			17.8			18.9			18.9		

Table 2. Numbers of live unionid mussels and shells (#), relative abundance (RA), and density (D, individuals/m²) recorded during transect surveys of the relocation site. (T= State threatened, SC= species of special concern)

* One fresh dead Wabash pigtoe was found at relocation site - transect B with all soft tissue still intact. This was counted as a shell.

Table 3. Length measurements for live mussels found during semi-quantitative transect surveys at the M60/66 bridge site and relocation site.

Transect and Species	Length (mm)
Bridge Site - Transect A	
Wabash pigtoe	59
Relocation Site - Transect A	
Mucket	99
Mucket	117
Mucket	117
Spike	54
Ellipse	52
Relocation Site - Transect B	
Wabash pigtoe	43
Wabash pigtoe	75
Wabash pigtoe	79
Pimpleback	51
Spike	61
Spike	82

Table 4. Percent of each substrate particle size class estimated visually for transects surveyed at the M60/66 bridge site and relocation site. Diameter of each size class: boulder (>256mm), cobble (256-64mm), pebble (64-16mm), gravel (16-2mm), sand (2-0.0625mm), silt/clay (<0.0625mm).

	Boulder	Cobble	Pebble	Gravel	Sand	Silt
Bridge Transect A	0	10	20	40	25	5
Bridge Transect B	0	25	30	35	10	0
Average	0	17.5	25	37.5	17.5	2.5
Relocation Transect A	0	20	25	25	20	10
Relocation Transect B	0	15	40	20	15	10
Average	0	17.5	32.5	22.5	17.5	10.0

Table 5. Stream habitat characteristics recorded at transects at the M60/66 bridge site and relocation site.

	Current speed (m/sec.)	Aquatic vegetation?	Woody debris?	Eroded banks?	%Pool	%Riffle	%Run	Max. water depth (cm)
Bridge Transect A	0.50	Y	Y	Y	25		75	65
Bridge Transect B	zero eddy-1.0	Y	Y	Y	10	60	30	65
Relocation Transect A	0.40	Ν	Y	Ν			100	45
Relocation Transect B	0.50	Y	Y	Ν			100	50



Figure 6. Rainbow darter (*Etheostoma caeruleum*), live Asian clam (*Corbicula fluminea*) and stream substrate at the M60/66 bridge site - transect A.



Figure 7. Guideline used to mark progress while searching the area of direct impact and stream substrate at the M60/66 bridge site - transect B.

Table 6. Mussel species found during this survey that utilize rainbow darter (*Etheostoma caeruleum*) and/or blackside darter (*Percina maculata*) as hosts. Compiled from the Freshwater Mussel Host Database (2017). Both fish species were observed at the M60/66 bridge site during the mussel survey.

		Rainbow	Blackside
Common name	Species	darter	darter
Mucket	Actinonaias ligamentina		
Elktoe (SC)	Alasmidonta marginata		
Purple wartyback (T)	Cyclonaias tuberculata		
Spike	Eurynia dilatata	Х	Х
Wabash pigtoe	Fusconaia flava	Х	Х
Plain pocketbook	Lampsilis cardium		
Flutedshell (SC)	Lasmigona costata	Х	Х
Round pigtoe (SC)	Pleurobema sintoxia		
Strange floater	Strophitus undulatus	Х	Х
Ellipse (SC)	Venustaconcha ellipsiformis	Х	Х

Table 7. Numbers of live unionid mussels (#), relative abundance (RA), and density (D, individuals/m²) recorded in the area of direct impact and downstream buffer zone during the salvage survey and relocation. Shells of special concern or state threatened species are also noted. (T= State threatened, SC= species of special concern)

