United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pennsylvania Field Office
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State College, Pennsylvania 16801-4850

May 31, 2024

Camille Otto
Director, Program Development
Federal Highway Administration
228 Walnut Street, Room 558
Harrisburg, PA 17101-1720

RE: USFWS Project #2022-0067141 (Formerly 2007-1722)

Dear Ms. Otto:

The enclosed programmatic Biological Opinion supersedes our May 13, 2016, *Effects of the Pennsylvania Department of Transportation Bridge Replacement and Maintenance Program on the Northern Riffleshell, Clubshell, Rayed Bean, Snuffbox, Sheepnose, and Rabbitsfoot Pearly mussels in the Ohio River Basin, Pennsylvania* Biological Opinion. There have been changes to the program descriptions, newly listed species, and changes to regulations, including updating the species and their habitats covered by the Programmatic Biological Opinion (PBO). This includes the addition of the longsolid (*Fusconaia subrotunda*) and round hickorynut (*Obovaria subrotunda*) as threatened freshwater mussel species with designated critical habitat; clarification of the management unit definitions and their best management practices; extending the duration of the biological opinion (to a twelve-year period); updating the covered project lists, effects of the actions and take estimates; improving conservation measures; and updating and revising project type direct disturbance areas.

The enclosed PBO and supporting consultation concerns the possible effects of the proposed Pennsylvania Department of Transportation's Bridge Program over a twelve-year period on the following federally listed Freshwater Pearly mussels:

Endangered	**Threatened**
Northern riffleshell (*Epioblasma rangiana*)	Rabbitsfoot (*Quadrula* (=*Theliderma*) *cylindrica cylindrica*)
Rayed bean (*Villosa fabalis*)	Longsolid (*Fusconaia subrotunda*)
Sheepnose (*Plethobasus cyphyus*)	Round Hickorynut (*Obovaria subrotunda*)
Clubshell (*Pleurobema clava*)	
Snuffbox (*Epioblasma triquetra*)	

In addition, the rabbitsfoot, longsolid and round hickorynut have areas of designated critical habitat in the consultation plan area that is considered in this PBO.

This consultation also considers the effects of the program on the salamander mussel (*Simpsonaias ambigua*), a species proposed as endangered, with proposed critical habitat (88 Federal Register 161 (August 22, 2023) 57224-57290). Proposed endangered or threatened species are not protected by the take prohibitions of section 9 of the ESA unless the proposed listing rule is adopted. Although take is not prohibited, under section 7, Federal agencies are required to conference on Federal actions that may jeopardize the species. A non-jeopardy conference opinion may be converted to a biological opinion at the Action Agency's request in the event that the species becomes listed.

This programmatic consultation involves a two-tiered approach: Tier 1 consists of the programmatic consultation on the action agency's Bridge Program (a framework programmatic action), while Tier 2 involves streamlined section 7 consultations on individual actions carried out under this framework. Issuance of this programmatic biological opinion will not itself result in the take of listed species; therefore, no incidental take is anticipated, and that issue will be reexamined during the consultation process for site-specific actions under the umbrella of the larger planning document.

Programmatic Informal Consultation and Concurrence

The BA included a request for Service concurrence with the following may affect, not likely to adversely affect determination(s). The action area is delineated into five Management Units, based on the distribution and density of endangered and threatened mussel species as detailed in the Opinion. Two of these, Management Unit 5 and Management Unit 4, are not expected to be occupied by any of the federally listed species considered, however, these species may be affected downstream of project actions.

Management Unit 5

Streams in Management Unit 5 are not likely to support populations of federally listed mussels. Some streams in Management Unit 5 are intermittent or headwater streams that do not meet the habitat requirements of clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, or salamander mussel. Other, larger streams are within the range of these species, but no longer appear to support these species because of siltation, poor water quality, or pollutants, and many have been degraded for decades (Ortmann 1909). Water and sediment originating in Management Unit 5 contributes to the quality of other streams in the Ohio River basin, including those that do support endangered or threatened mussels. While no specific avoidance measures are proposed in Management Unit 5, standard best management practices will be implemented.

As in other Management Units, introduction of invasive species, erosional silt, and toxins can have wide-ranging downstream consequences. These impacts will be avoided through invasive species best management practices and erosion and sedimentation control measures that protect water quality and habitat in Management Unit 5. The action agencies (*i.e.,* PennDOT/FHWA/FEMA/Corps) have determined that Bridge Program activities in Management

Unit 5 will have no effect on any of the eight federally-listed endangered or threatened mussels, or the proposed listed salamander mussel, because these bridges are not located in suitable habitat for these species. However, this is contingent on measures being taken to ensure that individual projects are not likely to result in siltation, channel modification, and contaminant releases are not likely to adversely affect the eight listed, and one proposed listed mussel species considered.

Collectively, the large number of proposed projects, distributed across the action area, may affect endangered and threatened species at distant locations downstream. PennDOT's commitment to implement erosion and sediment control measures and best management practices to protect water quality and control invasive species are important to avoid broad declines in these parameters. To the extent that water quality is improved through replacement and maintenance actions that reduce erosion, scour, and the need for repeated streambed disturbance, basin-wide reductions in silt and improved water quality may occur to benefit endangered mussel populations downstream. The consistent use of best management practices and silt and erosion control measures will ensure Bridge Program activities in Management Unit 5 result in effects that are insignificant, discountable, or potentially beneficial. Consequently, Bridge Program activities in Management Unit 5 are not likely to adversely affect the any of the eight federally-listed endangered or threatened mussels, or the proposed salamander mussel or designated critical habitat for these species.

Management Unit 4

Streams categorized as Management Unit 4 are typically small tributaries within 1 mile of streams in Management Units 1, 2 and 3. These habitats are not likely to provide habitat for endangered or threatened mussel species due to small drainage size, water quality limitations (*e.g.,* lower pH or low calcium levels), and unsuitable stream gradients. However, these streams directly contribute to habitat quality and water quality within downstream habitats occurring within Management Units 1, 2, and 3. Bridge Program actions may result in profound downstream adverse effects unless precautions are taken to avoid this. Consequently, avoidance measures that focus on maintaining habitat and water quality within 50 feet of the project limit of disturbance will reduce the risk of indirect effects on downstream mussel populations. Avoidance and minimization measures for maintaining water quality in Management Unit 4 streams are described in subsequent section of this document. A complete list of management Unit 4 streams can be found in Table 1.

The Service concurs with the action agencies' determination that Bridge Program activities in Management Unit 4 "may affect, but are not likely to adversely affect" northern riffleshell, clubshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, or salamander mussel. While bridge projects in Management Unit 4 do not occur in suitable habitat for any of the nine federally-listed endangered, threatened mussels, or proposed endangered species, there is an increased risk adverse effects resulting from individual projects to downstream populations in Management Units 1, 2 and 3. Actions that result in siltation, instream use of concrete, instream excavation, placement of scour protection, bank vegetation removal, and contaminant releases have the potential to result in water quality degradation that could kill or harm the listed endangered mussels downstream unless measures are taken to preclude this from happening.

With the implementation of avoidance measures listed in the BA the risk of take from associated with projects in Management Unit 4 will be substantially reduce such that any effects on federally-listed mussels are expected to be insignificant or discountable. Our concurrence is based on the action agencies' commitment to implement all avoidance measures. Key among these are maintaining downstream water quality and, for instream concrete work, isolating the instream work area and monitor pH as described in PennDOT's Bridge Maintenance Manual (Publication 55, Chapter 25).

Table of Contents

BIOLOGICAL AND CONFERENCE OPINION

This document represents the U.S. Fish and Wildlife Service's (Service) programmatic biological opinion on the effects of the Federal Highway Administration (FHWA) and Pennsylvania Department of Transportation's (PennDOT) Bridge Program over a twelve-year period (March 31, 2036). The Bridge Program includes bridge replacement, removal, rehabilitation, preservation, and restoration actions. The projects considered in this opinion are those funded, permitted, or conducted by the Federal Highway Administration (FHWA); the U.S. Army Corps of Engineers, Pittsburgh District (Corps); and the Federal Emergency Management Agency (FEMA) in the Ohio River basin in the range of eight federally listed Freshwater Pearly mussels: the northern riffleshell (*Epioblasma rangiana*), clubshell (*Pleurobema clava*), rayed bean (*Villosa fabalis*), snuffbox (*Epioblasma triquetra*), sheepnose (*Plethobasus cyphyus*), rabbitsfoot (*Quadrula (=Theliderma) cylindrica cylindrica*), longsolid (*Fusconaia subrotunda*), and round hickorynut (*Obovaria subrotunda*),. This biological opinion is issued in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.).

During previous consultations regarding portions of FHWA and PennDOT's Bridge Program, the Service, FHWA, and PennDOT (acting as the designated nonfederal representative for section 7 consultation for FHWA), recognized that many of the threatened and endangered species issues encountered were very similar from project to project. Consequently, the Service, FHWA, and PennDOT determined that a programmatic approach to the consultation process was appropriate and have been using that approach since December 15, 2011. The programmatic consultation approach streamlines and expedites the consultation process. To ensure the protection of federally listed species, FHWA and PennDOT developed programmatic conservation measures that will be incorporated into bridge projects within the Ohio River basin.

The Pennsylvania Fish and Boat Commission (PFBC), PennDOT, FHWA, Corps, and Service have coordinated on a variety of projects to understand the effects of PennDOT's bridge program on listed mussel species. Significant insight regarding the effects of Bridge Program actions has resulted from monitoring conducted as part of section 7 consultations on individual bridge projects. Other efforts were more specifically targeted at assessing and mitigating the effects of PennDOT's bridge program. For example, in 1997, PennDOT, in cooperation with the U.S. Geological Survey and the Service, began development of a standardized mussel survey protocol designed to produce consistent, reliable information about the presence and abundance of listed mussels in bridge project action areas. This survey protocol was later incorporated into two programmatic agreements (*e.g.,* "strike-off letter" and "Letter of Agreement") describing locations and habitats likely to support listed mussels.

In 2000, PennDOT hosted a Unionid Research Workshop to gather information and prioritize research needs to better understand how transportation projects affect listed mussels. Similarly, to better understand the consequences of several proposed bridge replacement projects over the Allegheny and Shenango Rivers, PennDOT, FHWA, PFBC, and the U.S. Geological Survey cooperated on mussel surveys in these rivers. In 2006, the Service coordinated with PennDOT and FHWA regarding a multistate review of avoidance and minimization practices used by other state transportation agencies to conserve endangered or threatened freshwater mussels. Each of these efforts contributed to developing a knowledge base and methods that improve Bridge Program project delivery, while reducing adverse effects on endangered and threatened freshwater mussels. This programmatic approach has been largely successful at streamlining the consultation process, while reducing adverse effects to endangered and threatened freshwater pearly mussel for 12 years. FHWA and PennDOT have a proven record for contributing to the successes of the program. These successes, in turn, provide a rationale for expanding the duration of this programmatic consultation from a 5-year to a 12-year period of time (through 2036).

Bridge removal and replacement projects are typically funded jointly by FHWA and PennDOT. Rehabilitation, restoration and preservation projects may also include federal funding, but are often entirely funded by Pennsylvania. Bridges over waterways also frequently require Corps permits for instream activities issued under section 10 of the Rivers and Harbors Appropriation Act of 1899 (30 Stat. 1151, as amended; 33 U.S.C. 403 *et seq*.) and section 404 of the Clean Water Act of 1977 (33 U.S.C. 1344 *et seq*.). Finally, subsequent to the immediate emergency response action, FEMA may be providing funding to restore damaged infrastructure. The federal nexus for section 7 consultation for PennDOT's Bridge Program may therefore vary for comparable activities; however, FHWA agreed to act as the lead federal agency for this programmatic consultation.

To reduce adverse effects, PennDOT proposes to incorporate avoidance, minimization, and conservation measures for the protection of State and federally-listed mussels into the project design of individual projects funded, permitted, authorized, or conducted by FHWA, Corps and/or FEMA. The Service evaluated PennDOT's overall Bridge Program in light of these measures and their effects on the status and recovery of the clubshell, northern riffleshell, rayed bean, snuffbox, and sheepnose, which are all federally listed as endangered species; the rabbitsfoot, longsolid, and round hickorynut which are federally listed as threatened; and the salamander mussel, which is proposed to be listed as endangered.

This programmatic consultation involves a two-tiered approach: Tier 1 consists of the programmatic consultation on the overall agency program, while Tier 2 involves streamlined consultations on individual actions carried out under the Program. This programmatic biological opinion serves as the Tier 1 consultation and encompasses PennDOT's overall bridge program for a 12-year period, beginning with the issuance of this programmatic biological opinion. Individual bridge projects or actions carried out under PennDOT's Bridge Program must continue to undergo individual (Tier 2) consultation to ensure consistency with programmatic avoidance, minimization, and conservation measures outlined within PennDOT's program description, and the reasonable and prudent measures and terms and conditions of this programmatic biological opinion. In addition, project-specific information for individual actions carried out under the Bridge Program will be evaluated by the Service to ensure the assumptions regarding program-level effects on federally listed species were correct.

With respect to Act compliance, all aspects of the Bridge Program, as described in the Service's biological opinion, will be binding, including the specific nature, timing, and extent of proposed removal, replacement, and maintenance activities, as well as implementation of all avoidance, minimization, and conservation measures proposed in the biological assessment and 2023 addendum (collectively referred to as BA) to conserve listed species. Reasonable and prudent measures and the accompanying terms and conditions provided within the biological opinion are nondiscretionary and are designed to minimize or monitor incidental take of northern riffleshell, clubshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussels anticipated as a result of the Bridge Program. To be exempt from the prohibitions of section 9 of the Act, the PennDOT, FHWA, Corps, and FEMA must comply with the terms and conditions in the biological opinion, which implement the reasonable and prudent measures.

Individual projects or activities that cannot be designed or carried out to conform to the protective programmatic conservation measures developed by FHWA and PennDOT, or projects that will exceed the anticipated effects or level of take described within this PBO, will require individual formal consultations and biological opinions. The Service will re-evaluate this programmatic consultation annually to ensure that its continued application will not result in unacceptable effects on the northern riffleshell, clubshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel.

This biological opinion is based on information provided in the following documents: *Final Programmatic Consultation: Programmatic Biological Assessment and Commonwealth of Pennsylvania Species Coordination for Federally and State-Listed Mussels in the Ohio River Basin Pennsylvania* (hereinafter, BA) dated March 2010, and amended August 2015; the *PennDOT Programmatic Consultation Re-initiation Addendum,* dated February 2023; PennDOT's September 7, 2023 request to provide a conference report for the salamander mussel;

and other information available in Service's files. A complete administrative record of this consultation is on file at the Service's Pennsylvania Field Office in State College, Pennsylvania.

DESCRIPTION OF THE PROPOSED ACTION

As defined in the Act, section 7 regulations (50 CFR 402.02), "action" means "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas." The action area is defined in 50 CFR 402.02 to mean "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." This analysis is not limited to the "footprint" of the action, nor is it limited by the Federal Action Agency's authority. Rather, it is a biological determination of the reach of the proposed action on listed species. Analyses of the environmental baseline, effects of the action, and levels of incidental take are based upon the action area.

This biological opinion evaluates proposed bridge projects currently under consideration by PennDOT and funded, in part, by the FHWA or FEMA. Because most of these projects occur over or are within waters of the United States, they fall under the regulatory authority of the Corps, and federal permits from that agency are often required.

The program action includes projects that are planned, or anticipated, over a 12-year period starting with the issuance of this PBO. Due to deterioration of bridge structural integrity, annual funding variations, and changing priorities it has not been possible to accurately predict all bridge actions that may occur over the 12-year period. Therefore, the list of proposed projects provided in the biological assessment may change over the duration of the PBO. Any individual bridge project may also change in focus and purpose over time, thereby changing the impacts and/or footprint of the project. Because of this lack of certainty, the scheduled projects as of February 17, 2023, (when the new BA addendum was completed) is the basis to provide an overall estimation of the number and type of projects that may occur over a 12-year period. The overall scope of actions in the Bridge Program is likely to remain relatively constant. However, as the 5-year time period has been extended to a 12-year time period, this scope of actions, number and types of projects becomes increasingly unpredictable. Similarly, this consultation includes some emergency bridge actions funded in part by the FEMA. The scope and timing of these actions are unpredictable, but the average number of such actions over a period of years was used as the basis for considering possible future emergency actions. FHWA and PennDOT's proven successes with the five-year duration of previous PBOs, have facilitated consideration of expending the duration of this biological opinion for a twelve-year time period (2024 to 2036).

PennDOT's bridge and culvert construction, replacement, repair, and maintenance projects may include activities that require instream or riparian disturbance. These projects can vary greatly in the level of disturbance they may cause and range from minimal siltation (when no instream access is required) to significant channel disturbance (when instream, temporary causeways and cofferdams are used to access portions of the action area).

Some projects, such as creation of new roadway alignments, are likely to have substantially greater levels of adverse effects (Wheeler *et al.* 2005) than those considered at existing bridge

locations; therefore, new alignments are beyond the scope of this consultation and will require individual review and consultation when federally listed species may be affected.
Finally, section 7 of the Act requires that federal agencies 1) use their authority to develop programs that conserve federally listed species [section 7(a)(1)], and 2) consult with the Service to ensure that their actions do not jeopardize the continued existence of federally-listed species [section 7(a)(2)]. Consequently, the following PBO considers the benefits of proposed conservation commitments associated with the Bridge Program, as well as whether implementation of the Bridge Program is likely to jeopardize the continued existence of listed endangered and threatened species.

DESCRIPTION OF THE BRIDGE PROGRAM

In general, the Bridge Program activities below are listed in order of the potential magnitude or extent of effects on stream and river habitats. The degree of adverse effects that these projects may have depends upon a variety of site-specific factors, such as surrounding land cover/use, terrain, and extent of the project area (length and size of bridge, bridge design, *etc*.). The inherent site-specific variability associated with each individual project makes it very difficult to predict the disturbance area associated with each work activity.

Direct and indirect effects for all bridge projects typically extend 200 – 400 feet from the upstream extent of in stream work to 400 – 1,200 feet downstream of the downstream extent of work (Appendix B). Table 5 lists the estimated number of bridge projects of each type within the Management Units.

Action Area

The BA divides the Ohio River basin into five (5) Management Units, based upon measured, or presumed, presence and population density of threatened and endangered mussels (both state-listed and federally-listed species). These units are comparable to those listed in a previous interagency Letter of Agreement between PennDOT and the Service, which identified streams with known, or probable, endangered mussel populations (Appendix A). Specific avoidance, minimization and conservation measures are proposed for projects that are part of the Bridge Program within each of the Management Units. These measures are designed to mitigate the effects of the projects, commensurate with the existing freshwater mussel resource.

The five Management Units encompass approximately one-third (15,164 square miles) of Pennsylvania within the upper Ohio River basin. The eastern part of the basin is more mountainous, transitioning west to "rolling hills" largely within the Appalachian Plateaus Physiographic Province. The northwest portion of the basin borders the Lake Erie watershed, and topography in the northwest has comparatively low relief. These topographical conditions affect land use and stream habitat. Northern and eastern sections of the basin have relatively large, forested areas (*e.g.,* the Allegheny National Forest). Southern and western sections have a more industrial history and larger human populations (*e.g.,* Pittsburgh, Sharon, and New Castle). Streams originating at higher elevations are often poorly buffered as compared to those in the northwest portion of the basin that flow over glacial alluvium and have higher alkalinity. The southern portion of the basin is also the location of past and ongoing coal extraction, which has had profound effects on aquatic habitat (Anderson *et. al* 2000).

The natural geologic characteristics limited northern riffleshell, clubshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel to portions of the basin. When combined with anthropogenic land use changes that have altered water quality, these species now have a more limited distribution that is largely restricted to the northern portion of the basin in Armstrong, Clarion, Crawford, Erie, Forest, McKean, Mercer, Potter, Venango, and Warren Counties. However, several other Pennsylvania counties are within the range of these species including Allegheny, Butler, Beaver, Fayette, Greene, Indiana, Lawrence, and Westmoreland Counties. Some of these areas have been poorly surveyed for mussels, and since 2000, extant populations have been discovered, or rediscovered, because of recent survey efforts.

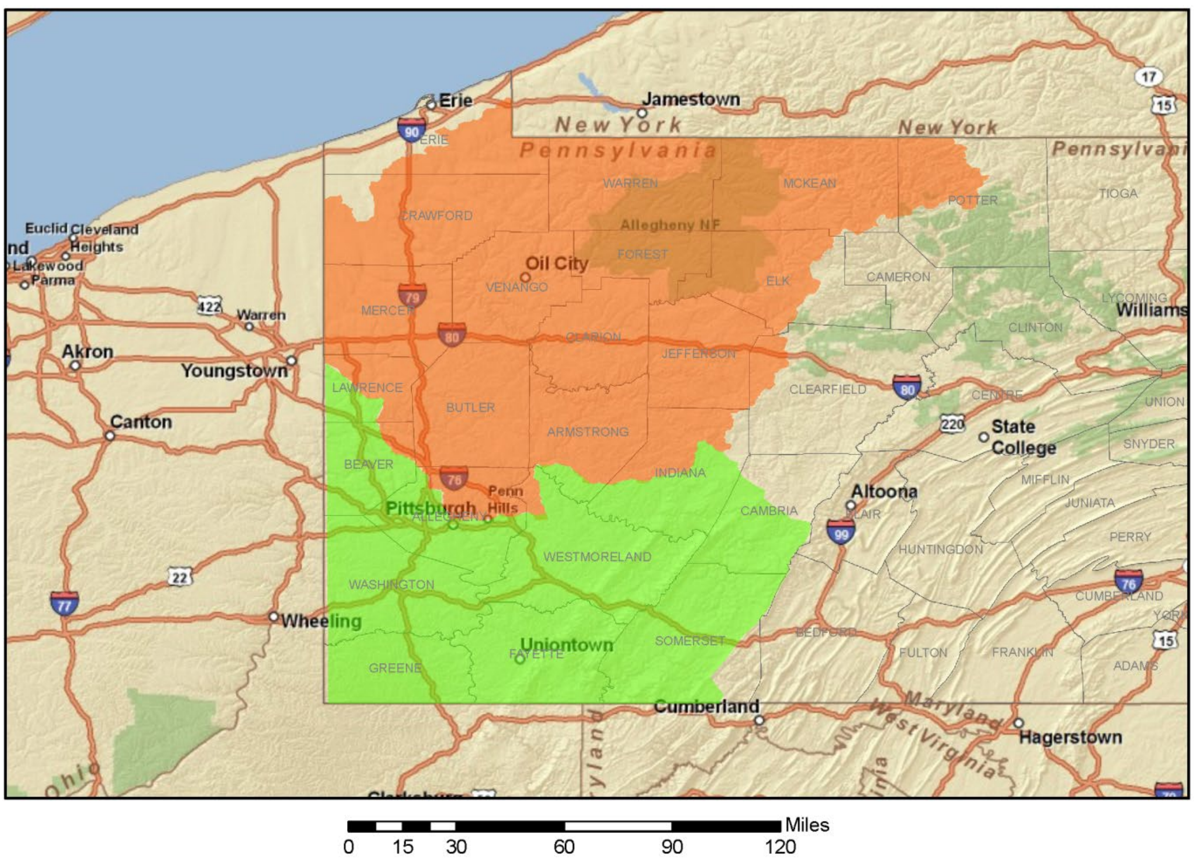

Figure 1. Watersheds in the range of northern riffleshell, clubshell, rayed bean, snuffbox, sheepnose, longsolid, round hickorynut and salamander mussel in Pennsylvania are highlighted in orange. Watersheds with known extant populations of rabbitsfoot in Pennsylvania are highlighted in both orange and green.

Management Unit 1

Stream segments in Management Unit 1 (Table 1) typically have higher densities of endangered mussels and are defined in the BA as locations having an *average density of threatened and endangered mussels (State and federal species combined) ranging from a minimum of 0.5 per* *square meter up to a maximum of 37.3 per square meter*. Support for the specified minimum and maximum site population densities is referenced as EnviroScience (2006) in the BA. Unfortunately, the cited supporting documents differ from the above definition.

The maximum site population density defining Management Unit 1 is 37.3 threatened and endangered mussels (State and federal species combined) per square meter. However, the citation upon which this was based (EnviroScience 2006) reports a population density of 37.3 per square meter for all mussel species combined in French Creek near Venango, Pennsylvania. The population density estimate for northern riffleshell at the referenced site was 3.4 per square meter, and the density of all state and federal threatened and endangered species combined was 5.8 per square meter (EnviroScience 2002), which is consistent with estimated population densities listed in the BA. Based on the aforementioned information and information provide in the updated BA (2015), this biological opinion will use a maximum density of 6.0 rather than 37.3.

Table 1. Management Unit 1. Stream and stream segments known to support federally listed mussel species. The number of anticipated projects is based upon the BA.

Management Unit	***Anticipated projects***	***Description***
1	*17 projects*	*Selected stream segments that are known to support federally listed mussel species* • *Allegheny River in Armstrong, Butler, Clarion, Warren, Forest, and Venango Counties* • *French Creek in Mercer, Venango, Crawford, and Erie Counties* • *Shenango River in Mercer and Crawford Counties* • *LeBoeuf Creek in Erie County*

Given the wide variation of threatened and endangered mussel species densities in this management unit, the specific stream and drainage segments included in Table 2 are further classified with an estimated density of all threatened and endangered species (State and federal species combined) per meter squared. The individual stream segments are identified as sub-management units and were derived from best commercial and scientific information available from past surveys and biological opinions.

Table 2. Management Unit 1 Stream/Stream Reach Maximum Threatened and Endangered species (State and federal species combined) Density Estimates per Meter Squared (adapted from the 2023 BA, EnviroScience 2023).

Stream	Counties	Sub-Management Unit	Stream Reach Description	Max T&E/m^2 Estimate
French Creek	Erie & Crawford	**1FC1**	From Union City Dam (41.921, -79.900) to (and including) SR 0006 Bridge (south of Meadville) (41.623, -80.157)	1.2
	Crawford, Mercer, & Venango	**1FC2**	From SR 0006 Bridge (south of Meadville) (41.623, -80.157) to the Allegheny River (41.393, -79.820)	5.8
Allegheny River	Warren	**1AR1**	Downstream of the confluence with Conewango Creek (41.840, -79.145) to the Forest County line (41.626, -79.402)	1.2
	Forest	**1AR2**	Forest County line (41.626, -79.402) to (and including) SR 0062 Bridge at Tionesta (41.494, -79.460)	6.0
	Forest & Venango	**1AR3**	From SR 0062 Bridge in Tionesta (41.494, -79.460) to Village of President (41.467, -79.555)	> 6.0
	Venango	**1AR4**	Village of President (and including the Village of President) (41.467, -79.555) downstream to Sandy Creek Trail Bridge (41.332, -79.771)	6.0
	Armstrong, Butler, Clarion, and Venango	**1AR5**	Sandy Creek Trail Bridge (41.332, -79.771) to Ford City (40.794, -79.519)	1.0
Shenango River	Crawford & Mercer	**1SR**	From Shenango River Reservoir (41.285, -80.341) upstream to Pymatuning Lake Dam (41.496, -80.460)	0.50
LeBoeuf Creek	Erie	**1LBC**	From LeBoeuf Lake (41.931, -79.982) to French Creek (41.902, -79.985)	0.50

*Maximum T&E Mussel Density/m2 estimates were derived from the Programmatic Consultation Re-Initiation Addendum: Programmatic Biological Assessment and Commonwealth of Pennsylvania Species Coordination for the Federally and State-Listed Mussels in the Ohio River Basin in Pennsylvania (FHWA & PennDOT, 2015).

This PBO considers stream reaches listed in the BA. In keeping with citations documenting the densities of endangered and threatened mussels (*e.g.*, BA, EnviroScience 2002, EnviroScience 2006), this document understands Management Unit 1 to include streams with an *average* *density of threatened and endangered mussels (State and federal species combined) ranging from a minimum of less than 0.5 per square meter up to a maximum of 6.0 per square meter*. Population densities for federal and state species that exceed this level (6.0 per square meter) are not within the scope of this PBO. While referring to this explanation of population densities for Management Unit 1, the biological opinion considers the Management Unit to be defined by the list of stream segments itself and defers to the BA for the actual list of stream segments in Management Units 1 and 2. Additionally, Management Unit 1 contains designated critical habitat units for the Rabbitsfoot (referred to as RF22, RF23, RF24, and RF31), longsolid (referred to as LS1, LS2, and LS3) and the round hickorynut (referred to as RH1), and proposed critical habitat for the salamander mussel (referred to as Unit 17, 18 and 19).

The objective in Management Unit 1 is to maintain existing mussel populations; therefore, avoidance and minimizations measures to reduce "take" are the priority during project design. Relatively few bridge projects are planned to occur over streams in Management Unit 1. In addition to the 17 identified projects listed in the BA, four other projects may occur, including one possible bridge replacement, one possible bridge restoration/rehabilitation, and two bridge preservation projects (EnviroScience 2023).

Management Unit 2

Stream segments in Management Unit 2 (Table 3) are known to support endangered mussels, but the available survey information suggests that population densities are lower than are those in Management Unit 1. The BA considers stream reaches with an *average population site density of federal and State-listed endangered and threatened mussels of less than 0.5 per square meter* as Management Unit 2. Population densities included in the BA range from a minimum of 0.01 federal and state listed threatened and endangered mussels per square meter to a maximum of 0.8 per meter square. Consistent with the approach described in Management Unit 1, Management Unit 2 streams are depicted in Appendix A maps and listed in the BA, and we considered this list to define Management Unit 2 rather than the specific population densities. Table 3 has been updated to reflect additional stream reaches that were evaluated via a PennDOT-sponsored study to evaluate and reclassify Management Unit 3 streams (EnviroScience 2020). Management Unit 2 also includes designated critical habitat for the rabbitsfoot (RF 22, RF24, and RF31) and has been updated to include a segment of designated critical habitat for the longsolid (LS1).

Table 3. Management Unit 2. Stream and stream segments known to support federally listed mussel species. The number of anticipated projects is based upon the BA.

Management Unit	***Anticipated projects***	***Description***
2	*21 projects*	*Selected stream segments that are known to support federally listed mussel species.* • *Allegheny River - Armstrong County, from City of Pittsburgh (40.473, -79.967) to the confluence of the Allegheny and Ohio Rivers (40.443, -80.015);* • *Sandy Creek -Mercer and Venango Counties from Sandy Lake (41.366, -80.084) to the confluence of Sandy Creek and the Allegheny River (41.325, -79.843);* • *French Creek - Erie County, from Union City Dam (41.939, -79.897) (1 mile north of S.R. 97) to the New York Border (42.019, -79.762);* • *Little Shenango River - Mercer County, upstream to the confluence with Crooked Creek;* • *Conneaut Outlet - Crawford County (from 41.603, -80.299 to 41.540, -80.103);* • *Oil Creek - Venango and Crawford Counties (from 41.784, -79.809 to 41.431, -79.709);* • *Conneautee Creek - Crawford and Erie Counties, French Creek (41.807, -80.076) to Lake Edinboro (41.877, -80.135);* • *Muddy Creek - Crawford County from the S.R. 77 Bridge (41.742, -79.888) to the confluence with French Creek (41.800, -79.994);* • *Conewango Creek - Warren County (from 41.999, -79.144 downstream to 41.840, -79.145) ; and* • *South Branch French Creek (from 41.917, -79.691 to 41.902, -79.901) and West Branch French Creek (from 42.134, -79.762 downstream to 41.998, -79.812) - Erie County.* • *Tionesta Creek (from 41.487, -79.456 to 41.479, -79.444) - Forest County* • *Allegheny River - Potter and McKean Counties, downstream of Coudersport to the New York line (41.999188, -78.350721 to 41.773499, -78.017354)* • *Oswayo Creek - Potter and McKean Counties* • *Oil Creek - Venango County, from confluence with Allegheny upstream to ice control dam (41.430795, -79.709575 to 41.491515, -79.684855)* • *Cussewago Creek - Crawford County, from confluence with French Creek upstream to Creek Road bridge (41.638704, -80.161216 to 41.759697, -80.239493)* • *Brokenstraw Creek - Warren County, from confluence of the Allegheny upstream to Spring Creek (41.831788, -79.25918 to 41.863756, -79.514955)* • *LeBoeuf Creek above LeBoeuf Lake - Erie County (41.935141, -79.986121 to 42.030079, -80.061652)*

While freshwater mussels typically exhibit a patchy distribution with highly variable population densities, sometimes long stream reaches have low mussel abundance, suggesting degraded habitat or water quality may be the cause. This may explain, in part, why mussel population densities are lower in Management Unit 2 than they are in Management Unit 1. Low abundance is not necessarily indicative of resource value for the conservation and recovery of endangered mussels, because all the federally listed endangered or threatened mussels persist in relatively few, linear populations that are potentially vulnerable to single catastrophic events (*e.g.,* toxic spills or floods). Outlying populations are not only likely to have divergent genetic characteristics that are beneficial, or necessary, for species recovery, but they also become vital as source populations in the event that the main population is damaged or lost due to stochastic events. Consequently, the action agencies and PennDOT propose a conservation objective in Management Unit 2 that focuses on implementing best management practices and conservation measures to restore and improve water quality. Avoidance, minimization, and conservation measures applicable to the bridge projects proposed in Management Unit 2 streams will be implemented to achieve this objective. In addition to the 21 identified projects listed in the BA, four other projects may occur, including one possible bridge replacement, one possible bridge restoration/rehabilitation, and two bridge preservation projects.

Management Unit 3

Stream segments categorized as Management Unit 3 are in the range of state or federal endangered or threatened mussels and represent possible habitat, but there is limited recent mussel survey information. Because available information is inadequate to evaluate project effects, additional survey effort is proposed to determine if endangered or threatened mussels are present before determining whether to develop avoidance, minimization, or conservation measures. Upon completion of surveys, projects in Management Unit 3 (Table 4) will implement the avoidance and minimization measures related to either Management Unit 1 or 2, depending upon the observed endangered or threatened mussel abundance. The BA did not indicate the fate of Management Unit 3 project sites where no endangered or threatened mussels are found during surveys. In light of this, the Service has concluded that such areas most appropriately fit into Management Unit 5 or 4 if within a location that may influence downstream endangered mussel populations. PennDOT initiated the Management Unit 3 survey study in 2020. The List of Management Unit three streams have been updated to reflect the results of that study (EnviroScience 2020). Table 4 also reflects reclassification of streams that were in the study, but not on the list, and one stream that contains new biological information.

The Service concurs with the action agencies' determination that the Bridge Program in Management Unit 3 "may affect" northern riffleshell, clubshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, or salamander mussel in some streams included in this Unit. Mussel surveys are proposed at bridge project sites in Management Unit 3 to determine placement in the appropriate Management Unit. Following mussel surveys, sites in Management Unit 3 will be assigned to Management Unit 1 or 2 (*i.e.,* may affect, likely to adversely affect) with appropriate avoidance, minimization, and conservation measures for those Units, as indicated by the population density of endangered and threatened mussels found during the survey. The BA did not indicate the fate of Management Unit 3 project sites where no endangered or threatened mussels are found during surveys. In light of this, the Service

concluded that such areas most appropriately fit into Management Units 5 or 4 if within a location that may influence downstream endangered mussel populations (see above).
Based upon existing survey data in Pennsylvania and the historic distribution of the eight endangered or threatened mussels, and one proposed listed mussel, it is unlikely that additional, unknown, high-population-density streams exist in Management Unit 3 that might be categorized as Management Unit 1. However, several streams in Management Unit 3 are known to support diverse mussel communities. In addition, some of these streams have potential mussel habitat and are in close proximity to streams that are known to support clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, or salamander mussel.

