Comparability of Channel Catfish Stock Descriptors Obtained from Different Hoop Net Configurations

John R. Jackson, *Department of Wildlife and Fisheries, Box 9690, Mississippi State University, Mississippi State, MS 39762*

Donald C. Jackson, *Department of Wildlife and Fisheries, Box 9690, Mississippi State University, Mississippi State, MS. 39762*

Abstract: Channel catfish (*Ictalurus punctatus*) stock characteristics of a small flood-plain river were compared from samples collected in 1994–1996 from 3 different hoop configurations (large hoop net (LH): 4.3 long with 7 1.07-m diameter hoops and 3.81-cm bar mesh netting; small hoop net (SH): 1.3 m long with 4 0.51-m diameter hoops and 3.81-cm bar mesh netting; and small hoop net (SM): 1.3 m long with 4 .0.51-m diameter hoops and 2.54-cm bar mesh netting). Channel catfish were fully-recruited at 35 cm total length (TL) in LH and SH configurations and 30 cm TL in the SM configuration. The SM configuration collected 2.5 times more channel catfish than LH and SH configurations combined. Length-frequency distributions of the fully-recruited component of the catch (fish ≥ 35 cm TL) were similar ($P > 0.05$) among hoop net configurations. Mean TL and mean weight differences among configurations were reduced after correcting for differences in bar mesh size. Mean daily CPUE (fish/net-night and g/net-night) was not significantly correlated ($P > 0.05$) between LH and SH configurations. Significant mean daily CPUE correlations ($P \leq 0.05$) with weak associations existed between LH and SM configurations ($r = 0.38$ for fish/net-night; $r = 0.32$ for g/net-night) and between SH and SM configurations ($r = 0.24$ for fish/net-night; $r = 0.23$ for g/net-night). Mean seasonal CPUEs were significantly correlated ($P \leq 0.05$) between SH and SM configurations and revealed moderate associations ($r = 0.69$ for fish/net-night; $r = 0.67$ for g/net-night). However, significant mean seasonal CPUE correlations did not exist ($P > 0.05$) between LH and SH configurations or between LH and SM configurations. As a result, comparisons of relative abundance using CPUE as an index from different configurations should be used with caution.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 51:79–87

Hoop nets are often the gear of choice for sampling channel catfish in rivers (Funk 1958, Nelson and Little 1986, Jackson et al. 1995). Their effectiveness is dependent upon gear configuration (i.e., hoop diameter and mesh characteristics) (Muncy 1957, Hesse 1979, Holland and Peters 1992, Stopha 1994, Walker et al. 1994), how and where the gear is fished (i.e., bait, habitat, and channel type) (Pierce et al. 1981, Hubert and Schmitt 1982, Gerhardt and Hubert 1989, Holland and Peters 1992), and environmental factors (i.e., season, water temperature, velocity, and turbidity) (Muncy 1957, Hubert and Schmitt 1982). Fisheries managers conducting stock assessments typically standardize hoop net sampling (gear and procedures) to enhance logistical efficiency and simultaneously provide comparable stock descriptors.

Hoop size determines the minimum water depth in which a net can fish and often limits sampling in small rivers (Pugibet and Jackson 1989). Boat access and use on small rivers often are restricted seasonally, making sampling with large-diameter hoop nets (a large river gear) logistically difficult or impossible. Therefore, it may be beneficial to set smaller diameter hoop nets if stock structural characteristics determined from hoop net catches are similar among different configurations.

State agency-sponsored riverine fish stock assessments in Mississippi typically use hoop nets with 1.07-m diameter hoops and 3.81-cm bar mesh netting (Garavelli 1985, Jackson and Jackson 1989, Jackson et al. 1995) The large diameter of this configuration may not be necessary to assess channel catfish stocks accurately in small rivers and streams. Additionally, the 3.81-cm bar mesh netting is not efficient in collecting small channel catfish (fish < 35 cm TL) that may be of interest in stock assessments (Holland and Peters 1992, Stopha 1994).

Our study was conducted to compare channel catfish stock structural characteristics in a small river using 3 different hoop net configurations. Configurations utilized in this study varied with respect to hoop diameter, hoop number, bar mesh size, length, and bait. In addition to the hoop net described above, 2 baited configurations with fewer hoops of smaller diameter and shorter length were utilized in this study. Except for differences in bar mesh size (3.81 and 2.54 cm), these 2 configurations were identical. Therefore, the comparison of channel catfish stock structure among the 3 hoop net configurations provided us opportunity to discern differences attributed to hoop diameter, bar mesh size, and bait.

Appreciation is extended to M. Brunson, E. Dibble, L. Miranda, and R. Reagan for reviews of this manuscript and to J. Flotemersch, J. Mareska, M. Owen, C. Russell, M. Griffith, and S. Harrell for assistance in the field. Funding for this study was provided by Texas Eastern Transmission Corporation, Houston, Texas. This manuscript was approved for publication as Manuscript No. WF085 of the Forest and Wildlife Research Center, College of Forest Resources, Mississippi State University.