Common name	Species	# Live	RA	D	# Shell
Mucket	Actinonaias ligamentina	9	0.36	0.012	
Elktoe (SC)	Alasmidonta marginata				2
Pimpleback	Cyclonaias pustulosa				
Purple wartyback (T)	Cyclonaias tuberculata				1
Spike	Eurynia dilatata	6	0.24	0.008	
Wabash pigtoe	Fusconaia flava	1	0.04	0.001	
Plain pocketbook	Lampsilis cardium	1	0.04	0.001	
Flutedshell (SC)	Lasmigona costata				1
Round pigtoe (SC)	Pleurobema sintoxia				5
Strange floater	Strophitus undulatus	1	0.04	0.001	
Ellipse (SC)	Venustaconcha ellipsiformis	7	0.28	0.009	1
	Total # individuals and density	25		0.033	
	# species shell	-			
	# species live	6			
	Area searched (m^2)	756			

Species	Tag #	Length	Width	Thickness
Spike	000	76	34	20
Ellipse	001	48	29	17
Spike	002	74	35	20
Mucket	003	84	51	27
Mucket	004	108	68	39
Ellipse	005	57	31	19
Plain pocketbook	006	116	82	50
Ellipse	007	42	25	15
Mucket	008	107	65	39
Mucket	009	87	51	27
Mucket	010	86	51	27
Mucket	011	93	55	33
Mucket	012	93	62	34
Mucket	013	71	45	22
Spike	014	61	31	16
Wabash pigtoe	015	80	60	33
Ellipse	016	42	24	15
Spike	017	69	33	19
Mucket	018	107	60	37
Spike	019	57	29	15
Spike	020	61	33	19
Ellipse	021	51	28	17
Ellipse	022	43	26	15
Ellipse	023	36	20	13
Strange floater	024	62	34	26

Table 8. Tag number and measurements of all live mussels relocated from the area of direct impact and downstream buffer zone at the M60/66 bridge site to the relocation site upstream.

Literature Cited

Badra, P.J. and R.R. Goforth. 2001. Current Status of Freshwater Mussels and Associated Communities in the Grand and St. Joseph Rivers, Michigan. Michigan Natural Features Inventory Report No. 2001-20, Lansing, MI.

Matousek, J. 2020. St. Joseph River Watershed Report. (MI/EGLE/WRD-20/001) Lansing, MI: Michigan Dept. of Environment, Great Lakes, and Energy.

Freshwater Mussel Host Database. 2017. The freshwater mussel host database, Illinois Natural History Survey & Ohio State University Museum of Biological Diversity, 2017. http://wwx.inhs.illinois.edu/collections/mollusk/data/freshwater-mussel-host-database. (accessed March 2021).

Gunderman, B. 2013. Nottawa Creek – Status of the Fishery Resource Report. (2013-167) Lansing, MI: Michigan Dept. of Natural Resources.

Hanshue, S., J. Rathbun, P. Badra, J. Bettaso, B. Hosler, J. Pruden, J. Grabarkiewicz. Michigan Freshwater Mussel Survey Protocols and Relocation Procedures, May 2019, version 2.

Hynes, H.B.N. The ecology of running waters. Vol. 555. Liverpool: Liverpool University Press, 1970.

Watters, G.T., M.A. Hoggarth, and D.H. Stansbery. 2009. The Freshwater Mussels of Ohio. The Ohio State University Press, Columbus.

Williams, S. 1998. Nottawa Creek Watershed Water Quality Planning Project - Watershed Plan. United States Department of Agriculture - Natural Resources Conservation Service, Calhoun Conservation District, Marshall, Michigan.

Addendum: One-Year Post Relocation Survey

Methods

At approximately one year post relocation (September 30, 2021) we performed a survey to find tagged relocated mussels. Visual and tactile methods were used to search for tagged individuals starting at the center point of the relocation site. Glass bottom buckets and snorkel gear were used. An area approximately 350m² was searched for three person hours, including two person hours with glass bottom buckets and one person hour with snorkel gear. The search area extended 5m upstream to 30m downstream of the relocation site. The search area extended further downstream of the relocation area to attempt to locate any tagged mussels that may have been swept downstream in the current. Length, width, and thickness (LWT) measurements were recorded for all tagged and non-tagged live individuals found.