Across the species range, clubshell, snuffbox, and rayed bean mussels are more likely to persist in smaller streams and at lower population densities than northern riffleshell. Consequently, we anticipate that a few streams in Management Unit 3 may be moved to Management Unit 2, based upon surveys that reveal low densities of clubshell, snuffbox and rayed bean. The northern riffleshell, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel have more restricted ranges than the other three species, and there are fewer unsurveyed, large-river habitats that could serve as potential habitat for these three species. However, as there are two newly listed threatened species and one proposed endangered species included in this group, we anticipate that a few streams in Management Unit 3 may be moved to Management Unit 2, based on surveys that reveal low densities of northern riffleshell, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel.

Table 4. Management Unit 3. Streams and stream segments within the range of federally listed mussel species. The number of anticipated projects is based upon the BA.

Management Unit	***Anticipated projects***	***Description***
3	*9 projects*	*Selected stream segments that are in the range of federally-listed mussel species, but for which recent site-specific survey information is lacking (Updated since EnviroScience surveys of 2020)* • *Allegheny River in Armstrong and Westmoreland Counties, from Ford City (Pool 6) (40.7620, -79.545)* to the City of Pittsburgh (40.473, -79.967): *No changes;* • *Allegheny River in McKean and Potter Counties (from 41.836, -77.878 to 41.999, -78.342): MU2 downstream of Coudersport, and MU5 upstream of Coudersport;* • *Ohio River in Allegheny and Beaver Counties (40.444, -80.021 to 40.637, -80.518): No changes;* • *Shenango River (from 41.271, -80.457 to 40.853, -80.323) in Mercer County (downstream of the Shenango River Reservoir Dam) and in Lawrence County: MU5 downstream of the Shenango River Reservoir Dam;* • *Little Mahoning Creek in Indiana County (from 40.797, -78.928 to 40.896, -79.196): MU5 entire stream length;* • *Cussewago Creek in Crawford County (from 41.848, -80.219): MU2 downstream of Creek Road bridge, MU4 1 mile upstream, and MU5 upstream of the MU4 section;* • *Brokenstraw (from 41.998, -79.621 to 41.834, -79.257) and Little Brokenstraw (from 41.998, -79.451 to 41.833, -79.383) Creeks in Erie and Warren Counties:MU2 downstream of Spring Creek, MU4 one mile upstream, and MU5 upstream of the MU4 section;* • *Neshannock Creek in Lawrence and Mercer Counties from 41.333, -80.253 to 40.992, -80.354): MU5 entire stream length;* • *Cowanshannock in Armstrong County (from 40.794, -79.302 to 40.851, -79.508): MU5 entire stream length.;* • *Oil Creek: MU2 below the ice dam, MU4 one mile upstream of the ice dam, and MU5 upstream of the MU4 section;* • *Beaver River: MU5 entire stream length;* • *Mahoning Creek: MU5 entire stream length;* • *Neshannock Creek: MU5 entire stream length;* • *Potato Creek: MU5 entire stream length; and* • *Fourmile Run, Westmoreland County: newly added to list due to survey findings. No classification.*

Table 5. Estimated number of Bridge Program actions per Management Unit for each species (Adapted from Table 5 of the Amended BA. (EnviroScience 2023)).

Management Units	Project Type	Northern riffleshell	Clubshell	Rayed bean	Snuffbox	Rabbitsfoot	Sheepnose	Longsolid	Round Hickorynut	Salamander mussel
1 (17 planned projects)	Bridge Replacement/Removal	3	3	3	3	3	0	3	0	3
	Bridge Preservation	9	9	9	9	9	3	2	1	3
	Bridge Restoration/Rehab	5	5	5	5	5	2	5	2	5
	Unplanned Projects	4	4	4	4	4	4	4	4	4
	FEMA	3	3	3	3	3	3	3	3	3
2 (21 planned projects)	Bridge Replacement/Removal	1	1	1	1	1	1	1	1	1
	Bridge Preservation	3	3	4	4	3	2	2	2	3
	Bridge Restoration/Rehab	13	12	14	12	12	6	13	8	10
	Unplanned Projects	4	4	4	4	4	4	4	4	4
	FEMA	2	5	5	5	2	0	2	2	2
3 (9 planned projects)	Bridge Replacement/Removal	0	0	0	0	0	0	0	0	0
	Bridge Preservation	3	3	0	5	5	5	5	5	3
	Bridge Restoration/Rehab	3	3	4	4	4	4	4	4	3
	Unplanned Projects	3	3	3	3	3	3	3	3	3
	FEMA	0	0	0	0	0	0	0	0	0
4 & 5	Bridge Replacement/Removal	With implementation of avoidance and minimization measures, no take anticipated								
	Bridge Preservation									
	Bridge Restoration/Rehab									
	FEMA[1]									

[1]Emergency bridge actions over Management Unit 4 streams were not estimated but may occur; however, no direct or indirect adverse effects are anticipated because the listed species covered by this biological opinion are absent from these streams. Separating any downstream indirect affect caused by the federal action would be difficult or impossible due to habitat alteration caused by the flood event.

Bridge Replacement

Bridge replacement projects involve the construction of new, multiple-span bridges, accommodating multiple travel lanes and shoulders. Within the action area, the direct effect areas associated with bridge replacement projects are equal to the length of the bridge over water times the bridge width times two.

New bridge structures are typically replacing obsolete, multiple-span truss structures with multi-span, continuous steel girders, or concrete structures, and sometimes result in the elimination of a pier, or improved pier placement. During the design phase, investigations (*e.g.,* mussel habitat surveys, hydraulics studies, geotechnical boring, and review of available bridge inspection and bathymetric data) are conducted to optimize the placement of piers. To the extent possible, piers are positioned to minimize scour effects of the new bridge and minimize encroachments (*i.e.*, pier placement) within suitable mussel habitat. Rip-rap is often placed at the piers to provide additional scour protection. Bridge approaches are usually realigned and widened as necessary to accommodate the new bridge structure.

Take (e.g., death, injury, harm) is expected to occur due to suffocation, smothering, crushing, and/or displacement construction and demolition activities. A subset of these effects also represents permanent and temporary impacts on designated critical habitat. Within the zone where direct effects are expected to occur, minimization efforts and commitments include:

1. Minimizing causeway areas through the use of temporary bridges or minimizing the duration of causeway use,
2. Placing causeways in such a manner or location to avoid concentrations of mussels,
3. Placing causeways and temporary bridges in a manner that reduces upstream backwater and downstream scour effects, based upon hydraulic analysis and modeling,
4. Using barges for construction in areas where sufficient water depth occurs,
5. Demolition using deconstruction methods that eliminate dragging to remove demolished bridge spans (in conjunction with successive deconstruction and non-shattering explosives), and
6. Salvaging mussels in Management Unit-1, where mussel populations are of the greatest densities,

An analysis of past consultations conducted under the programmatic consultation indicates that implementation of these minimization measures results in an average reduction of the footprint of all in-stream project features by 16 percent, thereby reducing take. A comparison of take assuming a bank-to-bank impact of two times the existing bridge widths (worst case scenario for bridge replacement project) versus the take expected with the incorporation of the minimization commitments described is presented in Table 6.

Habitat degradation, in the form of water quality impairment, may occur as a result of the operation and maintenance of bridges. In-stream areas may be degraded by runoff from the bridge deck, when rain flushes road surface deposits (e.g., oil, dirt, silt, hydrocarbons, and de-icing materials) directly into streams and rivers. Commitments to improve bridge runoff by directing increased amounts of runoff to land based areas (e.g., stone mats, grassed swales) will result in improvements to existing conditions.

The ecosystem stewardship and green ecological strategy commitments incorporated at the Tier 1 level will serve to improve water quality and restore mussel habitat in the Action Area watershed. Continued pursuit of PennDOT's management of stormwater facilities to meet water quality improvement standards for the Municipal Separate Storm Sewer System (MS4) permit measures that reduce the use of winter materials similarly contributes to continued water quality improvement in the basin. These measures provide opportunity for re-colonization of degraded streams by federally listed mussels. Effects on water quality may continue to improve as new de-icing materials and procedures that result in continued improvements in reducing the effects of de-icing materials occur.

New bridges are typically located within 50 feet of the existing (old) structure to minimize the use of causeways or barge locations during construction. Crossings of streams and rivers are typically infrequent in the region. Consequently, closure of an existing bridge so that it may be replaced on the same alignment is not typically pursued, as this alternative results in a detour for an extended period that disrupts the provision of essential services (*e.g.,* emergency services and school bus transportation).

In project areas where stream depths are shallow (typically less than 8 feet water depth), causeway work platforms are constructed from each shoreline and connected by temporary bridges that are used for bridge and in-stream construction. Causeway work platforms are usually installed during the spring and removed by late fall of the same year. In deeper rivers, construction is performed from a barge or combination of barges, with limited causeways in areas of the river where depth limits the use of barges. In navigable waterways, barges are floated to construction sites. In non-navigable waters, barges may be transported via trucks to the construction site and a launch area is established. Barges are held in place with spuds (16-inch diameter pipes) driven into the riverbed.

Regardless of causeway or barge access, pier construction is done behind cofferdams. Efficiency and availability of construction materials; and the shortest duration of the construction period dictates the method of cofferdam construction. Cofferdams may include pre-cast jersey barriers, barriers with waterproof fabric (*i.e.* bulk flexible intermediate bulk container (FIBC)), water-filled barriers, port-a-dams, or sheet piling driven to below foundation depth. The area within the cofferdam is de-watered and pier construction occurs in the dry.

The footprint of causeway work platforms and cofferdams is minimized for each project, and placement of these temporary structures and the incorporation of temporary bridges are pursued in a manner that reduces impacts on mussel habitat. For example, placement of these structures is intended to reduce scour and causeway-induced pooling. Also, additional culvert pipes may be used in conjunction with causeways and temporary bridges to reduce the effects of scour and pooling. Upon completion of construction, causeways and cofferdam materials are removed to the original riverbed level.

In contrast to the paragraph above, the Bridge Program may reduce adverse effects on mussel habitat by using new Service-approved causeway/cofferdam technologies that may not minimize footprint, but will reduce the duration of causeway/cofferdam use. The effectiveness of new construction technologies, if used, will be monitored using a Service-approved protocol.

For both the construction and demolition phases of a bridge replacement project, an erosion and sedimentation control plan is developed and submitted to the County Conservation District for review and approval. Erosion and sedimentation control measures are monitored during construction and bridge demolition. Similarly, a Pollution Prevention Plan is prepared, which includes contingency plans for rapid response or remediation of impacts from unexpected events in the construction area (*e.g.*, floods, fuel spills, and siltation). These plans are submitted to the Service and PFBC for review and comment.

PennDOT provides an inspector proficient in erosion and sedimentation control, pollution prevention plan implementation, and other environmental issues related to bridge and roadway construction. This inspector is briefed and is aware of all environmental mitigation commitments, BMPs, permit conditions and unique environmental concerns related to the project, including the presence of endangered or threatened species and how construction activities may affect these species and their habitats. This inspector will be on-site daily when the site is not stabilized and will supplement inspections conducted by the contractor(s). All sites are stabilized during winter and non-construction periods, and provisions for monitoring any un-stabilized areas are provided for by PennDOT or its contractor.

Contractors are made aware of the concerns about introduction of zebra mussels to bridge project sites (*e.g.,* on construction equipment). All equipment is decontaminated, and the contractor is required to document the "exotic free" condition of all equipment and protective gear utilized during the project.

In-stream construction activities associated with the new bridge structure are typically limited to one year. The removal of existing bridge structures, which includes removal of remnant piers, requires in-stream work during a limited portion of a second (not necessarily sequential) year.

<u>Bridge Removal</u>

Bridge Removal projects are typically associated with a bridge replacement, although they are a common activity associated with rehabilitating historic structures as well. The effects of bridge removal, when associated with a bridge replacement, were described as part of a bridge replacement project above. In the event that bridge removal is pursued as a single, complete project, the effects would be limited to the previously described effects for bridge demolition activities. Demolition is pursued using deconstruction methods that eliminate dragging to remove demolished bridge spans (in conjunction with successive deconstruction and non-shattering explosives). The footprint of these projects is more readily minimized as the footprint associated with a new structure, including locations of new piers, would not be present. However, given the uncertainty associated with removing varying structure types and the necessity for causeways and work platforms, the potential footprint is the same as that anticipated for a bridge replacement project or two times the existing bridge widths. Habitat restoration in the areas of pier removals would occur. In the event that salvage and relocation are pursued, the relocation will result in a reduction in take due to reduced mortality by salvaging mussels that may otherwise be taken during construction activities.

Methods used to remove bridge structures are dictated by the structure, size, and condition of the bridge, as well as the surrounding topography and site accessibility, including successive deconstruction. Prior to bridge demolition, pavement material, decking, and other non-structural components are removed by scraping, milling, or removing in a manner that minimizes the amount of material that enters the stream. Deck support panels or trusses are cut and lifted from the structure. Smaller bridge structures are removed by supporting each span on temporary support beams and removing the spans by crane. Smaller bridges may be removed without direct streambed disturbance. Larger bridges are demolished with rapid controlled-burn, non-shattering charges (not explosives) which cut the structure to manageable sized pieces and drop it into the waterway. Pre-cutting the bridge results in smaller pieces of bridge debris that can be picked up as opposed to dragged out of the stream. In some instances, removal may be completed by cranes staged on an adjacent new bridge structure rather than a causeway or barge.

Pier and abutment removal is completed after the bridge superstructure is removed. Pier materials are typically loosened and removed by cranes stationed on causeways, barges, or newly constructed bridges. Natural streambed material is placed into the hole that results after the pier is removed. Alternatively, these holes are allowed to refill via natural bed movement resulting in restored potential habitat.

Erosion and sedimentation planning and controls, pollution prevention planning, and onsite inspection occur for these projects as described previously for Bridge Replacement Projects.

A comparison of take, assuming a bank-to-bank impact of two times the existing bridge width (worst case scenario) versus the take expected with the incorporation of the minimization commitments described, is presented in Table 6. The percentage reduction of in-stream footprint is reduced by the same percentage as that identified for bridge replacement projects.

Bridge Restoration/Rehabilitation

Bridge Restoration and Rehabilitation Projects, although typically limited to superstructure repair, may require in-stream work. Those projects that do not involve in-stream work should result in clearances under the Pennsylvania Natural Diversity Inventory/Pennsylvania Natural Heritage Program (PNDI/PNHP) review and result in no effect to T&E mussels. However, during the design of these projects it may be determined that in-stream access or work is required, so these projects have been included in this consultation. In-stream intrusions for these projects might include applying scour countermeasures (*e.g*., rip-rap), foot traffic, ladders, or scaffolding associated with placing forms on the superstructure or the need for beam supports during the restoration of superstructure members. The effects of these activities for these projects, the in-stream construction activities would be of short duration. Take and a permanent loss of habitat associated with the application of rip-rap will be limited as this application would be undertaken in areas of scour where habitat for T&E mussels is typically limited, and few animals are typically present. It is estimated that the instream impacts could be limited to not more than 10 percent of the bank-to-bank area multiplied by one time the bridge width; however, this may not be achievable for all projects. A comparison of take assuming a bank-to-bank impact of one time the existing bridge width (worst case scenario) versus the take expected with the incorporation of the minimization commitments described is presented in Table 6. Erosion and sedimentation planning and controls, pollution prevention planning, and onsite inspection occur for these projects as described previously for Bridge Replacement Projects.

Bridge Preservation

Bridge preservation projects are more likely to involve instream activity than bridge restoration/rehabilitation projects. The instream project activities most often included are debris removal, including the removal of gravel bars and sediment deposition, and scour countermeasures, such as the application of rip rap and underpinning repairs. These projects may require the use of causeways and cofferdams, but some measures are undertaken through access from the banks or the bridge structures. When causeways and cofferdams are needed, the duration of these temporary structures in the stream is typically limited to two to four weeks and frequently less. Causeways and cofferdams are deployed in the same manner as previously described for bridge replacement projects, incorporating the same associated minimization measures and would result in the same effects previously described associated with these temporary in-stream features. However, since these temporary structures would be in place for only a portion of one construction season, the backwater and scour effects and effects on transport and reproduction are greatly reduced. The maximum anticipated causeway footprint for many projects may be limited to 50 percent of the bank-to-bank distance multiplied by the bridge width; however, this may not be achievable for all projects of this type. A comparison of take assuming a bank-to-bank impact of two times the existing bridge width (worst case scenario) versus the take expected with the incorporation of the minimization commitments described is presented in Table 6.

Debris removal is often limited to the removal of logs and trees from the nose of piers but may include the removal of streambed deposition that restricts the hydraulic capacity of the bridge within 50 feet of the bridge. In addition to rip-rap/rock placement to protect piers and abutments from stream scour, placement of underpinning is sometimes necessary to repair a bridge. Underpinning repairs often require dewatering an area facilitated by the use of cofferdams.

Bridge Preservation activities are undertaken on existing bridge structures to maintain their structural integrity and functional purposes. Such activities may include repair of expansion dams to ensure leak-proof joints; restoration and repair of beam ends; restoration and replacements of bridge bearings and supports; repair of bridge approach slabs; restoration of bridge decks and overlays; spot/zone painting; complete repainting; fatigue and fracture retrofits; debris removal; and scour countermeasures. These activities may include in-stream work. Within the action area, the direct effect areas associated with Bridge Preservation projects are equal to the length of the bridge over water times the bridge width times two.

Erosion and sedimentation planning and controls, Pollution Prevention Planning, and onsite inspection occur for these projects as described previously for Bridge Replacement Projects.

Disaster Response and Emergency Projects

Section 7 regulations define emergency actions as those resulting from natural disaster or other calamity that may require expedited consultation (50 CFR §402.05). They include *a situation involving an act of God, disasters, casualties, national defense or security emergencies, etc., and* *the response activities that must be taken to prevent imminent loss of human life or property*. Emergencies described in the BA that might require immediate attention due to a threat of imminent loss of human life or property include, but are not limited to, removal of storm debris at and near bridges, including gravel/sediment aggregation that blocks stream flow and results in flooding; failure of bridge structures; hazardous material spill response; and construction of temporary roads and bridges necessary for response to disasters or local emergencies. Emergencies, as defined, would not typically include predictable events such as those that result from a failure to perform routine structure maintenance.

One measure of emergency events is a Presidential Disaster Declaration. FEMA and its state counterpart, the Pennsylvania Emergency Management Agency, have documented 22 Presidential Disaster Declarations affecting one or more of the counties in the Ohio River Basin since 1953, including flooding associated with Hurricanes Sandy and Ida. Two of these emergency declarations occurred in a single year, 2013. The type of disaster that most frequently results in widespread damage affecting bridges in Pennsylvania is flooding.

FEMA and PennDOT specifically detail two emergency action categories related to initial emergency responses that may occur to eliminate imminent threats. These are similar to actions proposed for the Bridge Program but are unplanned so avoidance and minimization measures may not be feasible. They include debris removal (FEMA Category A), which includes removal of woody debris, building wreckage, sand, mud, silt, gravel, vehicles, and other disaster-related materials. These immediate emergency response actions are necessary to prevent imminent loss of life or property and would typically be completed within hours or days of the disaster event.

The second emergency category consists of protective measures (FEMA Category B), which includes actions taken before, during, and after a disaster to save lives, protect public health and safety, and prevent damage to improved public and private property. Emergency protective measures are typically similar to bridge preservation actions described above (*e.g.,* scour prevention or temporary bridge support), but during an emergency response, equipment may need to be driven into streams to access locations or causeways may be constructed hastily. As with emergency debris removal, emergency protective measures would typically be completed within a few hours to a few days of the emergency event.

PennDOT has records indicating that the most significant flooding events resulting in damage to bridges that required emergency response occurred in 1980-81, 1996, and 2006. In January 1996, flooding resulted from a mid-winter thaw and was most severe in the southern portion of the action area, with some locations exceeding the previous record in the Little Conemaugh River, Little Mahoning Creek, and West Branch Clarion (USGS 1996). The flooding event in 2006 resulted from a stalled storm front over the Susquehanna and Delaware River Basins. The events of 1996 and 2006 caused damage that required emergency action and later permanent repairs to approximately fifteen bridges. Although these events occurred after the clubshell and northern riffleshell were listed as endangered species, the highest flows did not overlap with the extant range of the clubshell or northern riffleshell. To date, FEMA and PennDOT have not requested expedited or after-the-fact consultation for emergency actions in the Bridge Program action area under consideration. Presumably, no take of either species has occurred due to emergency flood response actions.

FEMA typically funds bridge repair projects within a period of weeks to months following the actual emergency and emergency response. It is reasonable to assume that most, if not all, emergency response actions (as defined under the Act) have already taken place by then. These later, long-term corrective actions funded by FEMA, but occurring weeks to months after the emergency, are not emergency actions and will incorporate conservation measures as described for a comparable bridge replacement, repair, or preservation project undertaken in the Bridge Program.

Unplanned Projects for All Bridge Project Types

This section is added to this document and was not in the original 2010 document.
For unplanned project types that fall under the categories discussed in the above, a comparison of take, assuming each project type's assumptions, will be used to calculate the initial and minimized take estimates. Not knowing where these projects will occur, it is assumed that an average of known footprints from all projects in these categories will be used to calculate the potential impact area. Therefore, a comparison of take assuming an averaged bank-to-bank impact of two times the average bridge width (worst case scenario) versus the take expected with the incorporation of the minimization commitments described is presented in Table 6. The ratio of projects of these types in each Management Unit (1 and 2) will be assumed to be similar to known projects, and that number will be used to assign unplanned projects accordingly.

Excluded Projects

This programmatic biological opinion only considers implementation of the project types described above within the Ohio River watershed in Pennsylvania. This biological opinion does not consider or evaluate 1) the potential impacts to federally-listed species from major transportation projects on new alignments involving river crossings (with the exception of projects involving the repair and replacement of existing bridge structures, as described in the BA); 2) projects for which the minimum level of avoidance and minimization measures are not applied; 3) projects for which individual informal or formal consultations were completed prior to this programmatic consultation; 4) projects that are likely to adversely affect federally listed species other than the nine mussel species considered herein; or 5) projects affecting mussel populations with densities of 6.0 or more endangered or threatened mussels per square meter (*i.e.*, greater than the densities typically found in Management Unit 1). Separate consultation with the Service will be required for all excluded projects that may affect any federally listed species.

Table 1. Effects of the Bridge Program Included in this programmatic Biological Opinion Based on Estimated Mussel Density (Adapted from Table 3 and Table 7 of the BA (EnviroScience 2023). For expanded Table, please see Appendix C.

Management Unit	County	Waterway	Project Title	Type*	Northern Riffleshell	Clubshell	Rayed Bean	Snuffbox	Rabbitsfoot	Sheepnose	Salamander Mussel	Longsolid	Round Hickorynut	Critical Habitat	Critical Habitat Units **
1	CRAWFORD	French Creek	Crawford Co. Bridge Waterproofing 0010	BRPS	63	5	115	21	16		0	0		72	RF22, LS1
1	CRAWFORD	French Creek	Crawford Co. Bridge Waterproofing 0020	BRPS	38	3	70	13	10		0			44	RF22, LS1
1	CRAWFORD	French Creek	Crawford Co. Bridge Waterproofing 0070	BRPS	35	3	63	12	9		0			39	RF22, LS1
1	CRAWFORD	French Creek	Crawford Co. Bridge Waterproofing 0080	BRPS	33	33	33	33	33		33	33		33	RF22, LS1
1	WARREN	Allegheny River	US 6 Warren Co. Bridges	BRST	5813	453	10648	1976	1468	692	27	7	7	6655	LS2
1	CRAWFORD	French Creek	US 6 French Ck Br #3	BRPL	1477	115	2705	502	373		7	2		1690	RF22, LS1
1	ERIE	French Creek	US 6 Bridge over French Creek	BRST	988	77	1810	336	249		5	1		1131	RF22, LS1
1	ERIE	French Creek	PA 97: French Ck Bridge	BRST	885	69	1621	301	223		4	1		1013	RF22, LS1
1	CRAWFORD	French Creek	US 6 French Creek Br #1	BRPL	1391	108	2547	473	351		6	2		1592	RF22, LS1
1	WARREN	Allegheny River	PA 127 Bridge/Allegheny River	BRST	2532	197	4637	861	639	301	12	3	3	2898	LS2
1	ERIE	French Creek	Erie County Bridge Waterproofing	BRPS	34	3	63	12	9		0			39	RF22, LS1
1	CRAWFORD	French Creek	Cussewago St/French Creek	BRPL	1689	132	3094	574	426		8	2		1934	RF22, LS1
1	CRAWFORD	French Creek	SR 2034: Spring Street Viaduct	BRST	4505	351	8251	1531	1137		21	5		5157	RF22, LS1
1	FOREST	Allegheny River	Forest County Waterproofing	BRPS	301	23	552	102	76	36	1	0	0	345	LS2
1	MERCER	Shenango River	Mercer County Bridge Waterproofing 0040	BRPS	33	3	60	11	8	4				38	RF31, LS3, R H1
1	MERCER	French Creek	Mercer County Bridge Waterproofing 0060	BRPS	51	4	94	18	13		0	0		59	RF22, LS1
1	ARMSTRONG	Allegheny River	Graff Bridge Preservation	BRPS	1569	122	2873	533	396	187	7	2	2		
2	VENANGO	Oil Creek	PA 8 Bridge/Oil Creek	BRST	0		1								
2	CRAWFORD	Cussewago Creek	SR 2039: Dunham Rd Br	BRST	7		20								
2	ERIE	French Creek	SR 8 Bridge over East Branch French Creek	BRST	27	55	81	143	30		8	8		1660	RF22, LS1
2	WARREN	Brokenstraw Creek	SR 3022 Bridge over Broke	BRST	20	42	62	110	23			6	6		
2	ERIE	South Branch French Creek	Erie County Bridge Waterproofing	BRPS	0	1	1	2	0			0			
2	ERIE	West Branch French Creek	PA 8 Bridge over West Branch French Creek	BRST	27	55	81	143	30			8			
2	WARREN	Brokenstraw Creek	SR 3022 Bridge/Brokenstraw Ck	BRST	22	46	68	119	25			7	7		

2	WARREN	Brokenstraw Creek	SR 3014 Bridge/Brokenstraw Ck	BRST	2	4	6	10	2			1	1		
2	ERIE	French Creek	SR 1001 Bridge over French Creek	BRST	36	73	109	191	40		11	11		2218	RF22, LS1
2	FOREST	Tionesta Creek	PA 36 over Tionesta Creek	BRST								9			
2	CRAWFORD	Muddy Creek	SR 1033: Muddy Ck Bridge	BRST	10	21	31	54	11			3		628	RF24
2	VENANGO	Oil Creek	Venango County Waterproof	BRPS	2		6								
2	MERCER	Little Shenango River	Mercer County Bridge Waterproofing #2	BRPS				3							
2	MCKEAN	Allegheny River	2023 NC Bridge Preservation	BRST	3	6	9	15	3	6	1	1	1		
2	POTTER	Allegheny River	2024 NC Bridge Preservation	BRST	7	13	20	35	7	14	2	2	2		
2	POTTER	Allegheny River	SR 4003 over Allegheny Rv	BRPL	9	19	28	50	10	20	3	3	3		
2	ALLEGHENY	Allegheny River	Fort Duquesne Bridge Rehab & Preservation	BRST	97	199	295	519	109	205	30	30	30		
2	ALLEGHENY	Allegheny River	Fort Duquesne Bridge Rehab & Preservation	BRST	97	199	295	519	109	205	30	30	30		
2	ALLEGHENY	Allegheny River	SR 65 Ramps AND SR 279 Ft. Duquesne 0008	BRPS	7	14	20	35	7	14	2	2	2		
2	ALLEGHENY	Allegheny River	SR 65 Ramps AND SR 279 Ft. Duquesne 0009	BRPS	7	14	20	35	7	14	2	2	2		
2	ALLEGHENY	Allegheny River	40th Street Bridge	BRST	328	676	1004	1763	369	697	103	103	103		
3	ALLEGHENY	Allegheny River	New Kensington Bridge	BRPS	3	4	29	4	2	1	1	1	1		
3	BEAVER	Ohio River	Rochester - Monaca Bridge	BRPS			42	5	3	1		1	1		
3	ALLEGHENY	Allegheny River	Tarentum Bridge Ramp 'A'	BRPS	6	8	58	7	5	1	1	1	1		
3	ALLEGHENY	Allegheny River	Tarentum Bridge over NS RR	BRST	122	162	1149	143	90	18	18	18	18		
3	ALLEGHENY	Allegheny River	Highland Park Bridge	BRPS	8	10	74	9	6	1	1	1	1		
3	ALLEGHENY	Ohio River	McKees Rocks Bridge Phase	BRPS			98	12	8	2		2	2		
3	ALLEGHENY	Allegheny River	62nd Street Bridge	BRST	6	8	56	7	4	1	1	1	1		
3	ALLEGHENY	Ohio River	Sewickley Bridge Phase 2	BRST			409	51	32	6		6	6		
3	WESTMORELAND	Allegheny River	Freeport Bridge Truss Preservation	BRST	87	115	818	102	64	13	13	13	13		
1	Various	MU-1 Waterway	MU-1 Bridge Replacements / Removals	BRPL	13207	1028	24192	4491	3342	1573	61	15	15		ILS1,LS2,LS3,RF22,RF31,RH1
2	Various	MU-2 Waterway	MU-2 Bridge Replacements / Removals	BRPL	86	177	263	462	97	183	27	27	27		LS1, RF22, RF24
3	Various	MU-3 Waterway	MU-3 Bridge Replacements / Removals	BRPL	57	76	538	67	42	8	8	8	8		
1	Various	MU-1 Waterway	MU-1 Bridge Preservation	BRPS	27735	2159	50803	9430	7017	3302	127	32	32		:LS1, LS2, LS3, RF22, RF31,RH1
2	Various	MU-2 Waterway	MU-2 Bridge Preservation	BRPS	280	577	856	1503	315	594	87	87	87		LS1, RF22, RF24
3	Various	MU-3 Waterway	MU-3 Bridge Preservation	BRPS	370	491	3494	434	273	55	55	55	55		

1	Various	MU-1 Waterway	MU-1 Bridge Restoration / Rehab	BRPS	17170	1337	31450	5838	4344	2044	79	20	20		:LS1, LS2, L RF31, RH1 S3,RF22
2	Various	MU-2 Waterway	MU-2 Bridge Restoration / Rehab	BRPS	710	1464	2173	3814	798	1508	222	222	222		LS1, RF22, RF24
3	Various	MU-3 Waterway	MU-3 Bridge Restoration / Rehab	BRPS	313	416	2957	367	231	46	46	46	46		
1	Various	MU-1 Waterway	Bridge Preservation	EMER	15849	1234	29030	5389	4010	1887	73	18	18		LS1, LS2, LS3, RF22,RF31,RH1
2	Various	MU-2 Waterway	Bridge Preservation	EMER	258	532	790	1387	290	548	81	81	81		LS1, RF22, RF24
					98,406	**12,932**	**190,672**	**44,570**	**27,190**	**14,186**	**1,222**	**937**	**852**	**27,245**	
					Northern Riffleshell	**Clubshell**	**Rayed Bean**	**Snuffbox**	**Rabbitsfoot**	**Sheepnose**	**Salamander Mussel**	**Longsolid**	**Round Hickorynut**	**Critical Habitat**	**Critical Habitat Units**

*Definitions:

BRPL - (Bridge Replacement) The initial direct impact area for this project type was estimated as the bridge length (over water) x 2x bridge width.
BRPS / BRPSF - (Bridge Preservation) The initial direct impact area for this project type was estimated as the bridge length (over water) x 1x bridge width.
Subclass - Waterproofing - Assumed initial impact area was 10% of the bridge length over water X 1x bridge width.
BRST / HRST / SAFE- (Bridge Restoration / Rehab.) The initial direct impact area for this project type was estimated as the bridge length (over water) x 2x bridge width.
Subclass - Deck Only - Assumed initial impact area was 10% of the bridge length over water X 1x bridge width.
Subclass - Improvements - Assumed initial impact area was 10% of the bridge length over water X 1x bridge width
Subclass -Ramps - Assumed initial impact area was 10% of the project length over water X 1x width.
BRML (Bridge Removal) The initial direct impact area for this project type was estimated as the bridge length (over water) x 2x bridge width.
PennDOT's minimization rate of 16% was based on a review of 5 recent, similar projects.

**Definitions

RF – Rabbitsfoot Critical Habitat
LS – Longsolid Critical Habitat
RH – Round Hickorynut Critical Habitat

Conservation Measures

Section 7(a)(1) of the Endangered Species Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid the adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. Such measures should be closely related to the action and should be achievable within the authority of the action agency. The beneficial effects of conservation measures are taken into consideration in the Service's conclusion of jeopardy or non-jeopardy to the listed species and in the analysis of incidental take if they minimize impacts to listed species within the action area. More detailed descriptions of these measures are provided in the BA.

In addition to the site-specific avoidance, minimization and conservation measures described below, the federal action agencies and PennDOT have proposed to integrate the following program-level conservation measures into the Bridge Program.

Tier I

- Promote bridge designs and construction sequencing that reduces adverse effects on threatened and endangered mussel habitat.
- Initiate and participate in ecosystem conservation efforts, including:
  - In Management Units 1 and 2, implement and/or support projects that will improve water quality by reducing non-point source pollution. Such projects will include, but are not limited to, dam removals, open space preservation (green zoning), wetland preservation, wetland restoration, stream bank fencing, and stream bank restoration (via establishment of native plant species).
  - Pursue wetland restoration projects within the watersheds through the development of wetland mitigation banks.
- Develop and maintain a best management practice and conservation recommendation tracking/monitoring program that tracks implementation success and identifies implementation issues, such as poor performance. Develop procedures for regular notification of tracking results to the Service
- Continue to seek opportunities to participate in efforts to recover threatened and endangered mussels throughout the species' historic range (Recovery Plan, Task 4), including participation in the identification of relocation sites/opportunities, and in facilitating the transfer of animals to other States for reintroduction throughout the range. (For example, the Service and PFBC partnered with the State of Ohio to relocate northern riffleshell from the Allegheny River at Hunter Station to augment a declining northern riffleshell population in Upper Darby Creek, Ohio. This augmentation is monitored by the State of Ohio. Partnerships are being developed with other states and sovereign

Nations for relocation of additional endangered and threatened mussel species to achieve recovery objectives.)

- Incorporate ecosystem stewardship and green ecological strategy commitments. Stewardship and green ecological strategies incorporated at the Tier 1 level will serve to improve water quality and restore mussel habitat in the action area watershed. PennDOT's management of stormwater facilities and associated MS4 Permit objectives advance the department's goals of water quality improvement measures within the basin. These measures provide an opportunity for the recolonization of degraded streams by federally listed mussels. For additional details, see Appendix C.

- Pursue and expand the reuse and recycling of pavement materials to reduce the need for additional aggregate procurement from waterway sources.

- Promote the integration of Smart Transportation guidelines with "green" ecological planning strategies that promote appropriate land uses in sensitive stream corridors by enhanced coordination with municipalities, resource agencies and other stakeholders.

- Conduct an annual meeting in the first quarter of the calendar year to address the prior year's use of the PBO. The meeting will discuss successes, concerns, implementations, and deviations from the PBO, as well as summarize the implementation and use of the proposed conservation methods. A template of the annual meeting agenda can be found in the BA (Appendix C; Annual Meeting Template).

