WORKING DRAFT – 09/2005

Ohio River Long -Term Monitoring Program – Freshwater Mussels

Phase I - Protocol Development

Phase II – Implementation

Introduction:

Most everyone would agree that developing a comprehensive systematic survey of mussels throughout the entire 981 miles of the Ohio River would be an expensive and time consuming endeavor. Although some comprehensive surveys have been done in some reaches of the river (see Williams 1969, Williams and Schuster 1989, and Clarke 1995, all brail surveys), most mussel surveys in the Ohio River are conducted in ad hoc fashion in response to a particular site specific need (e.g., facility siting decisions, dredging applications, discharge permit applications, refuge management). In order to effectively implement endangered species recovery and mussel restoration actions in the Ohio River, we need statistically valid and defensible data to describe how mussels are doing throughout the river and over a long term period. These data are also needed to evaluate the success of future mussel reintroduction efforts. Considerations of resources available (time, equipment, manpower, funding) in combination with sampling effort required to meet survey objectives will determine the number of sites which reasonably can be sampled per year, and consequently the periodicity of sampling. For trend detection it is best to revisit some sites regularly. However, to increase spatial coverage and get valid estimates of status we will need to sample some new sites each year. Consequently, we will propose to sample a small number of sites every year using semi-quantitative and quantitative techniques, and then use a rotating panel design of other sites for sampling on a three year rotation. If additional funds and personnel are available to conduct more surveys in a given year, then we can always add more sites.

Following the guidelines contained in Strayer and Smith (2003), we will establish objectives of the surveys, define the target population, estimate resources needed, decide if the study area will be stratified based on known differences in habitat and/or mussel communities, choose a sampling design, test the protocol/collect field data at a subset of sampling locations, analyze the pilot study data, and make appropriate modifications to sampling design as needed.

Conceptual design for this monitoring program was the result of discussions involving Rita Villella and Dave Smith of the USGS – Leetown Science Center, and Janet Clayton of the WVDNR. The draft was subsequently reviewed by Tom Watters, Leroy Koch, Jeff Thomas, and Dave Smith, and comments were incorporated.

Objectives:

1. Estimate species richness and trends in species richness in the area of the Ohio River known to support freshwater mussels;

2. Estimate density and trends in density of native mussels and zebra mussels in the area of the Ohio River known to support freshwater mussels;

3. Estimate recruitment and trends in species recruitment (expressed as a percentage of the population less than or equal to 40 mm in length) in the area of the Ohio River known to support freshwater mussels.

Equally important to setting objectives for the monitoring effort is detailing what is not going to be accomplished. This effort will not find all mussel concentration areas in the river, nor will it delineate the geographic extent or size of mussel beds. It will also not necessarily sample the "best" or most diverse mussel beds in the river. We will infer species richness, density, and recruitment in the large area known to support mussels by conducting surveys at a valid statistical sample of sites within that large area.

Target Population:

Freshwater mussels in the portions of the Ohio River known to support mussels are the target population, with aquatic snails in those areas being a secondary target. With the exception of the restricted areas near the dams and localized areas (e.g., near active loading facilities, or deep (>30') sites with limited visibility, etc.) where divers cannot work safely, the entire river is potentially subject to sampling.

The Ohio River is divided into distinct pools by 20 high lift dams built to facilitate year round commercial navigation (see Table 1). Once Olmsted Locks and Dam are completed, there will be 19 pools plus the 16.6 mile long free-flowing section which will remain below Olmsted. These pools are distinct units of the river, many with their own unique geological and hydrological features and tributaries. The dams separating the pools from one another have isolating effects on the mussel fauna, and consequently, the fauna of the various pools are now often quite different from each other. Based upon historical records we know that each pool or reach supported 40-50 species of mussels; today many have less than ten (Watters 2003).

The similarities or differences in habitat, mussel diversity, or mussel density are all important factors in deciding how to divide the river into distinct strata for sampling purposes. Stratification allows for flexibility in both the type of sampling design chosen for each strata and the amount of effort applied (Strayer and Smith 2003). Using mussel density as a criterion, the uppermost seven pools (Emsworth through Willow Island) have little to no recent mussel data at all (ESI 2000), and data which are available indicate that mussels appear to be low density (< 1 animal per square meter) and diversity. In these pools, some qualitative screening surveys must at least be done to define mussel concentration areas and habitat. From the Belleville pool downstream, there is recent information already documenting known mussel concentration areas and mussel densities generally exceed 1 animal per square meter. If data are available, we may also be able to define another stratum where mussel densities are >5 (or >10) per square meter, which would yield 3 strata total.

