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AN ASSESSMENT OF NIGHT TIME AND SEASONAL ELECTROFISHING IN THE LOWER WABASH RIVER

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ABSTRACT

Large rivers are highly important systems; being exploited both commercially and recreationally. Because of this usage by humans, close monitoring of the ecology of theses rivers is of the utmost importance. The Long-Term Electrofishing project (LTEF) monitors the fish communities of the Illinois, Mississippi, Wabash, and Ohio rivers using day time, pulsed-DC electrofishing during the late Spring through the early Fall each year. Given that previous studies have noted diel and seasonal changes in catch and composition of fish communities, the addition of night time electrofishing may be beneficial to the overarching goals of the LTEF. This study sought to determine whether significant diel and seasonal changes are occurring in the Wabash and whether these changes are significant enough to warrant additional sampling the LTEF protocol. To investigate this question, I used night time, pulsed-DC electrofishing at fixed sites corresponding to LTEF sites in the Lower Wabash River from October 2016 to November 2017. I compared catch per unit of effort (CPUE), length distributions, and family composition between my night time electrofishing data and LTEF day time electrofishing data from 2017. Additionally, I compared these three parameters between seasons using my night time data. Diel comparisons showed some variation in catch rates between night and day but were proportionate in composition. Similarly, seasonal comparisons showed variation in catch rates but generally lower catches of all families during the Winter. Night time electrofishing had a significantly higher mean CPUE than day time sampling ($p < 0.05$), the three most prevalent families being Catostomidae, Cyprinidae, and Sciaenidae. Of the three families, only Sciaenidae had a significantly different length distribution; showing a shift towards smaller fish during the night ($p <$

0.025). Seasonally, average CPUE did not differ significantly between seasons ($p > 0.05$). However, the individual families compared had significantly lower CPUEs in the Winter and Sciaenidae had significantly higher CPUEs in the Fall compared to other seasons ($p < 0.008$). Seasonal length distributions of Sciaenidae did not differ significantly, however. Other fish families did have significant seasonal differences in length distributions, generally showing a shift towards mid-sized fish in the Summer ($p < 0.008$). These results indicate that diel and seasonal variations do occur in the Wabash. However, Given the proportionality of families captured between night and day as well as the relatively low catch rates in the winter, I would not recommend the addition of night time electrofishing or extended seasonal sampling to the LTEF as it would not benefit the overarching goals of the project.

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Introduction

Large rivers provide a wealth of information regarding the ecology of fish populations both commercially and recreationally exploited, making large rivers highly valuable to humans and animals alike. The high degree of usage requires continual monitoring and research to ensure the longevity of the fish populations. Because of this need, multiple programs have been put in place to assess large river fish communities within the Mississippi River drainage basin.

Many large rivers, given their commercial value, have been negatively affected through human impacts. Anthropogenic disturbances can have severe effects on the ecology of large rivers and this increases the need for management as they can lead to declines in native fishes and an overall loss of biodiversity (Hoberg & Pegg, 2016). Additionally, human activity may facilitate the introduction and spread of potentially invasive species that can be detrimental to large river ecology (Bunn & Arthington, 2002). For example, the Silver (*Hypopthalmicthys molotrix*) and Bighead carps (*Hypopthalmicthys nobilis*) were introduced to the Mississippi River via escape from aquaculture ponds and have spread throughout to Mississippi river basin (Irons et al., 2007). Due to dietary overlap, these invasive carps have been linked to a decrease in the condition of Gizzard Shad (*Dorosoma cepedianum*) and Bigmouth Buffalo (*Ictiobus cyprinellus*) since their introduction (Irons et al., 2007).

Large rivers are also a means of transport of goods and because of this, more than 85% of North American rivers have been extensively impounded by locks, dams, flood control structures (Poff et al., 2007). This kind of alteration of many large rivers has had negative impacts upon their ecology through increased pollution and a reduction in high quality habitats for spawning and foraging (Bunn & Arthington, 2002; Hoberg & Pegg, 2016).

With increasing alterations to these systems, the need for monitoring and management is imperative. Long-term monitoring therefore becomes increasingly important for detecting impacts of these alterations (Lohner & Dixon, 2013). When long-term monitoring projects are put into place, we may more easily determine trends in various aspects of river ecology. Fortunately, there are several long-term monitoring programs within the Mississippi River drainage that help fill in these informational gaps.

In 1957, Dr. William Starrett established the Long-Term Electrofishing Program (LTEF) in the Illinois River. This used AC electrofishing to monitor and assess the fish populations within the Illinois River, thus providing biologists a thorough data set over a large temporal scale to reference and is one of the longest-running monitoring programs in the world (DeBoer et. al, 2014). Since its implementation, the LTEF has been successful in documenting changes within the Illinois River; both positive and negative. These include the rebound of native fish communities following the Clean Water Act (DeBoer, et. al, 2014); transitioning from an almost solely Common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*) dominated system in the upper reaches to a diverse native-dominated community today (Gibson-Reinmer, et. al, 2017). Additionally, the program has been successful in documenting the increases and ranges of invasive species within the Illinois River including Asian Carps (*Hypopthalmichtys* spp.), Round Goby (*Neogobius melanostomus*), and White Perch (*Morone americana*) (DeBoer, et. al, 2014). Since its inception, this study expanded its range from the Illinois River to include the Mississippi, Ohio, and Wabash Rivers.

The Wabash river makes up the southeastern border of Illinois and Indiana and is a distinctive system relative to other large rivers in the Midwest. Its lower 322 kilometers are completely unimpounded and provides a unique research opportunity not afforded by many other rivers. The LTEF program was expanded to the lower Wabash in 2010 which has been sampled annually since then (DeBoer et. al, 2014). However, given that LTEF sampling is restricted to the day time hours and to a relatively small temporal window of the year, there may be some species or families of fish that are underrepresented in the LTEF dataset.

Although night and day electrofishing are commonly used as standard sampling methods on lentic systems; nighttime electrofishing has been shown to be more efficient than daytime electrofishing (Wilt & Campbell, 1959; Sanderson, 1960; Kirkland, 1965; McInerny & Cross, 2004; McInerny & Cross, 2000; Dumont & Dennis, 1997; Ross et al., 2016). Water transparency is suggested to be a factor in catch rates of some species of fish (Reynolds & Kolz 2012) as well as dissolved oxygen (Coble, 1982). For example, Eurasian Perches (*Perca fluviatilis*) have been known to move toward the shorelines in periods of low light penetration, thus taking advantage of optimal conditions for foraging and predator avoidance (Craig, 1977). Furthermore, fishes are known to be attracted to light sources during night time hours and the use of bow or stern lights may contribute to a higher catch rate (Utne-Palm et al., 2018). Additionally, temperature may be a factor in night time catch rates due to lower avoidance behavior (Reynolds & Kolz 2012).

All forms of sampling are inherently biased and, therefore multiple gears are required to collect an adequate sample in lentic systems. However, among the commonly-used gears, night electrofishing is often thought to be the most efficient (Blackwell et al., 2017). In lotic systems, the same multi-gear approach to sampling is also necessary and used in monitoring efforts such as the Long-Term Resource Monitoring Project (LTRMP) (Ratcliff et al., 2014). However, night electrofishing is not commonly used on large rivers and is used in neither LTEF nor LTRMP sampling currently. Initially, the LTRMP used night electrofishing along with day electrofishing (Gutreuter et al., 1995). Ickes & Burkhardt (2002) conducted an assessment of all gears used within the LTRMP protocol and proposed that night electrofishing, among other gears, be eliminated as it did not significantly increase efficiency or species detection. Following their recommendation, night electrofishing was discontinued in the LTRMP.

Previous studies have concluded that season also has a significant effect on catch rates, especially among species of fish (Cross et. al., 1995; Ross et al., 2016; Sammons & Betolli, 1988; Bacula et al., 2011; Fisher & Quist, 2014). The LTEF and LTRMP sampling seasons span from June to October of each year, leaving the Winter and Spring seasons unsampled (DeBoer et al., 2014; Ratcliff et al., 2014).

Given that diel and seasonal variation occurs in fish communities, it may be beneficial to analyze these differences within the Context of the LTEF program. This project aims to 1) determine if there are significant differences in the fish communities between day and night sampling, 2) Identify significant seasonal differences in these fish communities, and 3). If these differences do occur, are they sufficiently large to justify the added effort and risk of night sampling and/or multi-seasonal sampling to modify the LTEF protocol? I hypothesize that catch rates will differ significantly higher catch rates during night time hours due to fish utilizing low-light periods for foraging. I also predict significant seasonal variation in catch rates as well due to changes in activity, recruitment, and mortality.

Methods

Field Methods:

I used night time, pulsed-DC electrofishing during October 2016 through November 2017. I used a pulse rate of 60 hertz, a 25% duty cycle, and I determined my power goals based upon the temperature and conductivity of the water at each site, as per LTEF protocol (DeBoer, et al. 2014). LTEF uses random sampling, whereas I used 7 fixed sites. This was in order to familiarize myself with the potential hazards at each sampling site and to reduce any risk of injury to myself or my crew. Since LTEF sampling takes place in three distinct time periods, my night electrofishing trips were scheduled to coincide with these periods for the diel comparison.

