FINAL REPORT

Status Survey of the Northern Madtom, *Noturus stigmosus*, in the Lower Ohio and Wabash Rivers

To:
Glen Kruse
Division of Habitat Resources
IDNR-Office of Resource Conservation
1 Natural Resources Way
Springfield, IL 62702-1271
Phone: (217) 785-8691
Fax: (217) 785-2438

By:
Donovan B. Henry, Leonard J. Pitcher, and Collin Beachum
Three Rivers Environmental Assessments, LLC
374 South Williams Street
Murphysboro, Illinois 62966

30 December 2009

INTRODUCTON

The Northern Madtom is a small, secretive inhabitant of large creeks and rivers where there are moderate to swift flows, and clean sand and gravel substrates (Etnier and Starnes 1993). This species is sporadic and uncommon throughout its distribution. It is listed as threatened, endangered, or special concern in every state in which it occurs, and is disappearing from the margins of its range (Page and Burr 1991, Thomas and Burr 2004, Scheibly et. al. 2008). In Illinois it is listed as State Endangered (IESPB 2006), and is considered a Species in Greatest Need of Conservation (SGNC) by Illinois Wildlife Action Plan, and also has a global rank of G3 (Vulnerable).

Before 1997, the only records of this species in Illinois were from the Wabash River in 1888, the Vermilion River in 1962, and three records in the Ohio River. Subsequent sampling efforts to locate the Northern Madtom in the Wabash and Vermilion Rivers have been unsuccessful (Page and Retzer 2002). However, since 1997, Northern Madtom specimens have been collected four times from the lower Ohio River bordering Illinois. These recent collections and ongoing sampling activities in the lower Ohio River indicate that the Northern Madtom may be much more abundant in these Illinois waters than previously thought. This population has likely been overlooked for many years due to difficulty sampling small, benthic fishes in large, dynamic systems such as the Ohio River. This may also be the case in the lower Wabash River. The habitat in the Wabash River is suitable for Northern Madtoms, it is a large system that is also difficult to effectively sample, and the Mountain Madtom, *Noturus eleutherus*, which is very similar in appearance and ecology is common in this stream. Other factors may include the seasons and times in which sampling took place, as well as sampling gear selectivity.

The collection of baseline data for this species was also significant at this time due to the construction of the new lock and dam near Olmstead, Illinois at RM 964.4. This structure is within the area these fishes have most recently been found. The effects of this dam will be increased depth and reduced flows upstream, altered hydraulic regimen

immediately downstream, and altered navigational patterns (Payne and Miller 2002). Theses shifts in river hydraulics impact sedimentation, substrate composition and substrate stability, all of which are crucial factors for benthic species.

METHODS

Sampling for Northern Madtoms was conducted in five sections of the lower Ohio River between Smithland Dam and the confluence of the Ohio and Mississippi Rivers. Four of these sample sections included areas where specimens were recently encountered; one below Lock and Dam 53, and three between Lock and Dam nos. 52 and 53. The fifth section was between Lock and Dam 52 and Smithland Lock and Dam. Below Lock and Dam 53, sampling was conducted throughout a seven mile reach including River Miles (RM) 966 – 973. This is in the area of Olmstead and Mound City, Illinois. The three sample sections between Lock and Dam 52 and 53 included a six mile reach near Grand Chain, Illinois from RM 955 – 961; a nine mile reach near Joppa, Illinois from RM 945 – 954; and, a six mile reach near Metropolis, Illinois from RM 939 – 945. Sampling locations between Lock and Dam 52 and Smithland Lock and Dam were scattered due to the scarcity of habitats likely to harbor Northern Madtoms.

In the lower Wabash River, the sample area encompassed the approximately 200 miles that this river borders Illinois. Sampling methods and results are detailed in the report "Status Survey and Management Implications of the Harlequin Darter and Eastern Sand Darter in Southeastern Illinois" (Henry et. al. 2009). A brief summary the Wabash River sampling, as it relates to the Northern Madtom, is given in the discussion section of this report, but the following methods and results are for the Ohio River sampling.

Sample sites were selected by reconnoitering an area to locate clean gravel/cobble/sand substrates with at least a minimal amount of flow that could be effectively sampled. Substrates in potential sample areas were evaluated with repeated ponar grabs throughout the reach. Areas with higher flows and coarser substrates that were less embedded were

given preference. These areas were usually less than 20 feet deep along gravel bars (e.g America Bar, Grand Chain Bar, Sharps Bar, Little Chain Bar, etc), tributary mouths, or the main channel border.

Sampling was conducted with a 4' x 8' benthic trawl in non-wadeable habitats at varying depths and distances from shore. A pulse D/C electrofishing system was fitted to the benthic trawl to enhance sampling efficacy. Each trawl site consisted of a minimum of three minutes of downstream trawling, with sample time starting once the trawl was effectively deployed (i.e. on the bottom and opened). Wadeable habitats were further sampled with a backpack electrofisher and 6' x 15' minnow seine with 1/8" mesh. Seine sites typically consisted of ten hauls or kick sets at as site. Less hauls were taken at sites where good habitat was present, but the wadeable area of the site was small. Sampling effort was quantified by time, area, number of seine hauls, and/or number of trawl hauls, to facilitate comparisons among and within sample sections, as well as to future sampling efforts.

Sampling was conducted during September and October 2008, and March and July 2009. Winter and spring sampling was limited due to the prolonged high water event from December to June 2009. Sampling was conducted at night, as well as, in the day, as Madtoms are nocturnal in their habits and are more readily collected at night (Burr and Stoeckel 1999).

Non-lethal sampling procedures were used and handling of captured SGNC's was kept to a minimum to avoid mortality. Each Northern Madtom was enumerated, measured to total length, and released. All other species were also enumerated to characterize the fish assemblage associated with the Northern Madtom, and further facilitate monitoring efforts in the lower Ohio River. All vouchered specimens were deposited in the Southern Illinois University Fluid Vertebrate Collection.

Habitats were quantitatively and qualitatively assessed at sites where Northern Madtoms were collected and habitats were qualitatively described for areas where the species did

not occur. Habitat parameters measured included, water temperature, water velocity, substrate composition, depth of habitat, depth of capture (if discernable), instream cover, and perceived threats. Substrate categories included boulder (>256mm), cobble (964-256mm), gravel (2-64mm), sand (0.06-2mm), silt (0.004-0.06mm), clay, detritus, muck-mud, and marl. Sample sites were georeferenced with a handheld Global Positioning System receiver.

RESULTS

A total of 154 trawl sites and 23 seine sites were sampled to determine the current distribution of the Northern Madtom in the Lower Ohio River in 2008 – 2009 (Table 1). The number of sites per sample reach was proportionate to the amount of appropriate habitat. Extensive bars and gravel in main channel border habitat were most prevalent in the lower three sample reaches (below LD 53, Grand Chain area, and Joppa area), so a relatively high amount of effort was expended here (Table 1). In addition, the recent collections of Northern Madtoms by SIUC, IDNR, and TREA were between Lock and Dam 53 and Lock and Dam 52. The reach in the area of Metropolis is characterized by sandier substrates, as evidenced by the repetitive dredging in this reach, but some gravel habitats are present below the dam and along bars and channel borders. The entire pool from Lock and Dam 52 to Smithland Dam was examined for likely habitats by taking flow measurements and using ponar samples to determine substrates. Flows throughout the pool were sluggish to none, with the exception of the area immediately below Smithland Dam. The bedrock outcrops below the dam, were the only significant rocky substrates encountered throughout the remainder of the pool except revetment or river training structures. Although it is quite likely that Northern Madtoms could thrive in the bedrock outcrops below Smithland Dam, no feasible means could be determined to sample this area. With the relative absence of quality habitat elsewhere, few samples were taken in this reach.

Sampling was conducted during September and October 2008, and March and July 2009. Winter and spring sampling was limited due to the prolonged high water event from early December to June 2009 (Figure 2). During this time, water levels never dropped to ideal or even marginal levels for effective sampling, however, during the lowest levels in mid-March 2009, trawling and seining was conducted in near shore habitats.

A total of 3,649 fishes representing 55 species and one hybrid in 13 families were captured during this survey (Table 2). The most commonly captured fishes were Freshwater Drum (*Aplodinotus grunniens*), Channel Catfish (*Ictalurus punctatus*), Silver Chub (*Macrhybopsis storeriana*), River Darter (*Percina shumardi*), Gizzard Shad (*Dorosoma cepedianum*), and Logperch (*Percina caprodes*) (Table 2).

However, a total of only 28 Northern Madtoms were collected during these sampling trips (Table 2). Nineteen were captured in the pool between Lock and Dam 52 and 53, and 9 were collected downstream of Lock and Dam 53. No Northern Madtoms were collected between Lock and Dam 52 and Smithland Lock and Dam. Sizes of collected Northern Madtoms ranged from 29 mm – 61 mm, with a single gravid female collected on 25 July 2009.

Twenty of the 28 collected Northern Madtoms were captured in night-time trawls, with only 4 captured in daytime trawls (Table 3). Two Northern Madtoms were collected during the one nighttime seine sample and two were collected in the other 23 daytime seine samples.

Northern Madtoms were captured in as little as a few inches of water to depths of 14 feet, with sample sites encompassing areas nearly 25 feet deep (Table 3). The average depth at positive sites (sites where Northern Madtoms were captured) was 5.5 feet, with the shallowest site being a seine site in less than 8 inches of water (Table 3). The average depth at sites without Northern Madtoms was only slightly higher, 7.4 feet, with considerable overlap in sampled depths between sites with and without Madtoms being collected. Average flows where Northern Madotms were found did not significantly

differ from areas where they were not collected, 0.28 m/sec and 0.32 m/sec, respectively. Northern Madtoms were found in flows as low as 0.03 m/sec and in swift currents as high as 0.68 m/sec (Table 3).

Nearly all sampled sites contained sand, gravel, and cobble substrates, with less than 10% of the sites containing silt, detritis, clay, or boulder. Positive sites always had some combination of sand, gravel, or cobble substrates, but some areas with what appeared to be identical, suitable habitat yielded no Northern Madtoms.

DISCUSSION

A number of reasons were suspected as to why the collections of the Northern Madtom in the Lower Ohio River have been so rare. Sampling difficulty is one of the primary barriers to determining the current population status of this cryptic species. Due to the nocturnal habits of Madtoms, the number of captured specimens per unit effort was five times higher in nighttime trawl hauls versus daytime trawls (20 captured at night vs. 4 during the day). This is even more significant when considering 105 of the 154 (68%) of the trawl sites during this survey were during the day (Table 3). On several occasions, a site sampled during the day would yield no Northern Madtoms, but when sampled immediately after sunset, one or two individuals would be captured in the same locality. In addition, the only seine site conducted at night yielded two Northern Madtoms, while the 23 combined day seine sites yielded only two individuals as well. Night trawls were also conducted in the very same areas in which daytime trawls were conducted. The species is likely buried in the substrate during daylight hours, and ventures out to forage only at night. Trawl hauls during daytime hours may drag over the top of the buried Madtoms; the trawl being unable to dig them out of the substrates. Night trawling was conducted during this survey on every sample date, but trawling at night is difficult and dangerous in these river channel habitats with sharply varying depths, barge traffic, motor hazards, snags, etc. Night sites were carefully scouted during the day, and a course, were

laid with a Global Positioning System, but snags, shallow humps, and floating debris still proved difficult to maneuver around in nighttime situations.

Sampling ability was also one of the limiting factors in accurately characterizing the population below Smithland Dam. The bedrock outcrops have extensive interstitial spaces, good flow, and abundant aquatic invertebrate colonization. However, the jagged, irregular, configuration of the substrate with abrupt depth changes make sampling for these fishes nearly impossible.

A second factor influencing the lack of information on this species seems to be the paucity of quality habitat. Northern Madtoms typically prefer gravel/cobble substrates with swift flows. The remaining gravel habitats in the lower Ohio are mostly in non-wadeable habitats along the main channel border. These habitats are often the result of dredge material placement for maintenance of the navigation channel, as opposed to naturally forming gravel bars from natural river processes. Reduced flows in much of this stretch of the Ohio River, especially above Lock and Dam 52, has caused habitat to become embedded from sand deposition, leaving only pockets of functional gravel habitats preferred by Northern Madtoms. Locating these isolated pockets is very difficult, causing much of the sample time to be spent over marginal to inadequate habitats.

An earlier concern with the low catch rates of Northern Madtoms was gear selectivity. Capturing these small benthic fish on the bottom of such a large body of water is challenging. The addition of the electrofishing capability to the trawl seemed to be effective, as other catfishes, including blue and channel catfish, were often stunned in the cod end of the trawl. In addition, when examining the most abundant taxa captured in this study, five of the six most prevelant species were benthic (Tabele 2). These included two darters, River Darter and Logperch, Channel Catfish, Freshwater Drum, and Silver Chub. The only non-benthic species found in the top five captured species was the Gizzard Shad. This species is very abundant in the Ohio River, accounting for its high relative abundance in these samples. Given that the relative abundance of captured fishes

was so skewed toward the benthic community, a more effective gear type for these conditions may be difficult to design.

The unionid mussel community may play an important role to the Northern Madtom in the lower Ohio River, providing interstitial spaces for hiding and foraging, as well as cavities for spawning. The successful collections of Northern Madtoms made near Joppa, Illinois in the mid-1990's were when water levels were extremely low and the mussel beds typically under many feet of water could be sampled with seines and backpack electrofishers (B.M. Burr pers. comm.). It was among these mussel beds that Northern Madotms were found. In addition, U.S. Army Corps of Engineers personnel diving for unionid mussels downstream of Olmstead on 5 September 2007, found Northern Madtoms in two different moribund unionid mussel shells. The two shells with madtoms in them were collected in deep water along the mian channel border (Steven George pers comm.). Northern Madtoms tucked into unionid mussel shells buried in the river bottom may further lessen the efficacy of trawls or seines to capture this species.

Artificial substrates such as river training structures or revetment are also utilized by Northern Madtoms in this stretch of river. Two of the sites the Northern Madtom had been collected from in the years just before this survey were near Grand Chain and upstream of the Joppa boat ramp. Both of these sites consisted of man-made rock dikes. The Grand Chain specimen, collected by IDNR just downstream of the Grand Chain boat launch, came from a pile of large rocks on the upstream side of a private boat launch. Upstream of the city of Joppa boat ramp, the individual was collected while seining at an old wing dike by TREA personnel. The madtom at this site was collected during high water and had moved up to where the top of the structure keys into the shore. The area from which it was collected is typically far out of the water. Subsequent efforts during this survey to capture Northern Madtoms at these sites were unsuccessful.

In addition to the sampling conducted during this survey, supplementary data on the current population of Northern Madtoms in the lower Ohio River came from monitoring of the impingement mortality at the Tennessee Valley Authority's Shawnee Steam Plant

just downstream of Metropolis, Illinois on the Kentucky shore. Under Section 316(b) of the Clean Water Act, the impingement mortality of fish and shellfish was characterized at all facilities in the United States that, on average, withdraw 50 million or more gallons of water per day from their respective source water body. A total of 38, twenty-four hour samples were collected at the Shawnee Steam Plant from June 2005 to June 2007. From these samples, 82 Northern Madtoms were observed among the impinged fishes (Joe Vondruska pers. comm.). Over two-thirds of the Northern Madtoms impinged on the traveling screens at this facility were during the month of January. The remaining one-third of impinged Northern Madtoms was made up of one to three individuals per date throughout the remainder of the year. Nearly 80% of the Northern Madtoms that were impinged and washed off of the screens, were alive and appeared healthy enough to survive as they were collected in the return outlet to the Ohio River.

If a simple extrapolation from these 38 collection dates is done (not taking into account any of the numerous variables affecting impingement rates at this particular facility) an estimate of nearly 2.15 Northern Madtoms per day are impinged. Over the course of a year, using this extrapolation, nearly 800 Northern Madtoms are washed off of the traveling screens per year. At the Shawnee Steam Plant, the outfall channel and the intake channel are also widely separated, so it is unlikely that the same individuals come through the system repeatedly during collection periods. Although this data suggests that the rate of impingement of Northern Madtoms may be high at the Shawnee Steam Plant, it also suggests that the population may be more robust than this study and previous sampling were able to show.

The habitat in the intake channel at Shawnee is largely a silt bottomed canal oriented perpendicular to the Ohio River. This canal fills with sediment to the point it requires periodic dredging to maintain ample depth from the river to the plant. There are large metal bar racks where water first enters the plant. Woody debris, detritus, leafpack, and organic and inorganic matter often collect along these racks. The debris in front of the racks was colonized by many groups of invertebrates, which were observed when pieces broke loose and were washed in with the impingement collection (personal observation).

The draw of water to the plant from the river creates nearly constant flow through the debris. The habitat created by the near constant flows, abundant woody debris with interstitial spaces, as well as the available forage colonizing the debris, may actually attract the Northern Madtoms to this site. Reduced swimming ability in the peak winter months may account for the increased impingement during this time.

Impinged Northern Madtoms were often larger than those collected during this study, up to 84 mm. To develop a length frequency distribution representative of the population in the lower Ohio River, both data sets were combined (Figure 4). Little has been done on the biology of the Northern Madtom other than reproductive data (Scheibly et al 2008). But it appears that the Age-0 Northern Madtoms in the Ohio River reach approximately 50 – 54 mm, with the Age-1 individuals ranging from 55 – 75 mm, and Age-2 ranging from 75 – 85 mm (Figure 4).

Threats to the Northern Madtom in the lower Ohio River are likely related to alteration and maintenance of the system for navigation. The reduced flows caused by dams resulting in deposition of fine sediments over rocky habitats and physical dredging of the river bottom appear to be the most consistent factors affecting this population. Much of the available gravel habitat in this stretch of river is heavily embedded with little or no interstitial spaces for benthic dwelling organisms to thrive. Side casted dredge material is often placed on these main channel border habitats, and may quickly cover the few exposed gravel habitats. Exposed gravel and cobble bars give the appearance of abundant rocky substrates in this stretch of river. However, wind and wave activity remove sand and silt on the exposed portion of the bar; just a few feet from shore, under the surface of the water, these rocky substrates are typically buried by sand. The addition of the lock and dam at Olmstead will likely increase the amount of pooled habitat in the river, further reducing suitable gravel areas for this species.

The Ohio River population of the Northern Madotm is most likely not as stable as it was pre-navigation, but it has continued to persist in this reach, despite the severe alterations to the hydrology. Traditional sampling methodologies are likely underestimating the

population, and any future monitoring of the Northern Madtom in the lower Ohio River should be limited to nighttime sampling. The preferred habitat of several of the unionid mussels in the Ohio River seems to overlap with that of the Northern Madtom. Monitoring and preserving the remaining habitat with moderate flows and coarse substrates, as well as, the unionid mussel populations, would be a critical step for the future preservation of the Northern Madtom.

In the Wabash River, four species of madtom were encountered, including Freckled Madtom (*Noturus nocturnus*), Slender Madtom (*Noturus exilis*), Brindled Madtom (*Noturus miurus*), and Mountain Madtom (*Noturus eleutherus*), but no Northern Madtoms were collected (Henry et al 2009). Habitat in the Wabash River was of good quality above the confluence with the Little Wabash River and quite suitable for Northern Madtoms. However, suspected inputs of silt/sediment from the Little Wabash River and the effects of impoundment from the Ohio River were becoming evident in the lower Wabash River. Higher sustained water levels with reduced flows gave the lower Wabash a more reservoir appearance. Sluggish flows, increased sedimentation, and decreased benthic macroinvertebrate colonization became evident in this stretch of river.

The Ohio River below the confluence with Wabash River was also very reservoir like, with little or no flow and silt/sand substrates. If Northern Madtoms no longer occur in the Wabash River, the pooled habitat through the series of dams above Lock and Dam 22, and into the lower Wabash may act as a barrier and prevent connectivity with the lower Ohio River population. The presence of Northern Madtoms could be still be overlooked in the Wabash River and require extensive nighttime sampling to confirm their presence, but it is unlikely that a viable population is still present in the this stream.

LITERATURE CITED

Burr, B. M. and J. N. Stoeckel. 1999. The natural history of madtoms (genus Noturus), North America's diminutive catfishes. American Fisheries Society Symposium 24:54-101.

Etnier, D. A., and W. C. Starnes. 1993. The Fishes of Tennessee. University of Tennessee Press, Knoxville.

IESPB (Illinois Endangered Species Protection Board). 2006. Checklist of endangered and threatened animals and plants in Illinios.

Page, L. M. and B. M. Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston. 432 p.

Page, Lawrence M. and Michael E. Retzer. 2002. The Status of Illinois' Rarest Fishes and Crustaceans. Transactions of the Illinois State Academy of Science. Volume 95, #4, pp.311-326.

Payne, B. S. and Miller, A. C. (2002) "Freshwater Mussels in the Lower Ohio River in Relation to the Olmsted Locks and Dam Project: Update Through 2001 Studies," ERDC/EL TR-02-31, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Scheibly, J. F., D. J. Eisenhour, and L. V. Eisenhour. 2008. Reproductive biology of the Northern Madtom, Noturus stigmosus, in the Licking River, Kentucky. Journal of the Kentucky Academy of Science 69(2):178-186.

Thomas, M. R. and B. M. Burr. 2004. Noturus gladiator, a new species of madtom (Siluriformes: Ictaluridae) from Coastal Plain streams of Tennessee and Mississippi. Ichthyological Explorations of Freshwaters 15:351-368.

Table 1. Trawl and seine sites for Northern Madtom in five sections of the lower Ohio River, 2008-2009.