Results

Five of the 25 mussels that were tagged and relocated in 2020 were recaptured (Figures 8a-8e). They were found within five meters of the spot where they were relocated in 2021. All tagged individuals found were live and apparently healthy based on their position in the substrate (planted upright) and their response to being picked-up (shells closed tightly). Both the left valve and right valve tags were present and firmly attached to the recaptured mussels, indicating good tag retention. No tagged empty shells were found. Six live mussels without tags were found. All live mussels were returned to the spot where they were found with tags intact.

Photos of the six live mussels found without tags were compared to individuals tagged in 2021 to confirm that they were not previously tagged individuals that had lost their tags. Comparing length, width, and thickness measurements between 2021 and 2020 showed strong evidence for growth in one of the five recaptured mussels, plain pocketbook 006 (Table 9). Measurements for the other four mussels were within +/- 1mm between 2020 and 2021 and were within the range of error for the measurement technique. Incidental finds during the recapture survey included logperch (*Percina caprodes*), blackside darter (*Percina maculata*), creek chub (*Semotilus atromaculatus*), and common shiner (*Luxilus cornutus*).

Table 9. Length, width, and thickness measurements (mm) for tagged mussels found during the one-year post relocation survey on September 30, 2021, compared to measurements taken on October 8-15, 2020.

		<u>2021</u>				2020	<u>)</u>	Difference			
Species	Tag #	Length	Width	Thickness	Length	Width	Thickness	Length	Width	Thickness	
Spike	002	75	35	20	74	35	20	1	0	0	
Mucket	003	84	50	27	84	51	27	0	-1	0	
Mucket	004	109	68	40	108	68	39	1	0	1	
Plain pocketbook	006	119	93	51	116	82	50	3	11	1	
Mucket	013	72	44	23	71	45	22	1	-1	1	

Figures 8a-8e. Five tagged mussels recaptured on September 30, 2021.



Figure 8a. Spike - 002



Figure 8b. Mucket - 003.



Figure 8c. Mucket - 004.



Figure 8d. Plain pocketbook - 006.



Figure 8e. Mucket - 013.





Mucket (Actinonaias ligamentina)







Mucket - 004



Mucket - 008



Mucket - 009





Mucket - 010

Mucket - 011



Mucket - 012



Mucket - 013



Mucket - 018



Elktoe (Alasmidonta marginata, SC)



Pimpleback (Cyclonaias pustulosa)



Purple wartyback (Cyclonaias tuberculata, T)



Spike (Eurynia dilatata) - 000



Spike - 002



Spike - 014



Spike - 017





Spike - 019

Spike - 020



Wabash pigtoe (Fusconaia flava) - 015



Plain pocketbook (Lampsilis cardium) - 006



Flutedshell (Lasmigona costata, SC)



Round pigtoe (Pleurobema sintoxia, SC)



Round pigtoe (Pleurobema sintoxia, SC)



Strange floater (Strophitus undulatus) - 024



Ellipse (Venustaconcha ellipsiformis, SC) - 001



Ellipse - 005







Ellipse - 021



Ellipse - 022



Ellipse - 023

Appendix B. Scientific Collector's Permit and State Threatened and Endangered Species Permit.



STATE OF MICHIGAN

DEPARTMENT OF NATURAL RESOURCES



Date Issued: 10/24/2018

SCIENTIFIC COLLECTOR'S PERMIT Fish, Reptile, Amphibian, Crustacean, and Mollusk

Under the provisions of Part 487, Act 451, P.A. 1994, as amended, being section 324.48735, permission is hereby granted to:

Name: Brian Klatt

Driver's License No.: K 430 098 352 993 MI

Address: Michigan Natural Features Inventory Michigan State University Extension P.O. Box 30444 Lansing, MI 48909

to take, catch, or kill and possess the aquatic species from the waters and land within the jurisdiction of this state, as specified below in the special provisions section. This permit limits the take of aquatic species to the **minimum** number needed.