I began sampling at least one-half hour past the local sunset time. This start time has been used in several previous studies using night time electrofishing (Dumont & Dennis, 1997, Fischer & Quist, 2014, Reynolds, 1983). Prior to sampling, I recorded environmental factors following LTEF protocol with the exception of Secchi depth which requires natural light. At each site, I conducted three, 20-minute electrofishing transects; one Illinois shoreline transect, one Indiana shoreline transect, and one mid-channel transect. Each of these transects were treated as separate samples for later analyses. All fishes collected were identified to species, measured to total length (mm), and catch per unit of effort (CPUE) was calculated as fish per hour. All fishes that were unidentifiable in the field were preserved in formalin and were identified and measured in the lab.

Statistical Analyses:

In my diel comparison, I used shoreline transects to evaluate the community composition between my night time samples and daytime LTEF sampling. The use of shoreline transects is the standard for LTEF as it allows for multiple habitat structures to be thoroughly sampled (Gutreuter et al., 1995). I used Non-Metric Multidimensional Scaling (NMDS) with a Bray-Curtis Dissimilarity Matrix to determine if relative abundances varied between night and day. I compared CPUE data from each sample using a One-way ANOVA with a Levene's Test for homogeneity of the variance. For the ANOVA, my CPUE data were log10+1 transformed, if needed, to better fit the assumption of equality of variance. For comparison, I selected the two LTEF transects that were spatially closest to my fixed sites for each time period. I calculated length frequency distributions for all fishes collected as well as several important families within the Wabash: Catostomidae since they are commercially exploited in the Wabash River, Cyprinidae since they include several invasive species, and Sciaenidae since Freshwater Drum (*Aplodinotus grunniens*) are a highly widespread fish species, ubiquitous to large rivers. I used a Kolmogorov-Smirnov (K-S) Test and, when necessary, I used a Bonferroni correction (0.05/2 comparisons: p=0.025) to compare these distributions.

In my seasonal analysis, I used three, 20-minute electrofishing transects; 2 main-channel border transects and 1 mid-channel transect equaling an effort of 1 hour per sampling area. Each transect was treated as a separate sample. I evaluated the community composition across seasons using Non-Metric Multidimensional Scaling (NMDS) with a

Bray-Curtis Dissimilarity Matrix. For this analysis, I used the relative abundance of the families sampled. I used three dimensions as this reduced stress in the matrix. To analyze my seasonal CPUE data, I used a One-way ANOVA with a Levene's Test for homogeneity of the variance; all my CPUE data in this test was log10+1 transformed to better fit the assumption of equality of variance. When my CPUE data did not meet the assumption of homogeneity of variance, I used a non-parametric Kruskall-Wallis test with untransformed data. I calculated length frequency distributions for all fishes collected as well as several important Families within the Wabash as above.; I used a Kolmogorov-Smirnov (K-S) Test with a Bonferroni corrected critical value (0.05/6 comparisons: $p=0.008$) to compare these distributions.

Results

Diel Comparison

The results of my NMDS indicated that, while the two sampling times did show some variation in catch rates, the two were relatively similar in their community composition (Figure 1). Overall CPUE was higher at night compared to day (Night: 202 ± 23; Day: 119 ± 14; $p<0.05$; (Figure 2). When I compared catch rates between the three most prevalent families in my data sets, I also found significant differences in the mean CPUE of all three families favoring night electrofishing; Catostomidae: $p<0.05$, Cyprinidae: $p<0.05$, Sciaenidae: $p<0.05$ (Figure 3; Table 1). Within Cyprinidae, potential species driving the significance were the Emerald Shiner (Night: 20.18 ± 7.32; Day: 8.57 ± 2.84) and Silvery Minnow (Night: 12.6 ± 7.08; Day: 0.76 ± 0.41) (Table 2). For Catostomidae, potential drivers of this difference were River Carpsucker (Night: 21.68 ± 4.05; Day: 7.81 ± 1.67) and Smallmouth Buffalo (Night: 13.39 ± 1.78; Day: 5.71 ± 0.97)

(Table 3). When I compared the four fish families with noticeable differences between methods, I found that only Lepisosteidae had a significant difference in mean CPUE; Centrarchidae: $p>0.05$, Lepisosteidae: $p<0.05$, Ictaluridae: $p>0.05$, Clupeidae: $p>0.05$ (Figure. 3; Table 1) All of these differences showed a selectivity towards night time activity except for Clupeidae.

Although I sampled a much higher number of Catostomidae at night (Night: n=647; Day: n=192), the length distributions did not differ significantly ($p>0.025$; Fig. 4). When I compared the length distributions of Cyprinidae, I found that both the distributions for small-bodied, native minnows and for large-bodied, non-native minnows showed higher numbers at night (native: Night: n=859; Day: n=153; non-native: Night: n=187; Day: n=154). However, the size distributions between night and day did not differ significantly in either group of Cyrpinid (non-native: $p>0.025$, Figure 5; native: $p>0.025$, Figure 6.). Lastly, when I compared the length distributions of Sciaenidae between night and day samples I found that, along with yielding a higher number of fish, night sampling showed a significantly lower median total length (Night: n= 280, Day: n= 138; $p<0.025$) (Figure 7). In addition, I found that 6.8% of my night time samples were from 0-100 mm, whereas 0.7% of my day time samples were in this length group. Conversely, 43% of Sciaenids from my day time samples were from 300-400 mm, while only 12% of my night time samples were within this range.

Seasonal Comparison

When I assessed seasonal differences in nighttime fish communities of the Wabash River, I did not observe a significant difference in overall CPUE between the seasons ($p>0.05$). In my NMDS plot, the fish families sampled were relatively similar in composition and relative abundance between seasons (Figure 8). However, I found significant seasonal variation in catch rates within families. Specifically, I observed significant differences between seasons in the families Catostomidae, Ictaluridae, Lepisosteidae, and Sciaenidae (Figure 9; Table 4). In both Catostomidae and Ictaluridae families, I observed a significantly lower mean CPUE during the winter (Figure 9; individual species shown in Tables 5 and 6). In the family Lepisosteidae, Winter was significantly lower than both Spring ($p<0.05$) and Summer ($p<0.05$) (Fig. 9; individual species shown in Table 7). In the family Sciaenidae, Fall had a significantly higher mean CPUE than all other seasons. Additionally, Spring had a significantly higher mean CPUE than the Winter (Figure 9; individual species shown in Table 8). Despite not having statistically significant differences, other families showed noticeably different mean CPUEs across seasons.

Length frequency distributions of individual families also varied seasonally. The size distributions of Sciaenidae were not significantly different among seasons ($p>0.008$) (Figure 10). For native Cyprinids, Fall was significantly different than all other seasons, Winter was significantly different than both Spring and Summer, and Spring was significantly different than Summer ($p<0.008$) (Figure 11). For non-native Cyprinids, Summer was significantly different than both Fall and Winter ($p<0.008$) (Figure 12). For Catostomidae, Fall was significantly different than both Winter and Spring, Winter was significantly different than both Spring and Summer, and Spring was Significantly different than Summer ($p<0.008$) (Fig 13). These variations showed a generally higher number of mid-sized fish in the Fall and Summer and an influx of small-bodied individuals during the Spring.

Discussion:

My results indicate that there are indeed substantial differences between night and day electrofishing; the size and direction of these differences varied across fish families and species. Generally, night electrofishing showed higher catch rates relative to day electrofishing reflecting studies in both lentic and lotic systems (Dumont and Dennis, 1997; Fisher & Quist, 2014; Paragamian, 1989; Ross et al., 2016). Specifically, I found significant differences between the night and day catch rates of Catostomidae, Cyprinidae, Lepisosteidae, and Sciaenidae. In Catostomidae, my highest catches came from Smallmouth Buffalo (*Ictiobus bubalus*) and River Carpsucker (*Carpiodes carpio*). Several studies on movement in these families indicate that fishes move from deeper water to shoreline habitats at night for the purposes of spawning, foraging, and predator avoidance (Grabowski and Isley, 2006, McComish, 1967, Snedden et. al, 1999, Straight Et. Al., 2015). Based on the Bray-Curtis matrix, I observed a distinction in community assemblage between night and day sampling. However, overall composition was relatively similar and proportionate between methods.

My observation of high catch rates of young-of-year drum may be indicative of diel movement to the shoreline during the night in order to forage. A previous study found high abundances of larval cyprinids in overnight light traps (Roth, 2017; unpublished data) and young Drum are known to feed upon cyprinids (Pflieger, 1997). Rypel and Mitchell (2007) found similar results in Alabama lakes and rivers and speculated that the change in size structure from larger to smaller Drum during the night could be a result of lower predation risk and higher foraging opportunity. Similarly, Percid species have also been found to utilize low-light periods of the day as they provide optimal foraging and predator evasion conditions (Craig, 1977). Dennis & Dumont (1997) found significantly higher catch rates of Largemouth Bass and Gizzard Shad as well, though I did not observe significant differences between night and day sampling in these families or in Percids.

In my seasonal analysis, the results of my Bray-Curtis indicated a similarity among the four seasons and the families sampled were relatively equal among seasons. When I compared the CPUEs of individual families between seasons, I observed varying degrees of significant difference. This was also observed by Hatzenbeler et al. (2000) who found that, due to consistent fish-habitat association throughout seasons, most fish could be sampled from Spring to early Fall. In my data, I observed significant seasonal variation in the families Ictaluridae, Catostomidae, Lepisosteidae, and Sciaenidae. Channel Catfish in the Wisconsin River migrate downstream during the Fall, returning upstream during the Spring, and remaining in their home ranges through the summer (Pellett et al., 1998). Given that my catch rates for Ictaluridae were highest in the Summer and lowest in the Winter, this may reflect similar migration patterns in the Wabash. In addition, the significantly lower CPUEs in the Winter may indicate that Catostomidae and Ictaluridae are not as active or susceptible to electrofishing due to colder temperatures (Pope and Willis, 1996). For Lepisosteidae, the significant difference between Winter and Summer and between Winter and Spring indicate that Gar species may be more susceptible to electrofishing during the Spring and Summer as well. Buckmeier et al. (2013) found that increases in Alligator Gar movement in the Trinity River of Texas were correlated with increases in temperatures. I may be seeing a similar trend; Warmer temperatures increase activity of both the Gar species and bait fish species, such as Clupeids and Cyprinids, and the Lepisosteids may be increasing their foraging.