Tier II

As a proposed conservation measure and prior to submitting a Tier II programmatic biological assessment, a rapid site assessment (*i.e.*, an informal mussel and habitat survey) of mussel populations shall occur to guide the document. The methods to rapidly assess the mussel population prior to formal consultation are provided in the PBA (EnviroScience 2023 - Appendix E, Rapid Assessment Methods) and are tailored for Management Unit 1 streams under the Tier I Programmatic Agreement for endangered mussels. PennDOT-supported rapid surveys have been found to be helpful during the development of Tier II (alternatively referred to as a Mini-BA; as referred to in the 2010 PBA in section 6.1 Mini-Biological Assessment) biological assessments. These surveys allow PennDOT to avoid mussel resources and critical habitat. PennDOT has proposed this measure as a best practice/conservation measure even though formal (Phase I/Phase II) mussel surveys are not required in Management Unit 1 streams.

The Mussel Conservation Fund

The Mussel Conservation Fund (MCF) was established in February 2013 by an agreement between the Service, PA Fish and Boat Commission (PFBC), and PennDOT. It operates in conjunction with the Service's consultation and permitting activities under Section 7 and Section 10 of the ESA. It is administered by the PFBC and implemented for the benefit of freshwater mussel species that are listed under the ESA.

In most cases, contributions to the MCF are from project proponents and permit applicants as compensation for activities that are likely to adversely affect federally-listed mussels or their habitat. However, other entities (*i.e.* governmental agencies, non-government organizations, non-profit organizations, and others) that want to further the conservation and recovery of federally listed mussels may contribute to the Fund. Other contributions can be authorized by the PFBC if those contributions do not conflict with the purposes of the Fund (*i.e.*, they further the conservation of federally-listed mussel species). The objectives of the MCF are as follows:

1. Contributions provide a dedicated source of funding that:
    a. Ensures that the direct, indirect, and cumulative adverse effects on federally-listed mussels (of otherwise legal activities) are adequately offset within the Commonwealth of Pennsylvania; and
    b. Results in tangible conservation and recovery benefits to federally-listed mussels within the Commonwealth of Pennsylvania.

2. Contributions are not a substitute for appropriate avoidance and minimization measures to reduce potential adverse effects on federally listed mussels. Potential adverse effects on federally-listed species are first addressed through avoidance measures, then minimization measures, and lastly, through compensatory measures.

3. The MCF is to be used to fund actions important to the conservation and recovery of federally-listed mussels, including mussel habitat restoration or protection, mussel population augmentation, mussel propagation, mussel holding, fish host identification, and historic mussel habitat assessment.

4. Conservation actions funded by the Fund may also benefit other mussel species in the Commonwealth of Pennsylvania, as many species share common habitat, geography, life cycle needs, or other traits with federally listed species. However, the benefits to federally-listed species remain priority (Objectives 1 and 2), and benefits to other species should not supersede or supplant Objectives 1 and 2.

Fish Passage Improvements in Bridge Design

Fish Passage improvements through better design and construction practices represent an important conservation measure for freshwater mussels. Through improving ecological function of bridge designs, PennDOT will provide and ecological uplift through the bridge PBO. By documenting the number and types of bridge projects meeting this ecological uplift objective, PennDOT can provide valuable information to other DOTs and agency stakeholders in their annual reporting requirement. Additionally, addressing fish passage when designing a project provides host fish habitat connectivity throughout the basin. PennDOT identified three primary drainage facilities where fish passage is a consideration, including channels; bridges; and culverts.

Channels can be designed and constructed to restore and upgrade the functional values of a waterway, including such measures as enhancing riparian and instream cover; improving instream pools, riffles, and streambank geometry; and improving water and substrate quality. Bridges can be designed to span the ordinary high-water channel. However, culverts are the most common fish passage concern. Failure to consider fish passage during the design process of a culvert can result in blockage or impediments to upstream and downstream fish movements. Through work with the State Bridge and Culvert Task Force, PennDOT has adopted design considerations that takes into account aquatic passage improvements through their culvert structures, including depressing the culvert invert to allow for natural streambed substrate accumulation; baffle designs; and placing natural stream bed materials within the culvert where conditions merit.

Avoidance and Minimization Measures

The following avoidance and minimization measures have been incorporated into the project description. These measures are designed specifically to avoid and minimize impacts of the proposed action on freshwater mussels including northern riffleshell, clubshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, long solid, round hickorynut, and salamander mussels. The Service has analyzed the effects of the proposed action based on the assumption that all avoidance and minimization measures will be implemented. More detailed descriptions of these measures are provided in the BA.

Projects that lack one or more avoidance and minimization measures are beyond the scope of this programmatic biological opinion, and are therefore subject to an individual, project-specific section 7 consultation with the Service. When such projects are likely to adversely affect federally-listed mussels, the Federal Action Agency must request formal consultation and allow sufficient time for the full formal consultation process (at least 135 days from the Service's receipt of a complete initiation package).

As discussed above, the action area is delineated into Management Units, based on the distribution and density of endangered and threatened mussel species. Freshwater mussels typically exhibit a patchy distribution (sometimes referred to as mussel "beds") reflecting differences in microhabitats within a stream. Specific bridge locations may, therefore, support higher or lower population densities than adjacent habitats. At past bridge project locations, mussel surveys were completed prior to project design. These surveys provided information useful for describing local variation in mussel abundance, which in turn contributed to the development of site-specific avoidance and minimization measures. These surveys typically involved two separate mobilization efforts, the first to conduct the survey, and depending upon the results, the latter to complete a salvage of federally listed mussels to minimize the effect of the action on these species. By categorizing entire stream reaches into Management Units, assumptions are made about site-specific abundance of endangered mussels *in lieu* of conducting surveys. This in turn is used to select avoidance and minimization measures *a priori*, thereby eliminating initial survey time and costs, while implementing measures to conserve endangered mussels in the locations where they are most likely to be effective.

Management Unit 1 supports the highest densities of endangered and threatened mussels. Therefore, a mussel salvage and relocation is conducted for projects in Management Unit 1. Prior to implementing this minimization measure, a Mussel Salvage and Relocation Plan is prepared and submitted to the Service and PFBC for review and approval. Protocols used during salvage will provide survey data sufficient for determining mussel density by species for the threatened and endangered species encountered. Two post-construction monitoring events (not necessarily conducted in sequential years) are proposed for each project for which mussel relocation occurs.

For all bridge project types described in the BA, take of threatened and endangered mussels will be monitored and reported for each bridge project involving instream work.

The following specific avoidance, minimization, and conservation measures (referred to Standard Operating Procedures in the BA (EnviroScience 2023)) are part of the proposed action in all management units unless otherwise specified. Individual Bridge Program projects will include these avoidance, minimization, and conservation measures in the project description. An explanation and supporting documentation will be provided if any avoidance, minimization, or conservation measures are omitted from a proposed project because they are not necessary for species conservation.

Water Quality and Pollution Prevention (all Management Units)

- Transfer fuel and maintain vehicles within a containment site with buffering (via berms, vegetation, compost filter sock, containment basin, etc.) from receiving waters. Spill response kits will be clearly labeled and staged in a conspicuous location within the designated area, as well as staged on trucks and equipment for immediate spill response.
- Place staging areas for construction vehicles and equipment on appropriate work pads located at least 150 feet away from receiving waters.
- Inspect all construction vehicles and equipment used near waterways daily to identify and control possible leakage of toxic materials, including fuels, lubricants, and other materials. If a leakage is found, contain, and remove the fluids immediately in accordance with applicable regulations, and repair the equipment prior to further use.
- Store all potential toxic substances such as fuels, paints, solvents, lubricants, and other materials within a containment area surrounded by berms, vegetation, an 18-inch compost filter sock; or contained within a basin lined with an impermeable polyethylene geomembrane; or located at least 150 feet away from receiving streams.
- Report unpermitted discharges to waterways to the PennDOT District Environmental Unit immediately upon discovery.
- Stockpile accumulated debris and construction waste away from watercourses.
- Remove loose debris and road surface material piles from the work site promptly to eliminate possible scattering by rain or wind.
- Unpermitted discharges to waterways shall be reported to the PennDOT District Environmental Unit immediately upon discovery.
- Runoff from the bridge deck will not be discharged directly to rivers or streams. It will be discharged onto level stone mats in front of the abutments, to grassed swales, or similar areas. This will reduce the likelihood of roadway contaminants and any accidental spills of hazardous materials from reaching rivers and streams.

Erosion and Sedimentation Control (all Management Units)

- All projects will use design principles to minimize erosion and sedimentation found in the Department of Environmental Protection's Erosion and Sediment Pollution Control Program Manual.
- Install key sediment control measures before construction begins.
- Install temporary silt fences around each bridge approach and around the perimeter of the disturbed area of small drainages and downslope any areas to be disturbed.
- Temporarily stabilize exposed stream banks and shorelines with indigenous vegetation live stakes, biodegradable (*i.e.,* natural, not synthetic or photodegradable) erosion control blankets, riprap, or a combination of the aforementioned, immediately after the work in the exposed area is completed.
- Permanently stabilize disturbed areas within 7 days of construction completion, using rapid seed and mulch, and where necessary supplemented with additional topsoil, erosion control matting, riprap or retaining walls.
- Use sediment control devices (i.e., super or reinforced silt fence, compost filter sock, or equivalent) where volume of water exceeds capacity of geo-fabric silt fence.
- Locate stockpiled soil materials away from the watercourse and properly contain them by appropriate silt fencing around the entire perimeter and temporarily stabilized as appropriate.
- Use silt ditches with check dams adjacent to streams to intercept runoff or flow and/or to divert flow to a controlled outlet, along the project perimeter to minimize sediment loss and along all fill slopes exceeding 3 feet in vertical height.
- Do not clear or grub until immediately before other work is to begin. Sequence soil exposure in controlled phases, with disturbance limited to areas intended to be worked within the next 21 days.
- Restrict use of tracked and wheeled equipment to the area along the shoreline and avoid all work below the Ordinary High-Water Mark.
- Minimize sedimentation impacts by strict adherence to Erosion and Sedimentation (E&S) control plans, and by regular inspection and maintenance of all E&S measures immediately after all storms. Inspection of a storm event is defined as an inspection within 24 hours of each 0.25 in. or greater storm event, or the occurrence of snowmelt sufficient to cause a discharge.
- When pumping to de-water cofferdams, drilled shafts, and other similar areas, direct the discharge water into acceptable sediment containment bags or sediment containment area to minimize siltation in streams and other aquatic resources.
- Employ stream crossing designs and construction methodology to prevent and minimize the risk of roadway and ditch runoff from entering streams. No description of what constitutes construction methodology was provided in the BA.

Invasive Species Control (all Management Units)

- Wash and inspect all construction vehicles and susceptible equipment that enters the waterway to prevent Dreissenid (zebra and quagga) mussels, plant fragments, and other potential invasive or exotic species from entering another body of water.

    - More information can be found at the following link: https://seagrant.psu.edu/zebra-and-quagga-mussels/
    - Susceptible equipment is defined as any piece of equipment or personal gear or portion of equipment or personal gear that will be in contact with the waters of the Commonwealth.
- Clean, disinfect, and inspect all equipment inspected for zebra mussel adults and veligers using an accepted protocol prior to entering a new body of water. Provide evidence of the same.
    - This process only needs to occur prior to when the equipment or personal gear is first entering the site. Equipment or personal gear that remains on-site or does not have contact with additional waters in the Commonwealth only needs to be decontaminated initially and does not need additional decontamination unless moving to a new waterbody.
- For contractors working on multiple projects, decontaminate personal gear and small equipment more regularly when traveling between sites.

Decontamination Procedures

- Scrub equipment with a stiff-bristled brush or spray with pressurized water to remove any sediment.
- Steam-clean (≥ 212°F) or spray with hot water (≥140°F) for at least ten seconds of contact time as an effective method for disinfecting heavy equipment.
    - Steam-cleaning or hot water will not be effective if soil and other organic matter are present, so be sure to scrub equipment with a stiff-bristled brush.
- Conduct decontamination in areas where equipment is unloaded and loaded.
- Before transporting a piece of heavy equipment from one project site to the next, clean off the tracks, tires, and other portions of the piece(s) of equipment by hand with hand tools or with high-pressurized water, and remove all debris and soil. Coat the piece of equipment with steam/hot water after debris and mud are removed from the piece of equipment.
- Make every effort to keep the decontamination rinse water out of surface waters**.**
- Any heavy equipment or gear that has been dried for at least 5 days is a sufficient alternative if steam cleaning or spraying with hot water is not practical.

Minimization of Effects of Future Maintenance Activities (all Management Units)

- When constructing new bridges, use materials that do not require maintenance activities like sand-blasting or painting.
- Employ containment measures, shielding, or vacuum systems where sand-blasting or painting is unavoidable.

Communication and Compliance Monitoring (all Management Units)

- Provide notification and instruction for contractors regarding the presence of endangered or threatened species and proper implementation of avoidance and minimization measures.

- Conduct daily compliance inspections consistent with PennDOT construction inspection procedures using a compliance checklist (EnviroScience 2023 – Appendix C) to assure compliance with standard inspection procedures, including erosion and sedimentation control, pollution prevention plan implementation, and other environmental issues related to bridge and roadway construction.
- Include language providing notification and required conditions related to endangered mussels in contracts.
- Notify the Service and the Pennsylvania Fish and Boat Commission regarding spills and sedimentation events that may result in injury and/or mortality of federally listed mussels
- Conduct post-construction monitoring for all projects involving instream work, to assess habitat restoration and removal of construction debris.
- PennDOT or their contractors may consider Service-approved, new causeway/cofferdam technologies that may not minimize footprint but might otherwise minimize effects on mussel habitat by reducing the duration of causeway use, reduced scour effects, or result in reduced physical pressure to the riverbed. If used, the effectiveness of new construction technologies will be monitored using a Service-approved protocol. No description of what constitutes new technologies was provided in the BA, nor Service-approved protocols, as these may not be known at this time.

Geotechnical Borings and Inspections (Management Units 1, 2, 3, and 4)

- Avoid impacts to the streambed during site access.
- Do not impose environmental impacts outside the construction footprint when performing geotechnical drilling. Conduct drilling through existing piers or use offsite borings and interpret the results.
- If there is no feasible alternative to instream disturbance, document this and use minimization measures to reduce instream impacts and substrate disturbance. Such measures include, but are not limited to, the use of barges, and minimizing the number of core borings.
- In Management Unit 1 streams, barges may only spud or anchor in areas that have been previously salvaged to avoid additional impacts to federally-listed mussels outside the permitted area, unless the total impacts can be limited to be less than $2m^2$ (total impact of all repeated spud footprints and borings for each movement and repositioning). A Service recognized qualified mussel biologist (see Service link: https://www.fws.gov/sites/default/files/documents/Freshwater%20Mussel%20Surveyors%2006152023.pdf) must observe borings in areas not salvaged. If impacts exceed $2m^2$, the Service and Pennsylvania Fish and Boat Commission will be notified immediately. PennDOT will provide the Service with an estimate of the total take of species and habitat within 30 days of fieldwork and will make compensation to the Mussel Conservation Fund (MCF) for the total impacts.
- In Management Unit 2 streams, barges may only spud or anchor in areas that have been previously salvaged or if compensation is made to the MCF to avoid additional impacts to federally listed mussels outside the action area.
- Contractors and inspection staff will be briefed on all environmental issues and commitments and will conduct daily inspections using a Compliance Checklist to ensure compliance.

Minimization of Streambed Disturbance - Causeway Design (Hydrologic and Placement) (Management Units 1, 2, 3, and 4)

- The direct and indirect impact areas will be clearly delineated in the field to ensure that only planned activities occur in each area. This delineation will occur using construction survey techniques verified by construction inspection staff to ensure design and construction impacts remain consistent with planned activities.
- The use of rock fills and causeway areas will be minimized by using temporary bridges in the causeway. A concrete barrier (*i.e*., Jersey barrier), or an equivalent (*i.e*., filled Flexible Intermediate Bulk Containers (FIBCs) – often referred to as “bulk bags,” or driven sheet pile) will be used to support the sides of the causeway and retain fill. Clean rock fill will be used for the causeway. Concrete barriers or side supports, and rock fill will be completely removed following completion of the new bridge.
- Pier placement will minimize changes in river flow patterns, reduce scour potential, and minimize instream work areas. In instances when new piers cannot be placed on or immediately adjacent to the existing piers to limit changes in flow patterns described above, a minimal number of piers will be used.
- Alternative, less impactful Service-approved causeway/cofferdam technologies may be used. These technologies may not minimize the project footprint but may minimize effects on mussel habitat by reducing the duration of causeway use, reducing scour effects, or resulting in reduced physical pressure to the riverbed. No description of what constitutes new technologies were provided in the BA, as these may not be known at this time.

Minimization of Streambed Disturbance - Bridge Demolition and Removal (Management Units 1 2, 3, and 4)

- If there is an alternative to dropping bridge components into the water, that alternative to dropping the bridge must be considered in Management Units 2 through 4, but will be mandatory in Management Unit 1.
- If there is no feasible alternative, document reasons why the bridge must be dropped into the waterway (justification). Minimize the overall stream impacts through removal of the existing bridge, using successive deconstruction methods, including removal of the asphalt wearing course, bridge deck, and non-critical trusses and members, when possible, to minimize streambed disturbance that would result from a bridge collapse. This avoidance and minimization measure is mandatory in Management Unit 1 and will be considered in Management Units 2 through 4.
- Every bridge demolition will be accomplished by non-shattering methods. Shattering means any method which would scatter debris. Explosives, shears, and hoe-rams may be used in a manner that fractures, but does not shatter and scatter, bridge components into the water. An evaluation of the use of non-shattering demolition methods will be considered in Management Units 2 through 4, but is mandatory in Management Unit 1.
- Scour holes, and holes remaining following pier removal, will be filled with natural cobble and gravel materials.

- Existing piers will be removed to below streambed level and allowed to refill with natural bed material to create potential habitat for endangered and threatened mussels unless such pier removal would increase the take of these mussels.
- Monitor the removal of all demolition debris from the waterway as well as from adjacent upland locations.

Minimizing Effects through Communication (Management Units 1, 2, 3, and 4)

- The Federal Action Agency and PennDOT will provide notification and instruction for contractors regarding the presence of endangered or threatened species and proper implementation of avoidance and minimization measures.
- The Federal Action Agency and PennDOT will include language providing notification and required conditions related to endangered mussels in all contracts.
- The Federal Action Agency, PennDOT, and their contractors will notify the Service and Pennsylvania Fish and Boat Commission regarding spills and sedimentation events that may result in take beyond that estimated in this biological opinion.

Minimizing the Effect of Placement of New Structures (Management Units 1, 2, 3, and 4)

- Work platforms, causeways, and new piers will be placed in unsuitable mussel habitat or in areas of lowest mussel densities wherever practicable.
- Instream impacts, and the use of causeways will be minimized by carrying out construction from existing structures, scaffolding, cantilevered ramps/platforms, land, and/or barges.
- Timing restrictions:
  - Wherever possible, instream work will be limited to one construction season.
  - If multiple projects are scheduled within the same season within the same sub-watershed, care will be taken so that the cumulative impacts from all projects are considered.
- Construction material, rock fill, and debris will be removed from the streambed and the streambed will be restored to pre-construction grade upon completion of these new structures.

Mussel Salvage, Relocation, and Monitoring (Mandatory in Management Unit 1, optional in Management Unit 2)

- Take of endangered mussels will be minimized by salvaging and relocating the mussels to suitable habitat and/or an appropriate holding facility; or provide a contribution to a Service-approved mussel conservation fund.
- A mussel relocation and monitoring plan will be prepared and submitted for Service and Pennsylvania Fish and Boat Commission for review and concurrence for all bridge replacement projects proposed in Management Unit 1, and is also required when relocation is the selected conservation option for a project in Management Unit 2.
- Impacts to mussel communities and federally endangered mussels within the direct and indirect effect areas associated with the bridge project will be assessed, monitored, and reported.

- Monitoring of the direct impact area (one monitoring event) will be detailed in an approved monitoring plan and conducted three to five years post-construction to assess re-colonization of mussel populations.
- Two non-successive monitoring events at each relocation site will be implemented to assess survival within the five-year period post-construction. Methods will be detailed in a Service and Pennsylvania Fish and Boat Commission-approved monitoring plan.

Take Monitoring (Management Unit 2)

- When no survey or relocation is performed, the take of threatened and endangered mussels will be monitored and reported for bridge projects based on anticipated populations in the disturbance area (*i.e.* project footprint).

Mussel surveys (Management Unit 3)

- Mussel surveys will be performed. If results indicate that threatened and endangered species population density is greater than 0.50 mussels per square meter, then avoidance, minimization, and conservation measures indicated for Management Unit 1 will be applied. If the results indicate population densities of less than 0.50 mussels per square meter, then measures described for Management Unit 2 will be applied.

Maintenance of host fish populations (Management Units 1 and 2, and in Management Units 3 and 4, when survey results indicate endangered or threatened mussels are present)

- Fish habitat features such as deep pools, riffles, and woody debris will be avoided or restored post-construction.
- Emergent vegetation beds and habitat will be avoided or restored post-construction wherever possible.

Table 7. Summary of key avoidance and minimization measures for Bridge Program activities[1]

Management Unit 1	1. A detailed contract with special provisions will be prepared for all bridge replacement projects, to include a project description, documentation of alternatives considered and selected for minimization of stream bed and stream bank disturbance, a description of all erosion and sediment control measures to avoid and minimize downstream sedimentation, and construction monitoring plan. 2. A qualified professional biologist will be on site during construction. 3. Incorporate use of daily Compliance Monitoring Checklist for projects. 4. Monitor and report the take of mussels resulting from project implementation. 5. Assess/monitor impacts to mussel communities and federally endangered mussels within direct and indirect effect areas associated with bridge replacement projects. 6. Salvage and relocate threatened and endangered mussel species from direct impact areas to suitable alternative habitat in accordance with a mussel relocation and monitoring plan prepared for bridge replacement projects proposed for Management Unit 1 or provide a contribution to a Service-approved mussel conservation fund.
Management Unit 2	1. A riparian vegetation buffer zone of 100 feet in width and extending to the project limits will be maintained on both sides of the bridge crossing in vegetated riparian settings. Clearing is limited to the minimum necessary for equipment access. 2. Where such buffers extend beyond existing right-of-way, voluntary easements will be pursued; or contribute to a Service-approved mussel conservation fund. 3. Incorporate use of daily Compliance Monitoring Checklist for projects. 4. Salvage and relocate threatened and endangered mussel species from direct impact areas to suitable alternative habitat in accordance with a Service-approved mussel relocation and monitoring plan may be conducted.
Management Unit 3	Perform mussel surveys for projects in this Management Unit. If results indicate the threatened and endangered species population density is greater than or equal to 0.5 mussels/m^2, apply avoidance, minimization and conservation measures for Management Unit 1. If results indicate population densities of less than 0.5 mussels/m^2, apply measures described for Management Unit 2. If no endangered or threatened mussels are found, apply measures consistent with Management Unit 4/5.
Management Unit 4	1. Ensure water quality protection measures are in place within a 50-foot-wide riparian buffer on both sides of the stream reach to avoid take or enhance downstream populations of threatened or endangered mussels. 2. If the water quality protection cannot be implemented, pursue other restoration activities elsewhere in the watershed to improve water quality or contribute to the Mussel Conservation Fund.
Management Unit 5	Standard best management practices and erosion and sediment control measures will be used for in-stream locations to protect water quality and to control invasive species.

[1] This is only a partial list. A complete listing of avoidance and minimization measures is included in the BA, and immediately preceding this table in the biological opinion.

STATUS OF THE SPECIES

Per 50 CFR 402.14(g)(2), the Service must "Evaluate the current status and environmental baseline of the listed species or critical habitat." The following summarizes the species' general life history, threats, demographics and population trends, and recovery strategy drawn primarily from Service assessment, listing, and recovery documents.

Northern Riffleshell

The northern riffleshell was listed as endangered, without critical habitat, in 1993. It is a small to medium-size mussel, up to three inches long. The shell exterior is brownish-yellow to yellowish-green with fine green rays. The shell interior is typically white. The species is sexually dimorphic; male shells are irregular ovate in outline, with a wide shallow sulcus just anterior to the posterior ridge. Female shells are obovate in outline, and greatly expanded post-ventrally. The expanded shell shape of the female riffleshell results from shell growth around the expanded marsupial region.

Life History

Rodgers *et al*. (2001) found that males of the related tan riffleshell release sperm into the water in August and September, fertilizing eggs in females downstream. The eggs are then fertilized in the water tubes within the marsupium, where they are held until the following summer. The fertilized eggs develop into minute bivalve larvae, or glochidia, which are unique to freshwater mussels (Parmalee and Bogan 1998). While in the marsupium, developing glochidia are exposed to the adult's circulatory fluid, but not directly to the water column (Gardiner *et al.* 1991, Richard *et al.* 1991).

Like the larval stage of most freshwater mussels, northern riffleshell glochidia are obligate parasites on fish. Watters (1996) and O'Dee and Watters (2000) conducted host suitability studies that identified four fish species on which northern riffleshell glochidia develop into juveniles: banded darter (*Etheostoma zonale*), bluebreast darter (*E. camurum*), brown trout (*Salmo trutta*), and banded sculpin (*Cottus carolinae*). McNichols *et al*. (2007) reported that Iowa darters (*Etheostoma exile*), Johnny darters (*Etheostoma nigrum*), and mottled sculpin (*Cottus bairdi*) also transformed northern riffleshell glochidia. These studies did not test all of the fish species that are native to the range of the northern riffleshell. Further, these fish species do not occur in all habitats that support northern riffleshells. Therefore, there are probably other, as yet unidentified, suitable fish host species for the northern riffleshell – most likely several species of *Etheostoma* and *Percina* (Zanatta and Murphy 2007).

Many freshwater mussel species utilize lures or exhibit behaviors to attract host fish. Gravid females of the genus *Epioblasma* move to the substrate surface and gap widely, displaying a mantel "pad". Gravid northern riffleshells expose a brilliant white mantel margin to attract host fishes from May to October, although captive northern riffleshell females synchronously emerged from the substrate in early January 2006 (G.T. Watters, Ohio State University, 2007 personal communication). Jones (2004) reported that *Epioblasma* not only attract fish with the mantel display but capture and hold those that come in contact with the mantel pads. Fish are temporarily trapped between the valves of the rapidly closing female while she expels glochidia onto the fish's gills and other tissues.

Glochidia are discharged primarily in May and June and become encysted on a suitable host fish where they transform into juvenile mussels over a period of days to weeks. The transformed young fall from the host fish and burrow into the substrate. Unlike filter-feeding adults, juveniles are relatively mobile and appear to be pedial feeders, sifting food items from sediments with hair-like structures (cilia) arranged on their foot.

The northern riffleshell is a long-term breeder (bradytictic), with fertilization in the late summer and glochidial release the following spring or summer (Ortmann 1919). Individuals within a population exhibit a range of behaviors and may release glochidia from spring through late summer.

Habitat

The common name 'riffleshell' implies that riffle habitat often associated with the genus is required. However, the habitat requirement of the northern riffleshell may not be as narrowly constrained as the name implies. Northern riffleshell often occur in clean, packed, coarse sand and gravel in riffles and runs of small and large streams (Stansbery *et al.* 1982, Watters 1990). This species is also known to occur in relatively slow-flowing, more lentic, or deep run habitats. The species also occurred in Lake Erie, where wave action likely provided needed water flow. Northern riffleshells have been found in the Allegheny River in run-of-the-river navigation pools that are impounded to facilitate navigation and may only experience significant water flow during high river discharge periods. It is not clear if specimens living in more typical riffle/run areas can adapt to slower water should conditions change. Use of low-flow areas may also be limited in more turbid waters, where concomitant silt deposition may limit survival or successful reproduction.

Northern riffleshells bury themselves to the posterior margin of the shell, although females may be more exposed, especially during the breeding season (Service 1994). Rodgers *et al.* (2001) reported that tan riffleshell populations in Virginia are not visible on the substrate surface from November through January. Northern riffleshells also appear to undergo a seasonal vertical migration in the fall (Anderson 2000).

Population Dynamics

Riffleshells appear to have a relatively short life-span for a freshwater mussel. Sexual maturity can be reached in as little as three years, and most individuals probably live for only 7 to 15 years (Rodgers *et al.* 2001, Crabtree and Smith 2009). Like other mussels, the northern riffleshell probably experiences very low annual juvenile survival. The combination of short life span and low fecundity indicates that populations depend on a large annual cohort produced by a large population (Musick 1999). Species following this reproductive strategy are susceptible to loss of individuals from predation and stochastic events and are slow to recover from such losses (Rodgers *et al.* 2001). However, these species may be well suited to exploit dynamic micro-habitat shifts characteristic of free-flowing rivers.

With the exception of displaying females, northern riffleshell are cryptic, with an estimated 48 percent of a population occurring below the substrate surface (Smith *et al*. 2001); therefore, qualitative population estimates must take into account undetected individuals. In addition, where northern riffleshell are found at low population densities, population estimates may have large margins of error due to undetected mussels. Sparsely distributed juveniles, indicative of successful reproduction, are likely even more difficult to detect.

Successful recruitment of northern riffleshell populations is often difficult to detect when densities are very low or surveys are single-day, catch-per-unit efforts. Few intensive, statistically valid surveys have been conducted on populations of this species outside of French Creek and the Allegheny River, and populations with densities near or below the detection rate may not be practically assessed with quantitative techniques. The difficulty in detecting northern riffleshells results in poorly defined information about the species' distribution and abundance, even within the streams where the species is known to occur.

Distribution and Status

The northern riffleshell is sparsely distributed within a highly restricted range, although population numbers can be high in localized areas. Of 54 streams once known to be occupied by this species, only four show evidence of reproduction – three apparently large and recruiting populations occur in Allegheny River, French Creek, and East Branch Sydenham River. A fourth, smaller population in Ausable River has also recently (2006) been shown to be recruiting. Each of these populations is susceptible to both natural stochastic events, such as floods, and anthropogenic threats, such as toxic spills. Although northern riffleshells have been documented in one additional Allegheny River tributary (besides French Creek), and two French Creek tributaries, the species occurs in the lower reaches of these streams, and these occurrences may not be self-sustaining if the mainstem population is damaged.

In contrast to the above populations, five northern riffleshell populations have declined since the species was listed as endangered in 1994, and some of these may be extirpated. Extirpated or nearly extirpated populations include the following: the Detroit River, following zebra mussel infestation; the Green River, possibly due to point and non-point inputs, and hydrologic controls on flow and temperature from the Green River Reservoir; Big Darby Creek, as a result of urban and agricultural runoff; Fish Creek, following a 1993 diesel fuel spill; and the Tippecanoe River, where no living or fresh-dead northern riffleshell have been observed since the 1970s. A few individual specimens have been reported from the Elk River in West Virginia; however, no evidence of recent successful reproduction has been reported from this stream. Although specific events are cited as causing the apparent loss of several northern riffleshell populations, these events likely worked in concert with other events that cumulatively reduced overall population levels to the extent that a single event could result in extirpation.

In many cases, diverse freshwater mussel populations persist where northern riffleshells have not. Like other *Epioblasma,* this species may be more sensitive to environmental perturbations than other mussel species. This may be because life history traits make recovery from a disturbance less likely than with other mussels, or because this species is more sensitive to silt and contaminants.

The large populations of northern riffleshell in Pennsylvania provide a potential source of animals to implement recovery actions described in the species' recovery plan. However, translocation and population augmentation will only work to the extent that historic habitat is now suitable to support both the species and its fish host(s). Because the reasons for the original decline of northern riffleshell have often not been identified, transferred animals may also not survive.

Threats

Ongoing threats to the northern riffleshell include water quality degradation from point and non-point sources, particularly in tributaries that have limited capability to dilute and assimilate sewage, agricultural runoff, and other pollutants. In addition, the species is affected by hydrologic and water quality alterations resulting from the operation of impoundments such as Union City Reservoir on French Creek and Kinzua Dam on the Allegheny River. The presence of impoundments may have ameliorated the effects of downstream siltation on northern riffleshell, but these structures also control river discharges (and the many environmental parameters influenced by discharge), which may profoundly affect the ability of these populations to occupy or successfully reproduce in downstream habitats.

A variety of instream activities continue to threaten northern riffleshell populations, including sand and gravel dredging, gravel bar removal, bridge construction, and pipeline construction. Protecting these populations from the direct physical disturbance of such activities depends on accurately identifying the location of the populations, which is difficult with a cryptic species such as the northern riffleshell. The indirect effects of altering the streambed configuration following instream disturbance can result in long-lasting alteration of streamflow patterns that may cause head-cutting and channel reconfiguration, thereby eliminating previously suitable habitat some distance from the disturbance.

Coal, oil, and natural gas resources are present in some of the watersheds known to support northern riffleshell, including the Allegheny and Elk Rivers. Exploration and extraction of these resources can result in increased siltation, a changed hydrograph, and degraded water quality, even at a distance from the mine or well field. Northern riffleshell habitat in larger streams can be further threatened by the cumulative effects of multiple mines and well fields, along with their associated unimproved road systems.

Land-based development near streams of occurrence, including residential development and agriculture, often results in loss of riparian habitat, increased stormwater runoff due to increased impervious surfaces, increased sedimentation due to loss of streamside vegetation, and subsequent degradation of streambanks. *Epioblasma*, including northern riffleshell, appear to be exceptionally sensitive to the increased siltation and associated turbidity caused by changing land use (Peacock *et al*. 2005).

Development has also increased the number of sewage treatment plants in drainages that support northern riffleshell and increased the amount of sewage discharged from existing plants. Increasing evidence indicates that freshwater mussels are more sensitive to several components of treated sewage effluent (*e.g.,* ammonia, chlorine and copper) than are the typical organisms used to establish water quality criteria protective of aquatic life (*e.g.*, Newton, 2003). Small streams, such as LeBeouf Creek, are particularly vulnerable to sewage effluent which can comprise a significant portion of the total stream flow. In addition, the construction and operation of oil and gas wells has resulted in the discharge of brine into rivers occupied by the northern riffleshell. These brine discharges create large instream mixing zones that are acutely or chronically toxic to freshwater mussels. Point source discharges are typically regulated; however, some inputs may not be sufficiently regulated, particularly those originating some distance from a waterway supporting northern riffleshell. Since 2005, more than 18,400 oil and gas wells have been drilled in Pennsylvania within the range of the northern riffleshell (Pennsylvania Department of Environmental Protection, Bureau of Oil and Gas Management; accessed at http://www.dep.state.pa.us on October 13, 2015).

The zebra mussel (*Dreissena polymorpha*) is a highly invasive bivalve native to Europe and western Asia, but accidentally introduced to Lake Erie around 1985 via release of trans-Atlantic ship ballast water. Zebra mussels have spread throughout much of the eastern United States where they sometimes quickly reach enormous population densities. Such populations compete for food, oxygen, and space with native mussels, including the northern riffleshell, causing mortality and population declines. Zebra mussels are established in the French Creek watershed; however, population densities have remained low in most locations, and no negative effects on the northern riffleshell population have been documented thus far.

Clubshell

The clubshell was listed as endangered, without critical habitat, in 1993. The clubshell is a small to medium-size mussel, up to three inches long. The shell exterior is yellow to brown with bright green blotchy rays. The shell interior is typically white. The shell is wedge-shaped and solid, with a pointed and fairly high umbo. This species does not have sexually dimorphic shells.