	Below Lock and Dam 53	Lock and Dam 53 to Lock and Dam 52			Lock and Dam 52 to Smithland Dam
	Mound City-Olmstead RM 966 - 973	Grand Chain RM 955 - 961	Joppa RM 945 - 954	Metropolis RM 939 -945	RM 920 - 936
Trawl Sites	47	34	45	26	2
Seine Sites	8	8	5	2	1
Totals	55	42	50	28	3

Table 2. Summary table of captured fishes during 2008-2009 survey of the Northern Madtom in the lower Ohio River.

Common Name	Species	Below LD 53	LD 53 to LD 52	LD 52 to Smithland	TOTAL	Relative Abundance
Black Crappie	Pomoxis nigromaculatus	2			2	0.05
Blue Catfish	Ictalurus furcatus	67	10		77	2.11
Blue Sucker	Cycleptus elongatus		4		4	0.11
Bluegill	Lepomis macrochirus	10	69	2	81	2.22
Bluntnose Minnow	Pimephales notatus		2		2	0.05
Bluntnose Darter	Etheostoma chlorosoma		17		17	0.47
Bowfin	Amia calva	1			1	0.03
Brook Silverside	Labidesthes sicculus	3	17		20	0.55
Bullhead Minnow	Pimephales vigilax	8	82		90	2.47
Channel Catfish	Ictalurus punctatus	145	277		422	11.57
Channel Shiner	Notropis wickliffi	11	16		27	0.74
Chestnut Lamprey	Ichthyomyzon castaneus		1		1	0.03
Common Carp	Cyprinus carpio	5	2		7	0.19
Dusky Darter	Percina sciera	1	1		2	0.05
Emerald Shiner	Notropis atherinoides	8	79		87	2.39
Flathead Catfish	Pylodictus olivaris	2	8		10	0.27
Freckled Madtom	Noturus nocturnus	1			1	0.03
Freshwater Drum	Aplodinotus grunniens	612	769		1381	37.87
Gizzard Shad	Dorosoma cepedianum	52	100		152	4.17
Golden Redhorse	Moxostoma erythrurum		2		2	0.05
Goldeye	Hiodon alosoides	1	13		14	0.38
Grass Carp	Ctenopharyngodon idella		2		2	0.05
Green Sunfish	Lepomis cyanellus		2		2	0.05
Hybrid Striped Bass	Morone saxatilis x M. chrysops	1	1		2	0.05
Largemouth Bass	Micropterus salmoides		5		5	0.14
Logperch	Percina caprodes	34	98		132	3.62
Longear Sunfish	Lepomis megalotis	12	18	8	38	1.04
Longnose Gar	Lepisosteus osseus	1	8		9	0.25
Mooneye	Hiodon tergisus	1	1		2	0.05
Mud Darter	Etheostoma asprigene	33	47		80	2.19
Northern Madtom	**Noturus stigmosus**	**9**	**19**		**28**	0.77
Orangespotted Sunfish	Lepomis humilis	1	3		4	0.11
Quillback	Carpiodes cyprinus		4		4	0.11
Redear Sunfish	Lepomis microlophus		1		1	0.03
River Carpsucker	Carpiodes carpio	5	9		14	0.38
River Darter	Percina shumardi	98	96		194	5.32
River Shiner	Notropis blennius		10		10	0.27
Sauger	Sander canadense	15	41		56	1.54
Shoal Chub	Macrhybopsis hyostoma	4	66		70	1.92
Shortnose Gar	Lepisosteus platostomus	5	8		13	0.36
Silver Carp	Hypophthalmichthys molitrix	2	1		3	0.08
Silver Chub	Macrhybopsis storeriana	151	215	1	367	10.06
Skipjack Herring	Alosa chrysochloris		4		4	0.11
Slough Darter	Etheostoma gracile	3			3	0.08
Smallmouth Bass	Micropterus dolomieu		1		1	0.03
Smallmouth Buffalo	Ictiobus cyprinellus		10		10	0.27
Smallmouth Redhorse	Moxostoma breviceps	2	1		3	0.08
Spotfin Shiner	Cyprinella spiloptera		2		2	0.05
Spotted Bass	Micropterus punctulatus	4	9		13	0.36
Stonecat	Noturus flavus	1			1	0.03
Striped Bass	Morone saxatilis		1		1	0.03
Tadpole Madtom	Noturus gyrinus	1	1		2	0.05
Threadfin Shad	Dorosoma petenense	27	38	2	67	1.84
White Bass	Morone chrysops	19	35		54	1.48
White Crappie	Pomoxis annularis	5	2		7	0.19
Yellow Bass	Morone mississippiensis	5	38		43	1.18
	TOTAL	1368	2266	13	3647	100.00

Table 3. Diel and habitat summary for Northern Madtom Survey in the lower Ohio River in 2008-2009.

	With Northern Madtoms (n = number of individuals)	Percentages with Northern Madtoms	Without Northern Madtoms	Percentages without Northern Madtoms
Total Number Seine Sites	3 (n=4)	14%	21	88%
Daytime Seine Sites	2 (n=2)	9%	21	91%
Nightime Seine Sites	1 (n=2)	100%	0	0%
Total Number Trawl Sites	17 (n=24)	11%	137	89%
Daytime Trawl Sites	4 (n=4)	4%	101	96%
Nightime Trawl Sites	13 (n=20)	27%	36	73%
Minimum Depth (ft)	0.6		0.5	
Maximum Depth (ft)	14		24.5	
Average Depth (ft)	5.5		7.4	
Minimum Velocity (m/sec)	0.03		0.01	
Maximum Velocity (m/sec)	0.68		0.81	
Mean Veloxity (m/sec)	0.28		0.32	

Figure 1. Sample Area of the Northern Madtom in the lower Ohio River.

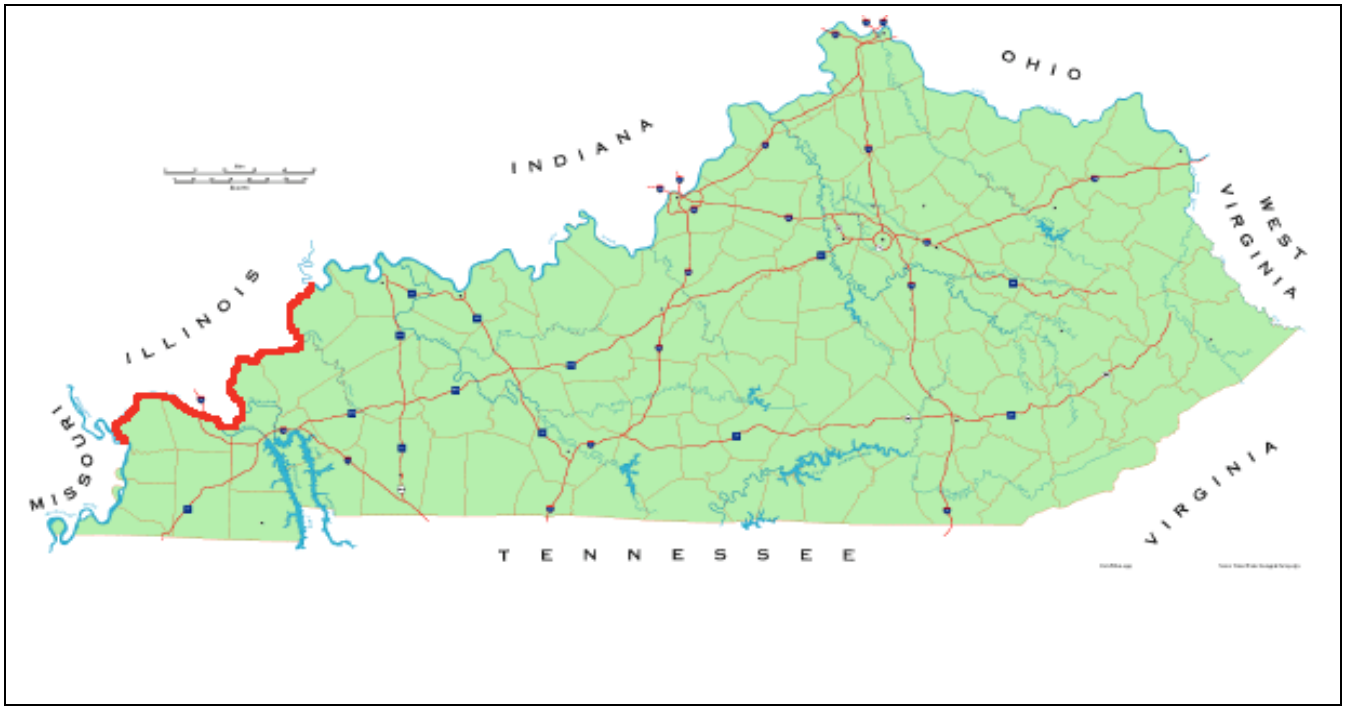


Figure 2. Sample locations for Northern Madtom in the lower Ohio River, 2008-2009.

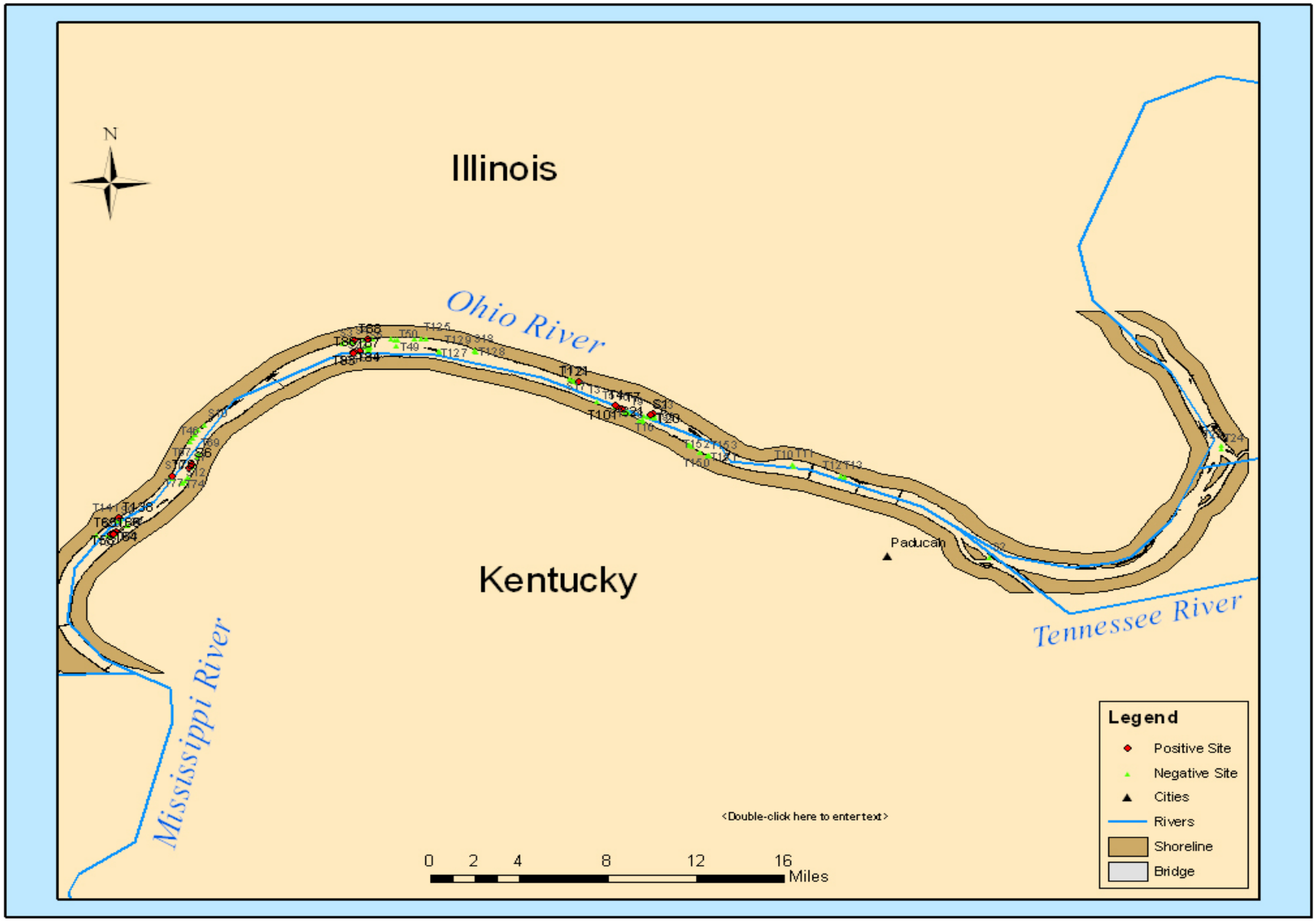


Figure 3. USGS Real-time Date for lower Ohio River from December 2008 through June 2009.

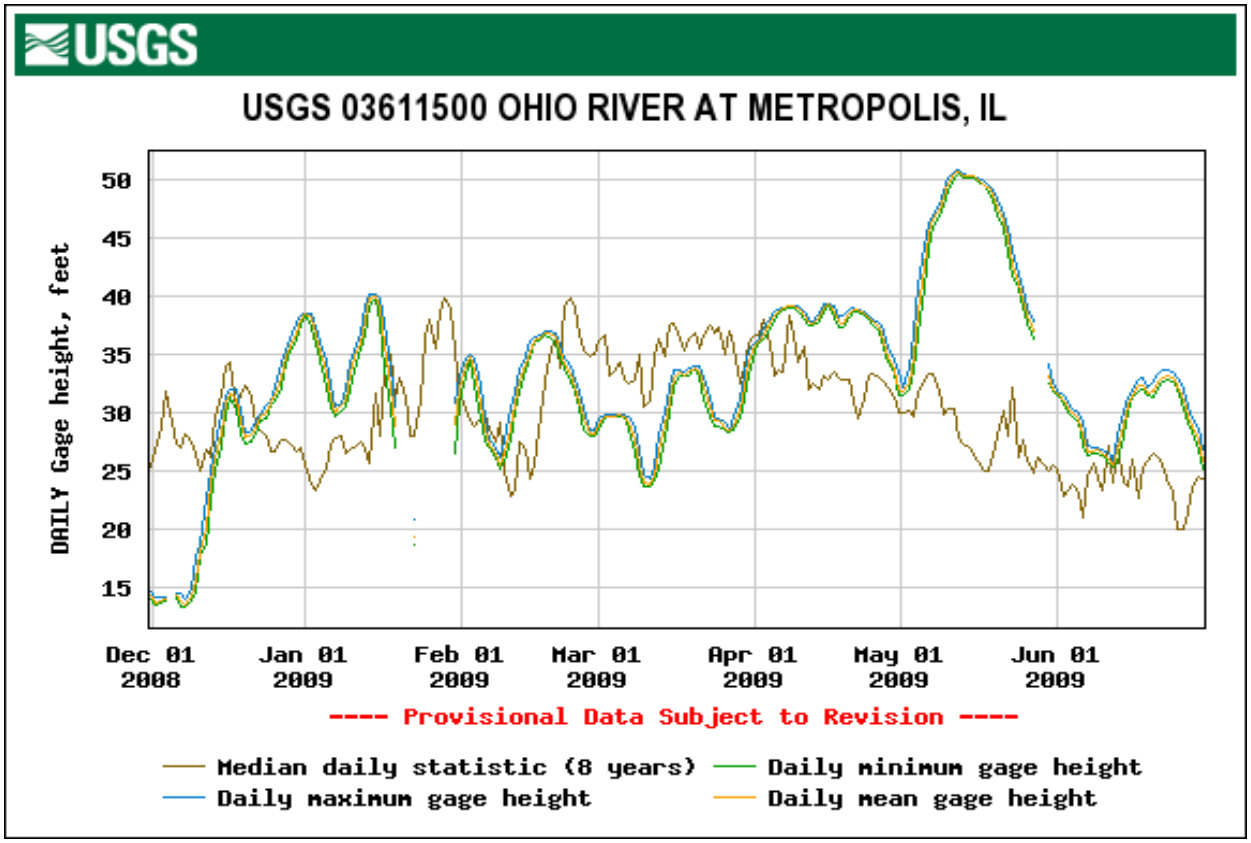
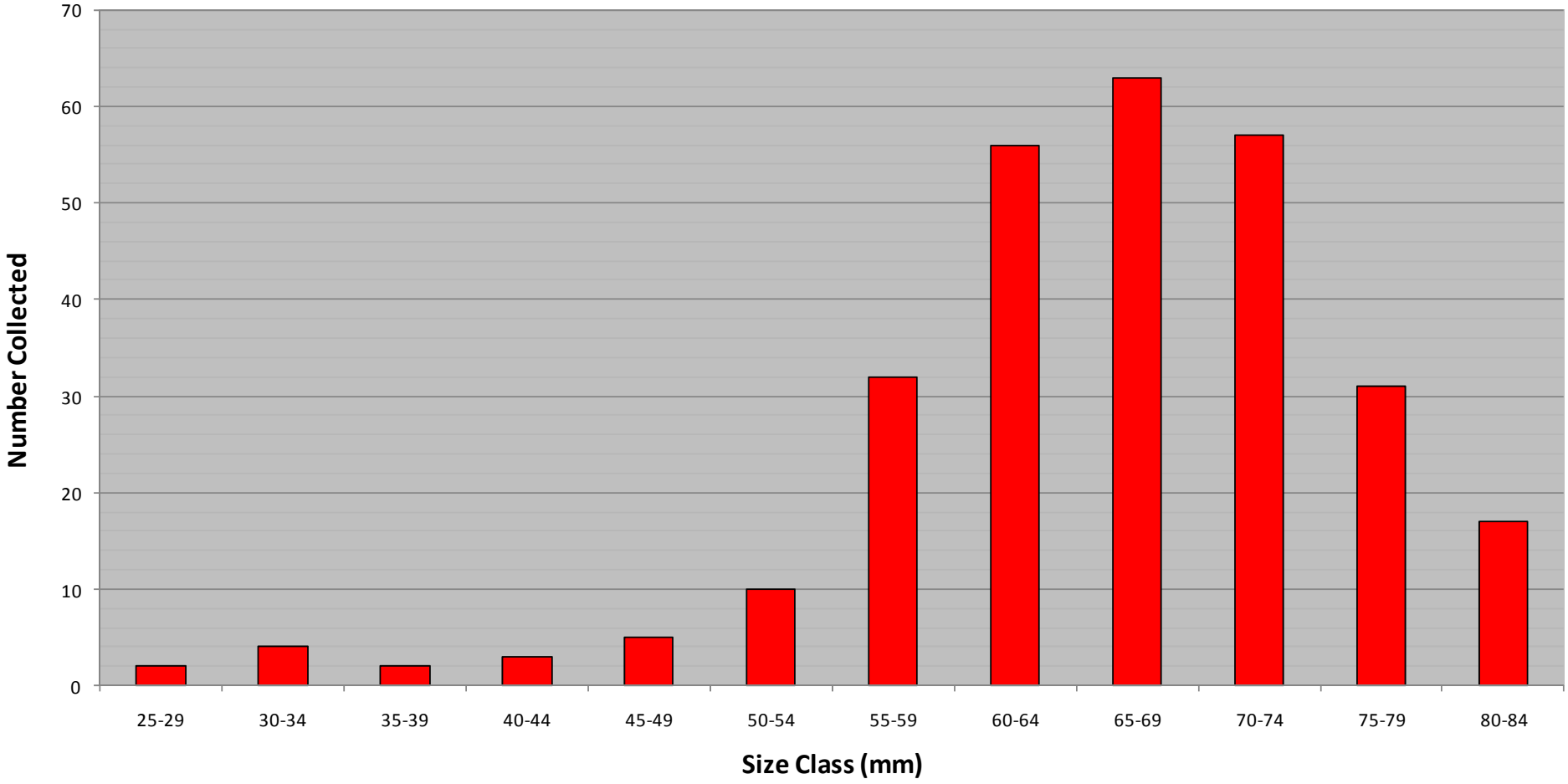
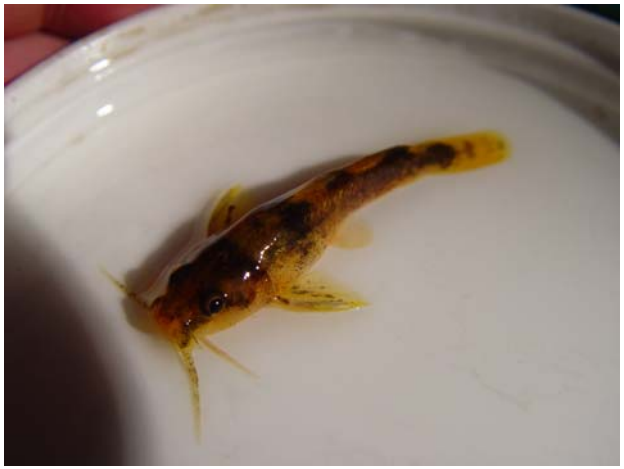


Figure 4. Length frequency distribution for Northern Madtom, *Noturus stigmosus*, in the lower Ohio River 2008-2009.



Appendix 1. Photo documentation of Status Survey of Northern Madtom in lower Ohio River.



Northern Madtom (*Noturus stigmosus*) collected from the lower Ohio River 2008-2009.

Removing collected fishes and substrate from trawl.

Substrates collected by trawl haul in lower Ohio River.

Sand/gravel habitat on bars in main channel border of lower Ohio River.

Sand/gravel habitat with moderate flow in lower Ohio River

Channel border habitat and old wing dike in lower Ohio River.

