APPENDIX K-3

Freshwater Mussel Survey Report

Clarification Note for Central Alternative 1: Central Alternatives 1A and 1B as described in the DEIS/FEIS are physically the same alternative. The only difference between them is that Central Alternative 1A would include tolls on both the new I-69 bridge and on the US 41 bridge. Central Alternative 1B would only include tolls on the new I-69 bridge. Any reference in this document to Central Alternative 1 or the Central Corridor applies to both Central Alternative 1A and Central Alternative 1B.

This document was completed before the development of Central Alternative 1B Modified (Selected); therefore, the alternative is not included in the document. Applicable information regarding Central Alternative 1B Modified (Selected) is provided in the FEIS.

OHIO RIVER CROSSING

Freshwater Mussel Survey Report

I-69 Ohio River Crossing Project
Evansville, IN and Henderson, KY

December 8, 2018

Prepared by:
Stantec

KENTUCKY TRANSPORTATION CABINET

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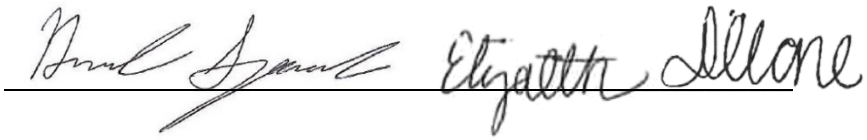
Prepared by 

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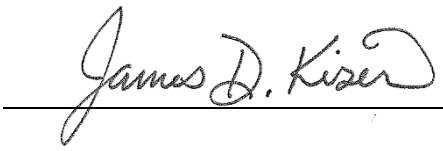
Reviewed by 

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EXECUTIVE SUMMARY

This study was conducted to assess the presence or probable absence of special status freshwater mussel species within the I-69 Ohio River Crossing (ORX) project corridor, specifically in the area of the three proposed Ohio River bridge alignments. The Western Corridor contains two alignments and is adjacent to the existing U.S. Route 41 (US 41) bridge, while the Central Corridor is approximately 1 mile downriver from the confluence of the Green River, Henderson County, Kentucky.

Stantec conducted a freshwater mussel survey from October 9-15, and 27-31, 2018 on the Ohio River between Evansville, IN and Henderson, KY. A failed mobilization attempt was made on September 9-10th, but encountered high flows unsuitable for surveying. One hundred and eight (108) of 231 scheduled search cells (20m x 20m/65ft x 65ft) were examined by divers for approximately 25 person-minutes each, totaling 47.07 search hours, resulting in collection of 452 live mussels from 20 species and 154 spent shells containing an additional 4 species. Seventy-four (74) percent (81/109) of the suitable substrate cells were sampled. One hundred twenty-three (123) cells were not fully surveyed due to flow intensity and barge traffic preventing divers from staying on the substrate. Species of special designation that were collected during the survey include 1 spent shell specimen of federally endangered *Potamilus capax* (Fat Pocketbook), 2 spent shells of Kentucky Endangered *Pleurobema rubrum* (Pyramid Pigtoe), 1 spent shell of Kentucky Endangered *Lampsilis ovata* (Pocketbook), and 11 live and 11 spent shells of Kentucky Special Concern *Fusconaia subrotunda* (Longsolid).

Mussel habitat was considerably better (both according to side-scan sonar and diving observations) on the Central Corridor, specifically the habitat outlined as coarse gravel/cobble/hardpan/bedrock by the side-scan sonar acoustic substrate classification system. Three hundred and ten (310) of the 452 total live mussels were collected in the 15 cells of this substrate type. Additionally, the *P. capax* shell was found in the Central Corridor, approximately 80m/262ft off the right descending bank.

Data indicate that the acoustic substrate classification system had poor accuracy for silt/clay habitat, but excellent accuracy for the mussel bed habitat (coarse gravel/cobble/ hardpan/bedrock). Based on the composition of the unsampled habitat, it can be predicted that the mussel bed may contain approximately 6 additional species in the 12 unsampled cells (for a total of 21 species in the mussel bed). The entire Survey Area most likely contains 5 additional species (for a total of 25 live species in the entire Project Area) but consists of mainly unsuitable sand habitats that have yielded relatively low mussel densities thus far.

While no live federally endangered mussel species were found during this survey, the possibility that they exist is present. Other large river mussel survey data as well as extrapolations of this survey's data suggest that several endangered riverine species could exist within the mussel bed found in the Central Corridor bridge alignment.

ABBREVIATIONS

ABBREVIATION	
cm	Centimeters
CPUE	catch per unit effort
DEIS	Draft Environmental Impact Statement
DO	dissolved oxygen
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
ft	Feet
hr	Hour
IDNR	Indiana Department of Natural Resources
INDOT	Indiana Department of Transportation
IPaC	Information for Planning and Consultation
KSNPC	Kentucky State Nature Preserves Commission
KYTC	Kentucky Transportation Cabinet
m	Meter
NTU	Nephelometric Turbidity Unit
USFWS	U.S. Fish and Wildlife Service

CHAPTER 1 – INTRODUCTION

This report documents the results of the freshwater mussel survey that took place in the Survey Area. This mussel survey was proposed to assess the presence or probable absence of special status freshwater mussel species.

1.1 PROPOSED PROJECT

The Federal Highway Administration (FHWA), Indiana Department of Transportation (INDOT), and Kentucky Transportation Cabinet (KYTC) issued a revised Notice of Intent (NOI) in the *Federal Register* on February 13, 2017 for the preparation of an Environmental Impact Statement (EIS) for the I-69 ORX project in the Evansville, IN and Henderson, KY area, which is part of the National I-69 Corridor that extends between Mexico and Canada. An NOI was previously issued for the project on May 10, 2001. Under that NOI, a Draft Environmental Impact Statement (DEIS) was completed in 2004, but the project was subsequently suspended in 2005.

Three bridge alignments are under consideration for construction between Evansville, IN and Henderson, KY, two near the present bridge location (US 41) and one approximately 1.5 miles to the east. This mussel survey examined all three locations, as a preferred alignment had not been selected at the time of survey. In this report, the term "Project Area" is used to describe the properties included in the three alignment alternatives being examined for selection for the I-69 ORX project. The term "Study Area" is used to describe the wetted area of the Ohio River that was surveyed for freshwater mussels, defined as the portion of the river where direct affects are expected plus a buffer of 10m/33ft upstream and 20m/65ft downstream (Figure A-1). The "Western Corridor" refers to the two western alignment alternatives, while the "Central Corridor" refers to the one central alignment alternative. GPS coordinates for the boundaries of each Corridor in the Survey Area can be found in Table 1.1-1. Construction plans have not been finalized, but potential impacts to freshwater mussels may include crushing, burying, interruption of life cycles, and alteration of habitat from the following:

- Placement of fill
- Alteration of bed topography
- Alteration of substrate composition
- Alteration of flow patterns
- Elevated suspended sediment concentrations
- Vibration and physical disturbance
- Falling materials
- Temporary behavioral avoidance by fish hosts
- Altered scour patterns

The Survey Area was delineated based on areas that may experience any of these impacts. Ohio River bed topography was surveyed using side-scan sonar to map distribution of substrate types within the Project Area (MCDI 2017). The ground-truthing survey by Stantec (2018a) suggested that substantial areas within the Survey Area appeared to be unstable shifting sand typical of dune waveforms, which is habitat expected to be unsuitable for freshwater mussels. However, smaller portions of the river bottom contained habitat deemed suitable for mussels including: coarse gravel, cobble, silt, and heterogenous mixtures. The Survey Area was divided into 20m/65ft by 20m/65ft search cells and consisted of the Survey Area plus a 10m/33ft upstream and 20m/65ft downstream buffer. Searches were scheduled in 100 percent of suitable substrates and 50 percent of unsuitable substrates.

Table 1.1-1 Survey Area Coordinates

		LATITUDE	LONGITUDE
West Corridor	Northeast Corner	37.907412 ° N	- 87.549376 ° W
	Southeast Corner	37.902773 ° N	-87.551122 ° W
	Southwest Corner	37.90319 ° N	-87.553118 ° W
	Northwest Corner	37.907909 ° N	-87.551222 ° W
Central Corridor	Northeast Corner	37.907021 ° N	-87.519923 ° W
	Southeast Corner	37.90146 ° N	-87.519723 ° W
	Southwest Corner	37.901377 ° N	-87.520694 ° W
	Northwest Corner	37.907004 ° N	-87.520861 ° W

The Ohio River and its larger tributary streams historically contained one of the most diverse freshwater mussel assemblages in North America. According to Haag and Cicerello (2016), the Ohio River and its minor tributaries historically contained 76 species of freshwater mussel. Many of these species, especially those considered endangered, may not still be present within the river due to modifications of habitat. Historically, the river was relatively shallow and contained numerous flow regimes, subsurface micro-habitats, sand and gravel bars, and shoals. Today the entire length of the river is impounded with a series of navigational dams, which has limited preferred mussel habitat. Despite impoundment and history of water pollution, portions of the river still contain a diverse mussel fauna. Based on data included on species distribution maps in Haag and Cicerello (2016), the section of Ohio River in Henderson County is known to have contained 37 species based on non-archeological site specimens (Table 1.1-2). An additional four species including *Lampsilis siliquoidea* (Fatmucket), *Toxolasma parvum* (Lilliput), *Utterbackia imbecillis* (Paper Pondshell), and *Villosa lienosa* (Little Spectaclecase) have been documented from

smaller perennial streams, sloughs, and ponds within Henderson County (Haag and Cicerello 2016).

Table 1.1-2 List of freshwater mussels documented from the Ohio River in Henderson County, adapted from distribution maps in Haag and Cicerello (2016)

Common Name	Scientific Name
Threeridge	*Amblema plicata*
Flat Floater	*Utterbackiana suborbiculata*
Rock Pocketbook	*Arcidens confragosus*
Purple Wartyback	*Cyclonaias tuberculata*
Butterfly	*Ellipsaria lineolata*
Elephantear	*Elliptio crassidens*
Spike	*Eurynia dilatata*
Wabash Pigtoe	*Fusconaia flava*
Longsolid	*Fusconaia subrotunda*
Plain Pocketbook	*Lampsilis cardium*
Pocketbook	*Lampsilis ovata*
Yellow Sandshell	*Lampsilis teres*
White Heelsplitter	*Lasmigona complanata*
Flutedshell	*Lasmigona costata*
Fragile Papershell	*Leptodea fragilis*
Black Sandshell	*Ligumia recta*
Washboard	*Megalonaias nervosa*
Threehorn Wartyback	*Obliquaria reflexa*
Hickorynut	*Obovaria olivaria*
Bankclimber	*Plectomerus dombeyanus*
Sheepnose	*Plethobasus cyphyus*

Common Name	Scientific Name
Ohio Pigtoe	*Pleurobema cordatum*
Pyramid Pigtoe	*Pleurobema rubrum*
Round Pigtoe	*Pleurobema sintoxia*
Pink Heelsplitter	*Potamilus alatus*
Fat Pocketbook	*Potamilus capax*
Pink Papershell	*Potamilus ohiensis*
Giant Floater	*Pyganodon grandis*
Rabbitsfoot	*Theliderma cylindrica*
Monkeyface	*Theliderma metanevra*
Wartyback	*Cyclonaias nodulata*
Pimpleback	*Cyclonaias pustulosa*
Mapleleaf	*Quadrula quadrula*
Pistolgrip	*Tritogonia verrucosa*
Ebonyshell	*Reginaia ebenus*
Deertoe	*Truncilla truncata*
Pondhorn	*Uniomerus tetralasmus*

Many of the rare species listed by USFWS for this portion of the Ohio River are based on shell material found at nearby archeological sites. Based on information obtained from the USFWS (2018), KSNPC (2015), KSNPC (2017), IDNR (2017a), and IDNR (2017b), the I-69 ORX project is within the historic/current range of 18 species of freshwater mussel with either federal and/or state protective status (Table 1.1-3). The probability of these species occurring has been discussed in the previously submitted habitat assessment report (Stantec 2018b).

Table 1.1-3 State and federally listed freshwater mussel species potentially occurring within the Project Area based on county level data obtained from IDNR, KSNPC, and USFWS IPaC

SPECIES SCIENTIFIC NAME	SPECIES COMMON NAME	FEDERAL STATUS[1]	IN STATUS[2]	KY STATUS[3]	DATA SOURCE
Margaritifera monodonta	Spectaclecase	E	-	E	USFWS IPaC 2017
Cyprogenia stegaria	Fanshell	E	SE	E	KSNPC 2015, USFWS IPaC 2017
Epioblasma obliquata	Catspaw	E	-	E	KSNPC 2015, USFWS IPaC 2017
Epioblasma rangiana	Northern Riffleshell	E	SE	E	USFWS IPaC 2017
Epioblasma triquetra	Snuffbox	E	SE	E	KSNPC 2015
Fusconaia subrotunda	Longsolid	-	SE	S	KSNPC 2015
Lampsilis abrupta	Pink Mucket	E	SE	E	KSNPC 2015, USFWS IPaC 2017
Lampsilis ovata	Pocketbook	-	-	E	KSNPC 2015
Obovaria retusa	Ring Pink	E	-	E	KSNPC 2015, USFWS IPaC 2017
Plethobasus cooperianus	Orangefoot Pimpleback	E	SE	E	USFWS IPaC 2017
Plethobasus cyphyus	Sheepnose	E	SE	E	IDNR 2017a, KSNPC 2015, USFWS IPaC 2017
Pleurobema clava	Clubshell	E	SE	E	USFWS IPaC 2017
Pleurobema cordatum	Ohio Pigtoe	-	SSC		IDNR 2017a
Pleurobema plenum	Rough Pigtoe	E	SE	E	USFWS IPaC 2017
Pleurobema rubrum	Pyramid Pigtoe	SOMC	SE	E	KSNPC 2015
Potamilus capax	Fat Pocketbook	E	SE	E	KSNPC 2015, USFWS IPaC 2017
Theliderma cylindrica	Rabbitsfoot	T	SE	T	IDNR 2017, KSNPC 2015, USFWS IPaC 2017
Villosa lienosa	Little Spectaclecase	-	SSC	S	KSNPC 2015

Source: IDNR, 2017a; KSNPC, 2015; USFWS IPaC, 2018.

Table Notes: 1. – = No Status, E = Endangered, T = Threatened, SOMC = Species of Management Concern; 2. SR = State Rare, SE = State Endangered, ST = State Threatened, SSC = State Species of Special Concern, SX – State Extirpated; 3. E = Endangered, S = Special Concern, T = Threatened, X = Extirpated, H = Historic

CHAPTER 2 – METHODS

2.1 SAMPLING PROTOCOL

Cell sampling rates were based on the side-scan sonar acoustic substrate classifications. Cells grouped as sand or bedrock were deemed potentially unsuitable for mussels and were randomly selected for surveying at a 50 percent rate. Cells grouped as coarse gravel/cobble/hardpan/bedrock, cobble/silt/clay, fine sand/coarse gravel, or silt/clay were determined to be potentially suitable for mussels and 100 percent were sampled. A conservative approach to grouping cells was taken by defaulting cells with mixed composition to the suitable group, despite potentially being majority unsuitable habitat. Cell classification can be seen in Figures A-2 & A-3. For consistency, this report will use the depth readings taken during the side-scan sonar data collection, as those depth readings were taken on the same day for all cells.

2.2 SURVEY METHODS

Cells were surveyed qualitatively via timed searches. Originally each 20m/65ft x 20m/65ft cell was scheduled to be surveyed by commercial and/or scientific divers for 20 minutes. Following discussions with USFWS (Phil DeGarmo, Personal Communication on October 10, 2018), survey times were increased to 25 minutes per cell to account for limited visibility. Divers positioned the dive vessel above the centroid points of each cell using ArcGIS Collector application on a handheld tablet and either a Bad Elf GNSS Surveyor receiver or a Trimble R1 GNSS receiver. Once the anchor was set and the boat was in position, divers lowered a "downline" for descents, ascents and to use as the center point of the search effort. Once the divers were on bottom, they would attach a search line to the downline and would stretch the search line approximately 5m/16ft from the downline. When divers were in position, their search time was started and they began travelling in an upstream direction. Divers terminated cell searches if the substrate was clearly unsuitable for mussels (e.g., unstable sand dunes, bedrock). Divers also terminated cell searches due to fast current preventing them from safely reaching bottom, increased boat traffic in the navigational channel or overhead environments encountered around the barge landing areas. USFWS requested more intensive follow-up surveys in cells with 10 or more species found during initial surveys (Appendix B). No cells reached this threshold during surveying. Tactile search methods were employed, consisting of moving cobble and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5cm/2in of substrate to better view the mussels which may be there. Mussels were brought to the surface for identification and data entry by a permitted malacologist before being returned to instream habitat. Substrate information was recorded by surface personnel via diver communications. Substrate grain size and percentage were estimated by divers using tactile methods due to low visibility. A total of 47.07 hours of search time was expended during survey operations.

Water samples were taken prior to field surveys each day. Conductivity, pH, and water temperature were taken with a Hanna HI98130 handheld unit. Dissolved oxygen readings were taken with a Yellow Springs Instruments (YSI) 500A handheld unit. Turbidity was measured using a Hach turbidimeter.

2.3 ANALYTICAL METHODS

Assemblage composition was assessed using simple metrics such as abundance, catch per unit effort (CPUE), density, diversity, and species richness. Simple Chi Square was used to compare presence/absence frequencies between the two Corridors. Species accumulation curves were used to estimate expected species richness. This was accomplished by regressing cell count against cumulative species richness. The resultant equation of the fitted line was used to extrapolate the expected number of species for the total number of cells in the survey area. Recruitment was assessed qualitatively using a length frequency diagram. Taxonomic nomenclature follows Williams et al. (2017).

CHAPTER 3 – RESULTS

3.1 SITE CONDITIONS

River discharges were unusually high in September and October of 2018 as a result of the remnants of two hurricanes moving through the watershed. Flow conditions were unsuitable for surveying for extended periods prior to mobilization by the survey team (Figure 3.1-1). Gauge height of less than 6m/20ft were suitable for diving, leaving the two survey windows (October 9-15, October 27-31) as the only times for completing safe and accurate dive surveys. Dive operations were suspended on October 13 as a catfish fishing tournament was ongoing, resulting in overcrowding of recreational boats within the Survey Area. Dive crews first mobilized on September 9-10th but cancelled field plans due to rain from Hurricane Florence (Figure 3.1-2). At gauge heights of greater than 6m/20 ft, flows were too fast for divers to remain on the substrate without being pushed downstream. At gauge heights of ~6m/20 ft, depths were approximately 3m/10 ft higher than those collected during the side-scan sonar substrate determination (MCDI 2017). This caused significant challenges to diving operations, limiting bottom time, decreasing efficiency, and reducing ability to stay on the river bottom during extreme high flows. On October 30, 2018, a dive boat moored to a barge collecting core samples in the center of the channel to eliminate the necessity of anchoring, but velocities were too great for divers to remain on the river bottom.

