

# **Final Report: Ohio River Unionid Survey, River Miles 204.3 to 218.0**

**Prepared for:**

**Ohio Municipal Electric Generation Agency-Joint Venture No. 5**

**FERC Project No. 6939**

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Table of Contents

1.0 Introduction ..... 1

2.0 Methods ..... 2

    2.1 Phase 1-Systematic Brail Survey ..... 2

    2.2 Phase 2-Monitoring Area Identification and Pilot Survey..... 6

    2.3 Phase 3- 1993 Baseline Monitoring..... 11

3.0 Results ..... 12

    3.1 Historical Records ..... 12

    3.2 Habitat Characteristics and Sampling Conditions ..... 12

    3.3 Phase 1, Brail Survey, ORM 204.4 to 218.0..... 12

        3.3.1 Population Characteristics ..... 12

        3.3.2 Unionid Distribution ..... 16

    3.4 Phase 2, Monitoring Area Selection ..... 20

    3.5 Phase 3, Baseline Population Characteristics ..... 23

        3.5.1 Qualitative Dive Survey ..... 23

        3.5.2 Quantitative Dive Survey ..... 26

        3.5.3. Quantitative versus Qualitative Results ..... 26

4.0 Summary and Conclusions ..... 29

5.0 Literature Cited ..... 31

Appendix A-Endangered and Threatened Wildlife and Plants, p. 22-23.

Appendix B-Phase 1 Data

Appendix C-Qualitative Data, Bed 1

Appendix D-Qualitative Data, Bed 2

Appendix E-Quantitative Data, Bed 1

List of Tables

Table 3-1. Unionid Species Historical Records ORM 204.3 to 218.0.....	13
Table 3-2. Unionid Survey River Conditions, ORM 204.3 to 218.0, June 1993.....	14
Table 3-3. Summary Statistics for Unionids Collected Between ORM 204.3 and 218.0, Phase 1 Brail Survey, June 1993.....	15
Table 3-4. Unionid Numbers Collected at Each Brail Transect, ORM 204.3 to 218.0, June 1993. .....	17
Table 3-5. Unionid Species and Numbers Collected in Each Bed during the Phase 1 Brail Survey, ORM 204.3 to 218.0. ....	19
Table 3-6. Unionids Collected at the Head and in Buffington Island Side Channel. ....	21
Table 3-7. Unionid Species and Numbers Collected during Qualitative Dive Survey, ORM 204.4 to 206.0, August 1993. ....	22
Table 3-8. Summary Statistics for Unionids Collected Between ORM 204.4 and 206.0, Qualitative Dive Survey, August 1993.....	24
Table 3-9. Bed 1 Unionid Age Distribution, Qualitative Dive Survey, August 1993. ....	25
Table 3-10. Summary Statistics for Unionids Collected Between ORM 204.4 and 206.0, Quantitative Dive Survey, August 1993.....	27
Table 3-11. Bed 1 Unionid Age Distribution, Quantitative Dive Survey, August 1993. ....	28

List of Figures

Figure 2-1. Brail Transect Locations ORM 204.3 to 218, June 1993. ....	3
Figure 2-2. Unionid Bed Locations, Ohio River Miles 204.4 to 218.0, June 1993.....	7
Figure 2-3. Diving Transect Locations ORM 204.4 to 206.0, August 1993.....	10

## 1.0 Introduction

Ohio Municipal Electric Generation Agency-Joint Venture No. 5 (OMEGA-JV5) has proposed installation of a hydropower facility in the Belleville Locks & Dam (Ohio River Mile (ORM) 203.9) (Federal Energy Regulatory Commission (FERC), 1988). Historic records indicate the Ohio River downstream of the Belleville Locks & Dam once supported and may still support unionid fauna. However little development has occurred in this river reach and recent unionid surveys downstream of the Belleville Locks & Dam are unavailable.

FERC and U.S. Fish & Wildlife Service (USFWS) are concerned this project might affect endangered species, particularly *Lampsilis abrupta*, that may live downstream of the proposed hydropower facility. Hydropower construction and operation could affect unionids. Construction activities could result in substrate disturbance, possibly resulting in downstream sediment deposition. Changes in the local hydrology and water quality due to altered flow regimes may also be detrimental to unionid populations, as unionids are dependent on flow for survival. Additionally, fish host activity in a unionid bed, necessary for reproduction, may be altered. Although OMEGA-JV5 has designed its hydropower plant to minimize effects on unionid habitat, FERC requires monitoring of the unionid bed closest to the facility harboring *Lampsilis abrupta* during project construction and operation.

Ecological Specialists, Inc. (ESI) recommended a systematic brailling survey between ORM 204.3 and 218.0 to determine the extent of the unionid fauna in the project area (Phase 1), a qualitative diving survey to identify an area for monitoring (Phase 2), and a quantitative and qualitative dive survey to characterize the unionid population for comparison with future monitoring efforts (Phase 3). The survey plan was reviewed and approved by the USFWS. Ms. Heidi L. Dunn and Mr. M. Brent McClane of ESI conducted the braill survey June 10 through 17, 1993. Ms. Dunn, Mr. McClane and Mr. James Duckworth and Mr. Joe Hickey of Ducktrail Diving conducted the diving surveys August 4 through 18, 1993. This report describes survey methods (Section 2.0), survey results (Section 3.0), and a summary of findings (Section 4.0).

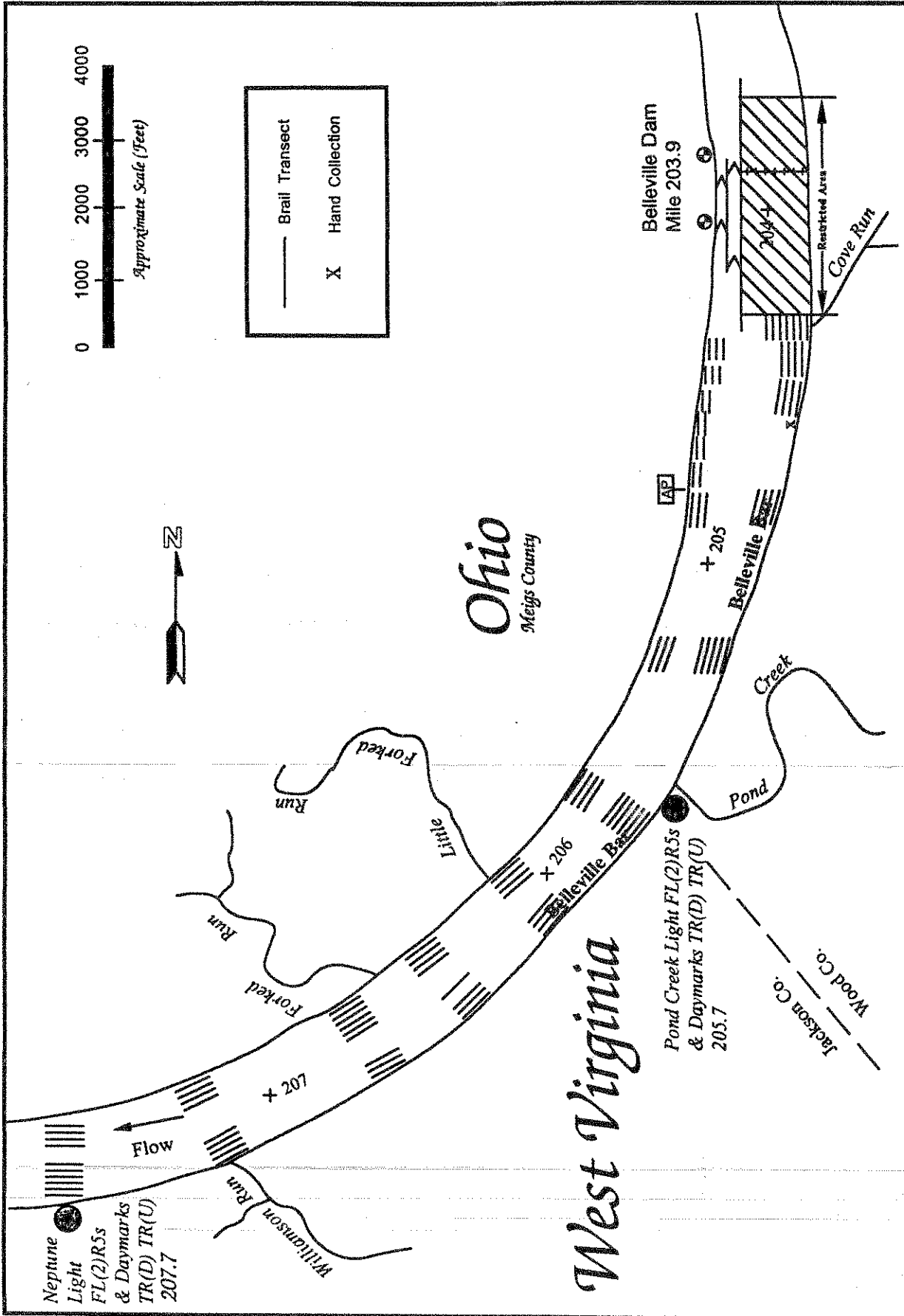
## 2.0 Methods

### 2.1 Phase 1-Systematic Brail Survey

The Racine Pool between ORM 204.3 and 218.0 was systematically surveyed by brail June 10 through 17 to determine the extent of unionid beds in the project area. Brail transects were established at 0.3 to 0.4 mile intervals beginning at ORM 204.3 and continuing downstream to the toe of Buffington Island (Figure 2-1). At each interval the brail was slowly towed downstream for five minutes (approximately 500 to 1000 feet) at six transects; 100, 200, and 300 feet from the Ohio bank and 100, 200, and 300 feet from the West Virginia bank. At the end of each tow, the brail was retrieved and all unionids and debris were removed. A substrate sample was collected at each transect with a petite ponar and substrate composition visually estimated. Water temperature and dissolved oxygen (DO) were measured at each transect throughout the first day with a YSI model 54A dissolved oxygen meter. The meter was calibrated before each measurement. Since water temperature and DO were consistent throughout the sampled area, measurements were henceforth recorded only at each sampled river interval.

