Lampsilis sp. with lure display, Potomac River.

Mussel collecting gear in the Potomac River Dam 5 site.

2010 Freshwater Mussel Survey of the Potomac Mainstem

Summary Report – Prepared 6/20/2011 by James D. Cummins, Jan Ducnuigeen, Adam Griggs
The Interstate Commission on the Potomac River Basin

Introduction

This is an annual summary report for a multi-year, two-phase freshwater mussel survey of the Potomac River mainstem initiated by the Interstate Commission on the Potomac River Basin in 2009. The primary long-term objectives of this survey are; 1) augment biological information collected at study reaches established in the Potomac River's mainstem through a nationwide survey of large river conducted by the US EPA[1], 2) improve our understanding of the status of Potomac River mussel species, their temporal variation and trends, relationship to the river's general health, and 3) help evaluate how mussel communities in typical sections of the river compare with sections potentially impacted by pollution or altered flows, especially where low-flows are exacerbated by consumptive water uses. Survey parameters include species richness, relative abundance, density, recruitment, and presence of any state or federally rare, threatened or endangered mussels.

Phase 1 was conducted in 2009 when freshwater mussel habitat was qualitatively evaluated and mapped for four mainstem river segments. This work was performed with assistance from the Maryland Department of Natural Resources and the USGS Leetown Science Center, Aquatic Ecology Branch. Estimates of search efficiencies were calculated through timed visual snorkel surveys conducted at 11 random locations within river segments. A separate report details this activity.

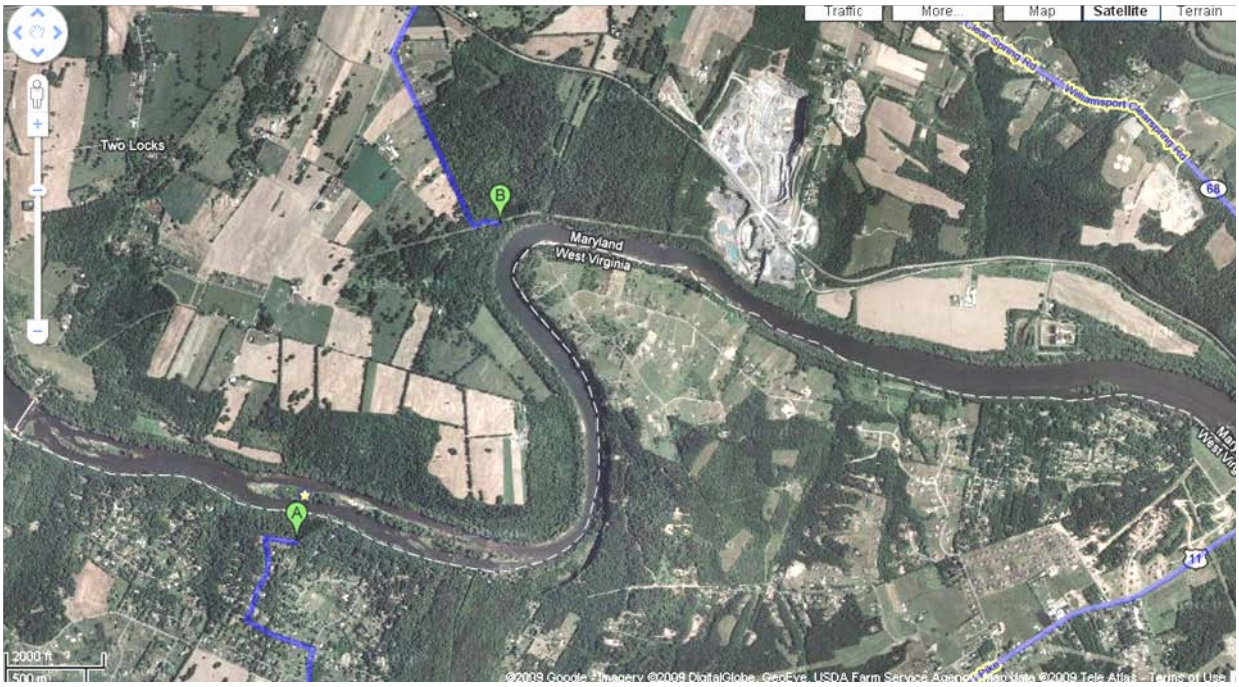
Phase 2 began in 2010 with an intensive quantitative survey conducted at a river segment just downstream of Dam #5 near Williamsport, Maryland. Six mussel's species represented by sixty-one individual mussels were collected, including two Maryland endangered species; the Brook Floater (*Alasmidonta varicosa*) and the Green Floater (*Lasmigona subviridis*), two species formerly considered extirpated in this portion of the Potomac River mainstem. One-hundred and fifty-six 0.25 m^2 quadrats were examined by visual examination of the surface (detection rate 2.5 min/individual) and one-hundred and four by excavation to approximately 10 cm depth (detection rate 11.9 min/individual). The presence of the state endangered mussels is important for considerations of proposed construction or disturbance activities, water withdrawals, and discharge permits.

[1]Flotemersch, J. E., J. B. Stribling, and M. J. Paul. 2006. Concepts and Approaches for the Bioassessment of Non-wadeable Streams and Rivers. EPA 600-R-06-127. US Environmental Protection Agency, Cincinnati, Ohio.

Methodology

The instream habitat area represented by the Potomac River's mainstem is over three hundred miles in length and ranges in width from approximately 200-600 meters. This area is so large that a complete survey of all mussel habitats would be prohibitively expensive and time consuming. Therefore, this survey uses an adaptive sampling approach incorporating a two-phase survey design (Strayer and Smith, 2003) in order to maximize efficiency and maintain representative spatial coverage. The survey re-assesses four randomly-selected 4-kilometer river reaches previously surveyed (2008-2009) for fish, benthic invertebrates and water and habitat parameters as part of a US EPA national survey of large rivers. However, the EPA study did not specifically incorporate a freshwater mussel component. Phase 1 of this study, conducted in 2009, used canoe-based field reconnaissance in conjunction with snorkel surveys to identify, estimate bounds and map qualitative mussel habitat categories within each of the four river reaches. These four mussel habitat categories were; 1) areas with living mussels, 2) areas of good mussel habitat but where no living mussels were observed, 3) areas of poor mussel habitat, such as bedrock areas, and 4) areas too deep to judge mussel habitat conditions without the deployment of scuba techniques which, unfortunately, would have exceeded the budget and resources of this study. Mussel diversity, general abundance, and preliminary estimates of search efficiencies were obtained through 44 timed visual snorkel surveys conducted at 11 random transect locations within the first two habitat categories. Phase 1 observations and analysis were used to prescribe quantitative sampling criteria in Phase 2. Site logistics obtained during Phase 1 were also used for operational planning in Phase 2.

