U.S. Fish & Wildlife Service

Species Survey Guidelines

Snuffbox Mussel

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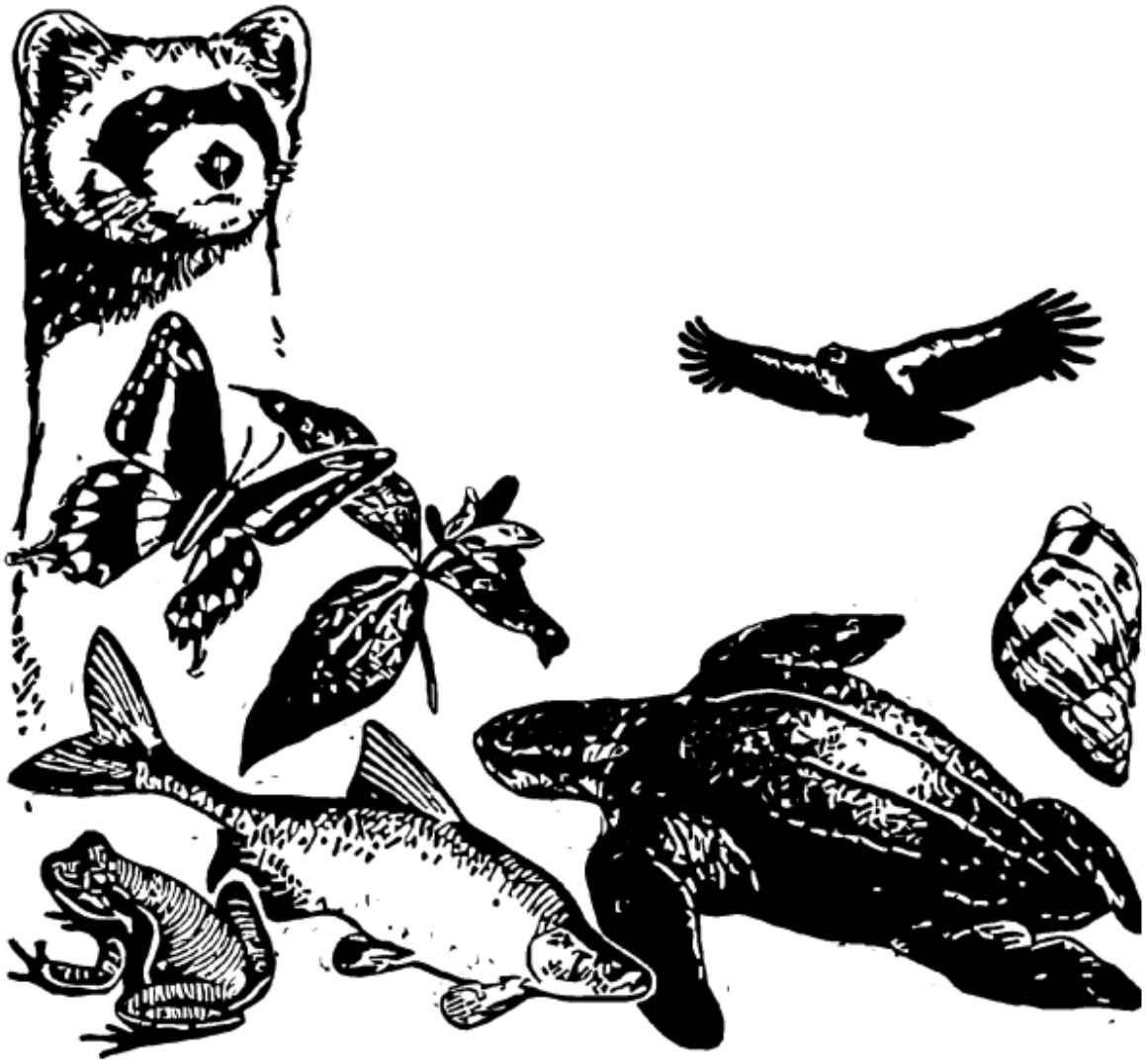

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Michigan Freshwater Mussel Survey Protocols and Relocation Procedures

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**Note to Readers

Michigan rivers and streams have been grouped according to existing knowledge of mussel distribution and individual species conservation status (Appendix A). These stream groups determine the survey effort and appropriate survey protocol(s) to conduct a mussel survey at the project site. They are described in detail in these Protocols.

The spatial data that outlines these river and stream groupings as well as the associated element occurrence data is publically available through the Michigan Natural Features Inventory: https://arcg.is/KKSLW.

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I. Introduction and Purpose

In North America, freshwater mussels (Order: Unionoida) have been identified as the most imperiled of any major group of animals (Williams *et al.* 1993; Master *et al.* 2000; Strayer 2008). Of the 44 mussel species found in Michigan, 19 (43%) are listed as either endangered or threatened pursuant to Part 365, Endangered and Threatened Species, of the Michigan Natural Resources and Environmental Protection Act (1994 PA 451) (MDNR 2009). Five of these species are also federally listed and receive additional protection pursuant to the Endangered Species Act (87 Stat. 884, as amended 16 U.S.C.§ 1531 et seq.). An additional 12 species are in decline and are identified as species of special concern. The primary reasons for decline of unionid mussels include habitat loss as a result of dam and road construction, stream channelization, water quality degradation, siltation, alterations to natural streamflow, and the introduction of non-indigenous species such as zebra mussels (Williams *et al.* 1993; Watters 2000; Strayer 2008). Many of these reasons for declines occur concurrently and more evidence is required to determine causation (Downing *et al.* 2010).

Freshwater mussels are an important component of the biodiversity of Michigan's aquatic ecosystems. They have a unique ecological role in both rivers and lakes and are valuable indicators of ecosystem integrity and function (Adkinson *et al.* 2013). Mussels are of significant value to the health of aquatic ecosystems (Vaughn 2017). They are a food source for some fish and terrestrial animals and often comprise a significant amount of the total biomass of all benthic invertebrates (Strayer *et al.* 1994, Strayer 2008). The spent shells also serve as physical habitat and are often colonized by a variety of aquatic insects and other macroinvertebrates. Since they are filter feeders, they play an important role in nutrient uptake and increasing water clarity (Strayer 2017). Freshwater mussels are sensitive to declines in physical habitat and water quality; this is especially true during early life stages which are likely one of the most sensitive of aquatic organisms (Newton *et al.* 2009). Because mussels are generally long-lived, relatively immobile, and reliant on fish hosts for reproduction and dispersal, their community status can provide an integrative view of physical, chemical, and biological changes in a watershed.

The protocols herein are designed to document the potential presence or absence of state or federally listed mussel species as well as provide guidance for survey and relocation activities to minimize impacts to native mussels in Michigan. The following mussel survey and relocation protocols are applicable to most Michigan streams and rivers; however, inland lakes, impoundments, the Great Lakes, Lake St. Clair, or Great Lakes connecting waters are not covered by these protocols. Projects that may adversely affect mussels in these waters will require project-specific survey, relocation, and monitoring plans.

The survey and relocation protocols described in this document were adapted for Michigan from the West Virginia Mussel Survey Protocols (Clayton *et al.* 2015) and the Ohio Mussel Survey Protocols (Boyer *et al.* 2016). The Michigan protocols provide project proponents with guidance to minimize impacts to mussel species that are currently identified as threatened or endangered by the State of Michigan or U.S. Government. This Protocol document represents the first iteration of standardized mussel protocols for Michigan and is intended to be updated as knowledge of mussel distributions increase and relocation techniques are refined. Michigan's native mussels and their current federal and state conservation status are listed in Table 1. Project managers should consult the online distribution maps maintained by the Michigan Natural Features Inventory (http://mnfi.anr.msu.edu/data/mussels.cfm) or University of Michigan Museum of Zoology (http://animaldiversity.ummz.umich.edu) to determine if listed freshwater mussels are previously documented to occur in a particular river or stream. **Applicants are advised that lack of survey information at a particular location does not mean that mussels are not likely to be present**. Project proponents are advised to contact the Michigan Department of Natural Resources (MDNR) and/or the U.S. Fish and Wildlife Service (FWS) early in the project planning process to determine if mussel survey and relocation work may be necessary. If listed mussels have been reported previously from the project location, coordination with FWS and/or MDNR, will be required (Figure 1).

Table 1.-List of freshwater mussels in Michigan and their current conservation status.

Species*	Common Name	Michigan Status	U.S. Status
Actinonaias ligamentina	Mucket		
Alasmidonta marginata	Elktoe	Special Concern	
Alasmidonta viridis	Slippershell	Threatened	
Amblema plicata	Threeridge		
Anodontotoides ferussacianus	Cylindrical papershell		
Cyclonaias pustulosa	Pimpleback		
Cyclonaias tuberculata	Purple wartyback	Threatened	
Elliptio complanata	Eastern elliptio	Special Concern	
Epioblasma obliquata perobliqua	White catspaw	Endangered	Endangered
Epioblasma torulosa rangiana	Northern riffleshell	Endangered	Endangered
Epioblasma triquetra	Snuffbox	Endangered	Endangered
Eurynia dilatata	Spike		
Fusconaia flava	Wabash pigtoe		
Lampsilis fasciola	Wavy-rayed lampmussel	Threatened	
Lampsilis siliquoidea	Fatmucket		
Lampsilis ventricosa	Pocketbook		
Lasmigona complanata	White heelsplitter		
Lasmigona compressa	Creek heelsplitter	Special Concern	
Lasmigona costata	Fluted-shell	Special Concern	
Leptodea fragilis	Fragile papershell		
Ligumia nasuta	Eastern pondmussel	Endangered	
Ligumia recta	Black sandshell	Endangered	
Obliquaria reflexa	Three-horned wartyback	Endangered	
Obovaria olivaria	Hickorynut	Endangered	
Obovaria subrotunda	Round hickorynut	Endangered	
Pleurobema clava	Clubshell	Endangered	Endangered
Pleurobema sintoxia	Round pigtoe	Special Concern	
Potamilus alatus	Pink heelsplitter	Special Concern	
Potamilus ohiensis	Pink papershell	Threatened	
Ptychobranchus fasciolaris	Kidney-shell	Special Concern	
Pyganodon grandis	Giant floater		
Pyganodon lacustris	Lake floater	Special Concern	
Pyganodon subgibbosa	Lake floater	Threatened	
Quadrula quadrula	Mapleleaf		
Simpsonaias ambigua	Salamander mussel	Endangered	
Strophitus undulatus	Strange floater		
Toxolasma lividus	Purple Lilliput	Endangered	
Toxolasma parvus	Lilliput	Endangered	
Truncilla donaciformis	Fawnsfoot	Threatened	
Truncilla truncata	Deertoe	Special Concern	
Utterbackia imbecillis	Paper pondshell	Special Concern	
Venustaconcha ellipsiformis	Ellipse	Special Concern	
Villosa fabalis	Rayed bean	Endangered	Endangered
Villosa iris	Rainbow	Special Concern	

*Follows Williams et al 2017.