Following an initial survey of the study area, the number of unionids collected at each transect was tabulated to identify areas of unionid concentrations. Additional transects were sampled upstream, downstream, and riverward of the initial transects to more accurately delineate unionid beds. In addition, unionids were collected by hand while wading for one hour in the shallow area near Belleville Bar (approximately ORM 204.6).

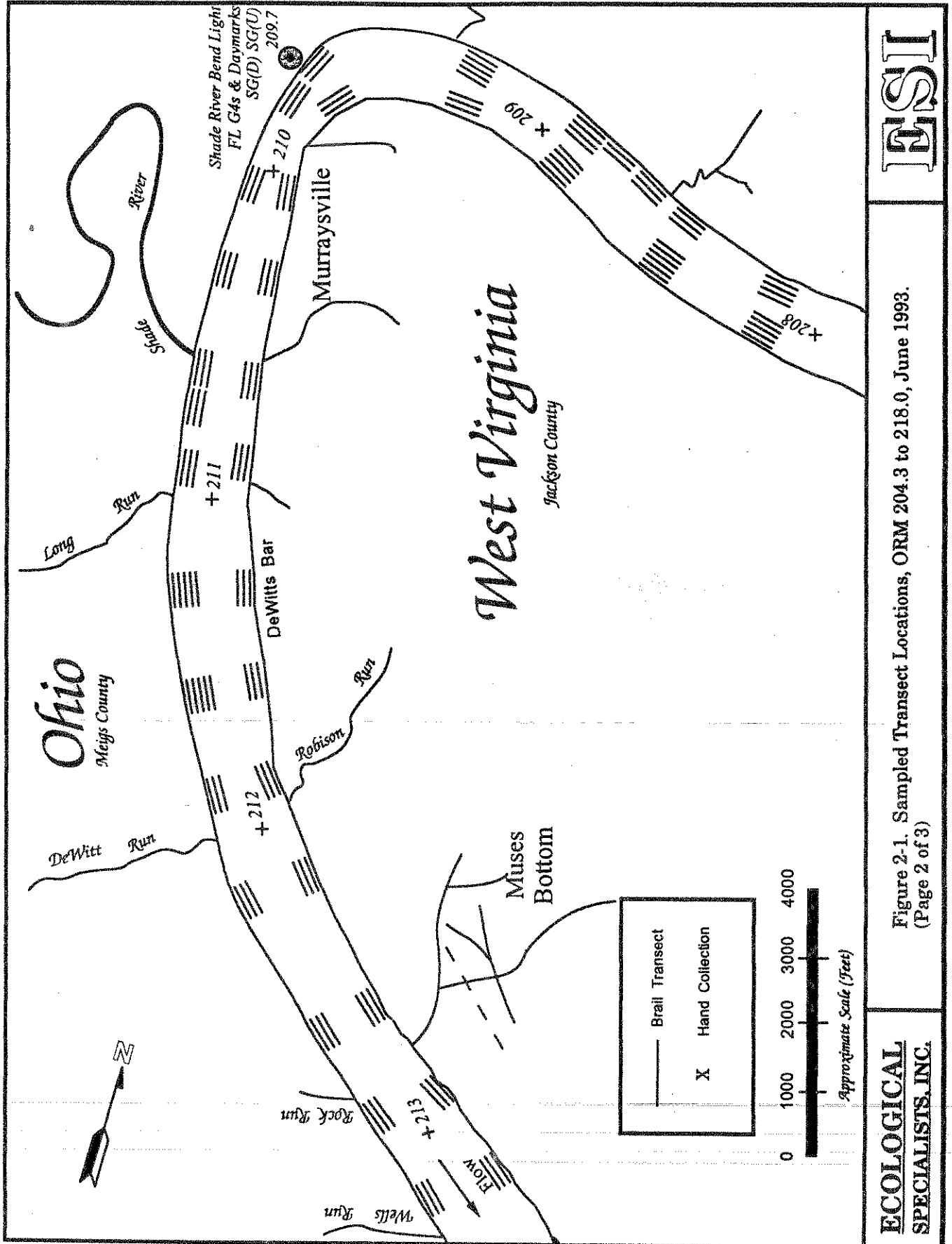
All collected live unionids were measured (length in mm), and weighed (wet weight in grams). Live unionids were aged by counting growth annuli on the exterior of the shell. This method has been criticized by Neves & Moyer (1988) as being of "limited use" (p. 179) because of its propensity to underestimate ages. However, other more accurate methods involve sacrificing the animal. While the problems associated with the growth annuli method are recognized and should be considered in data interpretation, it appears to be the only available method for aging live specimens.



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Figure 2-1. Sampled Transect Locations, ORM 204.3 to 218.0, June 1993. (Page 1 of 3)

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Figure 2-1. Sampled Transect Locations, ORM 204.3 to 218.0, June 1993.  
(Page 2 of 3)

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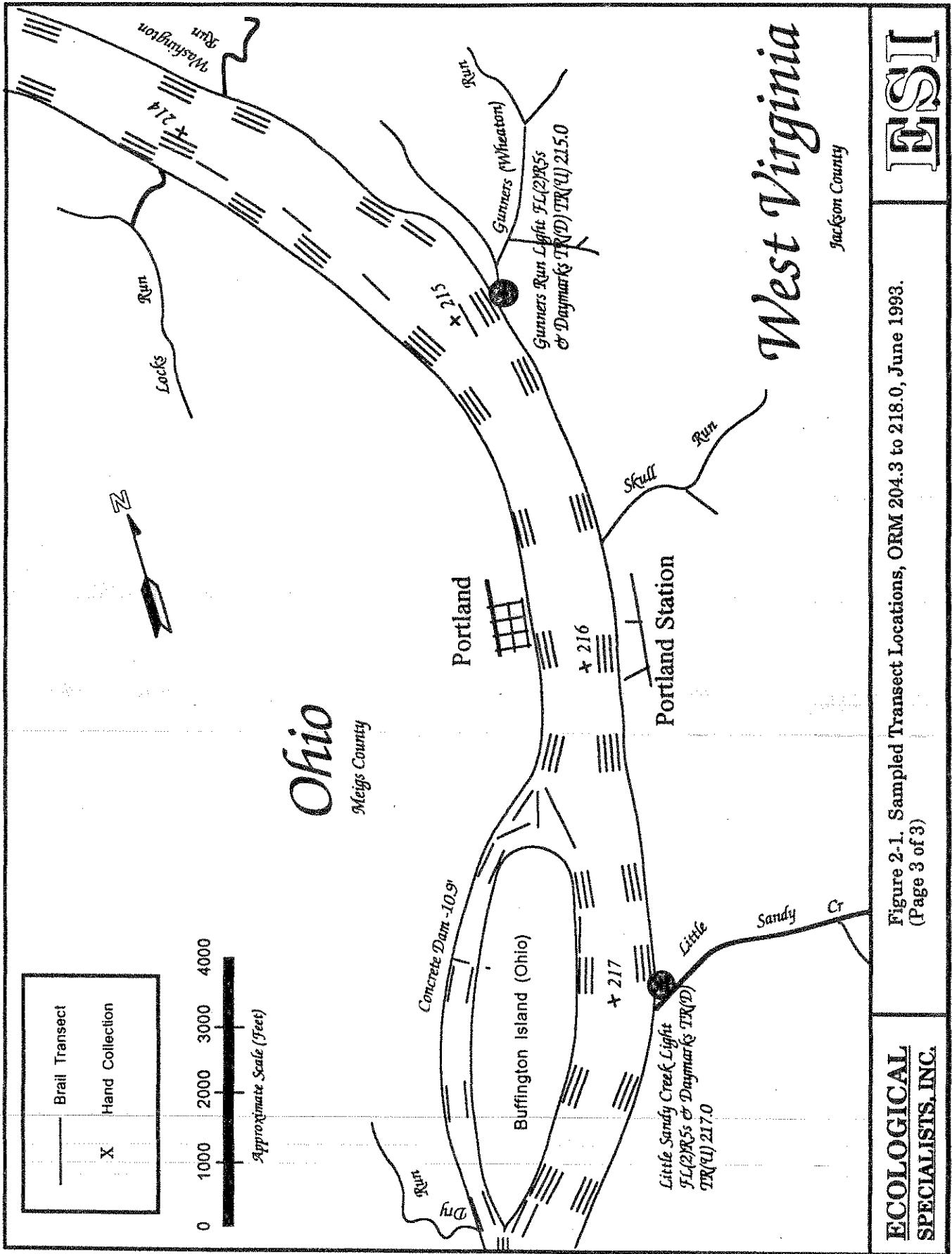


Figure 2-1. Sampled Transect Locations, ORM 204.3 to 218.0, June 1993. (Page 3 of 3)

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## 2.2 Phase 2-Monitoring Area Identification and Pilot Survey

Phase 2 was conducted August 3 through August 15, 1993. Sampling objectives included 1) locating the bed closest to the dam harboring *L. abrupta* (or other endangered taxa), and 2) conducting a pilot survey to determine the sample size necessary for statistical comparison of unionid populations between pre- and post-operation years. The Phase 1 survey identified unionid beds on both the West Virginia (Bed 1) and Ohio Banks (Bed 2) of the Ohio River immediately downstream of the dam (Figure 2-2). Since these beds were closest to the proposed project, they were further investigated for potential monitoring areas.