FY 2007-2008 State Wildlife Grant (SWG) Final Report

PROJECT TITLE:

Status Survey and Management Implications of the Harlequin Darter and Eastern Sand Darter in Southeastern Illinois

PROJECT NO.:
T-37-P-1

To:

Kathy Justison
Illinois Department of Natural Resources
One Natural Resources Way
Springfield, IL 62702-1271

And

Trent Thomas
Illinois Department of Natural Resources
301 South Date Street
Gibson City, IL 60936

By:

Donovan B. Henry, Lennie J. Pitcher, and Collin E. Beachum
Three Rivers Environmental Assessments, LLC
374 South Williams Street
Murphysboro, Illinois 62966

21 June 2009

INTRODUCTION

A comprehensive study was initiated to gather detailed information on the conservation status of two Illinois fish species in greatest need of conservation (SGNC), and to utilize this information for future conservation and management planning. The Harlequin Darter and Eastern Sand Darter, listed as state endangered and state threatened, respectively, occur in the Wabash River drainage in Southeastern Illinois. They both have very restricted ranges along the eastern margin of the state. According to the Illinois Wildlife Action Plan, Section X, Appendix 1, both species are considered Species in Greatest Need of Conservation (SGNC), meeting six of the eight criteria to be ranked as priority species. Both species are Illinois Conservation Priority Fishes, and the Eastern Sand Darter has a global status of G3 (a species in substantial decline and vulnerable). Both of these species are rare in Illinois and population size, density and current range information was needed. In addition, due to the ongoing threat of perturbations to Illinois waterways and the predilection of these two species for clear, silt free environments make them valuable as aquatic bioindicators. Their absence and/or presence may provide insight as to the health and overall quality of an aquatic ecosystem. Both of these fish species require habitats which are shared by a wide variety of other benthic fishes as well as mussels and crayfish species.

The Harlequin Darter was known only from a few localities in the Embarras River in Cumberland, Jasper, and Coles Counties (Smith 1979; Page and Retzer 2002), from the Wabash River along White and Wabash Counties (Burr et. al 1996), and one locality at in the Ohio River at the mouth of the Wabash (Page and Retzer 2002). Forbes and Richardson (1909) recorded a Banded Darter (*Etheostoma zonale*) from the Wabash River in White County, but Smith (1979) later hypothesized that this was actually a Harlequin Darter. This species has not been collected from the Embarras River since 1983 despite recent efforts to find it, and was only recently (1995-96) discovered in the Wabash River (Page and Retzer 2002). The Embarras River populations are the northernmost populations known of this fish species (Smith 1979). Boschung and Mayden (2004), state that the Harlequin Darter seems to be declining in some areas, especially on the periphery of its range. Despite apparent declines, populations of this

species still persist, and have likely been overlooked due to difficulty in sampling and relatively limited geographic coverage of sampling (ie. at bridge crossings).

The Eastern Sand Darter has extant populations in the Middle Fork of the Vermilion River and the middle Embarras River. It appears to be extirpated from the remainder of its range in Illinois, the upper Little Wabash drainage and the mainstem of the Wabash River, as it has not been collected from either of these systems in over half a century. Smith (1979) stated that the Eastern Sand Darter was formerly more general in occurrence but had been decimated as a result of siltation, impoundments, and possible deterioration of water quality. The Eastern Sand Darter population in the Middle Fork of the Vermilion River was not be included in this survey, but may also merit status evaluation.

Intense, habitat specific sampling was conducted to confirm the status of these two species in Illinois waters. A detailed assessment of habitat in the project area, as well as perceived threats in these waters, was evaluated to yield information useful for future conservation and management plans (e.g. habitat improvement/enhancement, translocation, etc.). Field surveys were conducted in the historic ranges of these species from 2007 – 2008. The Little Wabash River, Embarras River, and Embarras River tributaries were sampled in 2007, and the Wabash River was sampled in 2008.

METHODS

Fish Sampling

For sites in the Little Wabash, Embarras, and Embarras tributaries, sampling was achieved with a backpack electrofisher, 6' x 15' minnow seine with 1/8" mesh and 6' x 30' bag seine with 1/8" mesh. The two methods typically employed were "kick sets" and "downstream hauls". Both methods utilized a combination of the backpack unit and one of the seines. For kick sets, two persons positioned the 15' seine downstream of the habitat to be sampled while the backpack operator shocked their way downstream toward the net, disturbing substrates, logs, and rocks with their feet as they went. This method was employed in areas with current swift enough to sufficiently sweep stunned fishes into

the net and often over complex habitats (e.g. areas with snags, woody debris, cobbles, etc.). Downstream hauls were conducted by having two persons pull the seine (almost exclusively the 15' seine) downstream, keeping the lead line riding on the bottom, while the backpack operator walked in front of the net sweeping the anode back and forth just in front of the net. This method was typically employed in runs, pools, and riffle edges with few snags.

For quantitative sites in the Little Wabash and one tributary in the Embarras Drainage, a 500 meter reach of stream was sampled. It was determined that this level of effort resulted in time expenditure in the field and in laboratory processing that would prohibit having sufficient resources to sample the extensive area that we wanted to cover. Therefore, ten (10) seine hauls (kick sets/downstream hauls combined) became the standard level of effort to assess the remainder of the quantitative sites. Additional sites in the Embarras River and Embarras River tributaries were qualitatively sampled with one to nine seine hauls to determine presence/absence of the target species.

Habitats in the Wabash were often difficult to sample, with deep (> 1 meter) swift water present at most sites. Kick sets with the backpack electrofisher were employed when habitats were wadeable, but even in wadeable habitats, sampling efficiency was often compromised due to deep, swift flows and extensive snags that were not visible in the turbid waters. Much of the available habitat was not wadeable, so a method using the backpack elctrofisher and dipnet from the bow of the boat was employed to sample the majority of the sites in the river channel. Techniques developed by Brant Fisher (pers. comm.; Fisher 2009) were utilized in this survey in which the collector runs the probe of the backpack electrofisher from the upstream to downstream end of logs, brush piles, root wads, or other woody debris and dipping the Harlequin Darters as they "eject" from the structure. The boat operator would position the boat parallel to the current near the upstream end of the woody debris and drift to the end of the structure. The backpack operator and another collector with a dipnet would stand side-by-side on the port, starboard, or bow of the boat, depending on the location of the structure relative to the

boat. As the boat drifted downstream, the collectors would shock the length of the habitat, dipping any fishes that were observed.

Captured target fishes were enumerated, measured to total length, and released. In cases where more than 30 individuals of the target species were collected, a subsample of at least 30 individuals was measured. Voucher specimens of all other species, were preserved for enumeration to determine relative abundance of Eastern Sand Darter and Harlequin Darter.

Habitat evaluation.

A Physical Characterization/Water Quality Field Data Sheet and a Habitat Assessment Field Data Sheet (Barbour et. al. 1999) were employed at all quantitative seine sites (i.e. positive or negative for the target species) in the Little Wabash, Embarras River, Embarras tributaries, Wabash River, and at all qualitative sites where Eastern Sand Darters or Harlequin Darters were encountered (i.e. positive sites only). In addition, a Qualitative Habitat Evaluation Index (QHEI) was completed at these same sites.

Water quality and physical descriptive data was taken at each of the above mentioned sites, as well. Organic and inorganic substrates were classified based on percent coverage of the stream bottom and categorized according to particle diameter as follows: boulder (>60.4 cm), cobble (25.4 – 60.4 cm), pebble (7.6 – 25.4 cm), gravel (0.2 – 7.6 cm), sand (0.074mm – 0.2 cm), and bedrock, silt, muck/mud, and leafpack (no size classes). Depths were taken with a 2 meter graduated staff by wading in a zigzag pattern throughout the sample area and periodically taking a reading. A minimum of ten depths was recorded in each area. This method was employed to insure all available depth ranges are represented. Current velocity was measured with a Marsh-McBirney Flo-Mate Model 2000 flow meter at 0.6 of the depth from the surface. Features such as stream morphology types (e.g. riffle, run, and pool), woody debris, and aquatic vegetation were visually estimated.

The sampling methods employed for the Harlequin Darter in the Wabash River allowed for near pinpoint detection of where the individuals were captured. This lent itself to defining the microhabitat variables where these darters taken. Flows, depths, substrates, and detailed descriptions of capture sites of Harlequin Darters were recorded.

RESULTS

Sampling was completed throughout the Little Wabash and Embarras drainages in July - September of 2007, and in the Wabash River in September - October 2008 (Figure 1). Six (6) sites in the upper Little Wabash River in Effingham and Clay Counties were sampled for the Eastern Sand Darter (Figure 2). Thirty-six (36) sites in the Embarras River, between Lake Charleston in Coles County and the channelized portion of the Embarras River in Lawrence County, were sampled for the Eastern Sand Darter and the Harlequin Darter (Figure 2). And six additional sites in tributaries of the Embarras River were sampled for Eastern Sand Darters (Figure 2).

Eastern Sand Darters were collected at all but one of the thirty-six sites sampled in the mainstem of the Embarras River, and they were encountered at three of the six sampled tributaries of the Embarras (Table 1). Unfortunately, no Eastern Sand Darters were captured at any of the six sites in the Little Wabash River. In both the mainstem Embarras and the tributaries where they were encounterd, Eastern Sand Darters were often quite abundant. A total of 883 individuals were collected, with 134 individuals encountered at one site, and in excess of 60 at five different sites (Table 1). Abundant species most commonly collected with the Eastern Sand Darter included Steelcolor Shiner (*Cyprinella whipplei*), Spotfin Shiner (*Cyprinella spiloptera*), Bluntnose Minnow (*Pimephales notatus*), Bullhead Minnow (*Pimephales vigilax*), Sand Shiner (*Notropis stramineus*), Silverjaw Minnow (*Notropis buccatus*), and Dusky Darter (*Percina sciera*) (Table 2). The relative abundance of these common species was typically far greater than that of the Eastern Sand Darter, but it did rank in the top ten most abundant species at several sites.

Sampling for the Harlequin Darter in the Wabash River was conducted at 314 sites throughout the approximately 200 miles that this river borders Illinois (Figure 3). Twenty-one individuals of the Harlequin Darter were captured at fourteen (14) different sites (Table 1). Species most commonly encountered with Harlequin Darters at seine sites included Emerald Shiner (Notropis atherinoides), River Shiner (Notropis blennius), and Cyprinella spp. At boat sites, Dusky Darters (Percian sciera) were often observed in the same woody debris as Harlequin Darters (Table 3).

They were captured at nine (9) sites with kick sets using the combination backpack electrofisher and siene, and at five (5) sites with the backpack shocker dipping from the boat (Table 3). Of the 314 sites sampled, 72 sites were sampled with one or more seine hauls, almost exclusively kick sets (Table 4). The remaining 242 sites were sampled from the boat over habitats too deep to wade. These sites included 201 logs, 38 logjams or brush piles, and 3 rocks (Table 4).

Total length of captured Eastern Sand Darters ranged from 23 – 67 mm. Length frequency distributions were evaluated for populations captured in July 2007 and again in September 2007 (Figures 4 and 5). The July sample displays two fairly distinct age groups, and young of the year begin to show up in the September sample. Harlequin Darters captured in September and October ranged from 53 to 72 mm. Length frequency distribution in 2 mm increments indicates two year classes present for this species as well (Figure 6).

Sampled habitats in the Little Wabash River were largely sandy runs, mixed with small gravel riffles, and shallow pools (Table 5). Silt was the only other substrate found at every site, but was typically not prevalent. Average depths ranged from 0.25 m to 0.33 m, and mean flows ranged from 0.09 m/sec to 0.38 m/sec. Water quality measurements for each site, including dissolved oxygen, temperature, and conductivity were well within normal ranges for streams in this area during summer months. QHEI scores ranged from 53.5 to 74.5 (mean = 63), and Habitat Assessment scores ranged from 105 to 138 (mean

= 130.3). Despite the appearance of suitable habitat at these sites, no Eastern Sand Darters were encountered.

In the Embarras River and the Embarras River tributaries, the streambed coverage at sites where Eastern Sand Darters were collected was dominated by sand, typically comprising 60% or more of the available substrate (Table 6). Most sites had 10% or more gravel present, and a few sites contained some cobble substrates. Silt was present at most sites, but never comprising more than 20% coverage of the bottom, and almost always 10% or less. Flows at sites containing Eastern Sand Darters were typically in excess of 0.25 m/sec and as high as 0.46 m/sec, but they were also collected from some pool habitats with flows less than 0.15 m/sec and even in two areas with negligible flows (Table 6). Run was the most abundant habitat available and was also the most sampled habitat. Sample sites typically had some habitat complexity and contained riffle and pool areas as well. Eastern Sand Darters were captured in areas averaging 0.2 – 0.4 m deep, but were collected in areas with depths in excess of 1 meter. QHEI scores at sites where Eastern Sand Darters were caught ranged from 45.5 to 80.3 (mean = 62.1), and Habitat Assessment scores ranged from 95 to 164 (mean = 129.4). Dissolved oxygen was 5.0 mg/L or higher at positive sites, but was only 3.1 mg/L at the tributary site where they were not found. This site was intermittent and had only pooled water left in parts of the stream. Temperature and conductivity were fairly normal for the remainder of the sites.

Substrates in the sampled sites of the Wabash river were comprised mostly of sand (Table 7), similar to the Little Wabash and Embarras. However, other substrates, including gravel and silt, were much less prevalent in the areas sampled. The main channel and channel edges, where most sampling occurred, was predominantly run habitat. Pooled areas and riffles were present at some of the sample sites, likely due to sampling being conducted when the river was at low summer flow. Sampled areas in the Wabash River were typically 0.5 m or more, and often in excess of 1 meter deep. Velocities at the sampled sites averaged from 0.12 m/sec to 0.70 m/sec. Dissolved oxygen, conductivity, and temperature were all well within an expected range. QHEI scores ranged from 47.5 to 75 (mean = 61.6), and Habitat Assessment scores ranged from 107 to 166 (mean =

137.1) (Table 7). Habitat scores did not seem to be significantly higher or lower at sites with Harlequin Darters versus sites without. As is evidenced by the microhabitat data collected for Harlequin Darters (Table 8), the habitat factor that was congruent across all capture sites, was the presence of woody debris. Harlequin Darters were exclusively found on woody debris (logs, brush, rootwads, etc.) that appeared to have been in place for an extended period of time. The logs and brush were always highly colonized by caddisflies (*Trichoptera spp.*), and were stable and secured to the substrate. Multiple "new" logs with no invertebrate colonization were sampled during this survey, but no Harlequin Darters were found in these habitats. Velocities at the point of capture ranged from 0.14 m/sec to 0.91 m/sec, but were usually in the range of 0.30 m/sec to 0.50 m/sec (Table 8). Depths ranged from just under 0.50 m to over 1.5 meters. Substrates in these areas were typically sand, but were not considered significant since the Harlequin Darters were always found on the woody debris, often well off of the river bottom and even on the sides or tops of logs right near the surface.

DISCUSSION

Although habitat scores and habitat types in the Little Wabash River were suitable for Eastern Sand Darters, it was not surprising that they were not found. It has been since 1950 that the last individual was collected in this stream (Smith 1979). The site this individual came from near Effingham, Illinois is now impacted by a low water dam that creates a deep, sluggish, silt bottomed pool. Relatively high quality silt-free, flowing, sand habitats were found at five of the six sites, but they were typically separated from long, slow, muddy pools. It would likely be difficult for Eastern Sand Darters to thrive in this fragmented habitat, and re-colonization upstream and downstream of a source population is improbable. According to the EPA 2006 report on Little Wabash River TMDL's, data for the lower to middle portion of the river are sufficient to support the listings for manganese, pH, dissolved oxygen, fecal coliform, and atrazine on the 2006 303(d) list, and TMDL's are warranted. In the study area for this project, data were sufficient to support the listing of manganese and fecal coliforms on the 303(d) list (EPA

2006). According to the Illinois Department of Agriculture, the 1999-2000 census found that nearly 70% of the land cover type in the Little Wabash River drainage was agriculture. The 2002 Census of Agriculture found well over 100,000 hogs, pigs, cattle, and calves in Effingham County alone. The Eastern Sand Darter is thought to be in decline throughout most of its range, and the primary reasons seem to be siltation/sedimentation and degrading water quality (Smith 1979, Trautman 1981, Kuehne and Barbour 1983). Further assessment of the habitat and water quality should probably be conducted throughout the Little Wabash drainage before translocation or re-establishment of a population are considered.

The Eastern Sand Darter population in the Embarras River has previously been underrepresented. The finding of numerous individuals in this survey, and support for the fact that the population appears to be fairly stable for most of the length of the Embarras River, is likely due to a sampling bias. The methods in this survey were tailored specifically for capturing Eastern Sand Darters. The lack of a swim bladder and their ability to bury in the sandy substrates makes this species difficult to capture with several of the conventional fish community monitoring methods. Boat electrofishing, especially with Alternating Current (A/C), would likely stun the Eastern Sand Darters, but not pull them from the bottom for collectors to see. Seining without electrofishing is probably better suited to capture this species, but the authors observed sand darters burying in the substrate as they approached. The combination of the Direct Current (D/C) backpack electrofisher and seine was very effective at collecting this species. The backpack operator would walk directly in front of the net, waving the anode in front of the lead line of the seine. The D/C shocker would pull the sand darters out of and above the substrate by galvanotaxis, and the darters would subsequently be swept up with the seine (Figure 7). In some areas of the Embarras, the water was clear enough to observe this methodology work. This methodology, however, is not recommended for community-wide monitoring. The sampling crew often spooks large, mobile fishes as they approach; hence not a single common carp was caught in this survey. Relative abundance numbers for Eastern Sand Darters were given to illustrate their rank of

abundance next to the common mid-water and benthic species that are also susceptible to this sampling methodology.

Although Eastern Sand Darter numbers in the Embarras River were higher than previously thought, threats to the population are still prevalent. Row crop fields came all the way to the edge of the river in numerous places throughout the entire length of Embarras River that was sampled. In some cases the bankline supporting the row crops and the row crops themselves had washed into the river. Extensive areas of bank sloughing and siltation were observed in many places. Of the 220 stream miles assessed on the Embarras River by the Illinois Environmental Protection Agency (1996), 25 miles were rated as "good," and the overall resource quality of 195 stream miles were rated as "fair." Causes of pollution include nutrients and siltation attributed to agricultural runoff, resource extraction, hydrologic/habitat modifications, and point sources.

The Eastern Sand Darter does not appear to be in the lowest reaches of the Embarras River. The authors have conducted extensive collecting over the last 10 years in the area of Lawrenceville, Illinois and have never encountered the species. The area upstream and downstream of Lawrenceville is heavily modified by channelization and is subject to sewage effluents, industrial pollution, urbanization, and storm drainage. This stretch of the Embarras River may prevent immigration and emigration to and from the Wabash River, where the Eastern Sand Darter historically occurred.

This project and a study that was conducted by Brant Fisher of the Indiana DNR (2009) have both illustrated that the rarity of Harlequin Darter in the Wabash and other rivers has been in part a sampling bias. Capturing this species with conventional methods proved extremely difficult. Harlequin Darters found in this study were often in habitats that were not wadeable, and boat electrofishing would be ineffective due to the lack of swim bladder, diminutive size, and location in woody debris (Figure 8). The recent collections prove that the species is not as rare as once thought, but by no means proved that they are abundant or common. The difficulty in capturing this species, and the fact that once Fisher developed successful sampling techniques, the Harlequin Darter went

from being considered extirpated in Indiana to off the endangered list, leads the authors to believe that the species may still occur in the Embarras River. The last known locality was in Coles County below Lake Mattoon. In late summer of 2007, no flow was coming over the spillway of the lake, and for a great distance downstream, the Embarras River was pooled. Lack of flows in the upper reaches of the Embarras could have contributed to the decline of the Harlequin Darter. Pooled habitats, specifically during spawning times, over several years could be devastating to the population.

Observations of the Wabash River indicated that this river is still in good condition above the confluence with the Little Wabash River. According to the 1996 assessment by th Illinois EPA, all of the 108 stream miles assessed on the Wabash River were rated as "good" in terms of the overall resource quality. No causes or sources of pollution have been identified. However, below the confluence with the Little Wabash River, a covering of silt became apparent on the substrate and woody debris. Colonization of the woody debris by invertebrates became reduced as well. At the last island upstream of the confluence with the Little Wabash, six (6) Harlequin Darters were collected in ten (10) seine hauls. There was still a preponderance of habitat that was not sampled beyond the 10 hauls, and quite likely a number more Harlequin Darters at this site, but sampling had to cease due to approaching darkness. Sampling resumed below the confluence the next day, and no additional Harlequin Darters were captured throughout the remainder of the Wabash River. In addition to the suspected inputs of silt/sediment from the Little Wabash, the effects of impoundment from the Ohio River were becoming evident in the lower Wabash River. Higher sustained water levels with reduced flows gave the lower Wabash a more reservoir appearance. Sluggish flows and increased sedimentation were likely the reasons for the sudden lack of Harlequins in these samples.

No Harlequin Darters were captured in the Wabash upstream of the confluence with White River near Mt. Carmel, Illinois. This area may not be in the historic range of the species or the turbulent flows of "Grand Rapids" or "Beetle Dam" upstream of Mt. Carmel may act as a barrier. Habitat and stream health do not seem to be the limiting factor in the upper reaches of the Wabash River.

LITERATURE CITED

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Boschung, Herbert T. and Richard L. Mayden. 2004. Fishes of Alabama. Smithsonian Books, Washington. 736 pp.