Figure 1: The river reach designated DS Dam #5, between point A and B, located downstream of Dam #5, Potomac River.



Based upon the results of the 2009 Phase 1 study, three primary non-tidal river reaches were established for long-term Phase 2 monitoring, with the goal that each of these reaches would be sampled once over the course of three years, from 2010 until 2012. Additional monitoring will depend upon monitoring results and future funding. The river reach selected for Phase 2 monitoring in 2010 is located approximately one mile downstream from the C&O Canal National Historic Park's Dam #5, thereby designated as the river section "DS Dam #5" (See Figure 1). Dam #5 can be seen crossing the river at the far left of the image. The town of Williamsport, Maryland, is located just out of the right side of the image.

Habitat types were designated within each river reach, digitally mapped and respective areas calculated. Habitat designations applied to habitats in river reach DS Dam #5 are highlighted below (Figure 2, where the river flow is from the left to the right side).

The most upstream areas of this section had the greatest amount of observed habitat (yellow) and known mussel habitat (green). The habitat types applied to the other river sections scheduled to be surveyed in subsequent years can be found in Appendix A. During Phase 2, intensive sampling is conducted in the Type 1 (green – living mussels observed) habitat areas.

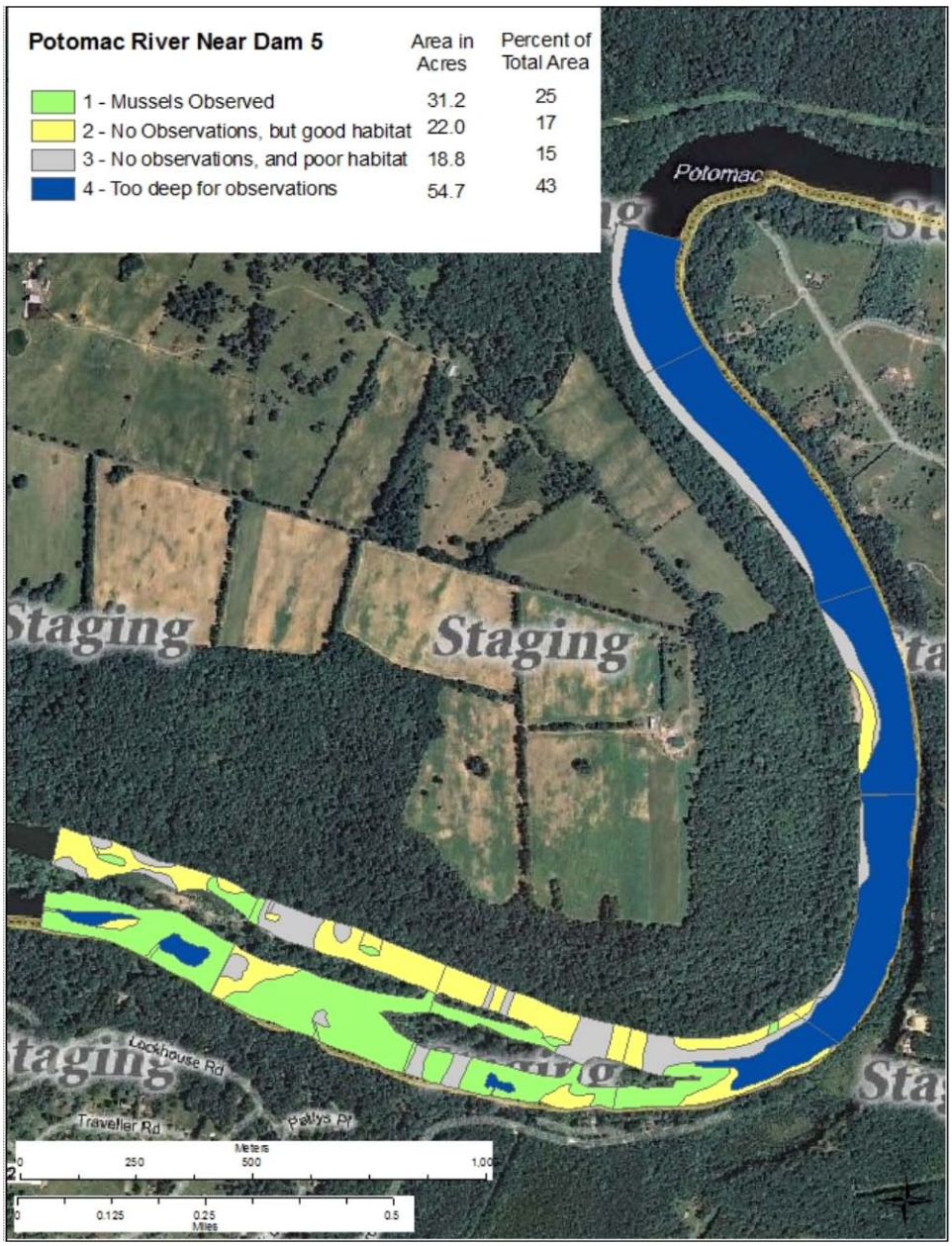


Figure 2: Mussel Habitat Categories for the river reach designated DS Dam #5, Potomac River.

Therefore, during 2010 efforts were concentrated in the most upstream sections of the DS Dam #5 reach. This area was subsampled using a randomized selection of sampling sites.

A numbered 25 m² grid pattern was digitally constructed over the Phase 1 DS Dam #5 reach habitat map (Figure 3, below) and a random number table was used to select the grid squares to be sampled.

