Ohio Mussel Survey Protocol

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Ohio Department of Natural Resources (ODNR), Division of Wildlife and U.S. Fish and Wildlife Service (USFWS), Ohio Ecological Services Field Office

Introduction

All native mussels are protected in the State of Ohio (Section 1533.324 of the Ohio Revised Code). In addition, ten federally listed species occur in the State and are protected by the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.). Impacts to State and federally protected mussels and their habitats should be avoided and minimized to the maximum extent practicable. If impacts cannot be avoided, all streams which contain mussels or potential mussel habitat must be surveyed prior to any proposed stream disturbance. When any survey criteria cannot be met, additional consultation with the appropriate State or Federal agency will be required. As a general reference for mussels in Ohio, please refer to *The Freshwater Mussels of Ohio* (Watters et al. 2009).

As such, the protocols herein are designed to determine the presence or probable absence of federally listed mussel species (FLS) as well as provide for the protection of all native mussels within Ohio. Furthermore, this protocol will help assess the size of mussel populations within the project area. These protocols were developed to provide standardized guidance to project applicants about acceptable survey methods and levels of effort for a variety of common project types. These protocols are adapted for Ohio from "West Virginia Mussel Survey Protocols, April 2015, by Clayton *et al.*" These protocols are generally applicable to all rivers, streams, and Lake Erie that may harbor mussels.

This protocol is divided into four sections: A) General Guidelines, B) Stream Group-specific Considerations, C) Relocations, and D) Project-specific Considerations.

A) General Guidelines

Stream Classification: Survey protocols in this document are based, in part, on stream size and the potential presence of FLS. Accordingly, for purposes of determining survey effort and protocols, Ohio streams have been divided into the five categories listed below (Appendix A). Appendix A will be updated as new location and mussel data information becomes available so please check the ODNR Division of Wildlife website for the latest information http://wildlife.ohiodnr.gov/licenses-and-permits/specialty-licenses-permits

- Unlisted: Streams not listed in Appendix A with watersheds >10 mi^2 with the potential for mussels but FLS not expected.
- Group 1: Small to mid-sized streams, FLS not expected.
- Group 2: Small to mid-sized streams, FLS expected.
- Group 3: Large Rivers, FLS not expected.
- Group 4: Large Rivers, FLS expected.

Reconnaissance of Group 1 streams and Unlisted streams with a drainage area over 10 mi^2 may be assessed using the *Reconnaissance Survey for Unionid Mussels* (Appendix B) to determine if mussels are present. The results of the reconnaissance survey will be sent to the ODNR Division of Wildlife Contact (Appendix C). The mussel habitat assessment using the *Ohio Mussel Habitat Assessment Form* must be conducted by someone that has met the minimum qualifications as described in Appendix D. If after review by ODNR it is determined that mussels are not present in the study area, then no mussel survey will be required. If it is determined that mussels are present, then the *Ohio Mussel Survey Protocol* will be followed. You may forgo a reconnaissance survey and conduct a full mussel survey as described below if desired. All Group 2, 3, and 4 streams require a mussel survey as described below. See USGS site for watershed size tool: http://water.usgs.gov/osw/streamstats/ohio.html

Project Justification: Various laws, regulations, and policies require that impacts to aquatic resources, including freshwater mussels and endangered species, be avoided and minimized to the maximum extent practicable. For example, Clean Water Act 404(b)(1) Guidelines state that "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem." The Guidelines further specify that the evaluation of practicable alternatives should include alternative construction methods that do not involve dredge or fill material into waters of the U.S. and alternative locations including "areas not presently owned by the project proponent but which could reasonably be obtained, utilized, expanded or managed in order to fulfill the basic purpose of the proposed activity" (§ 230.10 (a)(2)). The General Conditions that apply to all nationwide permits in Ohio also specify that "no activity may occur in areas of concentrated shellfish populations," unless the activity is related to various shellfish harvesting or restoration activities. The Endangered Species Act, through the section 7 consultation process, requires that Federal agencies and their permit applicants consult with the USFWS to identify and implement measures to avoid or minimize adverse effects to listed species, prior to issuing any permits for the incidental take of listed species.

Project proponents can frequently save time and money, and avoid delays in their project permitting by developing project alternatives early in their planning process. In addition, during previous project consultations involving impacts to mussel populations, the USFWS and ODNR have found that practicable alternatives to avoid and minimize impacts can be developed for almost all projects.

Avoidance: Accordingly, to ensure that projects are implemented in a manner consistent with these regulations and to minimize project delays, all survey proposals submitted to the USFWS and ODNR should include evidence that avoidance is not possible and also address potential alternatives. Survey permits may not be approved if the applicant does not provide adequate justification that instream impacts cannot be avoided. Discussion of alternatives and how

impacts will be avoided and minimized shall be included in the scope of work if the applicant wishes to proceed directly from a Phase 1 to a Phase 2 survey.

Alternative Construction Methods: Projects should first be designed to avoid and minimize impacts to waters of the U.S. including impacts to streams containing mussel populations. For example, where possible, road crossings should be designed to completely span streams containing mussels. Routes for pipelines should be designed to avoid crossing streams containing mussels and minimize the number of stream crossings.

Activities such as pipeline/waterline crossings shall address alternative methods such as horizontal directional drilling (HDD). Using HDD practices shall be the first priority over open trenching to avoid impacts to mussels and avoid habitat degradation and fragmentation. A response plan for an inadvertent release shall be provided along with a notation on the potential for such an event. If HDD are not being proposed, documentation as to why this alternative is not practicable should be provided. This documentation should include detailed information on project constraints, and engineering and/or geologic evaluations sufficient to justify why this construction method cannot be implemented or would have a high likelihood of failure.

Alternative Locations: Moving project locations slightly upstream or downstream or making minor modifications to project designs is often sufficient to avoid and minimize impacts to mussel populations including endangered species and may allow projects to proceed with minimal delays. Any project that has potential alternative locations for activities (example bridge alignments, pipeline crossings) should include surveys for alternative locations. We recommend a phased approach to prioritize sites with follow-up surveys within the least impacting project site selected. All proposals shall include surveys areas large enough to include all alternative locations.

Surveyor Qualifications: For Group 1 and Group 3 streams, surveyors must pass the *Standardized Freshwater Mussel Identification Test* (Appendix E) administered by The Ohio State University's Museum of Biological Diversity (Contact in Appendix C) and have the minimum qualifications described in Appendix D. A Federal permit from the USFWS is required to conduct surveys in streams that may harbor FLS (Groups 2 and 4).

Prior Notification: Even though standardized protocols are established, survey plans must be provided to appropriate State (all streams) and Federal (Group 2 and Group 4 streams) agencies. This is to ensure that the appropriate protocol is being applied for the given stream type and construction activity and to allow time for agency staff to review existing data from the proposed survey area and work with the applicant to design the appropriate survey extent as described below. Appropriate State and Federal agencies shall be notified at least 15 days prior to the time the actual survey will occur, and be given at least 30 days to review survey results prior to the anticipated start of any construction activities. State and Federal contact information is provided in Appendix C. Activities to be conducted in Group 2 or Group 4 streams must have received written concurrence from the USFWS prior to conducting any project activities including surveys, relocations and/or construction activities.

Survey Season: The survey season is from May 1 to October 1. Requests to conduct surveys outside this time period will be reviewed on a case-by-case basis, and will be approved only under extenuating circumstances. Approval must be obtained from the appropriate State and/or Federal agencies prior to conducting the work, and may require a revised protocol.

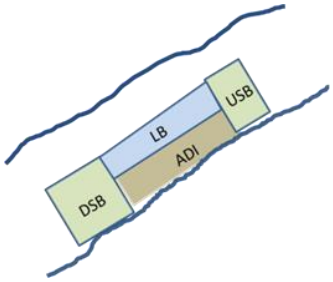
Workable flow requirements: If the area cannot be effectively surveyed under existing flow conditions then the survey must be re-scheduled. Any variance must be approved by the appropriate State and Federal agencies.

Visibility requirements: Visual or surface searches must have a minimum visibility of one-half meter (approx. 20 inches), with or without lights at depth of survey. When recording visibility along with other data, report the actual visibility rather than just noting that it met the minimum requirement. If suitable visibility is not present at the intended time of survey, then the survey must be re-scheduled, or a different protocol must be employed in consultation with the appropriate State and Federal agencies (Example, more extensive quantitative surveys with excavations may be required). If the normal flow conditions offer low visibility, the visibility requirement may be lifted in consultation with the appropriate State or Federal agency.

Data Longevity: Survey data will be considered valid for five years from the date of the survey. Areas that have been dredged within the previous five year period do not need to be resurveyed unless the area is to be expanded or moved.

Minimum Data Requirement: See Appendix F for a checklist of data that must be included in the survey report. Data must also be reported electronically in accordance with your State and Federal permits and any site specific authorization conditions. Vouchered specimens should be sent to the Museum of Biological Diversity at The Ohio State University, 1315 Kinnear Rd., Columbus, OH 43212.

Survey Area: The survey extent shall include the area of direct impact (ADI) and all applicable buffers upstream (US), downstream (DS), and laterally (LT), as indicated in Appendix G. If the project may affect stream hydrology, such as hydropower projects or installation of in-stream structures, the area of hydrologic impact shall be included in the ADI. Hydraulic modeling may be required to determine the extent of hydraulic changes. If modeling is not conducted prior to surveying, the survey shall extend at least 1.6km (1mi) downstream. Additional surveys may be required if subsequent modeling determines hydraulic changes will extend farther downstream. Likewise, the mixing zone of an outfall shall be included within the ADI. The LB applies to the length of the ADI. Where a project does not span the width of the stream, the survey widths of the US Buffer and the DS Buffer shall be equal to the width of the ADI and associated LB (example at right).



Survey Techniques: With the exception of streams with watersheds < 2590ha (10 mi^2) above ADI, all streams require mussel surveys of the ADI and all buffers US, DS, and LT, if applicable unless the results of the *Reconnaissance Survey for Unionid Mussels* (Appendix B) indicates that mussels are not present in Unlisted and Group 1 streams.

- **Visual or Surface Searches** include moving cobble and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5 cm (2 in) of substrate in order to better view the mussels which may be there. A minimum rate of 20 minutes per $100m^2$ of visual searching shall be expended in each segment of heterogeneous substrate. If mussels are found, an additional 30 minutes of visual searching shall be expended per $100m^2$.