Burr, B.M., Kenneth M. Cook, David J. Eisenhour, Kyle R. Piller, William J. Poly, Randy W. Sauer, Christopher A. Taylor, Elmer R. Atwood, and Gregory L. Seegert. 1996. Selected Illinois Fishes in Jeopardy: New Records and Status Evaluations. Transactions of the Illinois State Academy of Science. Volume 89, 3 and 4, pp.169-186.

Fisher, Brant. E. 2009. Current status and distribution of Indiana's seven endangered darter species (Percidae). Proceedings of the Indiana Academy of Science. FindArticles.com. http://findarticles.com/p/articles/mi_hb1430/is_2_117/ai_n31524688/

Kuehne, R. A. and Barbour, R. W. 1983. The American Darters. The University Press of Kansas. 177 pp.

Page, Lawrence M. and Michael E. Retzer. 2002. The Status of Illinois' Rarest Fishes and Crustaceans. Transactions of the Illinois State Academy of Science. Volume 95, #4, pp.311-326.

Rankin, Edward T. 1989. The Qualitative Habitat Evaluation Index [QHEI]: Rationale, Methods, and Application. Ecological Assessment Section, Division of Water Quality, Planning and Assessment, Ohio Environmental Protection Agency, Columbus, Ohio, USA. 54 pp.

Smith, Phillip W. 1979. The Fishes of Illinois. University of Illinois Press, Urbana. 314 pp.

Trautman, Milton B. 1981. The Fishes of Ohio. The Ohio State University Press. 7892 pp.

Table 1. Summary of collected Harlequin and Eastern Sand Darters 2007-2008.

DATE	STREAM	STATION #	# of A. pellucida	# of E. histrio
11-Jul-17	LITTLE WABASH RIVER	LWB01	0	0
12-Jul-07	LITTLE WABASH RIVER	LWB02	0	0
12-Jul-07	LITTLE WABASH RIVER	LWB03	0	0
12-Jul-07	LITTLE WABASH RIVER	LWB04	0	0
13-Jul-07	LITTLE WABASH RIVER	LWB05	0	0
13-Jul-07	LITTLE WABASH RIVER	LWB06	0	0
26-Jul-07	EMBARRASS RIVER	ERM01	75	0
27-Jul-07	EMBARRASS RIVER	ERM02	34	0
27-Jul-07	EMBARRASS RIVER	ERM03	19	0
27-Jul-07	EMBARRASS RIVER	ERM04	134	0
27-Jul-07	EMBARRASS RIVER	ERM05	23	0
27-Jul-07	EMBARRASS RIVER	ERM06	21	0
27-Jul-07	EMBARRASS RIVER	ERM07	23	0
27-Jul-07	EMBARRASS RIVER	ERM08	28	0
28-Jul-07	EMBARRASS RIVER	ERM09	1	0
28-Jul-07	EMBARRASS RIVER	ERM10	78	0
28-Jul-07	EMBARRASS RIVER	ERM11	31	0
28-Jul-07	EMBARRASS RIVER	ERM12	6	0
28-Jul-07	EMBARRASS RIVER	ERM13	0	0
29-Jul-07	EMBARRASS RIVER	ERM14	12	0
29-Jul-07	EMBARRASS RIVER	ERM15	17	0
29-Jul-07	EMBARRASS RIVER	ERM16	15	0
29-Jul-07	EMBARRASS RIVER	ERM17	2	0
29-Jul-07	EMBARRASS RIVER	ERM18	8	0
30-Jul-07	EMBARRASS RIVER	ERM19	10	0
30-Jul-07	EMBARRASS RIVER	ERM20	10	0
30-Jul-07	EMBARRASS RIVER	ERM21	9	0
31-Jul-07	EMBARRASS RIVER	ERM22	3	0
31-Jul-07	EMBARRASS RIVER	ERM23	3	0
25-Sep-07	EMBARRASS RIVER	ERM24	1	0
26-Sep-07	EMBARRASS RIVER	ERM25	5	0
26-Sep-07	EMBARRASS RIVER	ERM26	1	0
26-Sep-07	EMBARRASS RIVER	ERM27	5	0
27-Sep-07	EMBARRASS RIVER	ERM28	3	0
27-Sep-07	EMBARRASS RIVER	ERM29	2	0
27-Sep-07	EMBARRASS RIVER	ERM30	13	0
25-Jul-07	EMBARRASS RIVER	ERM31	21	0
24-Sep-07	EMBARRASS RIVER	ERM32	70	0
24-Sep-07	EMBARRASS RIVER	ERM33	63	0
25-Sep-07	EMBARRASS RIVER	ERM34	10	0
25-Sep-07	EMBARRASS RIVER	ERM35	13	0
27-Sep-07	EMBARRASS RIVER	ERM36	3	0
25-Jul-07	KICKAPOO CREEK	ERT01	4	0
24-Sep-07	MUDDY CREEK	ERT02	20	0
24-Sep-07	RANGE CREEK	ERT03	0	0
25-Sep-07	HURRICANE CREEK	ERT04	0	0
25-Sep-07	HURRICANE CREEK	ERT05	0	0
27-Sep-07	NORTH FORK EMBARRASS	ERT06	87	0

Table 1. (cont.) Summary of collected Harlequin and Eastern Sand Darters 2007-2008.

DATE	STREAM	STATION #	# of A. pellucida	# of E. histrio
10-Sep-08	WABASH RIVER	WAB01	0	0
10-Sep-08	WABASH RIVER	WAB02	0	0
11-Sep-08	WABASH RIVER	WAB03	0	0
17-Sep-08	WABASH RIVER	WAB04	0	0
17-Sep-08	WABASH RIVER	WAB05	0	0
17-Sep-08	WABASH RIVER	WAB06	0	0
14-Oct-08	WABASH RIVER	WAB07	0	0
14-Oct-08	WABASH RIVER	WAB08	0	0
14-Oct-08	WABASH RIVER	WAB09	0	0
14-Oct-08	WABASH RIVER	WAB10	0	0
15-Oct-08	WABASH RIVER	WAB11	0	0
15-Oct-08	WABASH RIVER	WAB12	0	2
15-Oct-08	WABASH RIVER	WAB13	0	0
16-Oct-08	WABASH RIVER	WAB14	0	0
16-Oct-08	WABASH RIVER	WAB15	0	1
16-Oct-08	WABASH RIVER	WAB16	0	1
16-Oct-08	WABASH RIVER	WAB17	0	1
17-Oct-08	WABASH RIVER	WAB18	0	1
17-Oct-08	WABASH RIVER	WAB19	0	1
17-Oct-08	WABASH RIVER	WAB20	0	1
17-Oct-08	WABASH RIVER	WAB21	0	1
17-Oct-08	WABASH RIVER	WAB22	0	2
18-Oct-08	WABASH RIVER	WAB23	0	1
18-Oct-08	WABASH RIVER	WAB24	0	1
18-Oct-08	WABASH RIVER	WAB25	0	1
18-Oct-08	WABASH RIVER	WAB26	0	1
18-Oct-08	WABASH RIVER	WAB27	0	6
19-Oct-08	WABASH RIVER	WAB28	0	0
TOTAL			883	21

Table 2. Species, numbers, and relative abundance of fish collected in the Embarrass River Drainage from 25 July, 2007 to 27 September, 2007.

Site:		ERM-01 Embarras River		ERM-10 Embarras River		ERM-14 Embarras River	
Species			Relative		Relative		Relative
Common Name	Scientific Name	#	Abundance	#	Abundance	#	Abundance
Gizzard Shad	Dorosoma cepedianum						
Creek Chub	Semotilus atromaculatus						
Central Stoneroller	Campostoma anomalum	8	0.46%	13	0.90%		
Suckermouth Minnow	Phenacobius mirabilis	17	0.97%	27	1.87%		
Silver Chub	Macrhybopsis storeriana						
Shoal Chub	Macrhybopsis hyostoma						
Redfin Shiner	Lythrurus umbratilis						
Steelcolor Shiner	Cyprinella whipplei	295	16.81%	123	8.51%	140	12.47%
Spotfin Shiner	Cyprinella spiloptera	330	18.80%	329	22.77%	219	19.50%
Striped Shiner	Luxilus chrysocephalus			1	0.07%	9	0.80%
Bluntnose Minnow	Pimephales notatus	86	4.90%	457	31.63%	390	34.73%
Bullhead Minnow	Pimephales vigilax	8	0.46%	6	0.42%	63	5.61%
Emerald Shiner	Notropis atherinoides						
River Shiner	Notropis blennius						
Sand Shiner	Notropis stramineus	245	13.96%	167	11.56%	178	15.85%
Silverjaw Minnow	Notropis buccatus	18	1.03%	64	4.43%	32	2.85%
Minnow	Cyprinidae						
Quillback	Carpiodes cyprinus						
River Carpsucker	Carpiodes carpio						
Highfin Carpsucker	Carpiodes velifer						
Carpiodes spp.	Carpiodes spp.			1	0.07%	1	0.09%
White Sucker	Catostomus commersoni						
Spotted Sucker	Minytrema melanops						
Creek Chubsucker	Erimyzon oblongus						
Northern Hog Sucker	Hypentelium nigricans	21	1.20%	32	2.21%		
Shorthead Redhorse	Moxostoma macrolepidotum			9	0.62%		
Golden Redhorse	Moxostoma erythrurum	52	2.96%	13	0.90%	32	2.85%
Moxostoma spp.	Moxostoma spp.						
Channel Catfish	Ictalurus punctatus	46	2.62%	41	2.84%	1	0.09%
Yellow Bullhead	Ameiurus natalis						
Flathead Catfish	Pylodictus olivaris						
Freckled Madtom	Noturus nocturnus	1	0.06%				
Mountain Madtom	Noturus eleuthurus						
Brindled Madtom	Noturus miurus	6	0.34%	2	0.14%	4	0.36%
Blackstripe Topminnow	Fundulus notatus						
Western Mosquitofish	Gambusia affinis						
Brook Silverside	Labidesthes sicculus	15	0.85%	12	0.83%	4	0.36%
Largemouth Bass	Micropterus salmoides						
Spotted Bass	Micropterus punctulatus	23	1.31%	3	0.21%	32	2.85%
Green Sunfish	Lepomis cyanellus						
Bluegill	Lepomis macrochirus			1	0.07%		
Longear Sunfish	Lepomis megalotis	11	0.63%	2	0.14%	1	0.09%
Orangespotted Sunfish	Lepomis humilis						
Dusky Darter	Percina sciera	89	5.07%	60	4.15%	3	0.27%
Slenderhead Darter	Percina phoxocephala	49	2.79%	4	0.28%	1	0.09%
Logperch	Percina caprodes	21	1.20%				
Eastern Sand Darter	**Ammocrypta pellucida**	**75**	**4.27%**	**78**	**5.40%**	**12**	**1.07%**
Johnny Darter	Etheostoma nigrum						
Greenside Darter	Etheostoma blennioides	320	18.23%			1	0.09%
Harlequin Darter	**Etheostoma histrio**						
Rainbow Darter	Etheostoma caeruleum						
Orangethroat Darter	Etheostoma spectabile	5	0.28%				
Fantail Darter	Etheostoma flabellare	14	0.80%				
	TOTAL	1755	1	1445	1	1123	1
Length of stream sampled/ Sampling effort		10 seine hauls		10 seine hauls		10 seine hauls	

Table 2. (cont.) Species, numbers, and relative abundance of fish collected in the Embarrass River Drainage from 25 July, 2007 to 27 September, 2007.

Site:		ERM-15 Embarras River		ERM-21 Embarras River		ERM-25 Embarras River	
Common Name	Species Scientific Name	#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Gizzard Shad	Dorosoma cepedianum						
Creek Chub	Semotilus atromaculatus	25	2.18%	5	0.60%		
Central Stoneroller	Campostoma anomalum	9	0.79%				
Suckermouth Minnow	Phenacobius mirabilis	31	2.71%	22	2.64%	25	2.99%
Silver Chub	Macrhybopsis storeriana						
Shoal Chub	Macrhybopsis hyostoma					1	0.12%
Redfin Shiner	Lythrurus umbratilis						
Steelcolor Shiner	Cyprinella whipplei	67	5.85%	118	14.17%	396	47.43%
Spotfin Shiner	Cyprinella spiloptera	155	13.53%	247	29.65%	121	14.49%
Striped Shiner	Luxilus chrysocephalus						
Bluntnose Minnow	Pimephales notatus	360	31.41%	195	23.41%	80	9.58%
Bullhead Minnow	Pimephales vigilax	46	4.01%	67	8.04%	77	9.22%
Emerald Shiner	Notropis atherinoides					4	0.48%
River Shiner	Notropis blennius						
Sand Shiner	Notropis stramineus	187	16.32%	21	2.52%	10	1.20%
Silverjaw Minnow	Notropis buccatus	9	0.79%	42	5.04%	6	0.72%
Minnow	Cyprinidae			27	3.24%		
Quillback	Carpiodes cyprinus						
River Carpsucker	Carpiodes carpio						
Highfin Carpsucker	Carpiodes velifer						
Carpiodes spp.	Carpiodes spp.	17	1.48%	3	0.36%		
White Sucker	Catostomus commersoni						
Spotted Sucker	Minytrema melanops						
Creek Chubsucker	Erimyzon oblongus	1	0.09%				
Northern Hog Sucker	Hypentelium nigricans	4	0.35%	2	0.24%		
Shorthead Redhorse	Moxostoma macrolepidotum						
Golden Redhorse	Moxostoma erythrurum	15	1.31%	8	0.96%	1	0.12%
Moxostoma spp.	Moxostoma spp.						
Channel Catfish	Ictalurus punctatus	42	3.66%	40	4.80%	75	8.98%
Yellow Bullhead	Ameiurus natalis						
Flathead Catfish	Pylodictus olivaris					1	0.12%
Freckled Madtom	Noturus nocturnus						
Mountain Madtom	Noturus eleuthurus						
Brindled Madtom	Noturus miurus	2	0.17%				
Blackstripe Topminnow	Fundulus notatus						
Western Mosquitofish	Gambusia affinis			6	0.72%		
Brook Silverside	Labidesthes sicculus	3	0.26%			10	1.20%
Largemouth Bass	Micropterus salmoides						
Spotted Bass	Micropterus punctulatus	12	1.05%	2	0.24%	1	0.12%
Green Sunfish	Lepomis cyanellus						
Bluegill	Lepomis macrochirus			1	0.12%		
Longear Sunfish	Lepomis megalotis						
Orangespotted Sunfish	Lepomis humilis						
Dusky Darter	Percina sciera	102	8.90%	16	1.92%	10	1.20%
Slenderhead Darter	Percina phoxocephala	42	3.66%	2	0.24%	10	1.20%
Logperch	Percina caprodes					1	0.12%
Eastern Sand Darter	**Ammocrypta pellucida**	17	1.48%	9	1.08%	5	0.60%
Johnny Darter	Etheostoma nigrum						
Greenside Darter	Etheostoma blennioides						
Harlequin Darter	**Etheostoma histrio**						
Rainbow Darter	Etheostoma caeruleum						
Orangethroat Darter	Etheostoma spectabile					1	0.12%
Fantail Darter	Etheostoma flabellare						
	TOTAL	1146	1	833	1	835	1
Length of stream sampled/ Sampling effort		10 seine hauls		10 seine hauls		10 seine hauls	

Table 2. (cont.) Species, numbers, and relative abundance of fish collected in the Embarrass River Drainage from 25 July, 2007 to 27 September, 2007.

Species		Site:	ERM-28 Embarras River		ERM-29 Embarras River		ERM-31 Embarras River	
Common Name	Scientific Name		#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Gizzard Shad	Dorosoma cepedianum							
Creek Chub	Semotilus atromaculatus						4	0.19%
Central Stoneroller	Campostoma anomalum						1	0.05%
Suckermouth Minnow	Phenacobius mirabilis		17	2.57%	18	2.59%	64	3.00%
Silver Chub	Macrhybopsis storeriana							
Shoal Chub	Macrhybopsis hyostoma				1	0.14%		
Redfin Shiner	Lythrurus umbratilis							
Steelcolor Shiner	Cyprinella whipplei		87	13.14%	150	21.58%	501	23.50%
Spotfin Shiner	Cyprinella spiloptera		130	19.64%	85	12.23%	393	18.43%
Striped Shiner	Luxilus chrysocephalus		1	0.15%				
Bluntnose Minnow	Pimephales notatus		68	10.27%	66	9.50%	541	25.38%
Bullhead Minnow	Pimephales vigilax		56	8.46%	48	6.91%	184	8.63%
Emerald Shiner	Notropis atherinoides		15	2.27%	20	2.88%	5	0.23%
River Shiner	Notropis blennius				4	0.58%		
Sand Shiner	Notropis stramineus		103	15.56%	115	16.55%	98	4.60%
Silverjaw Minnow	Notropis buccatus		47	7.10%	46	6.62%	62	2.91%
Minnow	Cyprinidae		18	2.72%				
Quillback	Carpiodes cyprinus							
River Carpsucker	Carpiodes carpio							
Highfin Carpsucker	Carpiodes velifer							
Carpiodes spp.	Carpiodes spp.		16	2.42%	16	2.30%		
White Sucker	Catostomus commersoni							
Spotted Sucker	Minytrema melanops							
Creek Chubsucker	Erimyzon oblongus							
Northern Hog Sucker	Hypentelium nigricans							
Shorthead Redhorse	Moxostoma macrolepidotum		19	2.87%	22	3.17%	7	0.33%
Golden Redhorse	Moxostoma erythrurum		3	0.45%			2	0.09%
Moxostoma spp.	Moxostoma spp.							
Channel Catfish	Ictalurus punctatus		26	3.93%	50	7.19%	134	6.29%
Yellow Bullhead	Ameiurus natalis							
Flathead Catfish	Pylodictus olivaris							
Freckled Madtom	Noturus nocturnus							
Mountain Madtom	Noturus eleuthurus							
Brindled Madtom	Noturus miurus							
Blackstripe Topminnow	Fundulus notatus							
Western Mosquitofish	Gambusia affinis		19	2.87%	17	2.45%	46	2.16%
Brook Silverside	Labidesthes sicculus		2	0.30%	2	0.29%	9	0.42%
Largemouth Bass	Micropterus salmoides							
Spotted Bass	Micropterus punctulatus		2	0.30%	3	0.43%	1	0.05%
Green Sunfish	Lepomis cyanellus							
Bluegill	Lepomis macrochirus						6	0.28%
Longear Sunfish	Lepomis megalotis						8	0.38%
Orangespotted Sunfish	Lepomis humilis							
Dusky Darter	Percina sciera		24	3.63%	24	3.45%	42	1.97%
Slenderhead Darter	Percina phoxocephala		4	0.60%	4	0.58%	3	0.14%
Logperch	Percina caprodes							
Eastern Sand Darter	**Ammocrypta pellucida**		3	0.45%	2	0.29%	21	0.98%
Johnny Darter	Etheostoma nigrum		2	0.30%	2	0.29%		
Greenside Darter	Etheostoma blennioides							
Harlequin Darter	**Etheostoma histrio**							
Rainbow Darter	Etheostoma caeruleum							
Orangethroat Darter	Etheostoma spectabile							0.00%
Fantail Darter	Etheostoma flabellare							
	TOTAL		662	1	695	1	2132	1
Length of stream sampled/ Sampling effort			10 seine hauls		10 seine hauls		10 seine hauls	

Table 2. (cont.) Species, numbers, and relative abundance of fish collected in the Embarrass River Drainage from 25 July, 2007 to 27 September, 2007.