Prior to field activities occurring on any stream, public lake or public lands under this permit, the permittee **must notify** the local fish biologist or Fisheries Division supervisor of the Management Unit where collections will occur. This contact must be made at least 48 hours prior to commencing field work <u>and</u> during normal business hours Monday-Friday between 8 a.m. and 5 p.m. If a set work schedule has been established for the field season, providing a copy to the unit may alleviate the need for additional contacts with a single unit. It is also strongly recommended that the permittee notify the District Law Supervisor for the county where the permit is being used. Failure to notify the law supervisor may result in the disruption of field work. Both of these contacts can be initiated by calling the appropriate operational service center (map and phone numbers provided).

SPECIAL PROVISIONS: Permittee, or any Michigan Natural Features Inventory permanent staff, or any temporary, contract, and volunteer personnel working under the direct supervision of the permittee or a permanent staff member, is authorized to collect, identify, mark, and release all fish, reptile, amphibian, crustacean, and mollusk species. Possession of dead or salvaged specimens is permitted. A permit from the Threatened and Endangered Species Unit of Wildlife Division is required in conjunction with this permit for any work with species listed in Michigan as threatened or endangered.

A list of Michigan's species as well as their relative health statuses can be found online at www.michigan.gov/scientificcollectorspermit

Fish may not be marked, clipped, or tagged prior to release under this permit without first reviewing and receiving prior approval of those marking plans from the DNR Fisheries Division Unit Manager responsible for the management area where the activity is to occur.

.

In response to the VHS virus and other aquatic invasive species in Michigan, the following is required:

- All equipment coming in contact with water including: boat hulls, boat trailers, buckets, waders, nets, etc. must be visually inspected and cleaned by hand picking any attached plants, sediments, or other debris. This should be done immediately upon leaving the water body being worked on.
- 2) All equipment coming in contact with water and/or fish and/or specifically working with aquatic invertebrates including: boat hulls, boat trailers, buckets, waders, nets, etc. must be disinfected using a 1 cup of bleach to 10 gallons of water solution at the end of each sampling day or prior to entering each successive water body if more than one is being sampled per day. If long periods of time (a week or longer) are anticipated in between sampling events, thorough drying of all equipment in the sun is an acceptable alternative to using the bleach solution.
 - a. A 20 min Virkon Aquatic bath can be substituted as a bleach alternative.
 - b. A 20 min 100% vinegar bath can be substituted as a bleach alternative.
- 3) If using a boat, live wells and bilges must be emptied and disinfected with a solution of 1 cup of bleach to 10 gallons of water at the end of each sampling day or prior to entering each successive water body if more than one is sampled per day.
 - a. A 20 min Virkon Aquatic bath can be substituted as a bleach alternative.
 - b. A 20 min 100% vinegar bath can be substituted as a bleach alternative.
- 4) All water used to transport live fish or aquatic invertebrates from the point of capture to the holding location must be disposed of in a municipal sewer system w/ water disinfection capabilities or on the grass/ground at least 300' from a water body.
- 5) All live fish that have been held for study, when they are no longer needed, **must be euthanized** and disposed of in a licensed landfill or any other approved location provided by the applicant. Under no circumstances are any live fish after being removed from a water body and held elsewhere to be released.
- 6) All water used to hold and rear fish or in performing any experiments must be disposed of in a municipal sewer system w/ water disinfection capabilities or on the grass/ground at least 300' from a water body.
- 7) All voucher specimens must be euthanized while in the field and preserved in a formalin or ethanol solution prior to transportation.

For more information on VHS or invasive species, go to the Fisheries link on the Department of Natural Resources web site at: <u>http://www.michigan.gov/dnr</u>

Reptile and Amphibian Disinfection PROTOCOL

Disease transmission between reptile and amphibian populations is becoming an important issue. Additionally, the movement and spread of aquatic invasive species continues to impact and threaten ecosystems across the state. To prevent disease and invasive species transmission between study/collection locations that are not "water connected" or that animals don't move freely between, the following disinfection protocols are provided. The procedure should be completed on all gear/equipment that may have touched site water or was used to handle animals, including but not limited to:

- Waders
- Shoes/boots
- Dip nets
- Rulers and other instruments
- Specimen bags/containers
- Traps