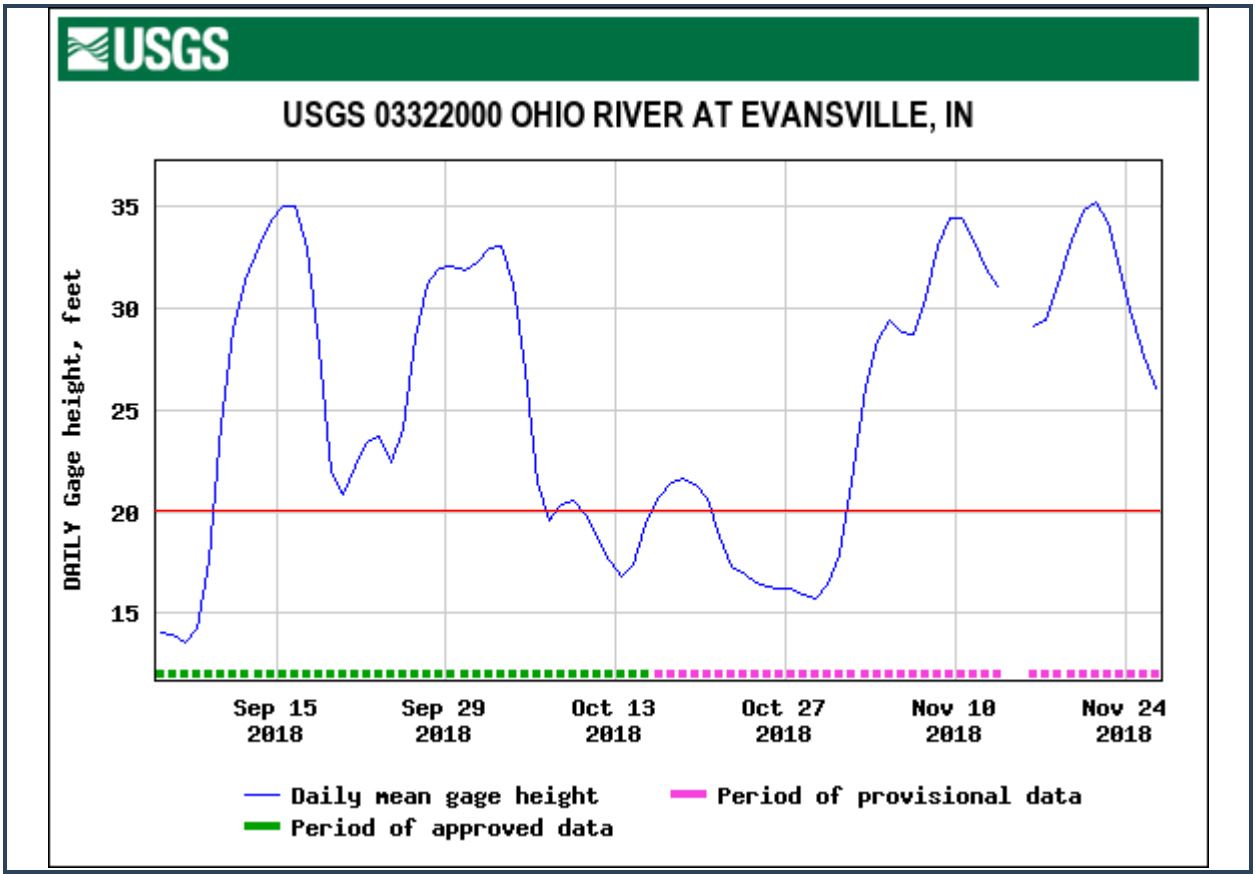
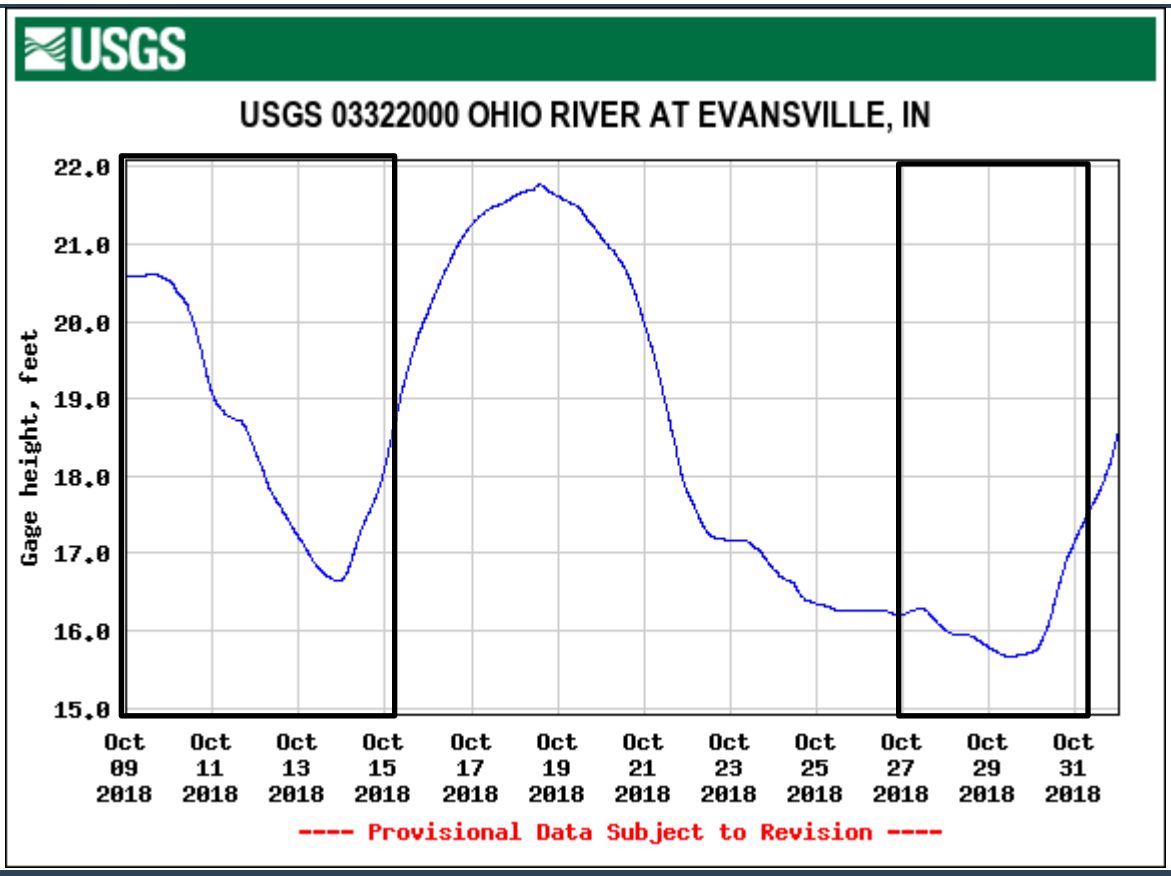


Figure 3.1-1 Flow Conditions at USGS 03322000 Ohio River at Evansville, Indiana

Water quality parameters were taken daily (except 10/27 & 10/28 when equipment was not yet onsite) as seen in Table 3.1-1. Turbidity was noticeably high, as both survey periods followed major rain events. Divers conducted the surveys in complete darkness that could not be ameliorated by dive lights and relied on tactile searching to locate mussels.



. Ohio River gauge height during freshwater mussel surveys at USGS 03322000 Ohio River at Evansville, IN

Figure 3.1-2 Ohio River gauge height during freshwater mussel surveys at USGS 03322000 Ohio River at Evansville, IN

Water temperatures fell steadily during the first round of surveying, with drastic differences between the first and second rounds (Table 3.1-1). Turbidity began lowering on October 29-30, but rain on the 31st eliminated any chance of visual searching. Conductivity stayed relatively constant throughout the duration of the project. Dissolved oxygen (DO Mg/L & DO % Sat) were relatively high, with the absolute concentration (Mg/L) increasing with decreasing temperatures during the second mobilization.

Table 3.1.1-1 Water quality parameters for the Ohio River at Evansville, Indiana

DATE	TEMP. °C	pH	DO %Sat	DO Mg/L	CONDUCTIVITY	TURBIDITY (NTU)
10/9/2018	22.86	7.83	85.8	7.35	315	56
10/10/2018	22.6	7.05	83.3	7.4	331	66
10/11/2018	22	6.89	96	8.36	322	67
10/12/2018	21.3	7.6	88.3	7.82	330	93
10/14/2018	20.4	7.6	86.9	7.7	328	58.1
10/15/2018	20.1	7.7	82.2	7.43	330	92
10/27/2018	-	-	-	-	-	-
10/28/2018	-	-	-	-	-	-
10/29/2018	15.3	8.34	97.5	9.72	301	39.2
10/30/2018	15	8.44	98	9.81	-	26.7
10/31/2018	15.6	7.41	96.2	9.6	295	59.6

3.1.1 Efficacy of Side-Scan Sonar

Side-scan sonar (MCDI 2017) and field ground-truthing (Stantec 2018a) were used to group each cell area into one of seven substrate categories (i.e. Acoustic Class). Divers reported the realized substrate classification during mussel survey operations. These data, along with biotic indices for each cell, can be viewed in Appendix D. These data can be compared to the acoustic classes to display the efficacy of the side-scan sonar for accurately portraying substrate class (Table 3.1.1-1). Approximately 55 percent (60/109) of the cells were properly classified by the acoustic side-scan sonar classes. The acoustic classifications were highly effective for sand (89 percent, 24/27 cells correct) and the coarse gravel/gravel/hardpan/bedrock (87 percent, 13/15 cells correct) classes, and highly ineffective for silt/clay (37 percent, 20/54 cells correct). Realized substrate compared to the acoustic classifications can be viewed spatially in Figures A-4 & A-5.

Table 3.1.1-1. Comparison of acoustic-based and field-verified substrate classes

	Acoustic Class						
Realized Substrate Class	Silt/Clay	Sand	F. sand, C. gravel	C. gravel C/HP/BR	Cobble, silt/clay	Het. mix	Total
Silt/Clay	13						13
Silt/Clay-Sand	4						4
Silt/Clay-Gravel	2						2
Silt/Clay-Sand-Gravel	1						1
Sand	2	18			1	1	22
Sand-Gravel	7	6	3			1	17
Sand-Cobble				2			2
Gravel	1						1
Gravel-Silt/Clay		2		1			3
Gravel-Cobble			1				1
C. gravel C/HP/BR	4			6			10
Cobble-Silt/Clay	2						2
Cobble-Gravel-Sand	1	1	2				4
Cobble-Gravel	5			6			11
Rip-rap	8						8
Boulder-Sand	1		1				2
Boulder-Gravel	3		3				6
Grand Total	**54**	**27**	**10**	**15**	**1**	**2**	**109**

Table Notes: C. gravel C/HP/BR = Coarse gravel, Cobble, Hardpan/Bedrock; F. sand, C. gravel = Fine sand, Coarse gravel; Het. Mix = Heterogenous mixture. Highlighted cells represent matches between side-scan sonar and diver-confirmed substrate categories.

3.2 SAMPLING EFFORT

Approximately 47 percent of scheduled search cells were sampled, including 74% of suitable cells, across the two survey periods (Table 3.2-1). Approximately 52 percent (44/85) of the cells were completed in the Central Corridor, with an additional 7 cell searches resulting in failed attempts, due to fast currents. Some failed cells yielded substrate data or spent mussel shells that are included in later analysis, but are not deemed completed. Cells that were not attempted or completed were deemed "unsampled." Approximately 44 percent of the scheduled search cells on the West Corridor were completed (64/146). Completed cells can be viewed spatially in Figures A-6 & A-7.

Table 3.2-1. Sampling effort of search cells by corridor

CORRIDOR	COMPLETED	FAILED	UNSAMPLED	TOTAL
Central	44	7	34	85
West	64	0	82	146
Total	**108**	**7**	**116**	**231**

3.2.1 SAMPLING BY DEPTH

Sampling was skewed towards shallow depths, as realized depths were significantly (~2.4m/8-3.6m/12ft) deeper than ideal conditions (Figure 3.1-2 & 3.2.1-1). Cells towards the thalweg of the river proved problematic as boats were often unable to anchor and maintain position or the combination of unstable substrate and high velocity made it impractical for divers to survey. Additionally, these cells were often in the shipping channel, which made anchoring of the boats for the necessary duration (i.e., > 30 minutes) difficult due to the frequency of barge traffic in the area. Cells were sampled in each depth category except the deepest (11m/35ft-14m/45ft), which only contained 2 cells. Negative values for depth indicated the cells were above water during acoustic surveying. All cells were under water during the mussel survey. Bathymetric data can be viewed in Figure A-8.

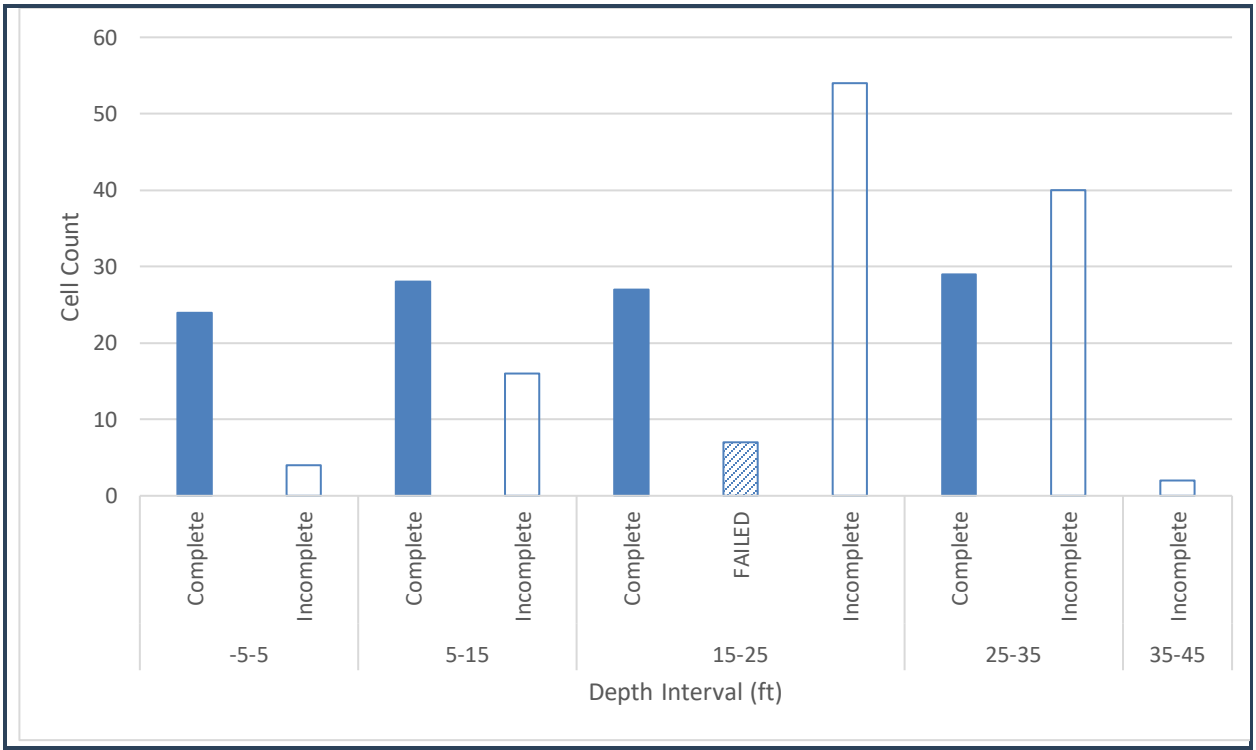


Figure 3.2.1-1. Depth of completed, failed, and unsampled survey cells

3.2.2 SAMPLING BY SUBSTRATE TYPE

While still attempting for suitable spatial coverage of all cells, priority was placed on suitable substrate cells. As a result, 74 percent (81/109) of the suitable substrate cells were sampled, while 22 percent (27/122) of the unsuitable cells were sampled (Figure 3.2.2-1). Attempts were made during sampling to cover each substrate type as determined by the side-scan sonar. Hardpan/bedrock cells were unsampleable due to increased depths preventing divers from being able to stay on the river bottom for surveying. When the survey plan was prepared the water depths were based on depths taken during side-scan sonar efforts, approximately 10ft shallower.

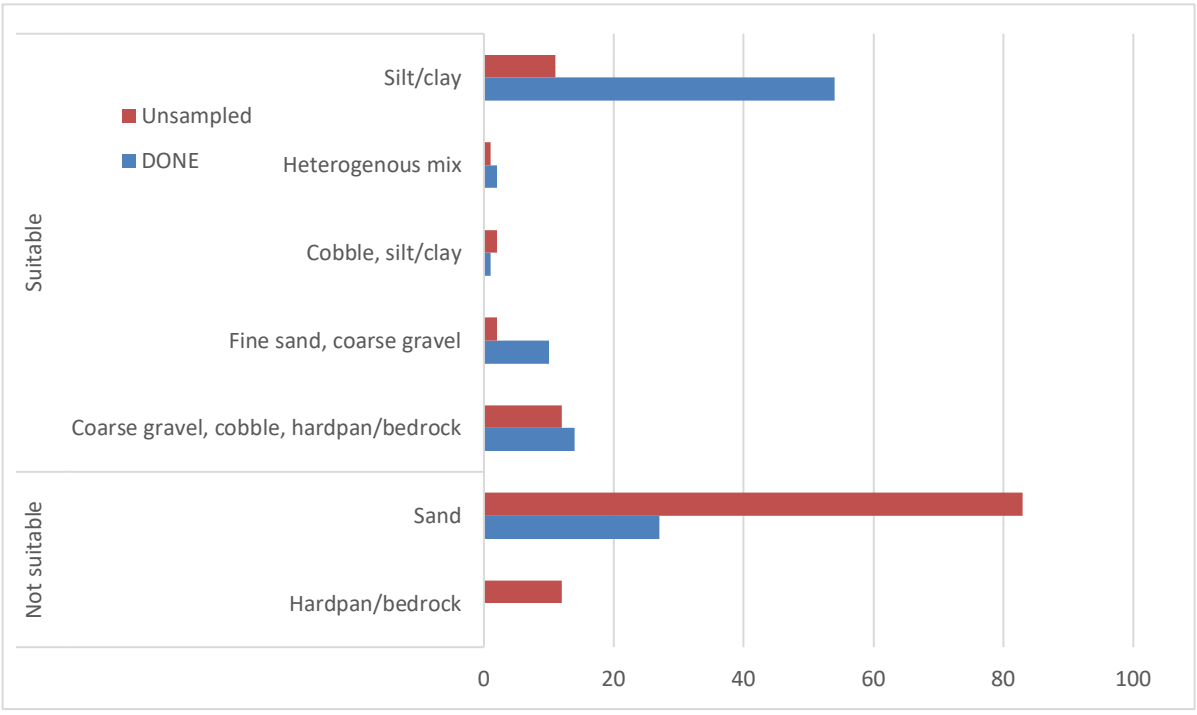


Figure 3.2.2-1 Total complete and unsampled cells for each acoustic substrate class

3.2.3 SIDE-SCAN SONAR ACCURACY

Table 3.2.3-1 displays the accuracy of the side-scan sonar relative to the unsampled cells, with most remaining cells being in the accurately-predicted sand substrate. Hardpan/bedrock areas were not sampled and therefore, do not have an acoustic class accuracy value. Cobble/silt/clay and heterogenous mixture have a functional 0 percent acoustic class accuracy since no cells of these substrate classes were accurately classified by the side-scan sonar. Ninety-five (95) cells (Sand, coarse gravel/cobble/hardpan/bedrock) remain that were accurately predicted by the side-scan sonar. This allows for more accurate assumptions about what remains in the unsampled cells.

Table 3.2.3-1 Side-scan sonar accuracy for completed and unsampled cells by substrate type

	COMPLETED	UNSAMPLED	SIDE-SCAN SONAR ACCURACY
Cobble, silt/clay	1	2	0 %
Fine sand, coarse gravel	10	2	30 %
Heterogenous mix	2	1	0 %
Sand	27	83	89 %
Silt/Clay	54	11	37 %
Coarse gravel, cobble, hardpan/bedrock	15	12	87 %
Hardpan/Bedrock	0	12	-

3.3 MUSSEL COMMUNITY

In total, 452 live mussels were collected during the 47.07 hours of searching, along with 216 spent shell specimens (Table 3.3-1). *Reginaias ebenus* (Ebonyshell) made up over half of the live specimens (n = 245). Species of note include a single subfossil *Potamilus capax* (Fat Pocketbook) shell, which is federally endangered. Species richness totaled 20 for the entire survey, with an additional 4 species collected as spent shells only. Ignoring nonrandom sampling of cells, a species accumulation curve shows sampling approaching the asymptote of species richness, with the logarithmic curve suggesting 4 additional missing species within the 231 target cells (Figure 3.3-1). Species voucher photos can be found in Appendix C.

Table 3.3-1. Live and spent shells found during I-69 freshwater mussel survey in Henderson County, KY, October 2018.