Methods

This study was conducted on the Yockanookany River, a small floodplain river, located in northcentral Mississippi. The Yockanookany River is a tributary of the Pearl River and is approximately 100 km long. It has a drainage area of 124,010 ha with a floodplain of 34,705 ha (Soil Conserv. Serv. 1983). Average monthly discharge within the river has varied between 2.0 and 28.4 m^3/sec between 1938 and 1995 (Plunkett et al. 1995). A small subsistence-recreational trotline and bank pole fishery exists on this river. Low summer flows, limited access, and numerous snags (large woody debris) resulted in logistical challenges typically associated with conducting fish stock assessments in small southeastern U.S. floodplain rivers.

To compare channel catfish stock structure among hoop net configurations, fish were collected seasonally for 3 years (1994–1996) from 9 1.5-km river sections. Logistical challenges associated with river access and travel required the establishment of permanent river sampling sections. In spite of statistical shortcomings associated with permanent sampling locations (Madenjian et al. 1986, Legendre 1993), permanent sites have been shown to display few statistical differences in either means or variances with regard to fish stock descriptors compared to random sites (King et al. 1981). Thus, permanent river sampling sections were deemed appropriate for our study. Sampling sections were ≥ 1 km from bridge crossing or adjacent sections. Section sampling order was randomly determined each season. Three hoop net configurations were set on each sample date [(1) 5 large hoop nets with standard assessment mesh (LH: 4.3 m long with 7 1.07-m diameter hoops and 3.81-cm bar mesh netting, unbaited); (2) 5 small hoop nets with standard assessment mesh (SH: 1.3 m long with 4 0.51-m diameter hoops and 3.81-cm bar mesh netting, baited with cheese); and (3) 5 small hoop nets with small mesh (SM: 1.3 m long with 4 0.51-m diameter hoops and 2.54-cm bar mesh netting, baited with cheese)]. Hoop nets were set overnight approximately 100 m apart from alternating banks with codends facing upstream at water depth that at least submersed net throats. Set order of the 3 configurations was randomly selected and repeated throughout a river section. Seasons were defined as winter (Jan–Mar), spring Apr–Jun), summer (Jul–Sep), and fall (Oct–Dec). A total of 1,615 hoop nets were set (N = 535 for LH, 540 for SH, 540 for SM). The discrepancy in the number of hoop nets set among configurations was due to setting only 8 river sections with the LH configuration during the summer of 1995.

Channel catfish collected were measured (TL, mm) and weighed in the field. Fish ≤1 kg were weighed to the nearest g using a Homs Model 1000 platform scale and fish >1 kg were weighed to the nearest 50 g using a Homs Model 50 pull-spring scale. Mean TL, mean weight, length-frequency distribution (% by number) and CPUE (fish/net-night and g/net-night) were determined for each hoop net configuration. Mean daily CPUE was determined from each set night (N = 5 nets/day for each net configuration) treated as a sample. The above stock descriptors were determined for each configuration using all channel catfish collected as well as the fully-recruited subset determined from length-frequency distributions. Channel catfish were considered fully-recruited into a hoop net configuration at the length group that contained the largest percentage of the catch.

Length-frequency distributions were compared among configurations using Kolmogorov-Smirnov 2-Sample Tests. Mean TL and mean weight of channel catfish were compared among configurations using analysis of variance (ANOVA, randomized complete block design). Hoop net configuration was the main effect and sample year was the blocking factor in the statistical model. Differences between means were determined using LSMEANS mean separation tests. A randomized complete block design was selected over a split-plot ANOVA for repeated measures design (sensu Maceina et al. 1994) because (1) fixed stations were not used within sampling sections, (2) fish were free to move among sampling sections, and (3) time lapse between samples within a section was sufficient for such fish movements to occur, which incorporated independence (Jackson 1995). Length-frequency distribution, mean TL, and mean weight comparisons were conducted using both the full data set and the fully-recruited subset. Mean daily CPUEs were compared among configurations using ANOVA (randomized complete block design) for the fully-recruited data set. Hoop net configuration was the main effect and sampling season the blocking factor in the statistical model. Differences between means were determined using LSMEANS mean separation tests. Sample size for each configuration was calculated to determine the number of set nights needed to detect a 50% difference in mean daily CPUE (fish/net-night) with 95% confidence (Steel and Torrie 1980). Pearson product-moment correlations were evaluated for mean daily and mean seasonal CPUE (fish/net-night and g/net-night) among net configurations for the fully-recruited data set.

Analyses were conducted using SAS (SAS Inst. Inc. 1990). The assumption of variance homogeneity in ANOVA could not be determined because an adequate test for models with >1 factor does not exist (Miller 1986). The assumption of normality was tested using the Shapiro-Wilk test. Most treatment cells were non-normal, but transformations did little to improve normality. Due to the robust nature of ANOVA, in spite of the possibility of heteroscedasticity and non-normality, each test was conducted using untransformed data (Milliken and Johnson 1984). All statistical tests were considered significant at the 0.05 alpha level.