### *Monitoring Area Identification*

Qualitative samples were collected from Bed 1 between ORM 204.4 and 206.0 to determine the shoreward and riverward bed boundaries and species composition. Twenty-six 150 meters long transects, marked at 10 meter intervals were established perpendicular to the riverbank between ORM 204.4 and 206.0 for qualitative and quantitative sampling (Figure 2-3). The diver swam along Transects 1 through 7, 9, 15, 21, and 26, collecting all visible unionids within an arms reach (approximately three feet) on the downstream side of the transect. The diver noted relative unionid density and substrate along each transect. Since unionid density along these transects was fairly low, additional qualitative sampling was conducted in the area of Transects 1 through 7 and Transects 14 through 19 in an effort to locate *Lampsilis abrupta* or other endangered taxa.

Over 5,400 unionids were collected in Bed 1 and no endangered species were encountered. A plot of the number of collected individuals versus species predicted that an additional 2,400 individuals would need to be collected to find an additional species. Since the probability of collecting an *Lampsilis abrupta* in Bed 1 appeared to be low, Bed 2 was also investigated for monitoring potential.

Similar to Bed 1, transects were established at 100 meter intervals between ORM 204.5 and 206.0 (see Figure 2-3). Transects 1, 5, 9, 17 and 21 were qualitatively sampled to determine habitat within the bed, shoreward and riverward limits of the bed, and species composition. Additional unionids were collected throughout the area in an attempt to locate an endangered species. Over 3,000 unionids were collected while diving in Bed 2 without recovering an endangered taxa. A plot of unionid numbers versus species predicted over 2,500 additional individuals would need to be collected to locate one additional species.

All unionids collected in qualitative samples were identified. Up to 100 individuals of each species were measured (length in mm), weighed (grams), and aged (years). Following processing, unionids were returned to their collected location by the diver. Shells collected during the survey were donated to the Ohio State Museum of Biological Diversity.

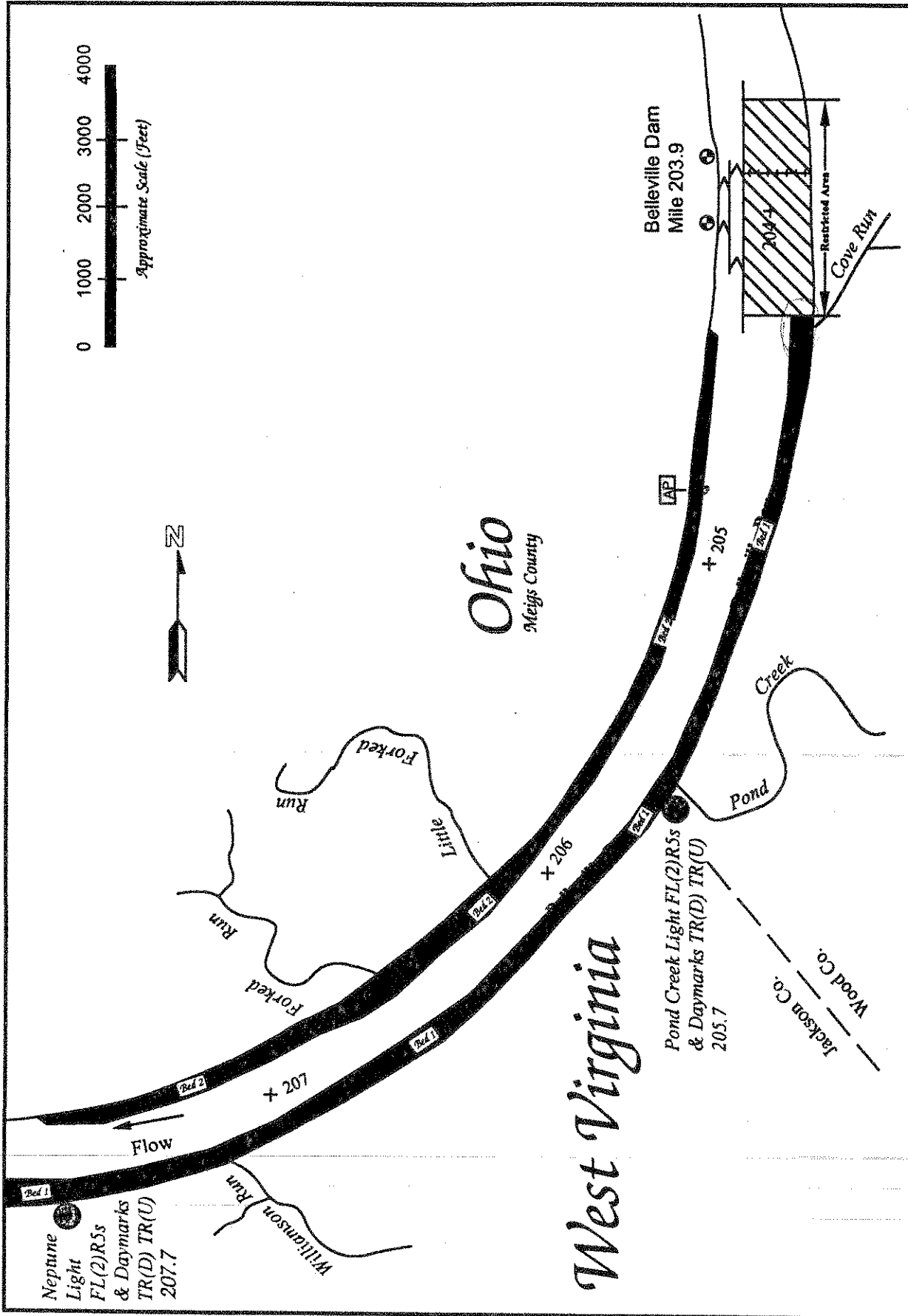
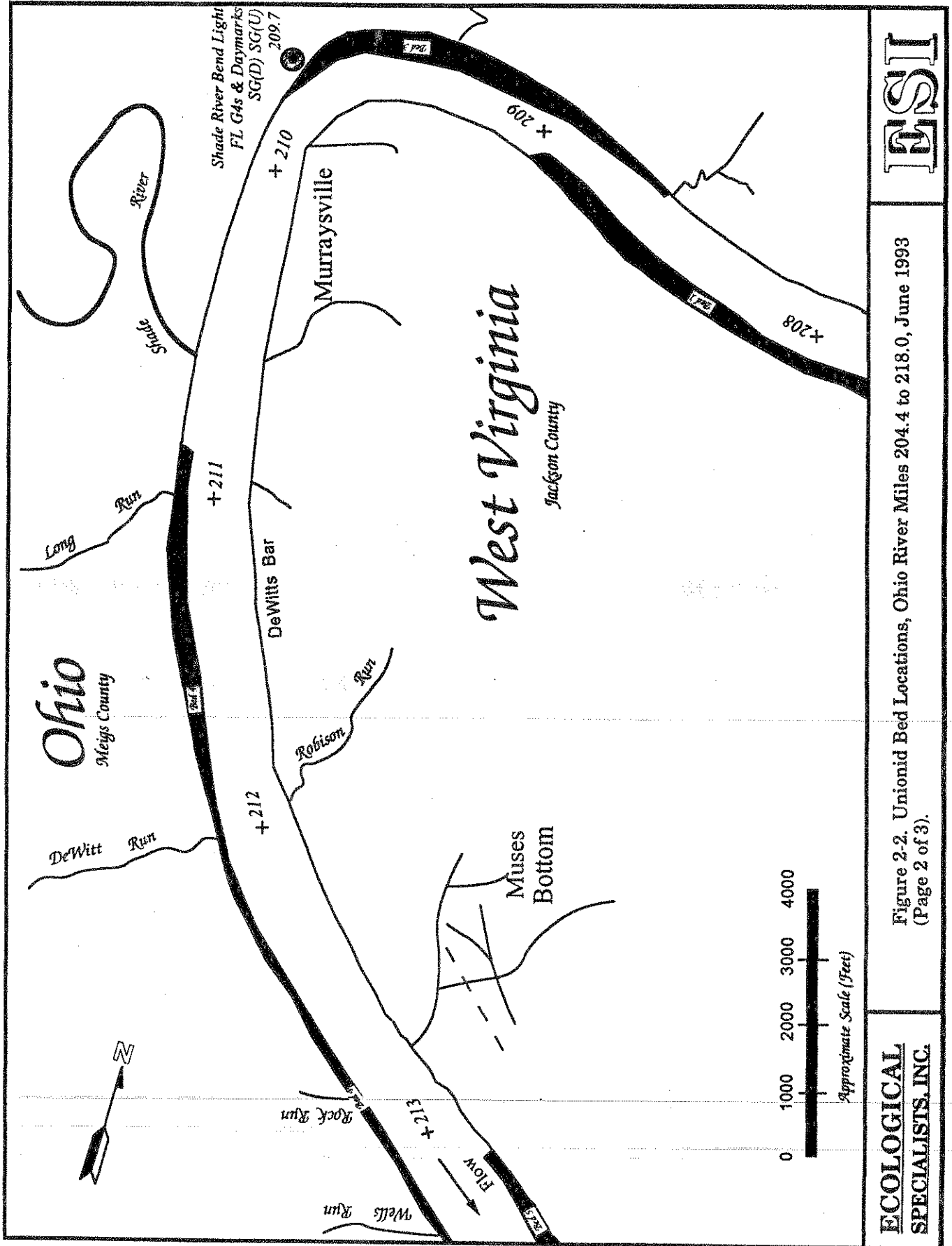


Figure 2-2. Unionid Bed Locations, Ohio River Miles 204.4 to 218.0, June 1993 (Page 1 of 3).