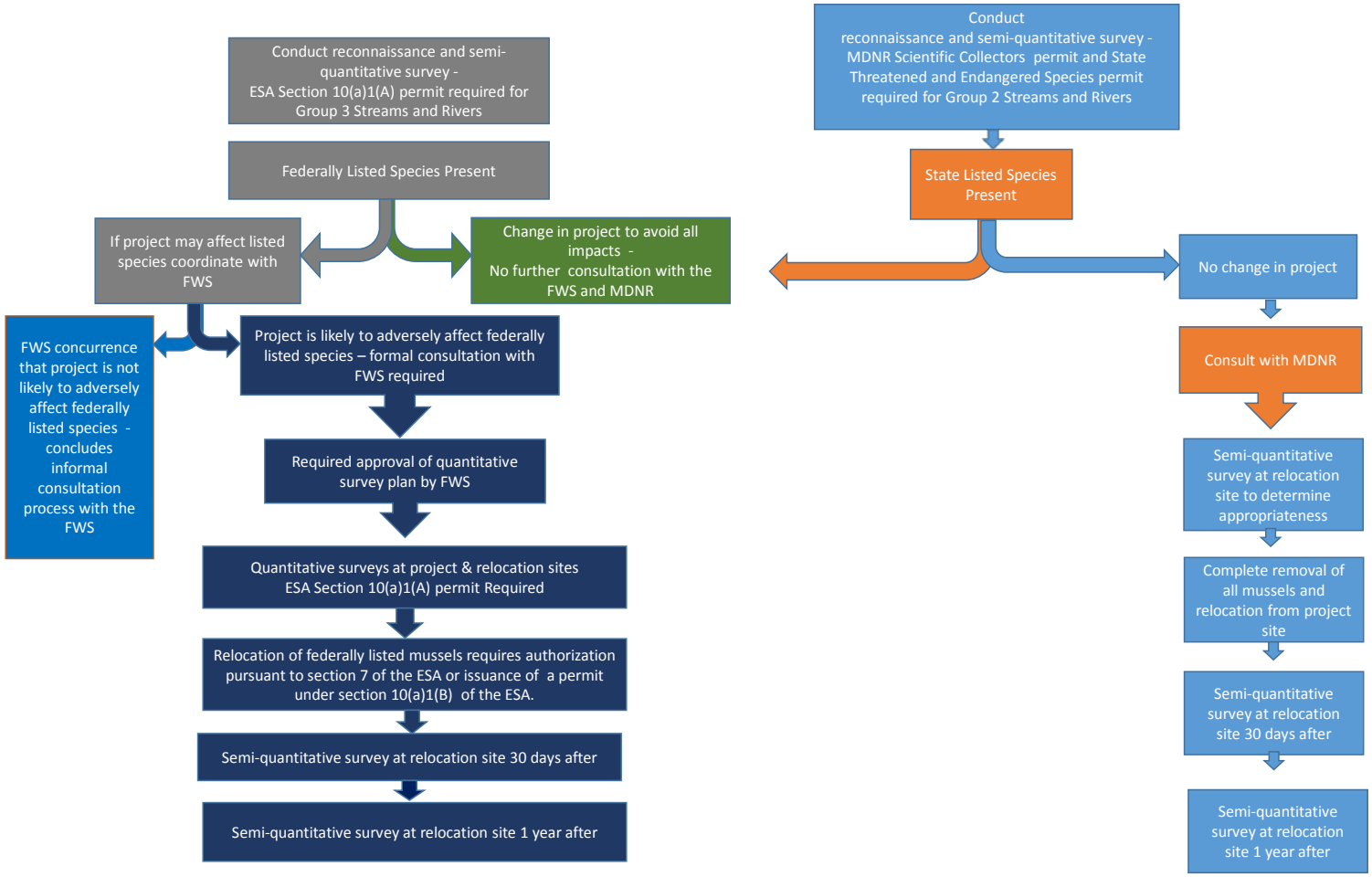


Figure 1. Survey coordination process for Group 2 and 3 streams and rivers.

II. Identifying Stream Group

Michigan rivers and streams have been grouped according to existing knowledge of mussel distribution and individual species conservation status (Appendix A). These stream groups determine the survey effort and appropriate survey protocol(s) to conduct a mussel survey at the project site.

Group 1: Stream and rivers known to support mussels considered to be special concern by the State, but lacking mussel occurrence data at the project site (Appendix A).

Group 2: Streams and rivers known to support populations of State threatened and endangered mussels (Figure 2).

Group 3a: Small and medium streams and rivers with a drainage area less than 300 mi^2 that support populations of federally listed mussels (Figure 3).

Group 3b: Large rivers (drainage area greater than 300 mi^2) that support populations of federally listed mussels (Figure 3).

III. State and Federal Permit Requirements

All mussels in the state of Michigan are protected either by State laws or by the federal Endangered Species Act. Those individuals undertaking surveys are required to obtain permits in advance of any work. The type of permits required will depend on whether state and/or federally listed species are present. The MDNR and FWS encourage all project proponents to consider ways to avoid and minimize adverse effects to listed mussels to the maximum extent practicable prior to conducting surveys.

State of Michigan Permits

All native mussels are protected in Michigan and cannot be handled without a Cultural and Scientific Collectors Permit issued by the MDNR Fisheries Division. Before conducting any mussel surveys or relocations, contact the program coordinator at (517) 284-5830.

In addition, if it is anticipated that state threatened or endangered mussels will be encountered at the project site, a Threatened and Endangered Species Permit is required. Before conducting any survey work, consult with the MDNR Endangered Species Program staff to obtain the necessary permits (517) 284-9453.

Federal Permits

The potential presence of federally listed species will also require coordination with the FWS (http://www.fws.gov/midwest/Endangered/lists/michigan-cty.html). A federal permit will be required to survey for listed species. For more information contact the Endangered Species Coordinator at the FWS Michigan Field Office in East Lansing, (517) 351-2555.

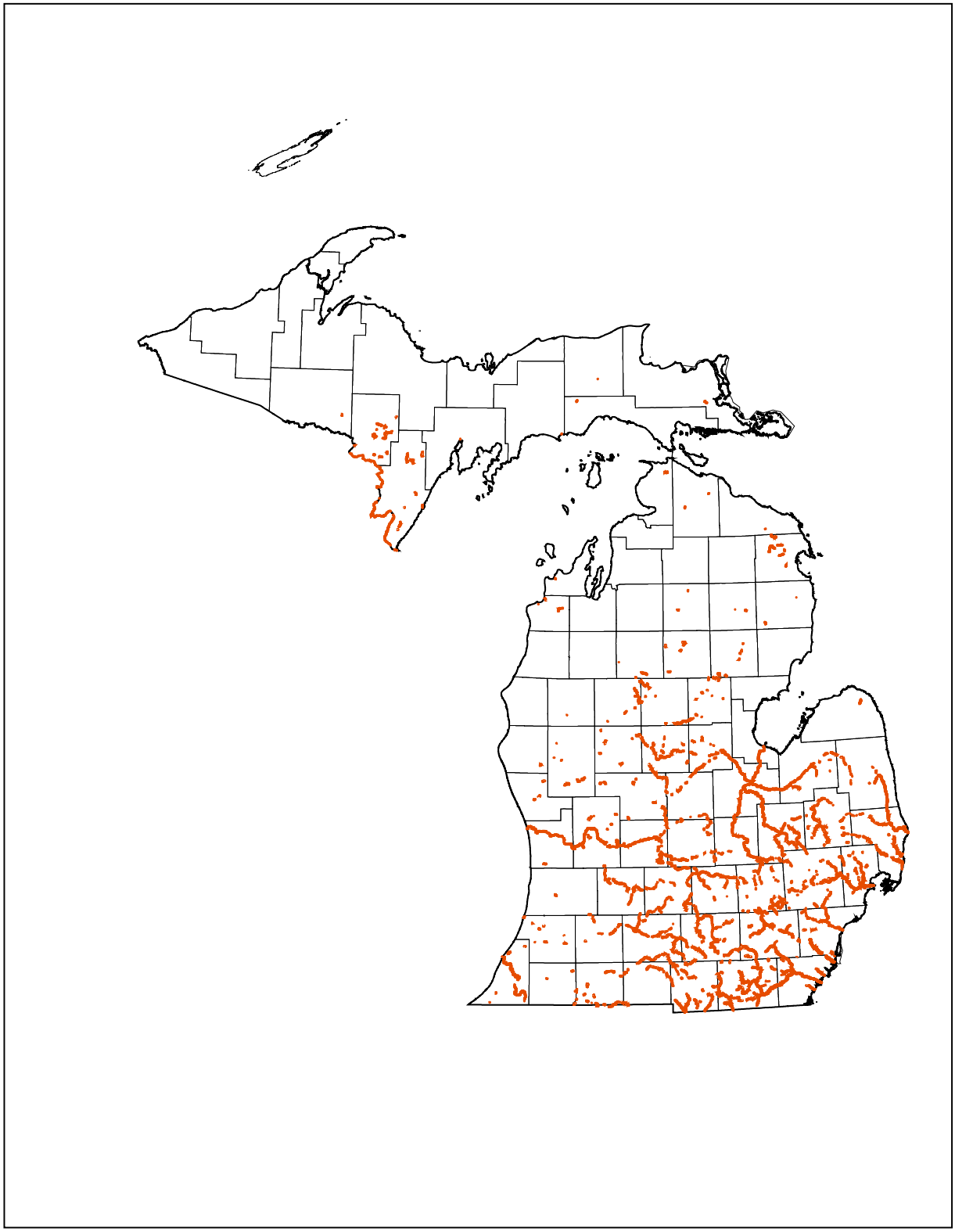


Figure 2. Group 2 streams and rivers known or expected to support populations of state threatened and endangered mussels (source MDNR unpublished data).