Table 1. Navigation pools of the Ohio River.

Pool name	River mile range	Length of pool (miles)
Emsworth	0 – 6.2	6.2
Dashields	6.2 – 13.2	7.0
Montgomery	13.2 – 31.8	18.6
New Cumberland	31.8 – 54.3	22.5
Pike Island	54.3 – 84.3	30.0
Hannibal	84.3 – 126.4	42.1
Willow Island	126.4 – 161.8	35.4
Belleville	161.8 – 203.9	42.1
Racine	203.9 – 237.6	33.7
R. C. Byrd	237.6 – 279.3	41.7
Greenup	279.3 – 341.0	61.7
Meldahl	341.1 – 436.2	95.1
Markland	436.2 – 531.5	95.3
McAlpine	531.5 – 606.0	74.5
Cannelton	606.0 – 721.0	115.0
Newburgh	721.0 – 776.3	55.3
J. T. Myers	776.3 – 846.0	69.7
Smithland	846.0 – 918.6	72.6
L & D 52*	918.6 – 939.0	20.4
L & D 53*	939.0 – 962.7	23.7
Free flowing Ohio River*	962.7 - 981	18.3

* Completion of construction of Olmsted locks and dam at RM 964.4 in 2014 will replace both L & D 52 and 53, and impound water up to Smithland Dam as well as reduce the length of free flowing river to 16.6 miles.

The river can also be stratified into at least four strata based on mussel communities, e.g., the free flowing section of the river where *P. cooperianus* still occurs; the reach below the Wabash River (Smithland and Olmsted pools) where *P. capax* occurs; the pools where "old river fauna" still dominate (Belleville pool through J. T. Myers pool); and the upper river (Emsworth pool through Willow Island pool) where re-colonization of native mussels is now occurring.

Sampling Design:

Because we are seeking data on species richness as well as density and recruitment, both qualitative and quantitative methods must be used in the monitoring program. I propose to stratify the river based on mussel community characteristics, which yields four distinct strata. Although we are interested in monitoring the status of the total mussel community at each site, the effort must also be sufficient to evaluate the status of some of the rarer animals in the community. The area searched (for qualitative sampling) and number of quadrats sampled (for quantitative sampling) will depend on the expected density of the species.

Given the large scale (i.e., 1000 river miles) of this monitoring effort and the large number of potential sites, we propose to apply a sampling design using a smaller number of fixed annual sites and a rotating "panel" of other sites. The annual sites will yield the trend information we need, and the rotating panel of other sites will insure we can get data on at least a three year cycle for all other sites and thereby reduce the annual monitoring costs to a reasonable and doable amount (see Figure 1). In any given year, there will be two panels sampled per strata, i.e., four sites will be sampled qualitatively and two sites quantitatively. Thereby, two panels of sites will be sampled in each stratum every year.