Site:		ERM-32 Embarras River		ERM-33 Embarras River		ERM-34 Embarras River	
Species			Relative		Relative		Relative
Common Name	Scientific Name	#	Abundance	#	Abundance	#	Abundance
Gizzard Shad	Dorosoma cepedianum						
Creek Chub	Semotilus atromaculatus	3	0.08%	9	0.38%		
Central Stoneroller	Campostoma anomalum	4	0.10%	7	0.29%		
Suckermouth Minnow	Phenacobius mirabilis	73	1.90%	31	1.30%	24	3.33%
Silver Chub	Macrhybopsis storeriana						
Shoal Chub	Macrhybopsis hyostoma						
Redfin Shiner	Lythrurus umbratilis						
Steelcolor Shiner	Cyprinella whipplei	741	19.30%	456	19.15%	237	32.92%
Spotfin Shiner	Cyprinella spiloptera	1111	28.94%	684	28.73%	169	23.47%
Striped Shiner	Luxilus chrysocephalus						
Bluntnose Minnow	Pimephales notatus	701	18.26%	371	15.58%	29	4.03%
Bullhead Minnow	Pimephales vigilax	598	15.58%	154	6.47%	78	10.83%
Emerald Shiner	Notropis atherinoides					39	5.42%
River Shiner	Notropis blennius					1	0.14%
Sand Shiner	Notropis stramineus	193	5.03%	194	8.15%	17	2.36%
Silverjaw Minnow	Notropis buccatus	103	2.68%	145	6.09%	4	0.56%
Minnow	Cyprinidae						
Quillback	Carpiodes cyprinus						
River Carpsucker	Carpiodes carpio			4	0.17%		
Highfin Carpsucker	Carpiodes velifer						
Carpiodes spp.	Carpiodes spp.	35	0.91%				
White Sucker	Catostomus commersoni						
Spotted Sucker	Minytrema melanops					1	0.14%
Creek Chubsucker	Erimyzon oblongus						
Northern Hog Sucker	Hypentelium nigricans	6	0.16%				
Shorthead Redhorse	Moxostoma macrolepidotum	2	0.05%			16	2.22%
Golden Redhorse	Moxostoma erythrurum	1	0.03%	1	0.04%		
Moxostoma spp.	Moxostoma spp.						
Channel Catfish	Ictalurus punctatus	91	2.37%	63	2.65%	53	7.36%
Yellow Bullhead	Ameiurus natalis						
Flathead Catfish	Pylodictus olivaris						
Freckled Madtom	Noturus nocturnus						
Mountain Madtom	Noturus eleuthurus					1	0.14%
Brindled Madtom	Noturus miurus	2	0.05%	1	0.04%		
Blackstripe Topminnow	Fundulus notatus						
Western Mosquitofish	Gambusia affinis	85	2.21%	190	7.98%	24	3.33%
Brook Silverside	Labidesthes sicculus						
Largemouth Bass	Micropterus salmoides						
Spotted Bass	Micropterus punctulatus	1	0.03%			1	0.14%
Green Sunfish	Lepomis cyanellus						
Bluegill	Lepomis macrochirus	1	0.03%			2	0.28%
Longear Sunfish	Lepomis megalotis	1	0.03%	1	0.04%		
Orangespotted Sunfish	Lepomis humilis						
Dusky Darter	Percina sciera	14	0.36%	7	0.29%	4	0.56%
Slenderhead Darter	Percina phoxocephala	2	0.05%			10	1.39%
Logperch	Percina caprodes						
Eastern Sand Darter	**Ammocrypta pellucida**	**70**	**1.82%**	**63**	**2.65%**	**10**	**1.39%**
Johnny Darter	Etheostoma nigrum	1	0.03%				
Greenside Darter	Etheostoma blennioides						
Harlequin Darter	**Etheostoma histrio**						
Rainbow Darter	Etheostoma caeruleum						
Orangethroat Darter	Etheostoma spectabile						
Fantail Darter	Etheostoma flabellare						
	TOTAL	3839	1	2381	1	720	1
Length of stream sampled/ Sampling effort		10 seine hauls		10 seine hauls		10 seine hauls	

Table 2. (cont.) Species, numbers, and relative abundance of fish collected in the Embarrass River Drainage from 25 July, 2007 to 27 September, 2007.

Species		Site:	ERM-35 Embarras River		ERM-36 Embarras River	
Common Name	Scientific Name		#	Relative Abundance	#	Relative Abundance
Gizzard Shad	Dorosoma cepedianum				2	0.13%
Creek Chub	Semotilus atromaculatus					
Central Stoneroller	Campostoma anomalum					
Suckermouth Minnow	Phenacobius mirabilis		6	0.59%		
Silver Chub	Macrhybopsis storeriana				1	0.06%
Shoal Chub	Macrhybopsis hyostoma		21	2.05%	39	2.49%
Redfin Shiner	Lythrurus umbratilis					
Steelcolor Shiner	Cyprinella whipplei		291	28.45%	265	16.89%
Spotfin Shiner	Cyprinella spiloptera		380	37.15%	647	41.24%
Striped Shiner	Luxilus chrysocephalus					
Bluntnose Minnow	Pimephales notatus		21	2.05%	31	1.98%
Bullhead Minnow	Pimephales vigilax		51	4.99%	308	19.63%
Emerald Shiner	Notropis atherinoides		22	2.15%	29	1.85%
River Shiner	Notropis blennius			0.00%		
Sand Shiner	Notropis stramineus		22	2.15%		
Silverjaw Minnow	Notropis buccatus		46	4.50%		
Minnow	Cyprinidae					
Quillback	Carpiodes cyprinus					
River Carpsucker	Carpiodes carpio		3	0.29%	1	0.06%
Highfin Carpsucker	Carpiodes velifer					
Carpiodes spp.	Carpiodes spp.		1	0.10%		
White Sucker	Catostomus commersoni					
Spotted Sucker	Minytrema melanops					
Creek Chubsucker	Erimyzon oblongus					
Northern Hog Sucker	Hypentelium nigricans				1	0.06%
Shorthead Redhorse	Moxostoma macrolepidotum		1	0.10%	7	0.45%
Golden Redhorse	Moxostoma erythrurum					
Moxostoma spp.	Moxostoma spp.					
Channel Catfish	Ictalurus punctatus		120	11.73%	154	9.82%
Yellow Bullhead	Ameiurus natalis					
Flathead Catfish	Pylodictus olivaris					
Freckled Madtom	Noturus nocturnus					
Mountain Madtom	Noturus eleuthurus				2	0.13%
Brindled Madtom	Noturus miurus					
Blackstripe Topminnow	Fundulus notatus					
Western Mosquitofish	Gambusia affinis		18	1.76%	44	2.80%
Brook Silverside	Labidesthes sicculus		2	0.20%		
Largemouth Bass	Micropterus salmoides					
Spotted Bass	Micropterus punctulatus					
Green Sunfish	Lepomis cyanellus					
Bluegill	Lepomis macrochirus					
Longear Sunfish	Lepomis megalotis					
Orangespotted Sunfish	Lepomis humilis					
Dusky Darter	Percina sciera		4	0.39%	9	0.57%
Slenderhead Darter	Percina phoxocephala				25	1.59%
Logperch	Percina caprodes				1	0.06%
Eastern Sand Darter	**Ammocrypta pellucida**		**13**	**1.27%**	**3**	**0.19%**
Johnny Darter	Etheostoma nigrum		1	0.10%		
Greenside Darter	Etheostoma blennioides					
Harlequin Darter	**Etheostoma histrio**					
Rainbow Darter	Etheostoma caeruleum					
Orangethroat Darter	Etheostoma spectabile					
Fantail Darter	Etheostoma flabellare					
	TOTAL		1023	1	1569	1
Length of stream sampled/ Sampling effort			10 seine hauls		10 seine hauls	

Table 2. (cont.) Species, numbers, and relative abundance of fish collected in the Embarrass River Drainage from 25 July, 2007 to 27 September, 2007.

Site:		ERT-01 Kickapoo Creek		ERT-02 Muddy Creek		ERT-06 North Fork of the Embarras	
Common Name	Scientific Name	#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Gizzard Shad	Dorosoma cepedianum			2	0.16%		
Creek Chub	Semotilus atromaculatus	25	0.73%	6	0.48%		
Central Stoneroller	Campostoma anomalum	362	10.52%				
Suckermouth Minnow	Phenacobius mirabilis	22	0.64%	77	6.20%	7	0.49%
Silver Chub	Macrhybopsis storeriana						
Shoal Chub	Macrhybopsis hyostoma						
Redfin Shiner	Lythrurus umbratilis	49	1.42%	14	1.13%		
Steelcolor Shiner	Cyprinella whipplei	193	5.61%	101	8.13%	162	11.38%
Spotfin Shiner	Cyprinella spiloptera	116	3.37%	158	12.72%	199	13.98%
Striped Shiner	Luxilus chrysocephalus	88	2.56%	43	3.46%	2	0.14%
Bluntnose Minnow	Pimephales notatus	417	12.12%	172	13.85%	199	13.98%
Bullhead Minnow	Pimephales vigilax			94	7.57%	16	1.12%
Emerald Shiner	Notropis atherinoides			12	0.97%	101	7.10%
River Shiner	Notropis blennius						
Sand Shiner	Notropis stramineus	253	7.35%	71	5.72%	206	14.48%
Silverjaw Minnow	Notropis buccatus	339	9.85%	113	9.10%	269	18.90%
Minnow	Cyprinidae						
Quillback	Carpiodes cyprinus			1	0.08%		
River Carpsucker	Carpiodes carpio			1	0.08%		
Highfin Carpsucker	Carpiodes velifer			1	0.08%		
Carpiodes spp.	Carpiodes spp.	8	0.23%				
White Sucker	Catostomus commersoni	63	1.83%	1	0.08%		
Spotted Sucker	Minytrema melanops					2	0.14%
Creek Chubsucker	Erimyzon oblongus						
Northern Hog Sucker	Hypentelium nigricans	160	4.65%	6	0.48%		
Shorthead Redhorse	Moxostoma macrolepidotum			34	2.74%	41	2.88%
Golden Redhorse	Moxostoma erythrurum	140	4.07%	33	2.66%	33	2.32%
Moxostoma spp.	Moxostoma spp.	38	1.10%				
Channel Catfish	Ictalurus punctatus			1	0.08%		
Yellow Bullhead	Ameiurus natalis	1	0.03%				
Flathead Catfish	Pylodictus olivaris						
Freckled Madtom	Noturus nocturnus						
Mountain Madtom	Noturus eleuthurus						
Brindled Madtom	Noturus miurus	6	0.17%	14	1.13%	21	1.48%
Blackstripe Topminnow	Fundulus notatus	3	0.09%	76	6.12%	6	0.42%
Western Mosquitofish	Gambusia affinis	1	0.03%	1	0.08%	6	0.42%
Brook Silverside	Labidesthes sicculus	9	0.26%	105	8.45%	4	0.28%
Largemouth Bass	Micropterus salmoides			1	0.08%		
Spotted Bass	Micropterus punctulatus	14	0.41%	12	0.97%	14	0.98%
Green Sunfish	Lepomis cyanellus	3	0.09%	2	0.16%		
Bluegill	Lepomis macrochirus			11	0.89%	3	0.21%
Longear Sunfish	Lepomis megalotis	7	0.20%	39	3.14%	21	1.48%
Orangespotted Sunfish	Lepomis humilis			1	0.08%		
Dusky Darter	Percina sciera	2	0.06%	7	0.56%	21	1.48%
Slenderhead Darter	Percina phoxocephala					2	0.14%
Logperch	Percina caprodes			1	0.08%	1	0.07%
Eastern Sand Darter	**Ammocrypta pellucida**	4	**0.12%**	**20**	**1.61%**	**87**	**6.11%**
Johnny Darter	Etheostoma nigrum	300	8.72%	3	0.24%		
Greenside Darter	Etheostoma blennioides	355	10.32%	6	0.48%		
Harlequin Darter	**Etheostoma histrio**						
Rainbow Darter	Etheostoma caeruleum	344	10.00%				
Orangethroat Darter	Etheostoma spectabile	119	3.46%	2	0.16%		
Fantail Darter	Etheostoma flabellare						
	TOTAL	3441	1	1242	1	1423	1
Length of stream sampled/ Sampling effort		500 m		10 seine hauls		10 seine hauls	

Table 3. Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Species		Site:	WAB-01 Wabash River		WAB-02 Wabash River		WAB-03 Wabash River	
Common Name	Scientific Name		#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus							
Gizzard Shad	Dorosoma cepedianum							
Common Carp	Cyprinus carpio							
Central Stoneroller	Campostoma anomalum							
Suckermouth Minnow	Phenacobius mirabilis							
Silver Chub	Macrhybopsis storeriana		1	0.18%				
Shoal Chub	Macrhybopsis hyostoma		1	0.18%				
Mississippi Silvery Minnow	Hybognathus nuchalis							
Steelcolor Shiner	Cyprinella whipplei		46	8.33%				
Spotfin Shiner	Cyprinella spiloptera		125	22.64%	66	70.21%		
Striped Shiner	Luxilus chrysocephalus							
Bluntnose Minnow	Pimephales notatus		1	0.18%				
Bullhead Minnow	Pimephales vigilax		17	3.08%	3	3.19%		
Emerald Shiner	Notropis atherinoides		222	40.22%	8	8.51%	27	65.85%
River Shiner	Notropis blennius		80	14.49%	9	9.57%		
Sand Shiner	Notropis stramineus							
Mimic Shiner	Notropis volucellus		1	0.18%	1	1.06%		
Bigeye Chub	Hybopsis amplops		5	0.91%				
Silverjaw Minnow	Ericymba buccata							
Ictiobus spp.	Ictiobus spp.							
River Carpsucker	Carpiodes carpio							
Carpiodes spp.	Carpiodes spp.		2	0.36%				
White Sucker	Catostomus commersoni							
Shorthead Redhorse	Moxostoma macrolepidotum							
Channel Catfish	Ictalurus punctatus		33	5.98%			2	4.88%
Flathead Catfish	Pylodictus olivaris		3	0.54%	1	1.06%	3	7.32%
Stonecat	Noturus flavus							
Freckled Madtom	Noturus nocturnus						1	2.44%
Slender Madtom	Noturus exilis							
Mountain Madtom	Noturus eleuthurus							
Brindled Madtom	Noturus miurus							
Western Mosquitofish	Gambusia affinis				1	1.06%		
Brook Silverside	Labidesthes sicculus							
White Bass	Morone chrysops							
Black Crappie	Pomoxis nigromaculatus							
Spotted Bass	Micropterus punctulatus		2	0.36%	1	1.06%	6	14.63%
Green Sunfish	Lepomis cyanellus		3	0.54%				
Bluegill	Lepomis macrochirus							
Longear Sunfish	Lepomis megalotis							
Orangespotted Sunfish	Lepomis humilis							
Dusky Darter	Percina sciera		8	1.45%	2	2.13%		
River Darter	Percina shumardi							
Slenderhead Darter	Percina phoxocephala							
Logperch	Percina caprodes						1	2.44%
Eastern Sand Darter	**Ammocrypta pellucida**							
Bluntnose Darter	Etheostoma chlorosomum				1	1.06%		
Greenside Darter	Etheostoma blennioides		1	0.18%				
Harlequin Darter	**Etheostoma histrio**							
Mud Darter	Etheostoma asprigene		1	0.18%	1	1.06%		
Orangethroat Darter	Etheostoma spectabile							
Freshwater Drum	Aplodinotus grunniens						1	2.44%
	TOTAL		552	1	94	1	41	1
Sampling effort/Type			10 seine hauls		10 seine hauls		10 seine hauls	

Table 3. (cont.) Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Site:		WAB-04 Wabash River		WAB-05 Wabash River		WAB-06 Wabash River	
Species							
Common Name	Scientific Name	#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus						
Gizzard Shad	Dorosoma cepedianum	1	0.26%				
Common Carp	Cyprinus carpio	1	0.26%	1	0.55%		
Central Stoneroller	Campostoma anomalum	1	0.26%				
Suckermouth Minnow	Phenacobius mirabilis			3	1.66%		
Silver Chub	Macrhybopsis storeriana	1	0.26%	13	7.18%	1	0.72%
Shoal Chub	Macrhybopsis hyostoma			4	2.21%		
Mississippi Silvery Minnow	Hybognathus nuchalis	5	1.32%	5	2.76%	11	7.91%
Steelcolor Shiner	Cyprinella whipplei			2	1.10%	4	2.88%
Spotfin Shiner	Cyprinella spiloptera	85	22.49%	8	4.42%	5	3.60%
Striped Shiner	Luxilus chrysocephalus	1	0.26%				
Bluntnose Minnow	Pimephales notatus	12	3.17%	7	3.87%	1	0.72%
Bullhead Minnow	Pimephales vigilax	2	0.53%			28	20.14%
Emerald Shiner	Notropis atherinoides	24	6.35%	3	1.66%	9	6.47%
River Shiner	Notropis blennius	172	45.50%	46	25.41%	14	10.07%
Sand Shiner	Notropis stramineus			1	0.55%		
Mimic Shiner	Notropis volucellus			1	0.55%	5	3.60%
Bigeye Chub	Hybopsis amplops						
Silverjaw Minnow	Ericymba buccata			1	0.55%		
Ictiobus spp.	Ictiobus spp.			1	0.55%		
River Carpsucker	Carpiodes carpio					1	0.72%
Carpiodes spp.	Carpiodes spp.					13	9.35%
White Sucker	Catostomus commersoni						
Shorthead Redhorse	Moxostoma macrolepidotum					1	0.72%
Channel Catfish	Ictalurus punctatus	2	0.53%	64	35.36%	16	11.51%
Flathead Catfish	Pylodictus olivaris	1	0.26%	1	0.55%		
Stonecat	Noturus flavus			2	1.10%		
Freckled Madtom	Noturus nocturnus			1	0.55%		
Slender Madtom	Noturus exilis						
Mountain Madtom	Noturus eleuthurus			1	0.55%		
Brindled Madtom	Noturus miurus	4	1.06%				
Western Mosquitofish	Gambusia affinis	34	8.99%			3	2.16%
Brook Silverside	Labidesthes sicculus	1	0.26%			2	1.44%
White Bass	Morone chrysops						
Black Crappie	Pomoxis nigromaculatus						
Spotted Bass	Micropterus punctulatus	2	0.53%	3	1.66%	10	7.19%
Green Sunfish	Lepomis cyanellus	1	0.26%	1	0.55%		
Bluegill	Lepomis macrochirus	17	4.50%			5	3.60%
Longear Sunfish	Lepomis megalotis	3	0.79%			1	0.72%
Orangespotted Sunfish	Lepomis humilis						
Dusky Darter	Percina sciera			7	3.87%		
River Darter	Percina shumardi			1	0.55%		
Slenderhead Darter	Percina phoxocephala						
Logperch	Percina caprodes						
Eastern Sand Darter	**Ammocrypta pellucida**						
Bluntnose Darter	Etheostoma chlorosomum	1	0.26%				
Greenside Darter	Etheostoma blennioides						
Harlequin Darter	**Etheostoma histrio**						
Mud Darter	Etheostoma asprigene	2	0.53%			1	0.72%
Orangethroat Darter	Etheostoma spectabile			2	1.10%		
Freshwater Drum	Aplodinotus grunniens	5	1.32%	2	1.10%	8	5.76%
	TOTAL	378	1	181	1	139	1
Sampling effort/Type		10 Seine Hauls		10 Seine Hauls		10 Seine Hauls	

Table 3. (cont.) Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Species		Site:	WAB-07 Wabash River		WAB-08 Wabash River		WAB-09 Wabash River	
Common Name	Scientific Name		#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus							
Gizzard Shad	Dorosoma cepedianum							
Common Carp	Cyprinus carpio							
Central Stoneroller	Campostoma anomalum							
Suckermouth Minnow	Phenacobius mirabilis							
Silver Chub	Macrhybopsis storeriana							
Shoal Chub	Macrhybopsis hyostoma						1	0.18%
Mississippi Silvery Minnow	Hybognathus nuchalis						7	1.24%
Steelcolor Shiner	Cyprinella whipplei		4	5.63%			117	20.78%
Spotfin Shiner	Cyprinella spiloptera		30	42.25%			237	42.10%
Striped Shiner	Luxilus chrysocephalus							
Bluntnose Minnow	Pimephales notatus							
Bullhead Minnow	Pimephales vigilax		6	8.45%			12	2.13%
Emerald Shiner	Notropis atherinoides		18	25.35%			54	9.59%
River Shiner	Notropis blennius		2	2.82%			104	18.47%
Sand Shiner	Notropis stramineus							
Mimic Shiner	Notropis volucellus						4	0.71%
Bigeye Chub	Hybopsis amplops							
Silverjaw Minnow	Ericymba buccata							
Ictiobus spp.	Ictiobus spp.							
River Carpsucker	Carpiodes carpio							
Carpiodes spp.	Carpiodes spp.							
White Sucker	Catostomus commersoni							
Shorthead Redhorse	Moxostoma macrolepidotum							
Channel Catfish	Ictalurus punctatus						13	2.31%
Flathead Catfish	Pylodictus olivaris		1	1.41%				
Stonecat	Noturus flavus							
Freckled Madtom	Noturus nocturnus							
Slender Madtom	Noturus exilis							
Mountain Madtom	Noturus eleuthurus				1	4.35%		
Brindled Madtom	Noturus miurus							
Western Mosquitofish	Gambusia affinis							
Brook Silverside	Labidesthes sicculus							
White Bass	Morone chrysops							
Black Crappie	Pomoxis nigromaculatus							
Spotted Bass	Micropterus punctulatus		5	7.04%	3	13.04%	7	1.24%
Green Sunfish	Lepomis cyanellus				1	4.35%		
Bluegill	Lepomis macrochirus							
Longear Sunfish	Lepomis megalotis							
Orangespotted Sunfish	Lepomis humilis						1	0.18%
Dusky Darter	Percina sciera		3	4.23%	12	52.17%	4	0.71%
River Darter	Percina shumardi							
Slenderhead Darter	Percina phoxocephala				6	26.09%		
Logperch	Percina caprodes							
Eastern Sand Darter	**Ammocrypta pellucida**							
Bluntnose Darter	Etheostoma chlorosomum							
Greenside Darter	Etheostoma blennioides							
Harlequin Darter	**Etheostoma histrio**							
Mud Darter	Etheostoma asprigene		2	2.82%			2	0.36%
Orangethroat Darter	Etheostoma spectabile							
Freshwater Drum	Aplodinotus grunniens							
	TOTAL		71	1	23	1	563	1
Sampling effort/Type			10 seine hauls		10 seine hauls		10 seine hauls	