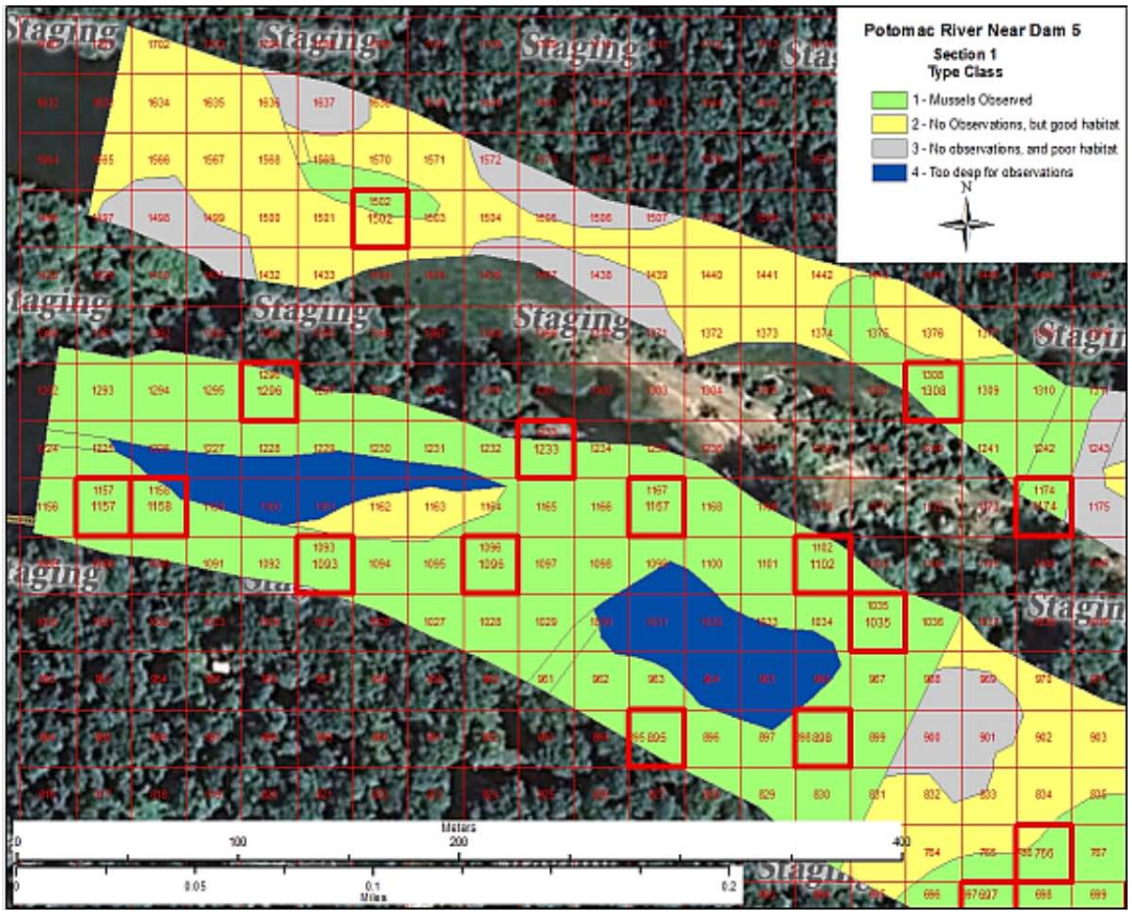
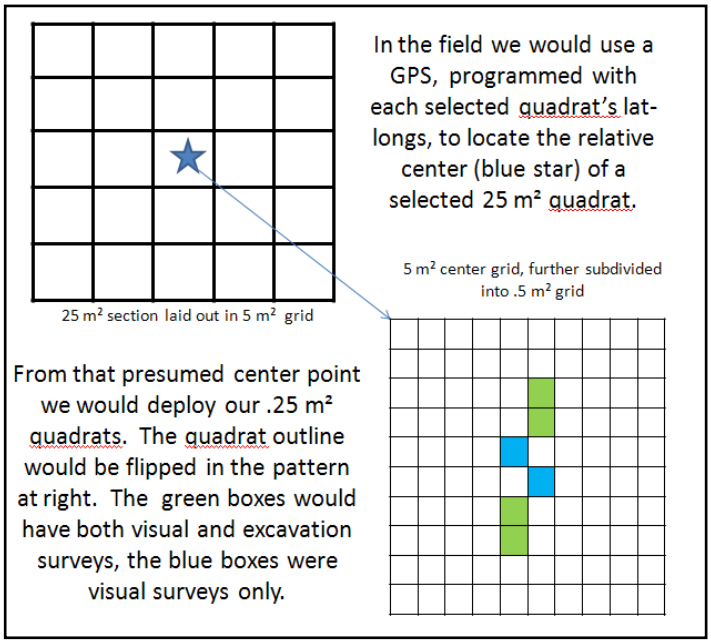


Figure 3: Example of grid squares and selections as superimposed over Section 1 of the DS Dam #5 river reach, Potomac River.



A Garmin Etrex, Model Legend H GPS was used to locate these positions in the field. Accuracy was to within several feet, therefore field locations were very close to the centers of selected 25 m² quadrats. Aerial image and topographic maps were also used to assist in verifying the location. A total of twenty-six 25 m² quadrat sites were selected for field examination. Within these larger quadrats, six standard 0.25 m² quadrats[2] were sampled visually, and four of those were then excavated.

Figure 4(Left): Method of selecting a starting point and subsequent location of the six 0.25 m² quadrats sampled within the larger 25 m² sites

The first 0.25 m² quadrat was positioned on the river bottom near the center of the 25 m² site and then sequentially flipped to the other quadrat locations (see Figure 4). Visual searches were performed first at all 0.25 m² quadrats. Visual searches were conducted with snorkels and were simple observations of mussels evident in the undisturbed substrate surface within each of the 0.25 m² quadrat borders. In cases when submerged vegetation was blocking the view of the surface, a slight fanning motion of the hand was generally all that was required to move the vegetation aside for surface observations. On a few occasions vegetation was so thick that it was necessary to pin the plants back with an arm before observations were conducted. Depths of sites ranged from just less than a meter to shoreline. All observed mussels were collected.

Following visual searches, quantitative mussel excavations were conducted at four of the six 0.25 m² quadrats within each center 5.0 m² grids box of the sampling site. Larger pieces of cobble and rocks were removed by hand and the remaining substrate within the quadrat was removed and placed into a 0.25 m² collection tray which has 14 cm. (5.5") sides and a 1 cm. (3/8") galvanized wire-mesh bottom. Material was removed and transferred by hand and/or with a gardening trowel, being careful to gently remove any mussels upon observation and transferring them to a secure location in the collection tray. After excavation the bottom of the quadrat area was allowed to clear if suspended sediment was a problem and then a final visual search was conducted until no visible mussels remained. The time of the search was recorded. Mussels were then identified, measured and enumerated, then repositioned into the substrate within the quadrat location. Mussel densities (individuals/m²) were calculated for both visual and excavation searches.