In Catostomidae, Grabowski and Isely (2006) found that the seasonal movements of Robust Redhorse in the Savannah River were correlated to changing temperatures; the fish moving downstream as temperatures decreased. For the Sciaenidae, Fall had a significantly higher CPUE than all other seasons which may indicate that conditions in my Autumn sampling periods may have provided optimal foraging opportunities. Pierce et al. (1985) found that varying river stages have an effect on Freshwater Drum catches and, thus, the varying river stages throughout the year in my study area may explain these seasonal differences in my own catch rates. Jackson and Hightower (2001) found no significant differences between seasons in Striped Bass of reservoirs in Virginia and North Carolina. Similarly, I did not find significant seasonal differences in Moronidae CPUE. However, McCauley et al. (2014) found that diel behavior of White Perch in the Carmans River of New York was dependent upon the season; the maximum movement occurring in the summer and decreasing significantly in the winter.

Length distributions of fish families showed a great deal of variation between seasons. In native Cyprinids, Spring had higher median lengths whereas winter had a high number of smaller fish and the Summer showed higher numbers mid-sized fish. For non-native Cyprinids, Summer samples had relatively smaller fish whereas Fall, Winter, and Spring all showed higher numbers of large-bodied fish. In Catostomidae, Fall, Spring, and Summer all showed a greater number of mid-sized fish while a shift towards relatively larger fish took place in the Winter. With some exceptions, I generally observed an influx of small-bodied fish during the Spring, which then lead to a shift to mid-sized fish during the Summer and Fall, and then another shift to larger-bodied fish in the Winter. These shifts in size structure may be due to recruitment of juvenile fishes, mortality, and changes in environmental factors such as temperature throughout the year (Pope and Willis, 1996). These results indicate that the LTEF sampling season most likely collects a sufficient range of size-classes among fish species.

Given that each of my sampling sites included a span of habitat types that are frequently sampled by LTEF and my electrofishing methods were standardized as per LTEF protocol, I can conclude that the data I collected is comparable to LTEF data. Because of this, I can conclude that the differences I observed between day and night sampling as well as between seasons would not impact the accuracy of the samples collected through current LTEF protocols. For the overarching goal of the LTEF program, which is to assess the fish communities of large rivers, I conclude that the current protocols do not need to be modified to include night sampling or off-season sampling. Based on my results, the added expense of effort, time, and money required to include night time and seasonal electrofishing would outweigh the value of the additional data gained.

Since the Wabash River is a highly dynamic system, it can be a relatively dangerous river to work on. With a lack of impoundments and no maintained channel, the Wabash is subject to flash flooding, high current, and free-floating debris as well as a multitude of sand and gravel bars. Additionally, sampling during the winter and early spring poses an increased danger factor. Freezing temperatures and ice during the winter as well as flash floods during the early spring can make electrofishing, both during the day and during the night, extremely dangerous. Therefore, the benefits of modifying the

LTEF protocol to include night and off-season electrofishing may not outweigh the cost in manpower and the risk of injury. The late Spring, Summer, and early Autumn pose far less risk than the late Fall and Winter months. Additionally, warmer temperature and lower river stages provide for increased fish activity and higher catch rates; thus, making for more optimal sampling conditions.

Night sampling as well as off-season electrofishing would, however, be beneficial in some scenarios outside of LTEF sampling. As was noted in several families, there were generally higher catch rates during the night and noticeable shifts in size structure among seasons. This would indicate that targeted sampling for certain species or size-classes of fish would greatly benefit from night time and/or off-season sampling. I would recommend that these methods be used for demographic assessments of fish species as well as for recruitment studies.

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Tables:

Table. 1. Mean CPUE ± one standard error of all families sampled from the Wabash River during October 2016 to November 2017 separated by sampling method

Family	**Night**	**Day**
Acipenseridae	1.35 (0.21)	0.10 (0.10)
Amiidae	0.00 (0.00)	0.10 (0.10)
Atherinopsidae	0.08 (0.08)	0.00 (0.00)
Catostomidae	48.76 (5.46)	18.29 (2.42)
Centrarchidae	19.02 (4.31)	14.57 (2.75)
Clupeidae	4.99 (1.09)	20.95 (9.28)
Cyprinidae	78.80 (16.62)	29.52 (4.21)
Hiodontidae	0.42 (0.18)	0.29 (0.16)
Ictaluridae	12.46 (3.04)	9.81 (1.99)
Lepisosteidae	12.38 (1.55)	9.81 (2.39)
Moronidae	1.35 (0.54)	1.81 (0.55)
Percidae	0.90 (0.34)	0.86 (0.35)
Petromyzontidae	0.00 (0.00)	0.10 (0.10)
Poeciliidae	0.00 (0.00)	0.10 (0.10)
Sciaenidae	21.08 (3.19)	13.14 (2.21)

Table. 2. Mean CPUE ± one standard error of all Cyprinidae species sampled from the Wabash River during October 2016 to November 2017 separated by sampling method

Species	**Night**	**Day**
Bighead Carp	0.08 (0.08)	0 (0)
Bluntnose Minnow	1.92 (0.64)	0.1 (0.1)
Bullhead Minnow	14.14 (4.74)	1.33 (0.5)
Common Carp	9.45 (2.25)	12.38 (2.36)
Emerald Shiner	20.18 (7.32)	8.57 (2.84)
Golden Shiner	0 (0)	0.1 (0.1)
Grass Carp	0.68 (0.29)	0.38 (0.18)
Mimic Shiner	0.08 (0.08)	0 (0)
River Shiner	2.25 (1.29)	0 (0)
Sand Shiner	4.8 (1.71)	0.48 (0.24)
Silver Carp	3.94 (0.81)	2 (0.86)
Silver Chub	2.03 (0.89)	0.19 (0.13)
Silvery Minnow	12.6 (7.08)	0.76 (0.41)
Speckled Chub	0.3 (0.18)	0 (0)
Spotfin Shiner	4.88 (1.35)	2.86 (0.92)
Steelecolor Shiner	1.05 (0.7)	0.19 (0.13)
Unidentified Cyprinid	0.45 (0.27)	0.19 (0.13)

Table. 3. Mean CPUE ± one standard error of all Catostomidae species sampled from the Wabash River during October 2016 to November 2017 separated by sampling method

Species	**Night**	**Day**
Bigmouth Buffalo	1.80 (0.55)	0.38 (0.23)
Black Buffalo	3.83 (0.86)	1.52 (0.33)
Blue Sucker	2.22 (0.57)	0.86 (0.35)
Golden Redhorse	0.75 (0.43)	0.1 (0.1)
Highfin Carpsucker	0.53 (0.21)	0.1 (0.1)
Quillback	1.2 (0.62)	0.29 (0.16)
River Carpsucker	21.68 (4.05)	7.81 (1.67)
River Redhorse	0.75 (0.57)	0 (0)
Shorthead Redhorse	2.1 (0.8)	0.57 (0.26)
Silver Redhorse	0.08 (0.08)	0.1 (0.1)
Smallmouth Buffalo	13.39 (1.78)	5.71 (0.97)
Unidentified Catostomid	0.45 (0.33)	0.86 (0.68)

Table. 4. Mean CPUE ± one standard error of all families sampled from the Wabash River during October 2016 to November 2017 separated by season

Family	**Fall**	**Spring**	**Summer**	**Winter**
Acipenseridae	0.57 (0.28)	0.62 (0.27)	2.71 (2.28)	0.46 (0.18)
Amidae	0 (0)	0.23 (0.13)	0 (0)	0.23 (0.17)
Atherinopsidae	0.07 (0.07)	0 (0)	0 (0)	0 (0)
Catostomidae	36.5 (5.22)	35.92 (7.09)	25.29 (5.84)	9.92 (2.18)
Centrarchidae	10.57 (3.71)	5.08 (1.79)	11.43 (4.45)	2.54 (0.78)
Clupeidae	5.93 (1.6)	7.23 (1.76)	2.86 (1.1)	7 (2.1)
Cyprinidae	63.93 (16.64)	28.69 (7.68)	23.29 (5.91)	148 (63.6)
Hiodontidae	0.29 (0.17)	0.77 (0.26)	0.57 (0.26)	0.69 (0.23)
Ictaluridae	6.36 (1.27)	4.46 (1.3)	13.86 (5.38)	1 (0.42)
Lepisostidae	8.36 (3.41)	12.77 (3.89)	8.43 (2.07)	5.31 (2.99)
Moronidae	1.14 (0.52)	0.54 (0.22)	0.43 (0.23)	0.15 (0.11)
Percidae	0.64 (0.32)	0.15 (0.11)	0.57 (0.26)	0.23 (0.13)
Petromyzontidae	0.07 (0.07)	0 (0)	0 (0)	0.08 (0.08)
Sciaenidae	26.57 (5.04)	10.85 (2.43)	7.43 (2.03)	5.31 (2.04)

Table. 5. Mean CPUE ± one standard error of Catostomidae sampled from the Wabash River during October 2016 to November 2017 separated by season