Table 3. (cont.) Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Species		Site:	WAB-10 Wabash River		WAB-11 Wabash River		WAB-12 Wabash River	
Common Name	Scientific Name		#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus							
Gizzard Shad	Dorosoma cepedianum							
Common Carp	Cyprinus carpio				1	10.00%		
Central Stoneroller	Campostoma anomalum							
Suckermouth Minnow	Phenacobius mirabilis							
Silver Chub	Macrhybopsis storeriana							
Shoal Chub	Macrhybopsis hyostoma		1	1.28%				
Mississippi Silvery Minnow	Hybognathus nuchalis							
Steelcolor Shiner	Cyprinella whipplei						4	3.70%
Spotfin Shiner	Cyprinella spiloptera		8	10.26%			24	22.22%
Striped Shiner	Luxilus chrysocephalus							
Bluntnose Minnow	Pimephales notatus							
Bullhead Minnow	Pimephales vigilax		7	8.97%			3	2.78%
Emerald Shiner	Notropis atherinoides		1	1.28%			45	41.67%
River Shiner	Notropis blennius		11	14.10%			1	0.93%
Sand Shiner	Notropis stramineus							
Mimic Shiner	Notropis volucellus		1	1.28%			7	6.48%
Bigeye Chub	Hybopsis amplops							
Silverjaw Minnow	Ericymba buccata							
Ictiobus spp.	Ictiobus spp.							
River Carpsucker	Carpiodes carpio							
Carpiodes spp.	Carpiodes spp.							
White Sucker	Catostomus commersoni							
Shorthead Redhorse	Moxostoma macrolepidotum							
Channel Catfish	Ictalurus punctatus		12	15.38%			2	1.85%
Flathead Catfish	Pylodictus olivaris		1	1.28%			1	0.93%
Stonecat	Noturus flavus							
Freckled Madtom	Noturus nocturnus		2	2.56%			2	1.85%
Slender Madtom	Noturus exilis							
Mountain Madtom	Noturus eleuthurus							
Brindled Madtom	Noturus miurus							
Western Mosquitofish	Gambusia affinis							
Brook Silverside	Labidesthes sicculus				1	10.00%	1	0.93%
White Bass	Morone chrysops						1	0.93%
Black Crappie	Pomoxis nigromaculatus							
Spotted Bass	Micropterus punctulatus		13	16.67%			7	6.48%
Green Sunfish	Lepomis cyanellus		4	5.13%				
Bluegill	Lepomis macrochirus		2	2.56%				
Longear Sunfish	Lepomis megalotis		6	7.69%				
Orangespotted Sunfish	Lepomis humilis		1	1.28%				
Dusky Darter	Percina sciera		3	3.85%	4	40.00%	6	5.56%
River Darter	Percina shumardi							
Slenderhead Darter	Percina phoxocephala							
Logperch	Percina caprodes							
Eastern Sand Darter	**Ammocrypta pellucida**							
Bluntnose Darter	Etheostoma chlorosomum							
Greenside Darter	Etheostoma blennioides							
Harlequin Darter	**Etheostoma histrio**						**2**	**1.85%**
Mud Darter	Etheostoma asprigene		5	6.41%	4	40.00%	2	1.85%
Orangethroat Darter	Etheostoma spectabile							
Freshwater Drum	Aplodinotus grunniens							
	TOTAL		78	1	10	1	108	1
Sampling effort/Type			10 seine hauls		9 seine hauls		10 seine hauls	

Table 3. (cont.) Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Species		Site:	WAB-13 Wabash River		WAB-14 Wabash River		WAB-15 Wabash River	
Common Name	Scientific Name		#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus							
Gizzard Shad	Dorosoma cepedianum							
Common Carp	Cyprinus carpio							
Central Stoneroller	Campostoma anomalum							
Suckermouth Minnow	Phenacobius mirabilis				2	2.90%		
Silver Chub	Macrhybopsis storeriana							
Shoal Chub	Macrhybopsis hyostoma				8	11.59%		
Mississippi Silvery Minnow	Hybognathus nuchalis				10	14.49%		
Steelcolor Shiner	Cyprinella whipplei							
Spotfin Shiner	Cyprinella spiloptera		3	8.82%	14	20.29%		
Striped Shiner	Luxilus chrysocephalus							
Bluntnose Minnow	Pimephales notatus							
Bullhead Minnow	Pimephales vigilax							
Emerald Shiner	Notropis atherinoides		2	5.88%	4	5.80%		
River Shiner	Notropis blennius							
Sand Shiner	Notropis stramineus							
Mimic Shiner	Notropis volucellus							
Bigeye Chub	Hybopsis amplops							
Silverjaw Minnow	Ericymba buccata							
Ictiobus spp.	Ictiobus spp.							
River Carpsucker	Carpiodes carpio							
Carpiodes spp.	Carpiodes spp.							
White Sucker	Catostomus commersoni							
Shorthead Redhorse	Moxostoma macrolepidotum				1	1.45%		
Channel Catfish	Ictalurus punctatus							
Flathead Catfish	Pylodictus olivaris		4	11.76%				
Stonecat	Noturus flavus							
Freckled Madtom	Noturus nocturnus				1	1.45%		
Slender Madtom	Noturus exilis							
Mountain Madtom	Noturus eleuthurus		4	11.76%	4	5.80%		
Brindled Madtom	Noturus miurus							
Western Mosquitofish	Gambusia affinis							
Brook Silverside	Labidesthes sicculus							
White Bass	Morone chrysops							
Black Crappie	Pomoxis nigromaculatus		2	5.88%				
Spotted Bass	Micropterus punctulatus		4	11.76%				
Green Sunfish	Lepomis cyanellus							
Bluegill	Lepomis macrochirus							
Longear Sunfish	Lepomis megalotis							
Orangespotted Sunfish	Lepomis humilis		1	2.94%				
Dusky Darter	Percina sciera		3	8.82%	14	20.29%		
River Darter	Percina shumardi				1	1.45%		
Slenderhead Darter	Percina phoxocephala		2	5.88%	5	7.25%		
Logperch	Percina caprodes							
Eastern Sand Darter	**Ammocrypta pellucida**							
Bluntnose Darter	Etheostoma chlorosomum							
Greenside Darter	Etheostoma blennioides							
Harlequin Darter	**Etheostoma histrio**						**1**	**100.00%**
Mud Darter	Etheostoma asprigene		8	23.53%	5	7.25%		
Orangethroat Darter	Etheostoma spectabile							
Freshwater Drum	Aplodinotus grunniens		1	2.94%				
	TOTAL		34	1	69	1	1	1
Sampling effort/Type			10 seine hauls		10 seine hauls		Boat Site	

Table 3. (cont.) Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Species		Site:	WAB-16 Wabash River		WAB-17 Wabash River		WAB-18 Wabash River	
Common Name	Scientific Name		#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus							
Gizzard Shad	Dorosoma cepedianum							
Common Carp	Cyprinus carpio							
Central Stoneroller	Campostoma anomalum							
Suckermouth Minnow	Phenacobius mirabilis							
Silver Chub	Macrhybopsis storeriana							
Shoal Chub	Macrhybopsis hyostoma				6	15.00%		
Mississippi Silvery Minnow	Hybognathus nuchalis		7	17.95%	3	7.50%	2	7.69%
Steelcolor Shiner	Cyprinella whipplei							
Spotfin Shiner	Cyprinella spiloptera		17	43.59%	1	2.50%	1	3.85%
Striped Shiner	Luxilus chrysocephalus							
Bluntnose Minnow	Pimephales notatus							
Bullhead Minnow	Pimephales vigilax				3	7.50%		
Emerald Shiner	Notropis atherinoides		4	10.26%	5	12.50%	21	80.77%
River Shiner	Notropis blennius		4	10.26%	6	15.00%	1	3.85%
Sand Shiner	Notropis stramineus							
Mimic Shiner	Notropis volucellus				7	17.50%		
Bigeye Chub	Hybopsis amplops							
Silverjaw Minnow	Ericymba buccata							
Ictiobus spp.	Ictiobus spp.							
River Carpsucker	Carpiodes carpio							
Carpiodes spp.	Carpiodes spp.							
White Sucker	Catostomus commersoni							
Shorthead Redhorse	Moxostoma macrolepidotum							
Channel Catfish	Ictalurus punctatus				1	2.50%		
Flathead Catfish	Pylodictus olivaris		1	2.56%				
Stonecat	Noturus flavus							
Freckled Madtom	Noturus nocturnus							
Slender Madtom	Noturus exilis				1	2.50%		
Mountain Madtom	Noturus eleuthurus							
Brindled Madtom	Noturus miurus							
Western Mosquitofish	Gambusia affinis							
Brook Silverside	Labidesthes sicculus							
White Bass	Morone chrysops							
Black Crappie	Pomoxis nigromaculatus							
Spotted Bass	Micropterus punctulatus		3	7.69%	3	7.50%		
Green Sunfish	Lepomis cyanellus							
Bluegill	Lepomis macrochirus							
Longear Sunfish	Lepomis megalotis		1	2.56%				
Orangespotted Sunfish	Lepomis humilis							
Dusky Darter	Percina sciera				3	7.50%		
River Darter	Percina shumardi							
Slenderhead Darter	Percina phoxocephala							
Logperch	Percina caprodes							
Eastern Sand Darter	**Ammocrypta pellucida**							
Bluntnose Darter	Etheostoma chlorosomum							
Greenside Darter	Etheostoma blennioides							
Harlequin Darter	**Etheostoma histrio**		**1**	**2.56%**	**1**	**2.50%**	**1**	**3.85%**
Mud Darter	Etheostoma asprigene		1	2.56%				
Orangethroat Darter	Etheostoma spectabile							
Freshwater Drum	Aplodinotus grunniens							
	TOTAL		39	1	40	1	26	1
Sampling effort/Type			10 seine hauls		10 seine hauls		Boat Site	

Table 3. (cont.) Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Site:		WAB-19 Wabash River		WAB-20 Wabash River		WAB-21 Wabash River	
Species			Relative		Relative		Relative
Common Name	Scientific Name	#	Abundance	#	Abundance	#	Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus	1	5.56%				
Gizzard Shad	Dorosoma cepedianum						
Common Carp	Cyprinus carpio						
Central Stoneroller	Campostoma anomalum						
Suckermouth Minnow	Phenacobius mirabilis						
Silver Chub	Macrhybopsis storeriana						
Shoal Chub	Macrhybopsis hyostoma	2	11.11%			13	28.26%
Mississippi Silvery Minnow	Hybognathus nuchalis						
Steelcolor Shiner	Cyprinella whipplei						
Spotfin Shiner	Cyprinella spiloptera	1	5.56%			6	13.04%
Striped Shiner	Luxilus chrysocephalus						
Bluntnose Minnow	Pimephales notatus						
Bullhead Minnow	Pimephales vigilax					1	2.17%
Emerald Shiner	Notropis atherinoides	4	22.22%			20	43.48%
River Shiner	Notropis blennius	7	38.89%				
Sand Shiner	Notropis stramineus						
Mimic Shiner	Notropis volucellus						
Bigeye Chub	Hybopsis amplops						
Silverjaw Minnow	Ericymba buccata						
Ictiobus spp.	Ictiobus spp.						
River Carpsucker	Carpiodes carpio						
Carpiodes spp.	Carpiodes spp.						
White Sucker	Catostomus commersoni						
Shorthead Redhorse	Moxostoma macrolepidotum						
Channel Catfish	Ictalurus punctatus						
Flathead Catfish	Pylodictus olivaris						
Stonecat	Noturus flavus						
Freckled Madtom	Noturus nocturnus						
Slender Madtom	Noturus exilis						
Mountain Madtom	Noturus eleuthurus						
Brindled Madtom	Noturus miurus						
Western Mosquitofish	Gambusia affinis						
Brook Silverside	Labidesthes sicculus						
White Bass	Morone chrysops					1	2.17%
Black Crappie	Pomoxis nigromaculatus						
Spotted Bass	Micropterus punctulatus	2	11.11%			3	6.52%
Green Sunfish	Lepomis cyanellus						
Bluegill	Lepomis macrochirus						
Longear Sunfish	Lepomis megalotis						
Orangespotted Sunfish	Lepomis humilis						
Dusky Darter	Percina sciera						
River Darter	Percina shumardi						
Slenderhead Darter	Percina phoxocephala						
Logperch	Percina caprodes						
Eastern Sand Darter	**Ammocrypta pellucida**						
Bluntnose Darter	Etheostoma chlorosomum						
Greenside Darter	Etheostoma blennioides						
Harlequin Darter	**Etheostoma histrio**	**1**	**5.56%**	**1**	**100.00%**	**1**	**2.17%**
Mud Darter	Etheostoma asprigene						
Orangethroat Darter	Etheostoma spectabile						
Freshwater Drum	Aplodinotus grunniens					1	2.17%
	TOTAL	18	1	1	1	46	1
Sampling effort/Type		6 seine hauls		Boat Site		6 seine hauls	

Table 3. (cont.) Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Site:		WAB-22 Wabash River		WAB-23 Wabash River		WAB-24 Wabash River	
Species			Relative		Relative		Relative
Common Name	Scientific Name	#	Abundance	#	Abundance	#	Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus						
Gizzard Shad	Dorosoma cepedianum						
Common Carp	Cyprinus carpio						
Central Stoneroller	Campostoma anomalum						
Suckermouth Minnow	Phenacobius mirabilis						
Silver Chub	Macrhybopsis storeriana						
Shoal Chub	Macrhybopsis hyostoma						
Mississippi Silvery Minnow	Hybognathus nuchalis						
Steelcolor Shiner	Cyprinella whipplei						
Spotfin Shiner	Cyprinella spiloptera	6	30.00%				
Striped Shiner	Luxilus chrysocephalus						
Bluntnose Minnow	Pimephales notatus						
Bullhead Minnow	Pimephales vigilax	1	5.00%				
Emerald Shiner	Notropis atherinoides	8	40.00%				
River Shiner	Notropis blennius						
Sand Shiner	Notropis stramineus						
Mimic Shiner	Notropis volucellus						
Bigeye Chub	Hybopsis amplops						
Silverjaw Minnow	Ericymba buccata						
Ictiobus spp.	Ictiobus spp.						
River Carpsucker	Carpiodes carpio						
Carpiodes spp.	Carpiodes spp.						
White Sucker	Catostomus commersoni						
Shorthead Redhorse	Moxostoma macrolepidotum						
Channel Catfish	Ictalurus punctatus						
Flathead Catfish	Pylodictus olivaris	1	5.00%				
Stonecat	Noturus flavus						
Freckled Madtom	Noturus nocturnus						
Slender Madtom	Noturus exilis						
Mountain Madtom	Noturus eleuthurus						
Brindled Madtom	Noturus miurus						
Western Mosquitofish	Gambusia affinis						
Brook Silverside	Labidesthes sicculus						
White Bass	Morone chrysops						
Black Crappie	Pomoxis nigromaculatus						
Spotted Bass	Micropterus punctulatus						
Green Sunfish	Lepomis cyanellus						
Bluegill	Lepomis macrochirus						
Longear Sunfish	Lepomis megalotis						
Orangespotted Sunfish	Lepomis humilis						
Dusky Darter	Percina sciera	2	10.00%				
River Darter	Percina shumardi						
Slenderhead Darter	Percina phoxocephala						
Logperch	Percina caprodes						
Eastern Sand Darter	**Ammocrypta pellucida**						
Bluntnose Darter	Etheostoma chlorosomum						
Greenside Darter	Etheostoma blennioides						
Harlequin Darter	**Etheostoma histrio**	**2**	**10.00%**	**1**	**100.00%**	**1**	**100.00%**
Mud Darter	Etheostoma asprigene						
Orangethroat Darter	Etheostoma spectabile						
Freshwater Drum	Aplodinotus grunniens						
	TOTAL	20	1	1	1	1	1
Sampling effort/Type		5 seine hauls		Boat Site		Boat Site	

Table 3. (cont.) Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Species		Site:	WAB-25 Wabash River		WAB-26 Wabash River		WAB-27 Wabash River	
Common Name	Scientific Name		#	Relative Abundance	#	Relative Abundance	#	Relative Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus							
Gizzard Shad	Dorosoma cepedianum							
Common Carp	Cyprinus carpio							
Central Stoneroller	Campostoma anomalum							
Suckermouth Minnow	Phenacobius mirabilis							
Silver Chub	Macrhybopsis storeriana							
Shoal Chub	Macrhybopsis hyostoma						10	4.02%
Mississippi Silvery Minnow	Hybognathus nuchalis						1	0.40%
Steelcolor Shiner	Cyprinella whipplei							
Spotfin Shiner	Cyprinella spiloptera		3	75.00%			12	4.82%
Striped Shiner	Luxilus chrysocephalus							
Bluntnose Minnow	Pimephales notatus							
Bullhead Minnow	Pimephales vigilax							
Emerald Shiner	Notropis atherinoides						12	4.82%
River Shiner	Notropis blennius							
Sand Shiner	Notropis stramineus							
Mimic Shiner	Notropis volucellus						4	1.61%
Bigeye Chub	Hybopsis amplops							
Silverjaw Minnow	Ericymba buccata							
Ictiobus spp.	Ictiobus spp.							
River Carpsucker	Carpiodes carpio							
Carpiodes spp.	Carpiodes spp.							
White Sucker	Catostomus commersoni							
Shorthead Redhorse	Moxostoma macrolepidotum							
Channel Catfish	Ictalurus punctatus						200	80.32%
Flathead Catfish	Pylodictus olivaris						2	0.80%
Stonecat	Noturus flavus							
Freckled Madtom	Noturus nocturnus							
Slender Madtom	Noturus exilis							
Mountain Madtom	Noturus eleuthurus							
Brindled Madtom	Noturus miurus							
Western Mosquitofish	Gambusia affinis							
Brook Silverside	Labidesthes sicculus							
White Bass	Morone chrysops							
Black Crappie	Pomoxis nigromaculatus							
Spotted Bass	Micropterus punctulatus				1	50.00%		
Green Sunfish	Lepomis cyanellus							
Bluegill	Lepomis macrochirus							
Longear Sunfish	Lepomis megalotis							
Orangespotted Sunfish	Lepomis humilis							
Dusky Darter	Percina sciera							
River Darter	Percina shumardi							
Slenderhead Darter	Percina phoxocephala							
Logperch	Percina caprodes							
Eastern Sand Darter	**Ammocrypta pellucida**							
Bluntnose Darter	Etheostoma chlorosomum							
Greenside Darter	Etheostoma blennioides							
Harlequin Darter	**Etheostoma histrio**		**1**	**25.00%**	**1**	**50.00%**	**6**	**2.41%**
Mud Darter	Etheostoma asprigene							
Orangethroat Darter	Etheostoma spectabile							
Freshwater Drum	Aplodinotus grunniens						2	0.80%
	TOTAL		4	1	2	1	249	1
Sampling effort/Type			2 seine hauls		Boat Site		10 seine hauls	

Table 3. (cont.) Species, numbers, and relative abundance of fish collected at each site on the Wabash River from 10 September, 2008 to 19 October, 2008.

Site:		WAB-28 Wabash River	
Species			
Common Name	Scientific Name	#	Relative Abundance
Shovelnose Sturgeon	Scaphirhynchus platorynchus		
Gizzard Shad	Dorosoma cepedianum		
Common Carp	Cyprinus carpio		
Central Stoneroller	Campostoma anomalum		
Suckermouth Minnow	Phenacobius mirabilis		
Silver Chub	Macrhybopsis storeriana		
Shoal Chub	Macrhybopsis hyostoma	1	1.27%
Mississippi Silvery Minnow	Hybognathus nuchalis		
Steelcolor Shiner	Cyprinella whipplei		
Spotfin Shiner	Cyprinella spiloptera	7	8.86%
Striped Shiner	Luxilus chrysocephalus		
Bluntnose Minnow	Pimephales notatus		
Bullhead Minnow	Pimephales vigilax		
Emerald Shiner	Notropis atherinoides	65	82.28%
River Shiner	Notropis blennius	2	2.53%
Sand Shiner	Notropis stramineus		
Mimic Shiner	Notropis volucellus	2	2.53%
Bigeye Chub	Hybopsis amplops		
Silverjaw Minnow	Ericymba buccata		
Ictiobus spp.	Ictiobus spp.		
River Carpsucker	Carpiodes carpio		
Carpiodes spp.	Carpiodes spp.		
White Sucker	Catostomus commersoni		
Shorthead Redhorse	Moxostoma macrolepidotum		
Channel Catfish	Ictalurus punctatus		
Flathead Catfish	Pylodictus olivaris		
Stonecat	Noturus flavus		
Freckled Madtom	Noturus nocturnus	2	2.53%
Slender Madtom	Noturus exilis		
Mountain Madtom	Noturus eleuthurus		
Brindled Madtom	Noturus miurus		
Western Mosquitofish	Gambusia affinis		
Brook Silverside	Labidesthes sicculus		
White Bass	Morone chrysops		
Black Crappie	Pomoxis nigromaculatus		
Spotted Bass	Micropterus punctulatus		
Green Sunfish	Lepomis cyanellus		
Bluegill	Lepomis macrochirus		
Longear Sunfish	Lepomis megalotis		
Orangespotted Sunfish	Lepomis humilis		
Dusky Darter	Percina sciera		
River Darter	Percina shumardi		
Slenderhead Darter	Percina phoxocephala		
Logperch	Percina caprodes		
Eastern Sand Darter	**Ammocrypta pellucida**		
Bluntnose Darter	Etheostoma chlorosomum		
Greenside Darter	Etheostoma blennioides		
Harlequin Darter	**Etheostoma histrio**		
Mud Darter	Etheostoma asprigene		
Orangethroat Darter	Etheostoma spectabile		
Freshwater Drum	Aplodinotus grunniens		
	TOTAL	79	1
Sampling effort/Type		10 seine hauls	

Table 4. Wabash River sample sites by type of cover and/or gear.