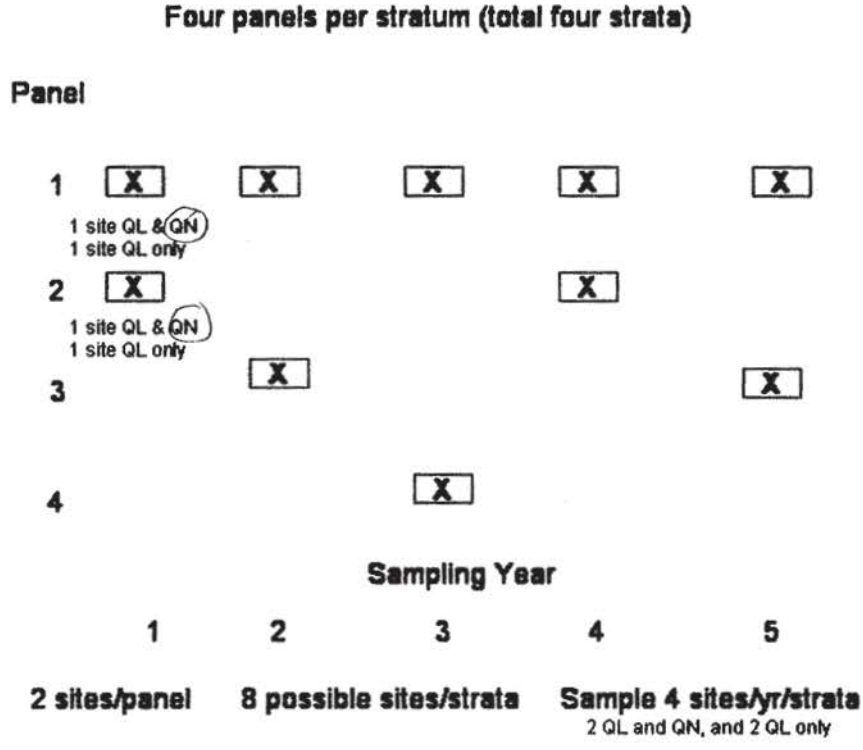

Figure 1. Diagram representing the rotating panel of sampling sites for each stratum.

For each of the strata, eight sites will be randomly selected from the river length within that stratum. Extras will be chosen in case one or more of the sites prove to be unworkable or are unsuitable mussel habitat. Those eight sites will be randomly assigned to four panels. Each site will be 100 meters long and 100 meters wide. The procedures for applying this sampling design to the various strata are detailed below.

Stratum 1 – Emsworth Pool through Willow Island Pool (ORM 0 to 161.8).

There are very few known mussel concentration areas in this reach of the Ohio River primarily because of low sampling effort. These uppermost seven pools span 162 miles of the river, and the pools range in length from 6 to 42 miles. The upper four pools (Emsworth, Dashields, Montgomery and New Cumberland) span 54 miles, and there is less known about these pools than the other three.

Before mussel communities in this stratum can be monitored, there needs to be significant screening level qualitative effort to determine potential mussel concentrations for long term monitoring. Since those pools generally have lower mussel diversity and lower abundance, we will use less effort than in other strata. Until such time as we have better information on mussel concentration areas, we will only sample two sites total from currently known mussel areas, using both qualitative and quantitative methods as outlined below.

Stage 1 (Qualitative). Each "site" is defined as 100 meters long by 100 meters wide. Within each site, five transects will be set perpendicular to the flow with a survey width of two meters (two divers each working one meter wide side by side). Each transect will be marked in 10-meter intervals for the width of the study reach (1/2 width of the river), and data on mussels and habitat will be recorded per these 10-meter segments. Divers will search each transect and collect mussels encountered at the surface of the substrate and with some probing, moving rocks, and subsurface "raking" with fingers. Collection time will be recorded for each transect in order to describe catch per unit effort (CPUE). Animals will be replaced in the substrate. Species-effort data will be also recorded, and if new species are still being collected or are expected from the slope of the curve after five transects are searched, then four additional transects will be set between the five.

Stage 2 (Quantitative). We will use 0.25 square meter quadrats, or quads, and systematic sampling with multiple random starts, following the procedures in Smith et al. 2001 for determining the number of samples needed and the interval between systematically placed quads. Quads will be searched for animals detectable by sight and feel, and a proportion (approximately 33% assuming a surface detection rate of 50%, as per Smith et al. 2000) will be excavated to calibrate the surface samples. A subset of the quads will be excavated with whole substrate for zebra mussel density and biomass information. Number of quads needed is based on density of the mussels, and we will strive for a coefficient of variation of $\leq$30% around the mussel density estimates at the 90% confidence interval.

Strata 2, 3, and 4 – Belleville Pool through Cairo, IL (ORM 161.8 to 981)

We have a pre-existing baseline data set on the recent occurrence of mussel concentration areas in most of these pools (dating back to 1967 for some areas). Recent

mussel density data ranges from 3 to 30 animals per square meter (ESI 2000, and ORINWR unpublished data). Eight sites per stratum will be randomly selected and assigned to four panels, each with two sites per panel. Criteria for final site selection (in the field) include workability of the site by divers, safety of divers, and, if possible, likelihood of preserving local habitat over the long term. For example, we don't want to pick a site for long term monitoring which is already being considered for a barge loading facility.