Species	**Fall**	**Spring**	**Summer**	**Winter**
Bigmouth Buffalo	0.5 (0.23)	0.92 (0.38)	1.71 (0.82)	0.31 (0.24)
Black Buffalo	3.43 (0.8)	3.23 (0.82)	2.43 (1.05)	1.77 (0.51)
Blue Sucker	2.86 (0.65)	0.62 (0.25)	2.8 (0.88)	0.23 (0.23)
Golden Redhorse	0.14 (0.1)	1.23 (0.51)	0.57 (0.39)	0.15 (0.11)
Highfin Carpsucker	0.07 (0.07)	0.62 (0.27)	0.43 (0.31)	0.08 (0.08)
Quillback	0.79 (0.32)	3.23 (1.05)	0.29 (0.2)	0.08 (0.08)
River Carpsucker	17.07 (3.94)	15.92 (4.41)	8.57 (2.45)	3.31 (1.1)
River Redhorse	0 (0)	0.54 (0.54)	0.43 (0.43)	0 (0)
Shorthead Redhorse	1.57 (0.5)	1.85 (0.84)	1.43 (1.07)	0.15 (0.11)
Silver Redhorse	0 (0)	0.15 (0.11)	0.14 (0.14)	0 (0)
Smallmouth Buffalo	9.5 (1.71)	7.62 (1.75)	6.79 (1.91)	3.69 (0.92)
White Sucker	0 (0)	0 (0)	0 (0)	0.08 (0.08)
Unidentified	0.57 (0.33)	0 (0)	0 (0)	0.08 (0.08)

Table. 6. Mean CPUE ± one standard error of Ictaluridae species sampled from the Wabash River during October 2016 to November 2017 separated by season

Species	**Fall**	**Spring**	**Summer**	**Winter**
Blue Catfish	0.57 (0.26)	0.15 (0.11)	0 (0)	0.23 (0.23)
Channel Catfish	5 (1.16)	2.92 (0.91)	5.15 (1.41)	0.77 (0.36)
Flathead Catfish	0.79 (0.34)	1.31 (0.79)	8.86 (4.95)	0 (0)
Mountain Madtom	0 (0)	0.08 (0.08)	0 (0)	0 (0)

Table. 7. Mean CPUE ± one standard error for Lepisosteidae species sampled from the Wabash River during October 2016 to November 2017 separated by season

Species	**Fall**	**Spring**	**Summer**	**Winter**
Longnose Gar	2.43 (0.70)	3.31 (0.91)	4.57 (1.29)	1.08 (0.72)
Shortnose Gar	5.86 (2.90)	9.46 (3.22)	3.86 (1.08)	4.15 (2.36)
Spotted Gar	0.07 (0.07)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Unidentified	0.00 (0.00	0.00 (0.00)	0.00 (0.00)	0.08 (0.08)

Table. 8. Mean CPUE ± one standard error of Sciaenidae species sampled from the Wabash River during October 2016 to November 2017 separated by Season

Species	Fall	Spring	Summer	Winter
Freshwater Drum	26.57 (5.04)	10.85 (2.43)	7.58 (2.04)	5.31 (2.04)

Figures:

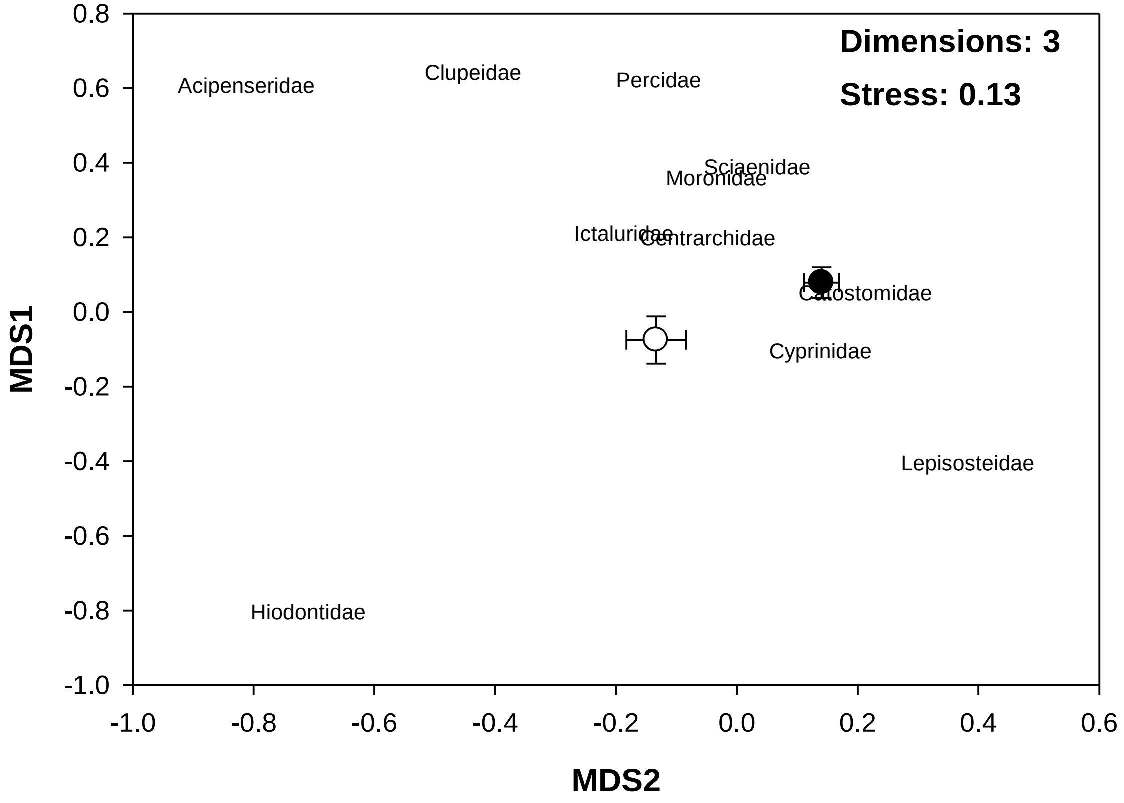

Fig. 1. Non-metric Multidimensional Scaling plot showing mean site scores ± (SE) for night (black) and day (white) electrofishing in the Wabash River from October 2016 to November 2017. Additionally, the names of the families sampled are plotted based upon their relative abundance.

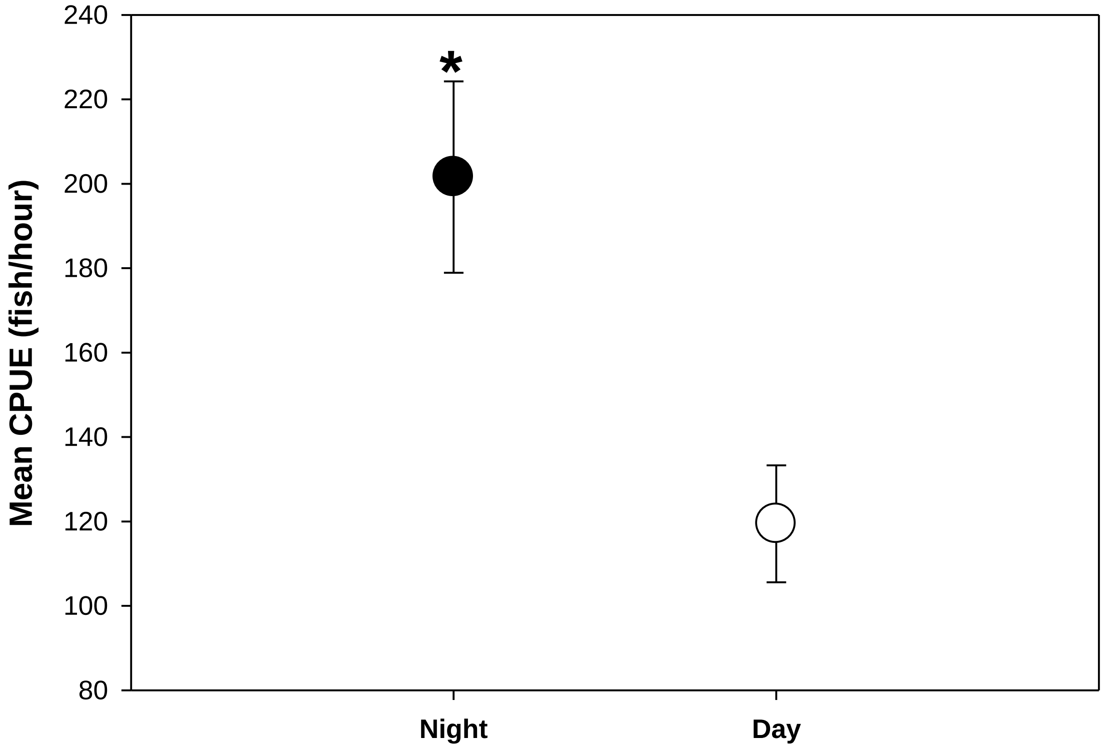

Fig. 2. Mean CPUE ± one standard error of all families sampled from the Wabash River during October 2016 to November 2017 separated by sampling method. Asterisks indicate a significant difference.