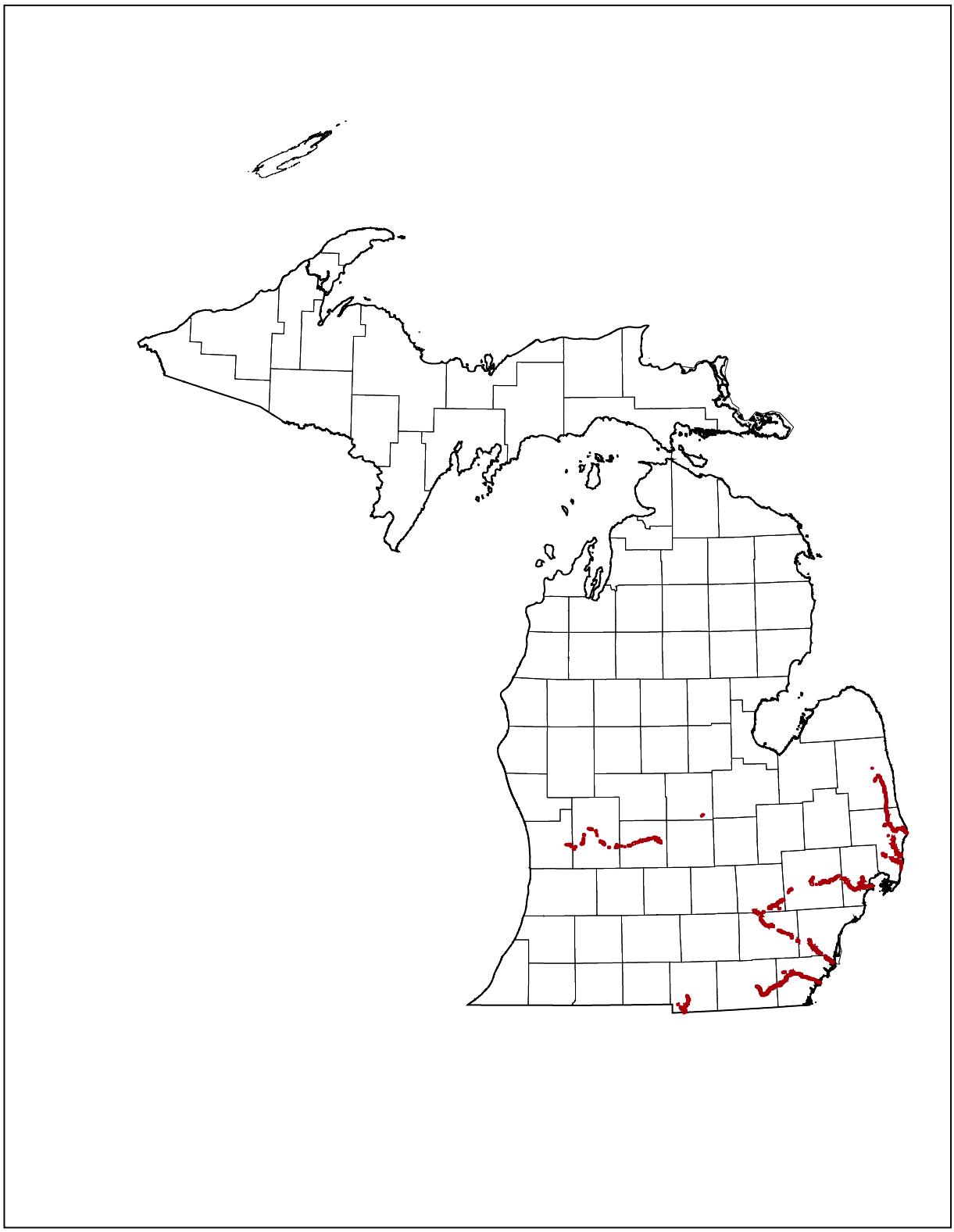


Figure 3. Group 3 streams and rivers known or expected to support populations federally endangered mussels (source MDNR unpublished data).

Prior Notification

Even though standardized protocols are established, survey plans must be provided to MDNR (all rivers/streams) and/or FWS (Group 3a and 3b only) for review in advance. This is to ensure that the appropriate protocol is being applied for a given stream type and construction activity and to allow time for agency staff to review existing data and work with the applicant to design the appropriate survey. MDNR and/or FWS staff shall be notified at least 15 days prior to the time the actual survey will occur. In addition, MDNR shall be given at least 30 days to review final survey results prior to the anticipated start of the construction activities. Activities conducted in Group 3 rivers and streams must have received written concurrence from the FWS prior to conducting any project activities including, surveys, relocations, and/ or construction activities.

Data Longevity

Survey data collected on a specific site will generally be considered valid for five years from the date the survey was conducted. In certain situations where significant habitat alteration has occurred within the 5 year period, additional surveys may be required. Facilities/areas that have been dredged within the past 5 years do not need to be resurveyed unless the dredged area is to be expanded or moved.

IV. Survey Guidelines

Surveyor Qualifications

Personnel conducting mussel surveys and relocations must possess a Bachelor of Science degree in biology, natural resources, or a related field, and knowledge of the biology and ecology of freshwater mussels. A mussel surveyor must have sufficient experience, including documented fieldwork, to execute these survey protocols and locate and identify state and federally protected mussel species. Surveyors must hold a current permit to handle native mussels from the MDNR Fisheries Division and in group 2 streams, surveyors must also have a Threatened and Endangered Species Permit from the MDNR Endangered Species Program. Additionally, in Group 3 streams surveyors must also hold a ESA section 10(a)(1)(A) permit from the FWS. Pursuant to their ESA permit, s**urveyors must receive site-specific authorization from the FWS, Michigan Ecological Services Field Office prior to conducting surveys on any Group 3 streams.**

Survey and Relocation Season

Mussel surveys and relocations in Michigan may be conducted only when the water temperature is greater than 50°F and the air temperature is between 50-90°F. Given the potential for mussels to burrow during the colder months, all surveys must be conducted between **June 1 and October 15**. Relocation efforts should be conducted between **June 1 and September 15** to allow for mandatory post relocation monitoring. Requests to conduct mussel surveys and relocations outside of this time period will be reviewed on a case by case basis. Any survey work conducted outside of this time frame will be conducted only under extenuating circumstances and with prior approval from MDNR and/or FWS.

Workable flow and visibility requirements

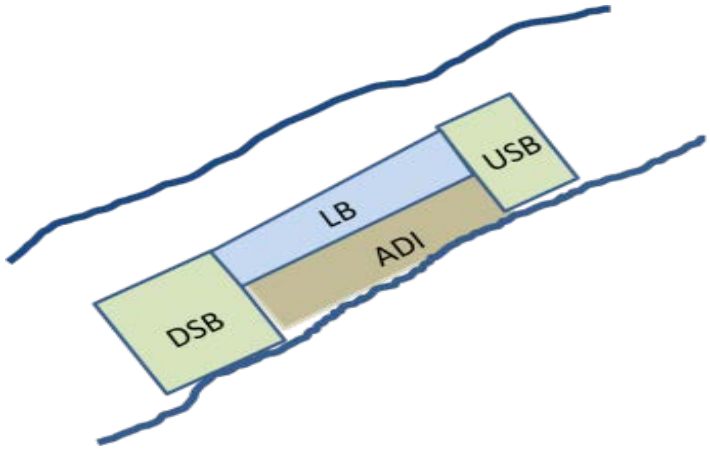
Surveys must be conducted during periods of stable flow and adequate visibility. Qualitative surface surveys must have a minimum visibility of 0.5 meter (m) (approximately 20 inches). If the area cannot be effectively surveyed due to high flow or poor visibility, then the survey must be rescheduled. In streams with high background turbidity, modified survey methods and/or excavation surveys may be required.

Minimum Data to be Recorded

Refer to Appendix B for a checklist of data that must be included in the final survey and/or relocation report. Habitat data to be collected at each transect, cell, or quadrat includes: water depth, visual estimates of percent areal coverage of macrophytes, percent areal coverage of woody material, and substrate particle composition (silt and clay, sand, gravel, cobble, boulder, rubble, detritus). Estimates of the percent of unsuitable mussel habitat (e.g., areas of scour, bedrock, etc.) in the project area must also be reported. The final report shall include a map of the survey and/or relocation area(s) along with the proposed project activities and a copy of the valid collecting permit(s). The final report must be submitted to permitting agencies within 30 days of completion of survey and relocation activities. Data must also be reported in accordance with the requirements of any other state and/or federal permits.