REACH	DATE	LOGS	LOGJAMS	ROCKS	SEINE SITES	TOTAL
DARWIN TO YORK	11-Sep-08	21	0	0	1	22
YORK TO HUTSONVILLE	10-Sep-08	27	7	1	0	35
HUTSONVILLE TO MEROM	10-Sep-08	27	0	1	1	29
WESTPORT TO ST. FRANCISVILLE	17-Sep-08	30	0	0	6	36
ST. FRANCISVILLE TO MT. CARMEL	14-Oct-08	9	0	0	8	17
MT. CARMEL TO JIMTOWN, IN	15-Oct-08	11	0	0	6	17
JIMTOWN, IN TO GRAYVILLE	16-Oct-08	32	9	0	6	47
GRAYVILLE TO HARMONIE STATE PARK	17-Oct-08	16	2	0	20	38
HARMONIE SP TO LITTLE WABASH R.	18-Oct-08	19	7	1	14	41
LITTLE WABASH R. TO OHIO RIVER	19-Oct-08	9	13	0	10	32
		201	38	3	72	314

Table 5. Habitat and water quality data for Little Wabash River sample sites.

STATION #	*A. pellucida?*	MEAN WIDTH (m)	MEAN DEPTH (m)	MAX DEPTH (m)	REACH LENGTH (m)	Percent			Percent of substrate						
						RIFFLE	RUN	POOL	BEDROCK	BOULDER	COBBLE	GRAVEL	SAND	SILT	CLAY
LWB01	NO	9.60	0.2447	0.50	127	10	65	25	0	0	0	15	80	5	0
LWB02	NO	18.27	0.3335	0.55	129	15	40	45	0	0	0	35	50	15	0
LWB03	NO	10.66	0.3138	0.68	156	15	60	25	0	0	0	20	75	5	0
LWB04	NO	17.86	0.3037	0.71	159	10	20	70	0	0	0	5	75	20	0
LWB05	NO	8.04	0.2929	1.22	125	10	75	15	0	0	0	5	90	5	0
LWB06	NO	12.12	0.2803	0.51	140	20	60	20	10	3	7	10	65	5	0

Table 5 (cont). Habitat and water quality data for Litlle Wabash River sample sites.

STATION #	*A. pellucida?*	HABITAT ASSESSMENT SCORE	QHEI SCORE	TEMP (C)	CONDUCTIVITY	DISSOLVED OXYGEN (mg/L)	VELOCITY 0.6 depth (m/sec)	(N) LAT	(W) LONG
LWB01	NO	129	61.5	26.3	290.1	7.4	0.29	39.27398	-88.55494
LWB02	NO	134	56.5	23.4	410.2	7.2	0.22	39.25900	-88.55595
LWB03	NO	135	68.0	27.7	342.4	9.2	0.34	39.19561	-88.57338
LWB04	NO	105	53.5	26.1	482.0	8.2	0.09	39.11975	-88.58746
LWB05	NO	141	64.0	24.5	455.5	6.7	0.38	39.03934	-88.61839
LWB06	NO	138	74.5	26.9	375.1	10.3	0.38	38.93877	-88.54818

Table 6. Habitat and water quality data for Embarras River and tributary sample sites.

						Percent			Percent of substrate						
STATION #	*A. pellucida?*	MEAN WIDTH (m)	MEAN DEPTH (m)	MAX DEPTH (m)	REACH LENGTH (m)	RIFFLE	RUN	POOL	BEDROCK	BOULDER	COBBLE	GRAVEL	SAND	SILT	CLAY
ERM01	YES	16.25	0.2173	0.4	36	35	65	0	2	3	20	30	43	2	0
ERM02	YES	20.40	0.3792	0.85	72	30	65	5	0	0	30	50	15	5	0
ERM03	YES	5.92	0.3024	0.61	70	5	90	5	0	0	0	15	70	15	0
ERM04	YES	12.44	0.3025	0.55	80	15	80	5	0	0	5	40	50	5	0
ERM05	YES	13.80	0.4463	0.97	60	0	65	35	0	0	0	45	45	10	0
ERM07	YES	10.13	0.3713	0.99	51	50	50	0	0	0	0	50	48	2	0
ERM10	YES	26.80	0.2014	0.37	60	15	80	5	0	0	0	10	75	15	0
ERM11	YES	15.40	0.3253	0.54	65	20	70	10	0	0	0	30	60	10	0
ERM14	YES	24.80	0.4793	1.03	75	0	65	35	0	5	5	20	60	10	0
ERM15	YES	15.80	0.5938	0.98	100	15	75	10	0	0	0	60	30	10	0
ERM19	YES	16.40	0.2100	0.38	84	25	65	10	0	0	0	15	65	20	0
ERM20	YES	32.60	0.3695	0.84	54	5	85	10	0	0	0	10	80	10	0
ERM21	YES	25.80	0.3120	0.76	54	10	85	5	0	0	0	15	80	5	0
ERM25	YES	26.20	0.3717	0.82	100	40	50	10	5	4	30	30	30	1	0
ERM26	YES	39.20	0.2992	0.46	55	5	80	15	0	0	0	5	90	5	0
ERM27	YES	34.75	0.3808	0.63	54	15	80	5	0	0	0	4	95	1	0
ERM28	YES	57.00	0.3124	0.8	101	30	60	10	0	0	0	20	75	5	0
ERM29	YES	23.80	0.3653	1	55	10	90	0	0	0	0	0	100	0	0
ERM31	YES	17.20	0.3220	0.89	86	30	45	25	0	0	5	30	60	5	0
ERM32	YES	30.80	0.2424	0.81	90	10	75	15	0	0	0	10	75	15	0
ERM33	YES	24.63	0.2300	0.45	90	10	80	10	0	0	0	3	95	2	0
ERM34	YES	22.76	0.1927	0.35	89.3	20	75	5	0	5	15	20	58	2	0
ERM35	YES	27.44	0.2826	0.91	103	5	90	5	0	0	0	5	90	5	0
ERM36	YES	29.02	0.2583	0.5	80.2	15	70	15	0	10	15	25	40	10	0
ERT01	YES	7.45	0.2600	1.06	125	15	60	25	0	3	12	25	60	0	0
ERT02	YES	10.94	0.4045	0.75	125	0	85	15	0	0	0	5	90	5	0
ERT04	NO	8.64	0.2240	0.37	89	2	13	85	0	0	0	7	90	3	0
ERT06	YES	9.08	0.3607	1.01	110	5	70	25	0	0	0	20	70	10	0

Table 6 (cont). Habitat and water quality data for Embarras River and tributary sample sites.

STATION #	*A. pellucida?*	HABITAT ASSESSMENT SCORE	QHEI SCORE	TEMP (C)	CONDUCTIVITY	DISSOLVED OXYGEN (mg/L)	VELOCITY 0.6 depth (m/sec)	(N) LAT	(W) LONG
ERM01	YES	156	72.5	26.2	512	4.3	0.27	39.45806	-88.15977
ERM02	YES	157	68.5	27	507	5.4	0.00	39.45507	-88.16055
ERM03	YES	159	61.5	27.4	504	5.6		39.45443	-88.15985
ERM04	YES	143	65.0	27.9	541	6.5	0.01	39.45121	-88.15786
ERM05	YES	148	63.5	29.2	560	8.4		39.44715	-88.15549
ERM07	YES	164	78.5	27.7	551	10.1	0.27	39.43819	-88.16771
ERM10	YES	124	53.0	24.5	525	8.5	0.26	39.38591	-88.17195
ERM11	YES	133	60.5	24.8	570	9.6	0.15	39.37347	-88.17779
ERM14	YES	96	57.0	25.4	548	13.6		39.34756	-88.17246
ERM15	YES	150	74.5	25.4	482.8	7.5		39.22805	-88.19198
ERM19	YES	104	49.5	27.2	523	11.2		39.17762	-88.22791
ERM20	YES	136	65.0	25.5	516	8.0	0.14	39.10034	-88.21038
ERM21	YES	127	62.5	27.1	531	9.1	0.45	39.08898	-88.19972
ERM25	YES	123	76.0	25.1	256	6.7	0.29	39.04273	-88.18315
ERM26	YES	103	50.0	27.3	555	8.2	0.27	39.02465	-88.17189
ERM27	YES	127	57.0	28.6	529	8.1	0.35	39.01861	-88.16796
ERM28	YES	124	58.5	27.4	491	6.4		38.85070	-87.97879
ERM29	YES	99	45.5	29.1	546	8.4		38.84182	-87.95355
ERM31	YES	154	74.5	22.9	538	5.0	0.46	39.15185	-88.20497
ERM32	YES	100	55.5	22.8	533	5.7	0.29	39.14220	-88.19949
ERM33	YES	120	52.5	23.2	540	7.0	0.36	39.11327	-88.20769
ERM34	YES	117	57.0	21.6	408	6.3	0.35	38.93742	-88.02481
ERM35	YES	95	51.5	23.3	524	7.5	0.43	38.89455	-87.87207
ERM36	YES	134	66.5	25.9	534	9.2		38.83572	-87.75614
ERT01	YES	152	80.5	25.4	552	10.1	0.31	39.46274	-88.19189
ERT02	YES	113	58.5	24.2	358	7.1	0.21	39.17996	-88.27276
ERT04	NO	95	58.0	23.4	547	3.1	0.42	39.30523	-88.14153
ERT06	YES	137	63.0	24.8	462	6.5	0.34	38.92447	-87.98772

Table 7. Habitat and water quality data for Wabash River sample sites.

STATION #	*E. histrio?*	MEAN DEPTH (m)	REACH LENGTH (m)	Percent			Percent of substrate						
				RIFFLE	RUN	POOL	BEDROCK	BOULDER	COBBLE	GRAVEL	SAND	SILT	CLAY
WAB01	NO	0.48	60	0	80	20	0	0	0	0	95	5	0
WAB02	NO	0.42	12	5	85	10	0	0	0	0	95	5	0
WAB03	NO	0.41	85	25	50	25	0	0	0	10	80	10	0
WAB04	NO	0.78	40	100	0	0	0	0	0	5	75	15	5
WAB05	NO	0.74	50	5	90	5	0	0	0	10	80	5	5
WAB06	NO	0.56	60	5	90	5	0	0	0	50	50	0	0
WAB07	NO	0.53	40	20	40	40	0	0	0	10	85	5	0
WAB08	NO	0.59	50	5	75	20	0	0	0	15	80	5	0
WAB09	NO	0.54	50	5	75	20	0	0	0	5	90	5	0
WAB10	NO	0.37	75	5	85	10	70	0	0	5	10	15	0
WAB11	NO	0.39	40	5	70	25	0	0	0	5	90	5	0
WAB12	YES	0.83	85	5	80	15	0	0	0	5	90	5	0
WAB13	NO	0.71	50	0	90	10	0	0	0	5	90	5	0
WAB14	NO	0.41	30	25	60	15	0	0	0	5	80	15	0
WAB15	YES	1.48	10	0	100	0	0	0	0	15	85	0	0
WAB16	YES	0.44	40	0	80	20	0	0	0	5	90	5	0
WAB17	YES	0.75	30	0	90	10	0	0	0	5	95	0	0
WAB18	YES	0.73	10	0	100	0	0	0	0	0	100	0	0
WAB19	YES	0.84	15	0	100	0	0	0	0	0	100	0	0
WAB20	YES	1.17	10	0	100	0	0	0	0	0	100	0	0
WAB21	YES	0.73	70	0	100	0	0	0	0	0	100	0	0
WAB22	YES	0.74	15	0	100	0	0	0	0	0	100	0	0
WAB23	YES	1.29	10	0	100	0	0	0	0	0	100	0	0
WAB24	YES	1.56	20	0	100	0	0	0	0	0	100	0	0
WAB25	YES	0.44	7	0	100	0	0	0	0	0	100	0	0
WAB26	YES	1.82	10	0	100	0	0	0	0	0	100	0	0
WAB27	YES	0.49	35	25	70	5	0	0	0	25	75	0	0
WAB28	NO	0.51	30	5	80	15	0	0	0	0	80	15	5

Table 7 (cont). Habitat and water quality data for Wabash River sample sites.

STATION #	*E. histrio?*	HABITAT ASSESSMENT SCORE	QHEI SCORE	TEMP (C)	CONDUCTIVITY	DISSOLVED OXYGEN (mg/L)	VELOCITY 0.6 depth (m/sec)	(N) LAT	(W) LONG
WAB01	NO	107	54.5	24.9	654	9.6	0.25	38.59545	-87.64518
WAB02	NO	113	62.0	24.9	654	9.6	0.24	39.08166	-87.60748
WAB03	NO	133	66.5	24.2	620	9.7	0.25	39.25440	-87.59945
WAB04	NO	123	60.0	23.7	543	9.4	0.16	38.67421	-87.59573
WAB05	NO	154	70.5	23.7	543	9.4	0.41	38.62860	-87.61745
WAB06	NO	150	66.5	23.7	543	9.4	0.12	38.59545	-87.62335
WAB07	NO	141	70.5	21.6	618	12.0	0.17	38.57989	-87.64049
WAB08	NO	131	64.0	21.6	618	12.0	0.18	38.55254	-87.65735
WAB09	NO	155	73.0	21.6	618	12.0	0.20	38.50507	-87.67325
WAB10	NO	131	62.0	21.6	618	12.0	0.24	38.45375	-87.74757
WAB11	NO	166	72.0	22.6	565	12.7	0.22	38.37299	-87.77945
WAB12	YES	154	75.0	22.6	565	12.7	0.14	38.36094	-87.80676
WAB13	NO	166	71.5	22.6	565	12.7	0.27	38.35126	-87.81882
WAB14	NO	137	62.5	22.6	565	12.7	0.45	38.29506	-87.88449
WAB15	YES	146	66.0	21.4	629	11.3	0.24	38.27364	-87.90414
WAB16	YES	148	65.0	21.4	629	11.3	0.17	38.21461	-87.98357
WAB17	YES	143	61.0	21.4	629	11.3	0.34	38.18808	-87.96211
WAB18	YES	147	65.5	20.0	633	10.2	0.26	38.18803	-87.96413
WAB19	YES	110	48.0	20.0	633	10.2	0.40	38.11640	-87.94921
WAB20	YES	121	47.5	20.0	633	10.2	0.32	38.09895	-87.96101
WAB21	YES	128	50.0	20.0	633	10.2	0.33	38.06831	-87.96780
WAB22	YES	140	53.0	19.2	639	12.1	0.27	38.05745	-87.98687
WAB23	YES	141	56.5	19.2	639	12.1	0.36	38.05302	-87.00239
WAB24	YES	142	55.5	19.2	639	12.1	0.70	38.05008	-88.01231
WAB25	YES	128	49.5	19.2	639	12.1	0.25	37.98263	-88.01339
WAB26	YES	138	57.5	19.2	639	12.1	0.30	37.93884	-88.03214
WAB27	YES	131	67.5	19.2	639	12.1	0.57	37.89281	-88.05990
WAB28	NO	116	51.5	18.2	621	10.5	0.28	37.86726	-88.07091

Table 8. Micro-habitat data for *Etheostoma histrio* captured from the Wabash River.

WAB-12	Log and rootwad well embedded in substrate. Leaf pack/detritus at head. Both logs and rootwad highly colonized with caddisfly larvae. Location at head of inside bend. Bigger Harlequin found on rootwad with leaf pack. Rootwad highly colonized. Smaller Harlequin found on colonized log parallel to current immediately upstream of bigger one.	
	Velocity (m/s): 0.19, 0.06, 0.22, 0.18, 0.21, 0.15, 0.18 0.28, 0.34 taken at 0.6/depth 5 ft upstream of capture points	Depth (cm): 77, 104, 85, 98, 94, 112, 93 Ave. depth = 94.71
WAB-15	Woody debris connectivity to shore. Captured off heavily colonized (Tricoptera) log oriented perpendicular to flow and anchored to vertical heavily colonized logs.	
	Velocity (m/s): 0.14 upstream of log 1 ft depth 0.34 over top of log at 8 cm	Depth (cm): 148
WAB-16	Captured on large stump ~ 12ft long and 30in diameter. Highly colonized with Tricoptera. Upstream side of small point bar.	
	Velocity (m/s): 0.25 over top of log at 6 in depth 0.17 over coarse sand at ~ 0.6/depth ~ 2 ft in front of log	Depth (cm): 48, 56, 66, 61 Ave. depth = 57.75
WAB-17	Smaller old colonized log holding old sticks also colonized and leaf pack.	
	Velocity (m/s): 0.25 upstream at 0.6/depth 0.34 downstream at 0.6/depth	Depth (cm): 83, 94 Ave. depth = 88.50
WAB-18	Harlequin captured from isolated large wood pile. Well colonized with Tricoptera. Wood pile combination of well rooted logs/stump and drift, all well colonized with inverts. Substrate coarse sand.	
	Velocity (m/s): 0.51 at head of habitat complex taken 0.6/depth	Depth (cm): 43, 71, 84, 92, 37, 109 Ave. depth = 72.67
WAB-19	Single log. Some invert colonization. Top and rootwad embedded in soft sand. Entire length not embedded. Log not connected to shore with other woody debris. Located in nearly 1 meter of water, fairly high flow, oriented parallel to flow on a sandbar on inside bend.	
	Velocity (m/s): 0.3 – 0.5 along surface of log 0.55 at 0.6/depth immediately upstream Most diverse velocity at rootwad/downstream end of log	Depth (cm): 87, 77, 74, 62, 82, 92, 92, 99, 82, 94 Ave. depth = 84.10

Table 8 (cont). Micro-habitat data for *Etheostoma histrio* captured from the Wabash River.

WAB-20	Point of capture at colonized (Tricops) old stable log, holding other logs, also well colonized, oriented mostly perpendicular to flow. Some leaf pack present. Logs with connectivity to bank.	
	Velocity (m/s): 0.36 at 0.6/depth upstream of habitat 0.22 – 0.42 across top of log.	Depth (cm): 117
WAB-21	Captured on log oriented parallel to flow. Good colonization of inverts. Connectivity to bank. Some leaf pack. Substrate sand.	
	Velocity (m/s): 0.30 at 0.6/depth upstream	Depth (cm): 82
WAB-22	Captured on rootwads of well colonized logs: 1 parallel to flow, 1 perpendicular to flow. Log old well colonized holding other old well colonized sticks, logs, and some leaf pack. No connectivity to bank. Substrates loose unconsolidated sands (fine – coarse grains).	
	Velocity (m/s): 0.44 head of habitat at 0.6/depth	Depth (cm): 56, 62 Ave. depth: 59
WAB-23	Captured from rootwad of large complex, well colonized log jam with connectivity to bank, angled parallel to flow	
	Velocity (m/s): 0.35, 0.37 at collection point Ave velocity: 0.36 0.45 upstream at 0.6/depth	Depth (cm): 129
WAB-24	Captured off rootwad at downstream end of well colonized log parallel to flow. Substrate sand. May have connectivity to shore. Some leaf pack.	
	Velocity (m/s): 0.70 upstream of capture at 0.6/depth Highly diverse velocity inside and around rootwad.	Depth (cm): 156
WAB-25	Captured from log, old, colonized, laying parallel to flow, leaf pack, over sand. No connectivity to bank.	
	Velocity (m/s): 0.25 upstream at 0.6/depth	Depth (cm): 46, 52, 33, 47, 42, 42 Ave depth: 43.67
WAB-26	Captured from log jam, well colonized, leaf pack, oriented perpendicular to flow, connectivity with bank.	
	Velocity (m/s): 0.30 upstream at 0.6/depth	Depth (cm): 182
WAB-27	Abundant extra habitat. Captured from old colonized logs oriented both parallel and perpendicular to flow. Shallow swift runs. Small gravel and coarse sand substrates. Head of island. Did not exhaust samplable habitat due to setting sun.	
	Velocity (m/s): 0.47, 0.36, 0.51, 0.38, 0.76, 0.91 Ave velocity: 0.57	Depth (cm): 45, 62, 44, 33, 51, 52, 52, 53, 45 Ave depth: 48.56

Figure 1. Sampling locations for Ammocrypta pellucida and capture and habitat collection sites for Etheostoma histrio in the Little Wabash River, Embarras River, and Wabash River.