SPECIES	ALIVE	FRESH DEAD	SUBFOSSIL	WEATHERED	TOTAL
Actinonaias ligamentina	-	-	-	1	1
Amblema plicata	59	-	6	19	84
Cyclonaias nodulata	15	-	5	1	21
Cyclonaias pustulosa	13	-	-	2	15
Cyclonaias tuberculata	2	-	-	-	2
Elliptio crassidens	1	-	-	6	7
Ellipsaria lineolata	1	1	-	-	2
Fusconaia flava	1	-	1	1	3
Fuscoanaia subrotunda[1,2]	11	-	1	10	22
Lampsilis cardium	2	-	-	-	2
Leptodea fragilis	9	-	-	-	9
Lampsilis ovata[3]	-	-	1	-	1
Ligumia recta	6	-	2	5	13
Lampsilis teres	1	-	-	2	3
Megalonaias nervosa	16	1	22	14	53
Obovaria olivaria	1	-	-	-	1
Obliquaria reflexa	30	-	4	3	37
Potamilus capax[1,3,6]	-	-	-	1	1
Pleurobema cordatum[4]	2	-	-	2	4
Potamilus alatus	23	-	7	9	39
Pleurobema rubrum[1,3,5]	-	-	2	-	2
Quadrula quadrula	11	2	2	5	20
Reginaias ebenus	245	1	4	70	320
Theliderma metanevra	3	-	-	3	6
TOTAL	**452**	**5**	**57**	**154**	**668**

Table Notes: 1. IN State Endangered 2. KY Special Concern 3. Endangered 4. IN State Species of Special Concern 5. Federal Species of Management Concern. 6. Federal Endangered

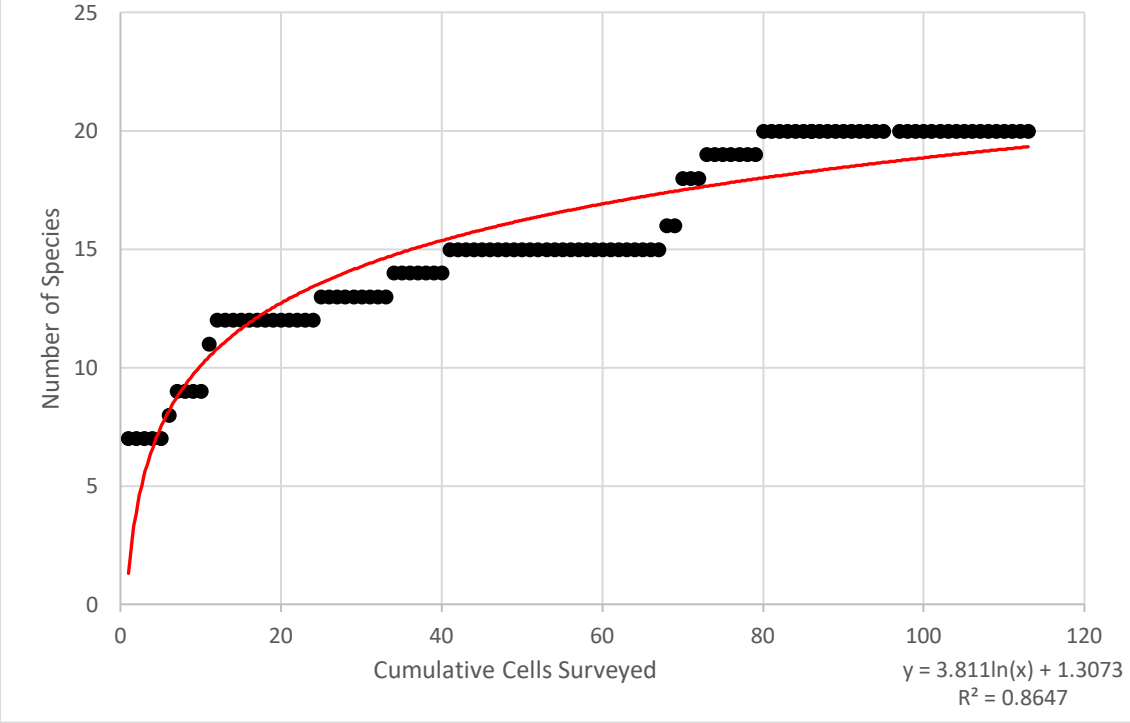


Figure 3.3-1. Species accumulation curve showing the cumulative number of species recorded as a function of sampling effort

3.3.1 Mussel Community by Corridor

Live mussels were absent at lower frequencies in the Central Corridor (27 present, 18 absent) than in the Western Corridor (27 present, 35 absent) as shown in Figure 3.3.1-1. The frequency distributions for presence/absence in cells did not differ at the 0.05 level but approached statistical significance ($X^2 = 2.82$, $p = 0.09$, $df = 3$). In addition to a higher ratio of presence/absence, catch per unit effort (CPUE, mussels per hour search time) was higher in cells in the Central Corridor (mean = 19.6) compared to the Western Corridor (mean = 2.3) (Table 3.3.1-1). The project overall had an average CPUE of 9.5 mussels per hour. The spatial distribution of CPUE and live mussel count data among survey cells is illustrated in Figures A-9 & A-10 and Figures A-11 & A-12, respectively. Average MacArthur diversity (MacArthur 1972) and species richness were also greater in the Central Corridor compared to the Western Corridor (Table 3.3.1-1). The spatial distribution of richness among survey cells is presented in Figures A-13 & A-14.

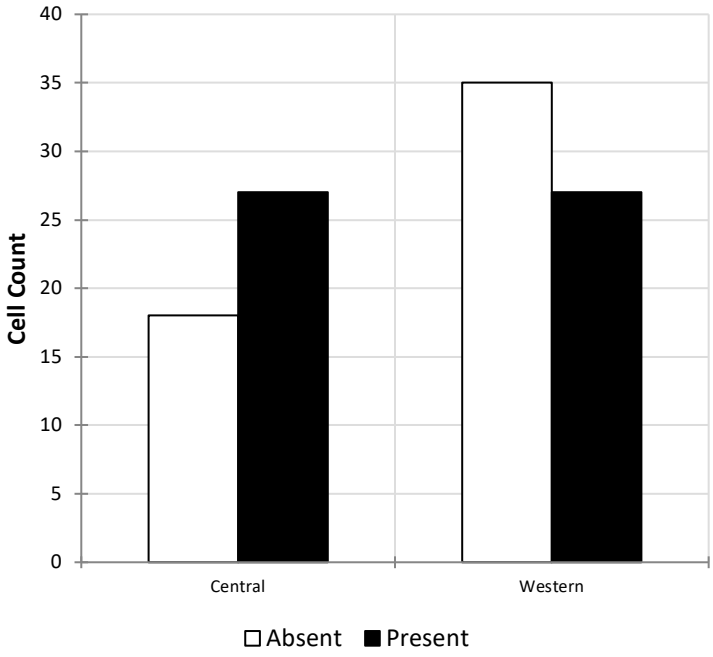


Figure 3.3.1-1 Count of survey cells where live mussels were found (present) and not found (absent) for the Central and Western corridors

Table 3.3.1-1. Mean catch per unit effort (CPUE), diversity, and species richness by corridor

	CATCH PER UNIT EFFORT			DIVERSITY			RICHNESS		
	MEAN	SD	COUNT	MEAN	SD	COUNT	MEAN	SD	COUNT
Central Corridor	19.62	32.07	45	1.82	0.79	27	3.59	2.47	27
West Corridor	2.29	3.10	62	1.74	0.79	27	1.78	0.85	27
Total	9.58	22.50	107	1.78	0.78	54	2.69	2.05	54

3.3.2 MUSSEL COMMUNITY BY DEPTH

Mussel presence/absence was fairly consistent across depth ranges. Mussels were absent in higher proportions in two depth ranges, the -1.5m/-5ft to 1.5m/5ft range on the Central Corridor and the 25-35ft range on the Western Corridor (Figure 3.3.2-1). As shown in Table 3.3.2-1, the mean CPUE was low (<5 mussels per hour) in all depth categories, except for the 4.6m/15ft to 7.6m/25ft category on the Central Corridor, where the diverse and abundant mussel bed was located. Average MacArthur Diversity Index was similar across all depth categories, with a maximum of 2.33 in the shallow (-1.5m/-5ft to 1.5m/5ft) range on the Central Corridor, and a minimum of 1.63 in the shallow range on the Western Corridor. Average species richness by cell was greatest (5.25) in the 4.6m/15ft to 7.6m/25ft range on the Central Corridor.

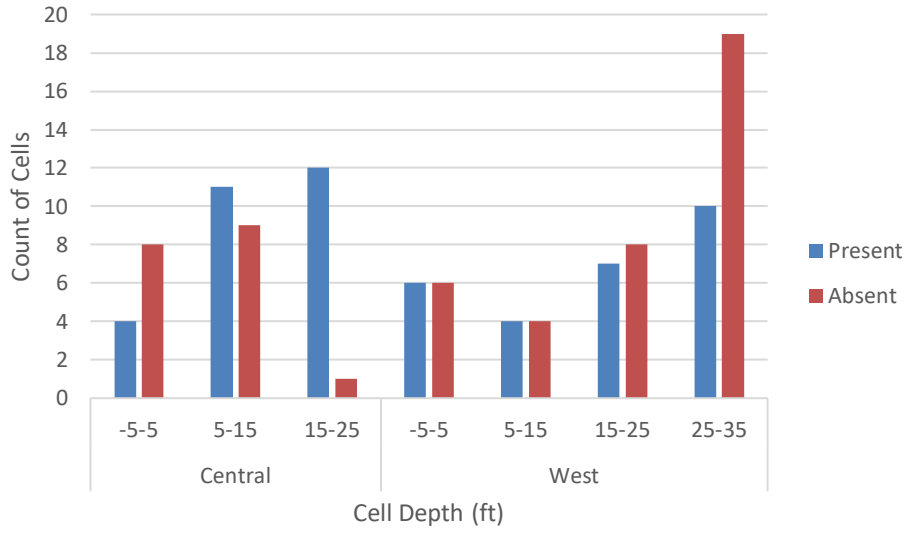


Figure 3.3.2-1 Count of survey cells where live mussels were found (present) and not found (absent) by cell depth for the Central and West Corridors

Table 3.3.2-1 Summary statistics for Catch per Unit Effort (CPUE), diversity, and richness by survey cell depths for Central and West Corridor

		CATCH PER UNIT EFFORT			DIVERSITY			RICHNESS		
		MEAN	SD	COUNT	MEAN	SD	COUNT	MEAN	SD	COUNT
Central Corridor	-5 – 5 ft	4.98	7.83	12	2.33	0.86	4	3.50	1.73	4
	5 – 15 ft	4.07	6.17	20	1.72	0.99	11	1.82	1.08	11
	15 – 25 ft	61.8	36.6	12	1.74	0.53	12	5.25	2.53	12
West Corridor	-5 – 5 ft	3.05	3.24	11	1.63	0.80	6	1.67	0.82	6
	5 – 15 ft	2.70	3.50	8	1.92	0.69	4	2.00	0.82	4
	15 – 25 ft	1.96	2.49	15	1.71	0.76	7	1.71	0.76	7
	25 – 35 ft	2.05	3.32	28	1.76	0.94	10	1.80	1.03	10

3.3.3 Mussel Community by Substrate Type

Live mussels were present in the majority of suitable substrate (50 of 92), while only present in 4 of the 17 sampled unsuitable habitats (Figure 3.3.3-1). When isolating individual substrate groups, live mussels were more frequently present than absent in the suitable sand, silt/clay, and coarse gravel, cobble, hardpan/bedrock categories (Figure 3.3.3-2). This analysis separated sand substrates into those with intruding 'suitable' substrate types and those that were 100% sand. Suitable sand cells (minority suitable substrate) had a higher ratio of presence to absence than that of unsuitable sand (isolated sand) cells (Figure 3.3.3-2). There were no mussels found in the heterogeneous mixture or cobble/silt/clay habitat classes. As shown in Table 3.3.3-1, the mean CPUE per cell was far greater in the coarse gravel/cobble/hardpan/bedrock acoustic class (49.59 mussels/hr). The mean species richness (4.92) was also greatest for the coarse gravel/cobble/hardpan/bedrock acoustic class. Total species richness was greatest for the coarse gravel/cobble/hardpan/bedrock acoustic class as well (Figure 3.3.3-2).

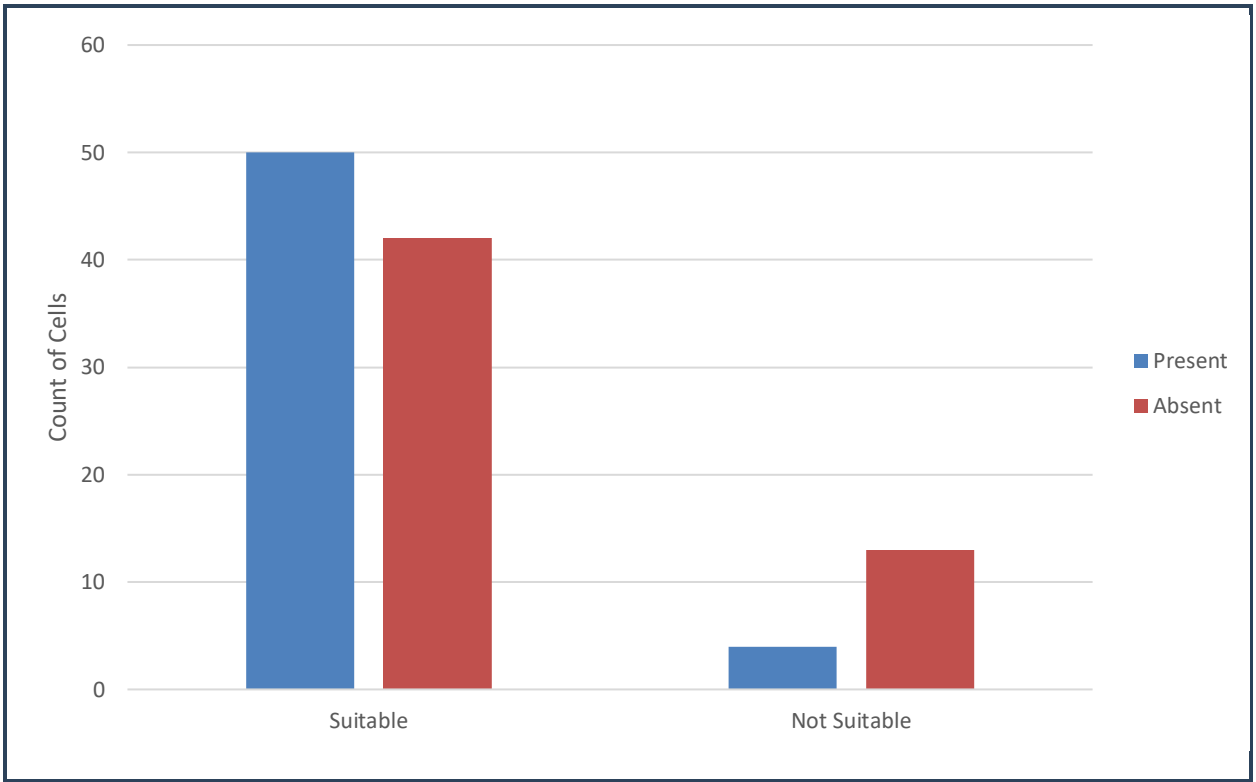


Figure 3.3.3-1. Number of survey cells where live mussels were found (present) and not found (absent) for potentially suitable and non-suitable habitat

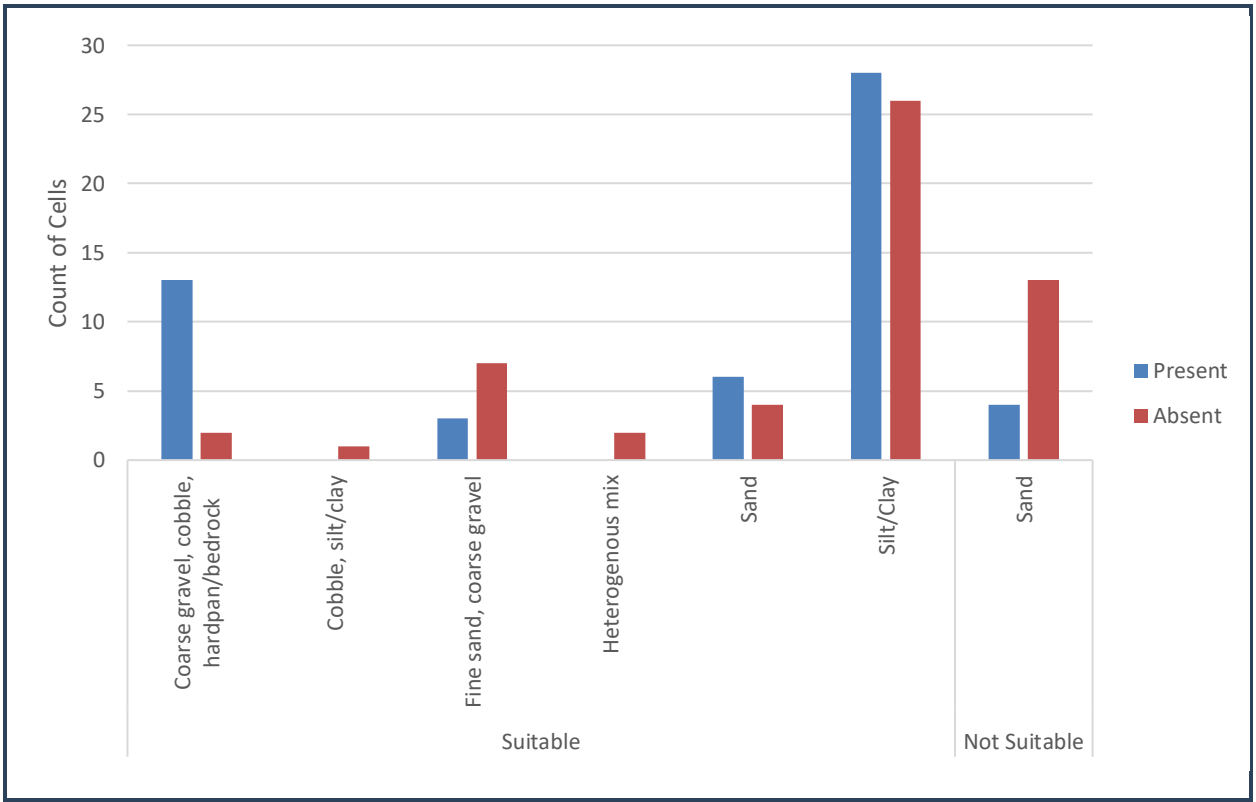


Figure 3.3.3-2. Number of survey cells where live mussels were found (present) and not found (absent) for each acoustic substrate class

Table 3.3.3-1 Summary statistics for Catch per Unit Effort (CPUE), diversity, and richness for each acoustic substrate class

SUBSTRATE CLASS	CATCH PER UNIT EFFORT			DIVERSITY			RICHNESS		
	MEAN	SD	COUNT	MEAN	SD	COUNT	MEAN	SD	COUNT
Coarse gravel, cobble, hardpan/ bedrock	49.59	41.1	15	1.68	0.55	13	4.92	2.69	13
Cobble, silt/clay	0.00	-	1	-	-	-	-	-	-
Fine sand, coarse gravel	1.91	3.19	9	2.00	1.00	3	2.00	1.00	3
Heterogenous mix	0.00	0.00	2	-	-	-	-	-	-
Sand	2.40	4.52	27	1.65	0.95	10	1.70	1.06	10
Silt/Clay	3.75	5.16	53	1.85	0.83	28	2.07	1.15	28

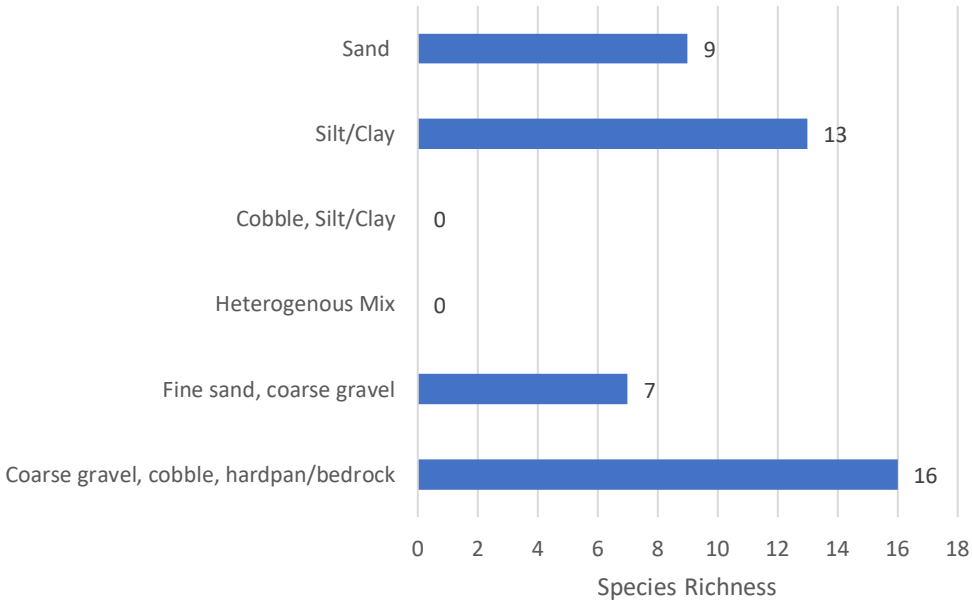


Figure 3.3.3-2. Cumulative species richness within each acoustic substrate class

3.3.4 MUSSEL BED COMMUNITY

The coarse gravel/cobble/hardpan/bedrock substrate class was revealed to contain a significant mussel bed. This area had a high CPUE (49.59 mussels/hr), mean species richness per cell (4.92), and yielded a total live mussel count of 310 from the fifteen surveyed cells. The species accumulation curve (Figure 3.3.4-1) suggests survey efforts somewhat approached the asymptote, finding a richness of 16 species in the mussel bed, with a suggested richness of 22 based on a logarithmic curve equation (ignoring nonrandom sampling) (Figure 3.3.4-1).