Survey Area

Survey coverage shall include the area of direct impact (ADI) and all applicable buffers: upstream (USB), downstream (DSB), and laterally (LB) (Figure 4). If the project will affect the natural hydrology of the stream upstream and/or downstream of the ADI (e.g., installation or removal of instream structures, stormwater outfalls, etc.), the affected area must be included in the ADI. In these instances hydraulic modeling may be necessary to delineate the bounds of the ADI. Likewise, the mixing zone of stormwater and other outfalls shall be included within the ADI. The size of the buffer areas will be determined on project specific basis and must include consideration of substrate particle size, indirect impacts (e.g., changes in flow regime, reduced water quality, etc.) and construction methods. Project proponents should consult with MDNR and FWS to delineate the ADI and appropriate buffers early in the project planning process.



ADI – area of direct impact
DSB – downstream buffer
USB – upstream buffer
LB – lateral buffer

Figure 4.- Survey extent shall include the area of direct impact (ADI) and all applicable buffers.

V. Survey Techniques

Reconnaissance Survey

A reconnaisance survey can be used to confirm the presence or absence of unionid mussels within a project area. Survey work must be conducted when water levels at the site are at normal or low flows and water clarity must be good. Streams that are very deep, consistently turbid, or with other issues that preclude searching the stream bottom throughout the entire survey reach cannot be surveyed using this technique. Those streams will require the use of timed search protocols described below. Beginning at the downstream end of the buffer zone, the stream substrates, stream banks, and gravel bars should be visually searched for evidence of shells, shell fragments, or live mussels. All stream habitats (not just suitable habitats) must be visually inspected, but special attention should be paid to heterogeneous substrates where living mussels may be difficult to see (e.g. sand and gravel interspersed with cobbles). Mussel viewing tubes or glass-bottom buckets may be used during the survey to aid in viewing the substrates. Live mussels should not be removed from the substrate for identification unless the surveyor has valid permits. The site should be searched for at least 60 minutes for smaller streams and medium streams (10-100) square miles, or 90 minutes for larger streams (above 100 square miles), unless evidence of a mussel population is found. Once the presence of live mussels or fresh dead shells is confirmed, the survey does not have to continue. If only weathered dead shells or shell fragments are observed, the entire survey time (either 60 or 90 minutes based on stream size) should be used to determine if mussels are still present within the survey area. No species list will be generated from these surveys, unless the biologist possesses the qualifications to accurately identify mussels to species. Representative photos of the survey area, and shell material observed and live mussels (in-situ) should be taken. The reconnaissance survey should be documented using the Michigan Mussel Habitat Assessment Form (Appendix C). The presence of fresh dead mussel shells and live mussels will trigger a mussel survey by a qualified surveyor as described further in Section V.

Semi-Quantitative Methods

Visual-Tactile Timed Search Surveys consist of a visual and tactile search of all microhabitat types throughout the defined project area including the ADI, USB, DSB, and LB buffers for a given period of time. This type of search is used to determine if mussels are present and to generate species richness curves. The visual search includes moving cobble, and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5cm (2in) of substrate to increase the likelihood of mussel detection. Hand grubbing and viewing buckets should be used in waters less than 0.5m (20in) in depth. In project areas where the water exceeds this depth, mask and snorkel combined with hand grubbing should be used. In large, deep rivers, surveying may require the use of SCUBA.

Transect Surveys consist of visual and tactile searches along transects. Transects shall be established throughout the proposed site and placed perpendicular to river flows. Transect spacing in small and medium rivers (drainage area less than 300 square miles) should not exceed 10m and in large rivers transects will be spaced 25m apart. Each transect will be sub-divided into 5-m segments. Along each transect, surveyors shall visually and tactilely search an area 1m wide for mussels.

Cells may be used in lieu of transects. The establishment of cells is more appropriate for smaller projects (*e.g.*, placement of scour protection around bridge piers, shoreline protection, outfalls, etc.). Rather than transects spaced throughout the project site, each affected area would be

divided into a series of cells in which each would be completely surveyed using visual-tactile methods. Maximum acceptable cell size is 100 m^2 with the dimensions determined by the surveyor based on stream channel morphology.

Survey Effort

Habitat complexity will determine search effort. A minimum of 0.5 minute/m^2 of visual searching shall be expended in homogenous substrates or shifting bedloads and 1 minute/m^2 in areas of with heterogeneous stable substrates. **Note: In waters known to support small-bodied mussels (*e.g.*, lilliput, rayed bean, slippershell, etc.), level of survey effort should be increased to 2 minutes/m^2 to enhance detection.**

Quantitative Methods

Quantitative Surveys provide more detailed information about sites. Quantitative sampling will be conducted using 1-m^2 quadrats and a systematic sampling design with three random starts in 3m by 5m blocks oriented perpendicular to stream flow in accordance with the methodology as described by Strayer and Smith (2003). Blocks will be arranged in a continuous manner to provide bank-to-bank coverage. Quantitative samples to be collected shall be 3 quadrats per 3m by 5m block. Quadrat surfaces will be visually inspected for mussels prior to excavation to 15cm (6 inches) followed by post-excavation visual searches. Data shall be reported separately for each quadrat sampled in the ADI and applicable buffers. In locations with high-density mussel communities (>2.5/m^2), quadrat size may be reduced to 0.25m^2 with excavation depth remaining 15cm (6in). Overall survey coverage must remain equivalent.

Species Richness Curve

Species richness curves (*i.e.*, species accumulation curves) will be developed during semi-quantitative surveys for Group 2 and 3 rivers and streams to confirm sampling effort adequately represents the number of species present at the project site (see Figure 5). A sufficient number of timed visual-tactile searches should be conducted such that a plateau is reached on a plot of cumulative number of individuals (x axis) vs. cumulative number of species (y axis) with 90% confidence intervals. Sampling in the project area shall be conducted until at least 5 timed searches are completed without the addition of new species. A chart depicting the curve and associated regression line should be provided. The number of individuals required to be collected for recovery of an additional species should be calculated. Note: surveys using cells do not need additional survey effort to develop a species richness curve because the entire area will be searched. In the example below, a total 352 individuals were collected, representing 19 species. Using the regression formula, it would require the collection of 611 individuals to find one additional species.

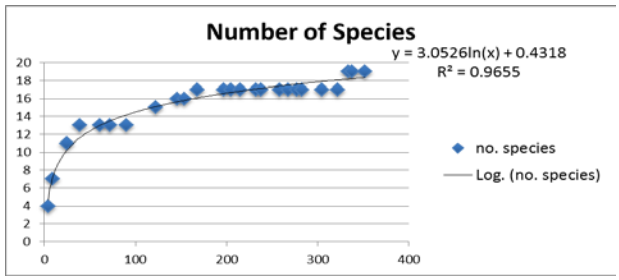


Figure 5: Species Richness Curve *(Y axis- number of species represented in collection; X axis- number of individuals collected)*

Mussel Processing

For survey methods other than reconnaissance, any mussels or valves observed will be placed in a mesh bag and brought to the surface for further processing and positive identification. Mussels observed along a transect or within a cell will be recorded as occurring in a particular segment or cell. Mesh bags, perforated buckets, or comparable containers may be used to temporarily hold mussels prior to identification, measuring, photographing, and marking. Bags or buckets should be placed in shaded flowing water to maximize dissolved oxygen concentrations and minimize temperature around the mussels. To minimize handling stress, collected mussels should be kept in water at all times, except for the brief period needed for processing. All live mussels will be identified to species and sexed where possible (see Appendix D for recommended field guides). To document the size distribution of the populations and potential recruitment, mussel shell lengths shall be measured to the nearest millimeter using vernier calipers. Photographic vouchers (live and shell) of all native species must be provided to MDNR and/or FWS. To confirm identifications, photographs of individuals should include a close-up view of the umbo and one of the valve. Any questionable species should include photographs of the left valve, right valve, and dorsal view as well to provide adequate reference for verification. All mussels will be returned to the river alive, either at the sample location or to the pre-approved relocation site (see **Mussel Relocation Procedures** below). Unique or out of known range specimens shall be forwarded to the University of Michigan Zoological Museum collections for cataloging.

Diverse Mussel Community

Failure to detect a state or federally listed mussel species during a survey does not confirm absence of a listed species. The presence of a diverse bed or high mussel concentrations indicates the potential for a listed species to be present. At this time, a diverse mussel community is defined as one that includes at least four mussel species within the ADI and associated buffers. This value is based on mussel survey data from several Michigan watersheds known to support federally listed species (unpublished data provided by R. Sherman Mulcrone, J. Rathbun, D. Woolnough, D. Zanatta). If a diverse mussel community is found, then listed species may be present and the project proponent should, wherever possible, develop/modify project plans to avoid impacts to mussels. If avoidance is not possible, the project proponent must then submit a survey proposal to the MDNR and FWS and receive approval before beginning work.

VI. Stream Type Specific Guidance

Note: Reconnaissance surveys are recommended for all stream groups where conditions are wadeable and where the substrate is visible to confirm presence or absence of unionid mussels within the project area. This includes Group 1 waters lacking mussel occurrence data and Groups 2 and 3 waters where presence of listed mussels is expected but site specific data is lacking or survey information is dated. Collection of recently dead individuals of any listed species should be interpreted as species presence and additional survey work will be required.

Group 1 Waters are rivers or streams known to support special concern mussels species and have suitable habitat but lack mussel occurrence data at the project site.