Stage 1 (Qualitative). Each "site" is defined as 100 meters long by 100 meters wide. In any given year and stratum, four sites will be sampled qualitatively. Within each site, five transects will be set perpendicular to the flow with a survey width of 2 meters (two divers each working one meter wide side by side). Each transect will be marked in 10-meter intervals for the width of the study reach (1/2 width of the river), and data on mussels and habitat will be recorded per these 10-meter segments. Divers will search each transect and collect mussels encountered at the surface of the substrate and with some probing, moving rocks, and subsurface "raking" with fingers. Collection time will be recorded for each transect in order to describe catch per unit effort (CPUE). Animals will be replaced into the substrate. Species-effort data will be also recorded, and if new species are still being collected or are expected from the slope of the curve after the five transects are searched, then four additional transects will be set between the original five. This technique is intended to yield species richness data.

Stage 2 (Quantitative). Sites in these strata will be sampled quantitatively, using 0.25 square meter quadrats, or quads, and systematic sampling with multiple random starts, following the procedures in Smith et al. 2001 for determining the number of samples needed and the interval between systematically placed quads. Within the two panels of sites (4 sites total) to be monitored in a given year, only two of the four sites will be sampled quantitatively. Quads will be searched for animals detectable by sight and feel, and a proportion (approximately 33% assuming a surface detection rate of 50%) will be excavated to calibrate the surface samples. This calibration can also be applied to the qualitative sampling being done at the same sites. A subset of the quads will be excavated with whole substrate for zebra mussel density and biomass information. Number of quads needed is based on density of the mussels, and we will strive for a coefficient of variation of $\leq$30% around the mussel density estimates at the 90% confidence interval.

Resources Needed:

Assuming the monitoring team has at least 6 capable mussel divers (3 teams of 2 divers each), it is estimated that 100 quads can be searched per day. Qualitative searches (assuming five transects per site and at least 6 capable mussel divers) should require less than one day per site. At least 3 boats are needed to tend the divers and move equipment and personnel. With a total of 26 sites river-wide proposed thus far and 14 locations to

be sampled in any one year (14 sites QL and 8 of those QN), it could take 20 to 24 field days per year.

Year 1 Implementation

During the 2005 field season, we propose to test the methodology at no more than 6 sites. Since there is not yet much known about the distribution of mussels in Stratum 1, monitoring there must await the outcome of qualitative screening in these upper pools. Work during 2005 will be done in Strata 2, 3, and 4, and 6 sites will be targeted – all 6 qualitative and 3 of the 6 quantitative surveys.

References:

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0-8 0-9

x1	y1	x2	y2	x3	y3
5.5	4	1.5	2.5	8	0
5.5	13	1.5	11.5	8	9
5.5	22	1.5	20.5	8	18
5.5	31	1.5	29.5	8	27
5.5	40	1.5	38.5	8	36
5.5	49	1.5	47.5	8	45
5.5	58	1.5	56.5	8	54
5.5	67	1.5	65.5	8	63
5.5	76	1.5	74.5	8	72
14.5	4	10.5	2.5	17	0
14.5	13	10.5	11.5	17	9
14.5	22	10.5	20.5	17	18
14.5	31	10.5	29.5	17	27
14.5	40	10.5	38.5	17	36
14.5	49	10.5	47.5	17	45
14.5	58	10.5	56.5	17	54
14.5	67	10.5	65.5	17	63
14.5	76	10.5	74.5	17	72
23.5	4	19.5	2.5	26	0
23.5	13	19.5	11.5	26	9
23.5	22	19.5	20.5	26	18
23.5	31	19.5	29.5	26	27
23.5	40	19.5	38.5	26	36
23.5	49	19.5	47.5	26	45
23.5	58	19.5	56.5	26	54
23.5	67	19.5	65.5	26	63
23.5	76	19.5	74.5	26	72
32.5	4	28.5	2.5	35	0
32.5	13	28.5	11.5	35	9
32.5	22	28.5	20.5	35	18
32.5	31	28.5	29.5	35	27
32.5	40	28.5	38.5	35	36
32.5	49	28.5	47.5	35	45
32.5	58	28.5	56.5	35	54
32.5	67	28.5	65.5	35	63
32.5	76	28.5	74.5	35	72
41.5	4	37.5	2.5	44	0
41.5	13	37.5	11.5	44	9
41.5	22	37.5	20.5	44	18
41.5	31	37.5	29.5	44	27
41.5	40	37.5	38.5	44	36
41.5	49	37.5	47.5	44	45
41.5	58	37.5	56.5	44	54
41.5	67	37.5	65.5	44	63
41.5	76	37.5	74.5	44	72
50.5	4	46.5	2.5	53	0
50.5	13	46.5	11.5	53	9
50.5	22	46.5	20.5	53	18
50.5	31	46.5	29.5	53	27

