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Assessment of Freshwater Mussels in the Allegheny River at Foxburg, Pennsylvania, 1998

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CONVERSION FACTORS AND ABBREVIATIONS

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch
millimeter (mm)	0.03937	inch
meter (m)	3.281	foot
meter (m)	1.094	yard
kilometer	0.6214	mile
	Area	
square meter (m^2)	10.76	square foot
	Flow rate	
cubic meter per second (m^3/s)	35.31	cubic foot per second
	Temperature	
degree Celsius	°F = 9/5 (°C) + 32	degree Fahrenheit

ASSESSMENT OF FRESHWATER MUSSELS IN THE ALLEGHENY RIVER AT FOXBURG, PENNSYLVANIA, 1998

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ABSTRACT

The upper reaches of the Allegheny River are a high-quality resource that supports populations of a number of endangered species. Two endangered species of freshwater mussel, the northern riffleshell, *Epioblasma torulosa rangiana*, and clubshell, *Pleurobema clava*, are present in this river reach. Prior to a

Among the bridges for which replacement is planned is the State Route (SR) 58 bridge crossing the Allegheny River (river mile 86.2) at the town of Foxburg, Pa., Armstrong and Clarion Counties (fig. 1). The aquatic resource potentially affected by the proposed construction includes two endangered species of freshwater mussels, the northern riffleshell, *Epioblasma torulosa rangiana*, and the clubshell, *Pleurobema clava*. These two species have undergone at least a 95-percent reduction in range (U.S. Fish and Wildlife Service, 1994). Although *Epioblasma* is the largest genus of freshwater mussels in the Ohio River Basin with 19 recognized taxa, 12 appear to have been made extinct in this century and all but 1 of the remaining species is endangered (Turgeon and others, 1998, Williams and others, 1993). The northern riffleshell is now common only in the upper Allegheny River and its tributary, French Creek. The clubshell, while extant in more streams nationwide than the northern riffleshell, is generally rare. Several stream reaches in the Allegheny River system support apparently healthy and relatively large clubshell populations (U.S. Fish and Wildlife Service, 1994). The study described here augments ongoing research being conducted by the U.S. Geological Survey (USGS) to assess the aquatic resource of the Allegheny River Basin in general and, more specifically, the nationally unique mussel resources in this river. This study was conducted in conjunction with the Pennsylvania Department of Transportation as part of an environmental assessment related to the replacement of the bridge at Foxburg, Pa.

Purpose and Scope

This report describes an investigation to determine if either of the endangered freshwater-mussel species, known to inhabit the upper Allegheny River, are present near the existing SR 58 bridge and to evaluate the extent of mussel habitat in the vicinity. A combination of qualitative and quantitative techniques were implemented in September and October 1998 to determine if mussels are present and, if so, their relative abundance. Depth, substrate, siltation, channel width, and stream velocity were measured concurrently with the mussel survey.

Description of the Study Area

The Allegheny River at Foxburg, Pa., is at river mile 86.2 (latitude 41°08′24″ and longitude 79°40′51″). The river averages 160 m wide during low-flow conditions. Flow in this reach of the river has been controlled to some extent since 1967 by releases from Kinzua Dam, a mainstem power and flood-control impoundment (Coll and Siwicki, 1998). The streambanks in the area are relatively steep, and the channel is constrained along a section of the east bank by a concrete wall. The bridge is supported by four piers, two of which are located in the water at low to moderate flows. Each pier is separated by 49 m. The bridge itself consists of a single lane, double deck steel span. The upper deck, although no longer in use, previously carried rail traffic. The water depth averages 2.4 - 3.6 m deep in much of the area; the maximum depth is 10 m. The water velocity is relatively slow at low flow and can be described as a slow deep run with little to no visible surface disturbance due to turbulence.

Acknowledgments

In addition to the USGS personnel who assisted in aspects of this study and report preparation, several individuals are recognized here for their particular efforts. Special thanks to the SCUBA divers and crew who braved current and cold water to collect the data used in this report: Patricia Morrison, Janet Butler, Thomas Cox, and R.J. Lewis from the U.S. Fish and Wildlife Service Ohio River Islands Refuge and William Muir, James Gouvas, and Elizabeth Ackerman from the U.S. Environmental Protection Agency. Patricia Morrison and David Smith, USGS Biological Resources Division, provided technical review and invaluable suggestions to improve this manuscript. Special thanks also go to the landowners in and around Foxburg for access to the river and interest in the study.