Visual-tactile timed search surveys are recommended, but not required, for Group 1 streams when the presence of mussels has been confirmed. The survey area must include ADI and applicable buffers. The surveys should first assess the areas to be searched determine areas of suitable mussel habitat, and determine if conditions (e.g., flow, turbidity, etc.) are suitable for conducting the survey. The survey should begin by conducting a visual search for dead valves along the shorelines, point bars, and other exposed bottomlands and muskrat middens. Tactile and visual searching should include all microhabitat types within the ADI and applicable buffers. If state listed mussels are encountered during the survey,

contact MDNR to develop a relocation strategy. If federally listed mussel species are encountered, surveyors must stop the survey, return the individuals to the substrate, and contact FWS and MDNR for further consultation. **Note: the collection of recently dead individuals (e.g., complete periostracum, lustrous nacre) of any listed species should be interpreted as species presence and additional survey work will be required**. Relocation of non-listed mussels from the project area in Group 1 streams to pre-approved sites can occur at the time of the initial survey (see **Mussel Relocation Procedures** below).

Group 2 Waters are streams and rivers with state threatened or endangered species expected. Mussel surveys on Group 2 streams include semi-quantitative methods. If state listed species are detected mussel relocation efforts will be required and surveyors must contact MDNR for further guidance (**Section V. Mussel Relocation Procedures)**. If federally listed mussels are encountered, surveyors must stop the survey, return the individuals to the substrate, and contact FWS and MDNR for further coordination. Prior to conducting the mussel survey, acceptable justification for not avoiding the area must be provided to the MDNR and should be included in the survey proposal.

If the above efforts do not detect state threatened or endangered mussels, timed search surveys will be conducted within the project site for development of a species richness curve. All mussels will be returned to the river alive, either at the sample location or to the pre-approved relocation site. Notification of preliminary survey results (e.g., species detected) must be provided to the permitting agencies within 5 business days of completion of the survey.

Group 3 Waters are streams and rivers where federally listed mussel species are expected. Surveys in these waters require prior consultation with FWS and MDNR. In most cases, these efforts will require completion of semi-quantitative surveys of the project area (ADI and appropriate buffers). The objective of a semi-quantitative survey is to determine if a federally listed mussel species, or a diverse mussel community, is present in the project area. If a trigger is met (see below) and avoidance is not an option, then the project proponent must submit a quantitative survey proposal to MDNR and FWS for approval and receive approval before beginning the quantitative survey.

Group 3a survey design shall consist of transects, 1m in width, spaced no more than 10m apart, placed perpendicular to stream flow, or cells not to exceed 100 m^2. If the stream width is 20m or less, the survey design shall consist of complete cell coverage. For streams greater than 20m wide, the preferred survey method is by cells; however, transects may be used to delineate the habitats that require further survey effort by cells. Data shall be compiled separately for the ADI and applicable buffers. Data shall be recorded by 5m segments along the transect or by cell position. If no mussels (live or shells) are observed in two adjacent transects, with at least one of the transects containing suitable mussel habitat, then a timed visual–tactile search will occur between the two transects in the area of suitable habitat. If any live or recent dead mussels are found between the two transects during the search, then an additional transect will be placed there and searched as described above.

Group 3b survey design shall consist of transects, 1m in width, spaced no more than 25m apart, placed perpendicular to stream flow, or cells not to exceed 100 m^2. If no mussels (live or shells) are observed in two adjacent transects, with at least one of the transects containing suitable mussel habitat, then a timed visual–tactile search will occur between the two transects in the area of suitable habitat. If any live or recent dead mussels are found between the two transects during the search, then an additional transect will be placed there and searched as described above.

Survey results that trigger a quantitative survey for Group 3a and 3b include:

1. Presence of a federally listed species;
2. Mussel density of $\geq 0.25/m^2$ within any area of the survey; and/or

3. Presence of a diverse mussel community (≥ 4 species) indicative of the likely presence of federally listed species.

The objective of a quantitative survey for Group 3 streams is to collect sufficient data to quantify the densities of live mussels in the ADI and buffer areas. The project proponent must receive approval for the survey scope of work before any sampling is conducted.

Notification of preliminary survey results (e.g., species detected) must be provided to the MDNR within 5 days of completion of the survey. The presence of federally listed will require consultation with the FWS.

VII. Mussel Relocation Procedures

Mussel relocation efforts will typically be required when state or federally threatened or endangered mussel species are found at the project site and impact avoidance options have been exhausted. Relocation is also recommended for non-listed mussel species that may be negatively affected by the proposed construction activities. No mussels are to be moved without prior authorization from MDNR and/or FWS for federally listed mussels. If mussels are assumed to be present in Group 1 and 2 streams, a relocation plan can be submitted with the survey plan for review and approval from MDNR. Coordination with the FWS and MDNR must occur prior to any relocation efforts on Group 3a and 3b streams. Relocation of federally listed mussels will require authorization through section 7 consultation (for federally funded or permitted projects) or issuance of a section 10 permit. Consultation with the FWS is necessary to determine which authorization process is appropriate depending on the nature of the project. Impacts to federally listed species and their habitats must be avoided or minimized to the maximum extent practicable. Conservation measures in addition to relocation efforts may be required if the proposed project may adversely affect federally listed species.

The general goals of mussel relocation efforts are to:

- Maximize survival and fitness of the relocated individuals, including genetic diversity.
- Minimize risk to the resident mussel fauna at the relocation site.
- Document relocation outcomes to inform future relocation efforts.

The procedures described below are intended to maximize attainment of these goals.

Site Selection

Selecting an appropriate relocation site is the most important decision in any mussel relocation project. Careful consideration must be given to the location of the relocation site in the landscape. A hierarchy of preferred destinations, modified from the USFWS (2008), is:

1. Same reach (*i.e.,* between two stream confluences).
2. Within the same watershed, but in a different reach or tributary.
3. A hatchery or other holding facility.
4. Presence of a diverse mussel community reflective of the community from which the individual was moved and that has evidence of recruitment.

More specific attributes for a relocation site are listed in Table 2.

Table 2.-Required attributes of potential mussel relocation sites.

- Relocation sites shall be upstream (preferred) and of equal or better habitat. Alternate locations will be reviewed on a case-by-case basis.
- The presence of a similar mussel community comprised of most or all of the species to be moved from the salvage area.
- Evidence of good recruitment as indicated by the presence of juveniles mussels.
- Habitat conditions should be as similar as possible to the project site, in terms of sediment composition and stability, water quality, water depth, flow regime, distribution of habitat features (pools, riffles, etc.), overall area (multiple relocation sites may have to be identified if the source site is particularly large), and upstream drainage area.
- Appropriate fish host species must be present.
- It should be secure for the foreseeable future from disturbances (e.g., dredging).
- If zebra mussels (*Dreissena polymorpha*) and Quagga mussels (*D. rostiformis*) are absent from the project site, they must not be present either at the relocation site or upstream of the relocation site.

Visual-tactile and quantitative surveys will be required to assess the composition of the mussel community at the relocation site (see Section III for details). An estimate of the size of the relocation site must be included in the survey. This survey may be performed no more than 5 years prior to the relocation. The relocation site survey may need to be repeated if an event or impact (e.g., a chemical spill) has occurred during the time between the original survey and the proposed relocation that could have impacted the resident mussel community or altered environmental conditions. Relocation sites lacking the listed species that need to be relocated should be avoided unless no other suitable sites are found and permission is obtained from the MDNR for Group 2 streams and FWS and MDNR for Group 3 streams.

If the ADI and buffers areas are large, it may be necessary to select more than one relocation site. In this case, the combined total area of the relocation sites should be equal to or greater than the area of the project site. The location of the relocation site(s) must be documented as indicated in the report checklist (Appendix B).

Prior to the relocation activities, a report on the relocation site(s) will be prepared and submitted to MDNR for state listed species or MDNR and FWS for federally listed species for approval. This report shall include summaries of the site attributes listed in Table 2.

Relocation methods

The intention of the collection scheme described below is to collect a high percentage of the mussels at the sediment surface and in the near-surface sediments within the relocation area (Strayer and Smith 2003). Mussels shall be collected by wading using view scopes or snorkeling in shallow water, or with SCUBA in deeper water. To facilitate mussel detection, cobble, and woody material should be moved; silt, sand and small detritus should be swept away. A moving transect may also be used to ensure the project area is cleared of all mussels.

When using a moving transect a defined section is cleared, and then the line is moved to define a new area for clearing. For example, a 1m area upstream of an established transect line is marked off, searched

and mussels are salvaged. A minimum effort of 1 minute/m2 is required per pass if mussels are observed. Successive passes are to be made through the area until two or fewer mussels or less than 5 percent of the original number of mussels observed on the first pass is recovered on the last pass. Once the area is cleared, the transect is moved upstream in 1m increments, and the new areas are cleared sequentially. The process is repeated until the entire salvage area is cleared of mussels.

The collection process entails three steps:

1. A visual-tactile search of the surficial substrate.
2. Excavation of the substrate to a depth of 15 cm (6 inches).
3. A second visual-tactile search.

If the second visual-tactile search yields more than 5 percent of the listed mussel species found in the first visual-tactile search, additional searches will be required until less than 5 percent of the numbers in the initial search are recovered.

If a federally listed species not previously known to occur at the project site is found, stop work and contact the FWS for guidance.

Relocated mussels must be marked or tagged in some fashion to facilitate post relocation monitoring. Specifically, the shells of:

- All relocated state and federally listed species must be tagged.
- All relocated non-listed species (or a subsample if high densities are encountered during relocation) must be marked.

Both valves will be marked. A file or small rotary tool can be used to etch a number on both shells of non-listed species. Great care must be taken while etching shells to not damage the mussel, as adults of some species and juveniles of all species have thin shells. The final report should detail methods used to mark relocated mussels. Listed mussels shall be tagged with shellfish and/or passive integrated transponder (PIT) tags as described by Woolnough and Barnett (2013) and Kurth *et al.* 2007.