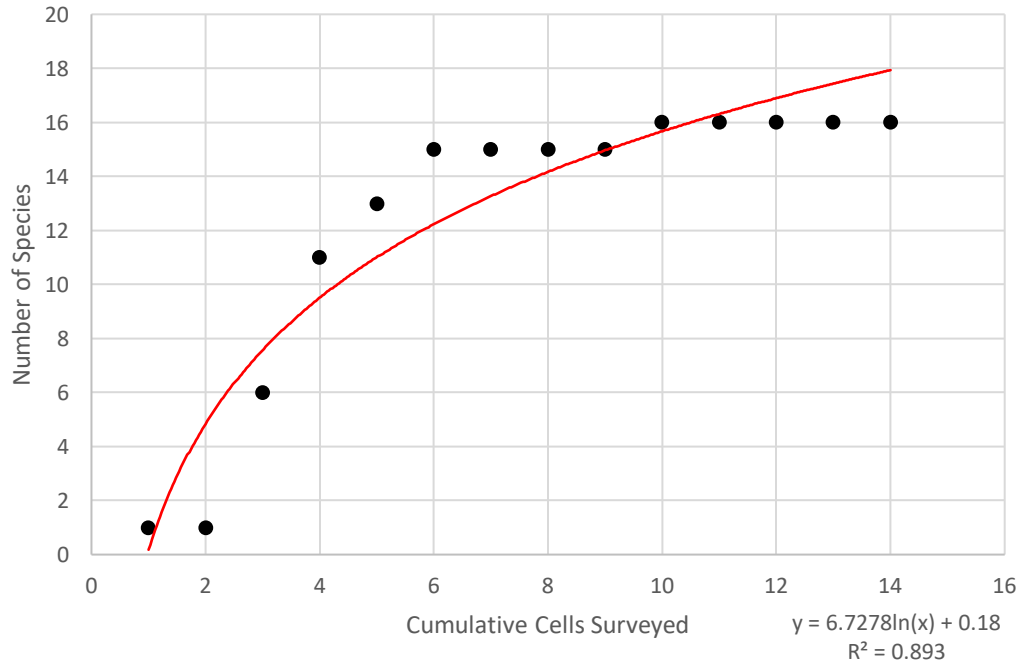


Figure 3.3.4-1. Cumulative number of species recorded as a function of sampling effort in the coarse gravel/cobble/hardpan/bedrock substrate class

3.3.5 COMMUNITY DATA

Figure 3.3.5-1 displays the length data from all mussels collected during the survey. Numerous species (*Amblema plicata, Cyclonaias nodulata, Cyclonaias pustulosa, Leptodea fragilis, Obliquaria reflexa, Potamilus alatus,* and *Reginaias ebenus*) were collected over a wide range of size classes, which can be interpreted as age classes. Numerous other species collected were noted only as large/older individuals (*Cyclonaias tuberculata, Elliptio crassidens, Ellipsaria lineolata, Megalonaias nervosa,* and *Lampsilis cardium*).

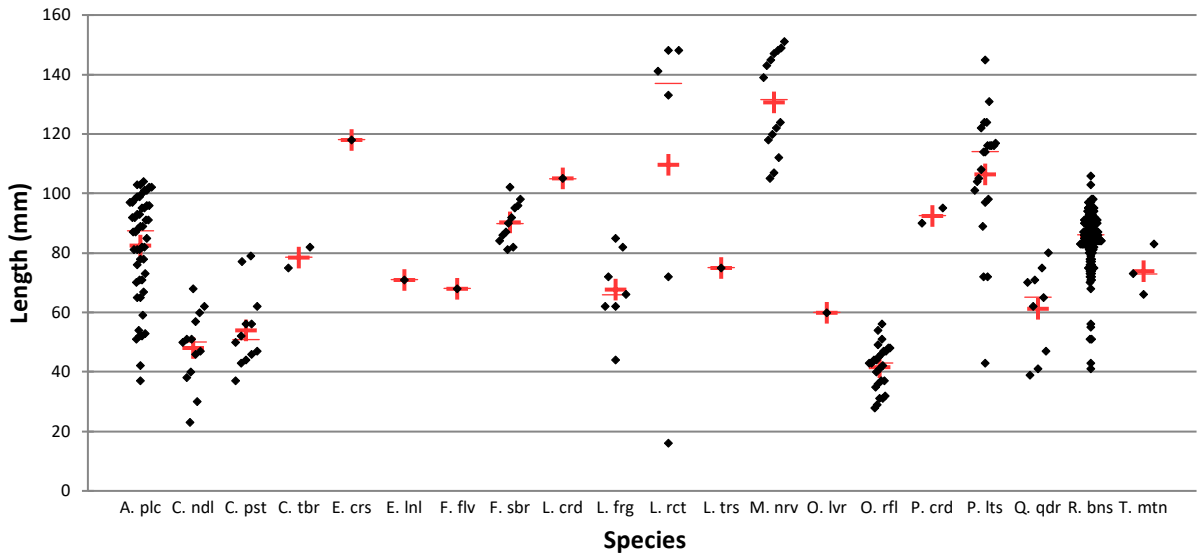


Figure 3.3.5-1. Length of live mussels found during mussel surveys in Henderson County, KY, October 2018

CHAPTER 4 – DISCUSSION

4.1 SITE CONDITIONS

River conditions made sampling a logistical challenge throughout the months of September and October, two months that, statistically speaking, are ideal for mussel surveys (Figure 4.1-1). Frequent prolonged periods of high flow resulted in velocities that made it impractical for divers to remain at depth on the substrate. Surveys were conducted in the only windows of opportunity provided during this period. Turbidity was high due to multiple basin-wide rain events prior to surveying but was not expected to have impacted efficacy of searching relative to normal conditions, as high catch per unit effort (CPUE) was recorded in multiple cells from multiple divers.

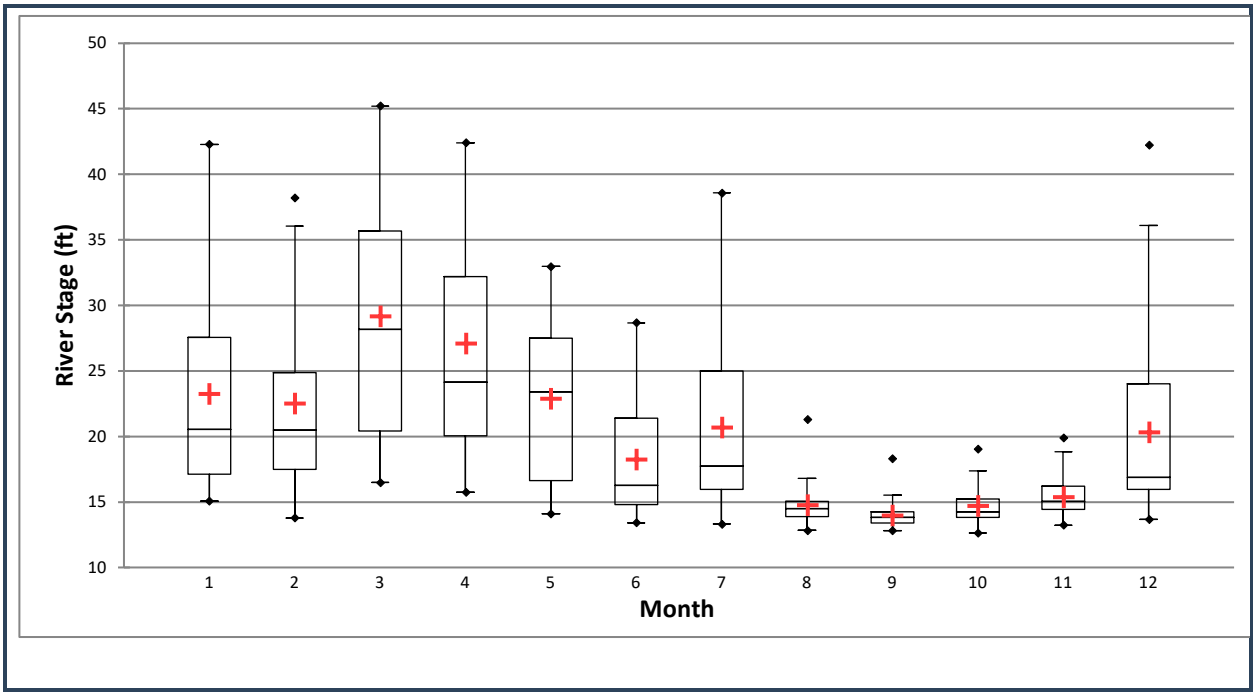


Figure 4.1-1. Historical (2014-2017) river stage measured at USGS gauge 03322000 Ohio River at Evansville, IN

Realized substrate differed greatly from the acoustic classes determined by side-scan sonar. As seen in Figures A-4 & A-5, some disagreements between the realized substrate and the acoustic classifications were partial disagreements (sand acoustic realized as a sand/gravel mixture), indicating the 55 percent accuracy is a conservative estimate of acoustic accuracy. It is worth noting that there have been multiple high flow events between the completion of the side-scan sonar substrate classification in November 2017 and the mussel survey in October, 2018. This could have resulted in changes in bedform that would appear as inaccuracy of the side-scan sonar. Seven acoustic classes are too broad to capture real-world substrate variability, however

CPUE suggests that some of the acoustic classifications are biologically significant. Confidence in some acoustic classes remains high due to the high detectable accuracy of habitat that turned out to be a mussel bed (e.g. 13/15 cells in the coarse gravel/cobble/hardpan/bedrock classification). The acoustic classification system struggled with the silt/clay class, and was accurate for only 37 percent of cells. However, for extrapolating findings from this survey to the unsampled cells, 54 of 65 silt/clay cells were sampled, leaving only 11 highly variable cells remaining. The majority of unsampled cells (81 sand) were accurate at a rate of 93 percent, suggesting that information obtained in the surveyed cells can suggest what mussels would be found in the unsampled cells.

4.2 SAMPLING EFFORT

Approximately half of the scheduled cells were surveyed (108 of 231), mainly leaving the midchannel cells unsampled. The midchannel cells proved hard to sample due to frequent barge traffic interrupting surveying when in the navigation channel. Seven cells were aborted during surveying due to high water velocity, but substrate data was recorded for these cells. The cells reporting biotic data provided enough to approach an asymptote on the species accumulation curve (Figure 3.3-1). Unsampled cells included those in the deepest portion of the river (>11m/35ft), as well as the only instances of bedrock substrate (Figures 3.2.1-1 & 3.2.2-1). Depth did not appear to have any influence on mussel abundance or richness, therefore we don't believe that the unsampled deep portion of the river would hold a different faunal assemblage compared to sampled areas. Bedrock is unsuitable freshwater mussel habitat, so this area is also not anticipated to hold different mussels than areas already sampled, however we lack evidence that this acoustic class was accurately determined via the side-scan sonar. All other habitats were sampled with sufficient frequency to make assumptions regarding the unsampled mussel assemblage within the Survey Area.

4.3 MUSSEL COMMUNITY

Species richness totaling 20 species plus an additional 4 spent shell species suggests a diverse mussel assemblage within the Survey Area, specifically the Central Corridor. The community is dominated by *Reginaias ebenus* (Ebonyshell), with over half of live mussels from this species. Species of interest include 1 spent shell specimen of federally endangered *Potamilus capax*, 2 spent shells of Kentucky endangered *Pleurobema rubrum*, 1 spent shell of Kentucky endangered *Lampsilis ovata*, and 11 live and 11 spent shells of Kentucky special concern *Fusconaia subrotunda.* A logarithmic curve for the species accumulation data suggest that four additional species may be occupying the Survey Area.

The Central Corridor contained the higher quality mussel community, with more cells with live mussels, higher average CPUE, diversity, and richness (Figure 3.3.1-1, Table 3.1-1). These characteristics were mainly driven by the mussel bed inhabiting the coarse gravel/cobble/hardpan/bedrock habitat.

Only 53 total mussels were found on the Western Corridor, suggesting that it doesn't hold abundant populations of mussels (Figure A-11). The Western Corridor proved to be mostly unsuitable habitat. Cells along the left descending bank that were suggested via acoustic surveying to be silt/clay (suitable) were entirely riprap, yielding few mussels. Some cells along

the left descending bank of the Western Corridor could not be sampled because the moored barges presented an overhead safety hazard for divers. The bridge piers at the Western Corridor forced barge traffic into close proximity of dive vessels when attempting to survey cells in the middle of the river or near piers, resulting in few midchannel cells from being surveyed.

Depth does not appear to be an important variable for this mussel community, as presence/absence varied between corridors along the same depth groupings (Figure 3.3.2-1). Mean CPUE was similar among depth groupings with the exception of the 15-25 foot depth interval at the Central Corridor which was much higher (Table 3.3.2-1). Mean Richness was also skewed by the mussel bed in the Central Corridor, with -1.5m/5ft to 1.5m/5ft deep on the Central Corridor also being somewhat elevated (3.5). All other depth groupings had similar mean richness per cell, between 1.67 and 2 species.

Using the conservative classification of sand substrates, the majority of "suitable" substrate cells (50 of 92 cells) as defined by the acoustic data yielded mussels, compared to only 4 of 17 "unsuitable" cells (See section 3.3.3). Coarse gravel/cobble/hardpan/bedrock, sand, and silt/clay suitable substrates all had more instances of live mussels present in cells than not. However, the coarse gravel/cobble/hardpan/bedrock category was an outlier, with mean CPUE a magnitude greater than that of silt/clay, the next highest (49.59 vs. 3.75). The accuracy of the acoustic classification in this area (89 percent), provides confidence that this habitat represents the only mussel bed habitat in the Survey Area. Ten cells of this habitat type remain unsampled in the center of the channel on the Central Corridor. This optimal substrate had the highest average cell species richness (4.9) and total species richness (16), with the next highest substrate/species richness being silt/clay (2.1 average & 13 total over 54 cells).

The mussel bed in the Central Corridor yielded 310 individuals and 16 species of the total 452 individuals and 20 species found during the entire survey. The species accumulation curve suggests a potential six missing species from the mussel bed community data. This area contained 8 of the 11 live *Fusconaia subrotunda,* a Kentucky species of Special Concern.

The lone subfossil *Potamilus capax* shell was found on the right descending side of the Central Corridor, approximately 80m from the right descending bank (Cell 19, Figure A-3). The condition of the shell indicates that it could have originated upstream of the Survey Area and been washed downstream. A lone subfossil shell is not enough evidence to state a population is living in the Survey Area. The length scattergram (Figure 3.3.5-1) suggests recruiting populations of most species, with some species not found in abundances high enough to predict. *A. plicata, C. nodulata, C. pustulosa, L. fragilis, O. reflexa, P. alatus,* and *R. ebena* were collected over a wide range of size classes, which can be interpreted as annually successful reproduction, Others, such as *L. recta*, were collected across a range of size classes but were observed infrequently. This could be a function of small sample size but could also be an indication of sporadic reproduction. Other species, such as *C. tuberculata, E. crassidens, E., lineolata, M. nervosa, L. cardium*, and others were collected as large and older individuals only. Reproduction for these species may occur only as infrequent episodes.

Although no live federally listed species were collected during this survey their presence cannot be definitively ruled out. Catch per unit effort was very high in coarse gravel/cobble/hardpan/bedrock substrates at the Central Corridor (max = 125 mussels per hour) and was higher than other projects where we have collected listed mussels such as the Green River at Rush Island (max = 91 mussels per hour) (Stantec 2016) or the Wisconsin River (max = 115 mussels per hour) (Stantec 2018c). In the latter example, no listed species were detected in the baseline presence/absence surveys but five *Plethobasus cyphyus* (Sheepnose) were collected during relocation. Approximately 4,000m²/43,000ft² of this substrate type in the Central Corridor remains unsampled due to unusual fall flow conditions. If listed mussels are present within the Central Corridor, they are likely present at low densities. Fleece et al. (2017) compiled readily available mussel studies for large river systems where federally listed species were detected, focusing mainly on the Ohio River. The studies ranged between 1992 and 2017, covered 20 sites, and over 12,400 live animals were collected of which 4 species were federally listed. The mode for listed mussel counts was one. The proportion of the assemblage comprised of federally listed animals was usually less than one percent and never more than eight percent. It seems unlikely that federally listed mussels are present along the Western Corridor given the low overall mussel abundance and the substantial extent of unstable sand substrate.

4.4 SUMMARY OF FINDINGS

- 452 live mussels were found during 47.07 hours of surveying
- Approximately half of the scheduled survey cells were completed during two mobilizations of field staff, including 74% of scheduled suitable substrate cells.
- Acoustic substrate classifications had low overall accuracy predicting realized substrate, but was accurate for high mussel density areas.
- Areas of low acoustic accuracy have been sampled at a higher completion level, leaving mainly areas of high acoustic accuracy unsampled.
- The mussel assemblage at the Central Corridor was more abundant and diverse than the assemblage of mussels at the Western Corridor.
- One sub-fossil spent shell specimen of federally endangered *Potamilus capax* was found during surveying.
- 2 spent shells of Kentucky endangered *Pleurobema rubrum*, 1 spent shell of Kentucky endangered *Lampsilis ovata*, and 11 live and 11 spent shells of Kentucky special concern *Fusconaia subrotunda* were found during survey operations.
- Species accumulation curves suggest that the Survey Area and the mussel bed area could contain additional undetected species.

CHAPTER 5 – CONCLUSIONS

Despite incomplete sampling of the Survey Area some conclusions can be made to what species of mussels inhabit these corridors. No live federally listed species were found during survey efforts. Eleven live *Fusconaia subrotunda* (Kentucky Special Concern) were found during survey operations, the only live specimens of listed species. Length scattergrams suggest a healthy mussel assemblage within the Project Area, albeit mainly within the Central Corridor, with evidence of active recruitment among all species that were abundantly sampled. The majority of remaining cells are within habitat that did not yield high abundances or richness, with 81 cells being within sand substrate that was not productive. Remaining survey cells (12) in the highly diverse (16 species) mussel bed habitat suggest that there may be remaining species within this assemblage that were not found during survey operations mentioned in this report. All indications suggest that the Central Corridor contains better mussel habitat, and therefore the higher probability of hosting a federally endangered species that went undetected during this survey.