Life History

Males of the genus *Pleurobema* release sperm into the water in April, May, and June, and downstream females uptake the sperm with incoming water (Weaver *et al.* 1991). *Pleurobema* are short-term brooding species that release glochidia shortly after fertilization, generally from June to August. Clubshell glochidia are obligate parasites on fish gills, a possible upstream dispersal adaptation for a relatively immobile organism living in flowing water that would otherwise be flushed from the river system over time. Not all fish species are suitable hosts. The striped shiner (*Notropis chrysocephalus*), central stoneroller (*Campostoma anomalum*), blackside darter (*Percina maculata*), and logperch (*Percina caprodes*) have been capable of serving as hosts for the clubshell under laboratory conditions (Watters and O'Dee 1997, O'Dee and Watters 2000). It is likely that additional untested fish species can be used by clubshell glochidia in the wild.

Habitat

The clubshell has been found in a variety of stream and river conditions, but it is most often observed in clean, stable, coarse sand and gravel runs, often just downstream of riffle areas, in medium to small rivers and streams (Stansbery *et al.* 1982). It typically burrows completely beneath the substrate to a depth of two to four inches, relying on water to percolate between the sediment particles (Watters 1990). More than 70 percent of a population may be hidden below the substrate surface (Smith *et al.* 2001). As a fluvial organism, the clubshell can tolerate a range of water velocities, and although often considered to be intolerant of permanently slack water conditions (Service 1994), it has been found living and reproducing in Navigation Pools 7, 8, and 9 in the Allegheny River at depths of 10 to 15 feet.

Population Dynamics

The clubshell likely reaches sexual maturity between three and five years (Weaver 1991) and has a life span of 20 years or more. The clubshell is long-lived, and annually has low juvenile survival rates. This species, like many mussels, is susceptible to permanent, temporary, and intermittent forms of environmental degradation. Reduced populations may take several decades to recover, even if no further degradation occurs.

Distribution and Status

Historically, this species was abundant and appears to have been a highly successful species occupying a range of riverine habitats throughout the Ohio River basin and tributaries of western Lake Erie (Stansbery *et al.* 1982). It has been documented in over 100 streams throughout its range, although it now appears to be limited to 13 populations distributed in 21 streams.

Few extant clubshell populations occupy habitats that are protected from the threats affecting this species. For unknown reasons, many of the remaining clubshell populations do not appear to be reproducing in locations were many other species of freshwater mussels show evidence of recent recruitment. Riverine habitat adjacent to extant populations is not easily protected, other than by state shoreline protection regulations or local land use regulations. Development of adjacent uplands continues to be a significant and pervasive threat to remaining populations.

The larger but geographically-limited clubshell populations found in the Allegheny River do not compensate for the declining populations and lost habitat elsewhere in the clubshells' range. Without significant recovery activities targeted at understanding those life history traits of the clubshell that make it susceptible to land use changes, as well as a concerted effort to address ongoing threats, there is a real possibility of further range contraction. There is increased interest and understanding of methods to augment and reintroduce clubshell populations; however, while promising, these efforts may be limited by an incomplete understanding of the factors that appear to be limiting natural population recovery in most of the extant populations.

Threats

Few mussel species have declined as drastically in numbers as the clubshell. There is probably no single causative factor, but the decline is attributed to physical loss of habitat and degraded water quality resulting from impoundment, altered hydrologic regimes, point and non-point source pollution, agricultural effects, streambank clearing, coal mining, and urbanization (Service 1994). The clubshells' apparent preference for smaller particle-size substrates that are relatively free of fine particulates (which would block interstitial flow) may also be a factor. Pockets of stable sand and small gravel substrates naturally occur in many streams; however, these areas may be more susceptible to deposition when sediment input is increased. Further, this substrate type may be more susceptible to scour resulting from more rapid precipitation runoff after land-clearing. Most of the remaining populations occur downstream of glacial lakes and reservoirs that reduce silt loads to the receiving stream, and buffer hydrologic changes resulting from land-clearing.

Ongoing threats to the clubshell include water quality degradation from point and non-point sources, particularly in small tributaries that have limited capability to dilute and assimilate sewage, agricultural runoff, and other pollutants. In addition, the species is affected by hydrologic and water quality alterations resulting from the operation of impoundments such as Union City Reservoir on French Creek, Green River Reservoir on the Green River, Pymatuning Reservoir on the Shenango River, Kinzua Dam on the Allegheny River, and Sutton Dam on the Elk River. The presence of impoundments may have ameliorated the effects of downstream siltation, but these structures also control river discharges (and the many environmental parameters influenced by discharge), which may profoundly affect the ability of these populations to occupy or successfully reproduce in downstream habitats.

A variety of in-stream activities continue to threaten clubshell populations, including sand and gravel dredging, gravel bar removal, bridge construction, and pipeline construction. Protecting clubshell populations from the direct physical disturbance of these activities depends on accurately identifying the location of the populations, which is difficult with a cryptic species such as the clubshell. The indirect effects of altering the streambed configuration following in-stream disturbance can result in long-lasting alteration of streamflow patterns that may result in head-cutting and channel reconfiguration, thereby eliminating previously suitable habitat some distance from the disturbance.

Coal, oil, and natural gas resources are present in a number of the watersheds that are known to support clubshell, including the Allegheny River, Hackers Creek, Meathouse Fork, and the Elk River. Exploration and extraction of these energy resources can result in increased siltation, a changed hydrograph, and degraded water quality even at a distance from the mine or well field. Clubshell populations in smaller streams are more vulnerable to these resource extraction activities, which can account for a much larger percentage of a small watershed. However, clubshell habitat in larger streams can also be threatened by the cumulative effects of a large number of mines and well fields.

Land-based development near streams of occurrence, including residential development and agriculture, often results in loss of riparian habitat, increased storm water runoff due to increased impervious surfaces, increased sedimentation due to loss of streamside vegetation, and subsequent degradation of streambanks. Because clubshells often live below the gravel surface, this species may be exceptionally sensitive to the increased siltation generated by these activities. The Little Darby Creek population on the western side of the City of Columbus (Ohio) is an example of a population threatened by development, while Hackers Creek, Pymatuning Creek, and Meathouse Fork appear to be strongly influenced by agriculture.

Development has also resulted in an increased number of sewage treatment plants in drainages that support clubshell as well as an increase in the amount of sewage discharged from existing plants. Mounting evidence indicates that freshwater mussels are more sensitive to several components of treated sewage effluent (*e.g.,* ammonia, chlorine and copper) than are the typical organisms used to establish criteria protective of aquatic life. Small streams, such as Conneaut

Outlet, are particularly vulnerable to sewage effluent, which can comprise a significant portion of the total stream flow. Like the northern riffleshell, construction and operation of oil and gas wells has resulted in the discharge of brine into rivers occupied by the clubshell. These brine discharges create large instream mixing zones that are acutely or chronically toxic to freshwater mussels. Point source discharges are typically regulated; however, some inputs may not be sufficiently regulated, particularly those originating some distance from a waterway supporting clubshell. Since 2005, more than 18,400 oil and gas wells have been drilled in Pennsylvania within the range of the clubshell (Pennsylvania Department of Environmental Protection, Bureau of Oil and Gas Management; accessed at http://www.dep.state.pa.us on October 13, 2015).

This species is also susceptible to exotic species invasions as described above for the northern riffleshell and like many mussels, is vulnerable to permanent, temporary, and intermittent forms of environmental degradation. Reduced populations may take several decades to recover, even if no further degradation occurs.

Rayed bean

The rayed bean was listed as endangered, without critical habitat, on March 15, 2012. The rayed bean is a small mussel, usually less than 1.5 inches (in) (3.8centimeters (cm)) in length (Cummings and Mayer 1992, Parmalee and Bogan 1998, West *et al*. 2000). The shell outline is elongate or ovate in males and elliptical in females, and moderately inflated in both sexes, but more so in females (Parmalee and Bogan 1998). The valves are thick and solid. Females are generally smaller than males (Parmalee and Bogan 1998). The shell is green, yellowish-green, or brown in color, with numerous, wavy, dark-green rays of various widths (Cummings and Mayer 1992, West *et al*. 2000). Key characters useful for distinguishing the rayed bean from other mussels are its small size, thick valves, unusually heavy teeth for a small mussel, and color pattern (Cummings and Mayer 1992).

Life History

The general biology of the rayed bean is poorly known but likely similar to other freshwater mussels belonging to the family Unionidae. Adults are suspension-feeders on algae, bacteria, detritus, microscopic animals, and dissolved organic material (Silverman *et al*. 1997, Nichols and Garling 2000, Christian *et al*. 2004, Strayer *et al*. 2004). These animals spending their entire lives partially or completely buried within the substrate (Murray and Leonard 1962).

Their life cycle includes a brief, obligatory parasitic stage on fish. Eggs develop into microscopic larvae called glochidia within special gill chambers of the female from May through October (Parmalee and Bogan 1998, Woolnough 2002). The female presents a mantel lure to attach fish host necessary for larva to complete development. The only published research identifies the Tippecanoe darter (*Etheostoma tippecanoe*) as a host fish for the rayed bean (White *et al*. 1996). Other rayed bean hosts are thought to include the greenside darter (*E. blennioides*), rainbow darter (*E. caeruleum*), mottled sculpin (*Cottus bairdi*), and largemouth bass (*Micropterus salmoides*) (Woolnough 2002).

Rayed bean is long-lived for such a small animal, growing rapidly until about the third year and living for 11 years or more (Watters *et al*. 2009). Females show evidence of reproduction through changes in the shape of the shell as early as their second year.

Habitat

The rayed bean is generally known from smaller, headwater creeks, but occurrence records exist from larger rivers (Cummings and Mayer 1992, Parmalee and Bogan 1998). They are often found in or near shoal or riffle areas but are also known from more lentic habitats that maintain adequate flow, or have shallow, wave-washed areas of glacial lakes, including Lake Erie (West *et al*. 2000). In Lake Erie, the species is generally associated with islands in the western portion of the lake. Preferred substrates typically include gravel and sand. The rayed bean has been reported to occur among vegetation (water willow (*Justicia americana*) and water milfoil (*Myriophyllum sp.*)) in and adjacent to riffles and shoals (Watters 1988, West *et al*. 2000). Specimens may be buried among the roots of the vegetation (Parmalee and Bogan 1998). Adults and juveniles appear to produce byssal threads (thin, protein-based fibers) (Woolnough 2002), apparently to attach themselves to substrate particles.

Distribution and Status

Based on historical and current data, the rayed bean has declined significantly range-wide and is now known from only 28 streams and 1 lake (down from 110), a 75 percent decline. This species has also been eliminated from long reaches of former habitat in hundreds of miles of the Maumee, Ohio, Wabash, and Tennessee Rivers and from numerous stream reaches and their tributaries.

The decline of the rayed bean (described by Butler 2002, 2007) is primarily the result of habitat loss and degradation (Neves 1991). Chief among the causes of decline are impoundments, channelization, chemical contaminants, mining, and sedimentation (Neves 1991, Neves 1993, Williams *et al*. 1993, Neves *et al*. 1997, Watters 2000). These stressors have had profound impacts on rayed bean populations and their habitat. The substantial reduction in the range of the rayed bean suggests that this species is more sensitive to environmental perturbation then are many other freshwater mussels that remain extant in now historic rayed bean habitat.

Threats

See "Threats" under Snuffbox

<u>Snuffbox</u>

The snuffbox was listed as endangered, without critical habitat, on March 15, 2012. The snuffbox is a small- to medium sized mussel, with males reaching up to 2.8 in (7.0 cm) in length (Cummings and Mayer 1992, Parmalee and Bogan 1998). The maximum length of females is about 1.8 in (4.5 cm) (Parmalee and Bogan 1998). Snuffbox have solid, thick, and very inflated shells. The species is sexually dimorphic, with females' shells being somewhat triangular and having downward-curved, tooth-like structures (denticles) on the posterior shell margin that aid in holding host fish (Barnhart *et al*. 2008). The shell of both sexes is generally smooth and yellowish or yellowish-green, becoming darker with age and with green, squarish, triangular, or chevron shaped marks. Key characters useful for distinguishing the snuffbox from other species include its unique color pattern, shape (especially in females), and high degree of inflation.

Life History

Snuffbox share a similar life history to the related northern riffleshell previously described in this programmatic biological opinion. Gravid females of the genus *Epioblasma* move to the substrate surface and gap widely, displaying a mantel "pad". Female snuffbox brood glochidia from September to May (Ortmann 1912, 1919). Snuffbox actively capture and hold host fish using the denticles on the posterior shell margin (Barnhart 2005, Barnhart *et al*. 2008). Juvenile snuffbox have successfully transformed on logperch (*Percina caprodes*), blackside darter (*P. maculata*), rainbow darter, Iowa darter (*E. exile*), blackspotted topminnow (*Fundulus olivaceous*), mottled sculpin, banded sculpin (*C. carolinae*), Ozark sculpin (*C. hypselurus*), largemouth bass, and brook stickleback (*Culaea inconstans*) in laboratory tests (Sherman 1994, Yeager and Saylor 1995, Hillegass and Hove 1997, Hove *et al*. 2000, Barnhart 2005,).

Snuffbox grow rapidly until about the third year, when growth slows (shell sexual dimorphism can be expressed on female shells in the second year). Snuffbox, like northern riffleshell are relatively short-lived compared to many other freshwater mussels, and individuals older than 15 years are rare (Watters *et al*. 2009).

Habitat

The snuffbox is found in small to medium-sized creeks to larger rivers and in lakes (Cummings and Mayer 1992, Parmalee and Bogan 1998). The species occurs in swift currents of riffles and shoals, and wave-washed shores of lakes over gravel and sand with occasional cobble and boulders. Individuals generally burrow deep into the substrate except when spawning or attempting to attract a host (Parmalee and Bogan 1998).

Distribution and Status

The snuffbox has declined range-wide and appears to be extant in 74 of 208 streams and lakes of historical occurrence, a 65 percent decline in the number of occupied streams. Realistically, much more than 65 percent of the habitat historically available for this species no longer supports its populations. Habitat losses measured in the thousands of miles have occurred range-wide. Since multiple streams may comprise single snuffbox population segments (for example, the French Creek system), the actual number of extant populations is somewhat less. Extant populations, with few exceptions, are highly fragmented and restricted to short reaches. The elimination of this species from scores of streams and thousands of miles of stream reaches indicates catastrophic population losses and a precipitous decline in overall abundance. It is reasonable to estimate that total range reduction and overall population losses for the snuffbox each approximate, if not exceed, 90 percent.

Threats (to rayed bean and snuffbox)

The decline of the rayed bean and snuffbox (described by Butler 2002, 2007) is primarily the result of habitat loss and degradation (Neves 1991). These losses have been well documented since the mid-19th century (Higgins 1858). Chief among the causes of decline are impoundments, channelization, chemical contaminants, mining, and sedimentation (Neves 1991, 1993; Williams *et al*. 1993; Neves *et al.* 1997; Watters 2000). These stressors have had profound impacts on rayed bean and snuffbox populations and their habitat.

Current Federal and State laws do not adequately protect rayed bean and snuffbox from non-point source pollution. The lack of information on the sensitivity of the rayed bean and snuffbox to point source discharges of common industrial and municipal pollutants prevents existing regulations, such as the Clean Water Act, from being fully used or effective. Despite the existing regulatory mechanisms, the rayed bean and snuffbox continue to decline due to the effects of habitat destruction, poor water quality, contaminants, and other factors.

The majority of the remaining populations of the rayed bean and snuffbox are generally small and geographically isolated (Butler 2002; 2007). The patchy distributional pattern of populations in short river reaches makes those populations much more susceptible to extirpation from single catastrophic events, such as toxic chemical spills. Furthermore, this level of isolation makes natural repopulation of any extirpated population virtually impossible without human intervention. Various nonnative species of aquatic organisms are firmly established in the range of the rayed bean and snuffbox; however, the exotic species that poses the most significant threat to the rayed bean and snuffbox is the zebra mussel (*Dreissena polymorpha*) (Butler 2002; 2007).

<u>Sheepnose</u>

The sheepnose was listed as endangered, without critical habitat, on April 12, 2012. Oesch (1984) and Parmalee and Bogan (1998) describe the sheepnose as a medium-sized mussel that reaches nearly 5 inches (13 cm) in length. The shell is elongate ovate in shape, moderately inflated, and with thick, solid valves. The shell is generally smooth, shiny, rayless, and light yellow to a dull yellowish brown with concentric, darker ridges resulting from growth arrests. There is a row of large, broad, tubercular swellings on the center of the shell extending from the beak to the ventral margin. Key characters useful for distinguishing the sheepnose from other mussels are its color, the occurrence of central tubercles, and its general shape.

Life History

Sheepnose is a short-term (tachytictic) brooder, spawning and releasing young within a few weeks during the summer (Watters *et al*. 2009). Female sheepnose release glochidia in conglutinates that contain several hundred glochidia. The conglutinates are narrow and lanceolate in outline, solid and red in color (Oesch 1984). Ortmann (1911) observed discharge of sheepnose conglutinates in late July. He described them as being pink and “lying behind the posterior end of the shell, which were greedily devoured by a number of minnows.” Judging from the size of the glochidia, total fecundity (including glochidia and ova) per female sheepnose is probably in the tens of thousands.

Little is known regarding host fish of the sheepnose. Laboratory studies have successfully transformed sheepnose glochidia on numerous cyprinid fish species including *Pimephales* minnows, various *Notropis, Nocomis, Luxilus,* and *Cyprinella* shiners, creek chub (*Semotilus atromaculatus*), golden shiner (*Notemigonis crysoleucas*) and central stoneroller (*Campostoma* *anomalum*) along with a topminnow (*Fundulus diaphanous*) and mosquitofish (Guenther *et al*. 2009, Wolf *et al*. 2012). However, sheepnose does not share the same habitat preferences with all of the fish species that appear to serve as acceptable hosts in laboratory settings, some of which are more typical of smaller stream habitats. Surber (1913) identified sheepnose glochidia attached to sauger (*Sander canadensis*), thereby documenting natural infestation of a fish that co-occurs with sheepnose.

Sheepnose are slow growing and long-lived species that may exceed 30 years of age (Watters *et al*. 2009)

Habitat

The sheepnose is primarily a larger-stream species occurring primarily in shallow shoal habitats with moderate to swift currents over coarse sand and gravel (Oesch 1984). Habitats with sheepnose may also have mud, cobble, and boulders. Sheepnose occur in larger rivers in shallow water with fast current, as well as in deeper water navigation pools (Parmalee and Bogan 1998).

Distribution and Status

Extant populations of the sheepnose are known from 26 rivers in 14 states. The sheepnose has been eliminated from two-thirds of the total number of streams from which it was historically known (26 streams currently occupied compared to 77 streams historically). This species has also been eliminated from long reaches of former habitat, including hundreds of miles of rivers in the Illinois and Cumberland River watersheds, and from several reaches of the Mississippi and Tennessee Rivers.

Threats

The decline of the sheepnose in the eastern United States (described by Butler 2002) is primarily the result of habitat loss and degradation (Neves 1991). These losses have been well documented since the mid-19th century (Higgins 1858). Chief among the causes of decline are impoundments, channelization, chemical contaminants, mining, and sedimentation (Neves 1991; Neves 1993; Neves *et al.* 1997; Watters 2000; Williams *et al.* 1993). These stressors have had profound impacts on sheepnose populations and their habitat. Although there are ongoing attempts to alleviate some of these threats at some locations, there appear to be no populations without significant threats, and many threats are without obvious or readily available solutions.

The majority of the remaining populations of the sheepnose are generally small and geographically isolated (Butler 2002). Recruitment reduction or failure is a threat for many small sheepnose populations range-wide, a condition exacerbated by reduced range and increasingly isolated populations (Butler 2002). If these trends continue, further significant declines in total sheepnose population size and consequent reduction in long-term viability may soon become apparent.

The patchy distributional pattern of populations in short river reaches also makes them much more susceptible to extirpation from single catastrophic events, such as toxic chemical spills. Furthermore, this level of isolation makes natural repopulation of any extirpated population virtually impossible without human intervention. In addition, captive husbandry of sheepnose is poorly known. Consequently, it is not currently feasible to carry out propagation to reestablish the species in restored habitats or to maintain nonreproducing populations. Because host fish requirements are also poorly understood, focused conservation of its fish host(s) may not yet be feasible.

Various exotic species of aquatic organisms are firmly established in the range of the sheepnose. The exotic species that poses the most significant threat to the sheepnose is the zebra mussel. The invasion of the zebra mussel poses a serious threat to mussel faunas in many regions, and species extinctions are expected as a result of its continued spread in the eastern United States (Ricciardi *et al*. 1998).

Rabbitsfoot

The rabbitsfoot was listed as a threatened species on September 17, 2013, and critical habitat was designated for it on April 30, 2015. The rabbitsfoot is a medium to large mussel, elongate and rectangular, reaching 12 cm (6 inches) in length (Oesch 1984). The external shell surface is generally smooth and yellowish, greenish, or olive in color becoming darker and yellowish-brown with age and usually covered with dark green or nearly black chevrons and triangles pointed ventrally, although these patterns are absent in some individuals. The shell interior is typically white. The species is not sexually dimorphic.

Life History

Rabbitsfoot is primarily an inhabitant of small to medium sized streams and some larger rivers. It usually occurs in shallow water areas along the bank and adjacent runs and shoals with reduced water velocity. Specimens also may occupy deep water runs, having been reported in 2.7 to 3.7 m (9 to 12 feet) of water. Bottom substrates generally include gravel and sand (Parmalee and Bogan 1998). This species seldom burrows but lies on its side (Watters 1988, Fobian 2007).

Suitable fish hosts for rabbitsfoot populations west of the Mississippi River include blacktail shiner (*Cyprinella venusta*) from the Black and Little Rivers and cardinal shiner (*Luxilus cardinalis*), red shiner (*C. lutrensis*), spotfin shiner (*C. spiloptera*), and bluntface shiner (*C. camura*) from the Spring River.Host suitability information is lacking for the eastern range (Fobian 2007). In addition, rosyface shiner (*Notropis rubellus*), striped shiner (*L. chrysocephalus*), and emerald shiner (*N. atherinoides*) served as hosts for rabbitsfoot, but not in all stream populations tested (Fobian 2007).

Rabbitsfoot exhibit seasonal movement towards shallower water during brooding periods, a strategy to increase host fish exposure but one that also leaves them more vulnerable to predation and fluctuating water levels, especially downstream of dams (Fobian 2007). It is a short–term brooder, with females brooding between May and late August (Fobian 2007). Similar to other species of *Quadrula*, the rabbitsfoot uses all four gills as a marsupium (pouch) for its glochidia (Fobian 2007). Female rabbitsfoot release glochidia as conglutinates (matrices holding numerous glochidia together and embryos and undeveloped ova), which mimic flatworms or similar fish prey.

Population Dynamics

Rabbitsfoot populations west of the Mississippi River reach sexual maturity between the ages of 4 to 6 years (Fobian 2007). Fecundity (capacity of abundant production) in river basins west of the Mississippi River ranged from 46,000 to 169,000 larvae per female (Fobian 2007), but like other mussels, rabbitsfoot experiences very low annual juvenile survival.

Distribution and Status

Rabbitsfoot historically occurred in 140 streams within the lower Great Lakes Subbasin and Mississippi River Basin. The historical range included Alabama, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Ohio, Oklahoma, Pennsylvania, Tennessee, and West Virginia. Rabbitsfoot populations are considered to be extant in 51 streams in 13 states (Butler 2005), representing a 64 percent decline (51 extant streams out of 140 historical streams). In streams where it remains extant, populations are highly fragmented and restricted to short reaches. Based on existing habitat use (need for flowing vs. impounded habitats) and fish host (small minnow species with limited individual ranges) data, it is unlikely that recruitment between populations or establishment of new populations could occur naturally.

In Pennsylvania, rabbitsfoot are extant in the Shenango River (Beaver River drainage), Allegheny River, French Creek, and three French Creek tributaries – LeBoeuf, Conneautee, and Muddy Creek. The Allegheny River and French Creek likely represent a metapopulation because no barriers exist between the streams, but the Alleghany population is evidently small and scattered (Butler 2005). In the Shenango River, rabbitsfoot are isolated between Pymatuning Reservoir Dam and headwaters of Shenango River Lake.

Threats

Like other mussel species considered in this opinion, threats to rabbitsfoot include loss and degradation of stream and river habitat due to impoundments, channelization, chemical contaminants, mining, and sedimentation. Rabbitsfoot require clean water; their decline often signals a decline in the water quality of the streams and rivers they inhabit.

<u>Longsolid</u>

On September 29, 2020, the Service proposed the longsolid as threatened with proposed critical habitat in several states, including Pennsylvania. This species was not considered in the May 13, 2016, PBO, but the species status and life history are available in the species status assessment (USFWS 2018. Accessed December 1, 2022, at www.ecos.fws.gov). Per the final listing rule (88 FR 14794), longsolid was listed as threatened on April 10, 2023.

Life History

The longsolid is a medium-sized, thick-shelled, mussel that is up to 5 inches (127 millimeters (mm)) in size. It can be long-lived - potentially up to 50 years. It is found in small streams to large rivers (such as the Ohio River mainstem), and prefers a mixture of sand, gravel, and cobble substrates. This species has been associated with slower, deeper microhabitats, and has a tolerance for pool and run habitat (USFWS 2018). Adult freshwater mussels, including longsolid, are suspension-feeders that filter water and nutrients to eat. Mussels may shift to deposit feeding, though reasons for this are poorly known and may depend on flow conditions or temperature. Longsolid, like other freshwater mussels is sensitive to altered water quality, siltation, and altered hydrologic regimes.

Females brood glochidia (larvae) in their gills, and once released, glochidia must attach to the gills or fins of a suitable host, typically a fish, to complete the transformation from the larval stage to a juvenile mussel. The Longsolid is a short-term brooder and is typically gravid from May to July (USFWS, 2018). Host fish species for Longsolid are unknown, but based on other species of Fusconaia, likely hosts are minnows of the family Cyprinidae and genera *Campostoma, Cyprinella, Notropis,* and *Luxilus*, as well as potentially sculpins of the family Cottidae, genus *Cottus* (USFWS, 2018).

Population Dynamics

Similar to other native North American mussels, males release sperm into the water, which is taken in by females. The longsolid is a short-term brooder, typically gravid from May-July. The longsolid has the potential to produce large numbers of young annually. However, survival of young is typically very low due to predation, the need for glochidia to attach to specific host fish, stochastic events such as flooding and droughts, and sensitivity to contaminants and excessive siltation. The low annual recruitment is balanced by a comparatively long reproductive life of the adult female. Host fish species are unknown, but based on other species in the genus *Fusconaia*, likely hosts are minnows of the family Cyprinidae as well as sculpins of the genus *Cottus*. The longsolid is historically known from 12 states, though now only occurs in 9 states. Known populations have declined in number from 162 historically to 60 today (USFWS 2018).

Distribution and Status

Historically, the longsolid was known from 162 populations in the Great Lakes, Ohio, Cumberland, and Tennessee River Basins, in Alabama, Georgia, Illinois, Indiana, Kentucky, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia (USFWS 2018). Many populations have been extirpated, reducing its occurrence to 60 populations in Alabama, Kentucky, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. In Pennsylvania, the longsolid is known to occur in the Allegheny River Basin, including Allegheny, Armstrong, Beaver, Butler, Clarion, Crawford, Erie, Forest, Lawrence, McKean, Mercer, Potter, Venango, Warren, and Westmoreland Counties.

Three areas have been identified as longsolid critical habitat in Pennsylvania, including:

1) Unit LS 1 – Consist of 120 stream miles (191.5 km) of French Creek in Crawford, Erie, Mercer, and Venango Counties, Pennsylvania. This unit begins immediately downstream of the Union City Dam, which is operated by the U.S. Army Corps of Engineers.
2) Unit LS 2 – Consists of 99 river mi (159.3 km) of the Allegheny River in Clarion, Crawford, Forest, Venango, and Warren Counties, Pennsylvania. This unit is immediately downstream of Kinzua Dam, which is operated by the U.S. Army Corps of Engineers.

3) Unit LS 3 – Consists of 22 river miles (mi) (35.5 kilometers (km)) of the Shenango River in Crawford and Mercer Counties, Pennsylvania. This unit is immediately downstream from the Pymatuning Dam, which is owned by the State of Pennsylvania.

Threats

Threats identified include the degradation of habitat and water quality from impoundments, siltation, and pollution due to resource extraction, agriculture, timbering practices, utility crossings, right-of-way maintenance, and human development (urbanization); flow reduction and water quality degradation due to water withdrawals and wastewater treatment plants; increased water temperature and drought; artificial barriers (dams); disease; and the presence of invasive, nonnative species. The following physical or biological features are essential to the conservation of the longsolid:

1. Adequate flows, or a hydrologic flow regime (magnitude, timing, frequency, duration, rate of change, and overall seasonality of discharge over time), necessary to maintain benthic habitats where the species is found and to maintain stream connectivity, specifically providing for the exchange of nutrients and sediment for maintenance of the mussel's and fish host's habitat and food availability, maintenance of spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats.

2. Suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (*i.e.,* channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussels and native fish (such as stable riffle-run-pool habitats that provide flow refuges consisting of predominantly silt-free, stable sand, gravel, and cobble substrates).

3. Water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages, including (but not limited to): dissolved oxygen (generally above 2 to 3 parts per million (ppm)), salinity (generally below 2 to 4 ppm), and temperature (generally below 86 °Fahrenheit (°F) (30 °Celsius (°C)). Additionally, water and sediment should be low in ammonia (generally below 0.5 ppm total ammonia-nitrogen) and heavy metal concentrations and lack excessive total suspended solids and other pollutants.

4. The presence and abundance of fish hosts necessary for recruitment of the longsolid.

Round Hickorynut

On September 29, 2020, the Service proposed the round hickory nut as threatened with proposed critical habitat in several states, including Pennsylvania. This species was not considered in the May 13, 2016, PBO, but the species status and life history are available in the species status assessment (Accessed October 26, 2023, at https://ecos.fws.gov/ecp/species/9879). Per the final listing rule (88 FR 14794), round hickorynut was listed as threatened on April 10, 2023.

Life History

Round hickorynut adults are greenish olive to dark or chestnut brown and can sometimes be blackish in older individuals. They may have a yellowish band. The shell is thick and solid, and can be up to three inches long, but on average, they are usually less than 2.4 inches (USFWS 2019). A distinctive characteristic is that the shell is round, and nearly circular. The foot can be pale tan to pale pinkish orange. This species is sexually dimorphic in appearance (USFWS 2019).

The round hickorynut are suspension-feeders, consuming food filtered from the water, but they may shift to deposit feeding, depending on flow conditions or temperature (USFWS 2019). Their diet consists of a mixture of algae, bacteria, detritus, and microscopic animals. They are typically found in medium-sized streams, and they exhibit a preference for sand and gravel in riffle, run, and pool habitats in streams and rivers, but also may be found in sandy mud (USFWS 2019). They can be found in shallow habitats with gentle flows at less than one foot with abundant American water-willow, but in larger rivers are commonly found up to depths of 6.5 feet. (https://www.fws.gov/species/round-hickorynut-obovaria-subrotunda, accessed October 26, 2023)

Population Dynamics

The round hickorynut relies on fish hosts for successful reproduction. Males release sperm into the water column, which is taken in by the female to fertilize eggs that develop into larvae, remaining in the gill chamber until they are ready for release. Larvae are released from the female in packets, and once in the water, these packets are targeted by feeding darters, bursting when bitten by the fish, releasing the larval mussels. These larvae snap shut when contacted by fish, and attach to its gills, head, or fins (USFWS 2019). Once on the fish, the larvae are engulfed by the host's tissue that forms a cyst. The cyst protects the glochidia and aids in their maturation. The larvae draw nutrients from the fish and develop into juvenile mussels, days to weeks after initial attachment. Juvenile mussels then drop off the host fish and settle to the bottom. The round hickorynut is known to be a long-term brooder in some southern population (gravid year-round), but gravid periods are known to be more contracted in the northern regions of its range (USFWS 2019). Several host fish species have been documented for the round hickorynut, but the dominant host fishes appear to be darters of the genera *Ammocrypta, Etheostoma*, and *Percina* (USFWS, 2019).

Distribution and Status

Historically, the round hickory nut was known to occur in 297 population in 12 states, including Alabama, Georgia, Illinois, Indiana, Kentucky, Michigan, Mississippi, New York, Ohio, Pennsylvania, Tennessee, and West Virginia (USFWS, 2019). Surveys conducted since 2000 indicate that the occupied range of the round hickorynut in America includes 65 rivers and streams. However, many of the historically known populations are considered to be extirpated. They no longer occur in Georgia, Illinois, or New York (USFWS 2019).

One area has been identified as round hickorynut critical habitat in Pennsylvania, including:

1) RH 1 – 22 river miles (mi) (35.5 kilometers (km)) of the Shenango River in Crawford County, Pennsylvania. This unit is immediately downstream from Pymatuning Dam, which is owned by the State of Pennsylvania.

Threats

Threats identified include the degradation of habitat and water quality from impoundments, siltation, and pollution due to resource extraction, agriculture, timbering practices, utility crossings, right-of-way maintenance, and human development (urbanization); flow reduction and water quality degradation due to water withdrawals and wastewater treatment plants; increased water temperature and drought; artificial barriers (dams); disease; and the presence of invasive, nonnative species. The following physical or biological features are essential to the conservation of the round hickorynut:

1. Adequate flows, or a hydrologic flow regime (magnitude, timing, frequency, duration, rate of change, and overall seasonality of discharge over time), necessary to maintain benthic habitats where the species is found and to maintain stream connectivity, specifically providing for the exchange of nutrients and sediment for maintenance of mussel and fish host habitat and food availability, maintenance of spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats.

2. Suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (*i.e.*, channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussels and native fish (such as stable riffle-run-pool habitats that provide flow refuges consisting of predominantly silt-free, stable sand, gravel, and cobble substrates).

3. Water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages, including (but not limited to): dissolved oxygen (generally above 2 to 3 parts per million (ppm)), salinity (generally below 2 to 4 ppm), and temperature (generally below 86 °Fahrenheit (°F) (30 °Celsius (°C)). Additionally, water and sediment should be low in ammonia (generally below 0.5 ppm total ammonia-nitrogen) and heavy metal concentrations and lack excessive total suspended solids and other pollutants.

4. The presence and abundance of fish hosts necessary for recruitment of the round hickorynut.

<u>Salamander Mussel</u>

On September August 22, 2023, the Service published a proposal to list the salamander mussel as threatened with proposed critical habitat in several states, including in Pennsylvania. This species was not considered in the May 13, 2016, PBO, but the species status and life history are available in the species status assessment (USFWS 2023. Accessed November 16, 2023, at www.ecos.fws.gov) and the proposed listing rule (85 FR 5744). Although not currently listed under the Endangered Species Act, FHWA and PennDOT requested conferencing on this species under the amended PBO.