Phillis 2009

$d = 9$ m

$n = 200$

coordinates for Phillis Island QN Sampling 2009

50.5	40	46.5	38.5	53	36
50.5	49	46.5	47.5	53	45
50.5	58	46.5	56.5	53	54
50.5	67	46.5	65.5	53	63
50.5	76	46.5	74.5	53	72
59.5	4	55.5	2.5	62	0
59.5	13	55.5	11.5	62	9
59.5	22	55.5	20.5	62	18
59.5	31	55.5	29.5	62	27
59.5	40	55.5	38.5	62	36
59.5	49	55.5	47.5	62	45
59.5	58	55.5	56.5	62	54
59.5	67	55.5	65.5	62	63
59.5	76	55.5	74.5	62	72
68.5	4	64.5	2.5	71	0
68.5	13	64.5	11.5	71	9
68.5	22	64.5	20.5	71	18
68.5	31	64.5	29.5	71	27
68.5	40	64.5	38.5	71	36
68.5	49	64.5	47.5	71	45
68.5	58	64.5	56.5	71	54
68.5	67	64.5	65.5	71	63
68.5	76	64.5	74.5	71	72
77.5	4	73.5	2.5	80	0
77.5	13	73.5	11.5	80	9
77.5	22	73.5	20.5	80	18
77.5	31	73.5	29.5	80	27
77.5	40	73.5	38.5	80	36
77.5	49	73.5	47.5	80	45
77.5	58	73.5	56.5	80	54
77.5	67	73.5	65.5	80	63
77.5	76	73.5	74.5	80	72
		79.5	2.5		
		79.5	11.5		
		79.5	20.5		
		79.5	29.5		
		79.5	38.5		
		79.5	47.5		
		79.5	56.5		
		79.5	65.5		
		79.5	74.5		