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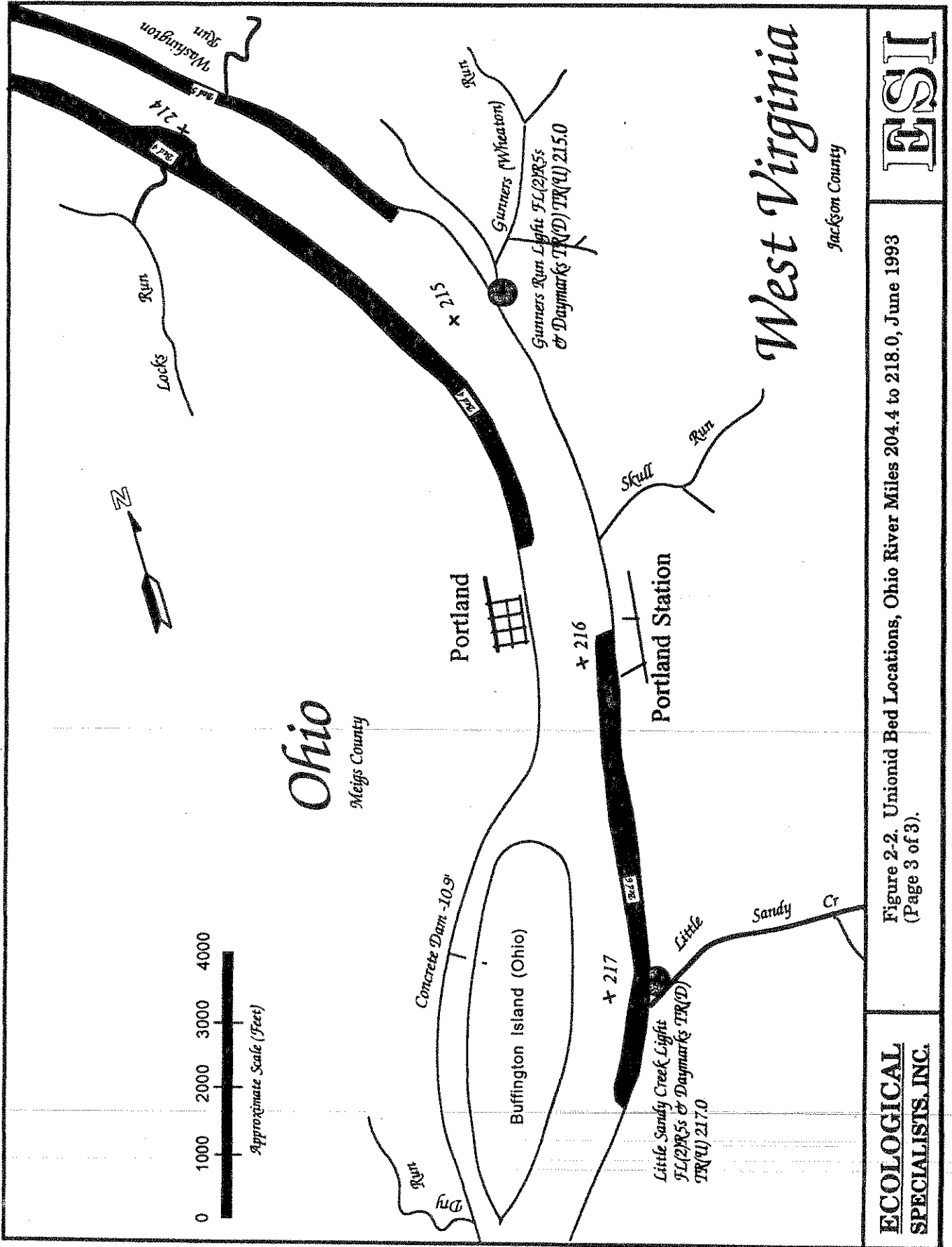
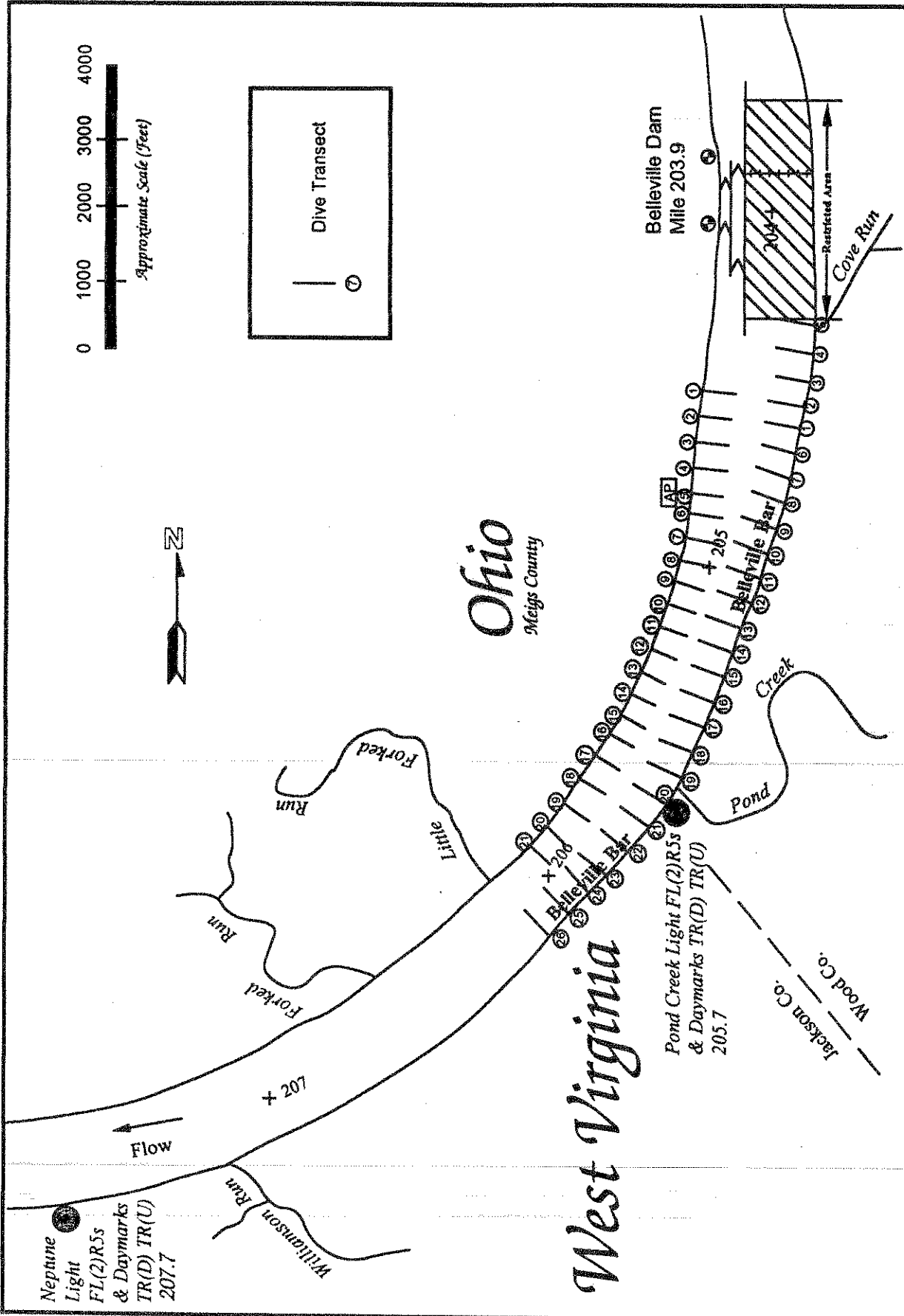


Figure 2-2. Unionid Bed Locations, Ohio River Miles 204.4 to 218.0, June 1993 (Page 3 of 3).

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Figure 2-3. Diving Transect Locations ORM 204.4 to 206.0, August 1993.

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Since no *Lampsilis abrupta* or other endangered unionid species were collected by qualitative diving in either Bed 1 or 2, Bed 1 was selected for monitoring due to its:

1. Location-Since the dam discharges on the West Virginia bank and flow from the dam follows the outside bend, Bed 1 is more directly influenced by the dam's flow patterns. Additionally, Bed 2 is more affected by navigation, as barges travel and park along the Ohio bank near the dam; and
2. Unionid abundance and diversity-Qualitative sampling in Bed 1 resulted in 5,408 individuals and 20 species, while similar effort yielded 3,103 individuals of 15 species in Bed 2.

### *Pilot Survey*

Once a suitable bed for monitoring was selected, relative density, species composition, and age structure needed to be determined for comparison with future years. A pilot quantitative survey was conducted within Bed 1 to determine the number of 1/4 of a square meter quadrat samples needed to estimate density within 30% of the mean.

Five points were randomly selected for quantitative sampling. Two quadrat samples were collected at each of the five selected points. A 1/4 of a square meter quadrat was placed near each point. All substrate and unionids to a depth of three inches within the quadrat were excavated into a five gallon bucket. Each sample was rinsed through 1/2", 1/4" and #16 mesh nested sieves. All recovered unionids were identified, measured, weighed, aged and returned to their sampled location. Mean density and sample variance from the quantitative pilot survey was used to determine the number of samples needed to estimate unionid density within 30% of the mean for comparison with future years.

### 2.3 Phase 3- 1993 Baseline Monitoring

Since 1993 was the baseline study year, Phase 2 and 3 were conducted concurrently. Additional qualitative sampling was not necessary in 1993 as the data collected in Phase 2 was sufficient to establish baseline parameters for species composition and relative abundance. Between August 15 and 17, an additional 106 quadrat samples were collected to reliably estimate density and ratio of juveniles to adults. Two quadrat samples were collected at 53 randomly selected points in the study area (between ORM 204.4 and 206, and between 0 and 100 meters from the West Virginia bank). Quadrat samples were collected and processed as in the pilot survey.

### 3.0 Results

#### 3.1 Historical Records

Thirty-eight (38) unionid species have previously been recorded from ORM 204 and 218 (ESI, 1993; USFWS, 1991 & 1992; Stansbery (pers. comm.), 1993; USFWS, 1986; Tolin *et al.*, 1982; Taylor, 1980; Table 3-1), including several species now listed on the Federal List of Endangered and Threatened Wildlife and Plants (USFWS, 1992; see Appendix A). Taylor (1980) found evidence of 16 species between ORM 204 and 218, including subfossil shells of the endangered species *Cyprogenia stegaria* and weathered shells of *Lampsilis abrupta*, *Obovaria retusa*, and *Plethobasus striatus*, also listed as endangered (Taylor, 1980; Stansbery, pers. comm. 1993). Tolin *et al.* (1982) found subfossil shells of 22 species including seven endangered species and one species proposed for endangered status (category 2 species) at the head of Buffington Island, ORM 216.7. Tolin (USFWS, 1986) also conducted a cursory survey between ORM 204.5 and 209 and recovered 18 species, 10 of which were collected live and six of which were freshly dead shells, indicating a diverse unionid fauna still occurred in this river reach.