CHAPTER 6 – LITERATURE CITED

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APPENDIX A – SURVEY FIGURES

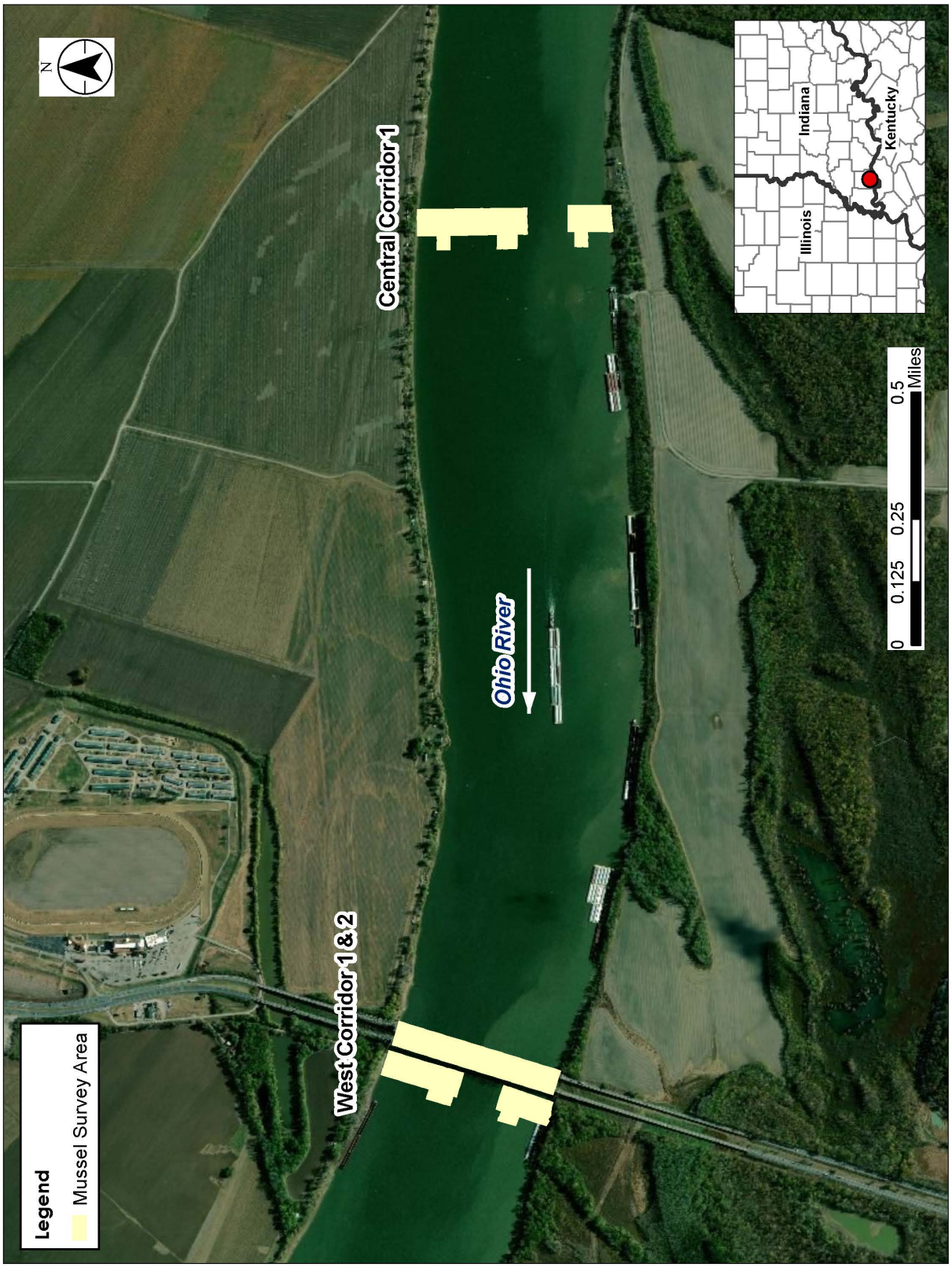


Figure A-1. Survey Area Overview

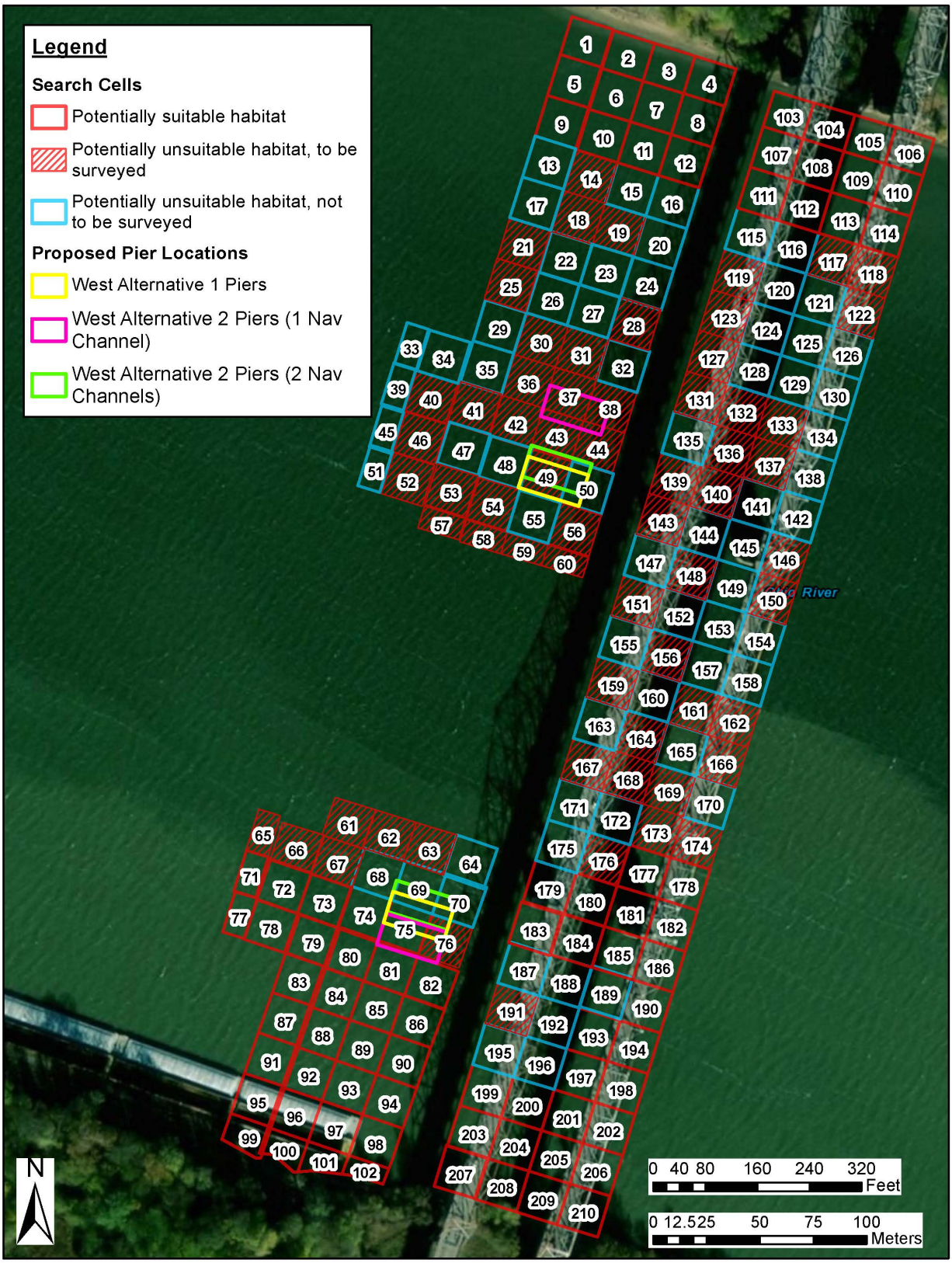


Figure A-2. West Corridor: Mussel Survey Plan

Appendix A

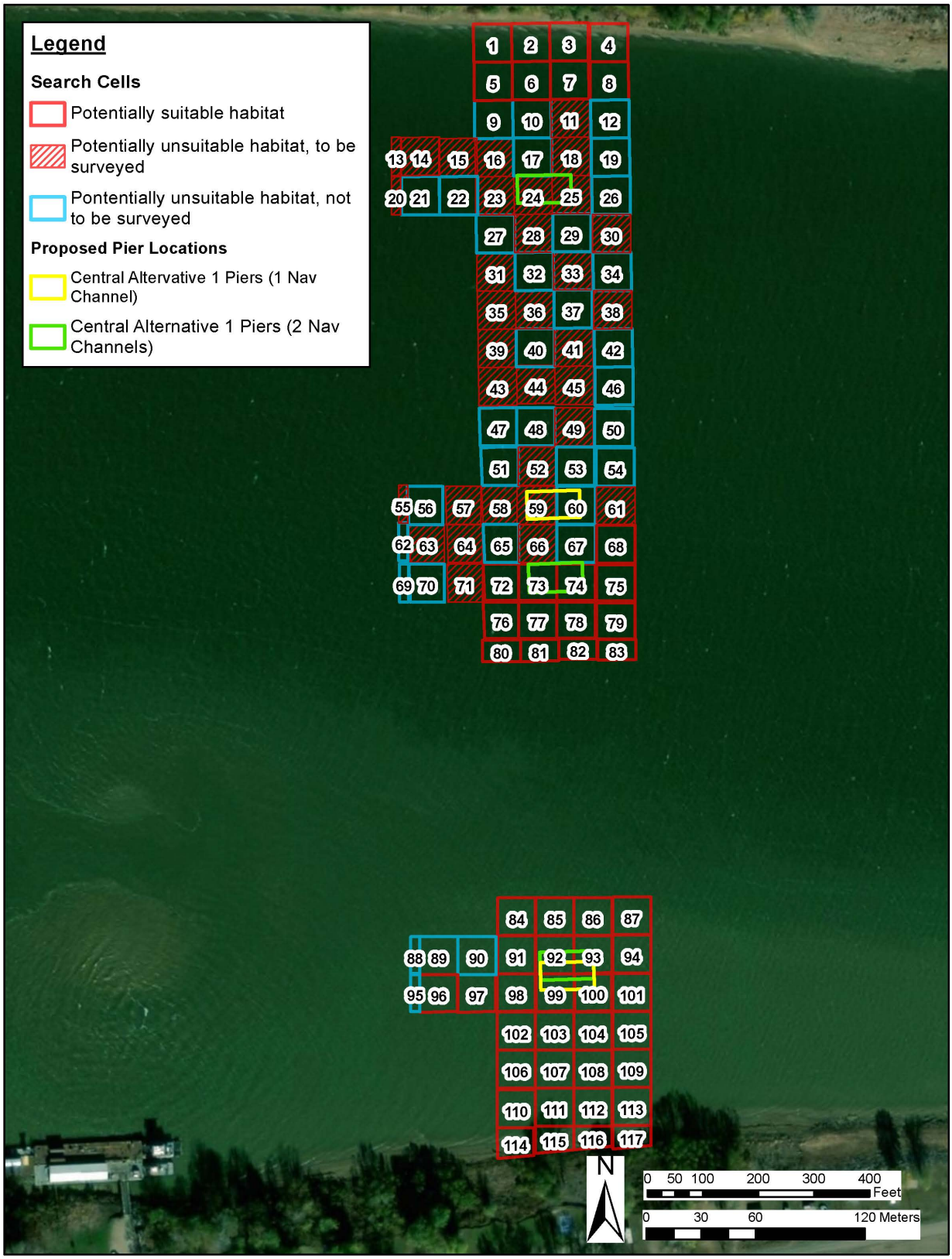


Figure A-3. Central Corridor: Mussel Survey Plan

Appendix A

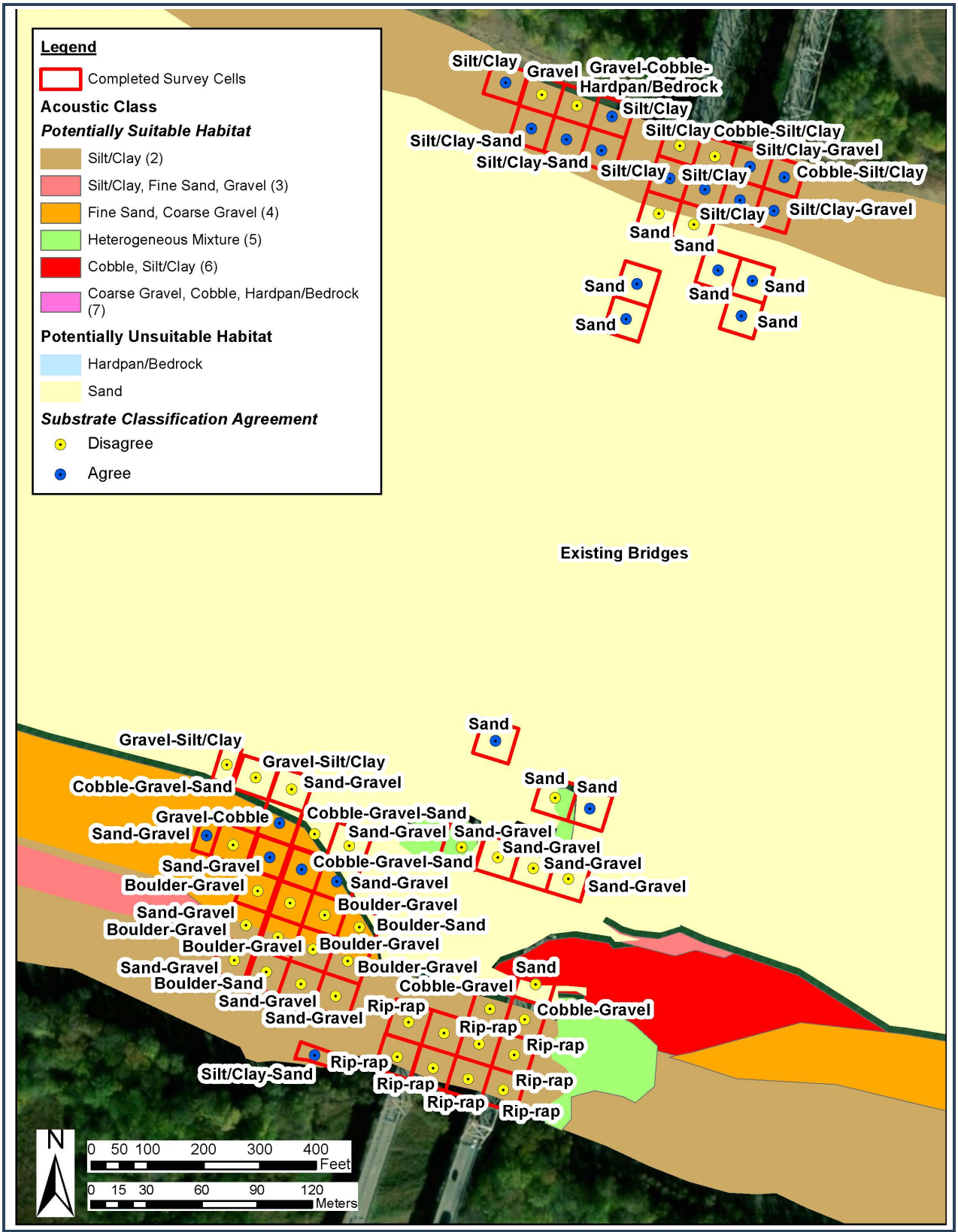


Figure A-4. West Corridor: Acoustic vs. Field-realized Substrate Classes

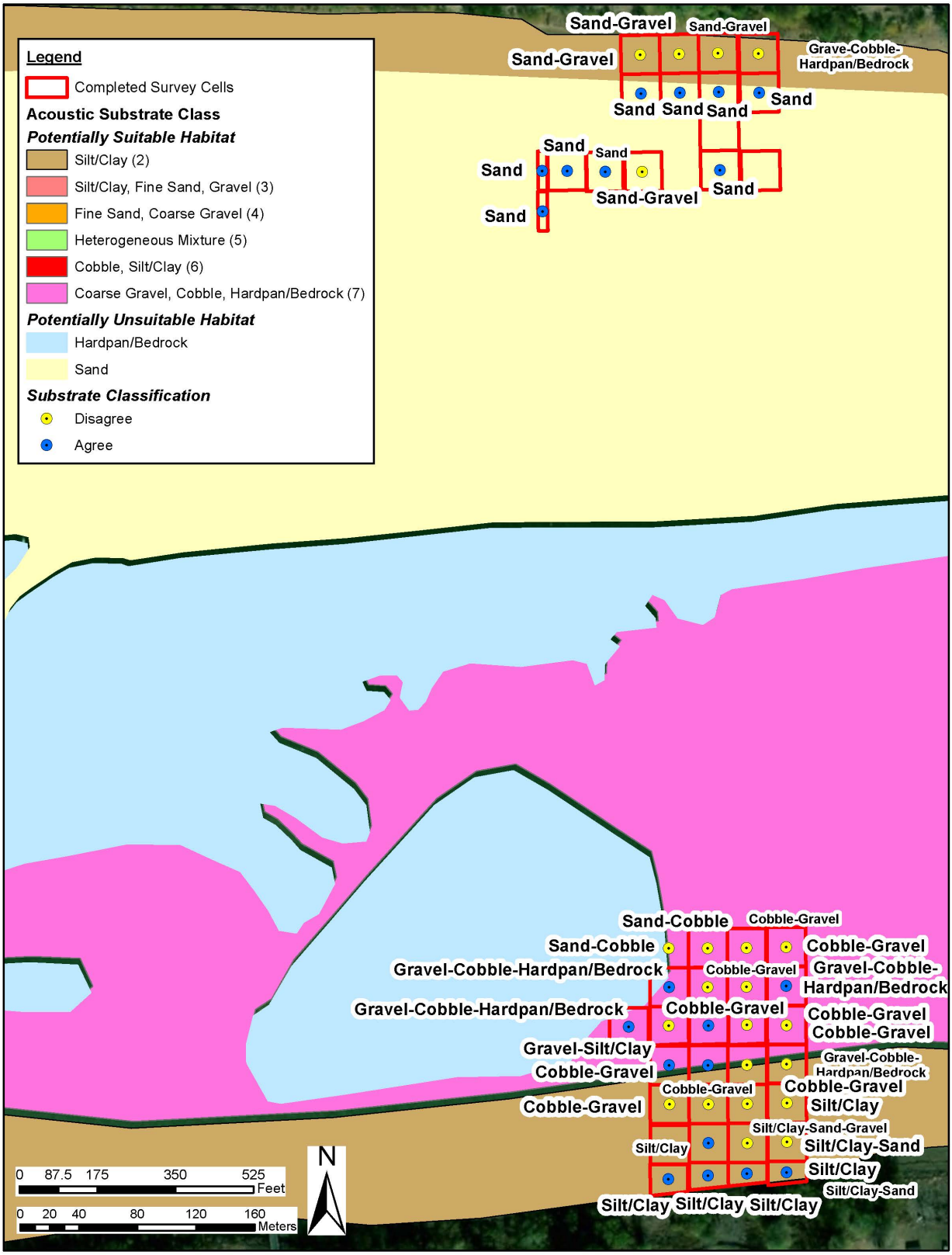
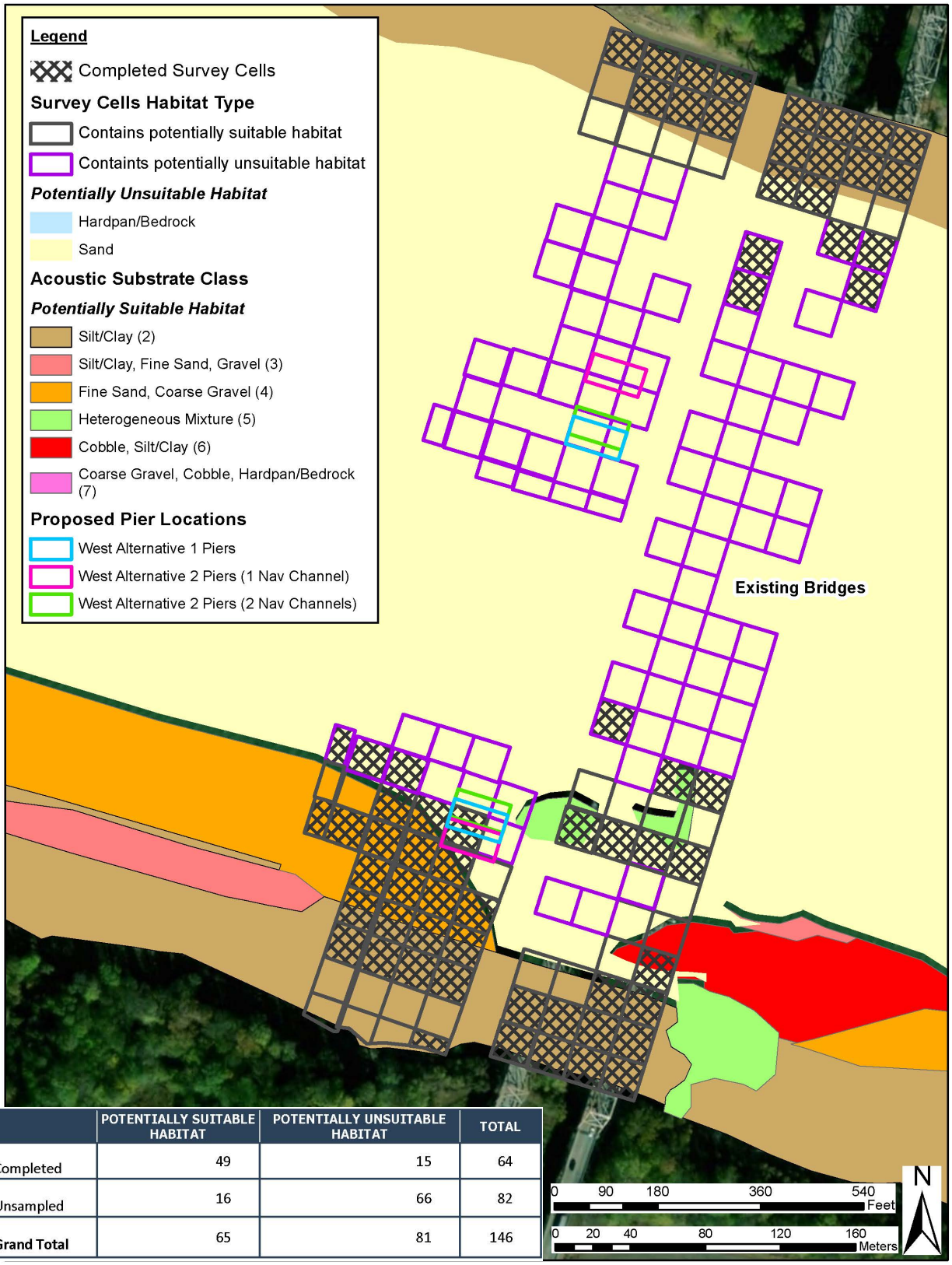
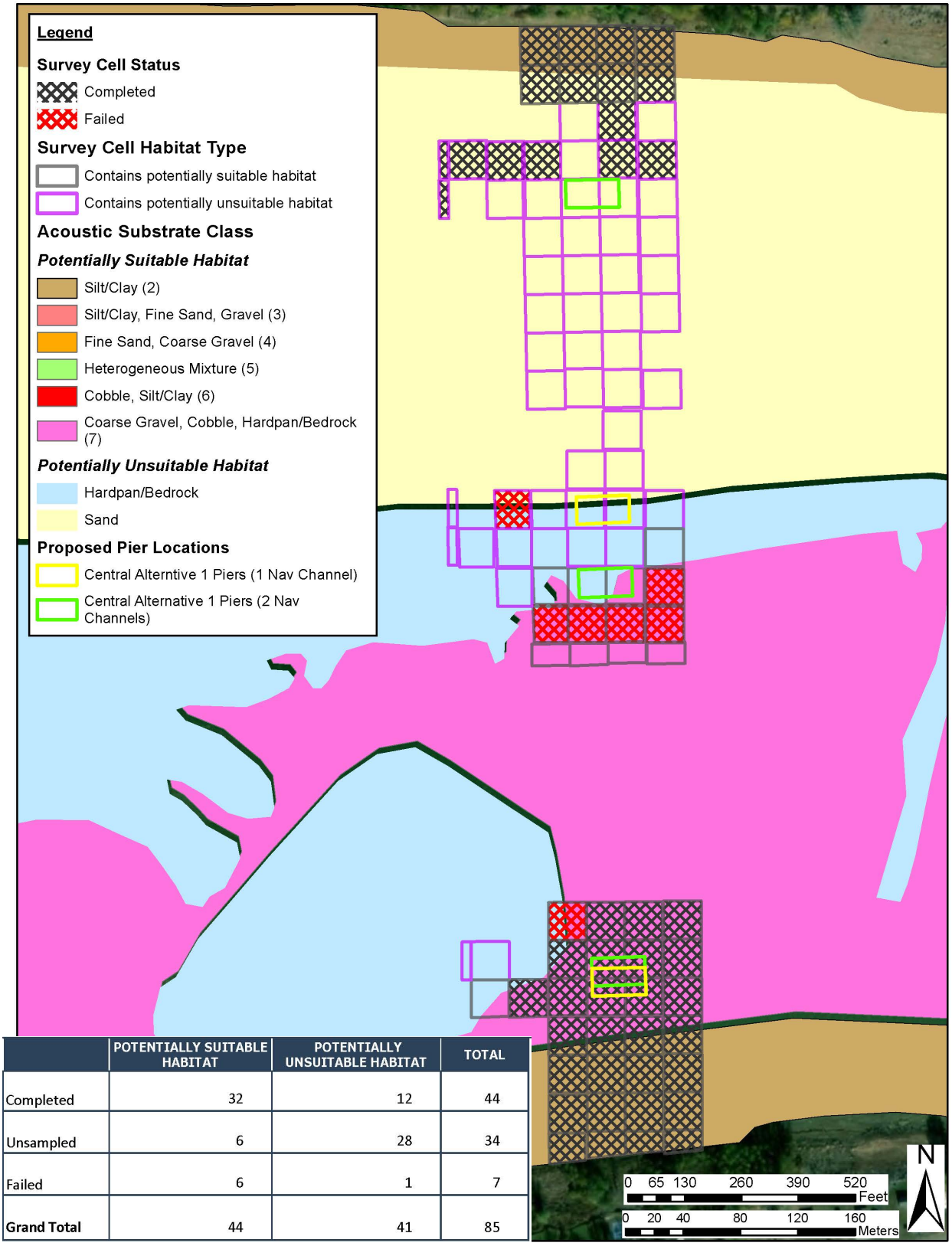