81 × 3
1

81
3
243
9
252

9

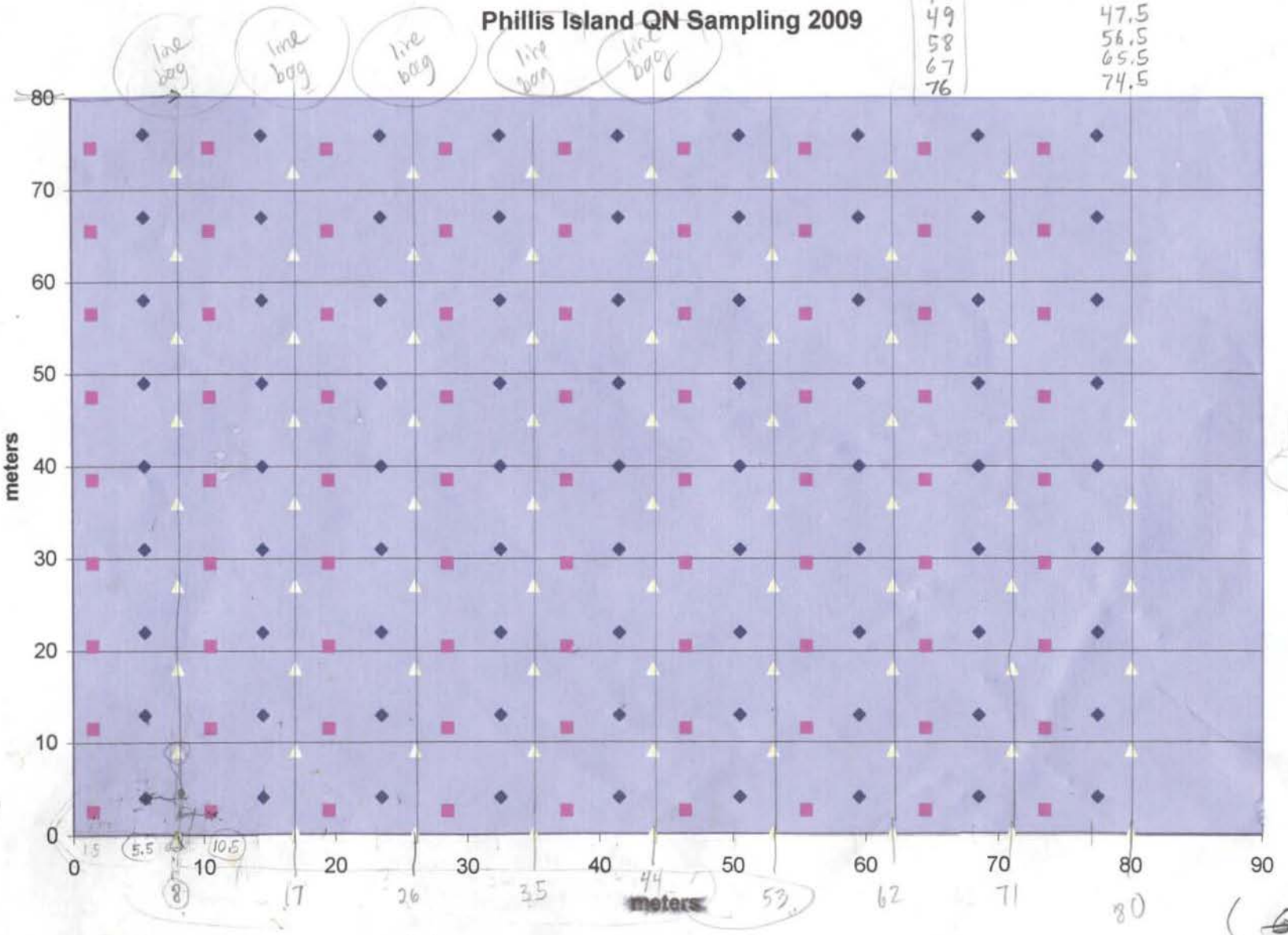
pop 1st 4
when done – upper end.

Y coords on slates

RS1	RS2	RS3
4	2.5	0
13	11.5	9
22	20.5	18
31	29.5	27
40	38.5	36
49	47.5	45
58	56.5	54
67	65.5	63
76	74.5	72

add -2.5 m

add + 2.5 m



This set needs 4 dives to finish in 2 days

80m

80m

Make short ropes w/ carabiner from line to sample spot!! For RS1 + RS2 (Line is on R3)

◆ RS 1 : - 2.5 m

□ RS 2 + 2.5 m

Both do RS3, then split up, meet again at RS3

← RS1
RS2 →

Position	Depth	Species	# Live	# FD	# WD	# SF	Notes
T1 lower	6 - 12'	Potamilus alatus	11	1	7		
		Quadrula quadrula	9		4		
		Actinonaias ligamentina	1				tag H887
2009 QL		Elliptio dilatata	0				
		Leptodea fragilis	0		1		
		Truncilla donaciformis	0		1		
		Truncilla truncata	0		1		
		Lasmigona costata	0				
		Obliquaria reflexa	0				
		Lampsilis siliquoidea	0				
		Lasmigona complanata	1				
		Ligumia recta	0				
			22				
T2 upper	6 - 11'	Potamilus alatus	11	2	8		
		Quadrula quadrula	4				
		Actinonaias ligamentina	0				
		Elliptio dilatata	0				
		Leptodea fragilis	0	2	3		
		Truncilla donaciformis	0		1		
		Lasmigona costata	0				
		Obliquaria reflexa	0				
		Lampsilis siliquoidea	1				
		Lasmigona complanata	0				
		Ligumia recta	0				
			16				
T3 middle	6 - 12'	Potamilus alatus	11	5	9		
		Quadrula quadrula	9		2		
		Actinonaias ligamentina	2		2		tags H765, H244, H060
		Elliptio dilatata	1				tag H825
		Leptodea fragilis	0	1	1		
		Truncilla donaciformis	0	2	1		
		Lasmigona costata	0		1		
		Obliquaria reflexa	0		1		
		Lampsilis siliquoidea	0				
		Lasmigona complanata	0				
		Ligumia recta	0				
			23				
QL test dive		Potamilus alatus	5				
		Quadrula quadrula	7	2			
		Elliptio dilatata			1		tag H788
		Leptodea fragilis			1		
		Truncilla donaciformis		1			
		Totals	73				
Muskrat middens		Potamilus alatus			18		
		Quadrula quadrula			81		
		Elliptio dilatata			1		
		Ligumia recta			2		
		Actinonaias ligamentina			1		
		Obliquaria reflexa			2		