#### 3.2 Habitat Characteristics and Sampling Conditions

Habitat throughout most of the study area was suitable for unionids, with clean gravel and cobble substrate and moderate flow. Water temperature and DO varied little within a day, but did vary between days. Water temperature ranged from 20°C to 21.5°C during June and between 24 and 26°C during August. DO was slightly below saturation, ranging from 7.1 ppm to 8.5 ppm in June and from 6.0 to 6.5 in August (Table 3-2). River stage and discharge also varied during sampling. Water elevation downstream of the dam ranged from 546.6 feet mean sea level (MSL) on June 10 to 542.4 feet MSL on June 17. Discharge declined from approximately 90,200 cubic feet per second (CFS) on June 10 to approximately 21,000 CFS on June 17. River stage and discharge varied little during August sampling. River stage ranged from 540.4 to 541 feet MSL and discharge remained near 10,000 CFS throughout August sampling. Substrate in most of the study area consisted of sand, gravel and cobble. Sandy substrate was more prevalent near the banks and along inside bend areas. Substrate at a few sampled intervals consisted of large rock and bedrock, most notably ORM 206 to 208, left descending bank, 210 to 211 right descending bank, 213.3 to 213.9, right descending bank.

#### 3.3 Phase 1, Brail Survey, ORM 204.4 to 218.0

##### 3.3.1 Population Characteristics

A total of 905 unionids of 17 species were collected in Phase 1 (Table 3-3). Unionids collected while brailing between ORM 204.4 and 218.0 ranged from two to 18 years of age. Young individuals (less than five years old) were collected for most of the common species (*Amblema plicata*, *Lampsilis cardium*, *Obliquaria reflexa*, *Potamilus alatus*, *Quadrula metanevra*), indicative of reproducing populations throughout the surveyed area. *Amblema plicata* was the most abundant species, representing over 63% of the collection. *Obliquaria reflexa* was the second most common, representing over 14% of the

Table 3-1. Unionid Species Historical Records ORM 204.3 to 218.0.

	Common Name	Federal Status*	Taylor 1980	Tolin <i>et al.</i> 1982	Tolin 1986	Best Condition
<i>Actinonaias l. carinata</i>	Mucket		WD**	SF	L	L
<i>Amblyma plicata</i>	Threeridge				L	L
<i>Anodonta grandis</i>	Giant Floater				FD	FD
<i>Anodonta imbecillis</i>	Paper Pondshell		WD			WD
<i>Cyclonaias tuberculata</i>	Purple Wartyback			SF		SF
<i>Cyprogenia stegaria</i>	Fanshell	E	SF	SF		SF
<i>Ellipsaria lineolata</i>	Butterfly			SF		SF
<i>Elliptio crassidens</i>	Elephant-ear		SF	SF	SF	SF
<i>Elliptio dilatata</i>	Spike		SF	SF	SF	SF
<i>Epioblasma t. torulosa</i>	Tubercled Blossom	E		SF		SF
<i>Fusconaia ebena</i>	Ebony shell		X			X
<i>Fusconaia flava</i>	Wabash Pigtoe		FD		FD	FD
<i>Fusconaia subrotunda</i>	Long-solid			SF		SF
<i>Lampsilis abrupta</i>	Pink Mucket	E	WD	SF		WD
<i>Lampsilis cardium</i>	Plain Pocketbook				L	L
<i>Lampsilis ovata</i>	Pocketbook		SF	SF		SF
<i>Lampsilis siliquoidea</i>	Fatmucket				FD	FD
<i>Lasmigona complanata</i>	White Heelsplitter				FD	FD
<i>Leptodea fragilis</i>	Fragile Papershell				L	L
<i>Obliquaria reflexa</i>	Threehorn Wartyback				L	L
<i>Obovaria olivaria</i>	Hickory Nut			SF		SF
<i>Obovaria retusa</i>	Ring Pink	E	WD	SF		WD
<i>Plethobasus cicatricosus</i>	White Wartyback	E		SF		SF
<i>Plethobasus cooperianus</i>	Orange-foot pimpleback	E	WD	SF		WD
<i>Pleurobema clava</i>	Clubshell	E		SF		SF
<i>Pleurobema cordatum</i>	Ohio Pigtoe			SF		SF
<i>Pleurobema plenum</i>	Rough Pigtoe	E		SF		SF
<i>Pleurobema pyramidatum</i>	Pyramid Pigtoe	2		SF		SF
<i>Pleurobema coccineum</i>	Round Pigtoe			SF		SF
<i>Potamilus alatus</i>	Pink Heelsplitter		WD		L	L
<i>Potamilus ohioensis</i>	Pink Papershell		FD		FD	FD
<i>Ptychobranchius fasciolaris</i>	Kidney Shell			SF		SF
<i>Quadrula metanevra</i>	Monkey Face			SF	L	L
<i>Quadrula pustulosa</i>	Pimpleback			SF	L	L
<i>Quadrula quadrula</i>	Maple Leaf		FD		L	L
<i>Strophitus undulatus</i>	Squawfoot		FD			FD
<i>Toxolasma parvus</i>	Lilliput		FD		L	L
<i>Unio merus tetralasmus</i>	Pondhorn				FD	FD
Total # Species			16	22	18	38
# Species Live (L)			0		10	10
# Species Freshly dead (FD)			5		6	7
# Species Weathered (WD)			6			4
# Species Subfossil (SF)			4	22	2	16

\*E=Endangered, 2=Category 2 species (proposed for listing)

\*\*L=Live, FD=Freshly Dead Shell, WD=Weathered Shell, SF=Subfossil Shell, X=Shell Condition Unknown

Sources: ESI, 1993; USFWS, 1991 & 1992; Stansbery (pers. comm.), 1993; USFWS, 1986; Tolin *et al.*, 1982; Taylor, 1980.



Table 3-2. Unionid Survey River Conditions, ORM 204.3 to 218.0, June 1993.

Date	Bank (Descending)	Temperature (°C)	DO (ppm)	River Stage (feet-MSL)	Discharge (CFS)
June 10, 1993	Right	20.3	7.6	546.6	90,200
	Left	20.4	7.4		
June 11, 1993	Right	20.9	8.5	546.2	84,200
	Left	20.8	8.5		
June 12, 1993	Right	21	8	544.4	61,525
	Left	21	8		
June 13, 1993	Right	21	7.2	543.4	46,800
	Left	21	7.3		
June 14, 1993	Right	21.1	7.2	543.4	48,300
	Left	21.1	7.3		
June 15, 1993	Right	21.4	7	542.6	25,800
	Left	21.3	7.1		
June 16, 1993				542.5	24,300
June 17, 1993				542.4	21,000

Source: ESI, 1993; USACE, 1993.

Table 3-3. Summary Statistics for Unionids Collected Between ORM 204.3 and 218.0, Phase 1 Brail Survey, June 1993.

Species	# Collected	Age (years)		Length (mm)		Weight (grams)				
		Average	Minimum	Maximum	Average	Minimum	Maximum			
<i>Actinonaias l. carinata</i>	3	10.50	9	12	120.50	111	130	335.00	240	430
<i>Amblyema plicata</i>	573	9.38	4	18	89.74	37	180	172.18	18	516
<i>Cyprogenia stegaria</i>	1	6.00	6	6	45.00	45	45	45.00	45	45
<i>Elliptio c. crassidens</i>	6	15.20	11	17	114.00	98	128	314.00	234	404
<i>Fusconaias flava</i>	1	7.00	7	7	76.00	76	76	120.00	120	120
<i>Lampsilis cardium</i>	18	8.13	5	14	105.38	78	130	233.75	90	410
<i>Lampsilis siliquoidea</i>	11	11.00	9	13	102.75	95	112	217.25	162	269
<i>Lasmsgona complanata</i>	6	8.20	7	13	113.80	85	135	164.00	50	272
<i>Lasmsgona costata</i>	1	11.00	11	11	128.00	128	128	242.00	242	242
<i>Ligumia recta</i>	4	6.33	6	7	110.67	99	120	118.00	80	164
<i>Megalonaias nervosa</i>	1	9.00	9	9	108.00	108	108	200.00	200	200
<i>Obliquaria reflexa</i>	131	5.58	2	14	49.12	30	103	45.98	6	226
<i>Pleurobema cordatum</i>	6	10.00	7	17	75.50	65	88	142.50	98	198
<i>Potamilus alatus</i>	28	6.15	3	9	103.85	42	132	117.35	10	240
<i>Quadrula metanevra</i>	49	6.56	4	13	60.63	35	81	79.67	32	188
<i>Quadrula pustulosa</i>	20	9.93	7	14	51.27	42	60	58.40	28	90
<i>Quadrula quadrula</i>	46	10.15	6	17	64.97	49	78	84.70	40	134
Total	905	8.47	2	18	79.90	30	180	137.30	6	516
# Species	17									

Source: ESI, 1993

collection. Other frequently collected species included *Lampsilis cardium*, *Potamilus alatus*, *Quadrula metanevra*, *Quadrula pustulosa*, and *Quadrula quadrula*. Only a few individuals of other species were collected, including one live *Cyprogenia stegaria*, a federally endangered species. This individual was collected by trail approximately 200 feet from the right descending bank, approximately 4,700 feet downstream of the lock structure (ORM 204.8). No other individuals of endangered species, including *Lampsilis abrupta* were collected during the Phase 1 survey.