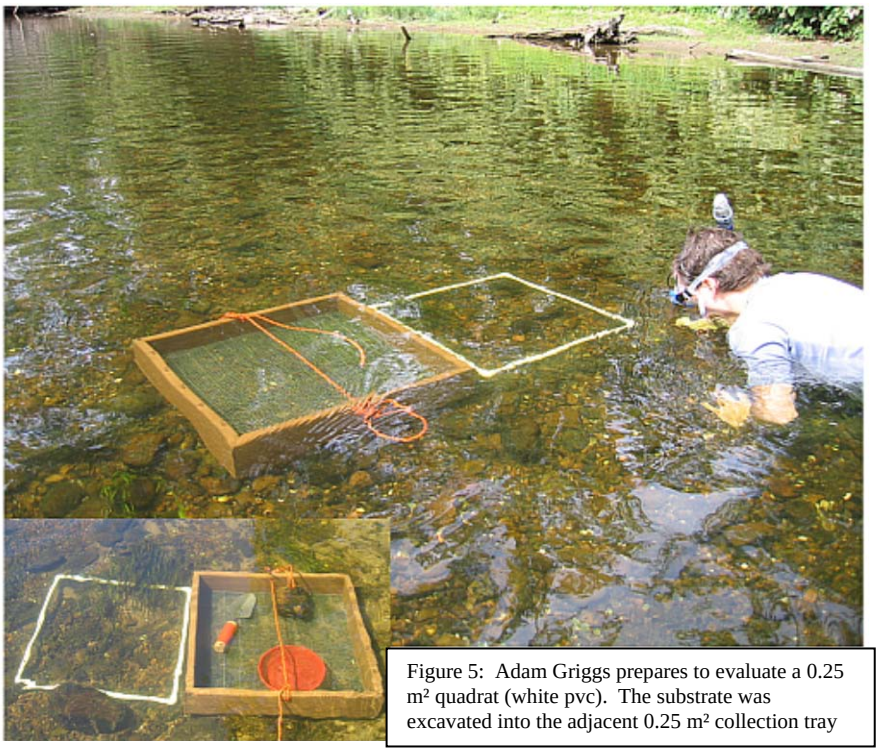


Figure 5: Adam Griggs prepares to evaluate a 0.25 m² quadrat (white pvc). The substrate was excavated into the adjacent 0.25 m² collection tray

Sampling was conducted in early and mid-September, during a low flow period when aquatic habitats were accessible and clarity of the water was good (flows averaged 412 cfs, roughly 35% of median, as measured at the USGS Gage # 01613000, at Hancock, MD,). Mussels were identified and recorded at the end of each quadrat collection. A subset of the fresh dead shells collected was retained for voucher specimens and provided to Matt Ashton of Maryland DNR. On-shore searches for dead shell material were also conducted in the vicinity of the 25m² sample sites in order to obtain voucher collections and to look for evidence of species not found in the collection areas. Dead specimens of mussel species not represented by live individuals were classified as either fresh dead, dead, or subfossil. Fresh dead shells represent individuals in which bits of the soft anatomy were still intact, indicating that the individual has recently perished. Dead shells retain a lustrous nacre (on the inside of the shell) and have a relatively intact periostracum (or "skin-like" covering on the outside of the shell). Subfossil shells have a chalky and lusterless nacre and the periostracum has peeled off considerably (Buchanan 1979) and likely represent mussels that have been dead for more than a year.

Results

Table 1 provides the total species and numbers of individuals collected along with detection rates for search type and the species densities in the search area (See Appendix B for photographs of selected species). Table 2, on the proceeding page, provides the 26 site numbers and site-specific duration of times for both visual and excavated searches and site-specific species and number of individuals collected. Site location information and images of these selected site locations are provided in Appendix C. At 26 sites, a total of 61 living mussels, representing six species, were collected at 156 0.25 m² quadrats, 104 of which were excavated. No other mussel species were found in the shells collected in the reach.

Species	Common Name	Individuals per Visual Search	Individuals per Excavation[3]	Totals	Density[4]/meter²
Alasmidonta varicosa	Brook Floater		2	2	.05
Elliptio complanata	Eastern Elliptio	5	12	17	.44
Elliptio producta	Atlantic Spike		4	4	.10
Strophitus undulatus,[5]	Creeper or Squawfoot	1		1	.03
Lasmigona subviridis	Green Floater	1	3	4	.10
Lampsilis sp.[6]	Plain Pocketbook	11	22	33	.85
	Totals	18	43	61	1.56

The average time spent on visual searches was 24 seconds/0.25 m² quadrat and the total time required searching all 156 quadrats, or 39 m², was 63 minutes. The average time for excavations was 343 seconds(5.7 minutes)/0.25 m² quadrats and the total time excavating 104 quadrats, or 26 m², was 594 minutes (9.9 hours). These times are solely representative of the quadrat evaluations, and do not account for the significant time accessing and locating the sites, setting up, processing and documentation.

The detection rate for visual searches was 2.5 minutes/mussel. This is almost identical to the visual detection rate of 2.6 minutes/mussels experienced during the 2009 Phase 1 transect surveys. The detection rate for excavations was 11.7 minute/mussel. The detection rate when visual and excavation searches were combined was 10.8 minutes/mussel, or 5.6 mussel/hour (calculated from 61 total mussels collected and the combined search time of 657 minutes (10.9 hours)).

Visual searches did not pick up any Brook Floaters (*Alasmidonta varicosa*) or Atlantic Spikes (*Elliptio producta*), however visual searches were 4.7 times faster at covering habitat and resulted in the collection of 4 of the 6 species and 41% of the individuals collected by both methods. Excavations collected more individuals and species per unit area, and thereby permit more accurate estimates of mussel density in the habitats surveyed. Excavations did not encounter the Creeper (*Strophitus undulates*), but that likely was more a factor of their relatively low abundance in the surveyed area than on differences between search methods.

[3] Excavations were performed after visual searches were surface mussels were removed. Therefore, detection rates for excavations include those mussels collected during visual searches.

[4] Density is calculated as the total mussels collected in the 156 quadrats, or 39 m²

[5] *Based upon an image identification by Bill Lellis, USGS. See appendix xx, at bottom right.*

[6] There are outstanding taxonomic issues with Lampsilis species, these may be *L. cariosa, L. cardium*, hybrids between the two, or a native subspecies *L. cardium cohongoroton*.

Table 2: Results of Mussel Collections at Twenty-Six Sampling Sites in the Potomac River at the reach downstream of Dam #5 (DS Dam #5).