- **Timed Search Surveys** consist of visually searching throughout a larger defined area (such as ADI, US buffer, DS buffer, and LT buffer or mussel concentration) for 20 minutes per $100m^2$. If mussels are found, then 30 additional minutes of visual searching shall be expended per $100m^2$. This type of search can be used in Group 1 streams to determine if mussels are present and to define the limits of a mussel concentration or generate a species richness curve in Group 2 and 4 streams. At a minimum, data shall be provided for each area separately.

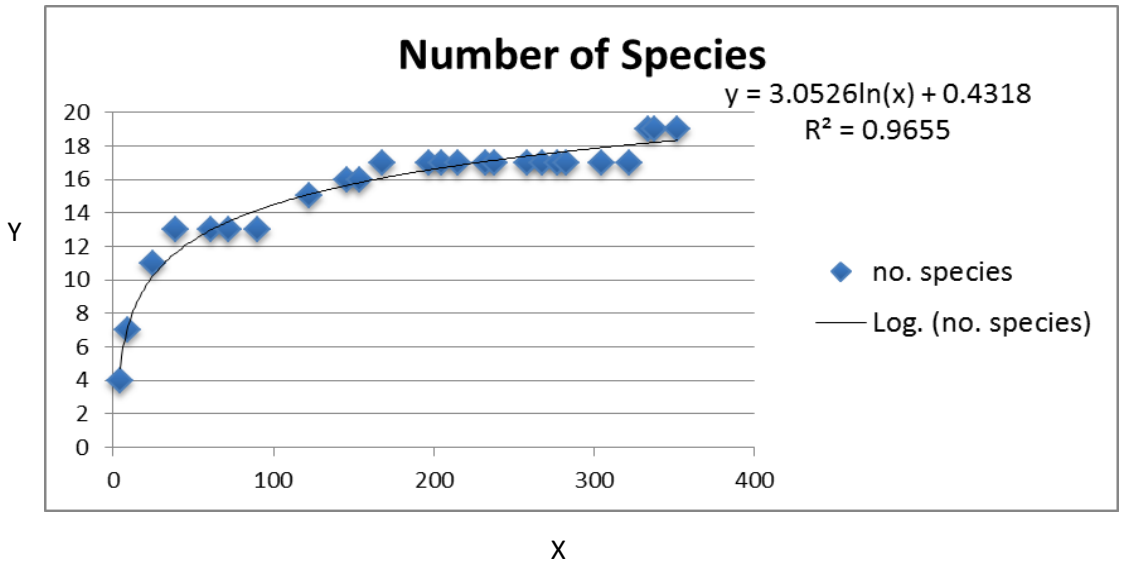
- **Transect Surveys** are required for Group 2 (greater that 20m wide), 3 and 4 streams unless conducting a complete coverage survey using cells (described below). Transects shall be established throughout the proposed site perpendicular to the river. Each transect will be sub-divided into 10m segments for Group 3 and 4 streams and 5m segments for Group 2 streams. Along each transect, surveyors shall visually search an area 1m wide for mussels at a minimum search rate of 1 minute/m^2 in heterogeneous substrates. If using transects, a Phase 1 survey for Group 2 and 4 streams must include a timed search survey for development of a species richness curve as previously discussed. All data is recorded separately for each segment and defined area (i.e., ADI, US buffer, DS buffer, and LT buffer).

- **Cells** may be used in lieu of transects and are encouraged except in those areas with extensive ADI and buffer areas. In these large areas, the mussel concentrations are best delineated using transects. The establishment of cells is more appropriate for small to mid-sized Group 2 streams, and is required on Group 2 streams 20m wide or less. Rather than transects spaced throughout each of the three designated areas, each area would be divided into a series of cells in which each would be surveyed. Maximum acceptable cell size is $100m^2$, with the dimensions determined by the surveyor based on the stream channel morphology. Minimum level of search effort per cell shall be 20 minutes per $100m^2$. If any mussels are found, an additional 30 minutes per cell is required; equivalent to a total search rate of 0.5 minutes/m^2. All data is recorded separately for each cell and defined area (i.e., ADI, US buffer, DS buffer, and LT buffer).

- **Quantitative Samples** are required as part of Phase 2 surveys on Group 2 streams within the salvage zone only. These samples shall consist of $0.25m^2$ systematic quadrats using the three random start methodology as described by Smith et al. (2001). Substrate shall be excavated

to a depth of 15cm (6in) or hardpan. The material shall be collected and taken to the surface and sorted, removing all live and dead shell material.

- **Species Richness Curves** shall be developed in addition to transect surveys for all streams listed as Groups 2 and 4. Surveys using cells do not need to conduct additional timed search surveys for development of a curve as the entire area has already been searched. The searches for curve development should be limited to the area of mussel concentrations (as determined in previous surveys). A sufficient number of searches should be conducted (typically 5 to 10 minute increments) such that a plateau is reached on a plot of cumulative number of individuals (x-axis) vs. cumulative number of species (y-axis). Searches shall be conducted until at least 6 samples are collected with the addition of no new species. If permission was received to conduct a Phase 2 at the same time as a Phase 1 then the qualitative sampling should be completed after the quantitative sampling. Conducting qualitative sampling first could impact the results of the quantitative sampling. 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. In the example below, a total 352 individuals comprised 19 species. Using the regression formula, it would take a total of 611 individuals to find one additional species.



Mussel Processing: In each segment or cell, any mussels observed will be bagged and brought to the surface for further processing and positive identification, unless the appropriate State and Federal agency representative both agree to allow some mussel identification to occur at the survey depth. However, any species which may resemble a FLS must be brought to the surface for positive identification. Mussels should be kept in water at all times, except for the brief period that they need to be out of the water to be measured or photographed, but no longer than 1 minute at a time. Mussels observed along the transect or within a cell will be recorded as occurring in a particular segment or cell. Appropriate information describing the depth and habitat conditions along each transect and within each cell, such as depositional areas, silt, mud, detritus, hard-pan, sand, and scoured areas where mussels cannot burrow, gravel, cobble, etc., shall be recorded for each segment or cell.

Moving Transect is a method used for mussel salvage whereby 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 salvaged. A minimum effort of 0.5 minute/m^2 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.

Mussel Concentrations and Potential FLS: Failure to detect FLS during a survey does not confirm their absence. In Group 2 and Group 4 streams, the detection of a mussel concentration and/or diverse mussel bed during Phase 1 surveys (as described below) indicates that FLS may be present. See specific survey protocols below for Group 2 and Group 4 streams for criteria that demonstrate a mussel concentration or diverse bed for these stream types. When an initial survey finds a diverse bed/mussel concentration, thus indicating possible presence of FLS, the project proponent should, wherever possible, develop/modify project plans to avoid impacts to mussels. If impact avoidance is not possible, the project proponent should submit justification for this determination to ODNR and USFWS. If avoidance is not possible, the project proponent must then submit a quantitative survey (i.e., Phase 2 survey, described below) proposal to ODNR and USFWS for approval. The project proponent must receive approval for the Phase 2 survey before work may begin.

- **Note:** In some instances, the project proponent may anticipate the presence of a diverse bed/mussel concentration prior to conducting Phase 1 surveys, and impact avoidance may not be possible. In these cases, a justification of non-avoidance and a Phase 2 survey proposal may be submitted concurrently with a Phase 1 proposal. Alternatively, a Phase 2 survey may be conducted in lieu of a Phase 1 survey if sufficient justification of why the proposed project cannot be modified to avoid stream impacts has been provided to ODNR and USFWS.

B) Stream Group-specific Considerations:

Group 1 Streams:

Timed visual search surveys are acceptable. At a minimum, data shall be reported for each area (ADI, US buffer, DS buffer, and LT buffer) separately. It is preferred that relocations (see Relocation section below) occur at time of initial survey so that mussels are not disturbed twice. If FLS are found during the survey, relocation activities must stop, and USFWS contacted for guidance on how to proceed (see Relocation section C, below).

Group 2 Streams:

Phase 1: A Phase 1 survey consists of a visual search of 1m wide transects, spaced a maximum of 10 m apart or a visual search by cells. 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 is recorded by 5m segments along each transect or by cell position. If one or both of the following triggers are met, FLS may be present, and the project proponent shall either (1) avoid impacts to mussels or, (2) if avoidance is not possible, conduct a Phase 2 survey in the area(s) where trigger(s) are met, to determine whether FLS are present:

- Mussel density of $0.5/m^2$ within any 5m segment along each transect or within any area of a cell and/or
- Observation of at least two species, live or fresh dead, not listed in Appendix H.

Phase 2: If a trigger is met and avoidance is not an option, then a Phase 2 survey shall be conducted within the salvage zone as described in Appendix G. The objective of Phase 2 is to collect sufficient data to determine if FLS are present within the mussel concentration defined in Phase 1. The Phase 2 survey for a Group 2 stream consists of a quantitative survey using excavations as described by Smith (2001). This survey shall be conducted using the three random start methodology throughout the area meeting the trigger criteria within the salvage zone areas connected by similar habitat plus a 10m buffer surrounding it. Multiple areas may be surveyed only if they are separated by more than 20m of dissimilar habitat or unsuitable habitat. The number of quantitative samples to be collected shall be calculated at the rate of 1 quadrat per 5m of transects or 1 quadrat per $5m^2$ cell area. The boundary of the Phase 2 should not exceed the salvage area.

If qualitative surveys for species richness curve development were not conducted during Phase 1, they must be conducted as part of the Phase 2.

Group 3 streams:

Survey of Group 3 streams may consist of transects or timed searches and buffers vary by project type, as indicated in Appendix G. When using cells in lieu of transects, timed search surveys are conducted for each area (ADI, US buffer, DS buffer, and LT buffer) shall be conducted at a minimum. The survey design shall consist of transects, 1m in width, spaced no more than 100m apart, placed perpendicular to stream flow or cells not to exceed $100m^2$ in size. Data shall be compiled for each of the survey areas (US buffer, DS buffer, LT buffer, and ADI) separately. Record data by 10m segment along the transect or by cell position. Relocation (see Relocation section C, below) is preferred to occur at time of initial survey, provided no FLS are found. If FLS are found during the survey, relocation activities must stop, and USFWS contacted for guidance on how to proceed (see Relocation section C, below).