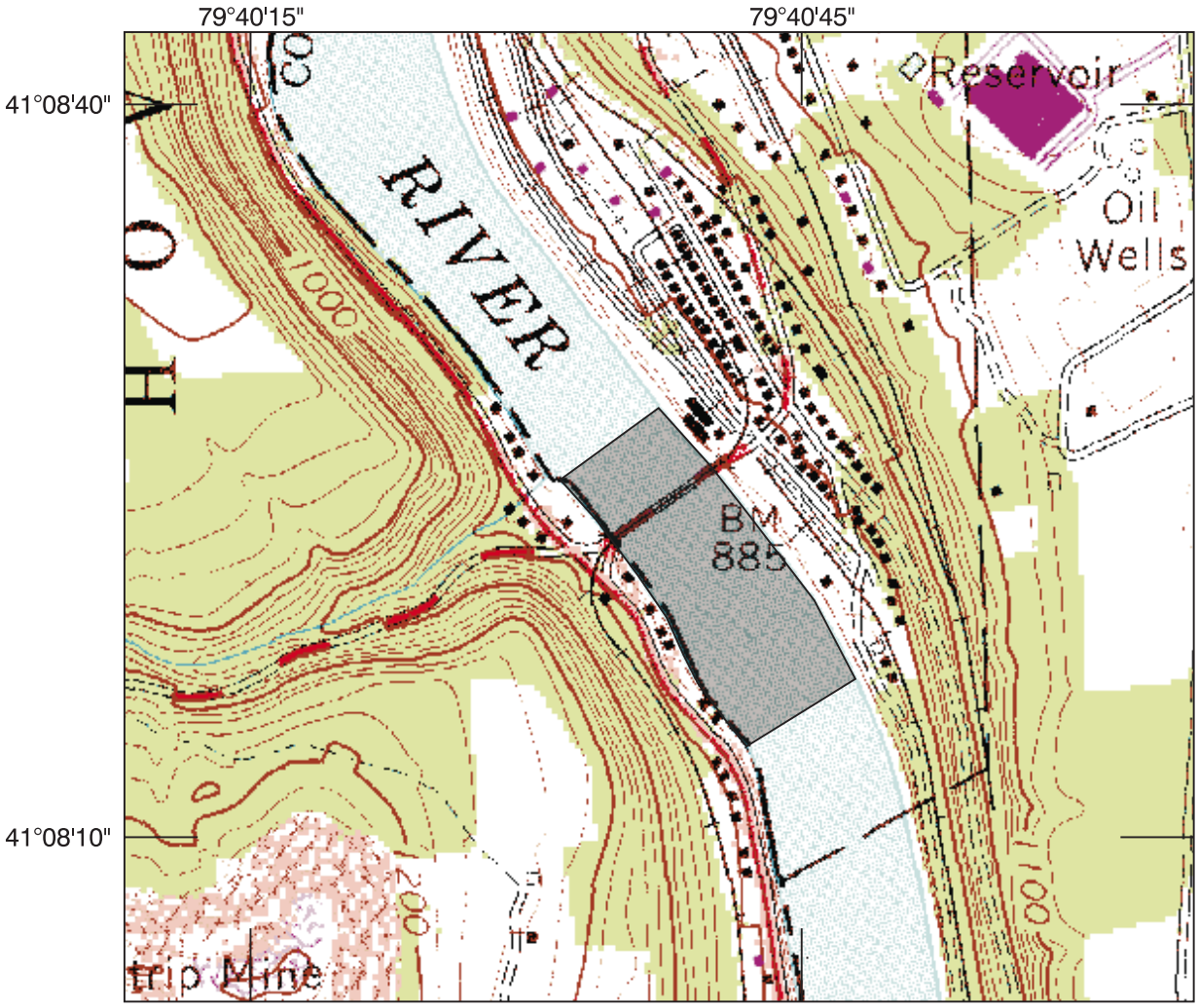

Figure 1. Location of stream segment, Allegheny River, Foxburg, Pennsylvania.

STUDY METHODS

The study design follows the revised mussel-survey protocols developed by the U.S. Fish and Wildlife Service and the Pennsylvania Fish and Boat Commission (U.S. Fish and Wildlife Service, 1996). Minor modifications, necessary because of the stream conditions, are outlined below. The qualitative survey was conducted on September 1-3, 1998, and the quantitative survey was initiated on September 3, 1998, and completed on October 1-2, 1998.

Survey Zone Delineation

The reach evaluated in this study started 92 m above the existing SR 58 bridge and extended to 370 m below the bridge. This reach was further divided into three zones. Zone A represents the upstream zone likely to be impacted by construction and extends above the bridge for 92 m; zone B, the downstream direct impact area, extends from the downstream side of the bridge for 183 m; and zone C, the area likely to experience indirect impacts from construction, extends from the end of zone B to the end of the reach, 370 m downstream from the bridge.

Habitat Assessment

Stream width and zone length were measured by use of a laser range finder (Bushnell Yardage Pro, Bushnell Corp.[1]). Stream depths and temperatures were recorded by divers and by a wire weight during water-velocity measurements. Divers estimated substrate size and silt cover on each qualitative transect. Substrate size was estimated into categories as described by Meader and others (1993). Near-shore habitat was similarly recorded during the qualitative survey. Water velocities were measured at 20 percent and 80 percent of the depth at eight points along four transects set perpendicular to flow in the three-zone reach. Velocities were measured with a standard flowmeter and lead weight suspended on a wire from a Jon boat. Although imprecise, these measurements provide relative estimates of the water velocity in the reach.

Qualitative Sample Design

Initially, both streambanks were searched to locate shell middens, such as those left by muskrats, *Ondatra zibethica*, which prey on freshwater mussels. Wadeable near-shore habitats also were qualitatively searched to a depth of 0.75 m. Relative locations of shell deposits and living mussels are recorded on a map of the area including locations of shells or living specimens of either endangered species (Appendix: Form 4).

The qualitative survey was extended into the river channel, focusing on areas considered to be suitable mussel habitat. Unsuitable mussel habitat is defined in the Mussel Survey Protocol as “clean-swept bedrock, silt deposits over 0.5 in. (inches) deep, concrete paving, or deep scour holes”(U.S. Fish and Wildlife Service, 1996). The majority of the substrate in the study reach could not be assessed from the surface, therefore the only areas excluded were those in shallow water that had been subjected to a search by wading and in which no mussels were found. Water depth necessitated utilizing two teams of paired SCUBA divers. Each diver searched for mussels along one side of a 91 m transect line placed on the river bottom parallel to the current. The divers searched a 1.5 m strip of substrate on each side of the transect line. Transects were placed 5 - 6 m apart in zone A and zone B and 10 m apart in zone C. Transects were staggered upstream and downstream of a 91 m center line in zones B and C rather than sampling 183 m transects (U.S. Fish and Wildlife Service, 1996). Staggering transects allowed qualitative assessment of the entire reach while maintaining diver search efficiency.

[1] The use of firm, trade, and brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Government.

Mussels found along the transects were recorded on diving slates and replaced in the substrate. Specimens that could not be identified underwater, and those believed to be an endangered species, were placed in a dive bag and brought to the surface to confirm identification. Abundant species were categorized in groups of 50 if more than 50 individuals were found. All mussels were returned to the transect after identification.