### 3.3.2 Unionid Distribution

Unionid distribution between ORM 204.4 and 218.0 appeared to be limited by substrate and the navigation channel. Unionids were most prevalent in areas with gravel and cobble substrate, and were scarce along rocky banks and in depositional areas along inside bends. Abundance declined near the channel even in areas with seemingly suitable substrate.

Six unionid beds (areas of unionid concentrations) were identified by brailing in the study area (Table 3-4 and see Figure 2-2):

- Bed 1. ORM 204.4 to 208.8, left descending bank from the bank to approximately 500 feet riverward;
- Bed 2. ORM 204.5 to 207.7, right descending bank, primarily from the bank to 300 feet riverward;
- Bed 3. ORM 208.65 to 209.7, right descending bank, from the bank to approximately 400 feet riverward;
- Bed 4. ORM 210.6 to 215.6, right descending bank, primarily from the bank to 200 feet riverward;
- Bed 5. ORM 213.3 to 214.65, left descending bank, from the bank to 200 feet riverward; and
- Bed 6. ORM 216.0 to 217.3, left descending bank, primarily 100 feet from the bank.

#### Bed 1

The largest and most diverse bed identified during Phase 1 was located between approximately ORM 204.4 and 208.8. Unionids were most abundant from the bank to 500 feet riverward of the bank (approximately mid-channel). The upper portion of the bed was located on the Belleville Bar, a shallow bar extending downstream of the dam to approximately ORM 206.4. Substrate along the bar consisted of sand, gravel, and cobble, and unionids were abundant in shallow areas. One hour of hand collecting along the bar yielded 141 individuals. The lower portion of the bed extended along an outside bend to ORM 208.8. Substrate in the downstream portion of the bed consisted of large gravel and cobble. Substrate was rockier near the bank in some areas of the bed and mostly gravel and cobble further riverward. Unionids were numerous up to 500 feet from the bank in some areas. The bed appeared to end as substrate became sandier and the river curved southward at ORM 209.0.

Table 3-4. Unionid Numbers Collected at Each Brail Transect, ORM 204.3 to 218.0, June 1993.

ORM	Distance (ft) from Right Descending Bank									Distance (ft) from Left Descending Bank												
	100	200	250	300	350	400	450	500	600	700	600	500	450	420	400	375	350	300	200	100	10	
204.3										1	1	0			0		0	0	1			
204.4	0	0	0												0		1	6	17			
204.5	1	3	0											3		5	2	2	141			
204.55	0	0																				
204.6	5	0																				
204.65	3	1																				
204.7	7	9																				
204.8	<b>B</b>	1	1	0										0		2	6	2				
205.2	<b>E</b>	2	1	0											2		11	3	9			
205.6	<b>D</b>																					
205.7		5	4	5	1										3		3	6	12		<b>B</b>	
206.1	<b>2</b>	10	9	1	0						0	1		3		6	4	3			<b>E</b>	
206.4		9	1	2	0								12				4	1	0		<b>D</b>	
206.7		3	2	3	3	0	0										5	7	3		<b>1</b>	
207.3		10	2	1	0									1	5		6	0	7			
207.7		4	1	1	0						2	4					5	5	9			
208.1		1	2	1	0							3					2	1	2			
208.5		1	1	0							1	4				4	7	2	4			
208.6		2	2	1																		
208.65	<b>B</b>	7	0																			
208.8	<b>E</b>	21	3	0	0							2		2			2	0	2			
209.3	<b>D</b>	18	10	12	21	0											2	0	0			
209.7	<b>3</b>	57	15	0													0	0	1			
209.85		4	0		1																	
210.0		0	0	0													1	0	1			
210.3		0	0	0													0	0	0			
210.6		0	0														0	0	0			
210.65		1		1	0																	
210.9		0	5	0													0	0	0			
211.3		3	2	4	1	0											0	1	0			
211.6		4	0	3	0	0											0	0	1			
211.9		1	1	0													0	0	1			
212.2		2	1	0													0	0	0			
212.6		2	0	1													0	0	0			
212.9		5	0	1													0	0	0			
213.3		2	1	1													0	0	7			
213.6	<b>B</b>	3	1	1													0	4	2			
213.9	<b>E</b>	2	4	4													0	0	5			
214.0	<b>D</b>				6	1	1															
214.05					0																<b>B</b>	
214.2	<b>4</b>	7	1	2													0	0	2		<b>E</b>	
214.5					0																<b>D</b>	
214.6		4	1	5																	<b>5</b>	
214.65																	1	1	3			
214.7																	0	1				
214.8					0																	
215.0		4	2	4	0								1				1	0	1			
215.2		0	3	0													5	6	0			
215.6		1	4	2													0	0	0			
216.0		1	1	0													0	0	5		<b>B</b>	
216.3		1	0	0									1				5	1	4		<b>E</b>	
216.6		3	3	1													2	1	3		<b>D</b>	
216.9		0																				
217.0		2	0	0													0	3	5		<b>6</b>	
217.3		1	1	1													1	0	5			
217.6		0	0	0	1												2	0	0			
217.9		4	1	1																		
217.95		1		1																		
218.0		0	0	1													0	2	1			
Total		225	99	2	59	1	33	0	1	1	1	4	27	1	1	20	4	6	79	62	117	141

Source: ESI, 1993.

A total of 375 unionids of 14 species was collected by brail (Table 3-5). Age ranged from three to 16 years. *Amblema plicata* was the most frequently collected species followed by *Obliquaria reflexa* and *Quadrula metanevra*. This was the most diverse area, the only bed where *Actinonaias l. carinata*, *Fusconaia flava*, and *Lampsilis siliquoidea* were collected, and one of the few areas where *Elliptio c. crassidens* and *Ligumia recta* were collected. No endangered taxa were collected by brail in this area.

Bed 1 was selected as a potential bed for monitoring due to its proximity to the dam, and high unionid numbers and species richness.

#### Bed 2

A second bed was identified along the right descending bank between ORM 204.5 and 207.7. Most unionids were collected within 200 feet of the bank, except between 205.7 and 206.7 where the bed extends 300 or more feet channelward. The bed appeared to be limited on the upstream end and channelward side by the navigation channel and on the downstream end by depositional substrates. Substrate within the bed was primarily gravel and cobble, whereas substrate became sandier near ORM 208.

A total of 110 unionids of nine species was collected in this area. Age ranged from two to 16 years. Similar to Bed 1, *Amblema plicata* was the dominant taxa, followed by *Obliquaria reflexa* and *Quadrula metanevra*. One *Cyprogenia stegaria*, a federally endangered species, was collected in this area.

#### Bed 3

Bed 3 was located in the outside bend habitat between approximately ORM 208.65 and 209.7, on the right descending bank. Unionids were concentrated near the bank throughout the bed, but extended 400 feet into the channel in the middle portion of the bed. This bed appeared to be limited on the upstream end by sandy substrate and by bedrock on the downstream end.

A total of 164 unionids of 10 species was collected in Bed 3. The number of unionids collected per brail haul was highest in this area, suggesting a dense unionid population. As with the upstream areas, *Amblema plicata* dominated the collection. *Quadrula quadrula*, however, was the second most abundant taxa, followed by *Obliquaria reflexa*. *Lasmigona costata* and *Megalonaias nervosa* were only collected from this area. Age ranged from four to 18 years.

#### Bed 4

A fourth bed was located between approximately ORM 210.6 and 215.6 (right descending bank). Unionids were primarily collected within 200 feet of the bank in this area, although several unionids were collected 400 feet from the bank near ORM 214.0. This bed was limited by rocky substrate on the

Table 3-5. Unionid Species and Numbers Collected in Each Bed during the Phase 1  
Brail Survey, ORM 204.3 to 218.0.

Species	Bed #						Total
	1	2	3	4	5	6	
<i>Actinonaias l. carinata</i>	2						2
<i>Amblema plicata</i>	263	72	117	60	9	16	537
<i>Cyprogenia stegaria</i>		1					1
<i>Elliptio c. crassidens</i>	1			4		1	6
<i>Fusconaia flava</i>	1						1
<i>Lampsilis cardium</i>	10	2		2	1		15
<i>Lampsilis siliquoidea</i>	10						10
<i>Lasmigona complanata</i>	1		2	2	1		6
<i>Lasmigona costata</i>			1				1
<i>Ligumia recta</i>	1				1		2
<i>Megalonaias nervosa</i>			1				1
<i>Obliquaria reflexa</i>	28	18	16	25	6	10	103
<i>Pleurobema cordatum</i>	2	1	1		2		6
<i>Potamilus alatus</i>	13	2	3	1		2	21
<i>Quadrula metanevra</i>	25	11	2	1	2	2	43
<i>Quadrula pustulosa</i>	6	2	3	2	2	3	18
<i>Quadrula quadrula</i>	12	1	18	6	1	2	40
Total #	375	110	164	103	25	36	813
# Species	14	9	10	9	9	7	17
Average Age	8.12	8.42	10.05	8.14	9.20	8.18	8.62
Minimum Age	3	2	4	3	4	4	2
Maximum Age	16	16	18	17	17	16	18

Source: ESI, 1993

upstream end, sandy substrate on the downstream end, and the navigation channel.

A total of 103 unionids of nine species was collected in this area. Age ranged from three to 17 years. As with other beds *Amblema plicata* dominated the collection. *Obliquaria reflexa* was also abundant. No species were collected exclusively in this bed, however, most of the *Elliptio c. crassidens* were collected here.

#### Bed 5

Bed 5 was located on the left descending bank between ORM 213.3 and 214.65. This was a small bed with most unionids collected only 100 feet from the bank. Substrate throughout this area was primarily gravel and cobble. However, upstream and downstream substrate consisted mostly of sand.

Only 25 unionids of nine species were collected within Bed 5, however this was one of the few areas where *Ligumia recta* was collected.