Group 4 streams:

Phase 1: The objective of Phase 1 is to determine if a diverse mussel community is present and to delineate the area(s) with a mussel concentration. The survey design shall consist of transects, 1m in width, spaced no more than 50m apart, placed perpendicular to stream flow or cells not to exceed $100m^2$ in size. If transect spacing is greater than 10m and no mussels are observed in two adjacent transects, with at least one of the transects containing apparent suitable mussel habitat, then a qualitative search for a minimum of 10 minutes must occur between the two transects in the area of suitable mussel habitat. If any live and/or fresh dead

mussels are found between the two transects during the search, then an additional transect will be placed there and a search conducted as previously described. Data shall be compiled separately for each survey area (ADI, US Buffer, DS Buffer, and LT Buffer). Record data by 10m segment along the transect or by cell position. If a trigger is met (see below) and avoidance is not an option, then a Phase 2 survey shall be conducted. If the entire area was surveyed during Phase 1 using cells, a Phase 2 survey is not required.

Survey results that trigger avoidance or a Phase 2 survey include:

- 5 individuals/10m segment in any area of the survey and/or
- Presence of at least three species not listed in Appendix H along any one transect or within a qualitative survey conducted between transects.

Phase 2: The objective of Phase 2 is to collect sufficient data to determine if FLS are likely to be present within the mussel concentration defined in Phase 1. A Phase 2 survey shall consist of additional transects placed between the original surveyed transects within the targeted area. The targeted area is defined as an area encompassing all triggered areas connected by similar habitat plus a 10m buffer surrounding it. The boundary of the Phase 2 area should not exceed the Phase 1 area.

C) Mussel Relocations

All native mussels are protected within the state of Ohio and if avoidance options are exhausted, mussels must be relocated from the ADI and appropriate buffer areas (Salvage Zone – Appendix G). No mussels are to be moved without prior authorization from appropriate State and/or Federal authorities. If mussels are assumed to be present at a Group 1 or Group 3 stream that will be impacted, a relocation plan can be developed without a mussel survey through coordination with the state regulatory agency (Appendix C). Coordination with the USFWS must occur prior to any relocation efforts on Group 2 and Group 4 streams. Relocation of any federally listed mussels will require formal consultation. This consultation process requires that the project applicant develop a Biological Assessment (BA) that quantifies the potential impacts to the species and that an incidental take authorization is issued by the USFWS prior to conducting any activities that could adversely affect these species. This process may take up to 135 days from the time that a completed BA is submitted to the USFWS. Impacts to federally listed mussel species and their habitats must be avoided and minimized to the maximum extent practicable. Additional conservation measures above and beyond relocations may be required if the proposed project may adversely affect federally listed species.

1. For Group 2 and Group 4 streams, relocations shall not be conducted until a review of findings by the USFWS has been conducted and approved. On Group 1 and 3 streams, prior approval by the ODNR to relocate at time of initial survey may be granted.
2. Multiple passes shall be made through the area until two or fewer mussels or less than 5 percent of the number collected on the original pass is recovered on the final pass.
3. Relocation effort shall be systematically conducted by a “moving transect” or establishing cells not to exceed $100m^2$.
4. Relocation efforts shall meet the same standards as surveys (i.e. visibility requirements, workable streamflow conditions, and mussel survey period).

5. Relocation sites shall be located upstream (preferred) in an area of equal or better habitat, or to an approved relocation site in a discrete area recommended by the ODNR and USFWS. At a minimum, conduct a 15 minute qualitative survey of the relocation site and note all observations of resident mussels. These shall be reported, including coordinates in decimal degrees, to the responsible agency (ODNR for all mussels, USFWS for FLS). If relocation efforts are likely to occur, mussel surveyors may scope out potential relocation sites during the initial Phase I or Phase 2 survey. Survey proposals should include any potential scoping activities for suitable relocation sites.
6. If any FLS are found during relocation efforts for projects where no FLS were found during previous survey efforts, and no incidental take authorization from the USFWS has been received, then relocation efforts must be stopped and the USFWS should be immediately contacted.
7. Relocations may only be conducted during the mussel survey season (May 1 – October 1), unless a variance is approved by the appropriate resource agencies. Relocations for Group 2 and 4 systems shall be done within the same field season as the expected in-stream activities, or if activities are to be conducted before June 15, relocations may be conducted in the previous field season. If relocation activities occur during the previous field season, additional effort may be required just prior to construction activities depending on the results of earlier relocation efforts. For Group 1 and 3 systems, relocations are good for two field seasons.

Salvage zones vary by stream Group and project type, and are listed in Appendix G. On streams with FLS, consultation with the USFWS must occur prior to any relocation. This formal consultation process requires that the Federal action agency (or project applicant on behalf of the Federal agency) develop a Biological Assessment (BA) that quantifies the potential impacts to the species and that an incidental take authorization is issued by the USFWS prior to conducting any activities that could adversely affect these species. This process may take up to 135 days from the time that a completed BA is submitted to the USFWS by the Federal action agency. Impacts to federally listed mussel species and their habitats must be avoided and minimized to the extent practicable.

D) Project-specific Considerations

In addition to survey and relocation criteria described above, the following criteria apply to the project types. The specific layout of buffer zones and survey areas, organized by stream group and potential project type are available in Appendix G. These project types and special considerations are discussed in more detail below.

<u>Dredging in Group 3 and Group 4 streams</u>: If less than five years has elapsed since the last dredging and if there will be no expansion or movement of the dredged area then no additional surveys are required. If more than 5 years has elapsed or the previously dredged area is being expanded or moved, mussel surveys shall be required. For Group 4 streams only, mussel beds shall be protected during dredging activities by a buffer of 500m US, 150m DS and 150m LT (Note: This protection buffer should not be confused with the survey area buffers in Appendix G). Instream disposal of dredge material is not covered under these buffers and will require additional coordination with the ODNR and USFWS.

Linear Projects in Group 3 and Group 4 streams (e.g., barge loading facility with mooring structures): If the location of new mooring structures are known, transects shall bisect these locations or be placed as close to them as possible. If structures are 50m apart, transects shall be placed 50m apart, not to exceed maximum transect spacing for Group 3 (100m) and Group 4 (50m) streams.

Log Jam Removal: For log jam removals, a mussel survey and relocation is not required if the heavy equipment is used outside the stream channel or if hand removal is used.

Dam Removal: For dam removals on Group 1 and 3 streams, mussel surveys will not be required prior to removal. While the dam is breached and the dam pool is lowered, we request that sufficient staffing is available to recover stranded mussels. If multiple teams are used in the rescue operation, at least one qualified malacologist (Group 1 and 3 systems - Appendix D) should be present as a team leader. Others on the rescue team do not have to be a qualified malacologist but will be briefed by the team leader on what to look for and how to handle stranded mussels. If a mussel survey is conducted in project area and the entire dam pool prior to dam removal and no mussels are found then no relocation will be necessary when the dam is removed. All recovered mussels should be recorded and moved to an appropriate relocation site as described in Section C. Group 2 and 4 systems will be handled on a case-by-case basis.

Discharge Outfalls: Depending on discharge composition of outfall, relocation of mussels from the mixing zone may be required.

HDD: If the impacts to the stream channel are minimized through the use of HDD technology then a mussel survey is not required. When HDD or other sub-surface installation techniques are utilized on Group 2 and 4 streams or on any Scenic River as defined by the ODNR Division of Watercraft then sufficient geotechnical data should be developed for all proposed stream and river crossing sites showing the soils, geology and stratification of the proposed crossing locations. Such data can be extremely important to facilitate successful subsurface crossings, especially in areas where rivers flow through glaciated regions of the state and have channels and river valleys composed of predominately unconsolidated glacial materials (sand, gravel, cobble and boulder mix). Such stream/river beds can be highly susceptible to frac-outs, upward migration and discharge of drilling fluids as well as stream/river bed subsidence. In such areas sufficient geotechnical analysis should be performed so as to identify a possible confining layer (bedrock, clay, etc.) that may limit the upward migration of drilling fluids thus reducing the risk of frac-outs. All geotechnical data and the Frac-Out Contingency plan should be sent to the appropriate contact (Appendix C). Please contact the appropriate agencies if there is an accidental stream bed disturbance during HDD operations.

Bridge Projects: For Group 2, 3, and 4 streams, a minimum of three transects shall be surveyed within the ADI (Note: hydrologic changes can occur with bridge and causeway construction, demolition, and design. The area of hydrologic change shall be considered as potential impact area, and therefore included in the ADI). Relocations are allowed at the time of the survey on Group 1 and 3 streams. For new bridges, initial surveys shall include all areas that can be used for alternative construction sites. If the project is confined to the channel edge (ex. encasing piers and abutment work) then the mussel survey/relocation will also be confined to the channel edge.

Waterline/Pipeline and other Corridor Disturbances: Three timed search surveys, one search for each area (ADI, US buffer and DS buffer) shall be conducted at a minimum. Data shall be recorded separately for surveys within the DS buffer, ADI, and US buffer. A minimum of three transects shall be surveyed within the ADI. One of these three should occur exactly where the proposed corridor construction (i.e. pipeline) will cross the stream.

Projecting Dike Structures (Group 3 and 4 streams only, finger dikes, zipper dikes, not parallel to shore): If trigger is reached, as previously identified, on a Group 4 stream, then a Phase 2 survey is required.

Shoreline Protection (example rip-rap, gabion baskets, longitudinal dikes, etc.): For Groups 1 streams, and when using cells in lieu of transects for Group 3 streams, timed search surveys are conducted in each area (ADI, US buffer, DS buffer, and LT Buffer) shall be conducted at a minimum. Please refer to Appendix G for ADI, US buffer, LT buffer, and DS buffer for Group 2 and 4 streams.

Non-Commercial Docks in Group 3 and 4 streams do not require a mussel survey as long as they meet the following criteria:

1. Do not extend riverward more than 10m from low water mark (water's edge),
2. Do not contain any fill material other than pilings or post, and any shoreline protection material such as riprap, is only placed above the low water mark,
3. Contain 4 or fewer pilings or posts that have a combined area less than $1m^2$,
4. Are less than 10m (32.8ft) in length,
5. If within 500m (1,640ft) of an island, must receive clearance from USFWS.

References

Smith, D. R., R. F. Villella, and D. P. Lemarié. 2001. Survey protocol for assessment of endangered freshwater mussels in the Allegheny River. J. N. Am. Benthol. Soc 20(1):118-132.