Ohio River Islands NWR Mussel Survey Data Sheet
Quantitative with Zebra Mussels

GPS unit 1

Cennum _____ Location Phillis IS Date 9/23/09 C. Time _____

Collectors - Line 8 Water Temp. _____ Min. Depth ____ Max. Depth 11

Quad #	Native Species	Cond.	Length (mm)	Total Wt. (g) with Zebras	Native Wt (g)	Weight Zebras (g)	Number Zebras	Comments
Center	P. alatus	L	107					
	P. alatus	L	109					
	P. canal.	4D						
PM	P. canal.	12L						
	"	15D						
Frank	T. donaciformis	WD						
	P. canal	6L	48D					
Center	P. canal	12L	7D					
C	P. acuta	2L						
Center	P. canal	9L	4D					
PM	P. canal	4L	2D					
Frank	P. canal	1L	3D					
Center	all sand, Ø							
PM	P. canal	7L	10D					
Frank	T. donaciformis	~~1D~~	~~2B~~					
	P. can	6A	7D					
PM	P. can	6A	4D					
Cent	P can	5A	12D					
C	frags							
Center	P. alatus	A	110					
	P can	1L	22D					
Frank	T donaciformis	WD	16					
	P can	6L	6D					
	P. alatus	W	100					

(84) quads (0.25 m²) = [21 m² total area]

Center 11 frag 4L 4B (skipped 2 in trees)
PM P can 19L 6B
P can

Ohio River Islands NWR Mussel Survey Data Sheet
Quantitative with Zebra Mussels

Cennum _____ Location Phillis Is Date 9.24.9 C. Time _____

Collectors - Line 8 Water Temp. 72 Min. Depth ____ Max. Depth 11

Quad #	Native Species	Cond.	Length (mm)	Total Wt. (g) with Zebras	Native Wt (g)	Weight Zebras (g)	Number Zebras	Comments
PM	P. canal.	5L/15D						
Ctr	P. canal.	9L/16D						
PM	P canal.	2L/5D						
	P. acuta	1D						
Ctr	P. canal	6L/11D						
FB	Truncilla sp.	Frag						
	P. canal	3L/3D						
FB	Q q.	L	51					
	P. canal.	2L/2D						
	L. fragilis	frag						
Ctr	Q q.	L	44					
	T. donaciformis	W	19					
	Q. q.	frag						
	P. canal	3L/10D						
PM	O. reflexa	L	30					
	P. canal.	5L/9D						
FB	Q. q.	L	95					
	P. alat.	F	81					
	P. alat	Frag						
	P. canal	3L/2D						
	Q q.	Frag						

Ohio River Islands NWR Mussel Survey Data Sheet
Quantitative with Zebra Mussels

Cennum _____ Location Phills _____ Date _____ C. Time _____

Collectors - Line 17 _____ Water Temp. 72 Min. Depth ____ Max. Depth 11

Quad #	Native Species	Cond.	Length (mm)	Total Wt. (g) with Zebras	Native Wt (g)	Weight Zebras (g)	Number Zebras	Comments
JB	P. canal 1	L						live Corbicula
Center	Quad	L	29.					
	P. canal	7A						
	P. acuta	D						
John	P. canal	6A						
John	T. donaciformis	WD	22 X					
	P. ccenal	9A						
Center	T. truncata	WD	19					
	P. canal	8L						
JB.	P. canal	4L						
John	Ø							
Center	P canal	1						
Center	P. can	1D						
	P. acuta	1D						
Janet	Ø							
John	T truncata (??)	WD	19					rayed --- no chevrons??
Janet	P can	1L						
Janet	T donaciformis	W	19					
John	P can	4L						
John	L fragilis	L	44.					
	Ø quad frag	W						
	Ø Potlexa	L	37.					
Dr.	P. can	4L						
Janet	Ø							
Center	Ø							