Figure A-5. Central Corridor: Acoustic vs. Field-realized Substrate Classes



	POTENTIALLY SUITABLE HABITAT	POTENTIALLY UNSUITABLE HABITAT	TOTAL
Completed	49	15	64
Unsampled	16	66	82
Grand Total	65	81	146

Figure A-6. West Corridor: Survey Cell Completion



	POTENTIALLY SUITABLE HABITAT	POTENTIALLY UNSUITABLE HABITAT	TOTAL
Completed	32	12	44
Unsampled	6	28	34
Failed	6	1	7
Grand Total	44	41	85

Figure A-7. Central Corridor: Survey Cell Completion

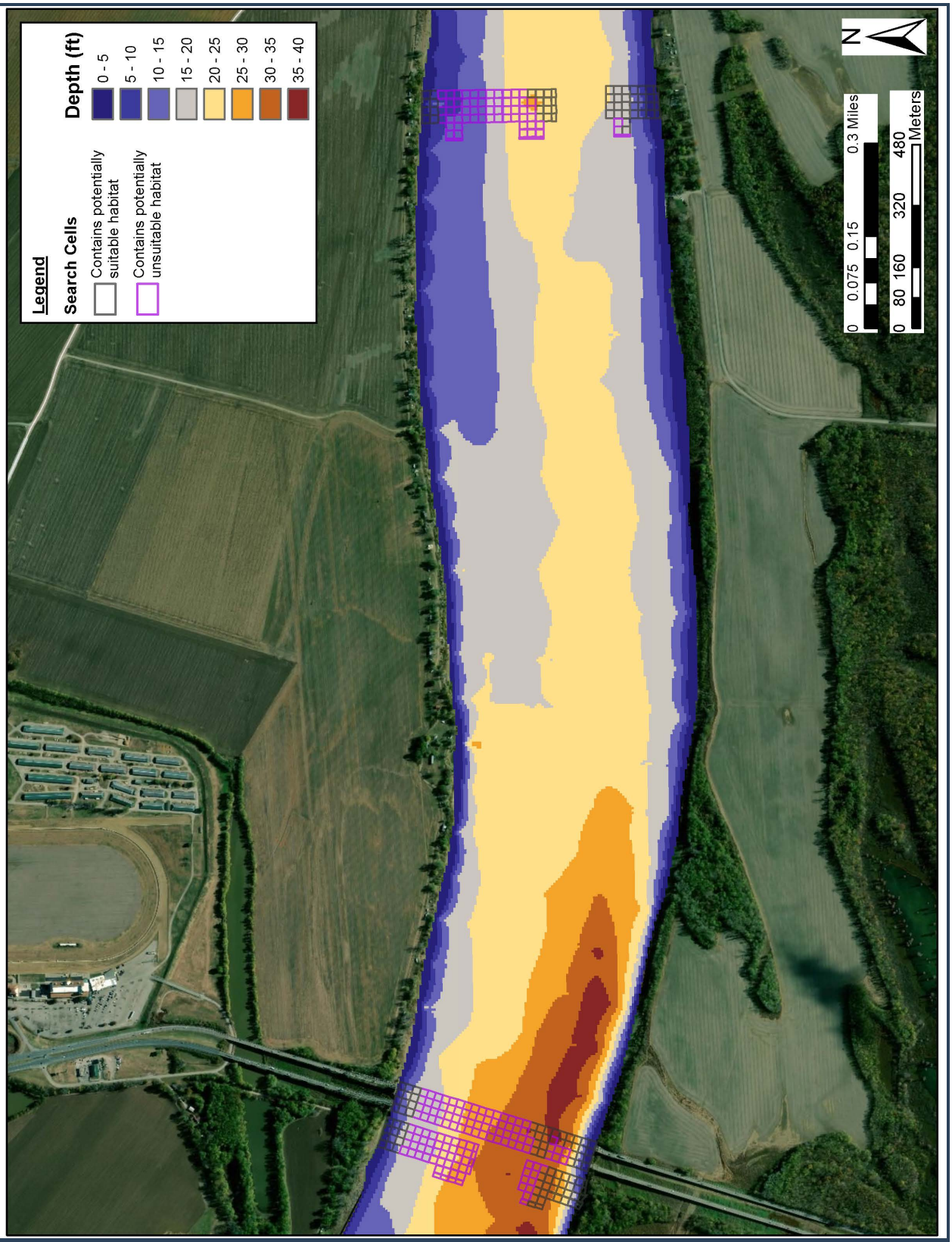


Figure A-8. Bathymetry Map

Appendix A

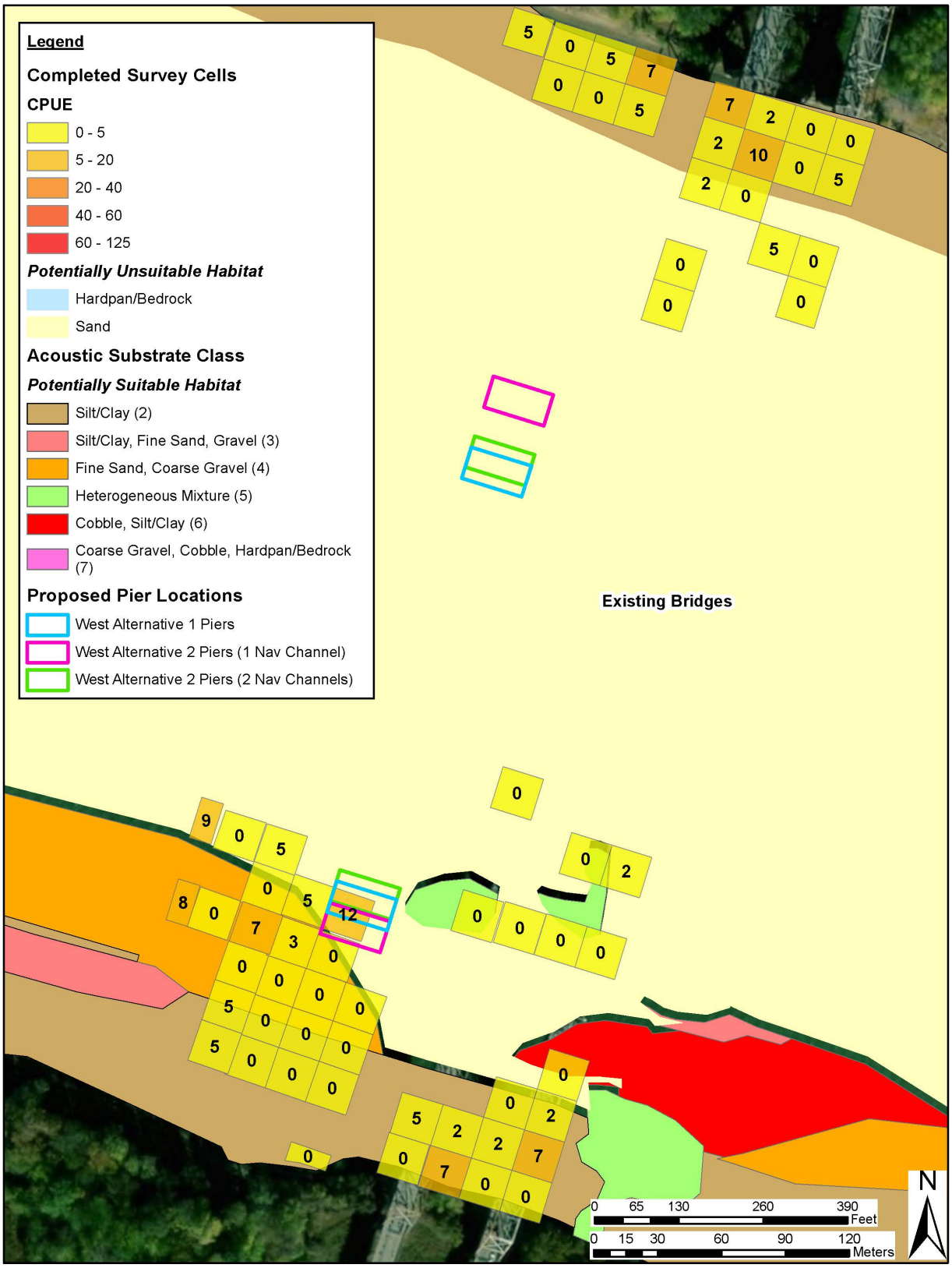


Figure A-9. West Corridor: Catch per Unit Effort

Appendix A

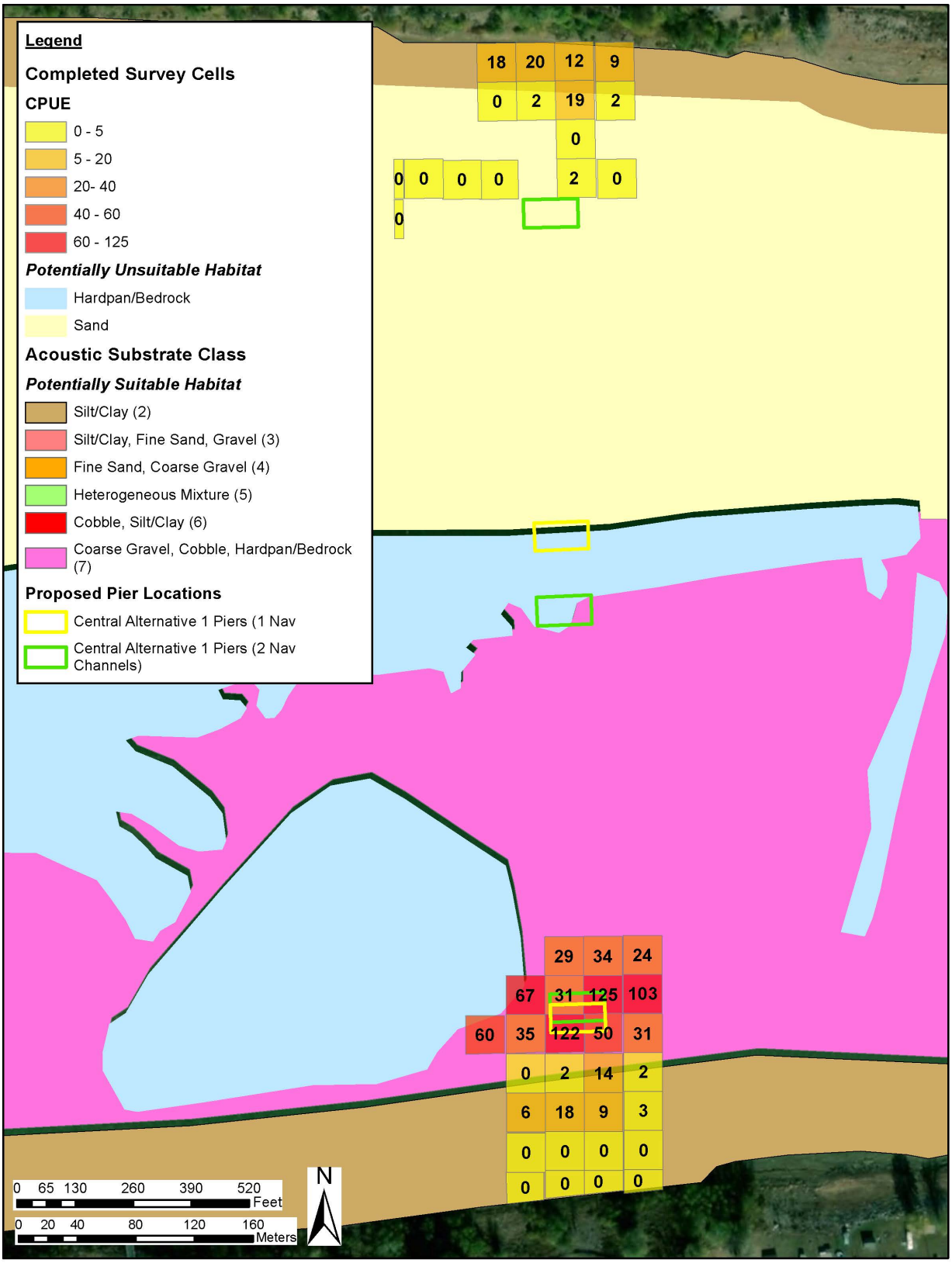


Figure A-10. Central Corridor: Catch per Unit Effort

Appendix A

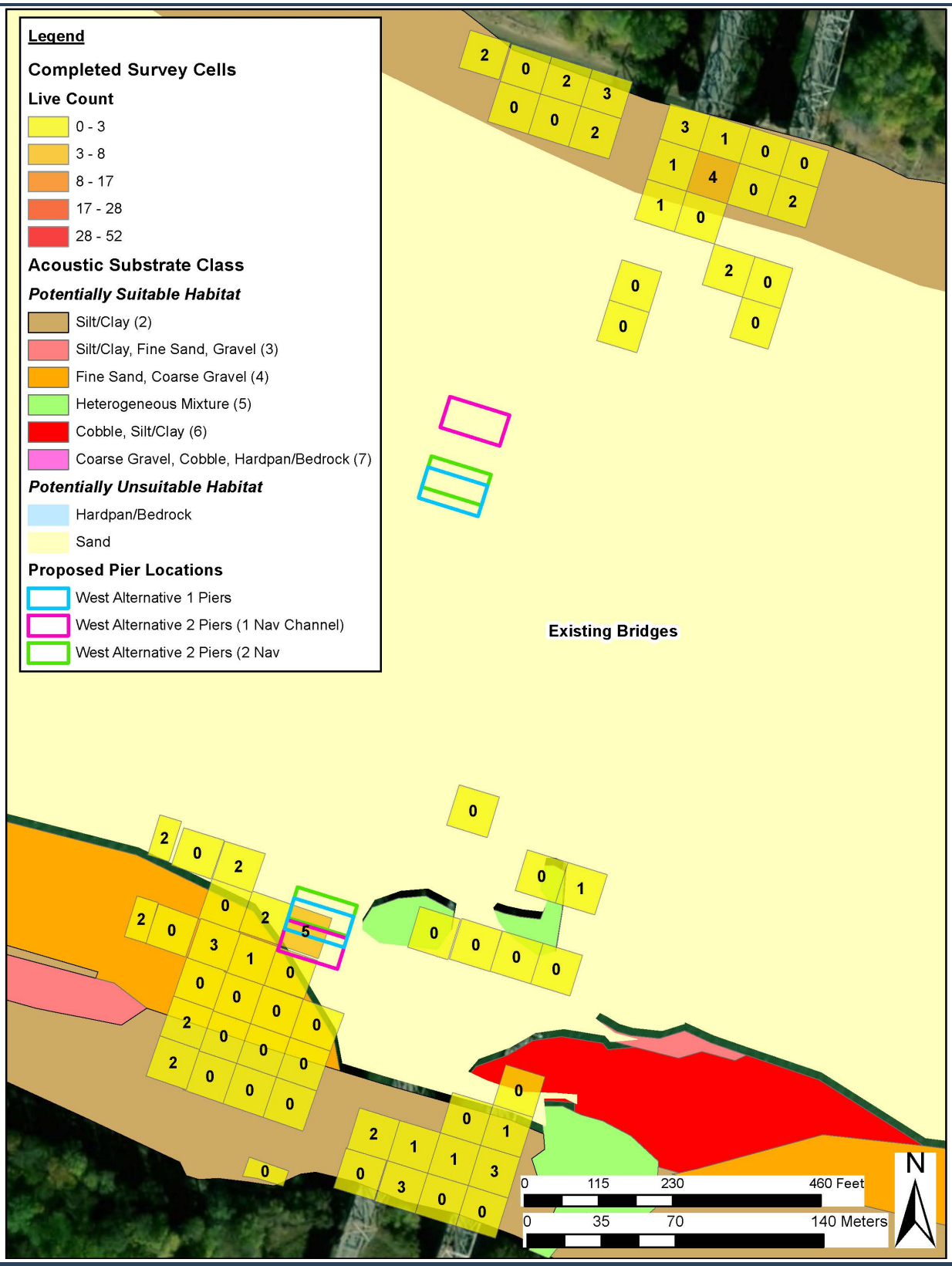


Figure A-11. West Corridor: Live Mussel Counts

Appendix A

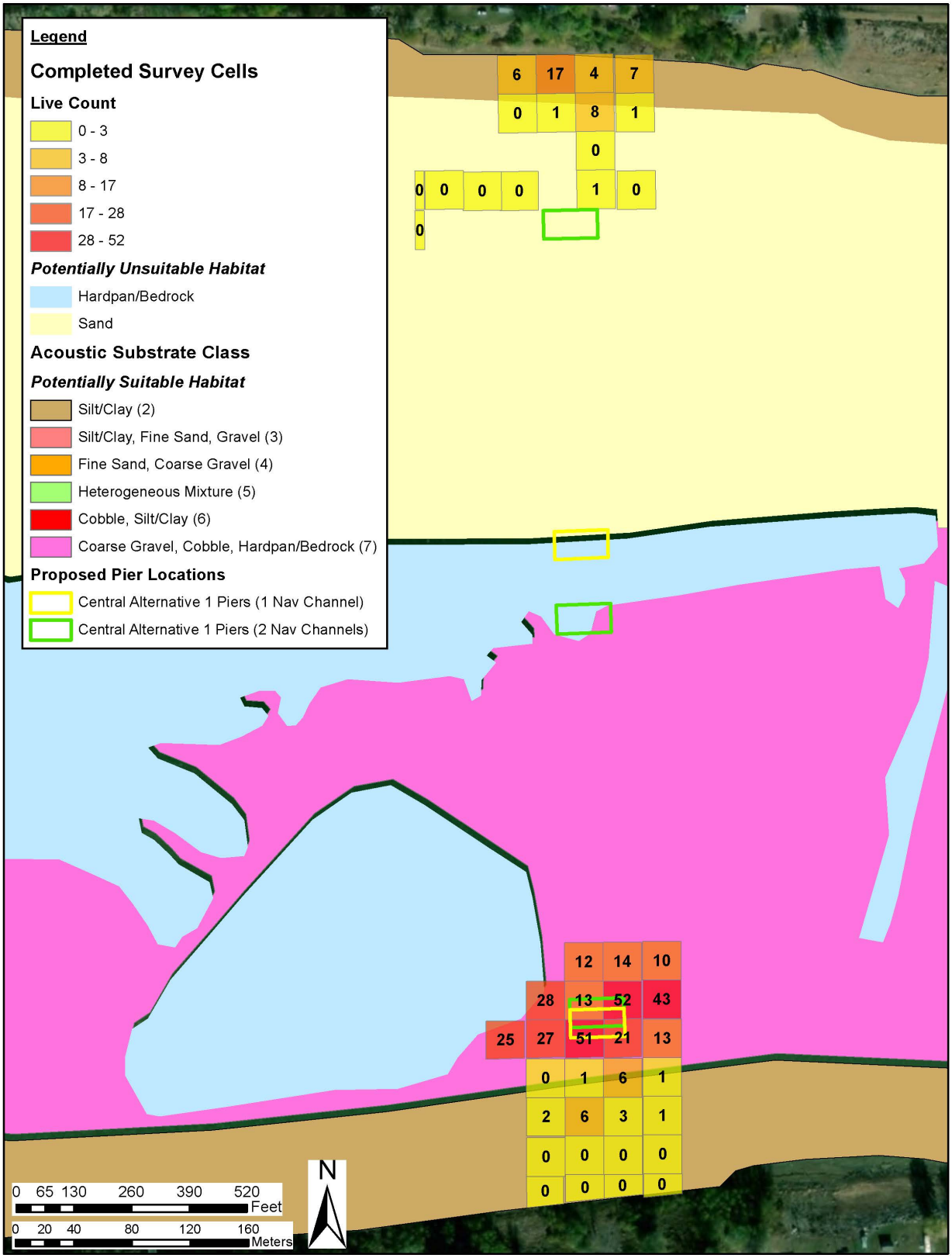


Figure A-12. Central Corridor: Live Mussel Counts

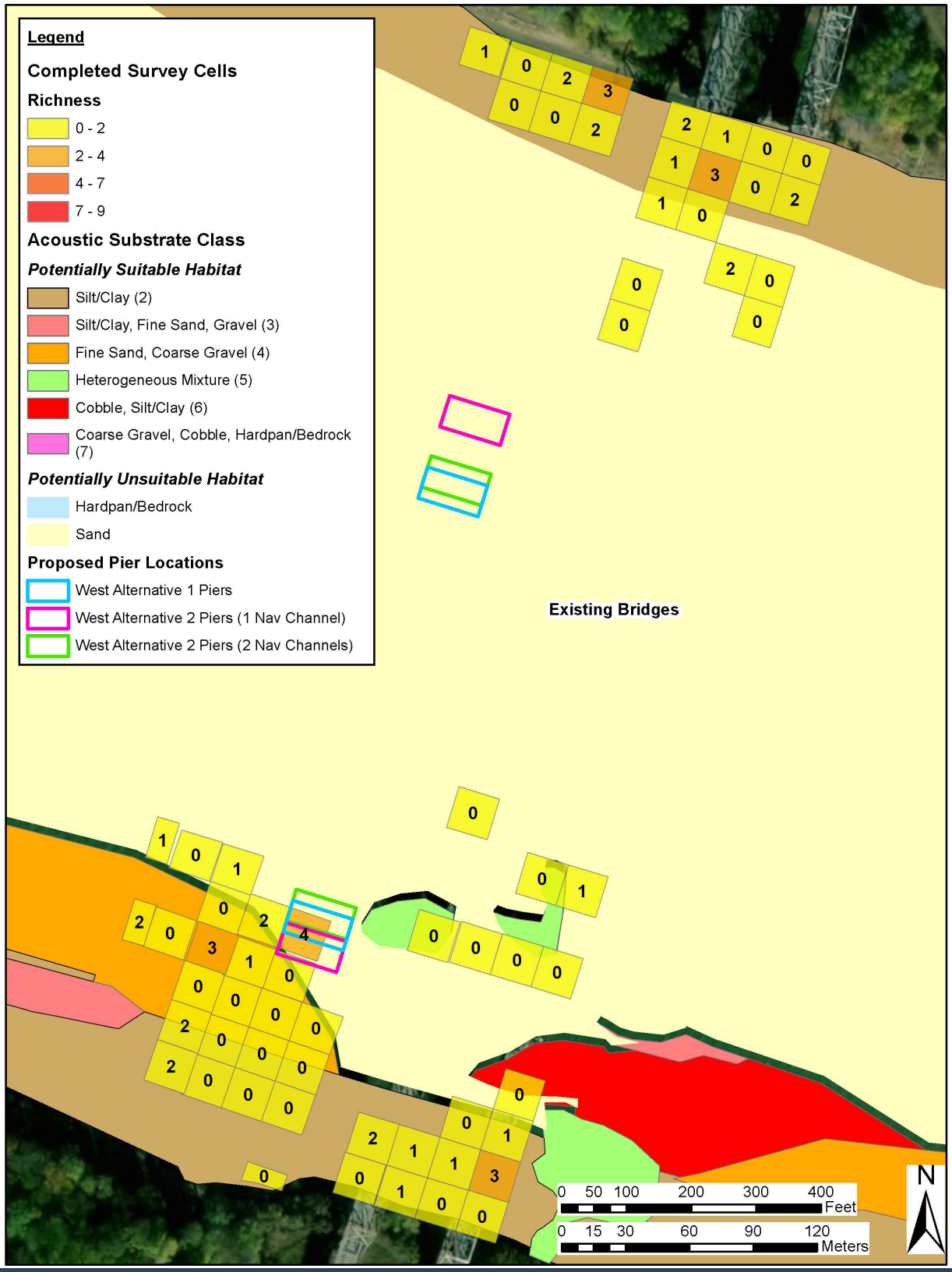


Figure A-13. West Corridor: Species Richness

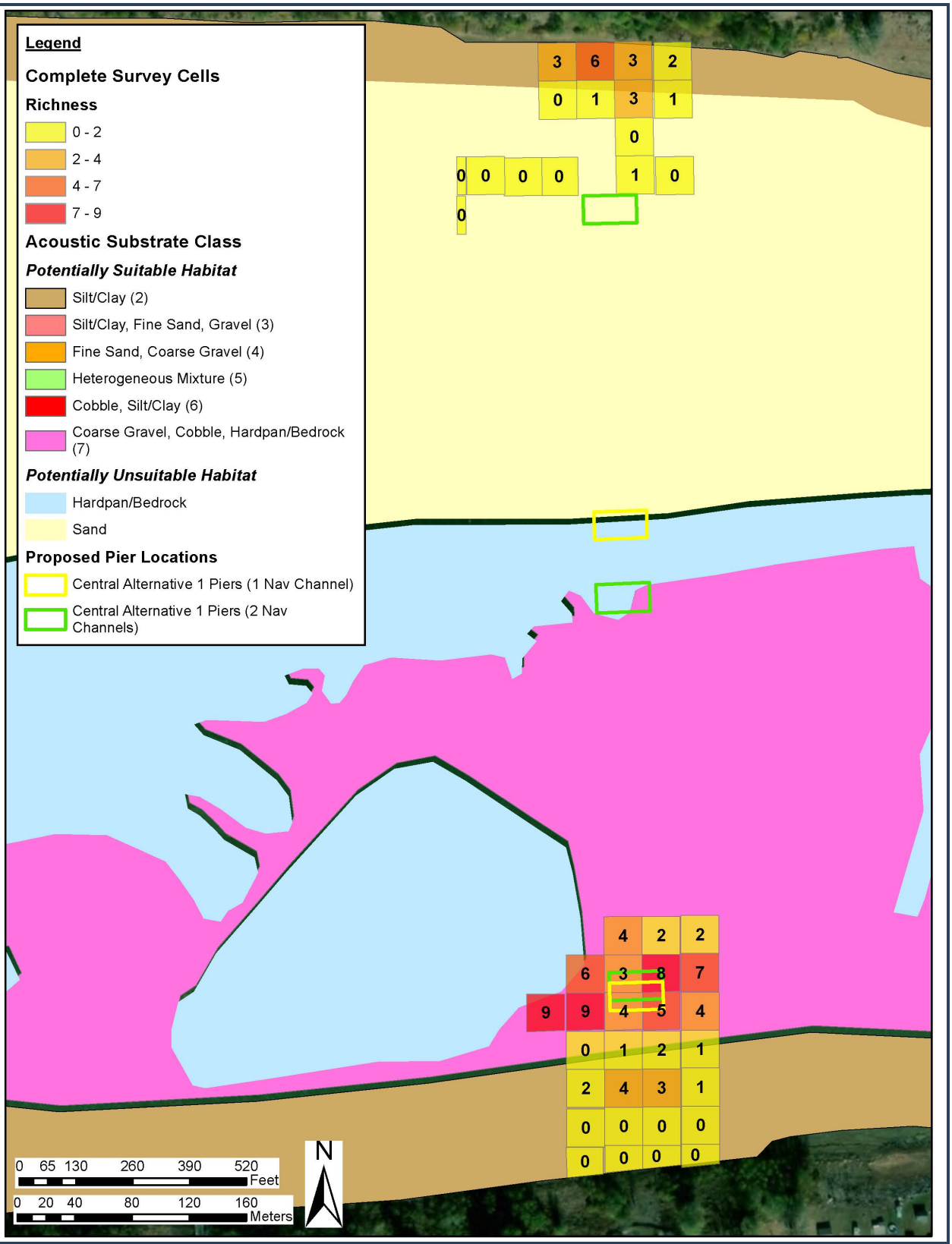


Figure A-14. Central Corridor: Species Richness

APPENDIX B – AGENCY CORRESPONDENCE

Meeting Minutes I-69 ORX Section 7 Meeting
September 2017

MEETING SUMMARY

Date: **September 11, 2017**

Time: **10:00 AM ET**

Meeting: **I-69 ORX Section 7 Meeting; Mussel Survey Approach**

Location: **Kentucky Transportation Cabinet; 200 Mero Street, Frankfort, KY 40622**

List of Attendees:

Name	Organization	Email
Dan Miller	Parsons	Daniel.J.Miller@parsons.com
Nancy Allen	Stantec	nancy.allen@stantec.com
Lee Andrews	U.S. Fish and Wildlife Service	Lee_Andrews@fws.gov
James Kiser	Stantec	James.Kiser@stantec.com
Leroy Koch	U.S. Fish and Wildlife Service	Leroy_Koch@fws.gov
Dave Harmon	KYTC/DEA	Dave.Harmon@ky.gov
Phil Degarmo	U.S. Fish and Wildlife Service	Phil_DeGarmo@fws.gov
Tim Foreman	KYTC	Tim.Foreman@ky.gov
Nathan Click	KYTC	nathan.click@ky.gov
Dan Prevost	Parsons	Daniel.Prevost@parsons.com
Eric Rothermal	FHWA	Eric.Rothermel@dot.gov
David Waldner	KYTC	David.Waldner@ky.gov

SUMMARY

1) Dave Waldner discussed the purpose of the meeting: To determine whether the benefits of getting mussel/habitat work done this fall outweigh the benefits of waiting and doing all of the work next year.

2) Dan Prevost, Parsons' Environmental Lead for the I-69 Ohio River Crossing (ORX) Project, gave an overview of the project:
   - The project started with five corridors (alternatives), and has been narrowed down to three (both eastern corridors have been eliminated).
   - Regarding the crossing of the Ohio, both west corridors are identical; immediately adjacent to the current US 41 bridges.

- Central Corridor 1 is approximately 1.5 miles upstream, and must occur in-between two existing interchanges, limiting the potential study area. Utilities, a state forest, TV tower, and an Imperiled Bat Conservation Fund (IBCF) property also limit where the bridge can potentially be placed.

3) Phil DeGarmo, U.S. Fish and Wildlife Service (USFWS) asked what was currently proposed for the existing bridges. Dan Prevost stated:
   - The bridges are approximately 80 and 50 years old, and are currently not in great condition.
   - All options are currently on the table and will be evaluated as part of the environmental process.
     - If the west corridor is built, both existing bridges may potentially be eliminated.
     - If the central corridor is built, options for keeping both, one, or none of the existing bridges will be evaluated.
   - The new bridge will potentially be tolled. This may affect the existing bridges.
     - Traffic access may potentially be limited.
     - The existing bridges may potentially be tolled.

   Phil DeGarmo, USFWS, stated that for the purpose of this meeting, the "worst-case" scenario (removing both bridges) would be assumed. Therefore, mussel surveys will be conducted at two locations; Central Corridor 1 and at the crossing for both West Corridors (at the existing bridges and potential new crossing).

4) Dan Prevost gave an overview of the project schedule.
   - The draft environmental impact statement (DEIS) is scheduled to be completed in the fall of 2018. The DEIS will identify the Preferred Alternative.
   - A combined final environmental impact statement (FEIS)/record of decision (ROD) is scheduled to be completed in the fall of 2019.

5) Phil DeGarmo stated that, until the results of the FEIS are finalized, USFWS will assume an impact on the West Corridors. Nathan Click, KYTC, clarified that it will be an assumed habitat impact, due to the known presence of mussels in the Green River and within this stretch of the Ohio, and the likelihood that suitable habitat is present. James Kiser, Stantec, noted that habitat around the existing piers has likely been reduced due to scour.