Quantitative Sample Design

Utilizing the results of the qualitative survey and habitat observations, 0.25-m^2 quadrants were placed in areas identified as being in a mussel bed containing the endangered target species. Quadrants were placed in groupings of four within a 16-m^2 area. Each 0.25-m^2 quadrant was separated by as much as a meter from others within the larger cell. Divers were instructed to place the quadrants without reference to presence or absence of visible mussels or shells. A total of 48 quadrants were sampled in 12 groups of 4 quadrants. Each was excavated to a depth of approximately 10 cm. Substrate was not removed from the water, however velocity and clarity were sufficient to provide excellent visibility. All mussels were taken to the surface to confirm identification before being returned to the river.

Data Analysis

The area utilized by mussels at the study site was estimated to be 26,800 m^2 from data collected in the qualitative assessment and from observations made of the habitat conditions in the reach. Quantitative mussel-population data were collected in a two-stage design. Population estimates ($\hat{\tau}$) were calculated utilizing the following equation from Thompson (1992):

$$\hat{y}_i = \frac{M}{m} \sum_{j=1}^{m_i} y_{ij} = M_i \cdot \bar{y}_i \qquad (1)$$

$$\hat{\tau} = \frac{N}{n} \sum_{i=1}^{n} \hat{y}_i \qquad (2)$$

The primary units (N=1,675) are represented by 16-m^2 cells of which a subset was sampled (n= 12) and 0.25-m^2 quadrants (M_i=64) sampled in the secondary stage (m_i=4). The three zones were combined to provide a larger sample size (N=1,675). The number and species of mussels in each quadrant were recorded ($\bar{y}_{ij}$). Variance calculations also followed Thompson (1992) and 95-percent confidence intervals were calculated by use of the following formula:

$$\text{C.I.} = \exp\left[\ln(\hat{\tau}) \; (\mp 1.96) \sqrt{\frac{\text{var}(\hat{\tau})}{\hat{\tau}^2}}\right], \qquad (3)$$

where $\hat{\tau}$ is the abundance estimate and var($\hat{\tau}$) is its variance.

QUALITATIVE MUSSEL SURVEY AND HABITAT ASSESSMENT

A total of 14 species of freshwater mussels were collected in the three-zone, 457-m reach of the Allegheny River at Foxburg, Pa. (table 1). All 14 species, including both of the endangered species, were observed living in this river reach. Stream conditions during sampling were generally clear and calm. The median streamflow during the sampling period at Parker, Pa., river mile 83.4, was 89.7 m^3/s (Coll and Siwicki, 1998). Divers recorded visibility ranging from 2.4 - 3.7 m and water temperatures of 22°C and 20°C on September 1-3 and October 1-2, respectively.

Table 1. *Freshwater mussels found in the qualitative survey in the Allegheny River at Foxburg, Pennsylvania, 1998*

Common name	Species name	Shell middens	Number living			Percentage relative abundance (living only)
			Zone A	Zone B	Zone C	
Mucket	*Actinonaias ligamentina*	>250	>500	>500	>1,000	51.27
Elktoe	*Alasmidonta marginata*	11	3	0	3	.15
Spike	*Elliptio dilatata*	>2,000	>350	>400	>850	42.70
Northern riffleshell	*Epioblasma torulosa rangiana*	28	7	9	3	.48
Pocketbook	*Lampsilis cardium*	12	7	3	7	.43
Wavyrayed lampmussel	*Lampsilis fasciola*	28	9	3	8	.51
Plain pocketbook	*Lampsilis ovata*	2	12	2	13	.69
Black sandshell	*Ligumia recta*	10	9	12	21	1.07
Fluted shell	*Lasmigona costata*	40	48	25	25	2.49
Clubshell	*Pleurobema clava*	5	0	1	0	.03
Round pigtoe	*Pleurobema sintoxia*	1	0	0	1	.03
Creeper	*Strophitus undulatus*	6	0	0	1	.03
Paper pondshell	*Utterbackia imbecillis*	[1] 1	0	0	0	0
Rayed bean	*Villosa fabalis*	4	3	0	2	.13

[1] A single living specimen was found in an onshore muskrat midden.

Northern riffleshells (n=19) were observed in all three zones and ranked seventh in relative abundance. A clubshell was found in zone B at a depth of 5.5 m in a gravel/cobble substrate. Dead and relic clubshell shells were collected in shore-side middens in zones A and C, indicating this species is distributed at low abundance levels throughout the reach.

During the September sample period, several female northern riffleshells were observed displaying a bright white mantle margin that was easily visible to divers. This behavior was not observed during the October sampling period 4 weeks later. *Epioblasma*, like several other Lampsiline mussels, use mantle displays to attract host fish (Parmalee and Bogan, 1998). The mantle display for the northern riffleshell has been reported in May (Trdan and Hoeh, 1993), and the species was gravid in summer and fall (Ortmann, 1919). Other gravid *Epioblasma* species have been found from spring to fall and are reported to actively display in May and June (Parmalee and Bogan, 1998). Whether mantle displays are related to water temperature, which decreased between sampling periods, or some other environmental queue is not known. It would be advantageous to conduct qualitative surveys of northern riffleshells during active mantle display. The relative abundance of female northern riffleshells found in this study is likely greater than if the same qualitative methodology had been implemented only in October.

The overall species assemblage is similar to those reported during other recent upper Allegheny River mussel surveys. The same general species composition was found at Allegheny River mile 108, Kennerdell, Pa., in 1997 (U.S. Geological Survey, 1998) with the exception of three species. The rabbitsfoot, *Quadrula cylindrica cylindrica (*one specimen*)*, and kidneyshell, *Ptychobranchus fasciolaris (*two specimens*)* were located at Kennerdell but not at Foxburg; the paper pondshell, *Utterbackia imbecillis*, (one specimen) was found only at Foxburg. These species are at very low abundance levels and may have been over looked at the respective sites from which they are missing.