Transporting and placement

On the day(s) of the relocation, minimum expected air temperatures should be greater than 50°F, and maximum expected air temperatures should be less than 90°F. Also, relocations should be performed when stream discharge is stable and turbidity is low. Mussels shall be transported in containers that minimize jostling or impact. It is not necessary to transport the mussels in water, but they must be kept cool and moist, which is best accomplished by covering with wet towels or burlap bags. Do not place the mussels on ice, which may cause temperature shock. Exposure to air during measuring, marking and transporting must be minimized, and should be kept to less than 5 minutes. Maximum processing time from collection to relocation should not exceed 24 hours (see Section III Mussel Processing). If a longer processing time is unavoidable, consultation with the permitting agency is required prior to the relocation. Signs of physiological stress include shell gaping, foot extension, and mucus secretion. Stress can be reduced by holding mussels in flowing water prior to processing (measuring and marking), reducing the number of mussels held and processed at one time, processing mussels in the shade, and having a short distance between the source site and the relocation site.

Mussels shall be placed into the sediment at the relocation site by hand, posterior end up, and buried half in the sediment. If necessary, use a trowel to dig a small pit.

Post relocation monitoring

Two post-relocation monitoring surveys are required to assess mussel survival at the relocation site. The first survey period must occur 30 to 45 days after relocation to assess acute mortality. Elevated acute post-relocation mortality (>25 percent) after the initial post-relocation survey may be interpreted that conditions at the relocation site are insufficient for long-term survival. If this occurs, the permitting agency should be contacted for additional consultation**.** The second survey must be conducted 1 year after relocation to quantify survivorship, gravidity, and growth. Greater than 50% mortality of relocated mussels should be reported and discussed with MDNR and FWS to determine what follow up action may be necessary.

The appropriate post relocation monitoring survey methodology should be determined in consultation with the MDNR and USFWS for Group 2 and Group 3 streams. A determination on the appropriate methodology should consider the scale of the relocation and the type of tags used on the relocated individuals. An effort to locate all pit tagged individuals should be made and should include searching a buffered area to account for movement. Shell dimensions of the marked mussels will be measured during the second post-relocation survey only.

Reporting

A report will be provided to the appropriate permitting agencies (MDNR for all surveys and FWS for Group 3 streams pursuant to Federal permit conditions) within 30 days of completion of the relocation and subsequent monitoring activities. Refer to Appendix B for a checklist of data that must be included in these reports.

VIII. References

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Michigan Stream and River Group by County (February 2018)

County	Stream/River	Group
Alcona	Au Sable River	2
Alcona	Sucker Creek	2
Allegan	Base Line Creek	1
Allegan	Gun River	1
Allegan	Kalamazoo River	2
Allegan	Pine Creek	1
Allegan	Rabbit River	1
Alpena	King Creek	2
Alpena	Lower South Branch Thunder Bay River	2
Alpena	North Branch Thunder Bay River	2
Alpena	Thunder Bay River	2
Alpena	Upper South Branch Thunder Bay River	1
Arenac	Pine River	1
Barry	Bassett Creek	2
Barry	Cedar Creek	2
Barry	Glass Creek	2
Barry	High Bank Creek	2
Barry	Thornapple River	2
Barry	Wanadoga Creek	2
Bay	Saginaw River	2*
Benzie	Brundage Creek	2
Benzie	Otter Creek	2
Benzie	Platte River	2
Berrien	Dowagiac River	1
Berrien	Galien River	2
Berrien	Hickory Creek	1
Berrien	Paw Paw River	2
Berrien	Saint Joseph River	2*
Berrien	Unnamed tributary to Spring Creek (U: 41.77972,-86.608619; D: 41.776469,-86.612379)	2
Branch	Coldwater River	1
Branch	Fawn River	2
Branch	Hog Creek	2
Branch	Nottawa Creek	1

Branch	Prairie River	1
Branch	Saint Joseph River	2
Branch	South Branch Hog Creek	2
Branch	Swan Creek	1
Branch	Unnamed tributary to Swan Creek (U: 41.892811,-85.158906; D: 41.893904,-85.160751)	1
Branch	Unnamed tributary to Swan Creek (U: 41.893904,-85.160751; D: 41.894002,-85.160431)	1
Calhoun	Battle Creek	2
Calhoun	Indian Creek	1
Calhoun	Kalamazoo River	2
Calhoun	North Branch Kalamazoo River	2
Calhoun	North Branch Rice Creek	2
Calhoun	Nottawa Creek	1
Calhoun	Pine Creek	1
Calhoun	Rice Creek	2
Calhoun	Saint Joseph River	2
Calhoun	South Branch Kalamazoo River	2
Calhoun	South Branch Rice Creek	1
Calhoun	Wanadoga Creek	2
Calhoun	Wilder Creek	2
Cass	Christiana Creek	1
Cass	Dowagiac Creek	2
Cass	Dowagiac River	1
Cass	Pigeon River	2
Cass	Rocky River	2
Cass	Saint Joseph River	2
Cass	Wood Lake Outlet	2
Cheboygan	Black River	2
Cheboygan	Indian River	2
Chippewa	Parker Creek	2
Clare	Clam River	2
Clare	Green Creek	2
Clare	Muskegon River	2
Clare	South Branch Tobacco River	2
Clare	West Branch Clam River	2
Clinton	Grand River	2

Clinton	Hayworth Creek	1
Clinton	Little Maple River	1
Clinton	Looking Glass River	2
Clinton	Maple River	2
Clinton	Pine Creek	2
Clinton	Stony Creek	1
Clinton	Unnamed tributary to Little Maple River (U: 43.002503,-84.436002; D: 43.005607,-84.419507)	2
Clinton	Vermilion Creek	2
Crawford	Au Sable River	2
Crawford	East Branch Au Sable River	2
Delta	Rapid River	2
Dickinson	East Branch Sturgeon River	2
Dickinson	Ford River	2
Dickinson	Menominee River	2
Dickinson	Pine Creek	2
Dickinson	Sturgeon River	2
Dickinson	West Branch Sturgeon River	2
Eaton	Battle Creek	2
Eaton	Grand River	2
Eaton	Indian Creek	2
Eaton	Spring Brook	2
Eaton	Thornapple River	2
Emmet	Carp Lake River	2
Genesee	Cranberry Creek	2
Genesee	Flint River	2
Genesee	Kearsley Creek	2
Genesee	North Ore Creek	2
Genesee	Shiawassee River	2
Genesee	South Branch Shiawassee River	2
Genesee	Swartz Creek	2
Genesee	Thread Creek	2
Genesee	Unnamed tributary to Lake Fenton (U: 42.81869,-83.723117; D: 42.820687,-83.723036)	2
Genesee	Unnamed tributary to Lake Fenton (U: 42.820687,-83.723036; D: 42.821177,-83.716534)	2
Gladwin	Cedar River	2
Gladwin	Chatman Creek	2

Gladwin	Middle Branch Tittabawassee River	2
Gladwin	Middle Branch Tobacco River	2
Gladwin	Molasses River	2
Gladwin	South Branch Little Sugar River	2
Gladwin	South Branch Tobacco River	2
Gladwin	Sugar River	2
Gladwin	Tobacco River	2
Gladwin	West Branch Tittabawassee River	2
Grand Traverse	Unnamed tributary to Duck Lake (U: 44.65831,-85.750078; D: 44.655082,-85.750461)	1
Gratiot	Maple River	3a
Gratiot	North Branch Pine River	1
Gratiot	Pine Creek	2
Gratiot	Pine River	2
Gratiot	Unnamed tributary to Pine River (U: 43.354732,-84.697257; D: 43.361061,-84.693995)	1
Hillsdale	Bean Creek	2
Hillsdale	Beebe Creek	2
Hillsdale	East Branch Saint Joseph River	2*
Hillsdale	East Fork West Branch Saint Joseph River	2
Hillsdale	East Fork West Branch Saint Joseph River	3a
Hillsdale	Laird Creek	2
Hillsdale	Lake Number One Outlet	2
Hillsdale	Saint Joseph Creek	2
Hillsdale	Saint Joseph River	2
Hillsdale	Sand Creek	2
Hillsdale	Silver Creek	2
Hillsdale	South Branch Hog Creek	2
Hillsdale	South Branch Kalamazoo River	2
Hillsdale	Unnamed tributary to Saint Joseph Creek (U: 41.888631,-84.415678; D: 41.876741,-84.399305)	2
Hillsdale	West Branch Saint Joseph River	2
Hillsdale	West Branch Saint Joseph River	3a
Hillsdale	West Fork West Branch Saint Joseph River	2
Hillsdale	West Fork West Branch Saint Joseph River	3a
Huron	Willow Creek	2
Ingham	Doan Creek	2
Ingham	Grand River	2

Ingham	Mud Creek	2
Ingham	North Onondaga Drain	1
Ingham	Red Cedar River	2
Ingham	Sycamore Creek	2
Ingham	West Branch Red Cedar River	2
Ionia	Dickerson Creek	1
Ionia	Fish Creek	2
Ionia	Grand River	3b
Ionia	Looking Glass River	2
Ionia	Maple River	3b
Ionia	Prairie Creek	2
Ionia	Seely Creek	1
Ionia	Stony Creek	1
Ionia	Unnamed tributary to Grand River (U: 42.950395,-85.275028; D: 42.933416,-85.276884)	2
Iron	Menominee River	1
Iron	Michigamme River	2
Iron	Paint River	1
Isabella	Chippewa River	2
Isabella	Coldwater River	2
Isabella	North Branch Chippewa River	2
Isabella	Pine River	2
Isabella	Salt Creek	2
Isabella	South Branch Salt River	2
Isabella	Unnamed tributary to Pine River (U: 43.525158,-84.991665; D: 43.509955,-84.998077)	1
Jackson	Brown Lake Outlet	1
Jackson	Center Lake Outlet	2
Jackson	Crittenden Drain	2
Jackson	Goose Creek	2
Jackson	Grand River	2
Jackson	North Branch Kalamazoo River	2
Jackson	Orchard Creek	2
Jackson	Portage River	2
Jackson	River Raisin	2
Jackson	Sandstone Creek	2
Jackson	Sharp Creek	2