Site #		Date	VisTotSecs	VisTotSp	VisTotInd	Visible Species and Number of Individuals	ExcTotSecs	ExcTotSp	ExcTotInd	Excavated Species and Number of Individuals
1	1157	20100903	175	0	0	0	1205	4	6	1 EcompD, 2Ecomp, 1 Eprod, 1 Lcarx, 1 Lsubv
2	1158	20100903	70	0	0	0	1081	0	0	0
3	1296	20100903	60	1	1	1 Lcarx	1050	1	3	3 Lcarx
4	1093	20100903	80	0	0	0	785	0	0	0
5	1096	20100903	60	0	0	0	932	2	4	3 Ecomp, 1Lcarx
6	1233	20100903	60	1	1	1 LcarxD	1230	2	2	1 LcarxD, 1 Eprod
7	1167	20100907	80	1	1	1 LcarxD	1125	1	1	1 LcarxD
8	1035	20100907	76	0	0	0	1260	0	0	0
9	895	20100907	65	2	2	1 LcarxD, 1 Ecomp	1660	4	10	5 Ecomp, 3 Lcarx, 1 Eprod, 1Avari
10	766	20100907	90	2	2	2 Lcarx	1565	2	4	3 Lcarx, 1 Ecomp
11	1102	20100907	95	0	0	0	1180	0	0	0
12	897	20100907	90	0	0	0	1270	0	0	0
13	701	20100907	70	1	1	1 Lcarx	1370	1	1	1 L carxD
14	697	20100907	60	2	4	1 Ecomp, 2 EcompD, 1 LcarxD	1400	2	4	2 Lcarx, 1 LcarxD, 1 Ecomp
15	838	20100910	195	1	1	1 Lcarx	1580	1	1	1 Lcarx
16	702	20100910	60	0	0	0	1495	1	1	1 Lcarx
17	708	20100910	210	1	2	2 Ecomp	1665	1	2	2 Lcarx
18	635	20100910	70	2	3	2 Lcarx, 1 Ecomp	1435	0	0	0
19	712	20100910	180	1	1	1 Lcarx	1775	0	0	0
20	502	20100910	150	3	4	1 Lcarx, 1 LsubvD, 1 Lsubv, 1 Sundu	1495	3	4	1 Lcarx, 1 Avari, 2 Lsubv
21	442	20100915	185	0	0	0	1370	0	0	0
22	309	20100915	90	0	0	0	1525	0	0	0
23	313	20100915	270	1	1	1 Lcarx	1485	2	2	1 Lcarx, 1Eprod
24	317	20100915	115	0	0	0	1345	1	1	1 LcarxD
25	250	20100915	840	0	0	0	1800	1	3	3 Lcarx
26	185	20100915	270	1	1	1LcarxD	1560	0	0	0
Totals			3766	4	25		35643	5	49	
			avg=24 s		151s/Ind or 2.5min/Ind	5 Ecomp, 2EcompD, 11Lcarx, 5 LcarxD, 1 Lsubv, 1 LsubvD, 1 ProbSundu	avg=343 s or 5.7 min		713s/Ind or11.9 min/Ind	12 Ecomp, 1 EcompD, 22 Lcarx, 5 LcarxD, 4Eprod, 3 Lsubv, 2 Avari
			Vis Quads Sampled # =156			18 living mussels, 4 species (no E. producta or A. varicosa)	Exc Quads Sampled # =104		699s/ind Or 11.7 Min/Ind	43 Living Mussels, 5 species (no S. undulata) 61 Living Mussels with vis ind added back to exc sites

Species codes: Avari = *Alasmidonta varicosa*, Ecomp = *Elliptio complanata*, Eprod = *Elliptio producta*, Sundu = *Strophitus undulatus*, Lsubv = *Lasmigona subviridis*, Lcarx = *Lampsilis cardium/cariosa/cardium cohongoroto* (there are outstanding taxonomic issues with Lampsilis species)

The suffix "D" means that specimen was from a dead shell. Shells were not counted in the totals**.**

The densities of the mussel species collected in the sampled quadrates were used in conjunction with our delineated Type 1 Habitat area (i.e., habitat had living mussels observed) in the Dam #5 river reach to develop estimates of the number of mussels within that reach. Mussel habitat Type 1 area coverage was calculated through GIS mapping projections and it represented 126,434 m² (or 31.2 acres and 25% of the total reach area). Table 3 below provides estimated numbers of mussels in the DS Dam #5 river reach, Type 1 Habitat only.

Species	Common Name	Total Individuals	Density[7]/meter²	Estimated individuals in DS Dam #5 Reach (Type 1 habitat only - area = 126,434 m²)
Alasmidonta varicosa	Brook Floater	2	.05	6,321
Elliptio complanata	Eastern Elliptio	17	.44	55,631
Elliptio producta	Atlantic Spike	4	.10	12,643
Strophitus undulatus,[8]	Creeper or Squawfoot	1	.03	3,793
Lasmigona subviridis	Green Floater	4	.10	12,643
Lampsilis sp.[9]	Plain Pocketbook	33	.85	107,469
	Totals	61	1.56	198,500

Table 3: Estimates of mussel numbers (Type 1 habitat only) of the 4 kilometer mainstem river reach designated as DS Dam #5, Potomac River.

Type 1 habitat represented 25% of the total habitat area of the reach. Only 15% of the remaining habitat was considered poor. The number of mussels which could occupy this reach if all available habitat (Types 2 and 4) were occupied would greatly exceed the above estimates and would have significant ecological benefits including; filtering and improved water quality, food-chain enhancement, habitat creation, and carbonate (CO_2) sequestration.

Literature Cited:

Buchanan, A.C. 1979. Mussels (Naiades) of the Meramec River Basin, Missouri. Final report prepared for U. S. Army Corps of Engineers, St. Louis District.

Flotemersch, J. E., J. B. Stribling, and M. J. Paul. 2006. Concepts and Approaches for the Bioassessment of Non-wadeable Streams and Rivers. EPA 600-R-06-127. US Environmental Protection Agency, Cincinnati, Ohio.

Strayer, D. L. and D. R. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society Monograph 8, 103 pages. Bethesda, Maryland (American Fisheries Society). ISBN 1-888569-506.