Ohio River Islands NWR Mussel Survey Data Sheet
Quantitative with Zebra Mussels

Cennum _____ Location Phillis Date 9/24 C. Time _____

Collectors - Line 17 Water Temp. 72 Min. Depth ____ Max. Depth 12

Quad #	Native Species	Cond.	Length (mm)	Total Wt. (g) with Zebras	Native Wt (g)	Weight Zebras (g)	Number Zebras	Comments
Ctr	Ø							
Ctr	P. canal	2L						
JB	T. donaciformis	W	23					
	P canal	5L						
JB	P. canal	2L						
	P. acuta	1L						
Ctr	Ø							
John	L. frag	W	43					
	P. acuta	1L						
JB	O. reflexa	L						
	P. canal	2L						
John	Ø							
John	Q. q.	L	69					
JB	P. canal	2L						

Ohio River Islands NWR Mussel Survey Data Sheet
Quantitative with Zebra Mussels

Cennum _____ Location Phillis Is Date 9/24/09 C. Time _____

Collectors - Line 53 Janet & John Water Temp. _____ Min. Depth _____ Max. Depth _____

Quad #	Native Species	Cond.	Length (mm)	Total Wt. (g) with Zebras	Native Wt (g)	Weight Zebras (g)	Number Zebras	Comments
Center	T. donaci frag							
	Ø g frag							
	P can.	5L						
Center.	P alatus	L	32					
R	P can	2L						
C	P can	1						
	P alatus frag							
L								
R	P can	2L						
R	P can	4L						
C	P can	4L						
R	T donaciformis	W	21					
	P can	2L						
L	P can	2L						
L	P can	2L						
C	T donaciformis	3D	19,19,20					why are they all dead?
	P. can	3L						
L	P. can	4L						
L	T. donaci frag							
	P can	ØL						

Ohio River Islands NWR Mussel Survey Data Sheet
Quantitative with Zebra Mussels

Cennum _____ Location Phillis Is Date 9/24/09 C. Time _____

Collectors - Line 44 Frank + Patty Water Temp. _____ Min. Depth _____ Max. Depth _____

Quad #	Native Species	Cond.	Length (mm)	Total Wt. (g) with Zebras	Native Wt (g)	Weight Zebras (g)	Number Zebras	Comments
L	Q quadrula	L	61					
	P. canal	1L						
C	Q quad	W	86					
	P canal	9L						
R	P canal	5L						
L	P canal	1L						
R	L. costata	W	117					
	P. canal	2L						
L	P. alatus	E	97 X					
	T donaciformis							
	P. acuta	1L						
	P. can	3L						
	T donaciformis	L	19					
C	P. canal	3L						
C	P. canal	4L						
C	Q reflexa	L	24					
	P. canal	1L						
R	T donaciformis	W	21 X					
	Q quad	L	27					
	P can	5L						
L	P can	5L						
	T donaciformis	W	20X					
R	Q quad frag	W						
	P can	2L						
	(OVER) P alatus frag	W						

Ohio River Islands NWR Mussel Survey Data Sheet
Quantitative with Zebra Mussels

Cennum _____ Location _____ Date _____ C. Time _____

Collectors _____ Water Temp. _____ Min. Depth _____ Max. Depth _____

Quad #	Native Species	Cond.	Length (mm)	Total Wt. (g) with Zebras	Native Wt (g)	Weight Zebras (g)	Number Zebras	Comments
C	P. glatus frag	W						donate
	P. can	5L						
C	P. can	1L						
L	P. can	6L						
	T. donaci frag	W						eaten by drum?
C	T. donaci frag	W						
	P. can	2L						
C	T donaciformis	FD	18					
	P. can	2L						
R	Ø							