Most freshwater mussels were found at depths between 2.4 and 5.5 m of water in cobble / gravel substrate. Mussels in zones A and B were largely restricted to the left side of the channel, to the right of the bridge pier. In zone C, mussels are more widely distributed although densities appear to be lower. Mussel habitat along the western side of the channel is limited by substrate composition, which is dominated by boulders and silt. Stream velocities during the survey were relatively low in this area (table 2), but the large boulder substrate composition suggests that higher velocities occur.

Table 2. *Habitat characteristic of the Allegheny River at Foxburg, Pennsylvania, 1998*
[m, meters; m/s, meters per second; m^2, meters squared; N/A, not applicable]

Zone	Distance from bridge (m, - is downstream)	Width (m)	Mean depth (m)	Median 20 percent of depth velocity (m/s)	Median 80 percent of depth velocity (m/s)	Estimated area of mussel bed in zone (m^2)
A	41	145	2.74	0.15	0.09	4,550
B	-51	161	5.98	.13	.14	7,245
B / C[1]	-182	161	2.78	.14	.12	N/A
C	-258	171	2.66	.15	.10	15,000

[1] At the transition from zone B to zone C.

Mussel habitat on the western side of the river is influenced by Fowler Run, a small tributary entering the Allegheny River approximately 80 m upstream of the SR 58 bridge. The watershed of Fowler Run is the site of coal-mine activity. The substrate of this small stream, and sections of the Allegheny River at the confluence, is stained with “yellow boy,” presumably iron oxide from mine discharges. Coal-mine runoff can reduce or eliminate mussel communities (Ortmann, 1909; Neel and Allen, 1964; Starnes and Starnes, 1980; Anderson and others, 1991) that are sensitive to lower pH and increased metal concentration and siltation. Fowler Run may affect mussel survival on the western shoreline until mixed with better quality water in the Allegheny River. The mixing zone of Fowler Run and the Allegheny River is influenced by streamflows, but this was not investigated in this study.

The highest water velocities experienced by the divers were between the two center bridge piers. Streambed scour is evident above and below the bridge at this point. The maximum depth recorded was 10.1 m occurring mid-channel approximately 50 m below the SR 58 bridge. The substrate is dominated by large boulders (over 50 cm) in much of the scoured area. Modifications to stabilize the two central bridge abutments included pouring concrete around the abutments and, possibly, placing boulders in the scour area as riprap. Above and below the scour area and encompassing much of the center of the river in zone A and zone B, the substrate was unconsolidated with few living mussels. Headcutting (upstream channel degradation from a disturbance), active substrate transport, and increased deposition can all affect mussel survival and colonization (Hartfield, 1993).

The lower part of zone B and the central part of zone C were covered in a layer of fine silt up to 2.5 cm thick. The majority of North American freshwater mussels are adapted to flowing waters and are considered to be intolerant of siltation of more than 1.2 cm. (Ellis, 1936). In the Allegheny River at Foxburg, mussels in areas of much deeper silt deposition were located in cone-shaped depressions in the silt layer. These animals were oriented in the gravel substrate to a similar depth as those observed in unsilted areas, however, the silt layer was reduced in the immediate area of the mussel. It appeared the mussels maintain contact with the water column by clearing silt in some manner, perhaps with valve closures or with excurrent water during feeding and respiration. The silt in the study area was readily disturbed by divers and would likely be swept clear by even slightly higher river velocity. The ability to clear silt buildup, in contrast to what is reported in the literature, may be related to the rate and duration of silt accumulation, particle size and composition, as well as the season as it is related to mussel behavior.

QUANTITATIVE MUSSEL SURVEY

Eight of the 14 mussel species known to be present at this site were collected in quantitative samples (n=101) for an average density of 8.4 mussels per square meter. The total area of the three-zone reach is 74,000 m^2; an estimated 26,795 m^2 (table 2) appeared to provide suitable mussel habitat based on mussel occurrence, river substrate, siltation, depth, and velocity. This determination included some areas, such as silted areas, that would have been categorized as "unsuitable" in the Mussel Survey Protocol. On the basis of the formula for a two-stage sample (Thompson, 1992), 225,567 mussels (standard deviation = 58,252) are located in the sampled area of the mussel bed (table 3). A two-stage sample design was used because it provided a better population estimate per effort than the fewer number of larger quadrants (five 1-m^2) suggested in the Mussel Survey Protocol. The two-stage design was more cost effective because of the logistics of moving the dive team. The abundance estimates, however, lack the precision that would have been obtained with a completely random design. The 48 0.25-m^2 quadrants can not be assumed to represent independent random samples because variance within the 12 cells sampled can be expected to be lower than in the population and the 12 cells were placed in the expected area of the mussel bed as well as being stratified to cover the length of the study reach. The river bed was not visible when dive sites were selected so site-selection bias, within the mussel bed, was hopefully minimal.

Table 3. *Freshwater mussels found in the quantitative survey in the Allegheny River at Foxburg, Pennsylvania, 1998*

Common name	Species name	Number found	Percentage relative abundance	Population estimate	95-percent confidence interval
Mucket	*Actinonaias ligamentina*	33	32.67	73,700	35,229 to 154,184
Spike	*Elliptio dilatata*	52	51.49	116,133	62,369 to 216,243
Northern riffleshell	*Epioblasma torulosa rangiana*	1	.99	2,233	315 to 15,848
Pocketbook	*Lampsilis cardium*	2	1.98	4,467	1,191 to 16,747
Black sandshell	*Ligumia recta*	1	.99	2,233	315 to 15,848
Fluted shell	*Lasmigona costata*	6	5.94	13,400	4,817 to 37,279
Creeper	*Strophitus undulatus*	1	.99	2,233	315 to 15,848
Rayed bean	*Villosa fabalis*	5	4.95	11,167	5,543 to 22,496
	TOTAL[1]	101	100	225,567	135,973 to 374,195

[1] Population estimate total and confidence intervals [α=0.10, df=11] are calculated independently, not summed.