Life History

The salamander mussel is a small, thin-shelled mussel. It is elongate or oblong, and it can reach up to 5 cm (2 in.) long. The outside of the shell is yellowish tan (younger mussels) to dark brown (older mussels), smooth, and rayless. This species is not known to be sexually dimorphic in appearance (iNaturalist https://www.inaturalist.org/guide_taxa/722262 Accessed November 16, 2023). Salamander mussels may live up to 10 years (Watson et al. 2001) but the age of sexual maturity is not known (USFWS 2023),

Like most mussels, salamander mussels are suspension-feeders, consuming food filtered from the water column. Their diet consists of a mixture of phytoplankton, zooplankton, rotifers, protozoans, detritus, and dissolved organic matter (USFWS 2023). They inhabit rivers, streams, and in some cases lakes with natural flow regimes. Salamander mussels may tolerate seasonal low flow. However, periodic drying or intermittent flow in lake and river habitats generally cannot support mussel assemblages (USFW 2023). Typically, salamander mussels are found to reside in moderate to swift-flowing rivers and streams, preferring shelter habitat under slab rocks or in bedrock where is dark and they are in contact with a solid surface to provide stability from swift current (Stegman 2020, p. 5). Often these rock structures have small amounts of sediment and silt present but are swept clean of excessive silt and fine sediments. Substrate typical of salamander habitat includes bedrock, sand, gravel, or mud.

Population Dynamics

Similar to other freshwater mussels, the salamander mussel has a unique life cycle that relies on a host for successful reproduction. However, the salamander mussel is the only freshwater mussel in North America to use a non-fish host, the mudpuppy (*Necturus maculosus*) (USFWS 2023). The mudpuppy is a fully aquatic salamander species that tends to be present within the same habitat preferred by the salamander mussel during the summer and fall when female mudpuppies are guarding their nests under large flat rocks (USFWS 2023). The salamander mussel's larvae (called glochidia) develop on the gills of the mudpuppy before falling off into stream substrates.

Males release sperm into the water column, which is taken in by the female to fertilize eggs that develop into larvae, remaining in the gill chamber until they are ready for release. Salamander mussels are long-term brooders and can hold mature larvae (glochidia) over the winter. As salamander mussels have an obligate parasitic relationship with their mudpuppy hosts, mudpuppies must be present when larvae are released in the summer (USFWS 2023). The larvae, or glochidia, attach to mudpuppy gills where they will grow and mature. Another way mudpuppies may become a host for this mussel species is by consuming adult salamander mussels (USFWS 2023). As they devour the mussel, mudpuppy gills become infested with mussel glochidia, which in time become encysted, mature, and drop off, usually in the span of 19 to 28 days (Watson 2001).

Distribution and Status

Historically, the salamander mussel was found in 110 populations across 14 states (Arkansas, Missouri, Tennessee, Kentucky, Iowa, Illinois, Indiana, Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania, New York, and West Virginia) and one Canadian province (Ontario). It also occurred in small streams to large rivers and in Lake Erie (USFWS 2023). It has been extirpated within Iowa but can be found within the Mississippi River only along the eastern border of the state. Other portions of the range are historical as well including Lake Erie. Much of Illinois' historical range has been diminished to four populations. The species status assessment for this species (USFWS 2023) found that of the 66 known existing populations across the salamander mussel's range, more than 80 percent are at high risk from one or more primary threats, and about 14 percent of the populations are at moderate risk. None of the populations across the range is experiencing low risk. Based on information contained in the species status assessment (USFWS 2023), it appears 37 areas nation-wide have been proposed a critical habitat for this species.

Three areas have been identified as longsolid critical habitat in Pennsylvania, including:

1) Unit 17 – Consists of 62 miles (99.78 km) of Conneaut Creek from the start of Conneaut Creek at Dicksonburg (Crawford County, Pennsylvania) downstream to the mouth with Lake Erie at Conneaut (Ashtabula County, Ohio).
2) Unit 18 – Consists of 74.37 miles (119.69 km) of French Creek from downstream of Union City Dam northwest of Union City (Erie County, Pennsylvania) downstream to the confluence of the Allegheny River at Franklin (Venango County, Pennsylvania).
3) Unit 19 – Consists of 39.45 miles (63.48 km) of Allegheny River from the Pennsylvania Route 68 bridge at East Brady (Armstrong County, Pennsylvania) downstream to the confluence of Kiskiminetas River northeast of Freeport (Armstrong County, Pennsylvania).

Threats

Threats identified include the degradation of habitat and water quality from impoundments, siltation, and pollution due to resource extraction, agriculture, timbering practices, utility crossings, right-of-way maintenance, and human development (urbanization); flow reduction and water quality degradation due to water withdrawals and wastewater treatment plants; increased water temperature and drought; artificial barriers (dams); disease; the presence of invasive, nonnative species; and vulnerability of host species. The following physical or biological features are essential to the conservation of the salamander mussel:

1. Adequate flows, or a hydrologic flow regime (magnitude, timing, frequency, duration, rate of change, and overall seasonality of discharge over time), necessary to maintain benthic habitats where the species is found and to maintain stream connectivity, specifically providing for the exchange of nutrients and sediment for maintenance of the mussels' and fish host's habitat and food availability, maintenance of spawning habitat (large flat rocks or bedrock the provides crevices for shelter) for native mudpuppies, and the ability for newly transformed juveniles to settle and become established in their habitats.

2. Suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (*i.e*., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussels and native fish (such as stable riffle-run-pool habitats that provide refuges consisting of predominantly silt-free, stable sand, gravel, and cobble substrates and large flat rocks or crevices in bedrock that are dark and have a solid surface).

3. Water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages, including (but not limited to): dissolved oxygen (generally above 2 to 3 parts per million (ppm)), salinity (generally below 2 to 4 ppm), and temperature (generally below 86 °Fahrenheit (°F) (30 °Celsius (°C)). Additionally, water and sediment should be low in ammonia (generally below 0.5 ppm total ammonia-nitrogen) and heavy metal concentrations and lack excessive total suspended solids and other pollutants.

4. The presence, abundance and distribution of the mudpuppy, the sole host species for this mussel, and its habitat (*e.g.,* large rock shelters, woody debris, and bedrock crevices within stable zones of swift current with low amounts of fine sediment silt), is crucial for recruitment of the salamander mussel.

<u>Status of Designated Critical Habitat</u>

Rabbitsfoot

Critical habitat was designated for the rabbitsfoot on April 30, 2015, on 1,437 river miles in 12 states (80 FR 24692). These states include Alabama, Arkansas, Illinois, Indiana, Kansas, Kentucky, Mississippi, Missouri, Ohio, Oklahoma, Pennsylvania, and Tennessee. In Pennsylvania, the Service identified 138.3 river miles of critical habitat in Crawford, Erie, Mercer and Venango Counties as essential to the conservation of the rabbitsfoot mussel. Areas of proposed critical habitat in Pennsylvania include portions of the Allegheny River, French Creek, Muddy Creek, and Shenango River.

Physical or Biological Features (PBFs) are the physical or biological features that, when laid out in the appropriate quantity and spatial arrangement to provide for a species' life-history processes, are essential to the conservation of the species. PBF components include features such as space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; and sites for breeding, reproduction, or rearing. In order to be considered critical habitat, an area must have all or most of the PBFs present, with the absent PBFs being readily developable. With respect to rabbitsfoot critical habitat, the PBFs include:

1) Geomorphically stable stream channel and banks (channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussels and native fish (e.g., stable riffles, sometimes with runs, and mid-channel island habitats

that provide flow refuges consisting of gravel and sand substrates with low to moderate amounts of fine sediment and attached filamentous algae.

2) A hydrologic flow regime (the severity, frequency, duration, and seasonality of discharge over time) necessary to maintain benthic habitats where rabbitsfoot are found and to maintain connectivity of rivers with the floodplain, allowing the exchange of nutrients and sediment for maintenance of rabbitsfoot and host fish habitat, food availability, spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats.

3) Water and sediment quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages.

4) The occurrence of natural fish assemblages, reflected by fish species richness, relative abundance, and community composition, for each inhabited river or creek that will serve as an indication of appropriate presence and abundance of fish hosts necessary for recruitment of rabbitsfoot. Suitable fish host for rabbitsfoot may include, but are not limited to, blacktail shiner (*Cyprinella venusta*) from the Black and Little River and cardinal shiner (*Luxilus cardinalis*), red shiner (*C. lutrensis*), spotfin shiner (*C. spiloptera*), bluntface shiner (*C. camura*), rainbow darter (*Etheostoma caeruleum*), rosyface shiner (*Notropis rubellus*), striped shiner (*L. chrysocephalus*), and emerald shiner (*N. atherinoides*).

5) Either no competitive or predaceous invasive (nonnative) species or such species in quantities low enough to have minimal effect on survival of freshwater mussels.

Longsolid.

Critical habitat was designated for the longsolid on April 10, 2023, on 1,115 river miles in 6 states (88 FR 14794). These states include Alabama, Kentucky, Pennsylvania, Tennessee, Virginia, and West Virginia. In Pennsylvania, the Service identified 241 river miles of critical habitat in Clarion, Crawford, Erie, Forest, Mercer Venango, and Warren Counties as essential to the conservation of the longsolid mussel. Areas of critical habitat in Pennsylvania include portions of the Allegheny River, French Creek, and Shenango River.

With respect to longsolid critical habitat, the PBFs include:

1) Geomorphically stable stream channel and banks (channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussels and native fish (e.g., stable riffles, sometimes with runs, and mid-channel island habitats that provide flow refuges consisting of gravel and sand substrates with low to moderate amounts of fine sediment and attached filamentous algae).

2) A hydrologic flow regime (the severity, frequency, duration, and seasonality of discharge over time) necessary to maintain benthic habitats where longsolid are found and to maintain connectivity of rivers with the floodplain, allowing the exchange of nutrients and sediment for maintenance of longsolid and host fish habitat, food availability, spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats.

3) Water and sediment quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages.

4) The occurrence of natural fish assemblages, reflected by fish species richness, relative abundance, and community composition, for each inhabited river or creek that will serve as an indication of appropriate presence and abundance of fish hosts necessary for recruitment of longsolid. Suitable fish host for longsolid may include, but are not limited to, minnows of the family Cyprinidae as well as potentially freshwater sculpins of the genus *Cottus.*

1) Either no competitive or predaceous invasive (nonnative) species or such species in quantities low enough to have minimal effect on survival of freshwater mussels.

Round hickorynut.

Critical habitat was designated for the round hickorynut on April 10, 2023, on 921 river miles in 9 states (88 FR 14794). These states include Alabama, Indiana, Kentucky, Mississippi, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. In Pennsylvania, the Service identified 22 river miles of critical habitat in Crawford and Mercer counties as essential to the conservation of the round hickorynut mussel. Areas of critical habitat in Pennsylvania include portions of the Shenango River.

With respect to round hickorynut critical habitat, the PBFs include:

1) Geomorphically stable stream channel and banks (channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussels and native fish (e.g., stable riffles, sometimes with runs, and mid-channel island habitats that provide flow refuges consisting of gravel and sand substrates with low to moderate amounts of fine sediment and attached filamentous algae).

2) A hydrologic flow regime (the severity, frequency, duration, and seasonality of discharge over time) necessary to maintain benthic habitats where round hickorynut are found and to maintain connectivity of rivers with the floodplain, allowing the exchange of nutrients and sediment for maintenance of round hickorynut and host fish habitat, food availability, spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats.

3) Water and sediment quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages.

4) The occurrence of natural fish assemblages, reflected by fish species richness, relative abundance, and community composition, for each inhabited river or creek that will serve as an indication of appropriate presence and abundance of fish hosts necessary for recruitment of round hickorynut. Suitable fish host for round hickorynut may include, but are not limited to, banded sculpin (*Cottus carolinae*), eastern sand darter (*Ammocryptapellucida*), emerald darter (*Etheostoma baileyi*), greenside darter (*Etheostoma blennioides*), Iowa darter (*Etheostoma exile*), fantail darter (*Etheostoma flabellare*), Cumberland darter (*Etheostoma gore*), spangleddarter (*Etheostoma obama*), variegate darter (*Etheostoma variatum*), blackside darter (*Percinamaculata*), and frecklebelly darter (*Percina stictogaster*).

1) Either no competitive or predaceous invasive (nonnative) species or such species in quantities low enough to have minimal effect on survival of freshwater mussels.

Salamander Mussel.

Critical habitat was proposed for the salamander mussel on August 22, 2023, on 62 river miles in 11 states (88 FR 57224). These states include Indiana, Kentucky, Michigan, Minnesota, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin. In Pennsylvania, the Service identified about 152 miles river miles of critical habitat in Armstrong, Crawford, Erie, Mercer, and Venango Counties as essential to the conservation of the salamander mussel. Areas of critical habitat in Pennsylvania include portions of the Allegheny River, Conneaut Creek, and French Creek. Salamander mussel proposed critical habitat PBFs are listed above under the species description.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR §402.02) define the environmental baseline as the past and present impacts of all federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions that are contemporaneous with the consultation in progress. For the purposes of this biological opinion, the action area is defined as streams in the Ohio River watershed in Pennsylvania. This fully encompasses the area where project-related direct and indirect effects to the clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussels are likely to occur.

<u>Previous incidental take authorizations</u>

Prior to 2012, no authorized incidental take of rayed bean, snuffbox, sheepnose, or rabbitsfoot, long solid, round hickorynut, or salamander mussel had been provided through section 7, because these species were not listed as endangered or threatened at the time.

Between 1998 and 2015, at least 22 federal actions have taken place that adversely affected the northern riffleshell (Table 8). From 2016 to 2023 an additional six federal actions have taken place. All of these actions occurred in Pennsylvania. The Service determined that these actions would not jeopardize the continued existence of the northern riffleshell and estimated incidental take for each action. The incidental take of northern riffleshell was estimated to be 37,669 individuals that would be directly killed or harmed by the actions, plus an unquantified number of animals indirectly affected by each action.

Between 1998 and 2015, nine federal actions have taken place or are proposed that have adversely affected the clubshell, and for which incidental take has been estimated (Table 8). From 2016 to 2023 an additional four federal actions have taken place. The Service determined that these actions would not jeopardize the continued existence of the clubshell and estimated incidental take for each action. The incidental take of clubshell was estimated to be 96,054 individuals that would be directly killed or harmed by the actions, plus an unquantified number of animals indirectly affected by each action.

Between 2013 and 2015, at least seven federal actions have taken place that adversely affected the rayed bean in Pennsylvania (Table 8). From 2016 to 2023 an additional five federal actions have taken place. The Service determined that these actions would not jeopardize the continued existence of the rayed bean and estimated incidental take for each action. The incidental take of rayed bean was estimated to be 14,337 individuals that would be directly killed or harmed by the actions, plus an unquantified number of animals indirectly affected by each action.

Between 2012 and 2015, at least eight federal actions have taken place that adversely affected the snuffbox in Pennsylvania (Table 8). From 2016 to 2023 an additional six federal actions have taken place. The Service determined that these actions would not jeopardize the continued existence of the snuffbox and estimated incidental take for each action. The incidental take of snuffbox was estimated to be 6,412 individuals that would be directly killed or harmed by the actions, plus an unquantified number of animals indirectly affected by each action.

One federal action in 2013 has taken place that has adversely affected the sheepnose in Pennsylvania (Table 8). From 2016 to 2023 only one additional federal action has taken place. The Service determined that this action would not jeopardize the continued existence of the sheepnose and estimated incidental take for this action. The incidental take of sheepnose was estimated to be 1,870 individuals that would be directly killed or harmed by the action, plus an unquantified number of animals indirectly affected by the action.

Between 2014 and 2015, at least four federal actions have taken place that adversely affected the rabbitsfoot in Pennsylvania (Table 8). From 2016 to 2023 an additional four federal actions have taken place. The Service determined that these actions would not jeopardize the continued existence of the rabbitsfoot and estimated incidental take for each action. The incidental take of rabbitsfoot was estimated to be 4,347 individuals that would be directly killed or harmed by the actions, plus an unquantified number of animals indirectly affected by each action.

Starting in 2023, at least two federal actions have taken place that adversely affected the longsolid in Pennsylvania (Table 8). The Service determined that these actions would not jeopardize the continued existence of the rabbitsfoot and estimated incidental take for each action. The incidental take of longsolid was estimated to be 2,502 individuals that would be directly killed or harmed by the actions, plus an unquantified number of animals indirectly affected by each action.

Table 8. Previous biological opinions authorizing incidental take for these species covered by the Service's Biological Opinion.

Project Name	Year BO Issued	Northern riffleshell	Clubshell	Rayed bean	Snuffbox	Sheepnose	Rabbitsfoot	Longsolid
Kennerdell Bridge [1]	1998	875	208					
Utica Bridge [1]	1998	389	0					
Foxburg Bridge [1]	2001	65	16					
East Brady Bridge[1,3]	2002	210	0					
Hickory Street Bridge	2003	23	0					
Leiter Ford Bridge	2004	0	2					
Mill Village Truss Bridge[1,2]	2004	9	61					
West Hickory Bridge[1,2,3]	2004	905	211					
Gravel Run Road Bridge	2006	519	7					
Millers Station Bridge	2009	10	19					
Race Street Bridge[1]	2012	95	0	0	83	0	0	
Carlton Bridge[1]	2013	1,626	0	1,105	40	0	0	
Hunter Station Bridge[1,4]	2016	27,077	90,142	212	104	104	0	
Hulton Bridge	2014	66	66	66	0	0	0	
Cochranton Bridge[1,5]	2014	121	0	15	15	0	15	
Washington Crossing Bridge[1]	2014	139	3	139	3	0		
Mead Avenue Bridge[1]	2014	95	0	6,644	759	0	0	
Saegertown Improvements[1]	2015	988	988	988	988	0	16	
Cambridge Springs[1]	2016	189	25	899	119	0	48	
Niemeyer Road Bridge	2017		10		10			
Kelly Road Bridge[1]	2017		28	1	23			
Wightman Road Bridge	2022	11	11	11	11		11	
SR 0006 B13[6]	2023	1,766	1,766	1,766	1,766	1,766	1,766	11
SR 0006 B12[6]	2023	2,491	2,491	2,491	2,491		2,491	2,491
Totals		**37,669**	**96,054**	**14,337**	**6,412**	**1,870**	**4,347**	**2,502**

1 Projects with mussel salvage and relocation components.
2 The estimated incidental take of northern riffleshell was substantially exceeded at West Hickory Bridge (2,750 relocated) and at Mill Village Truss (8 relocated), but this is not reflected on this Table.
3 Incidental of clubshell was substantially exceeded at the West Hickory Bridge (1,615 relocated) and the East Brady Bridge (19 relocated), but this is not reflected on this Table.
4 Incidental take for clubshell was substantially exceeded at the Hunter Station Bridge. Numbers on the table reflect those reported in the reinitiated Biological Opinion.
5 Incidental take for clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, and rabbitsfoot was substantially exceeded at the Cochranton Bridge, due to scour. Numbers on the table do not reflect those reported in the reinitiated Biological Opinion
6 Numbers on the table reflect the take estimates reported in the biological opinion.

STATUS OF LISTED SPECIES WITHIN THE ACTION AREA

As described under the Species Distribution and Status, the majority of the remaining populations of federally-listed endangered or threatened mussels is within the action area of PennDOT's Bridge Program and encompassed under Management Units 1 and 2. Each of the six federally listed endangered mussel species have been found in the vicinity of some of bridge crossings, perhaps due to the long-term protection afforded to the riverbed. Historically, bridges were often built at narrow or shallow channel cross sections, which are also often preferred mussel habitats. Bridge structures can act as hydrologic controls, stabilizing channel bed habitat, which over the life of a bridge structure maintains suitable habitat. In addition, bridge crossings and certain other infrastructure features in the navigable portion of the Allegheny and Ohio Rivers are protected from instream gravel mining. These bridge crossings constitute an important portion of habitat reserved from gravel mining and in some reaches represent the only remaining clubshell, northern riffleshell, and rayed bean habitat.

<u>Northern Riffleshell</u>

In the Allegheny River, Pennsylvania, northern riffleshells have been documented to occur in abundance at several locations, but the species' distribution is discontinuous (*i.e.*, localized to areas of suitable habitat). The condition of these populations ranges from those exhibiting successful reproduction to those with apparently depressed vigor and a predominance of older adults (USGS 2004). The most upstream location that northern riffleshells have been found alive in recent years is near the City of Warren, Pennsylvania (EnviroScience 2002). The Allegheny River in Warren is strongly influenced by hypolimentic releases from Kinzua Dam, and this population appears to be dependent on warmer, more nutrient-rich water coming from Conewango Creek, which confluences with the Allegheny River immediately upstream of the habitat supporting this species.

Northern riffleshells appear to become a frequent member of the Allegheny River mussel community about nine miles below Warren, with peak densities documented near the Forest and Venango County line. At that location, northern riffleshells are the dominant mussel species, with a mean density of 7.57 individuals per meter squared and an estimated population of 169,622 individuals in a 100-meter-wide cross-section of the Allegheny River (USGS 2002), substantially exceeding the maximum population density defined in Management Unit 1 and is therefore not within the scope of this biological opinion.

Sampling at the West Hickory bridge site in 1999 revealed a mean density of 0.5 per square meter (USGS 2004). Approximately 42,758 and 42,650 northern riffleshell were estimated to occur in 100-meter-wide river sections located 200 and 300 meters downstream of the existing bridge (USGS 2000). Compared to the West Hickory site, northern riffleshells have been found to be more abundant both upstream and downstream, with a mean density of 1.8 per square meter at five sites quantitatively sampled between Tidioute and Tionesta. Northern riffleshell populations are known from scattered locations in the middle Allegheny River (*e.g.*, near the towns of Kennerdell, Foxburg, Oil City, Parker, East Brady, and downstream to river mile 58), where population densities are generally less than 0.1 per square meter. The total population of northern riffleshell in the Allegheny River may exceed 6,500,000 individuals (Villella 2007).

The northern riffleshell population is discontinuously distributed in approximately 60 miles of lower French Creek in Pennsylvania, from its confluence with the Allegheny River at Franklin, upstream to the vicinity of the State Route 6 Bridge at Mill Village. Within this reach, northern riffleshells range from relatively common, to rare or absent at sites that have otherwise diverse mussel communities. For example, of 31 sites investigated along the length of French Creek in 2003, northern riffleshells were documented to occur at nine of the lower 21 sites, where population estimates in 2004 ranged from 23 to over 10,000 individuals (Smith and Crabtree 2005). These nine sites supported mussel assemblages containing between 6 and 19 species, although they were often separated by sites that appeared to be equally diverse (up to 15 species) but did not include northern riffleshells (Smith and Crabtree 2005).

Northern riffleshells have also been found in Conewango Creek in Warren County (an Allegheny River tributary), as well as in the lower reaches of two French Creek tributaries, Muddy Creek (Crawford County) and LeBoeuf Creek (Erie County). Due to the proximity of these populations to French Creek and the Allegheny River, they may represent extensions of the larger mainstem population rather than self-sustaining sub-populations.

Clubshell

In the Allegheny River in Pennsylvania, clubshells have been documented to occur in abundance at several locations, but the species' distribution is discontinuous (*i.e.*, localized to areas of suitable habitat). The condition of these populations ranges from those exhibiting successful reproduction to those with apparently depressed vigor and a predominance of older adults (USGS 2004). Clubshell populations are known from scattered locations in the middle Allegheny River (*e.g.*, near the towns of Kennerdell, Foxburg, Oil City, Parker and East Brady), downstream to river mile 58, which includes the three upper Navigation Pools (Pools 7, 8 and 9). In many of these locations, mussel population data are based solely on qualitative surveys, and the clubshell appears to be relatively less abundant than the other more common species with which it co-occurs in the Allegheny River, such as muckets (*Actinonaias ligamentina*) and spikes (Eurynia *(Elliptio) dilatata*).

Quantitative sampling has occurred at a few locations on the Allegheny River. For example, approximately 3,025 clubshells were estimated to occur in 100-meter-wide river sections located 200 and 300 meters downstream of the existing West Hickory Bridge (USGS 2000). The total population of clubshells in the upper 32 miles of the Allegheny River sampled by USGS may exceed 1,100,000 individuals (Villella 2007).

The clubshell population is discontinuously distributed in the upper approximately 15 miles of French Creek in Pennsylvania, from near the confluence with LeBoeuf Creek, downstream to the vicinity of the State Route 6 Bridge at Mill Village. Within this reach, clubshells vary from relatively common, to rare or absent at sites that have otherwise diverse mussel communities. Of 31 sites investigated along the length of French Creek in 2003, clubshells were documented alive at only three sites. The size distribution ranged from 17 millimeter (mm) to 81 mm, indicating that successful reproduction is occurring. In 2004, population estimates at these sites ranged from less than 10 to over 800 individuals per site (Smith and Crabtree 2005). In the French Creek watershed, the clubshell populations have a relatively small range that has little overlap with that of the northern riffleshell.

Clubshells have also been found in the reaches of four French Creek tributaries: Conneaut Outlet, Conneauttee Creek, and Muddy Creek in Crawford County, and LeBoeuf Creek in Erie County, Pennsylvania. Documentation of these tributary populations is often based on small numbers of individuals in highly restricted reaches of these streams. The population in Conneaut Outlet is isolated, does not appear to be reproducing, and is restricted to less than a mile of stream immediately above a wastewater treatment plant outfall.

Two clubshells were documented in Cassadaga Creek, a Conewango Creek tributary in New York in 2005. The distribution of this population beyond the single known site and its reproductive status are not known at this time (Smith and Horn 2006); however, the continued presence of clubshell in the New York portion of the Conewango Creek basin suggests the species may also remain in stream reaches in Pennsylvania that have not been recently surveyed.

Twenty-four living clubshells were found in quantitative sampling at one site related to a bridge replacement project on the Shenango River in Mercer County, Pennsylvania (EnviroScience 2003). This study provided a population density estimate of 0.33 clubshell per square meter, and a population estimate of 41 to 155 individuals in the 13,191 meter squared sampling area. The size of clubshells at this site ranged from 37 mm to more than 60 mm, indicating the population is successfully reproducing. The full extent of the Shenango River population is unknown due to a lack of sampling, but potential habitat extends from at least Pymatuning Reservoir to Shenango Reservoir and perhaps below into Lawrence County.

Rayed bean

There are nine streams and Lake Chautauqua that historically harbored rayed bean populations in the Allegheny River watershed system. Two of these streams, Olean Creek and Cassadaga Creek, along with Lake Chautauqua, are in New York. Ortmann (1909, 1919) was the first to report the rayed bean from the Allegheny River. The population once stretched from Cataraugus County, New York, to Armstrong County, Pennsylvania. Currently, rayed bean occurs in low numbers in the Allegheny River from about Allegheny River mile 175 downstream of Mead Island, Warren County to the four upstream navigation pools (9, 8, 7, and 6) where the species is locally common in higher flow, undredged reaches of these pools.

French Creek is a major tributary of the middle Allegheny River. As in the Allegheny River, rayed bean populations are locally abundant in some sections of French Creek from the vicinity of the confluence with LeBoeuf Creek to the Allegheny River. Rayed bean populations also extend into French Creek tributaries, including LeBoeuf Creek and Cussewago Creek.

Rayed bean are known to be present in several stream reaches within the action areas of several recent bridge replacement projects including the Allegheny River at Foxburg and East Brady, and French Creek at Utica. Because the species was not listed as endangered when these bridge projects were completed, no incidental take statements were developed. Concurrent with the salvage of endangered clubshell and northern riffleshell mussels at the East Brady bridge site, the FHWA and PennDOT agreed to assist with the relocation of 200 of the estimated 930 rayed bean that co-occurred with endangered mussels in the action area of this bridge.

Snuffbox

In Pennsylvania, snuffbox is known to occur in the French Creek watershed in Erie, Crawford, Mercer, and Venango Counties (a distance of approximately 80 river miles). Snuffbox collections made during 2002–2004 were summarized by Smith (2005) when living or freshly dead specimens were found at 19 sites. Snuffbox populations extend from French Creek upstream into several tributaries (West Branch French Creek, LeBoeuf Creek, Woodcock Creek, and Muddy Creek), making the species relatively more secure when compared populations that are sparsely distributed and, thus, more susceptible to stochastic events elsewhere in the species range (*e.g.,* Sydenham, Bourbeuse, and Clinch Rivers).

The snuffbox is rare but known from three separate reaches of the Allegheny River, where it is distributed over approximately 42 river-miles in Forest, Armstrong and Venango Counties. Despite extensive freshwater mussel surveys in the Allegheny River, due to low detection rates, the status (*i.e.,* ability to maintain self-sustaining population) of the snuffbox population in this river is largely unknown

Outside of the Allegheny River/French Creek systems, snuffbox are known to occur in the Shenango River (and its tributary the Little Shenango), which is part of the Beaver River system of the upper Ohio River. Six snuffbox mussels were collected from three sites sampled in 2001–02 between Jamestown and New Hamburg (about 25 river miles) in the Shenango River with the best habitat in the upper reach and in the Little Shenango River. Snuffbox where observed to be relatively abundant and reproducing in the lower portion of the Little Shenango River in 2002 (EnviroScience 2003)

Snuffbox were known from Dunkard Creek, a Monongahela River tributary, until 2009 when a toxic spill appears to have eliminated the species from this stream. Efforts to re-establish snuffbox in Dunkard Creek are likely to occur in the near future; therefore, its presence in this creek should be assumed.

Sheepnose

In Pennsylvania, the sheepnose was considered to be extirpated until around 1991 when an extant population was located in the middle Allegheny River drainage in Forest and Venango Counties. This population appears to be both stable and recruiting over a 6-mile reach in the middle Allegheny River. Greg Zimmerman reported several live and fresh dead specimens, including juveniles, near Oil City in 2002. Sampling efforts from 2006-2008 at 63 sites over 78 miles found sheepnose at 18 sites. A total of 244 individuals of 7 different age classes were collected in the Allegheny River from the vicinity of Tionesta, PA to Oil City, PA (Villella and Nelson 2006). These data suggest the presence of a viable population of the sheepnose in the upper Allegheny River. Few mussel surveys have been conducted between Oil City and the head of the maintained navigation system at East Brady, PA; therefore, the extent of the sheepnose population below Oil City (but above East Brady) is not known.

Sheepnose have not been documented within the action area of any previous transportation project biological opinions. Also, there are few bridges crossing the section of the Allegheny River known to support sheepnose that have not been recently replaced (*e.g.,* West Hickory

Bridge) or for which formal consultation has not already been completed (*e.g.*, Hunters Station Bridge, Forest County).

Rabbitsfoot

Historical records from Pennsylvania indicate rabbitsfoot was sporadically known in the Allegany River from at least Armstrong County upstream to Warren County, Pennsylvania (Butler 2005), but little sampling effort was performed over the past 100 years. Five live rabbitsfoot specimens were found from 1998 to 2001 at Kennerdell, Venango County, Pennsylvania (Villella 2008, pers. comm.). During Allegheny River surveys from 2001 to 2002 (25 sites) and 2007 (63 sites) encompassing 80 miles (129 km), rabbitsfoot was found only at three sites downstream of the French Creek confluence, and one site upstream. All had very low population densities of rabbitsfoot (Villella 2008, pers. comm.).

Rabbitsfoot in French Creek is known from downstream of Union City Reservoir to approximately 7 miles (11 km) above the Allegheny River confluence, a total of 75 miles (121 km) (Butler 2005). Intensive quantitative sampling at 4 sites in Venango County from 1998 to 1999 yielded 205 live rabbitsfoot specimens (Butler 2005). In 2003 and 2004, timed searches (qualitative) yielded 41 live rabbitsfoot specimens from 12 of 25 sites in Erie, Crawford, Mercer, and Venango Counties, Pennsylvania, while a quantitative survey at 7 of 10 sites yielded 57 live rabbitsfoot specimens (Smith and Crabtree 2010). Rabbitsfoot abundance at the seven sites was estimated to be from 43 to 372 individuals (standard error = 30 to 123). Evidence of recent recruitment was found at three sites (Smith and Crabtree 2010). In addition, rabbitsfoot are known from tributaries to French Creek, including LeBoeuf Creek and Conneautee Creek. The French Creek population appears to be healthy and stable, with evidence of recruitment; however, recruitment has not been confirmed in either LeBoeuf Creek or Conneautee Creek. These populations are considered marginal and likely an extension from French Creek. In another French Creek tributary, Muddy Creek, three live rabbitsfoot specimens were collected at 3 of 20 sites visited in 2003 (Mohler *et al.* 2006). The rabbitsfoot population in Muddy Creek is small and also part of the French Creek metapopulation. Overall, it appears that the lower Allegheny River and French Creek likely represent a metapopulation because no barriers exist between the streams, but the Alleghany population is considered marginal (Butler 2005).

In the action area, rabbitsfoot are also known from the Shenango River, which is a tributary of the Beaver River in Mercer County, Pennsylvania. Nelson and Villella (2010) surveyed the Shenango River from Pymatuning Reservoir to Shenango River Lake in 2009 and they collected 34 live rabbitsfoot specimens (relative abundance = 1.1 percent) from this reach (Nelson and Villella 2010).

As described above, some stream reaches in Management Unit 1 support relatively high population densities of clubshell, northern riffleshell, rayed bean, snuffbox, and sheepnose and account for most of the remaining populations of these species globally. Other stream reaches in Management Unit 2 have sparse populations of some of these species which may be indicative of degraded habitat, suggesting that not all of the biological requirements of the northern riffleshell, clubshell, rayed bean, snuffbox, sheepnose, and rabbitsfoot are being met under the environmental baseline. However, these smaller populations are also vital to the survival and recovery of these species. Improvements in the environmental conditions in Management Unit 2 streams are necessary to meet the biological requirements for survival and recovery of the endangered species living therein. Further degradation of these conditions could appreciably reduce the likelihood of survival and recovery of these demonstrably sensitive species.

Longsolid

The historical range in Pennsylvania shows that the longsolid once occupied the Upper Ohio River basin that stretches from Greene County north to Warren and McKean Counties, including tributaries such as the Monongahela River, Beaver River, Ohio River, Mahoning River, and Allegheny River Basins (Service. 2018). Populations have declined in the Ohio River basins, primarily due to habitat and water quality loss and degradation. According to the Species Status Assessment (Service 2018), the chief causes of lost or declining populations of the longsolid are impoundments (*i.e*., dams on the Allegheny River, Ohio River, Monongahela River, and Shenango River); channelization (channel maintenance – Allegheny River); chemical contamination (oil and natural gas extraction and high salinity wastewater); mining (abandoned mine drainage); and sedimentation (agricultural activities). Precipitous declines and extirpations of longsolid populations have been observed in the Beaver River (Ortmann 1920, p.276); Ohio River (Tolin 1987, p.11); and Mahoning River (Ortmann 1920, p.276). Current populations are represented by very few individuals. In the state of Pennsylvania, the longsolid is ranked as Critically Imperiled by NatureServe, and Imperiled by the State Wildlife Action Plan (Service 2018).

Extant longsolid populations are known to occur in the Upper Allegheny River Basin, including the Allegheny River and Oswayo Creek; the Middle Allegheny -Tionesta Basin, including the Allegheny River and Tionesta Creek; the French Creek Basin, including French Creek and Muddy Run; the Middle Allegheny - Redbank Basin, including the Allegheny River; the Lower Allegheny River Basin, including the Allegheny River; the Shenango River; and Slippery Rock Creek (Service 2018). According to the Species Status Assessment, all of these populations, except the Middle Allegheny and French Creek populations, have a low population condition, meaning that they are small and highly restricted populations with no evidence of recent recruitment or age class structure, and have a limited detectability. The Middle Allegheny and French Creek populations are spatially restricted to a lesser extent and have limited levels of recruitment (Service 2018).

For the Ohio River Basin, less than 100 longsolid were ever reported in the Upper Allegheny Management Unit, with four individuals located in a receding backwater, and only one specimen above the Allegheny Reservoir (unpublished data - 2005 by the PA Fish and Boat Commission). In 2006, PA Fish and Boat Commission found one live specimen in Oswayo Creek, above the Allegheny Reservoir. This population in isolated from other population further downstream in the Allegheny River by Kinzua Dam.