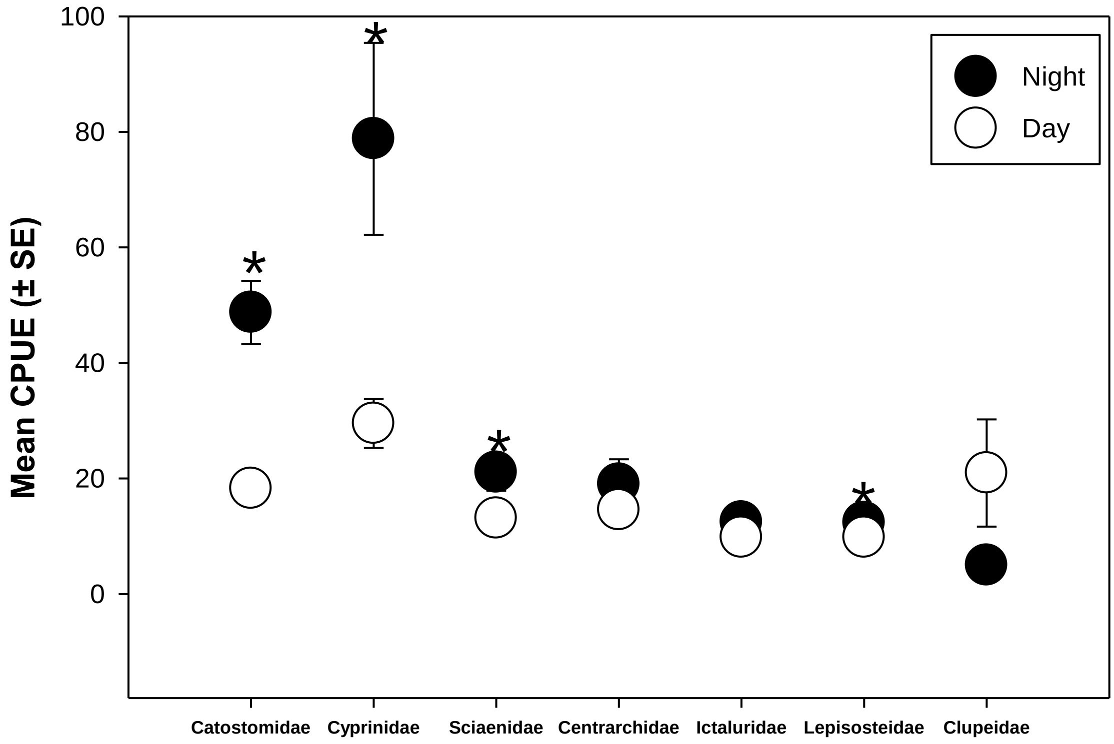

Fig. 3. Mean CPUE ± one standard error of common families sampled from the Wabash River during October 2016 to November 2017 separated by sampling method. Asterisks indicate a significant difference.

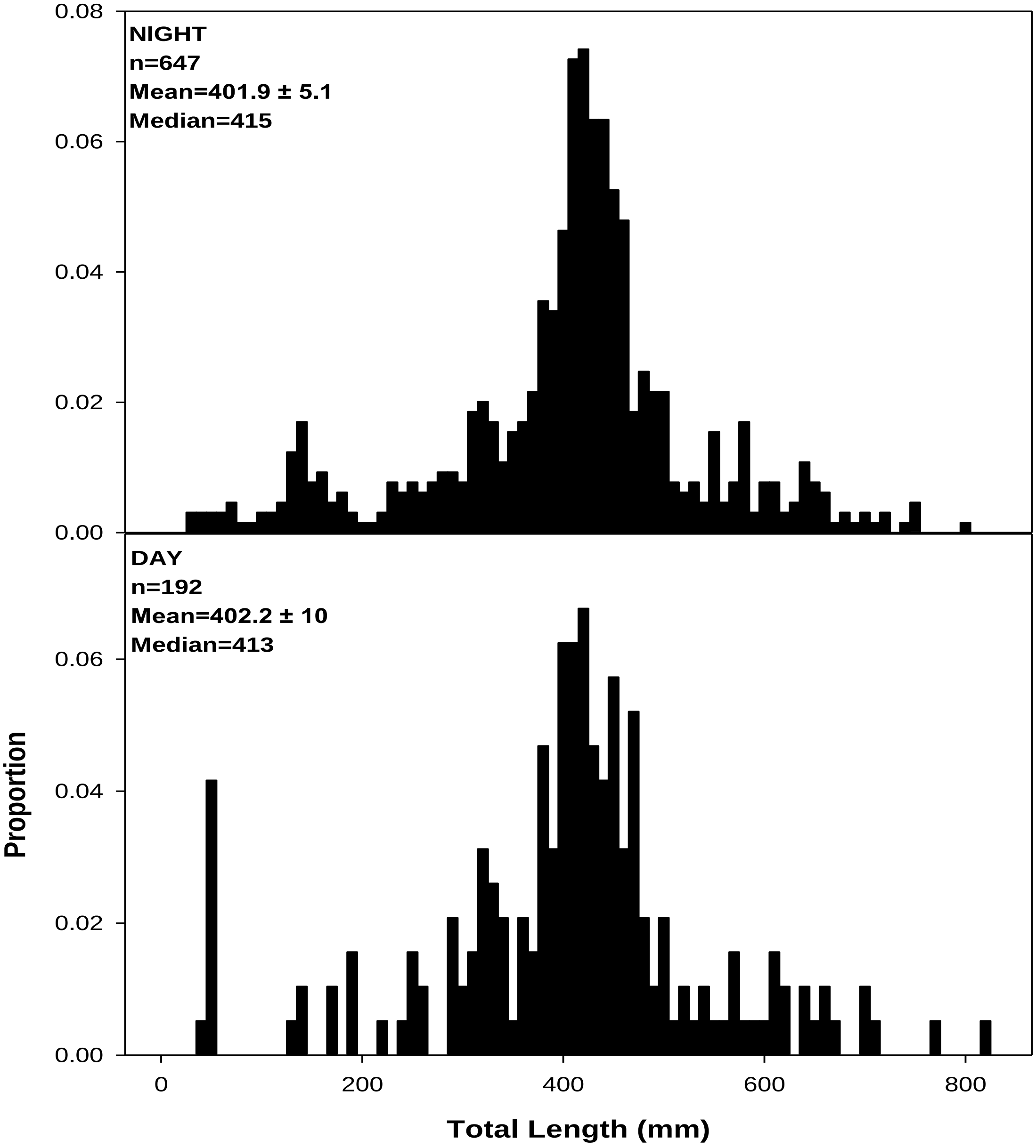

Fig. 4. Length frequency histogram showing length distributions of Catostomidae sampled from the Wabash River during October 2016 to November 2017 separated by method.

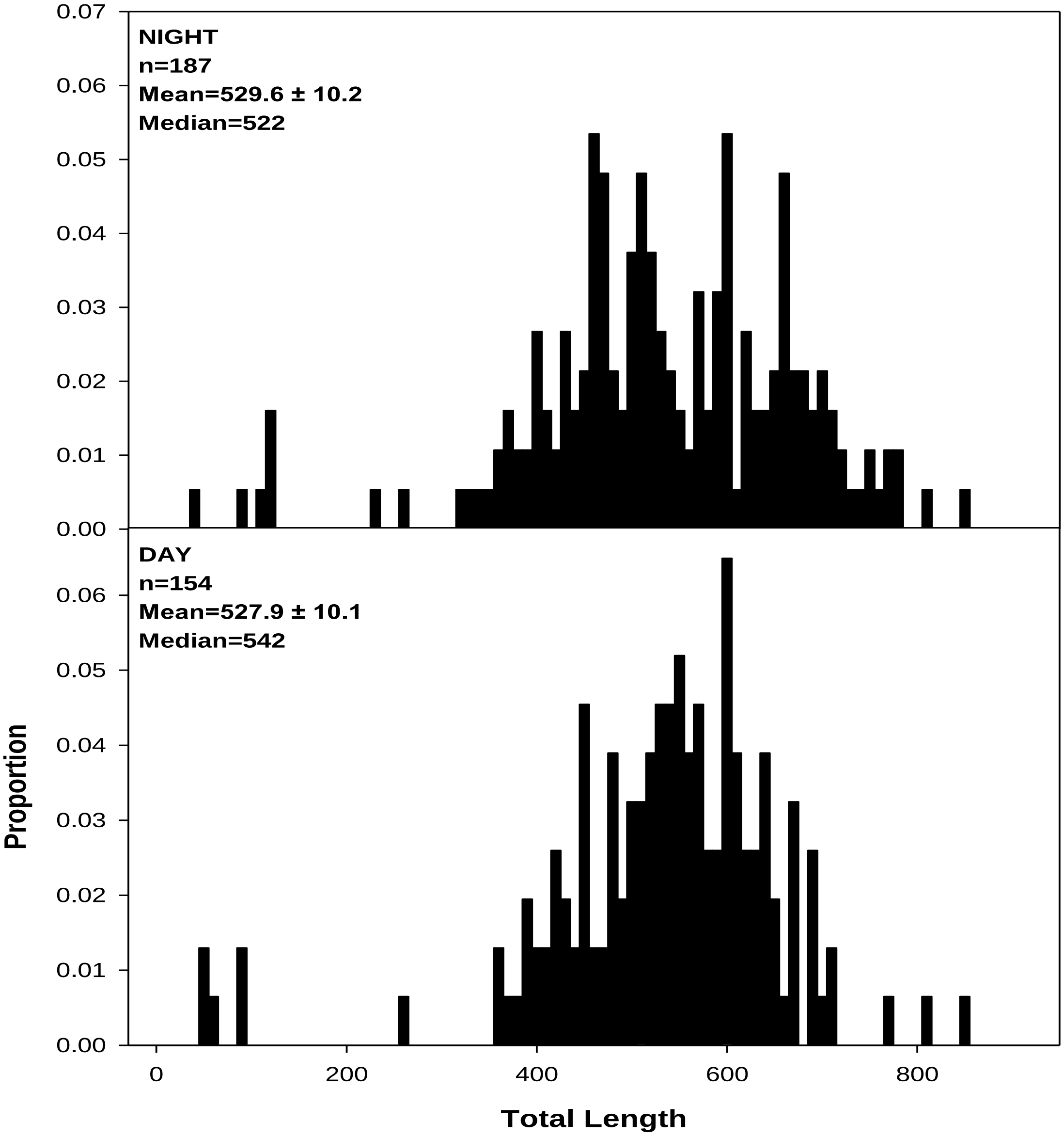

Fig. 5. Length frequency histogram showing length distributions of non-native Cyprinidae sampled from the Wabash River during October 2016 to November 2017 separated by method.