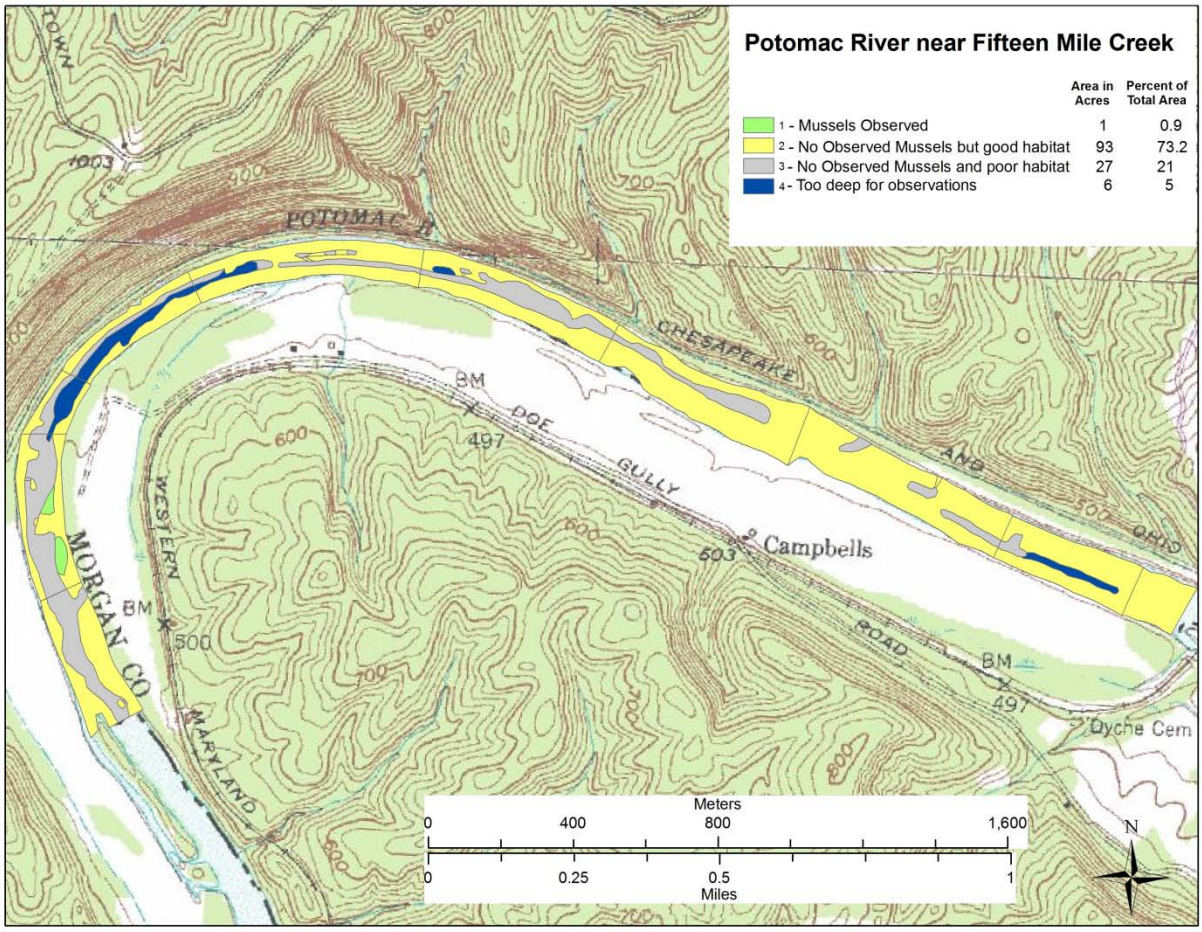
[7] Density is calculated as the total mussels collected divided by 39 m² (the total area of 156 0.25 m² quadrats)

[8] Based upon an image identification made by Bill Lellis, USGS. See Appendix B, at bottom right.

[9] *Lampsilis cardium/cariosa/cardium cohongoroto* (There are outstanding taxonomic issues with Lampsilis species).

Appendix A: Habitat Types Applied to Other River Reaches Surveyed in 2009

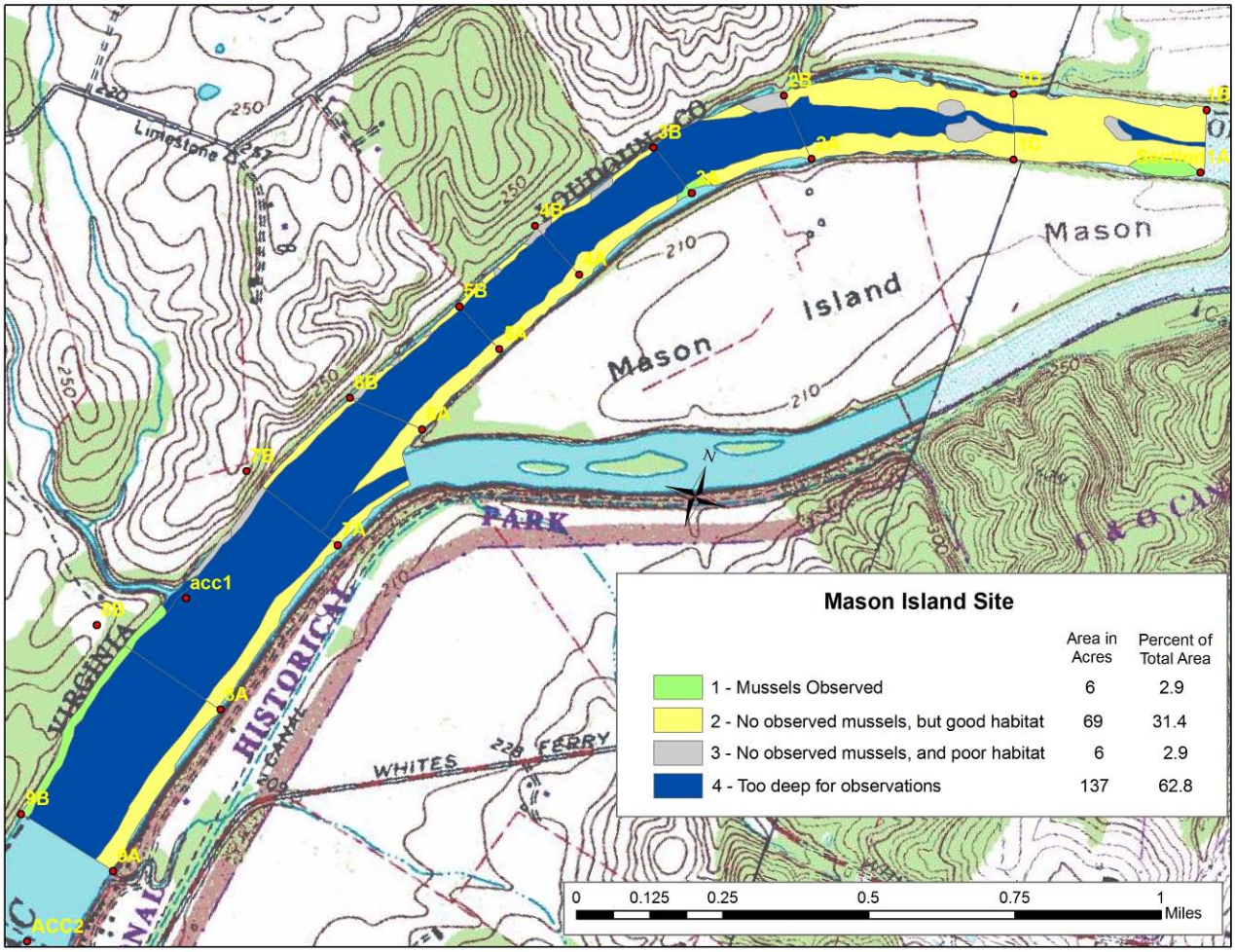
River Reach: PRus15MileCr = Potomac River Upstream of Fifteen Mile Creek



Potomac River upstream of Fifteen Mile Creek Site				
Type Class	Area in Sq Meters	Area in Acres	Area in Sq Mi	Percent of total
4	26037	6	0.01	5.0
3	108382	27	0.04	21.0
2	378193	93	0.15	73.2
1	4398	1	0.00	0.9
Total Area	517009	128	0.20	100.0

Appendix A: Habitat Types Applied to Other River Reaches Surveyed in 2009, cont.