The U.S. Geological Survey conducted qualitative and quantitative sampling in the Middle Allegheny – Tionesta Management Unit, Allegheny River in 2003 to 2005 (Warren, PA to Kennerdell, PA). A total of 40 out of 66 sites yielded longsolid. Villella and Nelson (2005) estimated the population in this reach to be about 22,300; while Smith *et al.* (2001 p.123) reported one longsolid in 562.25 square meters (a density of <0.01), and a population of 132 was found at the West Hickory bridge replacement project (Service 2018a, unpublished data). The longsolid prefers the "middle" reaches and was rare in the lowermost and uppermost reaches that have been surveyed in the past. Also included in the Middle Allegheny – Tionesta Management

Unit is Tionesta Creek. Only one live specimen was found in this stream near Kelletville, PA by Western Pennsylvania Conservancy (Bier 1994). A recent PA Fish and Boat Commission survey conducted at Wurtemburg, PA for a bridge replacement project did not detect longsolid (Service 2018a, unpublished data).

French Creek in the French Creek Management Unit has also been evaluated for longsolid via quantitative and qualitative surveys. Smith and Crabtree (2010) found 39 longsolid at 29 sites within this reach of stream through qualitative surveys, and 32 longsolid at nine sites through quantitative findings (mussel density of 0.03). Davis and Bogan (1990) indicate that French Creek has great species diversity, but the longsolid is rare and endangered in this drainage. Smith and Crabtree (2010) estimated longsolid densities to be 0.22 per m^2 at river kilometer 98; 0.04 per m^2 at river kilometer 89; 0.01 per m^2 at river kilometer 68; 0.01 per m^2 at river kilometer 52; 0.01 per m^2 at river kilometer 23; and 0.01 per m^2 at river kilometer 19. Additionally, Bier (1994) reported 19 longsolid at 11 or 21 sites that were sampled quantitatively.

In a French Creek tributary, Muddy Creek, Mohler *et.al* (2006) surveyed 11.4 miles of muddy Creek. They found seven longsolid at 4 of the 20 sites that were surveyed. The mussel community within this reach of stream that was sampled is afforded some level of protection, due to its location in the Erie National Wildlife Refuge, however, there are still threats to the aquatic community in that area, due to regional land development, commerce, and other influences (Mohler *et al.* 2006).

Many surveys have been conducted on the Middle Allegheny River, in the Redbank Creek area, including Smith and Meyer (2010, p. 548), who reported a collection of dead specimens in Pool 6. They sampled a total of five sites in Pools 4 through 8. However, Evans and Smith (2005 P.5) collected two live individuals at one of the 17 sites that they surveyed in Pools 4 and 6. In the pre-1920's, Bogan and Davis (1990, p.13, report #3) reported collections of longsolid in Allegheny Pools 5 and 6, and in their Report #2 (1990b, p.9) they reported one live individual at one station. This particular population is isolated from other populations farther up- and downstream in the Allegheny River by reservoirs. The lock and dams on the River altered the river from a free-flowing, well-oxygenated riffle and run reaches, to a series of deep, slower-flowing pools and lates (Ortmann 1909). Furthermore, invasive species, such as zebra mussels have been documented in this stream reach (Ricciardi *et. al.* 1998, and Strayer and Malcom 2012).

The Lower Allegheny Management Unit has also been surveyed by many individuals. In 2005, Smith and Meyer (2010) found two live individuals in Pool 4 during a quantitative survey after sampling Pools 4 through 8. In 2006, Evans and Smith (2005) reported two live longsolid individuals at one of 17 sites in pools 4 and 6. Historically, Bogan and Davis (1990, report #3) reported pre-1920 collections of species from Pools 5 and 6, and in their Report #2, they reported one live individual at one out of 15 stations. Bogan and Davis (1990) noted that the longsolid was rare. As noted previously, this population is also isolated from other populations farther up- and downstream in the Allegheny River by reservoirs. There is very little evidence of reproduction, and it is threatened by dredging.

In the action area, longsolid are also known from the Shenango River, which is a tributary of the Beaver River in Mercer County, Pennsylvania. Nelson *et.al*. (2010) surveyed the Shenango

River and they collected 150 longsolid as 10 of the 15 reaches that they sampled. Bursey (1987) reported the species as common in Mercer County in 4 out of 6 sites, however Ortmann (1909) reported the longsolid as abundant in the Shenango River.

Slippery Rock Creek, a tributary to the Connoquenassing Management Unit, has also been evaluated for longsolid. In an unpublished PA Fish and Boat Commission Document (Welte 1991) about 12 miles of stream were evaluated. One live and one weathered dead individual were found near a mill dam and state park.

Round Hickorynut

The historical range in Pennsylvania shows that the round hickorynut once occupied the Upper Ohio River basin that stretches in western Pennsylvania from Greene County north to Erie County, including tributaries such as the Shenango River, Crooked Creek, the Monongahela River, Ohio River, and Allegheny River Basins (Service. 2019) and the Great Lakes Basin, including Lake Erie tributaries (Service 2019). Populations have declined in the Ohio River basins, primarily due to habitat and water quality loss and degradation and in the Great Lakes Basin due to competition by nonnative species (*i.e*. Zebra mussel (Service 2019).

According to the Species Status Assessment (Service 2019), the chief causes of lost or declining populations of the round hickorynut are impoundments (*i.e*., Pymatuning and Shenango Dams on the Shenango River, and locks and dams on the Ohio River); channelization (channel maintenance – Allegheny River); habitat fragmentation; chemical contamination (oil and natural gas extraction and high salinity wastewater); mining (abandoned mine drainage); competition by nonnative species (zebra mussels (*Dreissena polymorpha*), Quagga Mussel (*Dreissena bugenis*), Black Carp (*Mylopharyngodon piceus*), Round Goby (*Neogobius melanostomus*), Didymo (a.k.a. rock snot; *Didymosphenia geminata*), and Hydrilla (a.k.a. water-thyme; *Hydrilla verticillata*)) and sedimentation (agricultural activities) (Service 2019). Precipitous declines and extirpations of round hickorynut populations have been observed in Crooked Creek (Ortman 1913). Current populations are represented by very few individuals. In the state of Pennsylvania, the round hickorynut is ranked as Critically Imperiled by NatureServe, and Critically Imperiled (Endangered) by the State Wildlife Action Plan (Service 2019).

Extant round hickorynut populations are known to occur in the Shenango River Basin. According to the Species Status Assessment, this population, has a low population condition, meaning that it is a small and highly restricted population with no evidence of recent recruitment or age class structure, and have a limited detectability.

The remaining population in Pennsylvania was documented by Nelson et.al. (2010). They examined a 23.1-mile reach of the Shenango River in Mercer County, between the Pymatuning Reservoir and the Shenango River Lake and found a total of seven live round hickorynut in 9.1 miles (two sites) of the 23.1-mile reach that they examined. Bursey (1987) documented live round hickory nut individuals in this same reach of stream and downstream of the Shenango River Lake Dam at Sharpsville. Bursey encountered round hickorynut at 2 of the 6 sites examined. He described its occurrence as “occasional.”

Salamander Mussel

Historically, the salamander mussel was found across 14 states, including Pennsylvania. It occurred in small stream to large rivers and in Lake Erie (Service 2023b). It has since been extirpated in Lake Erie. Given the paucity of data and lack of survey work specifically for the salamander mussel, the Species Status Assessment was unable to provide a large amount of data from the small number of populations across the range. The range in Pennsylvania shows that the salamander mussel once occupied portions of the Great Lakes Basin but is now reduced to the Chautauqua -Conneaut Creek population, in Conneaut Creek (Service 2023b). In addition, the salamander mussel once occupied the and the Upper Ohio River and has now been reduced to the Middle Allegheny-Redbank population (Service 2023b) in portions of the Allegheny River.

The French Creek population, in Pennsylvania, is considered to be extant (demographic conditions unknown), as well as the Middle Allegheny-Redbank population (low demographic population). The Upper Ohio-Wheeling population, found in portions of Pennsylvania in considered to be functionally extirpated (Service 2023b) due to the high risk of contaminants (*i.e.,* copper and sulfate).

Populations have declined in the Ohio River basins, primarily due to limited availability of their sole host species, the mudpuppy (*Necturus maculosus).* As the salamander mussel is the only North American freshwater mussel species known to have a non-fish host species, so it follows that the mussel's occurrence is related to the presence or absence of that species and their vulnerabilities. For example, the Chautauqua-Conneaut salamander mussel population is at high risk from copper and application of routine lampricide treatments, as mudpuppies are also vulnerable to the treatments (Service 2023).

According to the Species Status Assessment (Service 2019), the chief causes of lost or declining populations of the salamander mussel are host species vulnerability(i.e., mudpuppy susceptibilities); chemical contamination (*i.e.*, wastewater treatment, industrial effluents and targeted lampricide treatment); sedimentation (i.e., agricultural activities, roadway runoff, urbanization); alteration of the natural thermal regime (*i.e*. drought, increased temperature); alteration in the hydrological regime (i.e., the flow dynamics of a river); broken aquatic connectivity (*i.e.,* dams, road crossings, water control structures); competition by nonnative species (zebra mussels, Corbicula clam (*Corbicula fluminea)*, Quagga Mussel, black carp, rusty crayfish (*Faxonius rusticus*), spiney water flea (*Bythotrephes longimanus*), brown trout (*Salmo trutta*), common carp (*Cyprinus carpio*), and bighead carp (*Hypophthalmichthys nobilis*) (Service 2023b); and resource extraction (abandoned coal mine drainage, oil and gas extraction brines) (Service 2023).

EFFECTS OF THE ACTION

In accordance with 50 CFR 402.02, "effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. (See § 402.17)." Here, we considered direct consequences as those immediate effects of the project on the species or its habitat. We also considered effects that result from the proposed action but may occur later in time but are still reasonably certain to occur.

Effects of Previous Conservation Measures Contributing to the Current Environmental Baseline

The Service considers compensatory mitigation measures that result in conservation of threatened and endangered species to be a major component of the proposed action, as such measures have the potential to improve the environmental baseline and offset unavoidable incidental take. The previous Bridge program completed the following conservation actions:

- Salvaged and translocated 534 northern riffleshell, 382 rayed bean, 48 snuffbox, 4 clubshell, and 8 rabbitsfoot.
- Eliminated a bridge replacement project at Eddies Road over Muddy Creek and partnered with the Service to design and implement a stream restoration project at the location.
- Partnered with the PFBC to implement a stream restoration project involving the placement of log vanes on Blue Jay Creek.
- Removed of a large concrete apron and established a natural streambed at the outlet of the existing structure at Garrett's Run Bridge.
- Entered into an Interagency Agreement with the PFBC to fund a pilot relocation studies to facilitate the transfer of animals within their range in the Commonwealth.
- Completed a dam removal project on Scholars Run.
- Contributed approximately $69,500 into the Mussel Fund as a result of unanticipated impacts associated with the Hulton Bridge project.
- Restored approximately 650 feet of stream using natural stream channel design and constructed a wetland to improve water quality to Abers Creek.
- Restored 900 feet of stream and riparian area to improve water quality in Streets Run tributary.
- Pursued initiatives in the maintenance of roads and bridges that will reduce the use of winter and other chemical materials.
- Recycled 546,788 tons of road material within the action area, resulting in the conservation of virgin stone and a reduction in oil use.
- Contributed $550 to the Mussel Conservation Fund on December 9, 2020 for the SR 6 B18, MPMS# 57940, Cambridge Springs Truss Bridge over French Creek - Crawford County- (causeway modification leading to additional stream disturbance of 55 square feet outside of the area previously salvaged).
- Contributed $2140 to the Mussel Conservation Fund in 2022, for the Wightman Road Bridge Replacement Project
- Contributed to the Mussel Conservation Fund during 2018 as follows:
  - Erie County, MPMS 72613, SR 917 - $10,000; and
  - Mercer County, MPMS 1923, SR 318 - $6,735 (restitution for a truss member that was inadvertently dropped in the water on a project cleared as not having any instream impacts).
- Continued to promote bridge designs and construction sequencing (during the design development stage of bridge replacement and preservation) that reduces adverse effects on threatened and endangered mussel habitat.

- In 2020/21, PennDOT District 10-0 completed and monitored five (5) stream restoration projects for the benefit of watersheds in the basin: SR 2029 Logansport Bridge Stream Restoration on Taylor Run, SR 85 Sunnyside Bridge on Cowanshannock Creek, US 119 Homer City North on Two Lick Creek, SR 56 United High School Curve on Mardis Run, and SR 217 Grange Bridge on Stewart Run. In 2020/21 PennDOT District 12-0 completed and monitored ten (10) stream restoration projects for the benefit of watersheds in the basin: Lick Run in Westmoreland County, Dutch Hollow in Westmoreland County, Hunters Run in Westmoreland County, Tributary to Chartiers Creek in the Brigich Farm in Washington County, Tributary to Pigeon Creek in Washington County, Owl Hollow in Washington County, Jacobs Creek at Bridgeport Park, Ralston Run in Washington County, Pike Run in Rotary Park in Washington County, and Sherrick Run in Westmoreland County.
- PennDOT District 2-0 continued its practice of using their special provision (*i.e.,* capping the allowable absorption rate of aggregate contained within asphalt) to reduce new virgin aggregate use in the asphalt mixes.
- PennDOT Districts 1-0, 10-0, 11-0 and 12-0 pursued the following efforts during 2020 to reuse or recycle pavement materials to reduce aggregate procurement.
    - District 1-0, used 10,450 tons of High RAP binder to pave about 5.81 miles of roadway (cost savings of nearly $170K when compared to virgin warm mix binder asphalt). The District extracted about 977 tons of coated #8 aggregate stone for reuse at an average cost of $15/ton.
    - District 10-0 recycled 122,512.9 tons of millings during the 2020 construction season resulting in conservation of virgin stone/aggregate resources.
    - District 11-0 recycled #8 aggregate from millings as part of the seal coat process in Lawrence County resulting in reduced oil use by 0.04 gallon per square yard (about 280 gallons per lane mile). They also eliminated the need for 16 pounds per square yard (56 ton per lane mile) of virgin stone, conserving 3,716 tons within 32.6 miles of sealcoating.
    - District 11-0 also used 12,724 tons of RAP to complete base repair operations and 2,086 tons of RAP material for mechanized patches in Allegheny County further reducing virgin aggregate needs.
    - District 12-0 used 80,378 tons of recycled millings during the 2020 construction season resulting in conservation of virgin stone/aggregate resources.

The new Bridge Program will include similar conservation actions. These actions are intended not only to compensate for unavoidable impacts of bridge projects to species, habitats, and resource sites, but to achieve a net conservation benefit. As such, the mitigation and conservation actions allow the Bridge Program to support sections 7(a)(1) and 7(a)(2) of the Act and to achieve compliance related to broader habitat and resource concerns under the Fish and Wildlife Coordination Act, Compensatory Mitigation Rule of section 404 of the Clean Water Act, the Executive Order for Environmental Stewardship and Transportation Infrastructure Project Reviews (EO13274), and the FHWA's Eco-logical approach. Conservation priorities will be developed, the most effective actions will be identified and targeted, and integrated consideration of issues related to all applicable resources and regulations will occur. Methodologies for measuring, tracking, and accounting for implementation and performance of mitigation and conservation actions will be reported to the Service on annually.

The types and scope of programmatic conservation measures will be based on the functional assessment of adverse effects and replacement of equivalent functional value based upon the Management Unit to support section 7(a)(1) of the Act. Certain activities performed as part of the Bridge Program that may provide an overall benefit to federally-listed endangered or threatened freshwater mussels through habitat enhancement and improved understanding of the species include the following:

1. Species surveys to improve the understanding of how particular bridge projects may affect the species recovery. To understand the effects of Bridge Program actions on listed species, PennDOT has conducted mussel surveys on reaches of Allegheny and Shenango Rivers, rather than only at bridge locations. PennDOT proposes continued commitments to conduct mussel surveys within Management Unit 3 streams, to participate in comprehensive surveys of watersheds with minimal survey data (*i.e.* Shenango River, Fourmile Run (Westmoreland County), Allegheny River (from Clinton to the Ohio river confluence), and the Ohio River (from confluence to the State line)), and may locate currently undiscovered populations or define known populations. If so, these surveys may provide information that is useful for species conservation.

2. The project proponents propose to continue to pursue and expand the reuse and recycling of pavement materials, which reduces the need for additional aggregate procurement. The Corps identified PennDOT as the primary customer for river sourced aggregate dredged from the navigable sections of the Allegheny and Ohio Rivers in Pennsylvania (Corps 2006). Gravel dredging irreparably removes and degrades habitat that could be utilized by clubshell, rayed bean, and northern riffleshell, all of which are known to occur in the navigable reach of the Allegheny River. The batched nature of this program allows a greater amount of recycling, which decreases transport costs and reduces fossil fuel use. The actual extent of recycling cannot be estimated; therefore, the conservation benefit toward preserving mussel habitat that would have been dredged to obtain aggregate for road construction cannot be quantitatively evaluated.

3. New bridges typically have an improved hydrologic opening that reduces the scour and streambed instability that can result from older, undersized bridges. However, there is no commitment in the BA to monitor the benefits of constructing bridges that result in increased streambed stability. In some locations, particularly in Management Unit 2, existing older bridge crossings may provide a substantial amount of the existing mussel habitat due to local stability at the bridge, but also contribute to local habitat degradation due to accretion and scour upstream and downstream of the bridge. There appears to be no commitment to use natural stream design concepts at new bridge sites or to adopt bridge designs that result in streambed stability; therefore, it is not possible to assess habitat benefits at a programmatic level, although this may be possible on a project-specific basis during the Tier 2 review.

4. The project proponents commit to salvage mussels from the area of direct streambed disturbance of Management Unit 1 project sites and recognize that these animals could be used to restore, reintroduce, or augment populations that may benefit the species' recovery as described in the Recovery Plan. However, no specific program or resources

are proposed to meet this objective, so it is not possible to assess the extent to which this may benefit the species.

5. There is a commitment in the Bridge Program to implement and/or support projects that would improve water quality by reducing non-point source pollution. Dam removals, open space preservation (green zone), wetland preservation, wetland restoration, streambank fencing, and stream bank restoration via establishment of native plant species are proposed in the BA. These restoration activities will be pursued in the watershed with the intention that water quality and habitat improvement is realized. Fresh water mussels may benefit from such restoration and protection projects, but there is no description of how the projects will be directed to benefit water quality, increased streambed stability, and reduced need for instream bridge maintenance activity. The BA does not commit to implement a certain number or type of projects in relation to proposed Bridge Program activities, so it is not possible to assess the extent to which these conservation projects may offset project effects or benefit the species.

6. The project proponents commit to provide an unquantified contribution to a Mussel Conservation Fund. The fund is directed at achieving clubshell and northern riffleshell Recovery Plan objectives, would help achieve conservation of clubshell and northern riffleshell, as well as rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussels, for which recovery plans have not yet been developed.

The conservation measures above may result in enhanced clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel habitat and population numbers; however, the commitment to implement these actions is speculative in the BA and the benefits that may accrue if the measures are implemented are not quantified. Therefore, it is not possible to evaluate the beneficial aspects of the Bridge Program to the six federally-listed endangered and threatened mussel species considered until the project proponents develop and commit to implementing specific actions.

<u>Assessment of effects to clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel</u>

The Bridge Program contributes, both directly and indirectly, to the vulnerability of the clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel populations in the Ohio River basin. Adverse effects are considered in the BA for each project type (Bridge Replacement, Bridge Removal, Bridge Restoration/Rehabilitation, and Bridge Preservation).

Direct effects are expected to occur in the following in-stream areas: 1) areas disturbed by geotechnical boring and instream areas used to access boring locations; 2) areas where debris falls during bridge demolition; 3) the footprint of any construction pads, cofferdams, or causeways; 4) buffers that are subjected to scour during bridge construction and demolition activities (*e.g.*, during high-flow events beneath temporary bridges between causeway sections and construction pads); 5) the footprint of new piers (permanent habitat loss); and 6) areas adjacent to the existing piers and new piers, including those areas within and adjacent to cofferdams. Direct and indirect adverse effects are expected to occur in areas subjected to siltation, contaminants, or altered flow resulting in scouring or deposition.

Specific avoidance and minimization measures (BMPs) are proposed and will be applied based on the Management Unit within which a proposed project occurs. The project proponent's use of Management Units prioritizes resource value based upon the population density of state and federally listed mussel species. Higher population density often suggests better habitat quality and increased value toward species recovery within a population. However, population density alone underestimates the conservation value of isolated populations, including those at low density. The recovery plan for the clubshell and northern riffleshell establishes goals based upon the number of reproducing populations, not overall species abundance, because even relatively large populations distributed in a linear stream system are vulnerable to single catastrophic natural or anthropogenic events. Therefore, clubshell and northern riffleshell populations in Management Units 1 and 2 may have comparable conservation value for the recovery of these species, regardless of local abundance at a particular project location. Similar population and recovery goals are still being developed for rayed bean, snuffbox, sheepnose, and rabbitsfoot but extant populations have intrinsic recovery value similar to those already established for clubshell and northern riffleshell. Without effective avoidance and minimization measures, including avoidance of instream disturbance, effective sedimentation and pollution control measures, and consideration of local stream flow hydrodynamics, these important, albeit small, populations in Management Unit 2 could be significantly reduced or lost.

Local population abundance influences the selection of minimization and conservation options. Mussel salvage, which is proposed as a minimization measure for all instream disturbance areas in Management Unit 1, will likely be effective at reducing the number of animals killed because individual animals are likely to be found during salvage efforts. In Management Unit 2, low population densities may limit the ability to detect individual mussels within the area of direct streambed disturbance. While avoidance and minimization measures are expected to consistently reduce the potential for adverse effects on mussels and their habitat, conservation measures will only have a beneficial effect if they address a factor that is limiting endangered mussel populations. For example, riparian protection within the vicinity of the bridge will only be effective as a conservation measure if local erosion or runoff is a factor limiting the mussel population and if riparian protection occurs at a scale and location sufficient to mitigate that threat.

Bridge Replacement and Removal (Management Units 1 and 2[1])

From 1998 to 2015, Bridge Program actions that have resulted in take of either clubshell or northern riffleshell have all been bridge replacement or bridge removal projects, and all have occurred in Management Unit 1.

The BA considers the area within which direct effects are expected to occur to equal the area (length multiplied by width) of the bridge over water multiplied by the width. Within this zone,

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[1] Note that this also applies to projects in Management Unit 3 that are reclassified as Management Unit 1 or 2 projects, based on mussel survey results.

adverse effects on mussels will be reduced through the implementation of minimization measures, such as incorporating temporary bridges into causeways, reducing the number of piers, and overlapping areas of necessary streambed disturbance to reduce the overall area exposed to direct disturbance. In Management Units 1 and 2, most mussels that are not salvaged from the in-stream project footprint (*i.e.,* streambed disturbance area) will be killed during geotechnical boring, bridge demolition, bridge construction, and pier removal. In addition, mussels that are not salvaged from the area immediately adjacent to the cofferdams and causeway will be killed, injured, or disturbed during bridge construction and pier removal. Take (*e.g.*, death, injury, harm) is expected to occur due to suffocation, crushing, and/or displacement by construction and demolition activities.

Preconstruction activities may involve environmental surveys, aids to navigation/channel marking, geotechnical investigations, and hydraulic investigations. Many of these activities are typically completed by foot or from a boat, and often do not require instream access or riparian disturbance that is substantial enough to result in injury of mussels. Geotechnical investigations and hydraulic surveys are used to provide information necessary for the design of the bridge and its foundations (*e.g.,* pier and abutment configuration, depth and design). The area of streambed disturbance is minimal for any individual boring location. Access to instream locations can be accomplished from a barge or boat with anchor points in deeper water, or from wheeled or tracked vehicles driving on the streambed. Endangered mussels would be killed or injured at boring points, anchor points, and in vehicle tracks, especially in Management Unit 1 where the density of these species is greatest. Further, because the information acquired through these investigations is preliminary to the bridge design, geotechnical boring has typically preceded mussel salvage or relocation efforts. Geotechnical surveys (drilling) may contribute sediment-laden fluids to receiving waters, if not properly contained. The Bridge Program will continue to minimize impacts due to geotechnical investigations by focusing boring locations onshore or through existing bridge piers. Drilling through an existing bridge deck will also minimize the risk of take, particularly in areas of higher mussel density found in Management Unit 1. PennDOT has committed to try to avoid the instream use of vehicles to access geotechnical boring sites. When instream vehicle use is necessary, they will limit access and attempt to overlap access with proposed causeway locations. However, the causeway location may not be known during preliminary design, when geotechnical investigations occur.

Prior to construction and bridge demolition, stream access and staging areas are cleared and grubbed, and equipment is moved into the area. Clearing involves cutting and removing above-ground vegetation, removing felled trees and other vegetative debris, and earthwork to remove any remaining surface vegetation and buried debris. The effects associated with clearing activities vary depending upon factors such as weather conditions, soil type, local topography, *etc*. that alter the siltation and erosion risk at a site. Clearing activities are likely to result in some degree of ground disturbance and compaction, generating the potential for soil erosion, and consequently, temporary turbidity and sedimentation. To minimize this risk, PennDOT has committed to complete clearing and grubbing in accordance with a County Conservation District approved erosion and sediment control plan and to establish sediment control measures prior to starting work.

Equipment and materials staging increases the risk of accidental spills and contaminant releases. The primary effect associated with the storage and maintenance of vehicles and equipment on construction sites is the potential for leaks and spills of fuel, hydraulic fluids, lubricants, and other chemicals from equipment and storage containers. Additional effects could include soil compaction, ground disturbance, and vegetation loss in construction staging areas. Discharge of vehicle and equipment wash water, concrete wash-out, *etc*. can also add pollutants to the soil that are then delivered to waterways. PennDOT has proposed avoidance and minimization measures that include development of a spill avoidance plan that includes creation of containment berms, personnel training, and positioning of potential contaminants away from waterways. Due to the project proponents' commitment to develop and implement Pollution Prevention Plans, toxic spills are not anticipated; therefore, the effects of such spills have not been evaluated in this opinion.

Utilities that are attached to the bridge, or adjacent to an existing or proposed bridge, may need to be relocated prior to construction. These utilities are typically moved by the utility owner, potentially under a separate permit or permit waiver. The removal and installation of instream utilities (such as buried pipelines or transmission lines) may result in significant streambed disturbance. While the utility relocation area may not overlap with bridge demolition and construction areas, the effect on the species is similar to, and additive with, other Bridge Program features. Mussels in direct impact areas (*e.g*., utility line trenches) would be expected to be killed or injured, if not salvaged and relocated. Considering utility relocation is an interrelated and interdependent activity with Bridge Program activities, it should incorporate the avoidance, minimization, and compensation measures proposed for Bridge Program actions. Utility relocation will be considered in Tier 2 project evaluations.

Any sediment originating from shoreline construction, grading, and stream access activities is likely to remain concentrated near the source before becoming mixed in the stream and will, therefore, have more of an effect on mussels closer to the source. As filter feeders on microscopic food items, the six endangered or threatened mussels are very susceptible to smothering by silt and other sediments in the water (Ellis 1936 *in* Service 1994). Siltation may also result in reduced dissolved oxygen and increased organic material at the substrate level (Ellis 1936, Harman 1974 both *in* Service 1994). At sub-lethal levels, silt interferes with feeding and metabolism in general (Aldridge *et al*. 1987 *in* Service 1994). Because juvenile mussels typically burrow completely beneath the substrate, they are particularly susceptible to siltation, which clogs the substrate interstices and suffocates the animals. Sedimentation impacts will be minimized by strict adherence to approved Erosion and Sediment Control Plans, and by regular inspection and maintenance of all erosion and sediment control features immediately after all storms.

Both barges and causeways are at risk of flooding that can result in heavy equipment (*e.g*., cranes) overtopping, capsizing, or sinking during high flow events unless precautions are taken to avoid this. Construction materials and equipment may affect mussels downstream if washed into the river and either physically transported downstream by currents, or if they spill toxic materials such as fuel into the river. Due to the project proponents' commitment to develop and implement Pollution Prevention Plans, toxic spills are not anticipated; therefore, the effects of such spills have not been evaluated in this opinion.

Access to bridge replacement and demolition locations can occur from shore, from an adjacent structure, or instream. Instream access occurs from a barge or from a temporary causeway. In Management Unit 1, when causeways are necessary, these will include construction platforms and temporary abutments to support temporary bridges within the causeway structure. The incorporation of temporary bridges obviates the need for a full causeway extending from bank to bank. Such temporary bridges are expected to reduce take by reducing the area of streambed disturbance. The temporary bridges span streambed areas where causeway fill or dewatering would have otherwise resulted in 100 percent mussel mortality. These features also reduce adverse effects on mussels by decreasing the amount of the river channel blocked by the causeway, thereby reducing backwater effects upstream and potential scour locations downstream.

The extent of adverse effects outside of the footprint of the causeway and cofferdams will depend on construction practices, river flows, silt load in disturbed substrates, and the effectiveness of erosion and sedimentation control measures. The greatest potential for substrate scouring and deposition would occur in association with the construction, presence, and removal of the causeway sections, construction platforms, and cofferdams, particularly during high flows.

Juvenile and adult clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel mussels, and fishes that serve as hosts for their glochidia, are likely to be taken (*e.g.*, killed, injured, or stressed) by substrate disturbance (*e.g.*, scouring), increased turbidity, and sediment deposition. In addition, the physical presence of instream construction features (*e.g.*, construction pads, causeways, cofferdams, barges) may impair reproduction of these species upstream and downstream by affecting transport of sperm and glochidia, or by modifying host fish behavior, travel patterns, or habitat use. These effects are expected to be localized in extent and occur over a single construction season, resulting in take in the form of harm.

In the event of significant high flows while the construction pad, causeway, and cofferdam are in the river, localized scour is likely to occur in and downstream of the causeway openings, resulting in bed movement that mussels are not likely to tolerate. The scoured material, and any dislodged mussels, will be re-deposited downstream when water velocity decreases. Scouring will cause mussels to become displaced from the substrate, and either carried downstream by the current, or smothered when sediments redeposit. Those mussels not killed or injured during this process may still suffer death, injury, or increased predation risk if they are unable to right themselves and re-burrow into suitable habitat downstream. Mussels downstream of the causeway will also be subjected to the impacts (*e.g.*, gill clogging, suffocation) of sediment re-deposition.

In addition to the effects of barge anchoring and causeways, direct adverse effects resulting from bridge demolition and removal will occur in the following areas: 1) instream areas adjacent to piers and upland abutments, along with any associated cofferdams; 2) the drop zone of the bridge superstructure; 3) the area subjected to immediate siltation following bridge demolition; and 4) the areas where side-slope failure occurs during pier excavation. Avoidance and minimization measures will be used to reduce the area of streambed disturbance. The bridge structure will be removed to the extent that can be safely accomplished prior to demolition, and any remaining bridge members will be cut by charges and dropped into the stream. Demolished bridge sections will be lifted from the channel not dragged. Bridge piers and abutments will be removed to the substrate level or, if deeper, will be filled with natural streambed material to recover habitat. Mussels that are not salvaged and relocated from direct impact areas prior to bridge demolition will be killed or injured by crushing, dewatering, or smothering.

Indirect adverse effects are also expected from bridge replacement and removal in Management Units 1 and 2. Indirect effects are those effects that are caused by or will result from the proposed action and are later in time but are still reasonably certain to occur (50 CFR §402.02). The areas subjected to indirect effects are less well defined than are those that will be directly disturbed. However, indirect effects are expected to occur in areas subjected to altered hydrology resulting from placement of new, smaller, mid-channel piers, including areas where the substrate is destabilized during pier construction. In addition, new bridges will alter stormwater runoff patterns as compared to the existing condition. Stormwater runoff carries silt and contaminants; therefore, changes in localized stormwater input can alter habitat suitability.

A long-term alteration in habitat quality is likely to occur within individual bridge project action areas whenever a bridge is replaced or removed. In part, this is due to a different bridge structure with a typically wider hydrologic opening. Freshwater mussels, including the eight endangered or threatened species, and one proposed listed species, are adapted to withstand the effects of variable stream flows under natural conditions, especially in an armored channel. The location of freshwater mussel habitat is the result of complex hydrologic and substrate variables (Layzer and Madison 1995; Hardison and Layzer 2001; Howard and Cuffey 2003; Daraio *et al*., 2010; Allen and Vaughn 2010) rather than only stream velocity. At increasingly higher flows, a widened stream channel will reconfigure through scour and deposition. These effects may be far reaching, particularly where a bridge pier and abutments have created a hydrologic control for a long period. Long-term, habitat alteration can be expected to occur from several years to several decades post-construction, depending on the occurrence of high-flow stream events, channel morphology, and substrate composition. Velocity patterns will change in response to the new bridge, altering riverbed stability, and aggregation and scour patterns. The altered channel configuration is likely to result in sediment re-deposition in some areas of existing mussel habitat, as well as scour and re-deposition. The individual animals affected may die or fail to reproduce in the altered habitat due to changes in fish host distribution. A long-term reduction in habitat availability or quality for endangered mussels and/or their host fish would prevent the species from maintaining a population in the vicinity of the bridge even if immediate mortality is minimal.

Habitat degradation in the form of water quality impairment may occur as a result of the operation and maintenance of new bridges. In-stream areas are likely to be degraded by runoff from the bridge deck when rain flushes oil, dirt, and other road surface deposits directly into the river. Declines in mussel populations have been documented downstream of bridges; these declines appear, in part, to be related to water quality changes (Andersen *et. al* 2003). Water quality degradation may result from bridge deck and approach road runoff carrying silt, hydrocarbons, and de-icing materials. New de-icing materials may be adopted, or developed, during the life of the bridge. To the extent that these materials reach the receiving water below the bridge, endangered mussels may be adversely affected. The risk to listed mussels from bridge deck runoff is inversely related to the amount of runoff that can be intercepted and treated, rather than directly discharged to the stream or river. For new bridges, the bridge deck drainage system will be designed to intercept runoff using scuppers near the ends of the bridge, and in troughs below the tooth expansion dams at the abutments. Collected drainage will be conveyed through a piping system until runoff can be discharged to the ground on erosion and sediment-controlled areas. Directing some runoff to land based areas will ameliorate some of the risk from bridge deck runoff.

While the design of new bridges is expected to reduce the maintenance needed (compared to existing bridges), the widened high-flow channel that results from grading the stream banks is likely to induce the development of gravel bars. This may further alter mussel habitat if debris is entrained, or subsequent bridge maintenance actions are proposed to remove the accumulated gravel.

A large proportion of the mussels within bridge replacement project areas in Management Unit 1 are likely to be killed or injured during and after construction. However, the mussel community is not expected to be limited to the project area. Both the mussel community and populations of individual species (including endangered and threatened species) are expected to extend upstream and/or downstream of the project area. This provides an opportunity for the community and individual species populations to re-establish in the area that was affected by the project, provided suitable habitat and water quality are restored post-construction.