Clayton, J.L, B. Douglas, and P. Morrison. 2015. West Virginia Mussel Survey Protocols, April, 2015. Unpublished document.

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

Appendix A: Ohio Mussel Stream List - 4/15/2016		
County	**Stream**	**Group**
Adams	Beasley Fork (Ohio Brush Creek)	1
Adams	Cedar Fork (Scioto Brush Creek)	1
Adams	Cherry Fork	1
Adams	Crooked Creek (Ohio Brush Creek)	1
Adams	East Fork Eagle Creek (Eagle Creek)	1
Adams	Lick Fork (Ohio Brush Creek)	1
Adams	Middle Branch (Mill Creek)	1
Adams	Middle Fork (Ohio Brush Creek)	1
Adams	Ohio Brush Creek	1
Adams	Ohio River	4
Adams	Rogers Run	1
Adams	Scioto Brush Creek	2
Adams	South Fork Scioto Brush Creek	2
Adams	West Fork Ohio Brush Creek	1
Allen	Auglaize River	1
Allen	Buck Run	1
Allen	Camp Creek	1
Allen	Hog Creek	1
Allen	Jennings Creek	1
Allen	Little Hog Creek	1
Allen	Miami-Erie Canal	1
Allen	Pike Run	1
Allen	Ottawa River	1
Allen	Wrestle Creek	1
Allen	Riley Creek	1
Ashland	Black Fork Mohican River	1
Ashland	Buck Creek	1
Ashland	Clear Fork Mohican River	1
Ashland	Jamison Creek	1
Ashland	Jerome Fork	1
Ashland	Lake Fork Mohican River	1
Ashland	Mohican River	1
Ashland	Muddy Fork Mohican River	1
Ashland	Vermilion River	1
Ashland	West Fork (East Branch Black River)	1
Ashtabula	Ashtabula River	1
Ashtabula	Coffee Creek	1
Ashtabula	Conneaut Creek	1
Ashtabula	Cowles Creek	1
Ashtabula	Grand River	2
Ashtabula	Lake Erie	1
Ashtabula	Mill Creek	1
Ashtabula	Phelps Creek	1

Ashtabula	Pymatuning Creek	2
Ashtabula	Rock Creek	1
Ashtabula	West Branch Ashtabula River	1
Athens	East Branch Shade River	1
Athens	Federal Creek	1
Athens	Hocking River	1
Athens	Long Run	1
Athens	Margaret Creek	1
Athens	McDougall Branch	1
Athens	Middle Branch Shade River	1
Athens	Mud Fork	1
Athens	Ohio River	4
Athens	Sharps Fork	1
Athens	Strouds Run	1
Athens	Sugar Creek	1
Athens	Sunday Creek	1
Auglaize	Auglaize River	1
Auglaize	Clear Creek	1
Auglaize	Koop Creek (aka Kopp Creek)	1
Auglaize	Miami-Erie Canal	1
Auglaize	St. Marys River	1
Auglaize	Twomile Creek	1
Belmont	Captina Creek	1
Belmont	Stillwater Creek	1
Belmont	Ohio River	3
Brown	Cloverlick Creek	1
Brown	Eagle Creek	1
Brown	East Fork Little Miami River	2
Brown	East Fork White Oak Creek	1
Brown	Fivemile Creek	1
Brown	Honey Run	1
Brown	Indian Creek	1
Brown	Ohio River	4
Brown	Solomon Run	1
Brown	Sterling Run	1
Brown	West Fork Eagle Creek	1
Brown	West Fork Ohio Brush Creek	1
Brown	White Oak Creek	1
Butler	Dicks Creek	1
Butler	Fourmile Creek	1
Butler	Great Miami River	4
Butler	Millers Creek	1
Butler	Sevenmile Creek	1
Carroll	Conotton Creek	1

Carroll	Indian Fork	1
Carroll	Still Fork	1
Carroll	Sandy Creek	1
Champaign	Kings Creek	1
Champaign	Little Darby Creek	1
Champaign	Macochee Ditch	1
Champaign	Mad River	1
Champaign	Mosquito Creek	1
Champaign	Pleasant Run	1
Champaign	Proctor Run	1
Champaign	Spain Creek	1
Champaign	Treacle Creek	1
Clark	Beaver Creek	1
Clark	Buck Creek	1
Clark	Little Miami River	2
Clark	Mad River	1
Clark	Medway Creek	1
Clark	North Fork Deer Creek	1
Clark	North Fork Little Miami River	1
Clermont	Cloverlick Creek	1
Clermont	East Fork Little Miami River	2
Clermont	Indian Creek	1
Clermont	Little Miami River	2
Clermont	O'Bannon Creek	1
Clermont	Ohio River	4
Clermont	Poplar Creek	1
Clermont	Stonelick Creek	1
Clermont	Ten Mile Creek	1
Clinton	Anderson Fork (Caesar Creek)	1
Clinton	Caesar Creek	1
Clinton	Cowan Creek	1
Clinton	East Fork Little Miami River	1
Clinton	Grassy Branch	1
Clinton	Little East Fork	1
Clinton	Todd Fork (Little Miami River)	1
Clinton	West Branch Rattlesnake Creek	1
Clinton	West Fork of East Fork (East Fork Little Miami River)	1
Columbiana	Beaver Run	1
Columbiana	Bull Creek	1
Columbiana	Brush Creek	1
Columbiana	Cold Run	1
Columbiana	East Fork Stateline Creek	1
Columbiana	Little Beaver Creek	1
Columbiana	Little Bull Creek	1

Columbiana	Mahoning River	1
Columbiana	Middle Fork Little Beaver Creek	1
Columbiana	North Fork Little Beaver Creek	1
Columbiana	Ohio River	3
Columbiana	Patterson Creek	1
Columbiana	Sandy Creek	1
Columbiana	West Fork Little Beaver Creek	1
Coshocton	Killbuck Creek	2
Coshocton	Kokosing River	1
Coshocton	Little Wakatomika Creek	1
Coshocton	Mohican River	1
Coshocton	Muskingum River	4
Coshocton	Trib. to Tuscarawas R. (RM 3.78)	1
Coshocton	Tuscarawas River	3
Coshocton	Walhonding River	2
Coshocton	Wills Creek	1
Crawford	Broken Sword Creek	1
Crawford	Buckeye Creek	1
Crawford	Little Scioto River	1
Crawford	Mud Run	1
Crawford	Olentangy River	1
Crawford	Sandusky River	1
Crawford	Shumaker Ditch	1
Cuyahoga	Big Creek	1
Cuyahoga	Chagrin River	1
Cuyahoga	Chippewa Creek	1
Cuyahoga	Cuyahoga River	3
Cuyahoga	Doan Brook	1
Cuyahoga	East Branch Rocky River	1
Cuyahoga	Lake Erie	3
Cuyahoga	Ohio and Erie Canal	1
Cuyahoga	Rocky River	1
Cuyahoga	Sagamore Creek	1
Cuyahoga	Sulphur Spring Brook	1
Cuyahoga	Tinkers Creek	1
Cuyahoga	West Branch Rocky River	1
Darke	Boyd Creek	1
Darke	Dismal Creek	1
Darke	Dividing Branch	1
Darke	Grays Branch	1
Darke	Greenville Creek	1
Darke	Indian Creek	1
Darke	Millers Fork	1
Darke	Mississinewa River	1

Darke	Mud Creek	1
Darke	North Fork Stillwater River	1
Darke	South Fork Stillwater River	1
Darke	Stillwater River	2
Darke	Swamp Creek	1
Defiance	Auglaize River	1
Defiance	Big Run	1
Defiance	Gordon Creek	1
Defiance	Lick Creek	1
Defiance	Lost Creek	1
Defiance	Maumee River	3
Defiance	Miami-Erie Canal	1
Defiance	Middle Fork Gordon Creek	1
Defiance	Mud Creek	1
Defiance	North Powell Creek	1
Defiance	Powell Creek	1
Defiance	South Fork Gordon Creek	1
Defiance	St. Joseph River	2
Defiance	Sulphur Creek	1
Defiance	Tiffin River	1
Delaware	Alum Creek	1
Delaware	Bartholomew Run	1
Delaware	Big Run	1
Delaware	Big Walnut Creek	1
Delaware	Blues Creek	1
Delaware	Bokes Creek	1
Delaware	Brondige Run	1
Delaware	Culver Creek	1
Delaware	Delaware Run	1
Delaware	Duncan Run	1
Delaware	Fulton Creek	1
Delaware	Kebler Run	1
Delaware	Long Run	1
Delaware	Mill Creek	2
Delaware	North Fork Rattlesnake Creek	1
Delaware	Olentangy River	2
Delaware	Ottawa Creek	1
Delaware	Perfect Creek	1
Delaware	Scioto River	1
Delaware	Smith Run	1
Delaware	South Fork Rattlesnake Creek	1
Delaware	Sugar Creek	1
Delaware	Turkey Run	1
Delaware	West Branch Alum Creek	1
Delaware	Whetstone Creek	1

Erie	Chappel Creek	1
Erie	Huron River	1
Erie	Lake Erie	3
Erie	Sugar Creek	1
Erie	Old Woman Creek	1
Erie	Plum Brook	1
Erie	Rattlesnake Creek	1
Erie	Sandusky Bay	3
Erie	Sawmill Creek	1
Erie	Vermilion River	1
Fairfield	Arney Run	1
Fairfield	Baldwin Run	1
Fairfield	Blacklick Creek	1
Fairfield	Clear Creek	1
Fairfield	Dunkle Run	1
Fairfield	Hocking River	1
Fairfield	Hunters Run	1
Fairfield	Little Rush Creek	1
Fairfield	Pawpaw Creek	1
Fairfield	Pleasant Run	1
Fairfield	Rush Creek	1
Fairfield	Sand Run	1
Fairfield	South Fork Licking River	1
Fairfield	Sycamore Creek	1
Fairfield	Walnut Creek	1
Fayette	Compton Creek	1
Fayette	Crooked Creek	1
Fayette	Deer Creek	1
Fayette	East Fork Paint Creek	1
Fayette	Lees Creek	1
Fayette	Mills Branch	1
Fayette	North Fork Paint Creek	1
Fayette	Paint Creek	1
Fayette	Rattlesnake Creek	1
Fayette	Sugar Creek	1
Fayette	Thompson Creek	1
Fayette	West Branch Rattlesnake Creek	1
Fayette	Wabash Creek	1
Franklin	Alum Creek	1
Franklin	Big Darby Creek	2
Franklin	Big Run	1
Franklin	Big Walnut Creek	1
Franklin	Blacklick Creek	1
Franklin	Clover Groff Ditch	1
Franklin	Georges Creek	1