Materials that will be needed for disinfecting equipment include:

- Plastic bucket
- Gallon of chlorine bleach
- Two stiff scrub brushes, one for sterilization and one for cleaning off mud/dirt
- Spray bottle

Procedure:

- 1) Before leaving the site, visually inspect and wash off as much of the mud/dirt from equipment and gear in the site's water source removing any vegetation or detritus attached.
- 2) Fill bucket with two gallons (eight quarts/32 cups) clear water.
- 3) Add 36 capfuls (1 cup) of bleach (3% concentration) and stir to mix.
- 4) Rinse off any equipment used in the bleach solution. NOTE: Do all sterilizing with bleach solution well away from streams or ponds
 - a. Dip shoes in solution and scrub and shake off.
 - b. Dip and scrub waders in bucket or lay them on the ground and pour solution on them. A spray bottle can also be used to apply solution.
 - c. Sterilize brushes in solution.
- 5) If possible, save any remaining sterilization solution in a sealable container for future use. If solution must be discarded, dispose of on asphalt, cement or hard roadbed, away from any water bodies.
- 6) If at all possible, allow gear and equipment to dry completely before use at next site.

NOTE: The commercial product Virkon Aquatic can be used at 20 g/L solution for 20 minutes as an alternative to bleach. Rinse equipment well away from stream or ponds

***While it is still recommended, permittees collecting or working in a single site location are not obligated to disinfect gear/equipment. This includes nature center permittees or others working solely on their own property. Permittees must still remove by hand any plant material from their boats, trailers, or other equipment prior to transport.

Michigan Herp Atlas

The Michigan DNR has partnered with Herpetological Resource and Management, LLC to create and administer an inclusive database of reptile and amphibian sightings in Michigan. This project has become commonly known as the Michigan Herp Atlas. While not required, you are encouraged as a Michigan Scientific Collector's Permit holder working with herp species to aid in this effort by visiting the project website and providing locations (Lat and Long or Township/Range/Section) of any reptiles or amphibians you encounter while in the field. The Michigan Herp Atlas website is <u>http://www.miherpatlas.org/</u> Observational reports can be made online through the atlas website or by contacting David Mifsud (<u>DMifsud@HerpRman.com</u>). Reports of all species are welcome!

Permitted collection area: All watersheds statewide.

Permitted collection gear: By hand; cover boards, drift fences, funnel traps, SCUBA; ponar dredge; vacuum sampler; d-frame macroinvertebrate sampler; pit fall traps; electroshocking; and plankton, trap, seine, gill nets and any other commonly accepted scientific method of non-lethal sampling. **NOTE: Gillnets may only be used after consultation with a fisheries biologist in the management unit where sampling is to occur.**

A copy of all reports and scientific papers using organisms collected with this permit shall be provided to DNR, Fisheries Division in addition to a Collector's Report form.

GENERAL PROVISIONS: This permit must be in permittee's possession during collection and must be made available upon request of any Department representative. Collection is limited to species not threatened or endangered. This permit is not transferable. This permit does not provide any authorization to circumvent any federal, state, or local laws and ordinances, including, but not limited to restricted entrance to refuges or other areas closed to the public without written permission of the land administrator. For a complete list of provisions, see Guidelines for Holders of Cultural or Scientific Collector's Permits.

In addition to this permit, separate DNR Public Land Use permits are required from:

- 1) Parks and Recreation Division for activities in State Parks and Recreation Areas and at the state boat launches;
- 2) Wildlife Division for activities in State Game Areas; and
- 3) Forest Resources Division for activities in State Forests

Public Land Use Permit applications can be obtained online at: http://www.michigan.gov/dnr/0,16077,7-153-30301_31154_35728---,00.html

Michigan Department of Natural Resources Fisheries Division Collector's Permit

Permittees are also advised to contact the US Forest Service and National Park Service about any permit requirements for activities occurring in Michigan's National Forests and National Parks, respectively.