Calculating abundance for each species produces estimates with large confidence intervals, especially for rarer species (table 3). A single northern riffleshell was found in the quantitative survey, producing an estimate of 2,233 individuals in the reach with an upper limit confidence interval of 15,848 individuals [α=0.05, df=11]. No clubshells were found in the quantitative survey. A significant increase in sampling or a change in sample design will be necessary to obtain a more precise estimate of populations of rare species.

The relative abundance of individual species present in the quantitative sampling was similar to the qualitative part of this study with a few exceptions. Freshwater mussels, like most species, exhibit clumped distributions (i.e. mussels beds). Quadrant sampling tends to underestimate mussel diversity at a site, commonly missing rarer species unless many quadrants are sampled (Vaughn and others, 1997). Conversely, not all species are equally susceptible to sampling visually because of size, color, or habits. The rayed bean, *Villosa fabalis*, is ranked ninth in relative abundance in qualitative surveys, yet is not particularly rare at this site (table 3). This species is small, rarely exceeds 38 mm in length (Parmalee and Bogan, 1998), and is not as visible to divers as are the larger species.

The freshwater mussel population at Foxburg, Pa., is dominated by two species, the mucket, *Actinonaias ligamentina*, and spike, *Elliptio dilatata*, which account for 84 percent of the population. The mucket is a widely distributed species capable of utilizing several different fish host for the parasitic glochidial (larval) stage (Watters, 1994). The spike also is a widespread species that, although commonly

abundant where found, is apparently rather sensitive to water-quality changes and has undergone significant loss of range in some areas (Watters, 1988). Di Maio and Corkum (1995) found that the spike is a species typical of more hydrologically stable rivers.

SUMMARY AND CONCLUSIONS

The Allegheny River at Foxburg, Pa., supports a mussel population consisting of at least 14 species. This population is significant in that it includes two globally rare endangered species, the northern riffleshell and, more rarely, the clubshell. Overall, the composition of the mussel community at Foxburg is similar to that in other recently surveyed areas in the upper Allegheny River (U.S. Geological Survey, 1998, 1999). Limited data available suggest this community approximates historical species composition in the middle Allegheny River (Ortmann, 1919; Bates and Dennis, 1969).

The study design used follows a protocol established for conducting mussel surveys in Pennsylvania (U.S. Fish and Wildlife Service, 1996). The qualitative survey design documented, at the survey site, most species known to be present in the upper Allegheny River. The qualitative survey protocol includes diverse habitats, and with personnel experienced at finding these cryptic organisms, is likely to document all common species. The proportion of rare species documented at a site will depend on effort as well as expertise. Additionally, northern riffleshells appear to be significantly easier to locate during active mantle display. Surveys should be targeted during this period to increase sampling effectiveness. In general, qualitative surveys are suitable for documentation of species occurrence (Vaughn and others, 1997). The quantitative design covered a small area relative to the size of the river at Foxburg. Sampling is biased by stratifying the quadrants in the mussel bed and targeting areas known, from the qualitative surveys, to support the target species. The resulting abundance estimates have wide confidence intervals and are applicable only to the area defined as suitable habitat. The precision of the abundance estimates was improved in this case by using a two-stage design and increasing the number of quadrants sampled. Additional increases in quadrant numbers and the implementation of a full random design would improve the estimate further but also would require a considerable increase in effort. Foxburg would be a difficult site at which to implement a full random design because the river depth requires that SCUBA equipment be used.

Freshwater mussels at Foxburg are distributed throughout much of the study reach but are present primarily along the eastern part of the channel in 2.5 to 5.5 m of water in cobble and gravel substrate. Silt deposited in some parts of this area appears to be a seasonal occurrence due to water flow and is highly transient in nature. In general, mussel habitat in this river reach is somewhat atypical of what is usually associated with the species present. The water is deeper and has lower velocity and silt accumulation is greater than expected. This probably reflects a biased view of the habitat requirements of these species rather than actual habitat preference. Multiple-year classes appeared to be present for most species, and the overall community is similar to shallower, fast-flowing areas elsewhere in this river.

Several factors appear to be affecting mussel distribution in the study reach. The mussel population is limited along the western shore and mid-channel. Mussel habitat along the western shore may be affected naturally by stream velocity and a substrate dominated by boulders and silt, but also may be affected by mine drainage from Fowler Run. The mid-channel area exhibits a significant amount of scour between the bridge piers. Mussels in the scour area are transported away by scour events with the substrate. Scour degrades habitat downstream as bed material is deposited as well as upstream as channel degradation or head cutting occurs. Very few mussels were found in the scour-affected area that occupies a relatively large part of the study area upstream and downstream from the bridge. Colonization of this area is unlikely because most native freshwater mussels have life spans of years to decades and require long-term substrate stability to survive.

This survey was made near a bridge crossing as are several other recently reported freshwater-mussel surveys in the upper Allegheny River (U.S. Geological Survey, 1998, 1999). Thus, the mussel communities present may not represent those in most of the river away from the influence of bridges. Bridges are commonly placed in hydrologically stable areas, a condition also required by freshwater mussels. The hydrology in the vicinity of a bridge can be profoundly altered by the rigid constriction of the river

channel by the supporting structure. Historically, the Allegheny River at Foxburg may have provided suitable mussel habitat that is now degraded by mid-channel scour resulting from the two instream pilings. Alternatively, the bridge pilings may have stabilized the river substrate along the right ascending bank, resulting in suitable water velocities for subsequent mussel colonization. Studies of other sites, with and without bridges (or other channel restrictions), would be needed to determine the long-term effects of bridge placement on mussel habitat. A replacement bridge design that reduces stream scour may stabilize the river bed at Foxburg, which would benefit both bridge safety and aquatic habitats.