Franklin	Grant Run	1
Franklin	Hamilton Ditch	1
Franklin	Hellbranch Run	1
Franklin	Little Darby Creek	2
Franklin	Ohio and Erie Canal	1
Franklin	Olentangy River	1
Franklin	Plum Run	1
Franklin	Rocky Fork (Big Walnut Creek)	1
Franklin	Scioto Big Run	1
Franklin	Scioto River	4
Franklin	Sugar Run	1
Franklin	Walnut Creek	1
Fulton	Bad Creek	1
Fulton	Swan Creek	2
Fulton	Tiffin River	1
Gallia	Barren Creek	1
Gallia	Black Fork (Symmes Creek)	1
Gallia	Camp Creek	1
Gallia	Chickamauga Creek	1
Gallia	Dirtyface Creek	1
Gallia	Little Chickamauga Creek	1
Gallia	Ohio River	4
Gallia	Raccoon Creek	1
Gallia	Symmes Creek	1
Geauga	Black Brook	1
Geauga	Bridge Creek	1
Geauga	Chagrin River	1
Geauga	Cuyahoga River	1
Geauga	East Branch Cuyahoga River	1
Geauga	Grand River	1
Geauga	Griswold Creek	1
Geauga	South Branch Phelps Creek	1
Geauga	Spring Brook	1
Geauga	West Branch Cuyahoga River	1
Greene	Anderson Fork (Caesar Creek)	1
Greene	Caesar Creek	1
Greene	Hebble Creek	1
Greene	Little Miami River	2
Greene	Mad River	1
Greene	Massies Creek	1
Greene	North Branch Caesar Creek	1
Greene	North Fork Massies Creek	1
Greene	South Branch Caesar Creek	1
Greene	South Fork Massies Creek	1

Greene	Sugar Creek	1
Greene	Yellow Springs Creek	1
Guernsey	Brushy Fork	1
Guernsey	Buffalo Fork (Wills Creek)	1
Guernsey	Chapman Run	1
Guernsey	Leatherwood Creek	1
Guernsey	Rocky Fork (Sugartree Fork, Salt Fork)	1
Guernsey	Salt Fork	1
Guernsey	Seneca Fork	1
Guernsey	Seneca Lake	1
Guernsey	Sugartree Fork	1
Guernsey	Wills Creek	1
Hamilton	Bloody Run	1
Hamilton	Cooper Creek	1
Hamilton	Great Miami River	4
Hamilton	Little Miami River	2
Hamilton	Miami-Erie Canal	1
Hamilton	Mill Creek	1
Hamilton	Ohio River	4
Hamilton	Town Run	1
Hamilton	West Fork Mill Creek	1
Hamilton	Whitewater River	3
Hancock	Blanchard River (Upstream SR 568)	2
Hancock	Blanchard River (Downstream SR 568)	1
Hancock	Eagle Creek	1
Hancock	East Branch Portage River	1
Hancock	Jacob Burket Ditch	1
Hancock	Oil Ditch	1
Hancock	Ottawa Creek	1
Hancock	Potato Run	1
Hancock	Riley Creek	1
Hardin	Blanchard River	2
Hardin	Cottonwood Ditch	1
Hardin	McDonald Creek	1
Hardin	Panther Creek	1
Hardin	Scioto River	1
Hardin	Silver Creek	1
Hardin	Taylor Creek	1
Hardin	Wildcat Creek	1
Harrison	Clear Fork Little Stillwater Creek	1
Harrison	Conotton Creek	1
Harrison	Laurel Creek	1
Harrison	Little Stillwater Creek	1
Harrison	Skull Fork (Stillwater Creek)	1
Harrison	Stillwater Creek	1

Henry	Bad Creek	1
Henry	Brubaker Creek	1
Henry	Maumee River	3
Henry	Miami-Erie Canal	1
Henry	North Turkeyfoot Creek	1
Henry	South Turkeyfoot Creek	1
Highland	Baker Fork (Ohio Brush Creek)	1
Highland	Clear Creek	1
Highland	Dodson Creek	1
Highland	East Fork Little Miami River	1
Highland	East Fork White Oak Creek	1
Highland	Middle Fork Lees Creek	1
Highland	Lees Creek	1
Highland	North Fork White Oak Creek	1
Highland	Ohio Brush Creek	1
Highland	Paint Creek	1
Highland	Rattlesnake Creek	1
Highland	Rock Lick	1
Highland	Rocky Fork (Paint Creek)	1
Highland	South Fork (Rocky Fork, Paint Creek)	1
Highland	South Fork Lees Creek	1
Highland	Turtle Creek	1
Hocking	Clear Creek	1
Hocking	Hocking River	1
Hocking	Kitchen Run	1
Hocking	Little Monday Creek	1
Hocking	Monday Creek	1
Hocking	Pine Creek	1
Hocking	Rush Creek	1
Hocking	Salt Creek	1
Hocking	Sand Run	1
Hocking	Scott Creek	1
Holmes	Killbuck Creek	1
Holmes	Lake Fork Mohican River	1
Holmes	Mohican River	1
Huron	Cole Creek	1
Huron	East Branch Huron River	1
Huron	East Branch Vermilion River	1
Huron	Honey Creek	1
Huron	Marsh Run	1
Huron	Southwest Branch Vermilion River	1
Huron	Vermilion River	1
Huron	West Branch Huron River	1
Jackson	Buckeye Creek	1
Jackson	Little Salt Creek	1
Jackson	Little Scioto River	1

Jackson	Pigeon Creek	1
Jackson	Sugarcamp Creek	1
Jackson	Symmes Creek	1
Jefferson	Cross Creek	1
Jefferson	Brush Creek	1
Jefferson	Ohio River	3
Jefferson	Short Creek	1
Jefferson	Yellow Creek	1
Knox	East Branch of North Branch (Kokosing River)	1
Knox	Indianfield Run	1
Knox	Kokosing River	1
Knox	Mohican River	1
Knox	North Branch Kokosing River	1
Knox	North Fork Licking River	1
Knox	Otter Fork Licking River	1
Knox	Sycamore Creek	1
Knox	Vance Creek	1
Lake	Chagrin River	3
Lake	Chagrin River Estuary Channels	1
Lake	Grand River	2
Lake	Lake Erie	3
Lake	Marsh Creek	1
Lake	Mill Creek	1
Lawrence	Buffalo Creek (Symmes Creek)	1
Lawrence	Caulley Creek	1
Lawrence	Indian Guyan Creek	1
Lawrence	Johns Creek	1
Lawrence	Ohio River	4
Lawrence	Pine Creek	1
Lawrence	Storms Creek	1
Lawrence	Symmes Creek	1
Licking	Beaver Run	1
Licking	Dutch Fork Licking River	1
Licking	East Fork Rattlesnake Creek	1
Licking	Lake Fork Licking River	1
Licking	Licking River	1
Licking	Lobdell Creek	1
Licking	North Fork Licking River	1
Licking	Otter Fork Licking River	1
Licking	Quarry Run	1
Licking	Raccoon Creek	1
Licking	Rocky Fork (Licking River)	1
Licking	South Fork Licking River	1
Licking	Wilkins Run	1
Logan	Big Darby Creek	1
Logan	Bokes Creek	1

Logan	Flat Branch (Big Darby Creek)	1
Logan	Great Miami River	2
Logan	Hefflefinger Ditch	1
Logan	Macochee Creek	1
Logan	Mill Creek	1
Logan	Muchinippi Creek	1
Logan	Otter Creek	1
Logan	Rush Creek	1
Logan	Stony Creek	1
Lorain	Charlemont Creek	1
Lorain	East Branch Black River	1
Lorain	East Branch Vermilion River	1
Lorain	Lake Erie	3
Lorain	Plum Creek	1
Lorain	Vermilion River	3
Lorain	Wellington Creek	1
Lorain	West Branch Black River	1
Lorain	West Branch Rocky River	1
Lucas	Blystone Ditch	1
Lucas	Cedar Creek	1
Lucas	Driftmeyer Ditch	1
Lucas	Duck Creek	1
Lucas	Lake Erie	3
Lucas	Maumee River	3
Lucas	Miami-Erie Canal	1
Lucas	Ottawa River	3
Lucas	Otter Creek	1
Lucas	Swan Creek (Upstream of RM 4.3)	2
Lucas	Swan Creek (RM 4.3 to mouth)	1
Lucas	Ten Mile Creek	1
Lucas	Williams Ditch	1
Madison	Barren Creek	1
Madison	Big Darby Creek	2
Madison	Bradford Creek	1
Madison	Deer Creek	1
Madison	Glade Run	1
Madison	Little Darby Creek	2
Madison	North Fork Deer Creek	1
Madison	North Fork Paint Creek	1
Madison	Oak Run	1
Madison	Paint Creek	1
Madison	Phifer Ditch	1
Madison	South Fork Bradford Creek	1
Madison	Spring Fork (Little Darby Creek)	1
Madison	Sugar Run	1
Madison	Walnut Run	1

Mahoning	Indian Run	1
Mahoning	Mahoning River	1
Mahoning	Middle Fork Little Beaver Creek	1
Mahoning	Morrison Run	1
Mahoning	North Fork Little Beaver Creek	1
Mahoning	West Branch Meander Creek	1
Marion	Brondige Run	1
Marion	Cauquaw Run	1
Marion	Clendenon Ditch	1
Marion	Cusic Ditch	1
Marion	Grave Creek	1
Marion	Honey Creek	1
Marion	Little Sandusky River	1
Marion	Little Scioto River	1
Marion	McDonald Creek	1
Marion	Mud Run	1
Marion	Olentangy River	1
Marion	Pawpaw Run	1
Marion	QuQua Creek	1
Marion	Rockswale Ditch	1
Marion	Rocky Fork (Little Sicoto River)	1
Marion	Rush Creek	1
Marion	Scioto River	1
Marion	Tymochtee Creek	2
Medina	Chippewa Creek	1
Medina	Coon Creek	1
Medina	East Branch Black River	1
Medina	East Branch Rocky River	1
Medina	East Fork (East Branch Black River)	1
Medina	Mallet Creek	1
Medina	Remson Creek	1
Medina	River Styx	1
Medina	West Branch Rocky River	1
Medina	West Fork (East Branch Black River)	1
Meigs	East Branch Shade River	1
Meigs	Leading Creek	1
Meigs	Middle Branch Shade River	1
Meigs	Ohio River	4
Meigs	Oldtown Creek	1
Meigs	Shade River	1
Meigs	Sugarcamp Run	1
Meigs	West Branch Shade River	1
Mercer	Beaver Creek	1
Mercer	Big Run	1
Mercer	Black Creek	1
Mercer	Coldwater Creek	1