Any violation of the conditions of this permit may result in revocation of this permit and misdemeanor penalties of imprisonment for not more than 90 days or a fine of not more than \$500 or all of the above. Unless revoked, this permit **expires on 12/31/2022**.

Bv

James L. Dexter, Chief Fisheries Division

cc: Fisheries Division

Northern Lake Huron Management Unit Southern Lake Huron Management Unit Northern Lake Michigan Management Unit Central Lake Michigan Management Unit Southern Lake Michigan Management Unit Lake Erie Management Unit Threatened and Endangered Species Unit, Wildlife Division Eastern Lake Superior Management Unit Western Lake Superior Management Unit







June 26, 2019

Dr. Brian Klatt Michigan Natural Features Inventory, MSU Extension PO Box 13036 Lansing, MI 48901

Dear Dr. Klatt:

This letter is an official attachment to your Threatened and Endangered Species Permit (**TE 180**). Your permit is issued in the *Scientific* category only. Your permit expires on **March 31, 2022**. Renewal information will be sent in December of 2021.

Authorization:

To conduct the scientific activities listed under special conditions on the threatened/endangered species listed below. <u>All activities are subject to the standard permit conditions within this letter.</u>

- This permit provides legal authorization to work with all plant and animal species listed as threatened or endangered in Michigan, and the unintentional, incidental take of listed species during surveying, monitoring, and management duties associated with the Michigan Natural Features Inventory (MNFI). Additional Federal permits may be required for federally listed species.
- Collection of voucher specimens from new locations for documentation and identification is allowed under this permit. These collections will be conducted using standard and approved techniques.
- Collections must not significantly reduce the size of the local population and must be done in a manner that will not cause harm to the remaining population and habitat. Individual bats or their offspring cannot be held in captivity more than 45 days
- Permitted is the capture and handling of **Indiana bats** (*Myotis sodalis*) and attachment of radio transmitters.
- Any specimens collected, or dead specimens salvaged, are to be curated in a public institution appropriate for the species. Transportation or shipment of specimens is allowed under this permit. A copy of this permit should accompany specimens sent to experts or museums for identification or curation.
- Documentation of new locations must follow standard MNFI protocols.
- Subpermittees: MNFI scientists and seasonal field staff.

Standard Permit Conditions

A. All specimens authorized for collection under this Permit shall be deposited in the collection of an approved public educational or research institution prior to Permit expiration.

- B. None of the specimens collected shall become part of a private collection or private property.
- C. This permit does not allow or grant the right of trespass. Projects shall not take place on any private or public lands without permission from the owner or administrator of such lands.
- D. This permit does not provide authorization to circumvent any federal, state, or local laws and ordinances.
- E. Additionally, federal permits may be required for activities affecting federally listed threatened or endangered species and/or migratory birds. Contact the U. S. Fish and Wildlife Service at 2651 Coolidge Road, East Lansing, MI 48823.
- F. The activities covered under this Permit are not transferable to another person unless specifically authorized.
- G. Unless otherwise noted, within 10 days of the expiration of this Permit, the holder is required to file a report detailing the locations of any threatened and endangered species encountered and the number and disposition of specimens handled. Annual reports for multi-year permits are due at the end of each calendar year.
- H. A person conducting any activities authorized by this permit shall carry a copy of this permit and shall produce a copy of this permit upon request of a Department of Natural Resources employee or law enforcement officer.

All permits require and annual report unless indicated otherwise. You can use the enclosed report form and submit forms via email to <u>reitzc@michigan.gov</u>. In addition, please report any new occurrences of threatened and endangered species as soon as possible instead of waiting until the end of the year. This will allow new data to be incorporated into the Michigan Natural Features Inventory database sooner, thus ensuring greater protection for these species and their habitats.

Thank you for helping protect our threatened and endangered species. Feel free to contact me with any questions or concerns.

Sincerely,

Curry 7 Reitz

Casey M. Reitz, Permit Specialist DNR-Wildlife Division Phone: 517-284-6210 Fax: 517-335-6604 <u>reitzc@michigan.gov</u> www.michigan.gov/wildlifepermits