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APPENDIX
FRESHWATER MUSSEL SURVEY REPORT

FRESHWATER MUSSEL SURVEY REPORT

County: *Clarion and Armstrong*
Bridge name: *Foxburg Bridge*
USGS Quadrangle: *Emlenton, Pa.*
S.R. Number: *State Route 58*
River / stream: *Allegheny River*
Lat / Long of bridge: *79°40′51″/41°08′24″*
Tributary to: *Ohio River*
PennDOT District #: *10*

Survey Information

Dates of survey: *September 1-3, 1998, and October 1-2, 1998*

Surveyor Information:

Company Name: *U.S. Geological Survey*
Surveyor's Name: *Robert M. Anderson*
Address: *1000 Church Hill Road, Suite 200, Pittsburgh, Pa., 15206*
Telephone Number: *(412) 490-3810*

Conditions/Site Information

Stream width: *525* feet (average, within survey area)
Water temperature: *72° and 68° on each sample day respectively* (near stream bottom)
DEP stream designation[1] (e.g., CWF, WWF, TSF, HQ: _____
Watershed size at bridge site: _____ square miles [1]

Survey Extent[1] (check one)

X 100 yards upstream to 400 yards downstream of bridge
_____ Other: _____ upstream to _____ downstream of bridge (requires USFWA approval)

Comments on Survey

Data analysis and comments regarding this survey will be included in final report.

Exotic Mussel Species Found During Survey (check applicable categories)

X none
___ zebra mussel
___ Asiatic clam (Corbicula)

[1] This information should be provided by PennDOT.

Form 2

QUALITATIVE FRESHWATER MUSSEL SURVEY REPORT: INSTREAM AND MIDDEN DATA
ALLEGHENY RIVER AT FOXBURG, PA
SEPTEMBER 1-3, 1998

[—, no data]

Common name	Scientific name	Instream (excluding quadrats)		Middens	
		Zone [1]	Data [2]	Zone [1]	Data [2]
Mucket	*Actinonaias ligamentina*	A	510L	A	1L, 1F, 261R
		B	506L	B	1F, 71R
		C	1054L	C	2L, 7F, 318R
Elktoe	*Alasmidonta marginata*	A	3L	A	5R
		B	—	B	6R
		C	3L	C	1R
Spike	*Elliptio dilatata*	A	362L	A	3L, 1269R
		B	438L	B	2L
		C	933L	C	22F, 839R
Northern riffleshell	*Epioblasma torulosa rangiana*	A	7L	A	12R
		B	9L	B	1F, 6R
		C	4L	C	9R
Plain pocketbook	*Lampsilis cardium*	A	7L	A	3R
		B	3L	B	6R
		C	7L	C	1F, 2R
Wavyrayed lampmussel	*Lampsilis fasciola*	A	9L	A	8R
		B	3L	B	11R
		C	8L	C	2F, 7R
Pocketbook	*Lampsilis ovata*	A	12L	A	2R
		B	2L	B	—
		C	13L	C	—
Flutedshell	*Lasmigona costata*	A	48L	A	2L, 11F
		B	25L	B	5L, 1F, 12R
		C	38L	C	9R
Black sandshell	*Ligumia recta*	A	9L	A	2R
		B	12L	B	2R
		C	24L	C	6R
Clubshell	*Pleurobema clava*	A	—	A	2R
		B	1L	B	2R
		C	—	C	1R
Round pigtoe	*Pleurobema sintoxia*	A	—	A	1R
		B	—	B	—
		C	1L	C	—
Creeper	*Strophitus undulatus*	A	—	A	2R
		B	—	B	4R
		C	1L	C	1F, 1R
Paper pondshell	*Utterbackia imbecillis*	A	—	A	—
		B	—	B	—
		C	—	C	1L
Rayed bean	*Villosa fabalis*	A	3L	A	2R
		B	—	B	1F
		C	2L	C	1F

[1] Zone: A = 0-101 yards upstream of bridge: B = 0-200 yards downstream of bridge; C = 200-404 yards downstream of bridge.
[2] Data: Report number of paired valves, and condition (L = Live, F = Fresh dead, R = Relict)

Form 2A

QUALITATIVE FRESHWATER MUSSEL SURVEY REPORT:
DETAILED TRANSECT DATA OF LIVE MUSSELS (SUMMARIZED ON FORM 2)
ALLEGHENY RIVER AT FOXBURG, PA
SEPTEMBER 1-3, 1998, AND OCTOBER 1-2, 1998

Common name	Scientific name	Zone [1], transect number and data[2] (refer to Form 4)																		
		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	C5	Total
Mucket	*Actinonaias ligamentina*	155	200	17	62	63	13	99	200	33	75	7	75	17	400	175	400	29	50	2,070
Spike	*Elliptio dilatata*	65	89	13	70	109	16	54	200	30	50	6	59	39	300	150	400	33	50	1,733
Flutedshell	*Lasmigona costata*	16	12	0	1	17	2	10	7	3	0	0	2	3	6	15	2	2	13	111
Black sandshell	*Ligumia recta*	3	2	1	2	0	1	2	4	2	1	0	3	0	8	3	1	9	3	45
Pocketbook	*Lampsilis ovata*	5	4	1	1	1	0	0	0	0	1	0	1	0	2	2	7	2	1	28
Wavyrayed lampmussel	*Lampsilis fasciola*	4	3	0	0	2	0	2	1	0	0	0	0	0	4	2	1	1	0	20
Northern riffleshell	*Epioblasma torulosa rangiana*	2	3	0	2	0	0	1	5	0	1	0	2	0	2	0	1	0	1	20
Plain pocketbook	*Lampsilis cardium*	2	1	1	2	1	0	0	1	0	0	0	2	0	1	0	5	2	0	18
Elktoe	*Alasmidonta marginata*	2	0	0	0	0	1	0	0	0	0	0	0	0	2	1	0	0	0	6
Rayed bean	*Villosa fabalis*	0	1	0	0	1	1	0	0	0	0	0	0	0	1	0	0	1	0	5
Creeper	*Stophitus undulatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Round pigtoe	*Pleurobema sintoxia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Clubshell	*Pleurobema clava*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Total	254	315	33	140	194	34	168	419	68	128	13	144	59	726	349	818	79	118	4,059