Mercer	St. Mary's River	1
Mercer	Twelvemile Creek	1
Mercer	Wabash River	1
Miami	Great Miami River	2
Miami	Greenville Creek	1
Miami	Honey Creek	1
Miami	Little Painter Creek	1
Miami	Lost Creek	1
Miami	Miami-Erie Canal	1
Miami	Mill Creek	1
Miami	Spring Creek	1
Miami	Stillwater River	2
Miami	Trotters Creek	1
Monroe	Clear Fork (Little Muskingum River)	1
Monroe	Cranenest Fork (Little Muskingum River)	1
Monroe	Little Muskingum River	1
Monroe	Ohio River	3
Monroe	Sunfish Creek	1
Monroe	Witten Fork	1
Montgomery	Drylick Run	1
Montgomery	Great Miami River	3
Montgomery	Holes Creek	1
Montgomery	Mad River	1
Montgomery	Stillwater River	2
Montgomery	Toms Run	1
Montgomery	Twin Creek	1
Montgomery	Wolf Creek	1
Morgan	Dyes Fork (Meigs Creek)	1
Morgan	East Branch Sunday Creek	1
Morgan	Little Wolf Creek	1
Morgan	Mans Fork	1
Morgan	Meigs Creek	1
Morgan	Muskingum River	4
Morgan	Olive Green Creek	1
Morgan	West Branch Wolf Creek	1
Morrow	Alum Creek	1
Morrow	Big Walnut Creek	1
Morrow	Bunker Run	1
Morrow	Flat Run	1
Morrow	Kokosing River	1
Morrow	Mill Creek	1
Morrow	Shaw Creek	1
Morrow	West Branch Alum Creek	1
Morrow	Whetstone Creek	1
Muskingum	Bartlett Run	1
Muskingum	Licking River	1

Muskingum	Meigs Creek	1
Muskingum	Miller Creek	1
Muskingum	Muskingum River	4
Muskingum	Salt Creek	1
Muskingum	Wakatomika Creek	1
Muskingum	White Eyes Creek	1
Noble	Barnes Run	1
Noble	Beaver Creek	1
Noble	Buffalo Creek	1
Noble	East Fork Duck Creek	1
Noble	Olive Green Creek	1
Noble	Rannells Creek	1
Noble	Seneca Fork	1
Noble	Seneca Lake	1
Noble	South Fork (Seneca Fork)	1
Noble	West Fork Duck Creek	1
Noble	Wolf Run	1
Ottawa	Lake Erie	3
Ottawa	Crane Creek	1
Ottawa	Magee Marsh	1
Ottawa	Portage River	3
Ottawa	Sandusky Bay	1
Ottawa	Sugar Creek	1
Ottawa	Toussaint Creek	1
Ottawa	Toussaint River	1
Ottawa	Turtle Creek	1
Paulding	Auglaize River	1
Paulding	Blue Creek	1
Paulding	Flatrock Creek	1
Paulding	Gordon Creek	1
Paulding	Hoaglin Creek	1
Paulding	Little Auglaize River	1
Paulding	Marie Delarme Creek	1
Paulding	Maumee River	3
Paulding	Middle Creek	1
Paulding	North Creek	1
Paulding	Prairie Creek	1
Paulding	South Creek	1
Paulding	Zielke Ditch	1
Paulding	Zuber Cutoff	1
Perry	Center Branch Rush Creek	1
Perry	Coal Brook	1
Perry	Dotson Creek	1
Perry	Jonathan Creek	1
Perry	Little Rush Creek	1
Perry	Sunday Creek	1

Pickaway	Big Darby Creek	2
Pickaway	Big Walnut Creek	1
Pickaway	Deer Creek	1
Pickaway	Dry Run	1
Pickaway	Greenbrier Creek	1
Pickaway	Hargus Creek	1
Pickaway	Lick Run	1
Pickaway	Ohio and Erie Canal	1
Pickaway	Opossum Run	1
Pickaway	Peters Run	1
Pickaway	Salt Creek	1
Pickaway	Scioto River	4
Pickaway	Scippo Creek	1
Pickaway	Slate Run	1
Pickaway	Turkey Run	1
Pickaway	Walnut Creek	1
Pickaway	Yellowbud Creek	1
Pike	Beaver Creek	1
Pike	Morgan Fork (Sunfish Creek)	1
Pike	Ohio and Erie Canal	1
Pike	Scioto River	4
Pike	Sunfish Creek	1
Portage	Aurora Branch (Chagrin River)	1
Portage	Breakneck Creek	1
Portage	Cuyahoga River	1
Portage	Eagle Creek	1
Portage	Hinckley Creek	1
Portage	Mahoning River	1
Portage	Plum Creek	1
Portage	Sand Creek	1
Portage	Tinkers Creek	1
Portage	Trib. to Cuyahoga R. (RM 63.82)	1
Preble	Millers Fork	1
Preble	Sevenmile Creek	1
Preble	Twin Creek	1
Putnam	Auglaize River	1
Putnam	Blanchard River	1
Putnam	Jennings Creek	1
Putnam	Little Auglaize River	1
Putnam	North Powell Creek	1
Putnam	Ottawa River	1
Putnam	Plum Creek	1
Putnam	Riley Creek	1
Richland	Black Fork Mohican River	1
Richland	Cedar Fork (Clear Fork Mohican River)	1
Richland	Clear Fork Mohican River	1

Richland	Rocky Fork Mohican River	1
Ross	Buckskin Creek	1
Ross	Compton Creek	1
Ross	Deer Creek	1
Ross	Little Salt Creek	1
Ross	Middle Fork Salt Creek	1
Ross	North Fork Paint Creek	1
Ross	Paint Creek	1
Ross	Poe Run	1
Ross	Salt Creek	2
Ross	Scioto River	4
Ross	Walnut Creek	1
Ross	Yellowbud Creek	1
Sandusky	Green Creek	1
Sandusky	Gries Ditch	1
Sandusky	Lake Erie	3
Sandusky	Little Muddy Creek	1
Sandusky	Muddy Creek	1
Sandusky	Muskellunge Creek	1
Sandusky	Portage River	1
Sandusky	Raccoon Creek	1
Sandusky	Sandusky Bay	1
Sandusky	Sandusky River	1
Sandusky	Sugar Creek	1
Sandusky	Wolf Creek	1
Scioto	Hales Creek	1
Scioto	Little Scioto River	1
Scioto	Ohio River	4
Scioto	Pine Creek	1
Scioto	Rocky Fork Little Scioto River	1
Scioto	Scioto Brush Creek	2
Scioto	Scioto River	4
Scioto	South Fork Scioto Brush Creek	2
Scioto	Turkey Creek	1
Seneca	Beaver Creek	1
Seneca	Honey Creek	1
Seneca	Morrison Creek	1
Seneca	Sandusky River	1
Seneca	Sugar Creek	1
Seneca	Wolf Creek	1
Shelby	Great Miami River	2
Shelby	Loramie Creek	1
Shelby	Nine Mile Creek	1
Shelby	Tawawa Creek	1
Shelby	Turtle Creek	1
Stark	Deer Creek	1

Stark	East Branch Nimishillen Creek	1
Stark	Mahoning River	1
Stark	Middle Branch Nimishillen Creek	1
Stark	Nimishillen Creek	1
Stark	Sandy Creek	1
Stark	Swartz Ditch	1
Stark	Tuscarawas River	1
Stark	West Sippo Creek	1
Summit	Brandywine Creek	1
Summit	Cuyahoga River	1
Summit	Furnace Run	1
Summit	Haskell Run	1
Summit	Metzgers Ditch	1
Summit	Ohio and Erie Canal	1
Summit	Tuscarawas River	1
Summit	Yellow Creek	1
Trumbull	Baughman Creek	1
Trumbull	Eagle Creek	1
Trumbull	Grand River	1
Trumbull	Little Yankee Creek	1
Trumbull	Mahoning River	1
Trumbull	Pymatuning Creek	2
Trumbull	West Branch Mahoning River	1
Tuscarawas	Buckhorn Creek	1
Tuscarawas	Dunlap Creek	1
Tuscarawas	Goettge Run	1
Tuscarawas	Little Stillwater Creek	1
Tuscarawas	Ohio and Erie Canal	1
Tuscarawas	Sandy Creek	1
Tuscarawas	Stillwater Creek	1
Tuscarawas	Sugar Creek	1
Tuscarawas	Tuscarawas River	1
Union	Big Darby Creek	2
Union	Blues Creek	1
Union	Bokes Creek	1
Union	Buck Run	1
Union	Flat Branch (Big Darby Creek)	1
Union	Fulton Creek	1
Union	Little Darby Creek	2
Union	Mill Creek	2
Union	North Branch Crosses Run	1
Union	Powderlick Run	1
Union	Robinsons Run	1
Union	Rush Creek	1
Union	Spain Creek	1
Union	Sugar Run	1