By management unit definition, endangered mussel populations will have much lower abundance in Management Unit 2 of the Bridge Program action area (and all known snuffbox occurrences in Pennsylvania are in Management Unit 1). For similar project actions, the proportion of the population that is killed or injured will be similar to actions in Management Unit 1, but take of fewer individual mussels will occur. However, as a consequence of small and diffuse populations, the likelihood of natural recovery is reduced. Northern riffleshell, and perhaps rayed bean, appear to be more density-dependent for successful reproduction, and may therefore be expected to be susceptible to even small reductions in abundance as compared to clubshell, snuffbox, sheepnose, or rabbitsfoot. Northern riffleshell is currently known from only the Allegheny River, French Creek, and direct tributaries to these streams. The rabbitsfoot has a similar distribution but is typically far less abundant and also occurs in the Shenango River. The tributary streams that support northern riffleshell and rabbitsfoot in the French Creek drainage are included in Management Unit 2, but these populations are not isolated from the larger downstream populations. Recovery of this species in a Management Unit 2 project area is likely, provided suitable habitat conditions persist post-construction, but may be delayed if the site is distant from the Allegheny River or French Creek population centers. Sheepnose appears to be restricted to the Allegheny River and is not known to occur in any Management Unit 2 stream reaches. This species, however, is known to occur in the commercial navigation system of the Ohio River downstream of Pennsylvania. Similar suitable habitat is present in the lower Allegheny River and Ohio River in Pennsylvania. These reaches are poorly surveyed and sheepnose may still occur there.

In contrast to northern riffleshell and rayed bean populations, snuffbox and clubshell populations are known to persist at comparatively low abundance and in spatially isolated stream locations (Service 2008). In Management Unit 2, isolated and low abundance population may not recover from actions that result in extensive mortality through habitat alteration. Loss of such populations would be expected to reduce the overall recovery potential of clubshell by increasing the risk that a single catastrophic event could eliminate the remaining larger populations. As with northern riffleshell, implementing avoidance and minimization measures that reduce direct streambed disturbance and post-construction habitat alteration are vital to ensure that clubshell populations persist in Management Unit 2.

Limiting streambed disturbance during bridge demolition and replacement significantly reduces the expected take of endangered mussels and is expected to preserve portions of the population within Bridge Program action areas. Ensuring that undisturbed areas remain that can serve as sources of future recruitment is critical to the local population recovery. Salvaging endangered mussels further reduces take and provides an opportunity to use these animals to advance recovery. Finally, existing bridges were sometimes undersized for the stream, resulting in backwater during high flows events and concomitant local scour. New bridges, with wider hydrologic openings and smaller piers, and a drainage system that directs runoff to passive shoreline treatment areas, will result in overall habitat improvement, thereby facilitating habitat stability and local population recovery.

Overall, locally stable and reproducing populations of the eight federally-listed endangered or threatened mussels persist in the Allegheny River, French Creek, Shenango River (clubshell, rabbitsfoot, snuffbox, and round hickorynut only), and some tributaries to these streams. Bridge Program actions will periodically disturb river segments supporting these mussel populations, but the disturbance will be temporally distributed over a number of years, allowing for some local population recovery between actions. The Bridge Program avoidance and minimizations measures will reduce the direct and indirect effects of these actions and are vital to population recolonization at disturbed sites. The proposed conservation measures that offset take will contribute to the species ability to recover from localized bridge program disturbances.

Bridge Restoration/Rehabilitation (Management Units 1 and 2)

Many bridge restoration/rehabilitation and preservation projects are completed without instream access or streambed disturbance. In these instances, when avoidance measures are incorporated into the project design to avoid siltation and pollution spills, project effects on listed mussels are expected to be insignificant or discountable. When instream work is required, it is often limited to debris removal and placement of rock fill into scoured areas from the bridge deck. Although the northern riffleshell has been identified in some scour areas (Service 2002), the densities are typically low, even in Management Unit 1. In the BA, bridge restoration and rehabilitation projects that require instream disturbance are limited to an instream disturbance area of 10 percent of the stream width and the width of the bridge. Bridge preservation projects that require streambed disturbance may require a temporary causeway; therefore, the area of disturbance considered in the BA is equal to the area (length multiplied by width) of the bridge over water.

The effects of causeway placement and bridge support structures (*e.g*., bents) for a bridge preservation project are similar to those consider above for bridge replacement and removal projects. The duration of instream placement of both the causeway and temporary supports is typically much shorter, although this does not change the risk that eight federally-listed endangered or threatened mussel species, and one proposed listed mussel will be directly suffocated, crushed, or otherwise injured. The shorter duration of causeway use reduces some direct effects, such as the risk that animals will be disturbed by flooding and scour near the causeway. Further, the bridge substructure remains essentially the same for bridge restoration/rehabilitation and preservation projects; therefore, changes to local flow, scour, and deposition patterns are generally minimal and remain similar to the baseline condition.

Temporary stream diversion may be used while underpinning bridge abutments with rock fill or concrete. If exposed to stream water, concrete can leach very high pH water sufficient to kill or injure freshwater mussels (including endangered species) downstream. The use of instream diversions increases the risk that mussel will be killed in the dewatered area but reduces the risk and extent of downstream mortality due to high alkalinity.

As described in Bridge Replacement (see above), larger numbers of all eight federally-listed endangered or threatened mussels (and one proposed listed mussel) are likely to be killed or injured during Bridge Program actions in Management Unit 1. In this Management Unit, these species typically occur both upstream and downstream of bridge program action areas, which will provide sources for recolonization. The northern riffleshell, rayed bean and snuffbox appear to be relatively fast-growing, though short-lived mussel species that are capable of relatively rapid recolonization if suitable habitat, host fish, and water quality remain. Clubshell, rabbitsfoot, sheepnose, longsolid, round hickorynut, and salamander mussel populations appear to be less resilient, and these species are not typically as abundant. However, clubshell and northern riffleshell have been found to recolonize the direct disturbance area at bridge project sites when source populations are nearby. In Management Unit 2, northern riffleshell, clubshell, rayed bean and snuffbox occur at low densities and may be isolated from source populations. Loss of these populations has the potential to eliminate these species from the stream.

Bridge Preservation (Management Units 1 and 2)

Bridge preservation projects are more likely to involve in-stream activity than bridge restoration/rehabilitation projects. The in-stream project activities most often included are debris removal (removal of gravel bars and sediment deposition) and scour countermeasures (such as the application of rip rap and underpinning repairs). These projects may require the use of causeways and cofferdams, but some measures are undertaken through access from the banks or the bridge structures. The effects of causeway placement and bridge support structures for a bridge preservation project are similar to those consider above for bridge replacement and removal projects. The duration of instream placement of both the causeways, cofferdams, and temporary supports is typically much shorter, although this does not change the risk that eight federally-listed endangered or threatened mussel species, and one proposed listed mussel species will be directly suffocated, crushed, or otherwise injured. The shorter duration of causeway use reduces some direct effects, such as the risk that animals will be disturbed by flooding and scour near the causeway. Further, the bridge substructure remains essentially the same for bridge preservation projects; therefore, changes to local flow, scour, and deposition patterns are generally minimal and remain similar to the baseline condition. In the BA, direct effect areas associated with bridge preservation projects are equal to twice the area of the bridge over water (twice the length times width).

Temporary stream diversion may be used while underpinning bridge abutments with rock fill or concrete. If exposed to stream water, concrete can leach very high pH water sufficient to kill or injure freshwater mussels (including endangered species) downstream. The use of instream diversions increases the risk that mussel will be killed in the dewatered area but reduces the risk and extent of downstream mortality due to high alkalinity.

As described in Bridge Replacement (see above), larger numbers of all eight federally-listed endangered or threatened mussels and one proposed listed species are likely to be killed or injured during Bridge Program actions in Management Unit 1. In this Management Unit, these species typically occur both upstream and downstream of bridge program action areas, which will provide sources for recolonization. The northern riffleshell, rayed bean and snuffbox appear to be relatively fast-growing, though short-lived mussel species that are capable of relatively rapid recolonization if suitable habitat, host fish, and water quality remain. Clubshell, rabbitsfoot, sheepnose, longsolid, round hickorynut, and salamander mussel populations appear to be less resilient, and these species are not typically as abundant. However, clubshell and northern riffleshell have been found to recolonize the direct disturbance area at bridge project sites when source populations are nearby. In Management Unit 2, northern riffleshell, clubshell, rayed bean and snuffbox occur at low densities and may be isolated from source populations. Loss of these populations has the potential to eliminate these species from the stream.

Disaster Response and Emergency Projects

PennDOT and FEMA requested consultation regarding emergency debris removal (FEMA Category A) and emergency protective measures (FEMA Category B). Activities described for these categories are comparable to those that occur for similar programmed bridge preservation projects, but due to the immediacy inherent with an emergency action, implementation of avoidance and minimization measures may not be feasible. The most likely type of emergency that would require debris removal or protective measures would be a response to catastrophic flooding.

Debris build-up that occurs during a flood event often exacerbates local scour, so some mussel mortality may occur as a consequence of the flood and elevated scour potential. Rapid deposition or scour of sediments at a bridge crossing will likely smother resident mussel populations, although remnant individuals may colonize the area as the flood recedes. In Management Units 1, 2 and 3, removal of recently deposited sediments, or placement of rock scour protection into newly scoured areas will likely kill any endangered mussels that might remain in these areas. Instream access to scour or deposition areas by vehicle or via temporary causeways may impact streambed habitat minimally disturbed by flooding. Mussels within this pathway will be killed or injured by crushing. If scour protection or underpinning requires use of concrete within the wetted channel, high pH water could be transported downstream, resulting in injury or death of endangered mussels. Emergency actions will result in long-term habitat changes as stream flow adjusts to the reconfigured channel. These corrective actions will cause damage but to the extent that the stream channels, and mussel habitat, is re-stabilized following a flood event, ongoing mortality may be reduced.

Based on the frequency of past, major flood events that prompted emergency response actions by FEMA, the Service anticipates that three major flood events may occur during the 12-year period covered by this programmatic biological opinion. Estimating the number of structures that may be affected is difficult to determine. The majority of bridges that are over waterways that support the endangered or threatened mussels are in Management Unit 2, but the highest concentrations of clubshell, northern riffleshell, rayed bean, sheepnose, snuffbox, and rabbitsfoot are in Management Unit 1. In Management Unit 1, the Allegheny River, French Creek, and the Shenango River have flood control structures (*e.g.,* Kinzua Dam, Union City Dam, Woodcock Reservoir Dam, and Pymatuning Reservoir Dam) that are designed to reduce the potential for catastrophic flood events. Therefore, based upon past flood frequency and the presence of flood control structures in Management Unit 1, the Service estimates that no more than three FEMA Category A and B emergency response actions will occur in smaller streams in Management

Unit 1, and up to five FEMA Category A and B emergency response actions will occur in Management Unit 2.

Effects of Avoidance and Minimization Measures

The project proponents have incorporated measures into the proposed project design to avoid and minimize the adverse effects of the Bridge Program. The 2011 Bridge Program description estimated these measures would reduce adverse project effects by 35 percent. During implementation of the 2011 Bridge Program, it became apparent that a 35 percent reduction was an overestimation and the data supported a 16 percent reduction. Therefore, the applicant estimates the measures described herein will reduce take by at least 16 percent, as compared to designs that fail to incorporate these measures.

These measures are summarized in the "Avoidance, Minimization, and Conservation Measures" section of the BA, and their effects are considered in this opinion. Many of these measures involve limiting the area and duration of streambed disturbance during construction, which will limit temporal and spatial disturbance to mussels. This will allow the affected endangered mussel populations the opportunity to recruit from nearby, less disturbed habitat, and limit adverse effects on reproduction to only one reproductive season. Developing and implementing an Erosion and Sedimentation Control Plan and a Pollution Prevention and Control Plan will have the effect of reducing on-site and off-site effects, and the chance of accidental adverse events. This will limit the extent of direct and indirect effects on endangered mussels if the plans are effectively implemented.

The proposed salvage and relocation of endangered mussels from the in-stream project footprint (bridge drop area, piers, cofferdams, causeways, and construction pad) in Management Unit 1 is expected to further reduce take, although some mussels will not be found during the salvage effort and some mortality of translocated mussels is expected due to translocation-induced stress and/or placement in habitat potentially less suitable than that previously occupied. The rayed bean appears to be especially difficult to locate due to their small adult size. This species has also demonstrated high levels of mortality, perhaps due to handling stress during other salvage, holding and relocation efforts. The sheepnose appears to be limited in distribution within the bridge program action area to a section of the mainstem of the Allegheny River where few planned or unplanned bridge program actions will directly or indirect affect this species. Further, unlike the rayed bean, the sheepnose is larger and has frequently has a distinctive bright yellow color and is, therefore, a much more readily detected species during both mussel surveys and mussel salvage efforts. Noting this variability in probable success rates, salvaging and relocating mussels from areas where their survival is unlikely further reduces the number of animals that will be permanently lost. This provides an important opportunity to reduce take and advance recovery of the species by placing them in habitat that has recovered from past pollution or degradation events

Mussel salvage is an option for projects in Management Unit 2. In-lieu of salvage, protection of a 50-foot riparian habitat buffer upstream and downstream of the bridge is proposed, when feasible. The specific form that this protection will take was not specified in the BA; therefore, any benefit or conservation value cannot be evaluated at the program level. Riparian protection will not directly reduce the amount of take but is intended to provide a long-term habitat benefit. The potential compensatory effects of protecting the riparian area around an existing bridge are not quantified programmatically in the BA, and cannot be described here, but would be addressed during Tier 2 consultations on individual bridge projects.

Although total population abundance in Management Unit 2 is anticipated to be low (and sheepnose are not known to occur at all in Management Unit 2), any clubshell, northern riffleshell, rayed bean, rabbitsfoot, snuffbox, longsolid, round hickorynut, and salamander mussels within the area of direct streambed disturbance will be harmed since these mussels are not proposed to be salvaged and relocated. Further, because populations in Management Unit 2 appear to be depressed, individual projects may have profound effects on the local population, even though the anticipated take of individual endangered mussels is expected to be low. This is an especially important concern for snuffbox rabbitsfoot, longsolid, round hickorynut, and salamander mussels, as they generally occur in lower population numbers within the action area than the other species considered. Snuffbox, rabbitsfoot, round hickorynut, and salamander mussels are also more likely to be encountered in smaller streams than the other federally-listed species and are, occasionally, the only endangered or threatened species present. Nonetheless, population loss of any of the endangered or threatened mussels due to direct and indirect effects (including interrelated and interdependent actions such as utility relocation or fill and borrow activities) is possible in Management Unit 2, even when take estimates are substantially less than at Bridge Program sites in Management Unit 1.

Surveys in Management Unit 3, and minimization and conservation measures that involve salvage and relocation, are likely to be less effective for rayed bean due to the much smaller size of this mussel. For example, in qualitative mussel surveys conducted prior to the East Brady Bridge (S.R. 62) replacement project (Armstrong County, PA), the rayed bean was observed to be present but not notably abundant in the action area. However, quantitative sampling, which is less dependent on visual searches, demonstrated that this species was actually third in abundance at East Brady (Skelly and Loy 2001).

Table 8. Typical Causes and Types of Adverse Effects on Mussels and Habitat from Bridge Project Activities (shading indicates potential effect)

Effect / Project Activity (Cause)	*Stream Substrate Disturbance*	*Exposure to Sedimentation*	*Exposure to Contaminants*	*Exposure to Invasive Species*	*Habitat Degradation due to Riparian Vegetation Loss*	*Hydrologic Modifications (flow or water level changes)*	*Hydrologic Modifications (Scour)*	*Host Fish Disruption*
Vegetation clearing & grubbing								
Temporary Access Road/Staging								
Deck removal concrete/blacktop								
Deck removal wood/steel open grate								
Utility Placement or Relocation (not on bridge)								
Superstructure removal								
Substructure removal – in stream								
Substructure removal – adjacent to waterway								
Fertilizer application/seeding								
Installation of temporary bridge, access and/or causeway								
Causeway Removal								
Fuel, Paint or other storage								
Geotechnical core borings								
Bridge Design								
Stream bank stabilization/riprap/gabions								
Approach roadway construction								
Grading/excavation for substructure, approach work and temporary access								
Grading/excavation for pier construction in stream								

EFFECTS TO CRITICAL HABTIAT

The proposed action may affect and is likely to adversely affect the rabbitsfoot, longsolid, and round hickorynut critical habitat in the action area during construction, due to the instream causeways, cofferdams, and shoring, and following construction until the streambed achieves a new equilibrium with the replaced and repaired structures. This will likely occur following several bank-full flow events.

The effects of the Bridge Program to rabbitsfoot critical habitat were assessed by PennDOT and FHWA in a November 12, 2015, letter to the Service and concluded that the Bridge Program may affect rabbitsfoot critical habitat and is likely to adversely affect it. The BA (EnviroScience 2023) also concluded that the Bridge Program may affect longsolid and round hickorynut critical habitat and is likely to adversely affect it. Our analysis includes assessing how the action affects the physical and biological features, and how such effects on the PBFs will affect the survival and recovery of rabbitsfoot, longsolid, round hickorynut, and salamander mussel. The PBF's of rabbitsfoot, longsolid, round hickorynut, and salamander mussel critical habitat are detailed above in the section entitled *Status of Designated Critical Habitat.*

1) Will the proposed action temporarily to permanently alter a geomorphic stability of rabbitsfoot, longsolid, round hickorynut, and salamander mussel critical habitat in a manner that reduces the habitat function to support a diversity of freshwater mussels and native fish?

The change of the flow patterns around the existing bridge piers are likely to result in long-term effects, as flow patterns adjust to the presence of the new sub-structure around each pier base. We anticipate that shifts in locations of suitable habitat will occur, but that streambed will achieve a new equilibrium over time and that the overall amount and quality of rabbitsfoot, longsolid and round hickorynut critical habitat will then be similar to the existing condition. However, unless large flat rocks are placed or replaced to support the mussels and their host species, salamander mussel habitat may be lost or permanently altered.

2) Will the proposed action temporarily or permanently alter the hydrologic flow regime necessary to maintain (1) benthic habitats where rabbitsfoot, longsolid, round hickorynut, and salamander mussels are found; (2) connectivity of rivers with the floodplain, allowing the exchange of nutrients and sediment for maintenance of the mussels' and fish hosts' habitat and food availability; (3) spawning habitat for native fishes; and (4) the ability for newly transformed juveniles to settle and become established in their habitats?

Causeway, cofferdams, construction pads, and shoring installation sites, together with the dewatered work site will result in a temporary alteration of flow in the action area as a consequence of upstream backwater and increased water velocity between the bridged causeway, cofferdams, and shoring. During the duration of time during which the work platforms will be in place, there will likely be some substrate scouring within several feet of the in-stream construction structures during high flows, due to increased water velocities. The material will be deposited downstream when water velocity decreases.

A long-term reduction in habitat quality may occur within the footprint of the work site, in the cofferdam interiors, as the material near the existing piers will be excavated and replaced. The presence of additional concrete and rip-rap rather than native bed materials within the proposed critical habitat may reduce the quality and availability of habitat post-project. Scouring may also result in subtle changes in area hydrology, as channels are formed in the river bottom, and substrate composition is altered. In addition, without the placement or restoration of large flat rock materials to the restored substrates post-construction, habitat for salamander mussels and their host species may be lost or permanently altered.

3) Will the proposed action degrade water or sediment quality necessary to sustain natural physiological processes for normal behavior, growth, and viability of all mussel life stages?

Habitat degradation in the form of water quality impairment may also occur. There is the potential for elevated water pH, if the concrete installation at the pier bases does not cure properly or is subjected to high water events before completely curing. The potential for this will be greatly reduced by doing the work in the dry and monitoring the pH levels within the project area.

Instream areas may be adversely affected by equipment refueling and maintenance activities within the work area, especially if there is an accidental spill. This can be alleviated by preparing and implementing a Pollution Prevention Plan.

Mussels within the action area may be affected by silt once the causeway, cofferdams, and shoring are removed. Proper implementation of erosion and sedimentation controls, coupled with staged removal of the instream construction structures could minimize some of these effects. However, installation and removal of the causeway, cofferdams and shoring have not been detailed in the BA.

4) Will the proposed action preclude presence or reduce abundance of fish hosts necessary for recruitment of the rabbitsfoot, longsolid, or round hickorynut; or mud puppy hosts for salamander mussels?

Habitat for host species that for rabbitsfoot, longsolid, round hickorynut, or salamander mussel glochidia, could be adversely affected by substrate disturbance (e.g., scouring), increased turbidity, sediment deposition, and introduction of petroleum products into the river. The physical presence of construction activities may modify host species behavior, travel patterns, or habitat use. These effects are expected to be short term and localized in extent, and largely limited to the period of instream construction. Like the habitat modification described above, the amount and quality of fish habitat is likely to return as the stream channel shifts in response to the presence of the new structure. However, the salamander mussel is most likely to realize the effects of bridge replacement projects, if large flat rock substrate structures are eliminated post construction, as this habitat is necessary for both the mussels and their host species. Salamander mussels need the presence of the mudpuppy (host) for attachment and sufficient flow to ensure glochidia encounter this host.

5) Will the proposed action introduce or increase abundance of competitive or predaceous invasive (nonnative) species, to levels that effect the survival of rabbitsfoot, longsolid, round hickorynut, and salamander mussels?

PennDOT and FHWA committed to disinfect and inspect all vehicles and equipment for zebra mussels and other potential invasive or exotic species before entering streams. We do not anticipate any long-term habitat alteration will occur that would make critical habitat more conducive to invasive species that could reduce the amount or quality of habitat for survival of rabbitsfoot, longsolid, round hickorynut, or salamander mussels.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under section 7 of the Act.

A non-federal action that is reasonably likely to occur in the action area over the 12-year life of the Bridge Program is oil and gas development. Occasionally this activity may result in wetland or stream encroachments, necessitating a Corps' permit. Nevertheless, because there is often no federal action associated with this type of resource extraction activity that may require future consultation, this has been included as cumulative effect.

Gas and oil resources are present in a number of the action area watersheds where federally-listed mussels occur. In 2006, more than 3,700 permits were issued for oil and gas wells by the Pennsylvania Department of Environmental Protection, which also issued 98 citations for permit violations at 54 wells (Hopey 2007). In Pennsylvania, extraction of natural gas has increased dramatically in recent years, particularly in the Marcellus Shale formation.

Both exploratory wells and production wells in the Marcellus Shale require the construction and use of road networks and pipelines. Gas extraction from the shale requires large volumes of water to fracture (frac) the rock. Each well requires millions of gallons of water withdrawal and disposal, acres of cleared land, and truck loads of rock. The source of this water is often local streams and rivers, and the wastewater produced typically contains contaminants and high total dissolved solids that are not completely removed. The access roads and bridges required may be part of Pennsylvania's state highway network. The repair and maintenance of roads and bridges resulting from increased use due to oil and gas development may contribute to sedimentation in receiving waterways.

Freshwater mussels are very sensitive to water quality, sediment, flow changes, and most classes of contaminants. In 2009, Dunkard Creek experienced a spike in total dissolved solids and conductivity that resulted in the apparent elimination of freshwater mussels. Similar acute events and the potential for chronic siltation and water quality degradation has the potential to substantially change the Environmental Baseline considered in this opinion within the 12-year period considered.

CONCLUSION

After reviewing the current status of the clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel, the environmental baseline for the action area, the effects of Bridge Program activities, and cumulative effects, it is the Service's biological opinion that the Bridge Program is not likely to jeopardize the continued existence of these eight listed, and one proposed listed species. This determination is based upon the spatial and temporal distribution of anticipated Bridge Program activities with respect to the distribution of these listed mussel populations in the action area. In Management Unit 1, project area disturbances are such that mussel re-colonization is likely from adjacent, occupied habitat upstream and downstream of the project area (*e.g.,* U.S. Geological Survey 2002, 2008). In addition, avoidance and minimization measures will reduce the area of direct streambed disturbance, thereby reducing mussel mortality. Take will be minimized via pre-construction mussel salvaging in Management Unit 1, and conservation measures will be implemented to partially offset take over the 12-year Bridge Program period.

No critical habitat has been designated for northern riffleshell, clubshell, rayed bean, sheepnose, or snuffbox; therefore, none will be affected. However, Critical habitat was designated for rabbitsfoot on April 30, 2015, *Federal Register;* the longsolid on March 9, 2023, *Federal register*; the round hickorynut on March 9, 2023, *Federal Register*; and proposed for the salamander mussel on August 22. 2023 *Federal Register*. The Bridge Program is likely to adversely affect rabbitsfoot, longsolid, round hickorynut, and salamander mussel critical habitat during construction and for a period of time afterward until a new stream channel equilibrium is established. We anticipate that these changes will be temporary because a comparable area of suitable rabbitsfoot, longsolid, and round hickorynut habitat will become reestablished following several high (e.g., bank full) channel-shaping flow events. Therefore, after reviewing the current status of rabbitsfoot, longsolid and round hickorynut, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the Bridge Program, as proposed, is not likely to destroy or adversely modify designated critical habitat for rabbitsfoot, longsolid, or round hickorynut. However, without the presence of flat rocks and bedrock that provide crevices for shelter for the mussel and the mudpuppy (host) the Bridge Program may adversely modify salamander mussel critical habitat, unless FHWA and PennDOT take measures to ensure that these habitat "shelters" are replicated or restored.

The implementing regulations for section 7 define "jeopardize the continued existence of" as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402). This definition directs us to assess whether an *appreciable decrease* in the *probability* of survival and recovery is expected. Appreciable means noticeable, perceivable, or measurable. Therefore, our jeopardy analysis focuses on determining whether the anticipated reductions in the species' reproduction, numbers, or distribution would reasonably be expected to noticeably, perceivably, or measurably decrease the species' probability of survival and recovery.

An action would jeopardize a species if it appreciably reduced the species' ability to survive and retain sufficient resilience to allow recovery from endangerment. Survival is a condition characterized by a species with a sufficiently large population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter. Recovery would be compromised if an action made it difficult for a species to retain sufficient resilience to allow recovery from endangerment or if an action impeded the removal of threats to the species so self-sustaining and self-regulating populations can be supported as persistent members of native biotic communities.

Clubshell, northern riffleshell, rayed bean, snuffbox, rabbitsfoot sheepnose, longsolid, round hickorynut, and salamander mussels, like most freshwater mussels, have the potential to produce large numbers of young annually. However, survival of young is typically very low due to predation, the need for glochidia to attach to specific host species, stochastic events such as flooding and droughts, and sensitivity to contaminants and excessive siltation. The low annual recruitment is balanced by a comparatively long reproductive life of adult mussels. Site-specific disturbance that does not result in adult mortality is still likely to result in local recruitment failure during and following construction. However, provided habitat stability and water quality are maintained or enhanced, affected mussels may successfully reproduce in future years. The avoidance and minimization measures are vital for reducing the anticipated levels of take and increasing the likelihood that mussels will re-colonize and successfully reproduce in and near bridge project areas. Conservation measures that result in habitat enhancement or protection will facilitate recruitment away from bridge project sites.

The Bridge Program will affect both the numbers and distribution of the eight endangered or threatened mussel species, and one proposed threatened mussel species in ways that could affect the species likelihood of recovery. Genetic data for the species studied indicate slow rates of dispersal within the Allegheny River and its tributaries. Degraded habitats support low densities of these evidently sensitive endangered mussels, reducing opportunities for dispersal to other sites within the Bridge Program action area. Several isolated populations exist that cannot recover naturally due to unsuitable intervening habitats (*e.g.,* polluted reaches, dams, *etc.*). Single events can eliminate these small populations, and thereby further reduce the likelihood of species recovery. Particularly in Management Unit 2, a single bridge program action could eliminate an isolated clubshell, snuffbox, round hickorynut, or salamander mussel population. Even though the total number of mussels killed may be comparatively small, the loss of these remnant populations could have important implications for the species recovery. The avoidance, minimization and conservation measures are vital to reduce and offset the effects of Bridge Program implementation and allow or facilitate species recovery. With these measures, the project proponents have determined that no populations of endangered mussels will be eliminated. During Tier 2 consultation, the Service will evaluate site-specific conditions to ensure that we concur with this assumption.

The Service anticipates that take in the form of harm and harassment (as defined in 50 CFR §17.3) will occur as a result of the proposed action. The actual level of take will be difficult to detect or quantify because individual mussels (juveniles and adults) are small and often buried in the substrate, making it unlikely to locate all individuals; therefore, the Service will use occupied habitat as a surrogate for analyzing the effects of the Bridge Program to the eight federally listed mussel species, and one proposed listed species.

Direct effects from the action (Table 8) are initially expected to disturb 452,261 square meters of northern riffleshell habitat (Table 9 and Appendix C) over a 12-year period. The number of individuals killed will be reduced after mussel salvage operations are completed (Table 8) in Management Unit 1. After FHWA and PennDOT implements avoidance and minimization measures, the direct effects from the action to northern riffleshell habitat will be reduced to about 379,868 square meters. An additional, unquantified number of northern riffleshell may be killed, harmed, or harassed through the indirect effects of bridge program actions. Cumulatively, these projects will only affect a small percentage of known northern riffleshell habitat and the disturbance will occur in widely spaced locations over a period of years. The overall amount of available habitat is not expected to be reduced, and population recovery from adjacent undisturbed portions of the action area is likely to occur after each project is completed.

Direct effects from the action (Table 8) are initially expected to disturb 451,639 square meters of clubshell habitat (Table 9 and Appendix C) over a 12-year period. The number of individuals killed will be reduced after mussel salvage operations are completed (Table 8) in Management Unit 1. With implementation of avoidance and minimization measures, the direct effects from the action to clubshell habitat will be reduced to about 379,464 square meters. As with northern riffleshell, the habitat disturbance associated with bridge projects is expected to be a relatively small percentage of the overall clubshell habitat, and impacts will be temporary with implementation of best management practices. Similarly, clubshell recolonization of disturbed areas is likely to occur, albeit at a slower rate than for northern riffleshell, based on the lower reproductive potential of this species. We expect that local populations will eventually recover to near pre-project numbers over time.

Direct effects from the action (Table 8) are initially expected to disturb 462,497 square meters of rayed bean habitat, 461,878 square meters of snuffbox habitat, 435,894 square meters of sheepnose habitat, and 461,835 square meters of rabbitsfoot habitat (Appendix C) over a 12-year period. With implementation of avoidance and minimization measures, the direct effects from the action to mussel habitat will be reduced to about 388,464 square meters (rayed bean); 387,944 square meters (snuffbox); 366,151 square meters (sheepnose); and 387,908 square meters (rabbitsfoot) (Table 9 and Appendix C). Rayed bean and snuffbox are small and difficult to detect; therefore, salvage success will be less than for clubshell or northern riffleshell. There are no studies that have evaluated surface detection for these species but based on the disparate results from qualitative vs. quantitative sampling methods for small species like the rayed bean, we estimate only a quarter of The rayed bean and snuffbox are likely to be found during pre-construction searches. By contrast, sheepnose and rabbitsfoot are substantially larger and more noticeable at the substrate surface, and although few bridge projects are proposed in Management Unit 1, we estimate half of the sheepnose and rabbitsfoot would be salvaged from the area of direct streambed disturbance. As described above for clubshell and northern riffleshell, the largely temporary disturbance that occurs during the bridge program actions should allow habitat to stabilize, and the stabilized habitat should eventually be recolonized over time.

Direct effects from the action (Table 8) are initially expected to disturb 463,122 square meters of longsolid habitat, 438,733 square meters of round hickorynut habitat, and 445,321 square meters of the proposed salamander mussel habitat (Appendix C) over a 12-year period. With implementation of avoidance and minimization measures, the direct effects from the action to mussel habitat will be reduced to about 388,988 square meters (longsolid); 368,536 square meters (round hickorynut); and 373,978 square meters (salamander mussel) (Table 9 and Appendix C). Like the rayed bean and snuffbox, the salamander mussel is small and difficult to detect; and they are often hidden away under large slabs of rock or flat structures. They are uncommon, rarely collected (Parmalee and Bogan 1998) have a limited distribution and have narrow habitat requirements. Therefore, salvage success will also be less than for clubshell, northern riffleshell, sheepnose, longsolid, round hickorynut, and rabbitsfoot.

There are no studies that have evaluated surface detection for this species but based on the disparate results from qualitative vs. quantitative sampling methods for small species like the salamander mussel, we estimate only a small percentage of the salamander mussels are likely to be found during pre-construction searches, if at all. By contrast, longsolid and round hickorynut are substantially larger and more noticeable at the substrate surface, and although few bridge projects are proposed in Management Unit 1, we estimate that similar to clubshell and northern riffleshell (Smith et al. 2001), a third to half of the longsolid and round hickorynut could be salvaged from the area of direct streambed disturbance. As described above for clubshell and northern riffleshell, the largely temporary disturbance that occurs during the bridge program actions should allow habitat to stabilize, and the stabilized habitat should eventually be recolonized over time.

Recovery of northern riffleshell, clubshell, rayed bean, snuffbox, rabbitsfoot, longsolid, round hickorynut, and salamander mussel in Management Unit 2 is expected to be more dependent on full implementation of avoidance and minimization measures than in Management Unit 1, because of the reduced number, sparse distribution, narrow habitat requirements (salamander mussel), and increased vulnerability of endangered or threatened mussels in Management Unit 2. Nonetheless, the effects of Bridge Program actions on endangered or threatened mussels and their habitats as described in the BA and considered above will likely be temporary, presenting the potential for species recolonization or reintroduction following completion of individual projects.

Table 9. Initial and minimized direct impacts to mussel habitat over a 12-year PBO period (Adapted from Table 3 and Table 7 of the BA (EnviroScience 2023). For expanded Table, please see Appendix C.

Mussel Species	Initial Impact (M^2)	Minimized Impact (M^2)
Northern Riffleshell	452,261	379,868
Clubshell	451,639	379,345
Rayed Bean	462,497	388,464
Snuffbox	461,878	387,944
Rabbitsfoot	461,835	387,908
Sheepnose	435,894	366,151
Longsolid	463,122	388,988
Round Hickorynut	438,733	368,536
Salamander Mussel	445,321	373,978

Direct effects from the action (Table 8) are expected to impact 34,694 square meters of designated rabbitsfoot critical habitat; 53,234 square meters of designated longsolid critical habitat; and 5,000 square meters of designated round hickorynut critical habitat over a 12-year period (Table 10). This will only affect a small percentage of critical habitat and the disturbance will occur in widely spaced locations over a period of years. The streambed will achieve a new equilibrium following construction; therefore, the Service anticipates a temporary loss and shifting of habitat, but overall habitat quantity should remain similar to pre-construction levels.

Table 10. Critical Habitat take estimates (Mussels/M^2) (Adapted from Table 6 of the Mussel BA (EnvironScience 2023)).

	Rabbitsfoot	**Longsolid**	**Round Hickorynut**	**Salamander Mussel**	**Critical Habitat]* Area (m2)**
Total Mussel Take (No.)	**27,190**	**937**	**852**	**1,222**	
Planned (No.)	6432	327	241	357	
Unplanned (No.)	20,758	611	611	865	
Critical Habitat* Area (m^2)	17,347 **[34,694]**	26,617 **[53,234]**	38 **[5,000]****	**Unknown*****	44,002 **[92,928]**

*Note: Critical habitat by specific species was best calculated for planned projects where the exact location of projects as they overlap with designated critical habitats were known. Total estimated critical habitat for the bridge program for planned and unplanned projects was then estimated by doubling the take of planned projects for most critical habitats and is shown above in [brackets] with one exception.

**The exception to the standard critical habitat take calculation was Round Hickorynut where only one planned deck replacement project was known. Due to the likelihood of additional unplanned impacts that could result from an unplanned bridge replacement or similar project, the total estimated take of Round Hickorynut Critical Habitat was estimated as 5,000m^2 for purposes of this BA.