[1] Zone: A = 1-101 yards upstream of bridge; B = 0-200 yards downstream of bridge; C = 200-404 yards downstream of bridge.

[2] Number reported for mucket and spike are estimated in units of 50 if greater than 50.

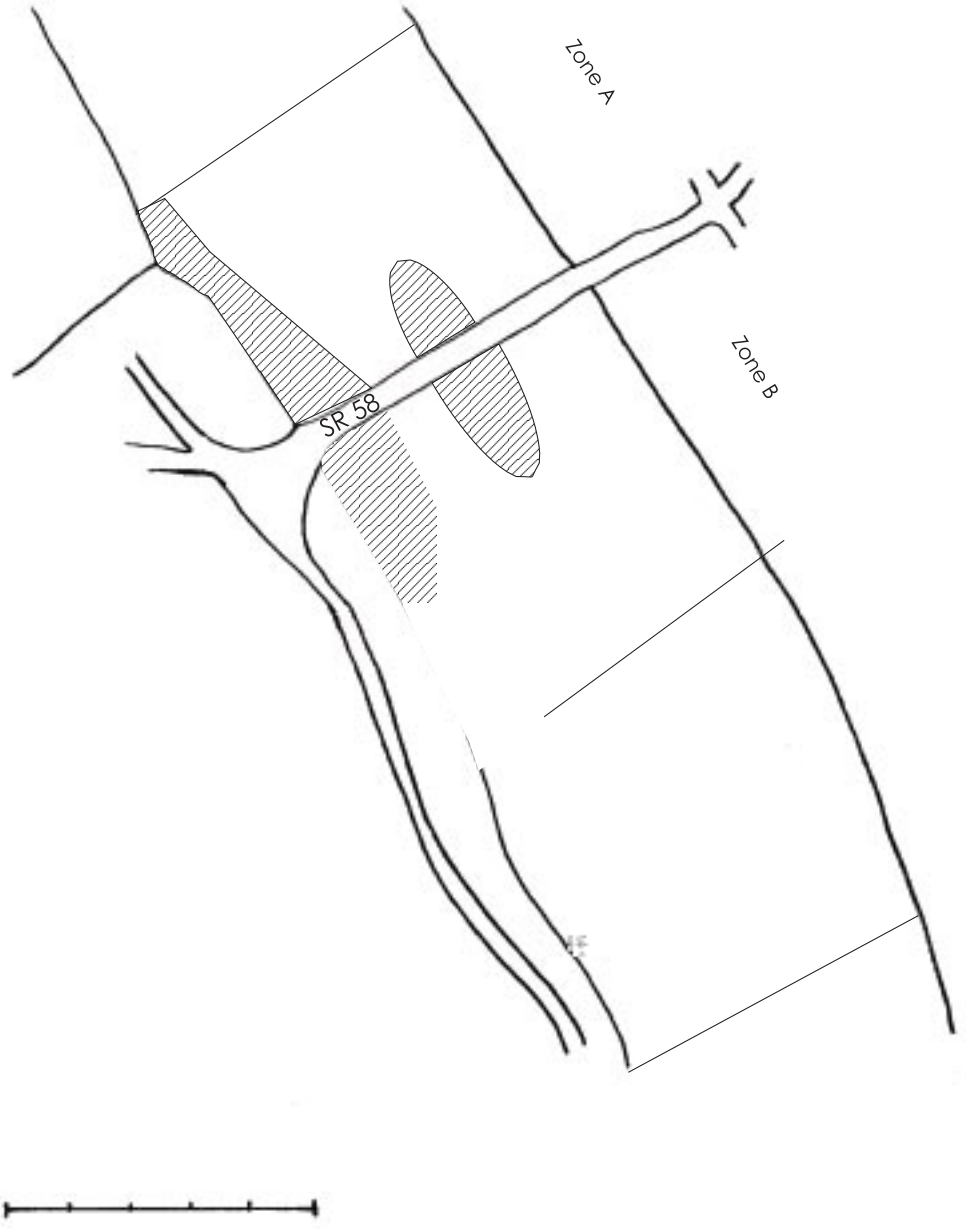
Form 3

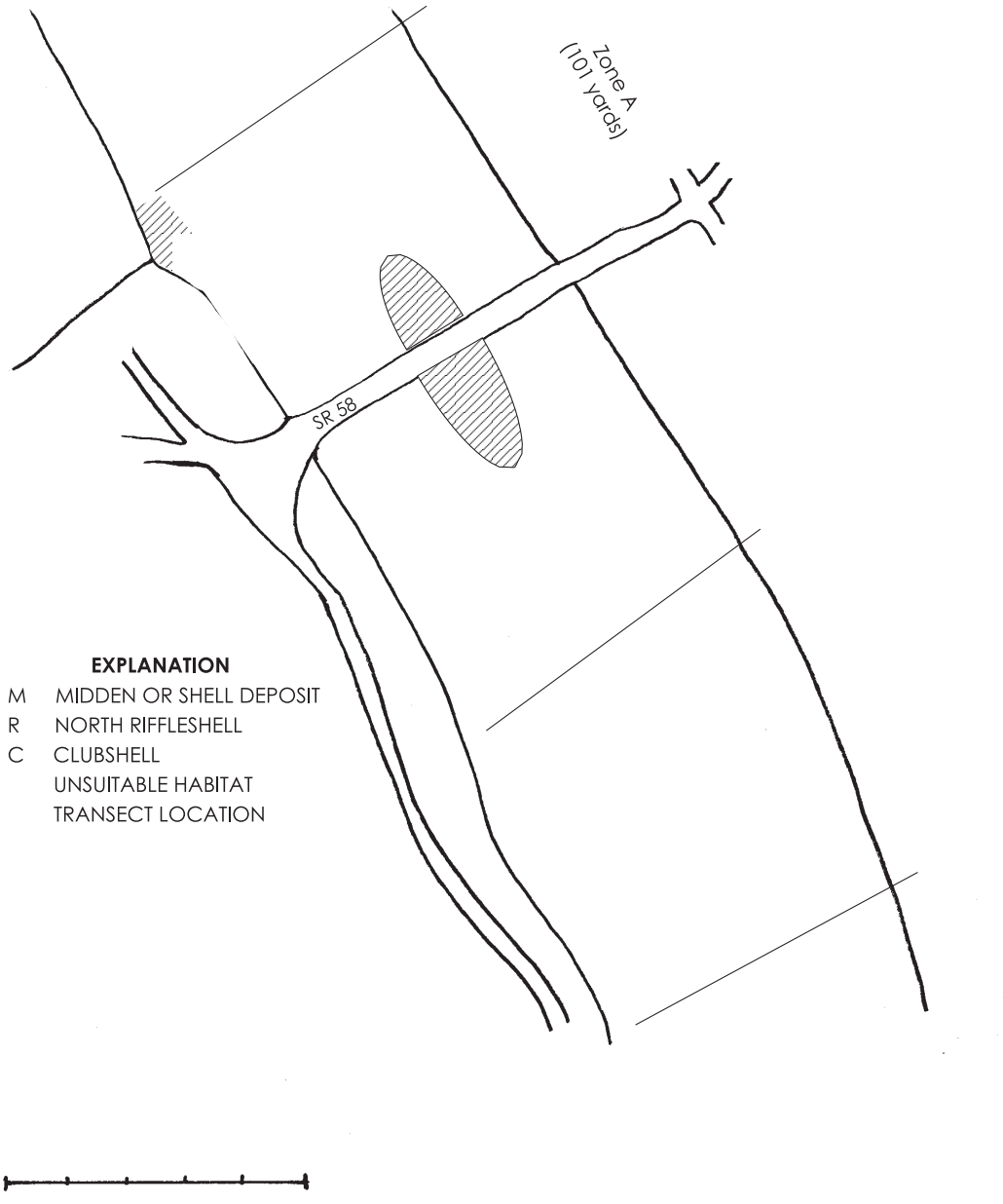
QUALITATIVE FRESHWATER MUSSEL SURVEY REPORT: QUADRANT DATA
ALLEGHENY RIVER AT FOXBURG, PA
SEPTEMBER 1-3, 1998, AND OCTOBER 1-2, 1998

	SURVEY AREA, QUADRANT NUMBER, and NUMBER OF INDIVIDUALS PER SPECIES															
	Area 1				**Area 2**				**Area 3**				**Area 4**			
Scientific name	Q1.1	Q1.2	Q1.3	Q1.4	Q2.1	Q2.2	Q2.3	Q2.4	Q3.1	Q3.2	Q3.3	Q3.4	Q4.1	Q4.2	Q4.3	Q4.4
Actinonaias ligamentina	1	1	0	0	3	2	0	2	0	0	0	0	0	0	0	2
Elliptio dilatata	0	0	0	0	2	2	1	2	0	0	0	0	0	0	0	0
Epioblasma torulosa rangiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lampsilis cardium	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Lasmigona costata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ligumia recta	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Strophitus undulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Villosa fabalis	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Area 5				**Area 6**				**Area 7**				**Area 8**			
Scientific name	Q5.1	Q5.2	Q5.3	Q5.4	Q6.1	Q6.2	Q6.3	Q6.4	Q7.1	Q7.2	Q7.3	Q7.4	Q8.1	Q8.2	Q8.3	Q8.4