#### Bed 6

Bed 6 was another small unionid bed, located between ORM 216.0 and 217.3 on the left descending bank. Substrate within the bed consisted of sand, gravel, and cobble. Upstream and downstream substrate was primarily cobble, a more difficult substrate for unionids to colonize and a more difficult substrate to sample with a brail.

A total of 39 unionids of eight species was collected in this location. Age ranged from four to 16 years. *Amblema plicata* and *Obliquaria reflexa* were the most abundant taxa. This was one of the few areas where *Elliptio c. crassidens* was collected.

#### Buffington Island

Previous surveys (Tolin *et al.*, 1983; Tolin, pers. comm.) suggested a unionid bed may occur at the head of Buffington Island. However, only three unionids were collected at the head of the island in this study. Severe erosion has recently occurred at the island's head (Morris, pers. comm.), altering substrate and flow patterns and also possibly affecting unionids. A few unionids were collected along the right bank within the side channel, indicating a sparse bed may occur in this area (Table 3-6).

### 3.4 Phase 2, Monitoring Area Selection

A total of 8,512 unionids of 21 species were collected by diving between ORM 204.4 and 206.0 within Beds 1 and 2. As with Phase 1, *Amblema plicata* dominated the collection, representing 64% of the unionids collected (Table 3-7). Other common species were *Obliquaria reflexa* (13.5%), *Quadrula quadrula* (5.2%), *Potamilus alatus* (5.0%), and *Quadrula metanevra* (4.4%). Diving, however, resulted in

Table 3-6. Unionids Collected at the Head and in Buffington Island Side Channel.

ORM	Distance (feet) from Descending Bank		
	Right		Left
	75	100	75
216.4 (island head)		3	
216.6 (upstream end of side channel)	5		0
217.0 (downstream of dike)	2		2
217.3 (lower 1/4 of side channel)	3		0
217.7 (island toe)	2		1
Total	12	3	3

Source: ESI, 1993



Table 3-7. Unionid Species and Numbers Collected during Qualitative Dive Survey, ORM 204.4 to 206.0, August 1993.

Species	Bed 1	Bed 2	Total #	% of Total
<i>Actinonaias l. carinata</i>	0	1	1	0.01
<i>Amblema plicata</i>	3327	2128	5455	64.09
<i>Ellipsaria lineolata</i>	2	1	3	0.04
<i>Elliptio c. crassidens</i>	3	0	3	0.04
<i>Fusconaia flava</i>	13	1	14	0.16
<i>Lampsilis cardium</i>	85	63	148	1.74
<i>Lampsilis siliquoidea</i>	55	10	65	0.76
<i>Lasmigona complanata</i>	40	24	64	0.75
<i>Lasmigona costata</i>	2	0	2	0.02
<i>Leptodea fragilis</i>	4	0	4	0.05
<i>Ligumia recta</i>	22	23	45	0.53
<i>Megalonaias nervosa</i>	35	6	41	0.48
<i>Obliquaria reflexa</i>	778	368	1146	13.46
<i>Plethobasus cyphus</i>	1	0	1	0.01
<i>Pleurobema cordatum</i>	29	7	36	0.42
<i>Pleurobema coccineum</i>	1	0	1	0.01
<i>Potamilus alatus</i>	297	129	426	5.01
<i>Quadrula metanevra</i>	238	140	378	4.44
<i>Quadrula pustulosa</i>	161	69	230	2.7
<i>Quadrula quadrula</i>	306	133	439	5.16
<i>Truncilla truncata</i>	9	0	9	0.11
Total #	5,408	3,103	8,511	
# Species	20	15	21	

Source: ESI 1993

the collection of several species not collected by brail in Bed 1 and 2. Species collected in Bed 1 during the dive survey but not during brailing included *Ellipsaria lineolata*, *Lasmigona costata*, *Leptodea fragilis*, *Megalonaias nervosa*, *Plethobasus cyphus*, *Pleurobema sintoxia*, and *Truncilla truncata*. Species collected while diving but absent in the brail survey of Bed 2 included *Actinonaias l. carinata*, *Ellipsaria lineolata*, *Fusconaia flava*, *Lampsilis siliquoidea*, *Lasmigona complanata*, *Ligumia recta*, *Megalonaias nervosa*, and *Truncilla truncata*. Although, one endangered species, *Cyprogenia stegaria*, was collected by brail in Bed 2, no endangered taxa were collected during the Phase 2 qualitative dive survey of either Bed 1 or Bed 2 eventhough the areas were extensively searched.

Although an endangered species was collected by brail in Bed 2, the upstream area of Bed 1 appeared more favorable for long term monitoring. Unionid abundance and richness was higher in Bed 1 and habitat more favorable than in Bed 2. A total of 5,408 unionids of 20 species were collected from Bed 1. A similar effort resulted in 3,104 unionids of 15 species in Bed 2. Flow from the dam currently follows the West Virginia bank downstream of the dam, along Bed 1. Whereas, Bed 2 is located along the Ohio bank, a depositional inside bend area. Substrate within Bed 1 was primarily a firm cobble, gravel, and sand. Substrate within Bed 2 was not as stable and clean, and the diver identified several areas within Bed 2 where substrate had been pushed into mounds, presumably by barges "nosing" into the bank while awaiting lockage. Additionally, any changes in flow patterns would be more likely to affect unionids along the West Virginia bank (Bed 1). Bed 1 was therefore selected for monitoring.

### 3.5 Phase 3. Baseline Population Characteristics

#### 3.5.1 Qualitative Dive Survey

Qualitative diving in Bed 1 resulted in the collection of 5,408 unionids of 20 species (Table 3-8). Five of the species collected have not historically been recorded from this river reach; *Lasmigona costata*, *Ligumia recta*, *Megalonaias nervosa*, *Plethobasus cyphus*, and *Truncilla truncata* (see Table 3-1). Only a few freshly dead shells were collected, indicating no recent die offs have occurred in the surveyed area.

Age of unionids collected qualitatively ranged from one to 20 years old, and averaged 8.3 years old. Eventhough, young unionids are generally not abundant in qualitative samples due to their small size and habit of occurring within the substrate, young individuals were prevalent in the qualitative samples collected from Bed 1. Almost 16% of the individuals collected were five years old or less (Table 3-9). Most collected species appeared to be reproducing, as young individuals (less than 5 years old) were present for all except rare species; *Elliptio c. crassidens*, *Fusconaia flava*, *Lasmigona costata*, *Plethobasus cyphus*, *Pleurobema cordatum*, and *Pleurobema sintoxia*. Species with over 20% of collected individuals under five years of age include *Amblema plicata*, *Ellipsaria lineolata*, *Leptodea fragilis*, *Obliquaria reflexa*, *Potamilus alatus*, and *Truncilla truncata*.

Table 3-8. Summary Statistics for Unionids Collected Between ORM 204.4 and 206.0, Qualitative Dive Survey, August 1993.

Species	# Live	# Collected Freshly Dead	% of Total	Age (years)			Length (mm)			Weight (grams)		
				Average	Min.	Max.	Average	Min.	Max.	Average	Min.	Max.
<i>Amblema plicata</i>	3327	3	61.5	7.2	1	15	76.0	12	117	133.5	2	380
<i>Ellipsaria lineolata</i>	2	1	0.0	5.0	2	8	56.5	30	83	108.0	16	200
<i>Elliptio c. crassidens</i>	3		0.1	13.3	11	15	107.7	101	113	254.0	170	300
<i>Fusconaia flava</i>	13		0.2	10.2	7	13	69.3	59	77	98.2	70	130
<i>Lampsilis cardium</i>	85	1	1.6	10.6	6	16	114.3	86	138	324.2	140	570
<i>Lampsilis siliquoidea</i>	55	2	1.0	10.6	3	15	104.1	45	119	224.9	8	310
<i>Lasmigona complanata</i>	40		0.7	10.5	4	16	124.7	83	159	224.6	58	445
<i>Lasmigona costata</i>	2		0.0	8.5	7	10	119.0	113	125	175.0	150	200
<i>Leptodea fragilis</i>	4		0.1	6.0	4	10	74.8	56	126	67.3	16	218
<i>Ligumia recta</i>	22		0.4	8.0	5	14	133.5	100	168	234.8	30	518
<i>Megalonaias nervosa</i>	35		0.6	11.3	3	20	133.2	51	200	458.5	24	1219
<i>Obliquaria reflexa</i>	778		14.4	5.1	1	13	42.6	12	65	38.6	2	130
<i>Plethobasus cyphus</i>	1		0.0	9.0	9	9	96.0	96	96	116.0	116	116
<i>Pleurobema cordatum</i>	29		0.5	10.4	6	17	73.6	41	106	152.4	30	306
<i>Pleurobema coccineum</i>	1		0.0	9.0	9	9	61.0	61	61	108.0	108	108
<i>Potamilus alatus</i>	297	6	5.5	6.9	3	15	109.4	57	148	146.8	18	406
<i>Quadrula metaneura</i>	238		4.4	7.6	4	11	64.5	49	80	103.3	44	166
<i>Quadrula pustulosa</i>	161	1	3.0	8.4	2	14	47.1	22	64	53.8	16	110
<i>Quadrula quadrula</i>	306	1	5.7	9.8	4	17	62.4	40	87	87.2	19	164
<i>Truncilla truncata</i>	9	1	0.2	2.9	1	4	25.9	18	42	6.8	3	24
<b>Total</b>	<b>5408</b>	<b>16</b>		<b>8.3</b>	<b>1</b>	<b>20</b>	<b>80.0</b>	<b>12</b>	<b>200</b>	<b>146.9</b>	<b>2</b>	<b>1219</b>

Source: ESI, 1993

Table 3-9. Bed 1 Unionid Age Distribution, Qualitative Dive Survey, August 1993.