***Salamander Mussel is proposed to be listed, and as such critical habitat is only proposed for this species.

The Service's evaluation of the effects of the Bridge Program on federally-listed species was based largely on a Program description that includes an extensive set of avoidance, minimization, and conservation measures to reduce the most significant direct and indirect effects on clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel. The project proponents propose to include these measures as part of the agency action; therefore, they were considered as an integral part of the Bridge Program and are nondiscretionary. Additionally, PennDOT and the action agencies will conduct further informal or formal consultation (Tier 2) on individual projects implemented within the Bridge Program action area in Management Units 1, 2, and 3. These consultations and annual program reviews will provide opportunities to assess the efficacy of Bridge Program avoidance, minimization, and conservation measures, and implications for survival and recovery of each of the eight federally-listed mussel species, and one proposed listed species considered herein.

After fully considering the environmental baseline; proposed avoidance, minimization, and conservation measures; the direct and indirect effects of the proposed action; and the cumulative effects, the Service has concluded that the northern riffleshell, clubshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel populations in the action area will recover to levels slightly below their present levels.

INCIDENTAL TAKE STATEMENT

Sections 4(d) and 9 of the Act, as amended, prohibit the take (harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided such taking is in compliance with the terms and conditions of this incidental take statement.

This programmatic consultation involves a two-tiered approach: Tier 1 consists of the programmatic consultation on the action agency's Bridge Program (a framework programmatic action), while Tier 2 involves streamlined section 7 consultations on individual actions carried out under this framework. Issuance of this programmatic biological opinion will not itself result in the take of listed species; therefore, no incidental take is anticipated and that the issue will be reexamined during the consultation process for site-specific actions under the umbrella of the larger planning document.

INDIVIDUAL PROJECT CONSULTATION (TIER 2)

Individual projects or actions carried out under PennDOT's Bridge Program must undergo individual (Tier 2) consultation to ensure consistency with programmatic conservation measures outlined within the Bridge Program description (avoidance, minimization and conservation measures). This programmatic consultation will be implemented in the following manner for Tier 2 consultation on individual projects or actions carried out under the Bridge Program in Management Units 1, 2 and 3.

1. The Federal Action Agency (or PennDOT, acting on their behalf) will submit a letter requesting consultation on the proposed individual project or action. The request will include the following: (a) a brief description of the project or action (including, but not limited to, site plans; project footprint; site photos; biological survey data; bridge demolition methods; the use, extent and placement of causeways, cofferdams, and access; project action area) and a map showing the location; (b) a determination of whether or not the project or action may affect federally listed species or their habitat; (c) a summary of any anticipated deviation from the Bridge Program description (avoidance, minimization and conservation measures)

detailed in this programmatic Biological Opinion; (d) an analysis of the effects of the project or action on federally listed species and their habitat, and (e) a summary of any new relevant information or other factors not considered during the programmatic consultation.

2. The Service will review the effects of the proposed project or action.

   A. If the project or action may affect but is not likely to adversely affect federally listed species, the consultation will be concluded through informal consultation.

   B. If the project is likely to adversely affect federally-listed mussels/designated critical habitat and the project type and effects are encompassed by this programmatic biological opinion, the Service will provide a streamlined formal consultation. The Service will verify the take levels contained in the project biological assessment. The regulations which implement section 7 allow the Service up to 90 days to conclude formal consultation and an additional 45 days to prepare a biological opinion. However, because this programmatic biological opinion streamlines the consultation process, the Service anticipates that issuance of a biological opinion in association with a Tier 2 formal consultation will take 60 days.

If the Federal Action Agency, PennDOT, or the Service determine that the potential effects of a proposed project or action, including the direct, indirect, interrelated and interdependent effects, fall outside the scope of this programmatic consultation, PennDOT and the Federal Action Agency will request initiation of a separate formal consultation. In that case, the standard provisions for section 7 consultation (*i.e.*, submission of a full biological assessment by FHWA, FEMA, or the Corps, up to 90 days to conclude formal consultation, and an additional 45 days for the Service to prepare a biological opinion) will apply throughout the remainder of the review process.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid the adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans (or conservation strategies for those recently listed species for which recovery plans have not yet been published), or to develop information.

The Service has identified the following actions which, if undertaken by PennDOT and/or FHWA, would further the conservation and assist in the recovery of the clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, or salamander mussel.

1. Implement conservation strategies identified by PennDOT's working group on mussels.

2. Participate in the development of conservation plans for clubshell, northern riffleshell, rayed bean, snuffbox, rabbitsfoot, sheepnose, longsolid, round hickorynut, or salamander mussels in Pennsylvania, along with agencies that carry out activities that potentially affect this species (see clubshell and northern riffleshell Recovery Plan, Task 1 for these species).

3. Seek opportunities to participate in efforts to recover clubshell, northern riffleshell, rayed bean, snuffbox, rabbitsfoot, sheepnose, long solid, round hickorynut, or salamander mussels throughout the species' historic range (see clubshell and northern riffleshell Recovery Plan, Task 4 for these species).

4. Support research to determine captive husbandry techniques suitable for propagation of clubshell, northern riffleshell, rayed bean, snuffbox, rabbitsfoot, sheepnose, long solid, round hickorynut, or salamander mussels if identified in species' recovery plans. This action would partially meet the objectives of the Clubshell and Northern riffleshell Recovery Plan (Tasks 4.23, 4.24, and 4.3 for these species) and may offset project-related effects elsewhere.

5. Within the Allegheny River and Shenango River watershed, implement and/or support projects that would improve water quality by reducing non-point source pollution. Such projects would include, but are not limited to, wetland preservation, wetland restoration, streambank fencing, and streambank restoration (via establishment of native plant species). This action would partially meet the objectives of the clubshell and northern riffleshell recovery plan (Recovery Plan, Task 2.2) and recovery plans under development for the covered species and may offset project-related effects elsewhere. See Appendix B.

6. Support research to further define the species' habitat requirements (see clubshell and northern riffleshell Recovery Plan, Task 3 for these species), and provide additional details regarding the species' distribution and threats (clubshell and northern riffleshell Recovery Plan, Task 2.5) and recovery actions developed for the other covered species when made available.

To be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of the conservation recommendations carried out.

REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the information presented with FHWA's June 20, 2023, biological assessment addendum request for initiation of formal consultation, and an emailed conferencing request of September 6, 2023, and is valid until May 31, 2036. As written in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law), and if (1) the amount or extent of incidental take is exceeded; (2) new information reveals the agency action may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In Instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease, pending reinitiation.

If the salamander mussel is designated as an endangered or threatened species, you may ask the Service to confirm the conference report portion of this document as a biological opinion for this species. The request must be in writing. If the Service reviews the proposed action and finds that there have been no significant changes in the action as planned, or in the information used during the conference, the Service will confirm the conference report as the biological opinion on the Bridge Program.

ADMINISTRATION OF THE PROGRAMMATIC BIOLOGICAL OPINION

Annually, the Service will evaluate the effects of actions that have occurred under this programmatic consultation to ensure that the continued implementation of the Bridge Program does not result in long-term adverse effects on the federally listed species covered by this programmatic biological opinion and the habitats upon which they depend. If unanticipated adverse effects on listed species are identified, new species are listed, or additional federally-listed species are documented to occur within the Bridge Program area, the Service will request that FHWA, as the lead federal agency, re-initiate formal programmatic consultation. This Biological Opinion may be modified or amended to address additional adverse effects on listed species that have not been previously evaluated.

ROBERT ANDERSON Digitally signed by ROBERT ANDERSON
Date: 2024.05.30 14:19:11 -04'00'

Robert M. Anderson Date
Acting Field Office Supervisor

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CONSULTATION HISTORY

The consultation history includes the past section 7 programmatic consultation for the bridge program; however, individual consultations regarding bridge replacement projects is contained within the administrative record of the individual actions and is not reiterated within this biological opinion. The individual bridge project consultations, informal consultations with the FEMA regarding past emergency bridge actions, and the programmatic efforts summarized above have all informed this programmatic consultation and the development of the BA.

Prior to FHWA requests to initiate consultation, the Service participated in numerous meetings, telephone calls, document reviews and other discussions. A summary of the consultation history for this programmatic consultation follows.

May 18, 2007	The Service, FHWA, PennDOT and PFBC participated in a conference call to discuss the scope of a possible mussel programmatic agreement.
May 21, 2007	The Service provided PennDOT with comments and edits regarding a business case to pursue a programmatic agreement regarding endangered mussels.
December 4, 2008	Service, PennDOT, PFBC and Pennsylvania Department of Environmental Protection (PADEP) staff met to discuss the status of the programmatic consultation and assessment.
October 27, 2009	The Service received PennDOT's request for review of a draft programmatic BA.
December 9, 2009	The Service provided PennDOT with comments regarding the draft BA, emphasizing that further development of the assessment and additional informal consultation was needed among the various involved agencies to improve the effectiveness and utility of the programmatic assessment to meet FHWA conservation guidance.
January 22, 2010	The Service met with PennDOT, FHWA, PFBC, and Corps to discuss the draft programmatic BA and review the goals and approach proposed in the draft assessment. The Service provided specific recommendations to reduce ambiguity regarding the project description and avoidance, minimization and conservation measures.
February 18, 2010	The Service, PFBC, PennDOT and their consultants participated in a conference call to review some revisions in the draft BA since the January 22, 2010, meeting.
April 23, 2010	The Service received FHWA's April 20, 2010, request to initiate formal consultation.

May 21, 2010	The Service and FHWA agreed to a 60-day extension regarding the programmatic consultation due to the complex nature of the consultation and FHWA's concurrent April 22, 2010, request to initiate formal consultation regarding a separate bridge replacement project that was not included as a proposed project within the programmatic BA for the Bridge Program.
June 4, 2010	FHWA agreed in writing to a 60-day extension for the programmatic consultation, with the consultation to end September 19, 2010, and the biological opinion due November 4, 2010.
September 7, 2010	The Service and FHWA agreed to an additional 60-day extension of the consultation period in order to expedite FHWA's July 22, 2010, request for reinitiation of formal consultation on the Gravel Run Road bridge removal project, a bridge that was in serious danger of catastrophic collapse.
February 9, 2011	The Service and FHWA agreed to an additional 60-day extension of the consultation period due to consultation complexity, with anticipated completion on February 28, 2011.
February 23, 2011	FHWA provided written notification of the extension for the development of a Bridge Program biological opinion to be due March 31, 2011.
April 25, 2011	The Service received FHWA's request to meet to discuss development of the draft programmatic biological opinion.
May 19, 2011	The Service and FHWA met to discuss the status of the programmatic consultation.
June 17, 2011	The draft biological opinion was completed and delivered to the FHWA, Corps and FEMA for review and comment.
October 4, 2011	The Service received comments from the FHWA on the draft biological opinion.
March 2, 2012	The FHWA requested reinitiation of formal consultation to consider the effects of the Bridge Program on the rayed bean and snuffbox.
March 14, 2012	The FHWA requested reinitiation of formal consultation to consider the sheepnose.
December 6, 2012	The Service provided the revised final biological opinion to the FHWA, Corps, and FEMA.

February 2013	PennDOT submitted the calendar year 2012 annual report to the Service. The report contained updates on Tier I and Tier II consultation activities covered under the Programmatic Biological Opinion.
October 17, 2013	The Service received the FHWA's September 26, 2013, request to reinitiate formal consultation to consider the effects of the Bridge Program on the rabbitsfoot.
December 13, 2013	The Service provided the revised final biological opinion to the FHWA, Corps, and FEMA
February 2015	PennDOT submitted the calendar year 2014 annual report to the Service. The report contained updates on Tier I and Tier II consultation activities covered under the Programmatic Biological Opinion.
August 25, 2015	The FHWA sent the Service a revised BA for PennDOT's bridge replacement program and requested reinitiation of formal consultation. The updated BA included a new 5-year time frame, additional bridge projects, and changes to the avoidance, minimization, and conservation measures
September 10, 2015	The Service sent PennDOT an email requesting an electronic copy of the BA.
September 10, 2015	PennDOT sent an email to the Service providing an electronic copy of the BA addendum.
October 8, 2015	The Service sent PennDOT and FHWA an email requesting clarification of "alternative causeway/cofferdam technologies" reference in the BA.
October 8, 2015	PennDOT sent the Service an email providing clarification. The text was referencing aqua dam technology but may include new technology in the future.
October 9, 2015	The Service sent PennDOT an email inquiring about discrepancies in the BA.
October 19, 2015	PennDOT sent the Service an email with new information on the proposed Bridge Program projects, correcting the discrepancies in the BA.

November 4, 2015	The Service requested additional information from FHWA. The information requested included a justification for the reduction minimized project area impact and an effect determination for rabbitsfoot critical habitat.
November 12, 2015	FHWA provided the information requested in the Service's November 4, 2015, letter.
January 29, 2016	The Service issued a new biological opinion to the FHWA, Corps, and FEMA.
March 11, 2016	The Service met with FHWA and PennDOT to discuss minor revisions to the new biological opinion.
April 5, 2016	PennDOT provided comments on the draft biological opinion.
April 19, 2016	PennDOT provided the Service with an updated project list.
May 3, 2016	The Service sent PennDOT and FHWA an email adding additional stream reaches to Management Unit 2. PennDOT responded to the email on May 9, 2016, indicating there were no planned bridge projects in the area.
May 13, 2016	The Service issued a revised programmatic biological opinion to the FHWA, Corps, and FEMA.
September 8, 2021	FHWA and PennDOT requested an extension to the expired PBO until May 31, 2022, and proposed to continue operating under the existing PBO while preparing an Addendum to the Programmatic BA.
November 5, 2021	The Service agreed to extend the PBO to May 31, 2022, recommended that FHWA reinitiate formal consultation prior to January 16, 2022, and requested that the BA addendum consider the longsolid (*Fusconaia subrotunda*) or round hickorynut (*Obovaria subrotunda*).
July 14, 2022	FHWA and PennDOT requested another extension to the expired PBO until March 2023, and proposed to continue operating under the existing PBO while preparing an Addendum to the BA. FHWA proposed to submit a PBO Addendum and formal PBO reinitiation request no later than September 2022

July 28, 2023	The Service agreed to extend the programmatic biological opinion to March 2023, recommended that FHWA reinitiate formal consultation prior to September 2022, and requested that the BA addendum consider the longsolid (*Fusconaia subrotunda*) or round hickorynut (*Obovaria subrotunda*).
June 20, 2023	FHWA and PennDOT sent the Service a request for reinitiation of formal consultation and a revised BA addendum for PennDOT's bridge replacement program. The updated BA addendum included a new 12-year time frame; additional bridge projects; improved conservation measures; updated mussel survey information; and consideration of the longsolid (*Fusconaia subrotunda*) or round hickorynut (*Obovaria subrotunda*) mussels.
August 24, 2023	The Service provided PennDOT with information on the Service's proposal to list the salamander mussel (*Simpsonaias ambigua*), and its proposed critical habitat.
September 7, 2023	FHWA and PennDOT requested a programmatic conference report for the proposed-listed, endangered salamander mussel in the Ohio River Basin of Pennsylvania.
November 8, 2023	The service requested an extension of time to review and sign the final Mussel programmatic biological opinion.
May 31, 2024	The Service issued a revised programmatic biological opinion to the FHWA, Corps, FEMA, and PennDOT.

APPENDIX A. WATERWAYS THAT SUPPORT CLUBSHELL, NORTHERN RIFFLESHELL, RAYED BEAN, SNUFFBOX, SHEEPNOSE, RABBITSFOOT, LONGSOLID, ROUND HICKORYNUT, AND SALAMANDER MUSSEL POPULATIONS (ADAPTED FROM THE PROGRAMMATIC BA, APPENDIX A, MAP 1)

I. MANAGEMENT UNIT 1: Stream reaches documented to support federally-listed endangered or threatened mussels, and site population density may exceed 0.5 per square meter

A. Allegheny River, between the Conewango Creek confluence and the City of East Brady (*i.e.,* Warren, Forest, Venango, Clarion, Armstrong, and Butler Counties) [PENNDOT Districts 1-0 and 10-0]
B. French Creek (Erie, Crawford, Mercer, and Venango Counties) [PENNDOT District 1-0]
C. LeBeouf Creek (Erie County from the Lake LeBeouf outlet to the confluence with French Creek) [PENNDOT District 1-0]
D. Shenango River (Mercer County) between Pymatuning Reservoir Dam to Shenango Reservoir [PENNDOT Districts 1-0]

II. MANAGEMENT UNIT 2: Stream reaches in the range of clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, rabbitsfoot, longsolid, round hickorynut, and salamander mussel site population density is expected to be less than 0.5 per square meter

A. Allegheny River, between the Kinzua Dam and the Conewango Creek confluence (i.e., Warren Counties) [PENNDOT District 1-0]
B. Allegheny River, between the City of East Brady and the City of Kittanning (i.e., Armstrong Counties) [PENNDOT District 10-0]
C. Conneaut Outlet (Crawford County) [PENNDOT District 1-0]
D. Conneautee Creek (Crawford County) [PENNDOT District 1-0]
E. Muddy Creek (Crawford and Venango Counties) [PENNDOT District 1-0]
F. Oil Creek (Venango County) [PENNDOT District 1-0]
G. Conewango Creek (Warren County) [PENNDOT District 1-0]
H. Little Shenango River (Mercer County) [PENNDOT District 1-0]
I. Brokenstraw Creek (Warren County) [PENNDOT District 1-0]
J. Sandy Creek (Mercer and Venango Counties) [PENNDOT District 1-0]
K. French Creek (Erie County) from Union City Dam to New York Boarder [PENNDOT District 1-0]
L. South Branch French Creek (Erie County) [PENNDOT District 1-0]
M. Tionesta Creek (Forest County) [PENNDOT District 1-0]
N. Allegheny River (Potter and McKean Counties) downstream of Coudersport to the New York line [PENNDOT District 2-0]
O. Oswayo Creek (Potter and McKean Counties) [PENNDOT District 2-0]
P. Cussewago Creek (Crawford County) [PENNDOT District 1-0]
Q. LeBeouf Creek (Erie County) above LeBeouf Lake [PENNDOT District 1-0]

III. MANAGEMENT UNIT 3: Selected stream reaches in the range of clubshell, northern riffleshell, rayed bean, snuffbox, sheepnose, and rabbitsfoot with potential habitat

A. Allegheny River, between the City of Kittanning and Pittsburgh (i.e., Armstrong and Allegheny Counties) [PENNDOT District 10-0 and 11-0]
B. Ohio River, Pennsylvania Allegheny and Beaver Counties
C. Little Beaver Creek, Beaver County
D. Fourmile Run (Westmoreland County) No classification.

IV. MANAGEMENT UNIT 4: Stream reaches that are within 1 mile of confluence with a stream defined above as Management Unit 1 or 2.

APPENDIX B. MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4)

Storm sewer systems can decrease water quality and habitat quality in receiving waters, as they carry high sediment loads from roadways and other sources and convey large volumes of stormwater at higher-than-normal velocities during storm events. Increased suspended solids impact native mussels by decreasing food availability and physically interfering with filter feeding and respiration (Goldsmith et al., 2021). Wang et al. (2018) also found sedimentation affects mussels and their host fish and reduces water quality. Increased sediment disrupts various aspects of mussel reproduction and mussel–host fish relationships by causing declines in fertilization success and glochidial development, leading to reproductive failure. In addition, negative impacts to host fish attachment and glochidial encystment occurs with increased sedimentation (Goldsmith et al., 2021). In extreme cases, mussels are sensitive to smothering, and mortality can occur at sediment depths as low as 0.6–2.5 cm. Substrate stability as it pertains to scour and entrainment, is shown to result in significant declines in mussel biodiversity.

To reduce sedimentation from road run-off, PennDOT instituted an Individual MS4 Permit to address stormwater conveyances that are operated by PennDOT. These conveyances collect and convey stormwater run-off on PennDOT roads, bridges, and related structures. They are:

- Owned by a state, city, town, village, or other public entities,
- Designed to collect or convey stormwater (including storm drains, pipes, ditches, etc.)
- Not a combined sewer
- Not part of a publicly owned treatment works (*i.e.*, sewage treatment plant)

As part of an MS4 Permit, PennDOT is required to develop and implement a Stormwater Management Program (SWMP) Best Management Practices (BMPs) to reduce the discharge of pollutants from a small MS4. PennDOT's current MS4 permit is valid from November 1, 2021, through October 31, 2026. The permit includes six minimum control measures and pollution reduction plan components, similar to the general MS4 Permit required for municipalities, resulting in similar stormwater management program requirements for both PennDOT and municipalities. The six minimum control measures include:

1. Public education and outreach,
2. Public participation/involvement,
3. Illicit discharge detection and elimination,
4. Construction site runoff control,
5. Post-construction runoff control, and
6. Pollution prevention/good housekeeping.

PennDOT recently completed Construction Stormwater Inspection Training, to emphasize the importance of erosion and sediment pollution controls, improve the effectiveness of visual site inspections. Done correctly, site inspections reduce the potential for pollution, minimize PennDOT's and their contractors' exposure to risk associated with stormwater pollution, and ensure the PennDOT is compliant with the applicable permits. This web-based training covered a variety of subject matter dealing with the construction, inspection, maintenance, and potential compliance issues related to E&S controls on PennDOT projects.

A comprehensive approach to stormwater management will address challenges produced by runoff from PennDOT's facilities. As part of PennDOT's MS4 obligations in the Ohio River drainage basin, PennDOT is required to provide sediment reduction in impaired urban watersheds in the amount of 485,000 pounds over the course of the five-year permit period. PennDOT will work with municipal partners to fund approximately 9,616 miles of stream restoration on impaired watersheds within the Ohio River basin. This will result in just under one million tons of sediment reduction in the Ohio River basin over the course of this Programmatic Biological Opinion (EnviroScience 2023, Appendix H). Additionally, PennDOT implemented 817 individual Stormwater Control Measures (SCM) in the Ohio River Watershed, using 27 different standard techniques to control water volume discharge rates and sediment reduction (EnviroScience 2023, Appendix I). Of those, 15 occur in MU-1 streams, including four in critical habitat units for Rabbitsfoot (RF22) and Longsolid (LS1 and LS2). Two projects occur in MU-2 streams, and one in a MU-3 stream.

Strategy for Addressing Stormwater Management Issues

Changes to natural flow regimes and thermal stress can also have adverse effects on native mussels (Archambault et al., 2014; Galbraith et al., 2012; Khan et al., 2019; Pandolfo, 2008; Pandolfo et al., 2010; Pandolfo et al. 2012; Watters et al., 2000). To reduce stresses on freshwater ecosystems, PennDOT has adopted an antidegradation and post-construction stormwater management (PCSM) policy. This policy is a proactive approach to protecting the surface waters of the Commonwealth from degradation; an overall program to enable PennDOT to adapt to current practices and maintain consistency with evolving stormwater requirements. PennDOT employs a comprehensive "E5" strategy for addressing stormwater management issues, which is consistent with their MS4 permit, and integrates each of the E5 components into the overall design process to achieve a sustainable and efficient program. The E5s are:

1. Encourage low impact practices for preventing runoff,
2. Evaluate site characteristics and BMP needs early in the design process,
3. Engage Pennsylvania Department of Environmental Protection (PA DEP) through pre-application meetings,
4. Establish a process to evaluate new technologies, assess the performance of existing ones in the field, and update/expand the BMP toolbox, and
5. Educate PennDOT staff, consultants, and contractors on stormwater policy and implementation.

In Pennsylvania, the three primary concerns related to the effects of runoff on water resources from roadway facilities are:

1. Stream channel erosion and flooding resulting from increased runoff rate and volume,
2. Water quality impacts to streams and groundwater aquifers from particulates, floatables, hydrocarbons, and deicing materials, and
3. Thermal impacts on streams caused by heat transfer from pavement to runoff and loss of riparian buffer vegetation.

The PA DEP Stormwater BMP Manual lists a number of additional common pollutants in highway runoff. Many, if not most, of these pollutants occur in relatively small concentrations and are usually addressed with mitigation of increases in rate and volume of runoff. Chlorides and other soluble chemicals in deicing materials and salts can spike concentrations in groundwater. Additionally, fine sediments that make up anti-skid materials can be carried into an adjacent streams or accumulate over and clog an infiltration facility. The BMP Manual and the Department's MS4 permit list several good housekeeping approaches that minimizes pollutant loadings from winter maintenance materials, including:

- Monitoring and minimizing the volume of winter maintenance materials used,
- Protecting salt storage and loading areas from weather influences, and
- Cleaning around the area where materials are dispensed immediately after deicing operations have ceased.

APPENDIX C. EFFECTS OF THE BRIDGE PROGRAM

Expanded Effects of the Bridge Program Including Initial Take and Take Expected with Incorporation of Minimization Commitments Based on Estimated Density (adapted from Table 3 and Table 7 of the BA (EnviroScience 2023)).

Management Unit	**County**	**Waterway**	**Project Title**	**Type ***	**Initial Impact (M^2)**	**Minimized Impact (M^2)**	**Northern Riffleshell**	**Clubshell**	**Rayed Bean**	**Snuffbox**	**Rabbitsfoot**	**Sheepnose**	**Salamander Mussel**	**Longsolid**	**Round Hickorynut**	**Critical Habitat**	**Critical Habitat Units ****
I	CRAWFORD	French Creek	Crawford Co. Bridge Waterproofing 0010	BRPS	85	72	63	5	115	21	16		0	0		72	RF22, LS1
I	CRAWFORD	French Creek	Crawford Co. Bridge Waterproofing 0020	BRPS	52	44	38	3	70	13	10		0			44	RF22, LS1
I	CRAWFORD	French Creek	Crawford Co. Bridge Waterproofing 0070	BRPS	47	39	35	3	63	12	9		0			39	RF22, LS1
I	CRAWFORD	French Creek	Crawford Co. Bridge Waterproofing 0080	BRPS	79	33	33	33	33	33	33		33	33		33	RF22, LS1
I	WARREN	Allegheny River	US 6 Warren Co. Bridges	BRST	7923	6655	5813	453	10648	1976	1468	692	27	7	7	6655	LS2
I	CRAWFORD	French Creek	US 6 French Ck Br #3	BRPL	2012	1690	1477	115	2705	502	373		7	2		1690	RF22, LS1
I	ERIE	French Creek	US 6 Bridge over French Creek	BRST	1347	1131	988	77	1810	336	249		5	1		1131	RF22, LS1
I	ERIE	French Creek	PA 97: French Ck Brdg	BRST	1206	1013	885	69	1621	301	223		4	1		1013	RF22, LS1
I	CRAWFORD	French Creek	US 6 French Creek Br #1	BRPL	1895	1592	1391	108	2547	473	351		6	2		1592	RF22, LS1
I	WARREN	Allegheny River	PA 127 Bridge/Allegheny River	BRST	3450	2898	2532	197	4637	861	639	301	12	3	3	2898	LS2
I	ERIE	French Creek	Erie County Bridge Waterproofing	BRPS	47	39	34	3	63	12	9		0			39	RF22, LS1
I	CRAWFORD	French Creek	Cussewago St/French Creek	BRPL	2302	1934	1689	132	3094	574	426		8	2		1934	RF22, LS1
I	CRAWFORD	French Creek	SR 2034: Spring Street Viaduct	BRST	6139	5157	4505	351	8251	1531	1137		21	5		5157	RF22, LS1
I	FOREST	Allegheny River	Forest County Waterproofing	BRPS	410	345	301	23	552	102	76	36	1	0	0	345	LS2
I	MERCER	Shenango River	Mercer County Bridge Waterproofing 0040	BRPS	45	38	33	3	60	11	8	4				38	RF31, LS3, R H1
I	MERCER	French Creek	Mercer County Bridge Waterproofing 0060	BRPS	70	59	51	4	94	18	13		0	0		59	RF22, LS1
I	ARMSTRONG	Allegheny River	Graff Bridge Preservation	BRPS	2138	1796	1569	122	2873	533	396	187	7	2	2		

2	VENANGO	Oil Creek	PA 8 Bridge/Oil Creek	BRST	16	13	0		1								
2	CRAWFORD	Cussewago Creek	SR 2039: Dunham Rd Br	BRST	496	417	7		20								
2	ERIE	French Creek	SR 8 Bridge over East Branch French Creek	BRST	1977	1660	27	55	81	143	30		8	8		1660	RF22, LS1
2	WARREN	Brokenstraw Creek	SR 3022 Bridge over Broke	BRST	1516	1274	20	42	62	110	23			6	6		
2	ERIE	South Branch French Creek	Erie County Bridge Waterproofing	BRPS	24	20	0	1	1	2	0			0			
2	ERIE	West Branch French Creek	PA 8 Bridge over West Branch French Creek	BRST	1977	1660	27	55	81	143	30			8			
2	WARREN	Brokenstraw Creek	SR 3022 Bridge/Brokenstraw Ck	BRST	1641	1379	22	46	68	119	25			7	7		
2	WARREN	Brokenstraw Creek	SR 3014 Bridge/Brokenstraw Ck	BRST	137	115	2	4	6	10	2			1	1		
2	ERIE	French Creek	SR 1001 Bridge over French Creek	BRST	2641	2218	36	73	109	191	40		11	11		2218	RF22, LS1
2	FOREST	Tionesta Creek	PA 36 over Tionesta Creek	BRST	2067	1736								9			
2	CRAWFORD	Muddy Creek	SR 1033: Muddy Ck Bridge	BRST	747	628	10	21	31	54	11			3		628	RF24
2	VENANGO	Oil Creek	Venango County Waterproof	BRPS	150	126	2		6								
2	MERCER	Little Shenango River	Mercer County Bridge Waterproofing #2	BRPS	43	36				3							
2	MCKEAN	Allegheny River	2023 NC Bridge Preservation	BRST	207	174	3	6	9	15	3	6	1	1	1		
2	POTTER	Allegheny River	2024 NC Bridge Preservation	BRST	485	407	7	13	20	35	7	14	2	2	2		
2	POTTER	Allegheny River	SR 4003 over Allegheny Rv	BRPL	688	578	9	19	28	50	10	20	3	3	3		
2	ALLEGHENY	Allegheny River	Fort Duquesne Bridge Rehab & Preservation	BRST	7177	6029	97	199	295	519	109	205	30	30	30		
2	ALLEGHENY	Allegheny River	Fort Duquesne Bridge Rehab & Preservation	BRST	7177	6029	97	199	295	519	109	205	30	30	30		
2	ALLEGHENY	Allegheny River	SR 65 Ramps AND SR 279 Ft. Duq. 0008	BRPS	488	410	7	14	20	35	7	14	2	2	2		
2	ALLEGHENY	Allegheny River	SR 65 Ramps AND SR 279 Ft. Duq. 0009	BRPS	488	410	7	14	20	35	7	14	2	2	2		
2	ALLEGHENY	Allegheny River	40th Street Bridge	BRST	24402	20497	328	676	1004	1763	369	697	103	103	103		
3	ALLEGHENY	Allegheny River	New Kensington Bridge	BRPS	542	456	3	4	29	4	2	1	1	1	1		
3	BEAVER	Ohio River	Rochester - Monaca Bridge	BRPS	777	652			42	5	3	1		1	1		
3	ALLEGHENY	Allegheny River	Tarentum Bridge Ramp 'A'	BRPS	1069	898	6	8	58	7	5	1	1	1	1		

3	ALLEGHENY	Allegheny River	Tarentum Bridge over NS RR	BRST	21380	17959	122	162	1149	143	90	18	18	18	18		
3	ALLEGHENY	Allegheny River	Highland Park Bridge	BRPS	1371	1152	8	10	74	9	6	1	1	1	1		
3	ALLEGHENY	Ohio River	McKees Rocks Bridge Phase	BRPS	1814	1523			98	12	8	2		2	2		
3	ALLEGHENY	Allegheny River	62nd Street Bridge	BRST	1047	879	6	8	56	7	4	1	1	1	1		
3	ALLEGHENY	Ohio River	Sewickley Bridge Phase 2	BRST	7605	6388			409	51	32	6		6	6		
3	WESTMORELAND	Allegheny River	Freeport Bridge Truss Preservation	BRST	15213	12779	87	115	818	102	64	13	13	13	13		
1	Various	MU-1 Waterway	MU-1 Bridge Replacements / Removals	BRPL	18000	15120	13207	1028	24192	4491	3342	1573	61	15	15		LS1,LS2,LS3,RF22, RF31,RH1
2	Various	MU-2 Waterway	MU-2 Bridge Replacements / Removals	BRPL	6400	5376	86	177	263	462	97	183	27	27	27		LS1, RF22, RF24
3	Various	MU-3 Waterway	MU-3 Bridge Replacements / Removals	BRPL	10000	8400	57	76	538	67	42	8	8	8	8		
1	Various	MU-1 Waterway	MU-1 Bridge Preservation	BRPS	37800	31752	27735	2159	50803	9430	7017	3302	127	32	32		:LS1, LS2, LS3, RF22, RF31,RH1
2	Various	MU-2 Waterway	MU-2 Bridge Preservation	BRPS	20800	17472	280	577	856	1503	315	594	87	87	87		LS1, RF22, RF24
3	Various	MU-3 Waterway	MU-3 Bridge Preservation	BRPS	65000	54600	370	491	3494	434	273	55	55	55	55		
1	Various	MU-1 Waterway	MU-1 Bridge Restoration / Rehab	BRPS	23400	19656	17170	1337	31450	5838	4344	2044	79	20	20		LS1, LS2, L RF31, RH1 S3,RF22
2	Various	MU-2 Waterway	MU-2 Bridge Restoration / Rehab	BRPS	52800	44352	710	1464	2173	3814	798	1508	222	222	222		LS1, RF22, RF24
3	Various	MU-3 Waterway	MU-3 Bridge Restoration / Rehab	BRPS	55000	46200	313	416	2957	367	231	46	46	46	46		
1	Various	MU-1 Waterway	Bridge Preservation	EMER	21600	18144	15849	1234	29030	5389	4010	1887	73	18	18		LS1, LS2, LS3, RF22,RF31,RH1
2	Various	MU-2 Waterway	Bridge Preservation	EMER	19200	16128	258	532	790	1387	290	548	81	81	81		LS1, RF22, RF24
					464,607	**390,236**	**98,406**	**12,932**	**190,672**	**44,570**	**27,190**	**14,186**	**1,222**	**937**	**852**	**27,245**	

					Initial Impact (M²)	Minimized Impact (M²)	Northern Riffleshell	Clubshell	Rayed Bean	Snuffbox	Rabbitsfoot	Sheepnose	Salamander Mussel	Longsolid	Round Hickorynut	Critical Habitat	Critical Habitat Units

*Definitions:

BRPL – (Bridge Replacement) The initial direct impact area for this project type was estimated as the bridge length (over water) x 2x bridge width.
BRPS / BRPSF - (Bridge Preservation) The initial direct impact area for this project type was estimated as the bridge length (over water) x 1x bridge width.
Subclass - Waterproofing - Assumed initial impact area was 10% of the bridge length over water X 1x bridge width.
BRST / HRST / SAFE - (Bridge Restoration / Rehab.) The initial direct impact area for this project type was estimated as the bridge length (over water) x 2x bridge width.
Subclass - Deck Only - Assumed initial impact area was 10% of the bridge length over water X 1x bridge width.
Subclass - Improvements - Assumed initial impact area was 10% of the bridge length over water X 1x bridge width
Subclass - Ramps - Assumed initial impact area was 10% of the project length over water X 1x width.
BRML - (Bridge Removal) The initial direct impact area for this project type was estimated as the bridge length (over water) x 2x bridge width.
PennDOT's minimization rate of 16% was based on a review of 5 recent, similar projects.

**Definitions:

RF – Rabbitsfoot Critical Habitat
LS – Longsolid Critical Habitat
RH – Round Hickorynut Critical Habitat