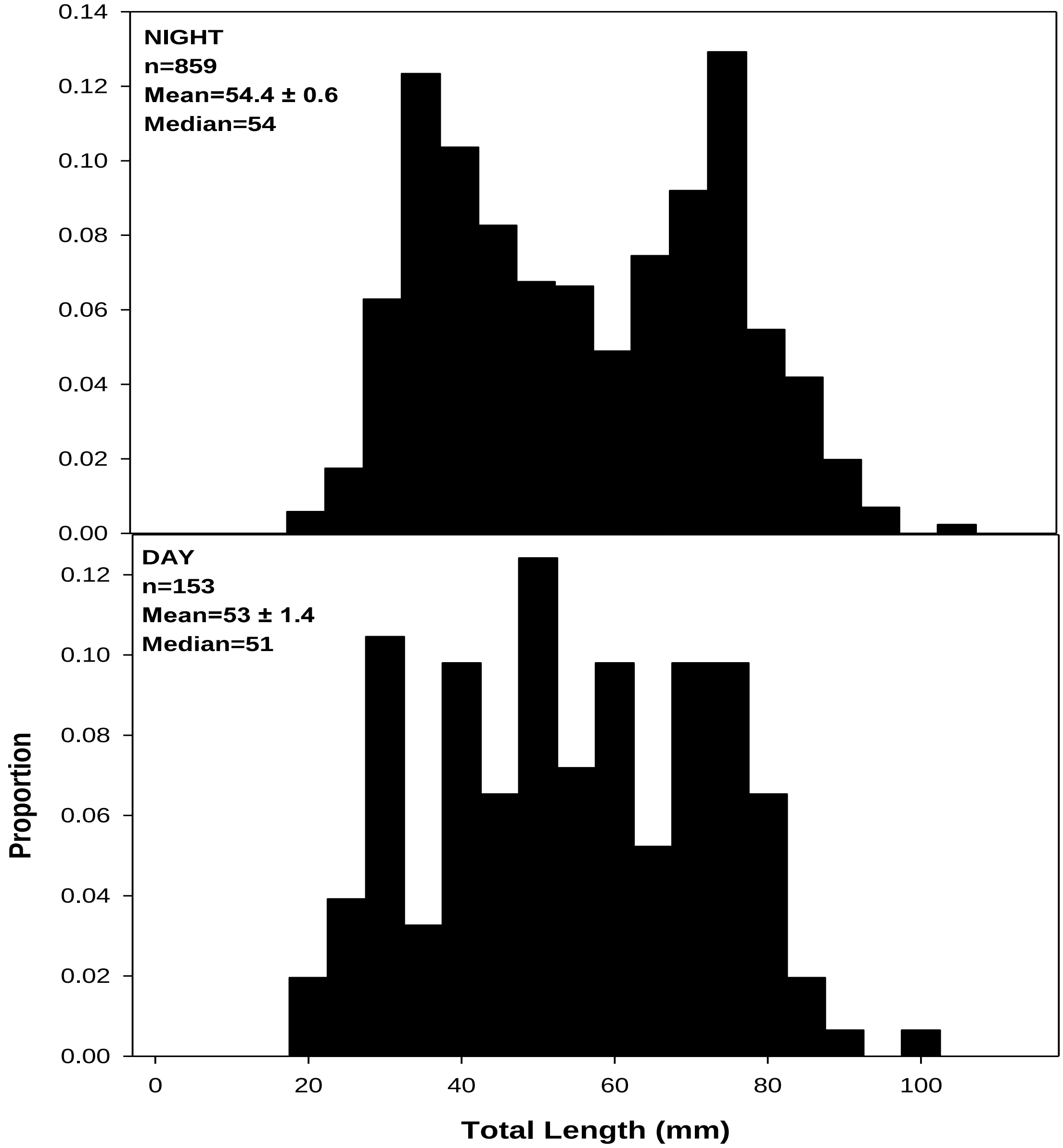

Fig. 6. Length frequency histogram showing length distributions of native Cyprinidae sampled from the Wabash River during October 2016 to November 2017 separated by method.

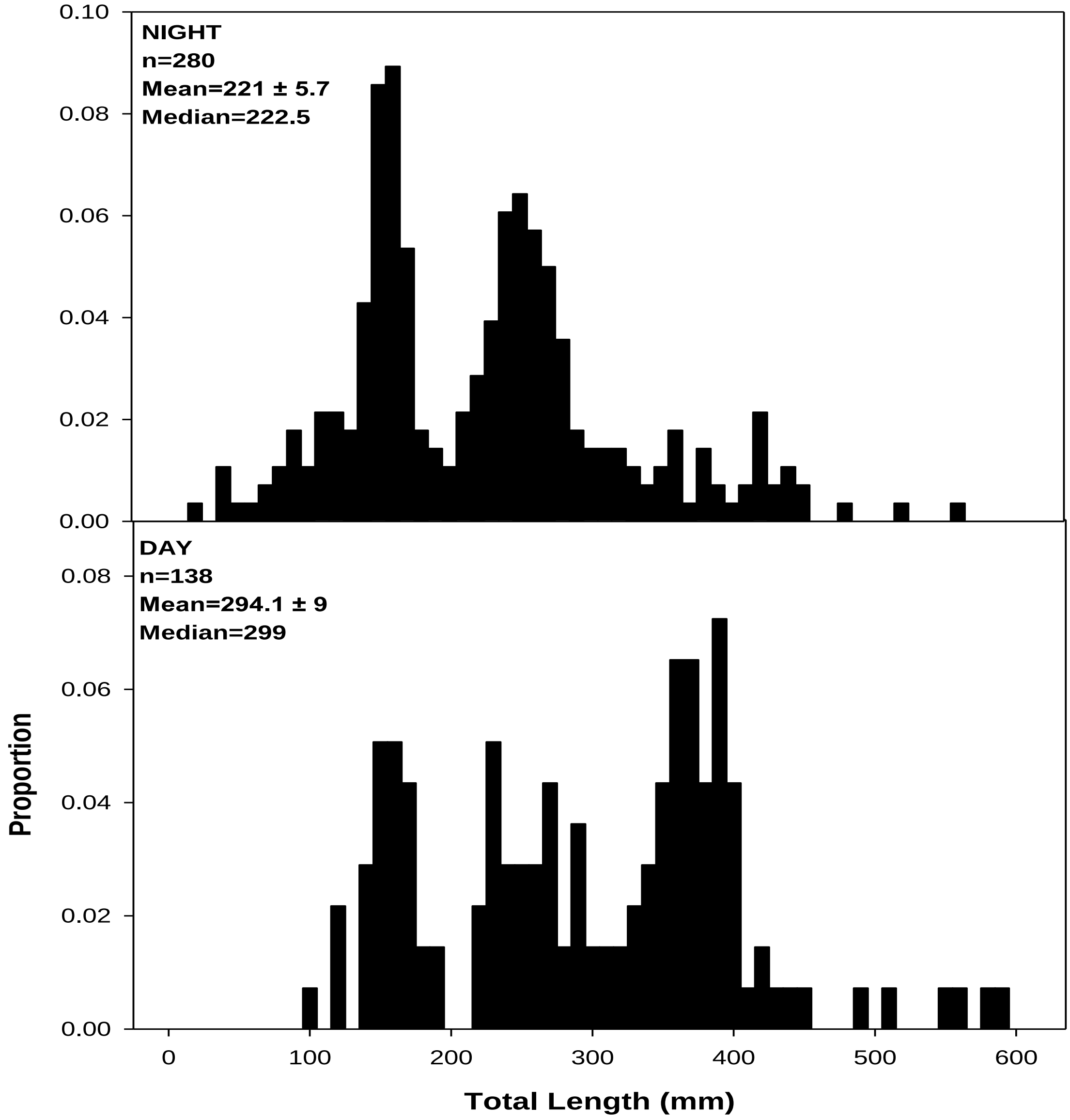

Fig 7. Length frequency histogram showing length distributions of Sciaenidae sampled from the Wabash River during October 2016 to November 2017 separated by method.