Actinonaias ligamentina	0	0	0	0	0	0	0	0	2	2	0	7	1	0	3	3
Elliptio dilatata	0	1	0	0	0	1	1	0	0	1	0	5	2	4	0	1
Epioblasma torulosa rangiana	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Lampsilis cardium	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Lasmigona costata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Ligumia recta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strophitus undulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Villosa fabalis	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Area 9				**Area 10**				**Area 11**				**Area 12**			
Scientific name	Q9.1	Q9.2	Q9.3	Q9.4	Q10.1	Q10.2	Q10.3	Q10.4	Q11.1	Q11.2	Q11.3	Q11.4	Q12.1	Q12.2	Q12.3	Q12.4
Actinonaias ligamentina	0	0	0	1	0	0	0	1	0	1	1	0	1	0	1	0
Elliptio dilatata	1	1	0	0	2	1	2	1	2	5	8	2	0	1	1	0
Epioblasma torulosa rangiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lampsilis cardium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lasmigona costata	0	0	0	0	0	2	0	0	0	1	0	1	0	0	0	0
Ligumia recta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strophitus undulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Villosa fabalis	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0

Form 4

FRESHWATER MUSSEL SURVEY REPORT




Zone A
(101 yards)
SR 58
EXPLANATION
M MIDDEN OR SHELL DEPOSIT
R NORTH RIFFLESHELL
C CLUBSHELL
UNSUITABLE HABITAT
TRANSECT LOCATION