River Reach: PRMasonIs = Potomac River at Mason Island
(reach does not included southern side-channel)



Potomac River Near Mason Island

Type Class	Area in Sq Meters	Area in Acres	Area in Sq Mi	Percent of total
4	556440	137	0.21	62.8
3	25582	6	0.01	2.9
2	278622	69	0.11	31.4
1	25384	6	0.01	2.9
Total Area	886028	219	0.34	100.0

Appendix B: Selected Images of Mussels Collected in the Potomac River in 2010

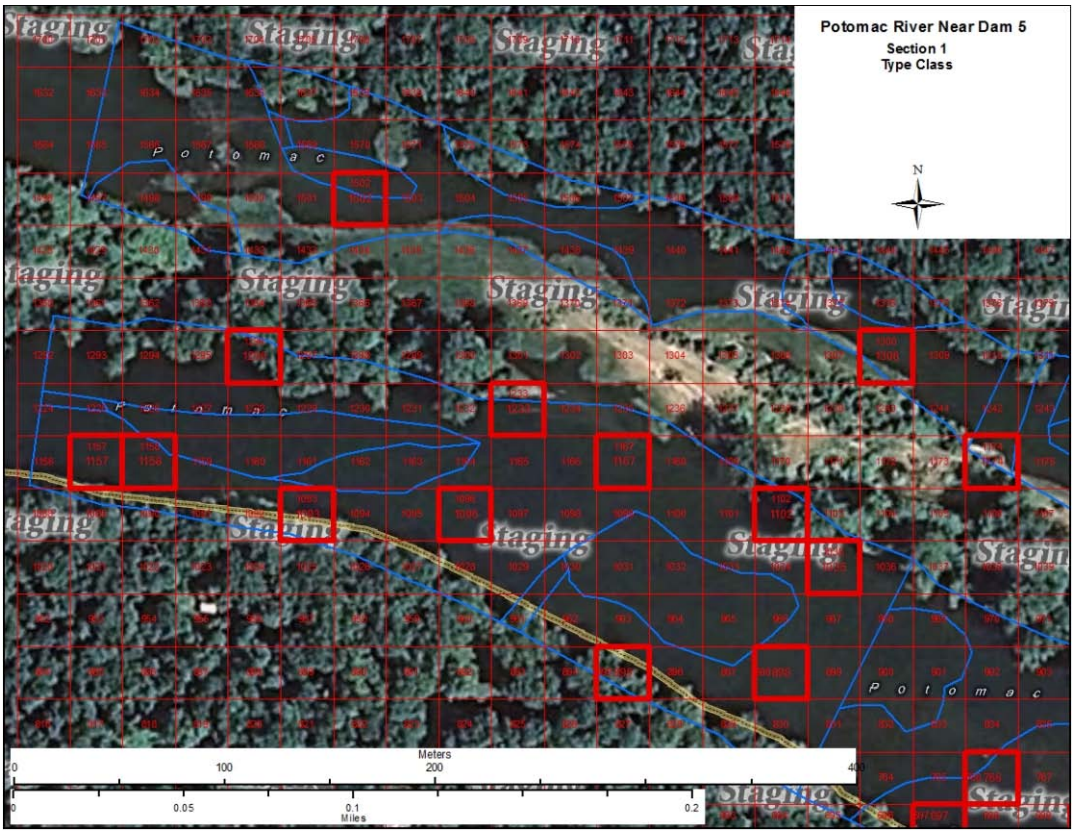
Left: An example of a mussel group collected at one quadrat. Predominantly Lampsilis and Elliptio species, the group includes a brook floater, *Alasmidonta varicosa* [at 2nd from top on right, and below].

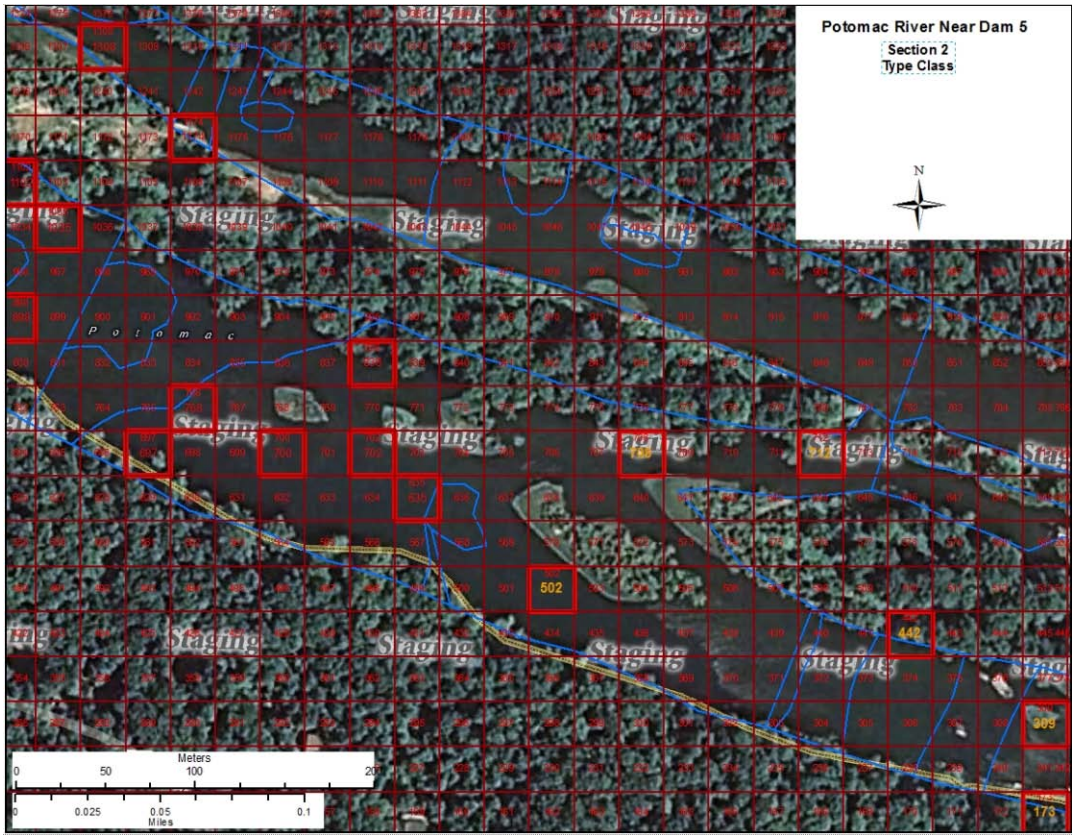
Bottom:
Creeper, *Strophitus undulatus.*
All specimens were released.