Union	Treacle Creek	2
Van Wert	Jennings Creek	1
Van Wert	Little Auglaize River	1
Van Wert	St. Marys River	1
Van Wert	Town Creek	1
Vinton	Little Raccoon Creek	1
Vinton	Middle Fork Salt Creek	1
Vinton	Pigeon Creek	1
Vinton	Raccoon Creek	1
Vinton	Salt Creek	1
Warren	Caesar Creek	1
Warren	Clear Creek	1
Warren	Flat Fork (Caesar Creek)	1
Warren	Great Miami River	2
Warren	Little Miami River	2
Warren	Millers Creek	1
Warren	North Branch Dicks Creek	1
Warren	Simpson Creek	1
Warren	Todd Fork (Little Miami River)	1
Warren	Turtle Creek	1
Warren	Twin Creek	1
Washington	Archers Fork	1
Washington	Danas Run	1
Washington	Davis Creek	1
Washington	Duck Creek	1
Washington	East Branch Little Hocking River	1
Washington	East Fork Duck Creek	1
Washington	Little Hocking River	1
Washington	Little Muskingum River	1
Washington	Muskingum River	4
Washington	Ohio River	4
Washington	Olive Green Creek	1
Washington	West Branch Little Hocking River	1
Washington	West Branch Wolf Creek	1
Washington	West Fork Duck Creek	1
Washington	Whipple Run	1
Washington	Wolf Creek	1
Wayne	Chippewa Creek	1
Wayne	Killbuck Creek	1
Wayne	Little Killbuck Creek	1
Wayne	Muddy Fork Mohican River	1
Wayne	Shreve Creek	1
Wayne	Steele Ditch	1
Wayne	Sugar Creek	1
Williams	Bear Creek	1
Williams	Beaver Creek	1

Williams	Brush Creek	1
Williams	Clear Fork St. Joseph River	1
Williams	Eagle Creek	1
Williams	East Branch St. Joseph River	1
Williams	Fish Creek	2
Williams	Mill Creek	1
Williams	Mill Stream Drain	1
Williams	Nettle Creek	1
Williams	Prairie Creek	1
Williams	Silver Creek	1
Williams	St. Joseph River	2
Williams	Tiffin River	1
Williams	West Branch St. Joseph River	2
Wood	Beaver Creek	1
Wood	Dry Creek	1
Wood	Maumee River	3
Wood	Miami-Erie Canal	1
Wood	Middle Branch Portage River	1
Wood	Needles Creek	1
Wood	North Branch Portage River	1
Wood	Portage River	1
Wood	Rader Creek	1
Wood	Rocky Ford	1
Wood	South Branch Portage River	1
Wood	Tontogany Creek	1
Wyandot	Broken Sword Creek	1
Wyandot	Little Sandusky River	1
Wyandot	Little Tymochtee Creek	1
Wyandot	Negro Run	1
Wyandot	Potato Run	1
Wyandot	Sandusky River	1
Wyandot	Sycamore Creek	1
Wyandot	Tymochtee Creek	2
Wyandot	Warpole Creek	1

Ohio Mussel Habitat Assessment Form

Project Information

Project Name: _____

County: _____ Township: _____

Latitude (DD.DDDD): _____ Longitude (DD.DDDD): _____

Stream Name: _____ Group # (From Appendix A): _____

Methods

Name of Surveyor(s): _____

Qualification of Surveyor(s): ☐ USFWS Approved ☐ ODNR Approved ☐ Aquatic Biologist (minimum)

Date of Survey: _____ Distance Surveyed (ft.): _____

Total Survey Time (min. x people): _____ Scientific Collector's Permit Number(s): _____

Note any deviations from the Ohio 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 _____

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 B: Reconnaissance Survey for Unionid Mussels

Objective: To determine the presence or absence of unionid mussels within a project area that will require in-stream work on a Group 1 stream or on streams which the watershed area above the impact point is 2590 ha (10 mi^2) or larger that contain suitable mussel habitat that are not listed as a mussel stream by USFWS and ODNR.

Limitations: This protocol is to be used on small wade-able streams that are not known to contain federally listed species, including streams on the Group 1 list in the Ohio Mussel Survey Protocol (ODNR 2015) or unlisted streams over 10 square miles with suitable mussel habitat. Survey work must be conducted during the warm months from May 1 to October 1, unless prior approval is granted. Water levels at the site must be normal or below normal, and water clarity must be good. All stream substrates within the survey reach must be visible and able to be surveyed. Streams that are very deep, consistently turbid, or with other issues that preclude searching the stream bottom throughout the survey reach cannot be surveyed using this protocol and a State and/or Federally permitted malacologist should survey the site using the Group 1 stream timed search protocol as outlined in the Ohio Mussel Survey Protocol.

The biologists conducting the surveys must have the qualifications stated in Appendix D and should possess a state scientific collector's permit.

Survey Area: The entire area under the existing structure, the area where the proposed structure will be placed (if different), and a buffer area beginning 400 feet downstream of the downstream edge of the existing or proposed structure to 200 feet upstream of the upstream edge of the existing or proposed structure (whichever is the larger survey area) should be surveyed. If the biologist feels that additional buffer is necessary to adequately assess the area for mussels, then the additional area should be searched. If weathered dead shells are observed but no live mussels are found during the upstream and downstream search, an additional 20 minutes should be dedicated to a search of the salvage zone.

A larger buffer area for these surveys is necessary as the surveyor is using only visual methods to determine if mussels are present, and some mussels in an area may not be visible above the stream-bed surface. The longer search area increases the likelihood that mussels will be observed if present in the area.

Methods: 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 is qualified to survey 1 – 4 systems as specified in Appendix D. The site should be searched for at least 60 minutes for smaller 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 and an additional 20 minutes should be dedicated to a search of the salvage zone to determine if mussels are still present within the survey area. No species list will be generated from these surveys, unless the surveyor is qualified to survey 1 – 4 systems as specified in

Appendix D. Representative photos of the survey area, and shell material observed and live mussels (in-situ) should be taken.

Reporting: In the *Ohio Mussel Habitat Assessment Form*, the surveyor will fill out the top portion of the Unionid Mussel table. Representative photos of the stream, stream habitats/substrates, and shells/live mussels will be included in the project photo log. The Additional Information box will include the following information:

1. Total length of survey area (including area directly under the existing and proposed structures, if different and buffers)
2. A brief description of the search methods used at the site.
3. A habitat description including substrate types, average water depths, stream development (riffle/run/pool), and any obvious pollution or stream stability issues.
4. Approximate numbers and location(s) of shells and live mussels (include species list if biologist has identification expertise).

Additional Survey Requirements: The presence of fresh dead mussel shells and live mussels will trigger a mussel survey by a qualified surveyor as described in the *Ohio Mussel Survey Protocol.*

Appendix C: Contact information for State and Federal agencies

State Of Ohio Contact
John Navarro Ohio Department of Natural Resources Division of Wildlife 2045 Morse Road, G-3 Columbus, Ohio 43229-6693 (614) 265-6346 John.navarro@dnr.state.oh.us
U.S. Fish and Wildlife Service Contact
Angela Boyer U.S. Fish and Wildlife Service Ecological Services 4625 Morse Road, Suite 104 Columbus, Ohio 43230 (614) 416-8993, ext.22 angela_boyer@fws.gov
The Ohio State University Contact
G. Thomas Watters, PhD The Ohio State University Museum of Biological Diversity 1315 Kinnear Road Columbus, OH 43212 USA 614-292-6170 watters.1@osu.edu

Appendix D: Minimum Qualifications for Mussel Reconnaissance and Surveys

To work with mussels in Ohio there are three levels of minimum qualifications required based on location and survey type. Satisfaction of a higher qualification level allows the surveyor to work at the lower levels. Work at all three levels require an *Ohio Scientific Collectors Permit* from the Division of Wildlife. The three levels of qualification are as follows:

1) **Survey of Group 2 and 4 Systems:** The minimum qualifications to survey Group 2 and 4 streams, which are likely to have federally listed mussels present, is a federal permit from the USFWS. For information on the requirements for a federal permit, reference the USFWS contact in Appendix C.

2) **Survey of Group 1 and 3 Systems:** The minimum qualifications to survey Group 1 and 3 systems, which are not likely to have federally listed mussels present, are based upon knowledge of and experience in the performance of mussel surveys.

   Survey Experience: Surveyors must have at least two (2) years of field experience in a position including direct responsibility for and participation in conducting mussel surveys.

   Proficient in Identification: Surveyors must have passed the *Standardized Freshwater Mussel Identification Test* (Appendix E).

   Education: Surveyors must have a Bachelor of Science degree in biology, environmental science, natural resources or related field with at least three 3-hour courses from or related to those in the following list: Aquatic ecology, Fisheries, Hydrology, Aquatic Entomology, Limnology, Ichthyology, and Plant Taxonomy.

   Qualifying Experience: In lieu of the educational experience listed above, surveyors must have a minimum of four years of experience in a position including direct responsibility for and participation in conducting surveys for and documenting aquatic fauna and flora is required.

3) **Reconnaissance of Group 1 Systems:** Reconnaissance surveys are used to determine if a full mussel survey is required. For reconnaissance of Group 1 streams (or on streams which the watershed is $\geq$10 mi^2) to determine if mussels are present, the surveyor must satisfy the educational or qualifying experience listed above.

Submittal Requirements for category 2 and 3 listed above:

- Resumes and, if applicable, curricula vitae.
- A list of each individual's academic coursework related to aquatic ecology or evidence of qualifying experience surveying for and documenting aquatic fauna and flora.
- Please send your qualifications to the Division of Wildlife contact in Appendix C.

Appendix E: Standardized Freshwater Mussel Identification Test

Anyone wanting to conduct mussel surveys in Ohio will need to have passed the mussel identification test or have a valid Federal permit. Passing the Ohio test allows you to survey Group 1 and 3 systems, while having a Federal permit allows you to survey all four groups. Anyone with a valid Federal permit is welcome, but will not be required, to take the mussel identification test.

Tests are administered by appointment only and at the discretion of the OSU Division of Molluscs. All efforts will be made to accommodate testing dates. Please call (614) 292-6170 to make your appointment. Three tests are available, so please specify which test you wish to take when making your appointment. The list of taxa on the test is available by request at watters.1@osu.edu or byrne.88@osu.edu. Records of who passed the test will be maintained by the ODNR Division of Wildlife.

Specific test information:

1. Three test are available: State-wide (60 species), Ohio River drainage (56 species), Lake Erie drainages (40 species).
2. The test will be given between 8 AM and 4 PM, Monday through Friday by appointment only.
3. The test will be given at the Museum of Biological Diversity (The Ohio State University, 1315 Kinnear Rd., Columbus, OH 43212).
4. Daily parking passes are available for participants for $6 (cash only).
5. The test is “open book” so you may bring any outside sources to the test.
6. The test must be completed in three (3) hours.
7. Only one person may take the test at a time.
8. You may return to any previous specimens as needed.
9. Feel free to ask questions.
10. You may retake the test as many times as necessary, but the entire test must be retaken each time. You must allow at least one (1) day in between attempts.
11. Passing grade:
    - 100% of federal T & E species
    - 80% of Ohio T & E species
    - 80% of entire test.