Jackson	South Branch Kalamazoo River	2
Jackson	Unnamed tributary to Grand River (U: 42.092134,-84.426905; D: 42.088797,-84.421437)	1
Jackson	Unnamed tributary to Portage River (U: 42.306869,-84.157702; D: 42.313776,-84.160089)	1
Jackson	Unnamed tributary to River Raisin (U: 42.1376,-84.144179; D: 42.150631,-84.132445)	1
Jackson	Vandercook Lake Outlet	1
Kalamazoo	Augusta Creek	1
Kalamazoo	Comstock Creek	1
Kalamazoo	Gourdneck Creek	1
Kalamazoo	Gull Creek	1
Kalamazoo	Kalamazoo River	2
Kalamazoo	Little Portage Creek	1
Kalamazoo	Portage Creek	1
Kalamazoo	Portage River	1
Kalamazoo	West Fork Portage Creek	2
Kent	Bear Creek	2
Kent	Coopers Creek	1
Kent	Flat River	2
Kent	Flat River (lower reaches)	3b
Kent	Grand River	3b
Kent	Plaster Creek	2
Kent	Rogue River	2
Kent	Seely Creek	2
Kent	Thornapple River	2
Kent	Unnamed tributary to Grand River (U: 42.936749,-85.418883; D: 42.924026,-85.421047)	2
Kent	Unnamed tributary to Grand River (U: 42.960307,-85.445752; D: 42.951141,-85.468407)	2
Kent	Unnamed tributary to Lamberton Creek (U: 42.991605,-85.604135; D: 43.013255,-85.629794)	2
Kent	Unnamed tributary to Wabasis Creek (U: 43.168831,-85.343708; D: 43.16482,-85.342616)	1
Kent	Wabasis Creek	2
Lake	Baldwin River	2
Lapeer	Belle River	2
Lapeer	Bottom Creek	2
Lapeer	Cedar Creek	2
Lapeer	Elk Lake Creek	2
Lapeer	Farmers Creek	2
Lapeer	Flint River	2*

Lapeer	Hasler Creek	2
Lapeer	Mill Creek	2
Lapeer	North Branch Belle River	2
Lapeer	North Branch Clinton River	2
Lapeer	North Branch Flint River	2
Lapeer	North Branch Mill Creek	2
Lapeer	Pine Creek	2
Lapeer	Plum Creek Drain	2
Lapeer	South Branch Flint River	2
Lapeer	Squaw Creek	2
Leelanau	Crystal River	2
Lenawee	Bean Creek	2
Lenawee	Bear Creek	2
Lenawee	Black Creek	2
Lenawee	Evans Creek	2
Lenawee	Gleason Brook	2
Lenawee	Goose Creek	2
Lenawee	Hazen Creek	2
Lenawee	Lime Creek	2
Lenawee	Little River Raisin	2
Lenawee	Macon Creek	2
Lenawee	River Raisin	3a
Lenawee	River Raisin	3b
Lenawee	Saint Joseph Creek	2
Lenawee	South Branch River Raisin	2
Lenawee	Swamp Raisin Creek	1
Lenawee	Unnamed tributary to Swamp Raisin Creek (U: 41.917286,-83.885957; D: 41.914003,-83.850355)	2
Lenawee	Wolf Creek	2
Livingston	Arms Creek	2
Livingston	Bogue Creek	2
Livingston	Cranberry Creek	2
Livingston	Davis Creek	3a
Livingston	Halfmoon Lake Outlet	1
Livingston	Honey Creek	2
Livingston	Horseshoe Creek	2

Livingston	Huron River	3a
Livingston	Huron River	3b
Livingston	Middle Branch Red Cedar River	2
Livingston	North Ore Creek	2
Livingston	Portage Creek	2
Livingston	Portage River	3a
Livingston	Red Cedar River	2
Livingston	South Branch Shiawassee River	2
Livingston	South Ore Creek	3a
Livingston	Tamarack Lake Outlet	2
Livingston	West Branch Red Cedar River	2
Livingston	Woodruff Creek	2
Luce	Tahquamenon River	2
Mackinac	Lower Millecoquins River	1
Mackinac	Portage Creek	2
Macomb	Belle River	3a
Macomb	Clinton River	3a
Macomb	Clinton River	3b
Macomb	East Branch Coon Creek	2
Macomb	East Pond Creek	2
Macomb	Healy Drain	2
Macomb	Middle Branch Clinton River	2
Macomb	North Branch Clinton River	3a
Macomb	Red Run	2
Macomb	Stony Creek	2
Macomb	Unnamed tributary to Middle Branch Clinton River (U: 42.666077,-83.038392; D: 42.686261,-83.036589)	2
Mecosta	Chippewa River	2
Mecosta	Gilbert Creek	1
Mecosta	Little Muskegon River	1
Mecosta	Muskegon River	2
Mecosta	North Branch Chippewa River	1
Mecosta	Ryan Creek	2
Mecosta	Sylvester Creek	2
Mecosta	West Branch Chippewa River	2
Menominee	Big Brook	2

Menominee	Cedar River	2
Menominee	Devils Creek	2
Menominee	Little River	2
Menominee	Menominee River	2
Menominee	Tenmile Creek	2
Menominee	Wilson Creek	2
Midland	Bluff Creek	2
Midland	Chippewa River	2
Midland	Howard Creek	2
Midland	Pine River	2
Midland	Salt River	2*
Midland	Tittabawassee River	2*
Midland	Tobacco River	1
Missaukee	Butterfield Creek	1
Missaukee	Clam River	2
Missaukee	Middle Branch Creek	2
Missaukee	Muskegon River	1
Monroe	Huron River	3a
Monroe	Huron River	3b
Monroe	Little Sandy Creek	1
Monroe	Macon Creek	3a
Monroe	Macon Creek	3b
Monroe	North Branch Macon Creek	2
Monroe	Otter Creek	2*
Monroe	River Raisin	3a
Monroe	River Raisin	3b
Monroe	Saline River	2
Monroe	South Branch Macon Creek	2
Monroe	Stony Creek	1
Monroe	Stony Creek	2
Monroe	Unnamed tributary to Macon Creek (U: 41.971036,-83.635876; D: 41.979007,-83.628089)	2
Montcalm	Coopers Creek	1
Montcalm	Fish Creek	2
Montcalm	Flat River	2
Montcalm	Little Muskegon River	1

Montcalm	North Branch Pine River	1
Montcalm	Pine River	2
Montcalm	Tamarack Creek	2
Montcalm	Wabasis Creek	1
Muskegon	Cedar Creek	2
Muskegon	Muskegon River	1
Muskegon	North Channel Muskegon River	2
Newaygo	Big South Branch Pere Marquette River	2
Newaygo	Muskegon River	2*
Newaygo	South Branch White River	2
Oakland	Buckhorn Creek	2
Oakland	Clinton River	2
Oakland	Clinton River	3a
Oakland	Davis Creek	2
Oakland	Galloway Creek	2
Oakland	Hayes Creek	2
Oakland	Huron River	3a
Oakland	Kearsley Creek	2
Oakland	Middle Straits Lake Outlet	1
Oakland	Norton Creek	2
Oakland	Paint Creek	2
Oakland	Paint Creek Drain	2
Oakland	Pettibone Creek	2
Oakland	River Rouge	2
Oakland	Sargent Creek	2
Oakland	Sashabaw Creek	2
Oakland	Shiawassee River	2
Oakland	Stony Creek	2
Oakland	Sunken Bridge Drain	2
Oakland	Swartz Creek	2
Oakland	Trout Creek	2
Oakland	Unnamed tributary to Inchwagh Lake (U: 42.447806,-83.634141; D: 42.452608,-83.634976)	2
Oakland	Unnamed tributary to Kearsley Creek (U: 42.847952,-83.440844; D: 42.848355,-83.441566)	2
Oakland	Upper River Rouge	2
Oakland	Walled Lake Branch	2

Oakland	Wilson Lake Outlet	2
Oceana	South Branch White River	2
Ogemaw	Chatman Creek	2
Ogemaw	East Branch Tittabawassee River	2
Ogemaw	Gamble Creek	2
Ogemaw	Middle Branch Tittabawassee River	2
Ogemaw	Rifle River	2
Osceola	Middle Branch River	2
Osceola	Muskegon River	2
Osceola	West Branch Clam River	2
Osceola	West Branch Middle Branch River	2
Oscoda	Au Sable River	2
Ottawa	Crockery Creek	1
Ottawa	Grand River	2
Ottawa	Grand River	3b
Ottawa	Lloyd Bayou	2
Ottawa	Macatawa River	2
Ottawa	Unnamed tributary to Grand River (U: 43.042785,-86.064409; D: 43.041381,-86.065887)	1
Presque Isle	North Branch Thunder Bay River	2
Roscommon	Backus Creek	2
Roscommon	Muskegon River	2
Roscommon	The Cut	2
Roscommon	West Branch Tittabawassee River	2
Roscommon	Wolf Creek	2
Saginaw	Birch Run	2
Saginaw	Cass River	2*
Saginaw	Fairchild Creek	2
Saginaw	Flint River	2
Saginaw	Saginaw River	2*
Saginaw	Shiawassee River	2*
Saginaw	South Fork Bad River	1
Saginaw	Tittabawassee River	2*
Sanilac	Black River	1
Sanilac	Black River	3a
Sanilac	Black River	3b