Below: Below, the green floater, Lasmigona subviridis, found very early in the survey. One of the reasons to use a Two Phase survey is to increase the likelihood of encountering rare species

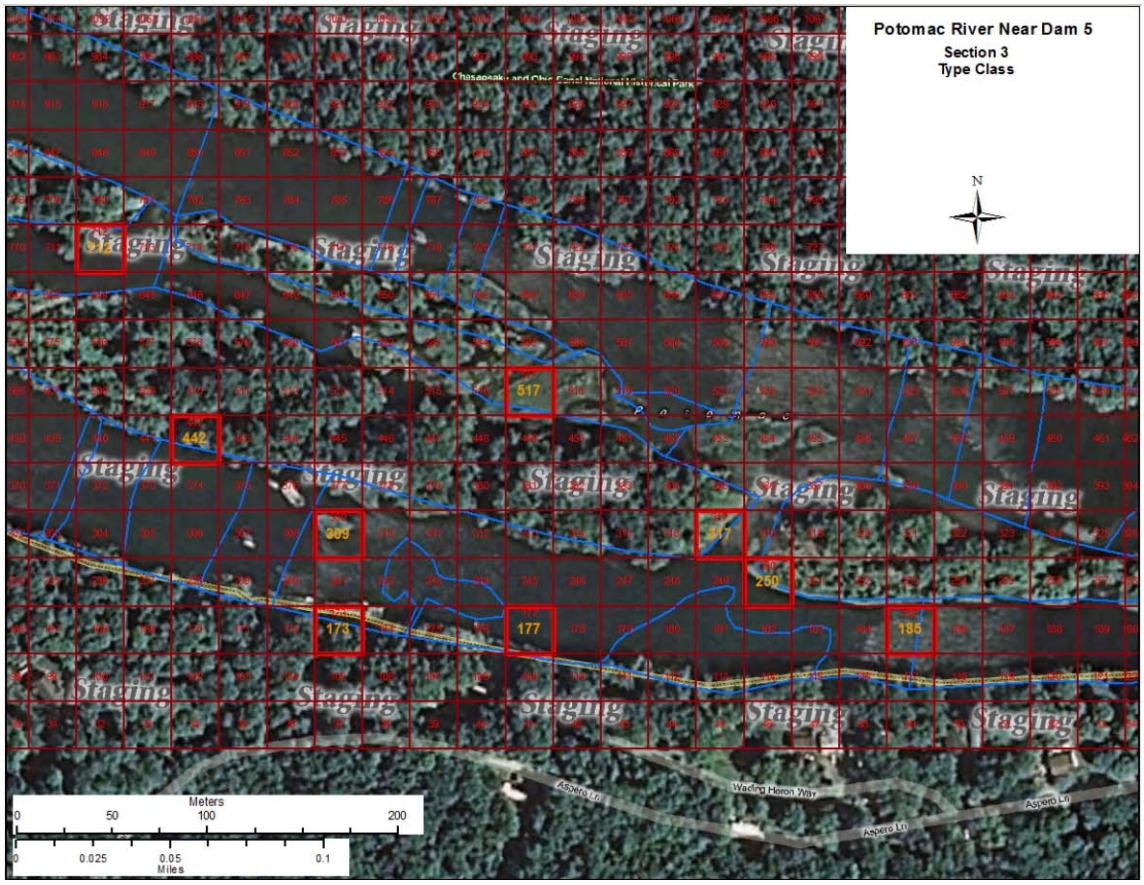
Appendix C: Site location information and map images of the 26 sites surveyed for freshwater mussels at DS Dam 5, Potomac River in 2010.

The locations of selected 25 m² sampling sites (red boxes) in the Potomac River sections Downstream of Dam5, presented as 3 sections starting from the most upstream.





Appendix C (Cont.): Site Location information and map images of the 26 sites surveyed for freshwater mussels at DS Dam 5, Potomac River in 2010.



Appendix C (Cont.): Site Location information of the 32 randomly selected sites, 26 of which were surveyed for freshwater mussels at DS Dam 5, Potomac River in 2010.

Sites with asterisks were not sampled for the reasons provided at the end of the page.

Site #	Longitude	Latitude
173*	-77.89141424430	39.59766143930
177*	-77.89025102350	39.59769040410
185	-77.88792457700	39.59774829870
250	-77.88880634880	39.59795156750
309	-77.89143296850	39.59811138590
313#	-77.89026102350	39.59805904410
442	-77.89232411880	39.59853960050
502	-77.89465995560	39.59870658940
517*	-77.89029781600	39.59881527150
635	-77.89555113210	39.59913477820
697	-77.89730537230	39.59931621780
701	-77.89643294060	39.59933798750
702	-77.89585131900	39.59935249690
708	-77.89410645170	39.59939600790
712	-77.89294320470	39.59942500070
766	-77.89702394250	39.59954844720
838	-77.89587007300	39.59980244160
895	-77.89907839480	39.59994757400
898	-77.89820595660	39.59996935720
1035	-77.89793391150	39.60042656060
1093	-77.90085144830	39.60057890180
1096	-77.89997900360	39.60060069860
1102	-77.89823411130	39.60064427270
1157	-77.90202410380	39.60077480020
1158	-77.90173328850	39.60078206950
1167	-77.89911594580	39.60084746060
1174*	-77.89708022900	39.60089827960
1233	-77.89970696820	39.60105790580
1296	-77.90117044680	39.60124654840
1308*	-77.89768062970	39.60133370730
1502*	-77.90061699070	39.60193599600

Rejected sites:

Site 173 was too deep, with too much bedrock/boulders to excavate.
Site 177 had too much bedrock, adjacent site 313# was substituted by random number.
Site 517 included a section of a braided channel, but was dry.
Sites 1174, 1308 and 1502 were dry.