APPENDIX F: 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 (if applicable)
    - County
  - ✓ Drainage area at survey site
  - ✓ Summary of any water quality data or previous mussel survey reports near the area of impact (OEPA Aquatic Life Use designation)
  - ✓ 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, US, DS)
  - ✓ Map delineating survey/buffer areas (ADI, US, DS, LT). Map can be included within text or in Figures & Tables section.
- Survey method, including:
  - ✓ Type of mussel survey completed (e.g. Phase I, Phase II, Timed Visual Search)
  - ✓ 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 Phase II studies
  - ✓ Description of additional transects (for Phase II 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
  - ✓ 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 from Phase I and Phase II 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)

<u>MUSSEL RELOCATION</u> (This is required for all relocations; however, additional information may be required for Group 2 and 4 systems where federal species may be encountered. For these situations, follow all requirements in the project specific Biological Opinion):

- Relocation site, including:
  - ✓ Location (coordinates at center)
  - ✓ Map delineating area. Map can be included within text or in Figures & Tables section.
  - ✓ Results of required 15-minute qualitative survey (provide coordinates in decimal degrees)
- Method of salvaging mussels from survey area

<u>CONCLUSION:</u>

- Summary of findings, and conclusions

<u>REFERENCES:</u>

- Include citations for any literature cited within the text of the report (e.g. Smith et al., for excavation methods)

<u>FIGURES & TABLES:</u>

- 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)

<u>APPENDICES:</u>

- 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 2 and Group 4 stream surveys

Appendix G. Summary of survey area buffer distances, salvage area buffer distances, and maximum transect spacing

(Survey extent shall include the area of direct impact (ADI) and all applicable buffers. After demonstrating need and receiving approval, mussels may be relocated from Salvage Area. Salvage Area includes the ADI and all applicable buffers. Units are in meters.)

		Survey Area Buffers (in addition to ADI)			**Salvage Area Buffers (in addition to ADI)**		**Maximum Transect Spacing**
		US	**DS**	**LT**	**US & LT**	**DS**	
Group 4		Potential Phase 2 Surveys Required					
Dredging		150	500	150	10	10	50_c
Linear Projects	Maintenance at Existing Facility	25	25	25	5	10	$50_{a,c}$
	New Facility or Expansion Downstream	150	500	150	5	10	$50_{a,c}$
	Expansion Upstream	150	150	150	5	10	$50_{a,c}$
Other Projects (Hydropower, dam removal, etc.)		Project Specific					100_c
Bridge Projects		50	100	BB	5	10	10
Waterline/Pipeline Corridor Disturbances		50	100	BB	5	10	10
Shoreline Protection		10	10	10	5	10	50
Bridge Projects		50	100	BB	5	10	10
Projecting Dike Structures (i.e., not parallel to shore)		10	20	10	5	10	TS
Outfalls		10	MZ + 100	10	PS		PS_c
Non-Commercial Docks		No Survey Required (see criteria on p. 9)					
Group 3		Relocation at time of survey if approved					
Dredging (Sand and Gravel)		150	500	150	10		50_c
Dredging (Maintenance)		50	150	50	10		50_c
Linear Projects		25	25	25	5	10	50_a
Other Projects (Hydropower, dam removal, etc.)		Project Specific					100
Bridge Projects		10	25	BB	5	10	TS

Waterline/Pipeline Corridor Disturbances	10	25	BB	5	10	TS
Shoreline Protection	10	10	10	5	10	TS
Projecting Dike Structures (i.e., not parallel to shore)	10	20	10	5	10	TS
Outfalls	10	MZ + 20	10	PS		
Non-Commercial Docks	No Survey Required (see criteria on p. 9)					
Group 2	Potential Phase 2 Surveys Required					
Other Projects (Hydropower, dam removal, etc.)	Project Specific					10
Bridge Projects	50	100	BB	5_b	10	10
Waterline/Pipeline Corridor Disturbances	50	100	BB	5	10	10
Shoreline Protection	10	10	10	5	10	10
Outfalls	10	MZ + 20	10	PS		10
Group 1	Relocation at time of survey if approved					
Other Projects (Hydropower, dam removal, etc.)	Project Specific					TS or 10
Bridge Projects	10	25	BB	5_b	10	TS
Waterline/Pipeline Corridor Disturbances	10	25	BB	5		TS
Shoreline Protection	10	10	10	5	10	10

a - transects should be placed to bisect instream structures
b - 10 m buffer to clear around culverted causeways
c - A minimum of 500 m of transects shall be surveyed
TS - Qualitative Timed Search Surveys permitted
PS - Project Specific
BB - Bank to Bank
MZ - Mixing Zone
US - Upstream
LT - Lateral
DS - Downstream

Appendix H. Species marked with an "X" should be excluded when defining a diverse mussel bed that may include FLS.

(These species are not used because of their general habitat preference and their common occurrence in silt and sand, and because they are not typically associated with the current list of FLS in Ohio.)

Species	Stream Group 2	Stream Group 4
Anodonta suborbiculata		X
Anodontoides ferussacianus	X	X
Lampsilis radiata luteola (=siliquoidea)	X	X
Lasmigona complanata	X	X
Leptodea fragilis		X
Potamilus ohiensis		X
Potamilus alatus		X
Pyganodon grandis	X	X
Strophitus undulatus	X	X
Utterbackia imbecillis	X	X

Appendix I: Formulae to determine area that needs to be searched to detect species presence with a pre-determined probability (with excavation)

Uses a simple formulae to determine area that needs to be searched to detect species presence with a pre-determined probability.
The formulae is Prob(species detection) = 1-exp(-a*b*m), where b is search efficiency or detectability and m is species density.

Input density, search efficiency, and search area or prob of spp detection

Solve for Prob of spp detection

Density or no. per m^2 (m)	Search efficiency (b)	Search area (m^2)	Prob of species detection
0.01	0.1	450	0.362372
0.01	0.6	450	0.932794

"=1-EXP(-A10*B10*C10)"

Solve for Search area (sq m)

Density or no. per m^2 (m)	Search efficiency (b)	Search area (m^2)	Prob of species detection
0.01	0.4	301	0.7
0.01	0.8	288	0.9

"=-LN(1-J10)/(G10*H10)"

Input study area and abundance instead of density

Solve for Prob of spp detection

Study Area (sq m)	Abundance	Search efficiency (b)	Search area (m^2)	Prob of species detection
4500	45	0.4	495	0.861931
4500	45	0.6	450	0.932794

"=1-EXP(-(B18/A18)*C18*D18)"

Solve for Search area (sq m)

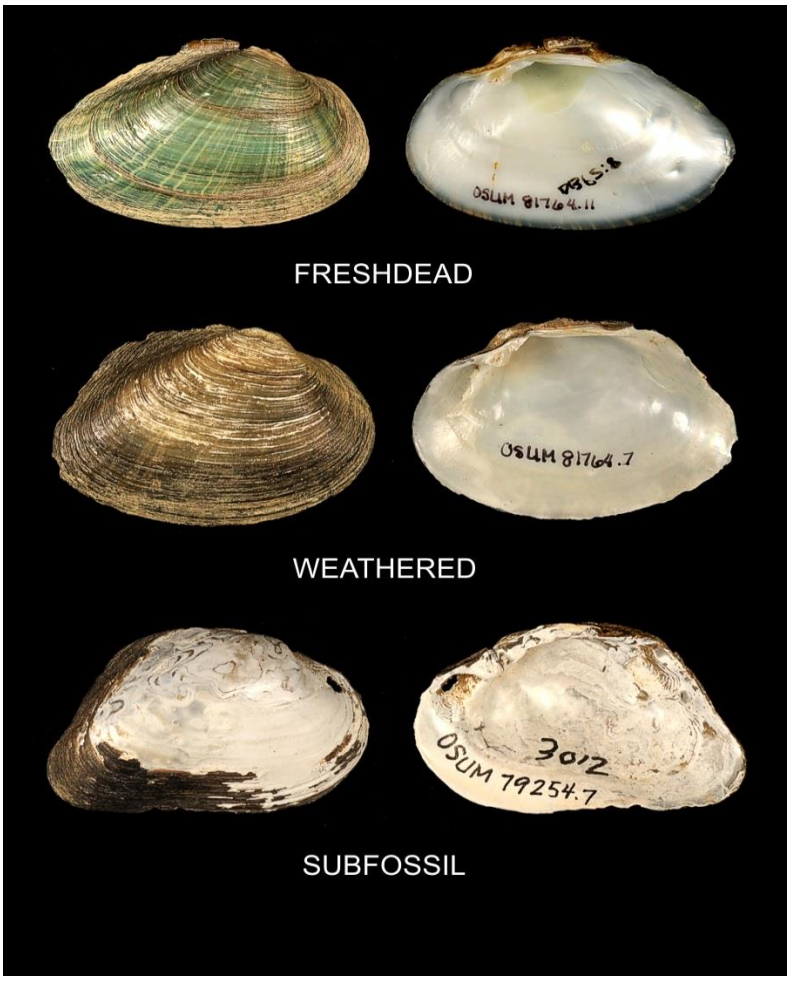
Study Area (sq m)	Abundance	Search efficiency (b)	Search area (m^2)	Prob of species detection
4500	45	0.4	301	0.7
4500	45	0.4	576	0.9

"=-LN(1-K18)/((H18/G18)*I18)"

Appendix J: Identification of Mussel Shell Weathering

Objective: It is important to recognize that the weathering process is a continuum and cannot always be assigned to one of the three categories below. Weathering depends on where the shell has been since the animal died. Shells exposed to the sun and elements may weather much faster than a shell buried in a river bank. Shells in collections may be in great condition for hundreds of years. For this reason it is difficult to say with any certainty how long a shell has been dead.

- Fresh Dead
  - ✓ Periostracum (outer layer) of shells not faded or peeling.
  - ✓ Inner layer still with mother-of-pearl sheen, not flaking or infused with green algae.

- Weathered dead
  - ✓ Periostracum faded or discolored, often peeling and brittle.
  - ✓ Inner layer no longer lustrous, often dull silver or faded, may be infused with green algae.

- Subfossil
  - ✓ Shell chalky, brittle.
  - ✓ Periostracum usually absent.
  - ✓ Inner layer faded, may be flaking off in layers.