Sanilac	Elk Creek	3a
Sanilac	Middle Branch Cass River	1
Sanilac	North Branch Cass River	1
Sanilac	South Branch Cass River	2
Schoolcraft	Milakokia River	2
Shiawassee	Byron Millpond Outlet	1
Shiawassee	Looking Glass River	2
Shiawassee	Maple River	1
Shiawassee	Shiawassee River	2*
Shiawassee	South Branch Shiawassee River	2
Shiawassee	Vermilion Creek	2
St. Clair	Belle River	3a
St. Clair	Black River	3a
St. Clair	Black River	3b
St. Clair	Mill Creek	3a
St. Clair	Mill Creek	3b
St. Clair	North Branch Mill Creek	2
St. Clair	Pine River	3a
St. Joseph	Fawn River	2
St. Joseph	Little Portage Creek	1
St. Joseph	Mill Creek	2
St. Joseph	Nottawa Creek	1
St. Joseph	Pigeon River	2
St. Joseph	Portage Creek	1
St. Joseph	Portage River	1
St. Joseph	Prairie River	1
St. Joseph	Profile Lake Drain	2
St. Joseph	Rocky River	1
St. Joseph	Saint Joseph River	2*
St. Joseph	Sherman Mill Creek	1
St. Joseph	Spring Creek	1
St. Joseph	Swan Creek	1
St. Joseph	Wood Lake Outlet	2
Tuscola	Cass River	2
Tuscola	Goodings Creek	2

Tuscola	North Branch Cass River	1
Tuscola	North Branch White Creek	2
Tuscola	Perry Creek	1
Tuscola	South Branch Cass River	2
Tuscola	South Branch White Creek	2
Tuscola	Sucker Creek	2
Tuscola	White Creek	2
Van Buren	Black River	2
Van Buren	East Branch Paw Paw River	2
Van Buren	North Branch Paw Paw River	2
Van Buren	Paw Paw River	2
Van Buren	South Branch Black River	2
Van Buren	South Branch Paw Paw River	1
Washtenaw	Arms Creek	2
Washtenaw	Fleming Creek	2
Washtenaw	Honey Creek	2
Washtenaw	Horseshoe Creek	2
Washtenaw	Huron River	3a
Washtenaw	Huron River	3b
Washtenaw	Iron Creek	2
Washtenaw	Letts Creek	2
Washtenaw	Mill Creek	2
Washtenaw	North Fork Mill Creek	2
Washtenaw	Portage Lake Outlet	2
Washtenaw	Portage Lake Outlet	3a
Washtenaw	Portage River	2
Washtenaw	Portage River	3a
Washtenaw	Portage River	3a
Washtenaw	River Raisin	3a
Washtenaw	Saline River	2
Washtenaw	Unnamed tributary to Mill Creek (U: 42.239654,-84.029583; D: 42.25266,-84.030439)	2
Washtenaw	Unnamed tributary to River Raisin (U: 42.1376,-84.144179; D: 42.150631,-84.132445)	1
Washtenaw	Unnamed tributary to Wood Outlet Drain (U: 42.209387,-83.765133; D: 42.180472,-83.788812)	2
Wayne	Brownstown Creek	2
Wayne	Huron River	3a

Wayne	Huron River	3b
Wayne	Johnson Drain	2
Wayne	Lower River Rouge	2
Wayne	Marsh Creek	2
Wayne	Middle River Rouge	2
Wayne	River Rouge	2
Wayne	Unnamed tributary to Huron River (U: 42.153044,-83.412952; D: 42.16037,-83.402931)	2

Group 1 Special Concern mussel known or expected to occur.

Group 2 State threatened and/or endangered mussels known or expected to occur.

Group 2* State threatened and/or endangered mussels known or expected to occur, historically supported federal listed mussel species.

Group 3 Federal threatened and/or endangered mussels known or expected to occur.

Appendix B

Report Checklist

Introduction

- ☐ Description of the stream and watershed including:
  - Name (if stream is named)
  - Receiving waters of surveyed stream
  - Location, including:
    - Coordinates – at center of ADI
    - River mile (if available)
    - Township Range Section
    - County
  - Drainage area at survey site
  - Summary of any water quality data or previous mussel surveys reports near the area of impact
  - Surrounding land use

Methods

- ☐ Personnel
- ☐ Date(s) of survey
- ☐ Area surveyed, including:
  - Description of survey/buffer areas (e.g., length, bank-to-bank)
  - Coordinates of survey/buffer areas (ADI, USB, DSB)
  - Map delineating survey/buffer areas (ADI, USB, DSB, LB). Map can be included within text or in Figures & Tables section.
- ☐ Survey method, including:
  - Type of mussel survey completed (e.g., visual-tactile, transects, cells)
  - Length and spacing of transects or size of the cells
  - Time searched
  - Method of detection (e.g., SCUBA, view bucket, quadrats)
  - Whether or not banks were searched for shells
  - Trigger – for quantitative studies
  - Description of additional transects (for quantitative studies), including coordinates and delineated map
- ☐ Mussel handling and processing procedures
- ☐ Quality Control Procedures (Includes taking representative photos of each species and video of any questionable specimens).

Results

- ☐ Habitat assessment within each transect, cell, or timed search area, including:
  - Substrate composition (include information about the stability of the substrates)
  - In-stream features (e.g., channel alterations, impoundments)
  - Average stream depth
  - Water velocity (cubic feet per second)
  - Visibility (say what the visibility was, not just that it met the minimum requirements)
  - Water temperature
  - Suitable habitats within the area of the survey
  - Photos of stream and substrate
- ☐ An overview of the results, including:
  - Number of individuals found
  - Number of species found
  - Any notable species found
- ☐ A description of the results of the semi-quantitative and quantitative surveys separately
- ☐ Tables of results, including (either within text or attached in Appendix):

- Species data for each transect and/or cell
  - Relative abundance
  - Condition (living/fresh dead/weathered/subfossil)
  - Sex of individuals if determinable
  - Morphometric data (optional if not required by permit or site-specific authorization)

Mussel Relocation (include this section when salvage and relocation was completed)

- Relocation site, including:
  - Location (coordinates at center)
  - Map delineating area. Map can be included within text or in Figures & Tables section.
  - Results of required semi-quantitative and quantitative surveys
  - Method of salvaging mussels from survey area
  - Environmental characteristics (water depth, velocity, sediment composition, etc.) of the relocation site
  - Number of each species relocated to the site
  - Type of mark used (shellfish tag, PIT tag, etching)

Post Relocation

Relocation site monitoring

- Environmental conditions at the relocation site(s) including the same parameters documented prior to relocation
- The numbers, lengths, and calculated percent of living, dead, and missing mussels for each marked relocated species
- Observations on the condition of the mussels and the relocation site(s).

Conclusion

- Summary of findings, and conclusions

References

- Include citations for any literature cited within the text of the report.

Figures and Tables

- If not provided in text, provide a separate section for Figures (including maps and aerial photos showing extent of survey) and Tables (transect and quadrat data, morphometric data)

Appendices

- Photos of stream and substrates
- Representative photos of each mussel species found
- Video of questionable species
- Raw Data Sheets

Copy of State and/or Federal permits
Site-specific authorization from USFWS for Group 3 stream surveys

Appendix C

Michigan Freshwater Mussel Habitat Assessment Form

Project Information

Project Name_____

Water body_____ Stream Group (see Appendix A)_____

County_____ Township/Range/Section_____

Latitude (DD.DDDDD)_____ Longitude (DD.DDDDD)_____

Methods

Name of Surveyors_____

Qualification of Surveyor(s): USFWS Permit Number_____
MDNR Scientific Collectors Permit Number _____

Date(s) of Survey_____ Distance Surveyed_____

Total Survey Effort (minutes X No. of Surveyors)_____

Describe in detail any deviations from the Michigan Mussel Habitat Assessment Methods:

Habitat Description of Survey Area

Drainage Area at Survey Location (mi^2):_____Water Temp. (^oF):_____Air Temp. (^oF): _____

Substrate Types (include %):

☐ Boulder _____	☐ Gravel _____	☐ Bedrock _____	☐ Detritus _____	☐ Silt _____
☐Cobble _____	☐ Sand _____	☐ Hardpan _____	☐ Muck _____	☐ Artificial _____

Water Level:	□High	□Up	□Normal	□Low	☐Dry/Interstitial
Visibility:	□0-15 cm	□15-30 cm	□30-50 cm	□>50 cm	□Visible to Bottom

Average Depth (cm):	Riffle _____	Run _____	Pool _____
Max Depth (cm):	Riffle _____	Run _____	Pool _____

Appendix C

Results

Evidence of Mussels: Presence of fresh dead mussel shells and living mussels will trigger a full mussel survey

□None □Mussel Shell Only - Subfossil □Mussel Shell Only - Weathered Dead □Mussel Shell Only - Fresh Dead □Living Mussels

Site Sketch. Approximate numbers and locations of shells and live mussels. Include species list if possible.

Required Attachments 1) Location Map and 2) Photo Log

Appendix D

Recommended Guides for Michigan Mussels

Mulcrone, R. S. and J. E. Rathbun. 2018. Field Guide to the Freshwater Mussels of Michigan. Michigan Department Natural Resources.

Other useful references:

Clarke, A. 1981. *The Freshwater Molluscs of Canada*. National Museums of Canada. National Museums of Science.

Cummings, K., and C. Mayer. 1992. *Field Guide to Freshwater Mussels of the Midwest*. Illinois Natural History Survey.

Klocek, R., J. Bland, and L. Barghusen. Undated. *A Field Guide to the Freshwater Mussels of Chicago Wilderness*. Available at: http://fm2.fieldmuseum.org/plantguides/guideimages.asp?ID=360

Metcalfe-Smith, J., A. MacKenzie, I. Carmichael, and D. McGoldrick. 2005. *Photo Field Guide to the Freshwater Mussels of Ontario.* St. Thomas Field Naturalists Club, St. Thomas, Ontario Canada.

Watters, G., M. Hoggarth, and D. Stansbery. 2009. *The Freshwater Mussels of Ohio*. Ohio State University Press.

Freeware-R Software for the development of Species Richness Curves

http://cc.oulu.fi/~jarioksa/softhelp/vegan/html/specaccum.html