6) Lee Andrews, USFWS, noted that:
   - The survey area is relatively small.

- Data collected won't change whether it is collected this year or next.
- Collecting data this year provides the benefit of additional time to react to what is found and figuring out solutions.

7) Phil DeGarmo discussed the side-scan sonar, and asked if it could be done within the same season as the official survey. He also asked if there were benefits to doing only the side-scan survey this season (without field verification), and doing all of field work next year.
   - James Kiser replied that, yes, it could be done in the same season. However, doing the side-scan sonar without field verification limits the accuracy and value of the sonar data.
   - Leroy Koch, USFWS, stated that doing the side-scan sonar without field verification would provide information on scour and stability. He noted that, whenever it is done, the data would be valid for a few years, and advised that it be done when it best fit into the project needs.

8) Dan Prevost asked if the side-scan sonar survey and field follow-up could eliminate the need for a formal survey.
   - Leroy Koch stated that it would not likely eliminate the need for the formal survey, but could significantly reduce the area of investigation. He also clarified that the side-scan sonar would require field verification, whether it is done this year or the following.

9) James Kiser noted that there is only likely 1.5 months remaining of safe dive time this year, if it is decided to do the side-scan sonar and field follow-up this year. He also noted that if Hurricane Irma brings a substantial amount of rain, the remaining field season could be affected/eliminated.

10) The project team and USFWS further discussed the different benefits between the side-scan sonar and field follow-up being conducted this year and the next.
   - Leroy Koch reiterated that there is likely habitat present where sensitive species could occur. Particularly the Fat Pocketbook, (*Potamilus capax*), which prefers soft sediment/sand that is relatively stable. His opinion was that doing the side-scan survey this year would benefit next year's survey. He also noted that a quick "drop down" follow-up by divers would help provide a lot of useful information.
   - Phil DeGarmo stated that the benefit would be saving time and reducing the level of effort on the following year's investigation. He reiterated that both surveys could be done back to back next year.

- Tim Foreman, KYTC, stated that it comes down to risk/reward. He noted that the data must be collected at some point, and that doing it this year will have time savings and not force the project team to schedule two dive surveys within one season.
- James Kiser stated that collecting the data this year also helps with the DEIS being prepared for the project by allowing the project team to better compare both alternatives and their potential impacts to endangered or threatened mussel species.

11) Nathan Click asked, if the side-scan sonar was done this year for both alternatives, and the preferred alternative is chosen before the formal survey, could the formal survey be done for just the preferred alternative?
    - Dan Prevost noted that by the time the preferred alternative is chosen, the project team will know:
        - What will happen with the existing bridges.
        - What type of new bridges will be built.
        - The location of the piers (the number of piers on the Central Corridor will depend on the # of spans used).
    - Leroy Koch noted that it would be very beneficial to have the follow-up surveys done with the side-scan sonar. Divers could take buckets of existing sediment and get photos (the project team was referred to a recent study done in Ohio).

12) David Waldner asked for clarification on if there was value to doing the side-scan sonar without verification now, and whether the side-scan survey alone could help reduce the area of investigations required for the formal survey.
    - Leroy Koch noted that by doing a side-scan survey without field testing, potential errors (or wrong assumptions) or difficult sediments, such as mixtures of sand and gravel, etc., could not be corrected or verified.
    - Lee Andrews noted that it could still be clarified at a later date, as the data from the side-scan sonar would still be valid.
    - Dave Waldner noted that by waiting, the project team would know the location of the piers and the decision on what is to happen to the existing bridges.

13) Dave Waldner asked, if the project team did the side-scan sonar and follow-up field work now, would it definitely eliminate transects?
    - Leroy Koch and Lee Andrews both noted that they could not definitely

promise less transects before the data is known.