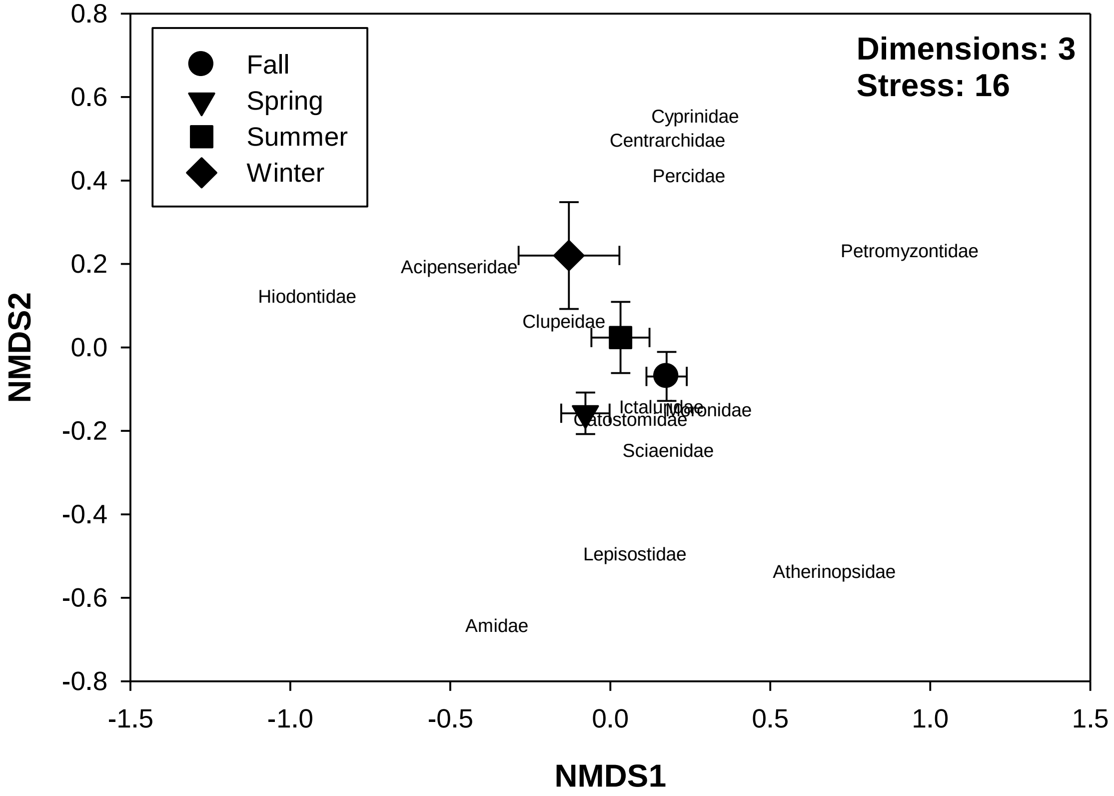

Fig. 8. Non-metric Multidimensional Scaling plot showing mean site scores ± (SE) for each season sampled in the Wabash River from October 2016 to November 2017. Additionally, the names of the families sampled are plotted based upon their relative abundance.

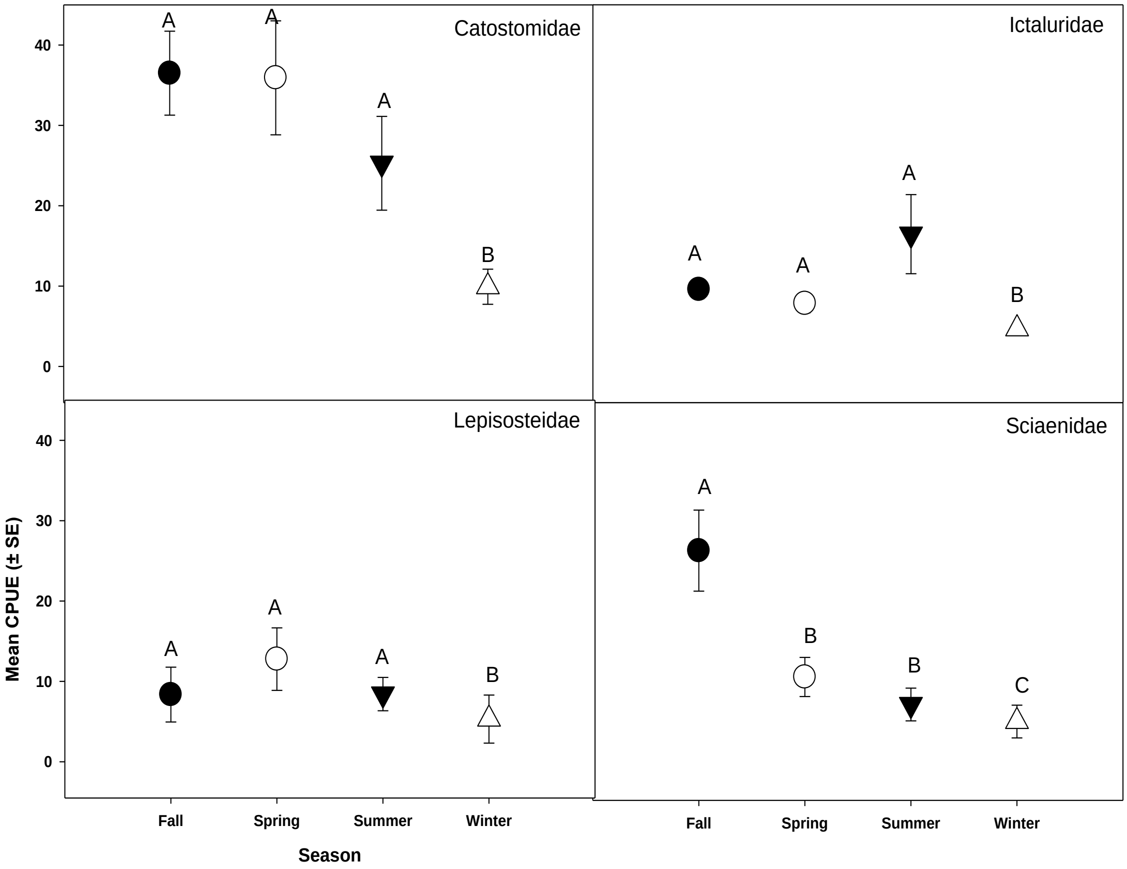

Fig. 9. Mean CPUE ± one standard error of common families sampled from the Wabash River during October 2016 to November 2017 separated by season. Letters indicate significant differences.

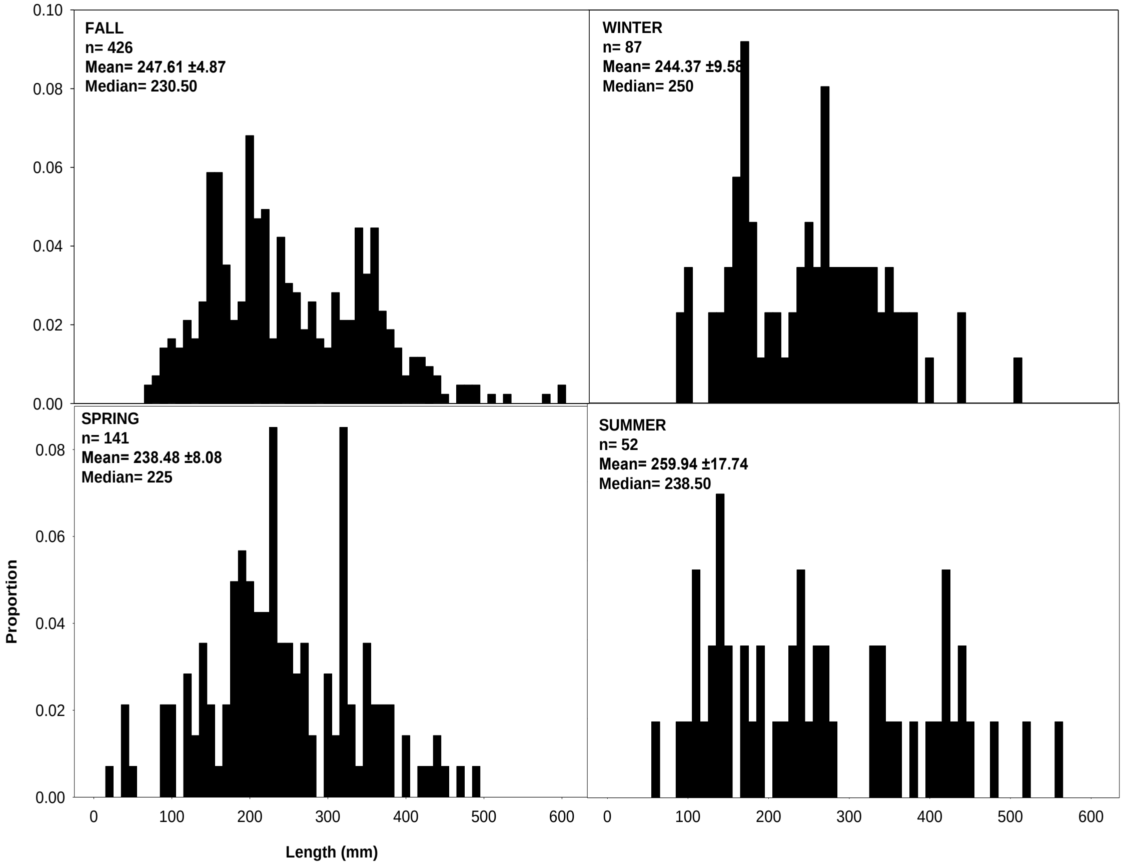

Fig. 10. Length frequency histograms showing length distributions of Sciaenidae sampled from the Wabash River during October 2016 to November 2017 separated by season.