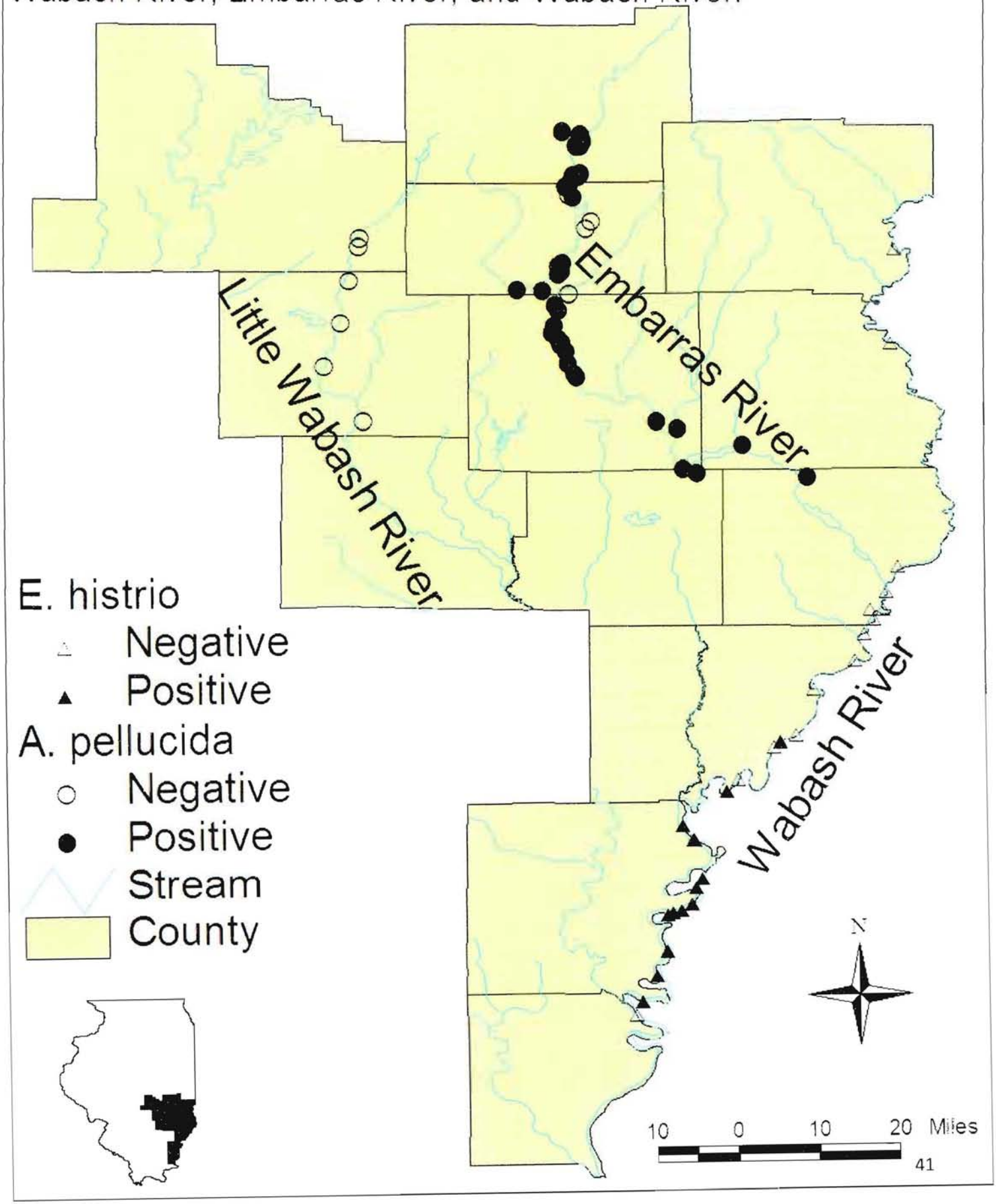


Figure 2. Sampling sites for Ammocrypta pellucida.

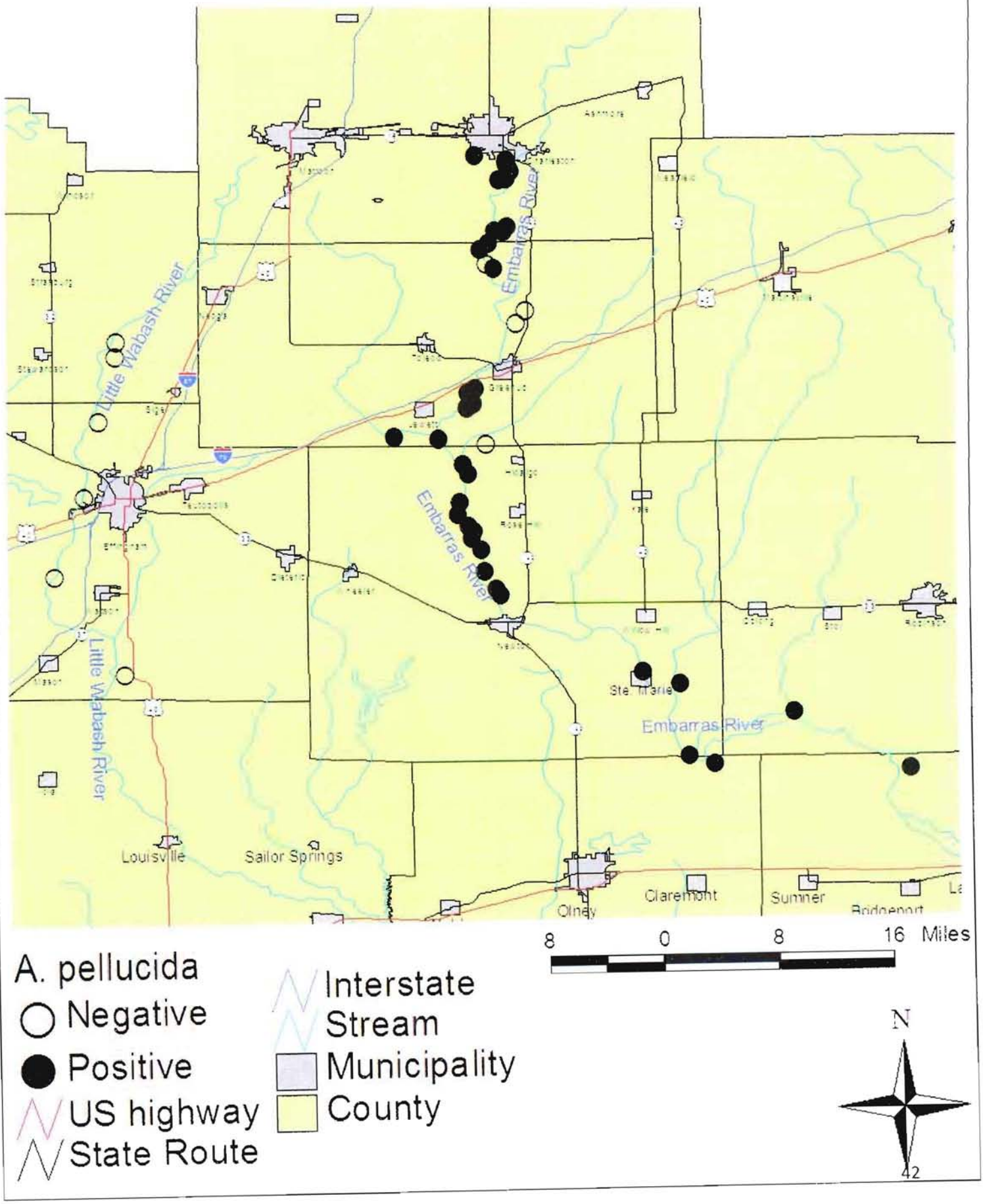


Figure 3. Capture and habitat collection sites for Etheostoma histrio.

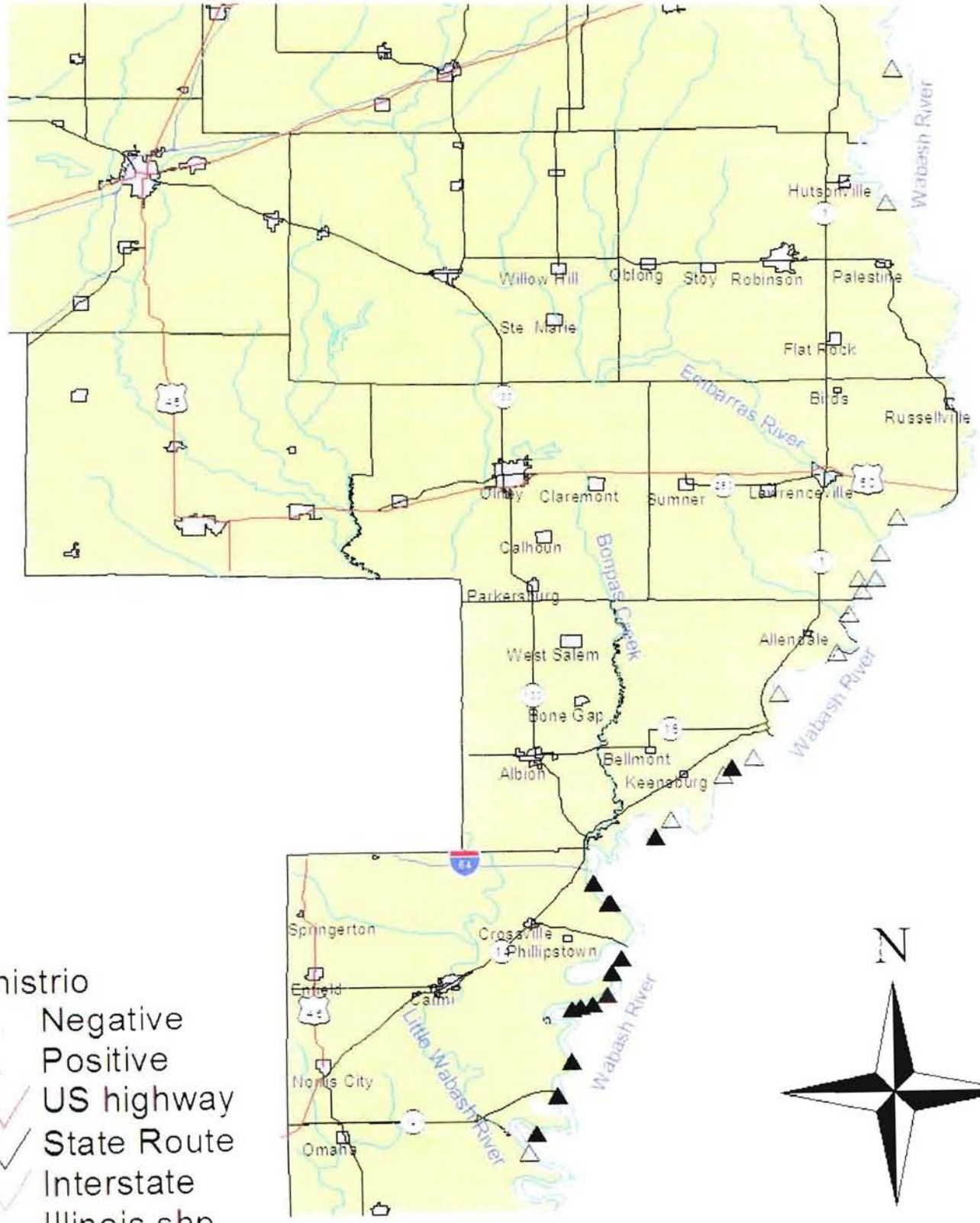


Figure 4. Length histogram for Ammocrypta pellucida captured from 26 July 2007 through 31 July 2007.

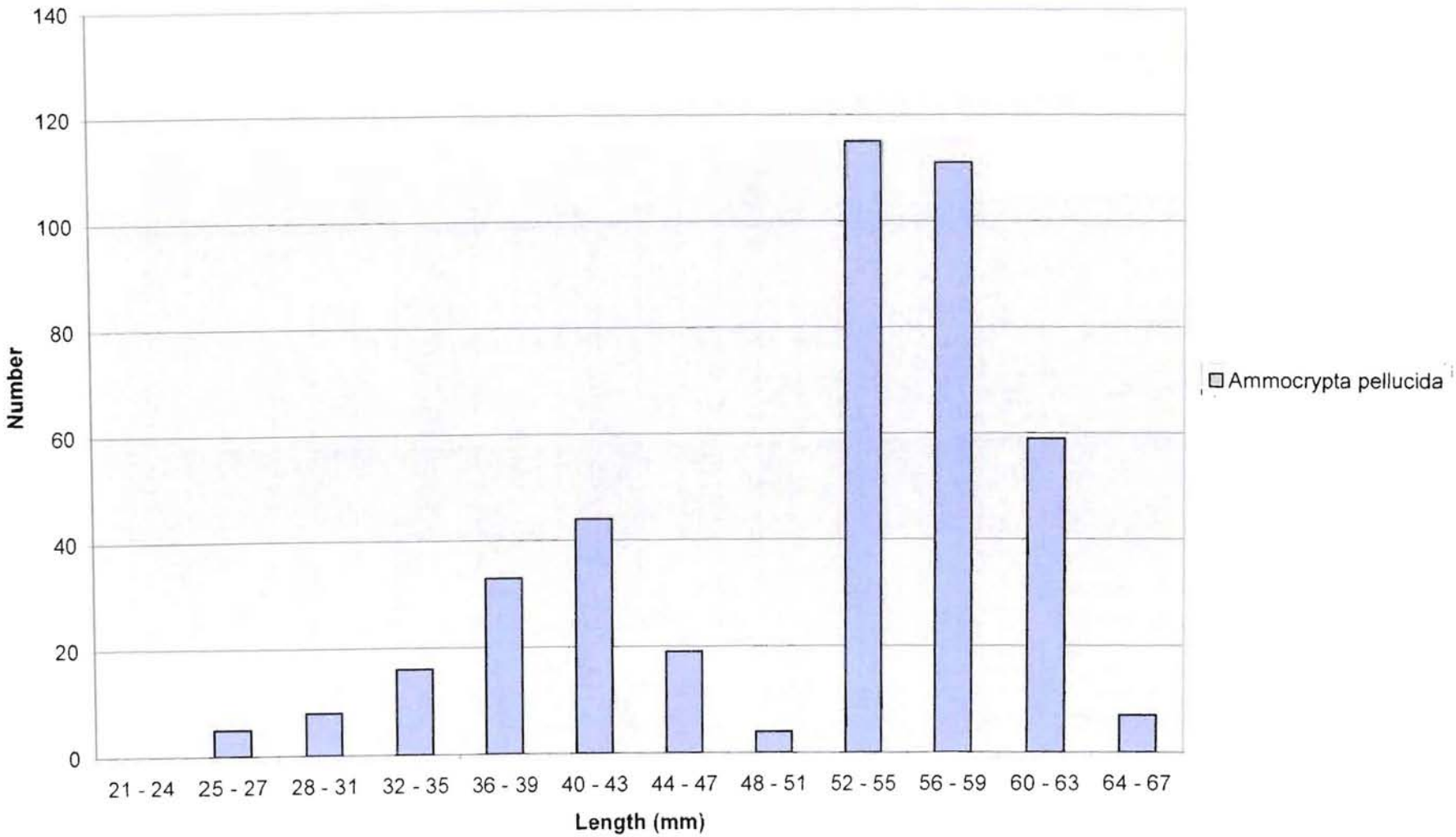


Figure 5. Length histogram for Ammocrypta pellucida captured in the Embarras River from 24 September 2007 through 27 September 2007

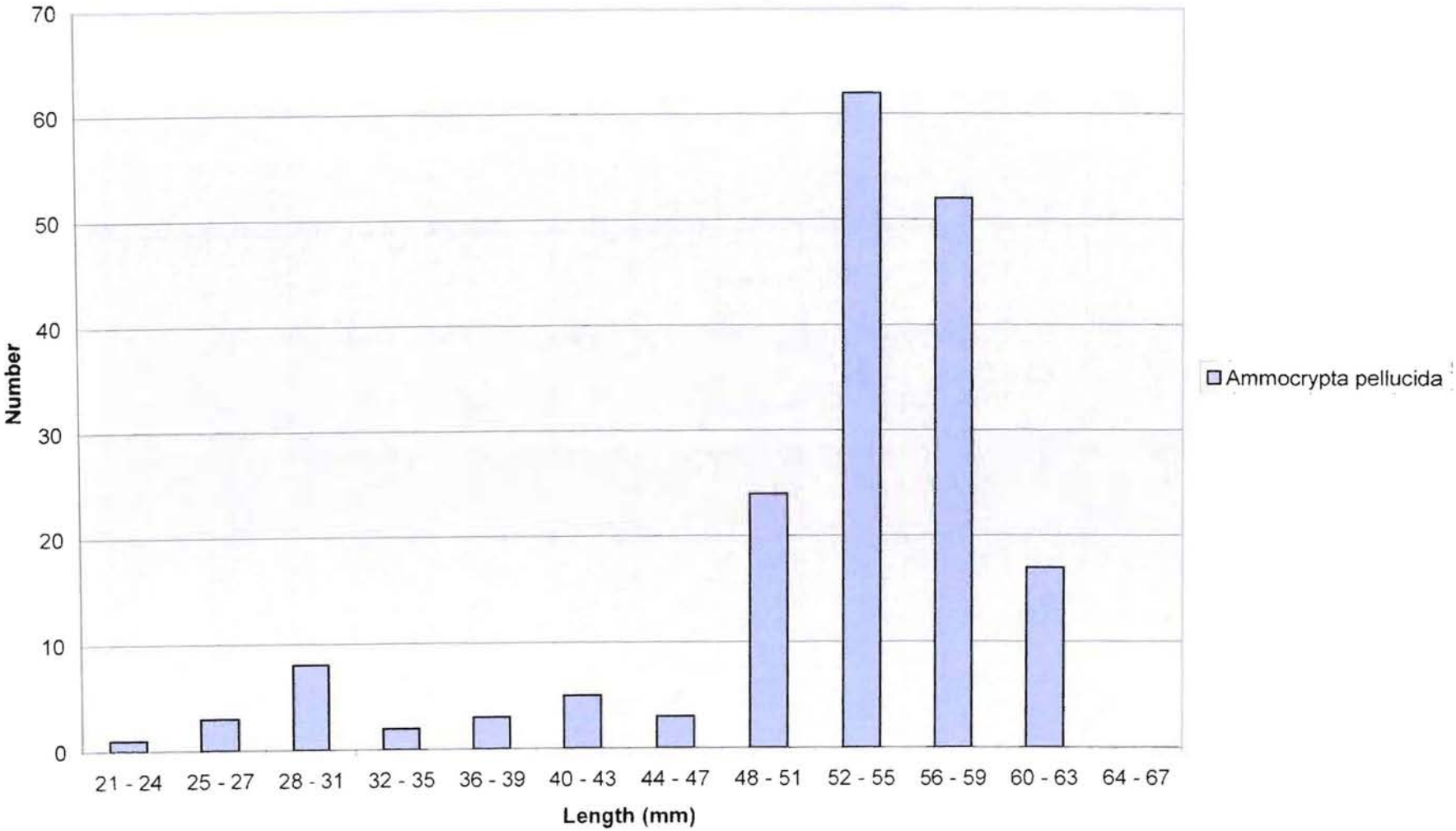


Figure 6. Length histogram for Etheostoma histrio captured in the Wabash River from 10 September 2007 through 19 October 2007.

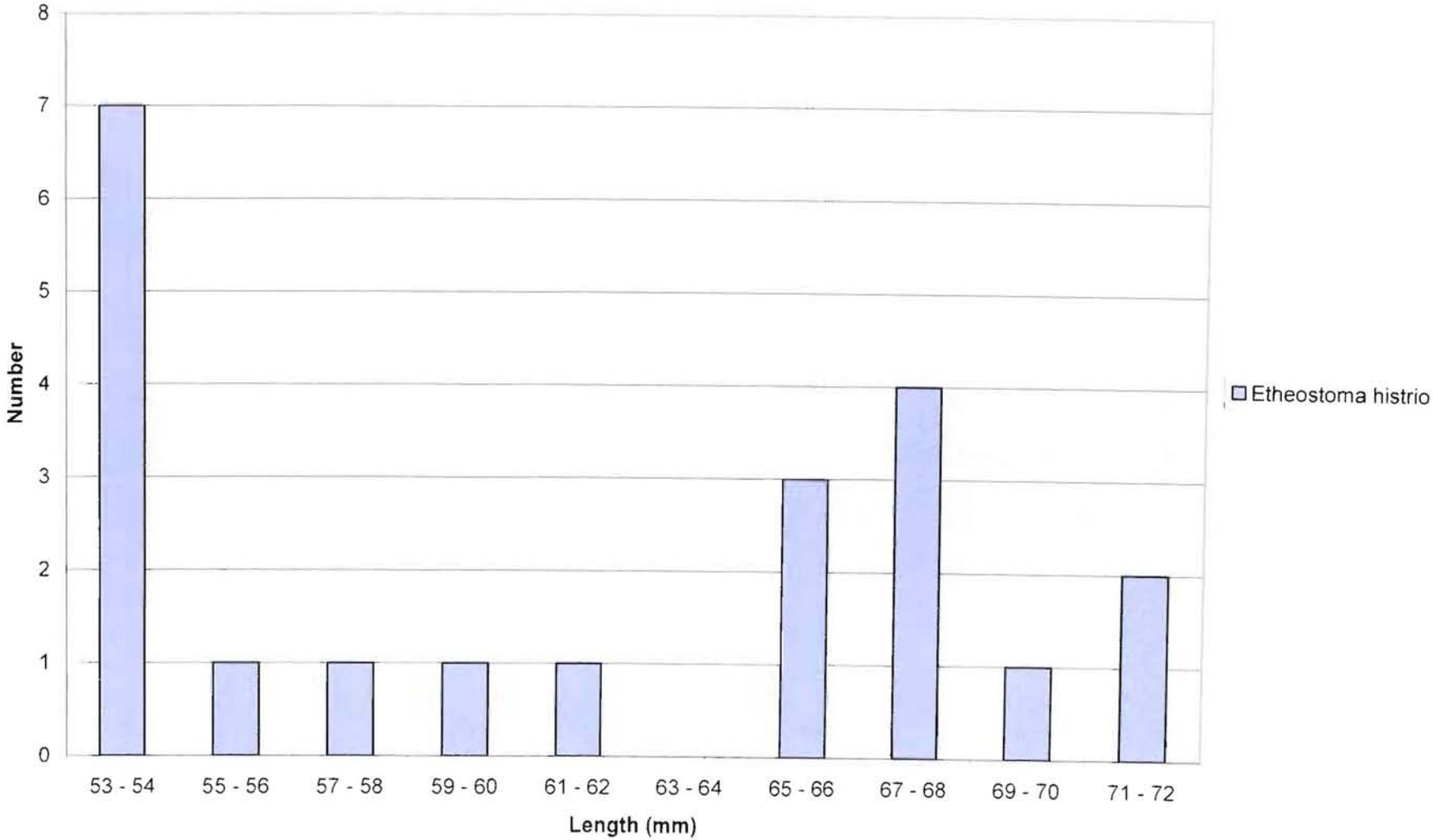


Figure 7. Sampling methodology for Eastern Sand Darter.

Figure 8. Collection site for Harlequin Darter.