14) James Kiser asked whether or not dredging would definitely be required for the removal of the existing bridges.
    - Lee Andrews noted that side-scan sonar would let you know how deep you are, and help plan out what methods may be required.
    - Phil DeGarmo stated that not everything can be foreseen, such as barge staging requirements, etc.
    - Dave Harmon, KYTC/DEA, noted that the side-scan survey would provide information on habitat needed for permitting.

15) After these discussions, Phil DeGarmo suggested that side-scan sonar and field verification be conducted this year, due to the benefits and the likelihood that it could help direct and refine recommendations throughout the process.

16) Dave Waldner asked for clarification on the proposal for the work to be done.
    - Dan Prevost stated that cost proposals have already been received for the side-scan sonar work.
    - James Kiser noted that the level of effort needed to be clarified to be able to put together the proposal for the follow-up field work.
        - Leroy Koch stated that the follow-up is not a full mussel survey, but just a quick check identifying substrate with minimal work done if any mussels are found. He noted that the survey would provide a quick quality assurance to the side-scan sonar. He reiterated that the follow-up checks are necessary to get more useful information such as percent substrate, and again noted the example from another location on the Ohio River as a template.
    - Tim Foreman stated that the work done this year needs to cover demolition impacts and the farthest reach of construction impacts.
    - Dave Waldner concurred, and asked for clarifications on a conservative survey area to ensure additional work would not be required later in the process.
    - Phil DeGarmo stated that side-scan sonar will help USFWS define the reach of construction impacts. He noted that if there is a minor change in limits, it should not have a substantial effect as the information collected will also provide information on what should be further upstream.
    - Leroy Koch and Phil DeGarmo determined that the project team should survey 300 meters downstream and 100 meters upstream of the areas of impact for the side-scan sonar. hey noted that this has been used on other large bridge surveys.

17) Dan Prevost asked whether the side-scan survey results may help determine/affect the demolition options on the existing bridges, and whether there could potentially be information collected this year that would drive the project team to a certain alternative.
    - Phil DeGarmo stated that the level of impacts can be substantially different depending on how a bridge is dismantled, etc. He noted that knowing the substrate type could help determine recommendations for how the work will be done. The level of impacts would be defined by what is found in the surveys.

18) James Kiser noted that, historically, if a project finds a decent concentration of mussels, USFWS typically assumes that endangered species known within the area will be present and considered impacted.
    - Leroy Koch confirmed that USFWS would assume listed species are present if such populations were found. He stated that if mussel populations are present, USFWS would want to see assemblages. From current known information, this is not likely. USFWS would want to know the number of Fat Pocketbook identified. Also, if the project team found more riverine assemblages, more work may be required.
    - Phil DeGarmo stated that, although the listed species were assumed, the impact would be more defined (much smaller than the entire reach).

19) Lee Andrews stated that due to the presence of the Green River, the sediment that it brings into the area, and the known species within the area, there is likely habitat present within the project area.

20) Nathan Click asked for a consensus that the side-scan survey and field follow-up will be conducted this year, and a full survey will occur next year within defined areas within the preferred alternative. This was agreed upon by everyone present.

CONCLUSIONS

1) A side-scan survey and field follow-up will be conducted this year, and a full survey will occur next year within defined areas within the preferred alternative.

2) The project team will survey 300 meters downstream and 100 meters upstream of the areas of impact for the side-scan sonar.

3) A report will be prepared detailing the information found.

Meeting Minutes Mussel Survey Work Plan Discussion
July 2018

MEETING SUMMARY

Date: July 16, 2018

Time: 2:00 PM ET

Meeting: Mussel survey Work Plan Discussion for KYTC #2-1088; I-69 Henderson, Ohio River Bridge

Location: Kentucky Transportation Cabinet; 200 Mero Street, Frankfort, KY 40622

List of Attendees:

Name	Organization	Email
Dan Miller	Parsons	Daniel.J.Miller@parsons.com
Dillon McNulty	Stantec	dillon.mcnulty@stantec.com
Marshall Carrier		
Cody Fleece	Stantec	cody.fleece@stantec.com
Leroy Koch	U.S. Fish and Wildlife Service	Leroy_Koch@fws.gov
Dave Harmon	KYTC/DEA	Dave.Harmon@ky.gov
Phil DeGarmo	U.S. Fish and Wildlife Service	Phil_DeGarmo@fws.gov
Tim Foreman	KYTC	Tim.Foreman@ky.gov
Nathan Click	KYTC	nathan.click@ky.gov
Dan Prevost	Parsons	Daniel.Prevost@parsons.com
Eric Rothermal	FHWA	Eric.Rothermel@dot.gov
Kristy Todd		
Steve Nicaise		
Laura Hilden?		

SUMMARY

1) Dan Prevost provided an overview of DEIS and project schedule.
2) Phil DeGarmo asked for clarification regarding schedule with respect to Section 7 Consultation. Reminded group that consultation must be complete before issuance of permit.
3) Dan Prevost explained that Section 7 would be completed before the combined FEIS/ROD (estimated November 2019). The Section 404 permit would be applied for after the ROD.

4) Cody Fleece provided an overview of the proposed study plan (see attachment 1).
5) Laura Hilden: Asked about USFWS determination if no listed mussels were located during the survey.
6) Phil DeGarmo: This survey was a likelihood of presence survey given that not every mussel in the disturbance area will be collected. USFWS would make a determination based on the quality of the beds present and types of species identified as to whether listed mussels are likely present.
7) Phil DeGarmo: Had questions about how piers would be constructed and whether the current buffers would be sufficient to account for construction disturbance.
8) Steve Nicaise: Piers will be installed in similar manner to those constructed for Louisville bridges. Contractor will build the pier cap inside a temporary form and use drilled shafts. Would not use a coffer dam.
9) Leroy Koch: The survey area should cover all of the disturbance footprint and the buffer size should be large enough to cover scour, hydraulic alteration, temporary piers, etc.
10) There was a discussion on pier alignment and the DB's flexibility/constraints
11) Dan Prevost explained that theplacement of piers for the navigation span(s) will be relatively inflexible based on feedback from the US Coast Guard. The contractor will have very limited ability to modify. Because the bridge type has not been determined, the spacing of approach spans has not been determined. Therefore, with the exception of the area immediately behind the navigation span piers, the location of approach piers is not known and the entire area should be treated as potential area of impact.
12) Dan Prevost: It is assumed that removal of the existing bridge(s) would be accomplished via implosion, dropping the bridge into the river and then removing it.
13) Steve Nicaise: We would anticipate that the contractor would utilize existing barge facilities in the area rather than construct new. No causeways are anticipated.
14) Phil DeGarmo asked if buffer would be sufficient to cover the teardrop effect resulting from new flow patterns.
15) Leroy Koch: if the piers are placed in "unsuitable" habitat USFWS probably wouldn't require relocation.
16) Phil DeGarmo: it is important to remember that if contractor works outside of survey area it could require re-initiation of consultation.
17) Phil DeGarmo: USFWS is open to allowing survey crews to terminate survey if habitat in cells is clearly unsuitable.
18) Leroy Koch: If high density beds are present (e.g., 10 – 12 species present), would like to see extra survey effort.
19) Phil DeGarmo/Leroy Koch: Would like to see study plan amended to include 1) a

detail for the piers and 2) an analysis of scour patterns.

20) Steve Nicaise: Detail to be provided. Will share scour analysis performed for Louisville bridges as it is directly applicable the I-69 bridges.
21) Phil DeGarmo concurred that what was proposed should be enough to make an effects determination.
22) Leroy Koch: in general, the methods proposed appeared to be sufficient.

CONCLUSIONS

Parsons will provide USFWS a pier detail.

Parson will provide USFWS with the bridge scour analysis performed for Louisville bridges.

USFWS will provide preliminary comment on the proposed study plan.

Stantec will revise study plan to incorporate 1) extra effort if high density beds detected, 2) flexibility to terminate survey in a cell if habitat is clearly unsuitable.

Stantec will enlarge search areas in the vicinity of piers if the results of the scour analysis indicate current disturbance area is not adequate.

APPENDIX C – MUSSEL SPECIES VOUCHER PHOTOS

Threeridge (*Amblema plicata)*

Wartyback (*Cyclonaias nodulata*)

Pimpleback (*Cyclonaias pustulosa*)

Purple Wartyback (*Cyclonaias tuberculata*)

Appendix C

Elephant ear (*Elliptio crassidens*)

Butterfly (*Ellipsaria lineolata*)

Appendix C

Wabash Pigtoe (*Fusconia flava*)

Long-solid (*Fusconia subrotunda*)

Plain Pocketbook (*Lampsilis cardium*)

Fragile Papershell (*Leptodea fragilis*)

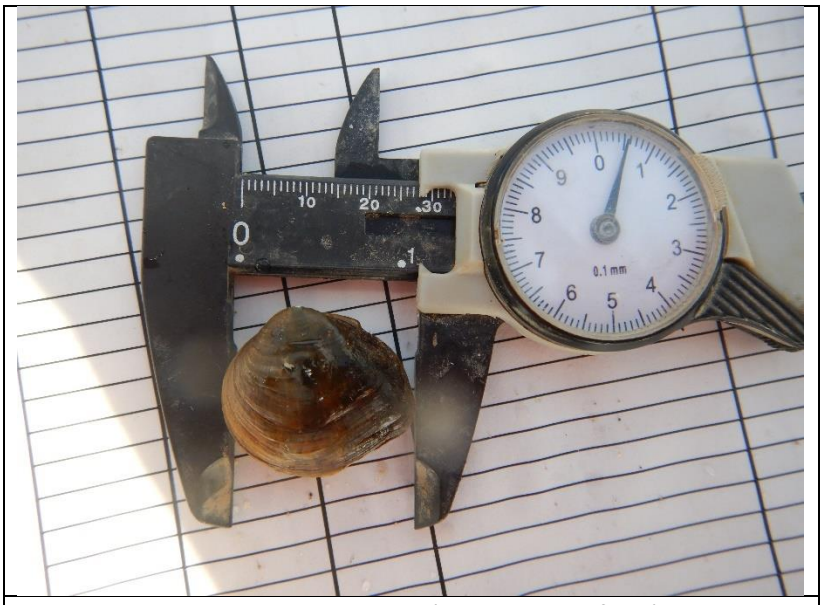
Black Sandshell (*Ligumia recta*)

Yellow Sandshell (*Lampsilis teres*)

Washboard (*Megalonaias nervosa*)

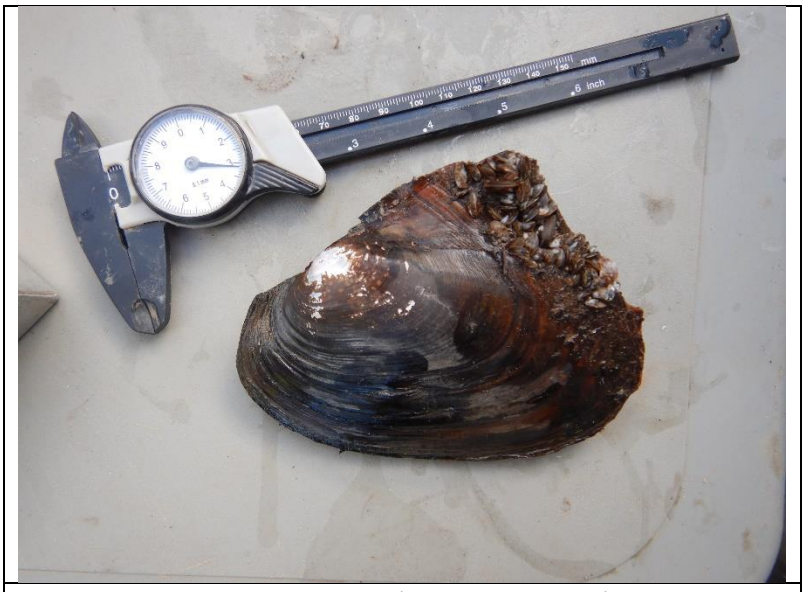
Hickorynut *(Obovaria olivaria*)

Appendix C



Threehorn Wartyback (*Obliquaria reflexa*)

Ohio Pigtoe (*Pleurobema cordatum*)



Pink Heelsplitter (*Potamilus alatus*)

Mapleleaf (*Quadrula quadrula*)

Ebonyshell (*Reginaias ebenus*)

Monkeyface (*Theliderma metanevra*)

Appendix C

APPENDIX D – SURVEY CELL SUBSTRATE DATA AND BIOTIC INDICES

Cell ID	Acoustic Substrate	Field-realized Substrate	CPUE	Diversity	Richness
WC-01	Silt/Clay	Silt/Clay	4.8	1	1
WC-02	Silt/Clay	Gravel			
WC-03	Silt/Clay	Gravel-Cobble-Hardpan/Bedrock	4.8	2	2
WC-04	Silt/Clay	Silt/Clay	7.2	3	3
WC-06	Silt/Clay	Silt/Clay-Sand	0		
WC-07	Silt/Clay	Silt/Clay-Sand	0		
WC-08	Silt/Clay	Silt/Clay	4.8	2	2
WC-57	Sand	Sand			
WC-65	Sand	Gravel-Silt/Clay	9.23	1	1
WC-66	Sand	Gravel-Silt/Clay	0		
WC-67	Sand	Sand-Gravel	4.8	1	1
WC-73	Fine sand, coarse gravel	Cobble-Gravel-Sand	0		
WC-74	Sand	Cobble-Gravel-Sand	5	2	2
WC-75	Sand	Sand-Gravel	11.54	3.57	4
WC-77	Fine sand, coarse gravel	Sand-Gravel	7.5	2	2
WC-78	Fine sand, coarse gravel	Gravel-Cobble	0		
WC-79	Fine sand, coarse gravel	Sand-Gravel	7.2	3	3
WC-80	Fine sand, coarse gravel	Cobble-Gravel-Sand	2.5	1	1
WC-81	Fine sand, coarse gravel	Sand-Gravel			
WC-83	Fine sand, coarse gravel	Boulder-Gravel	0		
WC-84	Fine sand, coarse gravel	Boulder-Gravel	0		
WC-85	Fine sand, coarse gravel	Boulder-Gravel	0		

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WC-86	Fine sand, coarse gravel	Boulder-Sand	0		
WC-87	Silt/Clay	Sand-Gravel	4.8	2	2
WC-88	Silt/Clay	Boulder-Gravel	0		
WC-89	Silt/Clay	Boulder-Gravel	0		
WC-90	Silt/Clay	Boulder-Gravel	0		
WC-91	Silt/Clay	Sand-Gravel	4.8	2	2
WC-92	Silt/Clay	Boulder-Sand	0		
WC-93	Silt/Clay	Sand-Gravel	0		
WC-94	Silt/Clay	Sand-Gravel	0		
WC-102	Silt/Clay	Silt/Clay-Sand	0		
WC-103	Silt/Clay	Cobble-Silt/Clay	7.2	1.8	2
WC-104	Silt/Clay	Cobble-Silt/Clay	2.4	1	1
WC-105	Silt/Clay	Silt/Clay-Gravel	0		
WC-106	Silt/Clay	Silt/Clay-Gravel	0		
WC-107	Silt/Clay	Silt/Clay	2.4	1	1
WC-108	Silt/Clay	Silt/Clay	9.6	2.67	3
WC-109	Silt/Clay	Silt/Clay	0		
WC-110	Silt/Clay	Silt/Clay	4.8	2	2
WC-111	Silt/Clay	Sand	2.4	1	1
WC-112	Silt/Clay	Sand	0		
WC-117	Sand	Sand	5.45	2	2
WC-118	Sand	Sand	0		
WC-119	Sand	Sand	0		
WC-122	Sand	Sand	0		
WC-123	Sand	Sand	0		
WC-171	Sand	Sand	0		
WC-177	Heterogenous mix	Sand	0		

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WC-178	Sand	Sand	2.4	1	1
WC-183	Heterogenous mix	Sand-Gravel	0		
WC-184	Sand	Sand-Gravel	0		
WC-185	Sand	Sand-Gravel	0		
WC-186	Sand	Sand-Gravel	0		
WC-198	Cobble, silt/clay	Sand	0		
WC-201	Silt/Clay	Cobble-Gravel	0		
WC-202	Silt/Clay	Cobble-Gravel	2.4	1	1
WC-203	Silt/Clay	Rip-rap	4.8	2	2
WC-204	Silt/Clay	Rip-rap	2.4	1	1
WC-205	Silt/Clay	Rip-rap	2.4	1	1
WC-206	Silt/Clay	Rip-rap	7.2	3	3
WC-207	Silt/Clay	Rip-rap	0		
WC-208	Silt/Clay	Rip-rap	7.2	1	1
WC-209	Silt/Clay	Rip-rap	0		
WC-210	Silt/Clay	Rip-rap	0		
CC- 01	Sand-Gravel	Silt/Clay	18	2	3
CC- 02	Sand-Gravel	Silt/Clay	20.4	3.321839	6
CC- 03	Sand-Gravel	Silt/Clay	12	2.666667	3
CC- 04	Gravel-Cobble-Hardpan/Bedrock	Silt/Clay	9.333333	1.324324	2
CC- 05	Sand	Sand	0		
CC- 06	Sand	Sand	2.4	1	1
CC- 07	Sand	Sand	19.2	2.909091	3
CC- 08	Sand	Sand	2.4	1	1
CC- 100	Cobble-Gravel	Coarse gravel, cobble, hardpan/bedrock	50.4	1.676806	5
CC- 101	Cobble-Gravel	Coarse gravel, cobble, hardpan/bedrock	31.2	1.942529	4

CC- 102	Gravel-Cobble-Hardpan/Bedrock	Coarse gravel, cobble, hardpan/bedrock	0		
CC- 103	Gravel-Cobble-Hardpan/Bedrock	Coarse gravel, cobble, hardpan/bedrock	2.222222	1	1
CC- 104	Cobble-Gravel-Sand	Silt/Clay	14.4	1.384615	2
CC- 105	Gravel-Cobble-Hardpan/Bedrock	Silt/Clay	2.4	1	1
CC- 106	Cobble-Gravel	Silt/Clay	6	2	2
CC- 107	Cobble-Gravel	Silt/Clay	18	3.6	4
CC- 108	Gravel-Cobble-Hardpan/Bedrock	Silt/Clay	9	3	3
CC- 109	Cobble-Gravel	Silt/Clay	3	1	1
CC- 11	Sand	Sand	0		
CC- 110	N/A	Silt/Clay	0		
CC- 111	Silt/Clay	Silt/Clay	0		
CC- 112	Silt/Clay-Sand-Gravel	Silt/Clay	0		
CC- 113	Silt/Clay-Sand	Silt/Clay	0		
CC- 114	Silt/Clay	Silt/Clay	0		
CC- 115	Silt/Clay	Silt/Clay	0		
CC- 116	Silt/Clay	Silt/Clay	0		
CC- 117	Silt/Clay	Silt/Clay	0		
CC- 13	Sand	Sand	0		
CC- 14	Sand	Sand	0		
CC- 15	Sand	Sand	0		
CC- 16	Sand-Gravel	Sand	0		
CC- 18	Sand	Sand	2.4	1	1
CC- 19	Sand	Sand	0		
CC- 20	Sand	Sand	0		
CC- 85	Sand-Cobble	Coarse gravel, cobble, hardpan/bedrock	28.8	1.714286	4

CC- 86	Cobble-Gravel	Coarse gravel, cobble, hardpan/bedrock	33.6	1.152941	2
CC- 87	Cobble-Gravel	Coarse gravel, cobble, hardpan/bedrock	24	1.219512	2
CC- 91	Gravel-Cobble-Hardpan/Bedrock	Coarse gravel, cobble, hardpan/bedrock	67.2	1.734513	6
CC- 92	Cobble-Gravel	Coarse gravel, cobble, hardpan/bedrock	31.2	1.373984	3
CC- 93	Cobble-Gravel	Coarse gravel, cobble, hardpan/bedrock	124.8	1.586854	8
CC- 94	Gravel-Cobble-Hardpan/Bedrock	Coarse gravel, cobble, hardpan/bedrock	103.2	1.664266	7
CC- 97	Gravel-Cobble-Hardpan/Bedrock	Coarse gravel, cobble, hardpan/bedrock	60	2.853881	9
CC- 98	Gravel-Silt/Clay	Coarse gravel, cobble, hardpan/bedrock	64.8	2.650909	9
CC- 99	Gravel-Cobble-Hardpan/Bedrock	Coarse gravel, cobble, hardpan/bedrock	122.4	1.329075	4