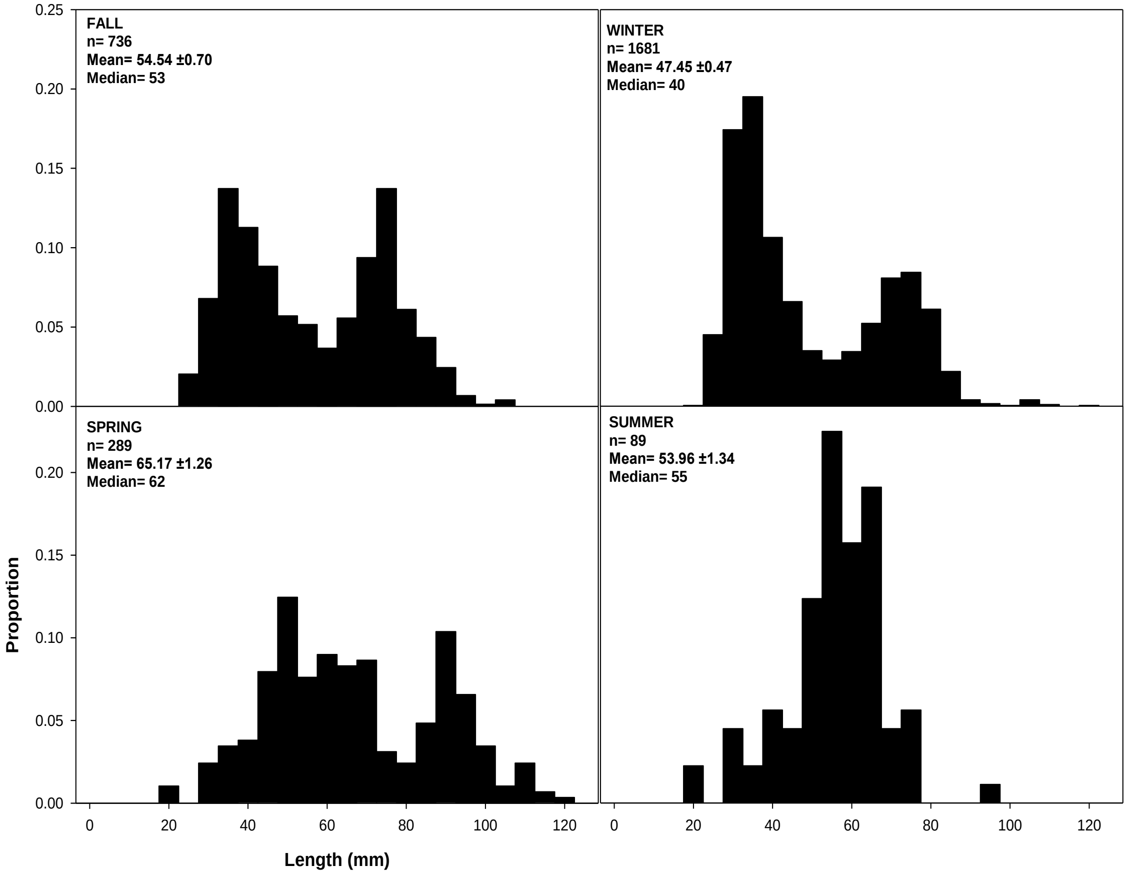

Fig. 11. Length frequency histogram showing length distributions of native Cyprinidae sampled from the Wabash River during October 2016 to November 2017 separated by season.

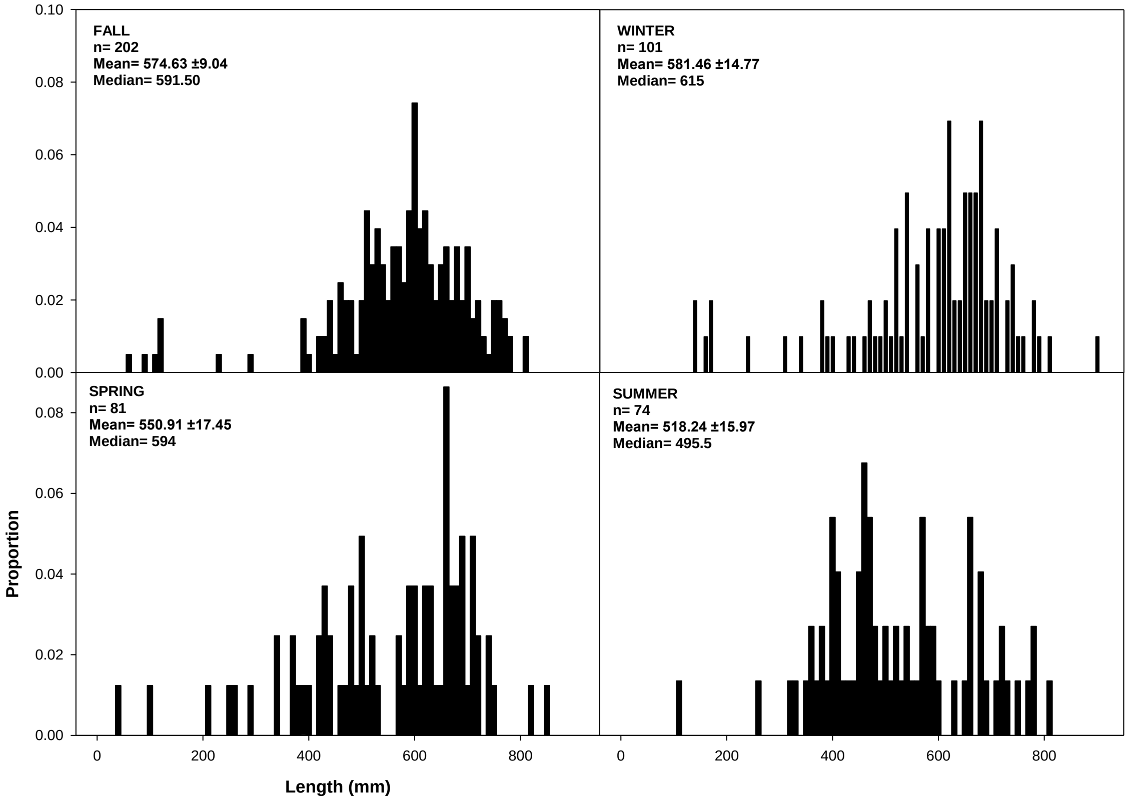

Fig. 12. Length frequency histogram showing length distributions of non-native Cyprinidae sampled from the Wabash River during October 2016 to November 2017 separated by season.

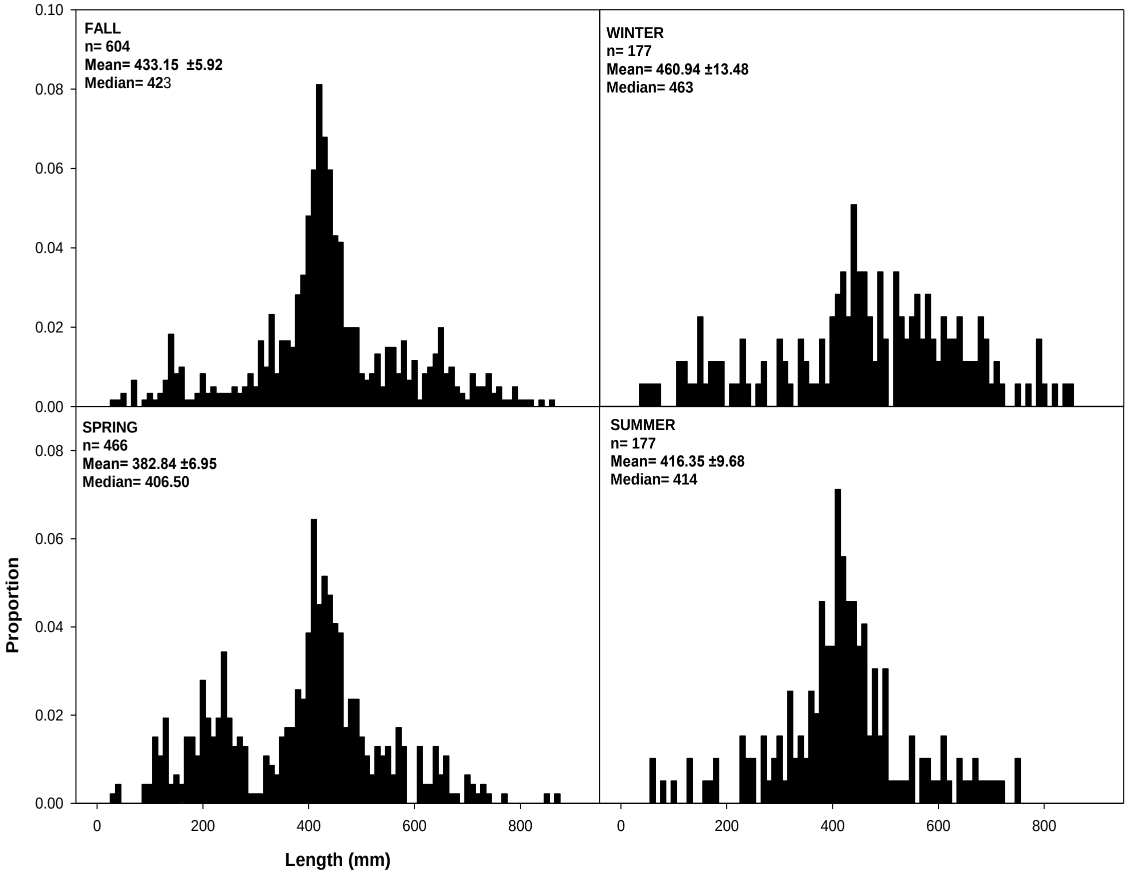

Fig. 13. Length frequency histogram showing length distributions of Catostomidae sampled from the Wabash River during October 2016 to November 2017 separated by season.