Species	Age																				Total	% 5 years or under
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
<i>Amblema plicata</i>	1										1	3	4	2	1						110	20.00
<i>Ellipsaria lineolata</i>	1						1														2	50.00
<i>Elliptio c. crassidens</i>										1			1								3	0.00
<i>Fusconaia flava</i>							2	1		3	4	2	1								13	0.00
<i>Lampsilis cardium</i>						3	10	7	12	9	11	11	8	7	5	2					85	0.00
<i>Lampsilis siliquoidea</i>			1	2	1	4	1	4	1	3	14	6	9	8	5	1					55	5.45
<i>Lasmigona complanata</i>				1	1	1		3	6	9	7	5	2	2	2	1					40	5.00
<i>Lasmigona costata</i>							1			1											2	0.00
<i>Leptodea fragilis</i>				1	2					1											4	75.00
<i>Ligumia recta</i>						1	5	5	3	3	3	1	1								22	4.55
<i>Megaloniaias nervosa</i>			1	1	1		2	4	4	3	6	3	4		2		2	1	1	1	35	5.71
<i>Obliquaria reflexa</i>	1	9	12	21	18	22	17	7			1		1								109	55.96
<i>Plethobasus cyphus</i>										1											1	0.00
<i>Pleurobema cordatum</i>							1	3	1	7	4	5	3	2	1		2				29	0.00
<i>Pleurobema coccineum</i>										1											1	0.00
<i>Potamilius alatus</i>			4	3	16	23	24	17	6	2	3	1	2		1						102	22.55
<i>Quadrula metanevra</i>				1	4	15	28	25	22	6	1										102	4.90
<i>Quadrula pustulosa</i>			1		8	10	14	27	14	13	10	4	2	1							104	8.65
<i>Quadrula quadrula</i>				3	3	6	8	15	11	17	9	9	9	4	4		2				100	6.00
<i>Truncilla truncata</i>	1		7	1																	9	100.00
<b>Total</b>	3	20	28	36	60	98	150	131	101	89	65	51	43	24	17	3	6	1	1	1	928	15.84

Source: ESI, 1993

### 3.5.2 Quantitative Dive Survey

Quantitative sampling resulted in the collection of 138 unionids of 12 species in 116 quadrat samples. Density averaged 4.88 ( $\pm 1.05$ ) per square meter (Table 3-10). All species collected in quantitative samples were also present in qualitative samples. Dominant taxa in qualitative samples however differed somewhat from qualitative samples. The four most prevalent species in quantitative samples were *Obliquaria reflexa* (1.98/m<sup>2</sup>), *Amblema plicata* (1.56/m<sup>2</sup>), *Potamilus alatus* (0.39/m<sup>2</sup>), and *Truncilla truncata* (0.25/m<sup>2</sup>).

Quantitative sampling indicated juveniles were more abundant than indicated by qualitative sampling. This is typical, as juveniles are often overlooked due to small size and are frequently buried within substrates. Juveniles were only absent for rarer species (fewer than five collected in quadrats); *Fusconaia flava*, *Lampsilis siliquoidea*, *Megaloniais nervosa*, *Quadrula metanevra*, and *Quadrula quadrula*. However, young individuals of most of these species were found while qualitatively sampling. Age averaged only 5.8 years in quantitative samples, compared to 8.3 for qualitative sampling and over 52% of the unionids collected in quantitative samples were under five years old (Table 3-11).

### 3.5.3 Quantitative versus Qualitative Results

Qualitative data appeared to be biased toward larger species and individuals. Relative abundance differed between sampling methods, as did the number of juveniles collected. Larger species and adults were more prevalent in qualitative samples while smaller species and juveniles were more abundant in quantitative samples. *Amblema plicata* was the dominant taxa in qualitative samples, but was second most abundant in quantitative samples representing only 32% of the collection. *Obliquaria reflexa* was the most abundant taxa in quantitative samples (41%), but only accounted for 14% of the qualitative collection. Similarly, *Truncilla truncata* was more abundant in quantitative than qualitative samples. In addition, average age, length, and weight were higher in qualitative than quantitative samples. Percent juveniles was only 16% for qualitative samples, but was 52% for quantitative samples. Although, qualitative sampling provides valuable data with respect to presence and absence of rare species, quantitative data will be used when comparing population statistics between study years.

Species	# Collected		Average Density (#/m <sup>2</sup> )	Age (years)			Length (mm)			Weight (grams)			
	# Live	# Freshly Dead		% of Total	Average	Min.	Max.	Average	Min.	Max.	Average	Min.	Max.
<i>Amblema plicata</i>	44		31.9	1.56	7.5	1	15	70.1	10	118	110.7	1	400
<i>Fusconaia flava</i>	1		0.7	0.04	8.0	8	8	65.0	65	65	68.0	68	68
<i>Lampsilis cardium</i>	3		2.2	0.11	7.0	5	8	103.3	89	111	218.0	128	276
<i>Lampsilis siliquoidea</i>	1		0.7	0.04	10.0	10	10	109.0	109	109	390.0	390	390
<i>Megalonaia nervosa</i>	1		0.7	0.04	9.0	9	9	153.0	153	153	540.0	540	540
<i>Oblitaria reflexa</i>	56		40.6	1.98	4.5	1	7	38.7	18	53	26.6	2	80
<i>Pleurobema cordatum</i>	2		1.4	0.07	5.5	5	6	38.5	37	40	31.0	30	32
<i>Potamilus alatus</i>	11		8.0	0.39	5.0	0	8	80.5	15	119	70.5	1	156
<i>Quadrula metanevra</i>	4		2.9	0.14	7.3	6	9	59.5	54	65	85.0	54	116
<i>Quadrula pustulosa</i>	4		2.9	0.14	6.8	4	8	46.0	36	51	45.8	17	62
<i>Quadrula quadrula</i>	4	1	2.9	0.14	7.8	7	10	52.5	39	65	57.3	26	96
<i>Truncilla truncata</i>	7		5.1	0.25	2.9	1	4	29.7	18	43	10.1	1	26
Total	138	1		4.88	5.8	0	15	55.7	10	153	70.1	1	540
# Species	12												

Source: ESI, 1993

Table 3-11. Bed 1 Unionid Age Distribution, Quantitative Dive Survey, August 1993.

Species	Age																			Total	% 5 years or under	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			19
<i>Ambleria plicata</i>	2	1			4	4	3	5	13	5	1	1	2	1	1	1					44	25.00
<i>Fusconaia flava</i>								1													1	0.00
<i>Lampsilis cardium</i>					1			2													3	33.33
<i>Lampsilis siliquoidea</i>										1											1	0.00
<i>Megaloniaias nervosa</i>										1											1	0.00
<i>Obliquaria reflexa</i>	1		6	24	14	9	2														56	80.36
<i>Pleurobema cordatum</i>					1	1															2	50.00
<i>Potamilus alatus</i>	1		1	2	2	3	2	2													11	54.55
<i>Quadrula metanevra</i>						1	2	1													4	0.00
<i>Quadrula pustulosa</i>				1			1	2													4	25.00
<i>Quadrula quadrula</i>							3				1										4	0.00
<i>Truncilla truncata</i>	1	2	1	3																	7	100.00
Total	1	4	3	8	34	22	17	13	20	7	3	1	2	1	1	1					138	52.17

Source: ESI, 1993

#### 4.0 Summary and Conclusions

The upper portion of the Racine Pool has historically supported unionids. Thirty-eight (38) species including eight species currently on the federal list of endangered species have been identified from the area. However, historical data is primarily limited to shell material collected along river banks. Few studies on live unionids have been conducted in the area. Ecological Specialists, Inc. sampled unionids and habitat characteristics between ORM 204.3 and 218.0, June 10 through 17, 1993 (Phase 1). The purpose of the Phase 1 survey was to locate unionid beds with a high probability of harboring *Lampsilis abrupta*.

Endangered species are most commonly collected within healthy unionid populations (i.e., several species, various age classes) in clean, stable, gravel and cobble substrate and good flow, dissolved oxygen, and water quality. Typically, less than 1% of the unionids in an area are collected by brail (Kovalak *et al.*, 1986). Efficiency is further reduced in very rocky substrates, cold or very warm water temperatures, and highly turbid conditions. Although inefficient, it is possibly the best reconnaissance device available, as it is less labor intensive than diving (two rather than four people) and a large area can be sampled in a short time. The probability of collecting an endangered species by brail is very small, however habitat suitable for endangered species can be identified by a systematic brail and habitat survey.

A total of 905 unionids of 17 species was collected during Phase 1. Most of the study area contained suitable unionid habitat; clean gravel, cobble and sand substrate. Unionids were less abundant in extremely rocky areas, depositional areas, and in the navigation channel. Six areas of higher unionid concentrations were located. The most diverse area was located downstream of the dam along the left descending bank and was approximately 4.4 miles long. The area with the highest catch per brail haul was located along the right descending bank between ORM 208.65 and 209.7. One specimen of federally endangered *Cyprogenia stegaria* was collected live approximately 200 feet from the right descending bank, approximately 4,700 feet downstream of the lock structure (ORM 204.8).

Beds 1 and 2 were selected for further study to identify an area suitable for monitoring (Phase 2). A qualitative dive survey did not result in the collection of any endangered species, although 5,408 unionids were collected in Bed 1, and 3,104 individuals were collected in Bed 2.

Qualitative sampling of Bed 1 resulted in 20 unionid species. Although biased toward larger individuals, juveniles of several species were collected. Quantitative sampling resulted in 4.88 ( $\pm 1.05$ ) unionids per square meter. Over 52% of collected individuals were under five years of age, indicative of a healthy, reproducing population. Juveniles were absent for species only represented by low numbers (less than ten in combined samples).



This survey identified good unionid habitat throughout the study area with the exception of a few rocky and sandy areas. Unionid age structure throughout the area (presence of young and older individuals) suggests a reproducing unionid population. Data collected directly downstream of the Belleville Dam during this survey will be compared with future years to determine if the proposed hydropower facility affects unionids residing downstream of the dam.

**5.0 Literature Cited**

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