Results

A total of 255, 188, and 1,107 channel catfish were collected in LH, SH, and SM hoop net configurations, respectively. Channel catfish were fully-recruited in LH and SH configurations at 35 cm TL (Fig. 1). The smaller mesh netting (2.54 cm) of the SM configuration collected smaller fish, thereby resulting in fully-recruited channel catfish at 30 cm TL.

Length-frequency distributions were significantly different among hoop net configurations for the entire catch, but were similar for the fully-recruited portion (comparison of fish ≥ 35 cm TL for all configurations) of the catch (Fig. 1). For the entire catch, the SM configuration was significantly different from SH and LH configurations. However, length-frequency distributions of LH and SH configurations were similar.

Mean TL and mean weights were significantly different among hoop net configurations for both the entire catch and the fully-recruited portion of the catch (Table 1). For the entire catch, mean TL of channel catfish collected with LH and SH configurations were significantly greater than those of fish collected with the SM configuration. Although statistically significant, the largest difference among mean TL (LH vs. SM configurations) decreased from 59 to 7 mm when the fully-recruited portion of the catch was compared. Additionally, mean weight of the entire channel catfish

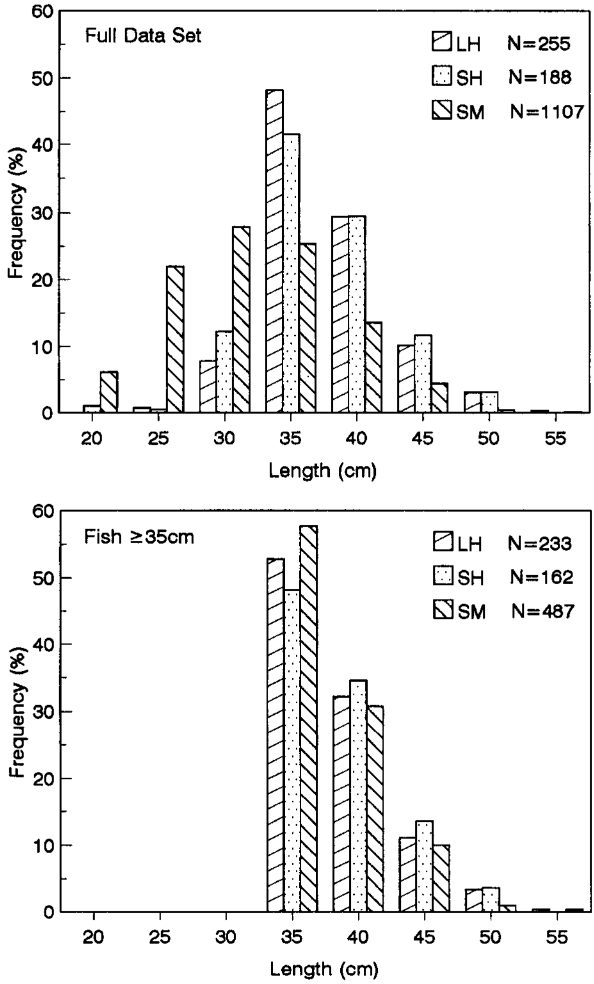

Figure 1. Length-frequency distributions of channel catfish collected with 3 hoop net configurations in the Yockanookany River, Mississippi, 1994–1996. LH = Large hoop net (4.3 m long with 7 1.07-m diameter hoops and 3.81-cm bar mesh netting). SH = Small hoop net (1.3 m long with 4 0.51-m diameter hoops and 3.81-cm bar mesh netting). SM = Small hoop net (1.3 m long with 4 0.51-m diameter hoops and 2.54-cm bar mesh netting).

catch was greatest in the LH configuration and smallest in the SM configuration. The largest difference among mean weights decreased from 212 to 49 g when the fully-recruited portion of the catch was compared.

Mean daily CPUE values (fish/net-night and g/net-night) of the fully-recruited stock were not significantly different among hoop net configurations (Table 2). This was primarily due to high variation of mean daily CPUE values. Daily CPUE

Table 1. Mean total length and weight of channel catfish collected with 3 hoop net configurations in the Yockanookany River, Mississippi, 1994–1996. Means in a column with the same letter are not significantly different ($P > 0.05$).

Hoop net	All fish					Fish ≥ 35 cm				
	N	Length	SE	Weight	SE	*N*	Length	SE	Weight	SE
LH[a]	255	400 A	3	555 A	15	233	406 A	3	576A	15
SH[b]	188	396 A	4	515 B	18	162	407 A	3	552AB	19
SM[c]	1,107	341 B	2	343 C	7	487	399 B	2	527B	10

a. Large hoop net (4.3 m long with 7 1.07-m diameter hoops and 3.81-cm bar mesh netting).
b. Small hoop net (1.3 m long with 4 0.51-m diameter hoops and 3.81-cm bar mesh netting).
c. Small hoop net (1.3 m long with 4 0.51-m diameter hoops and 2.54-cm bar mesh netting).

(fish/net-night) coefficients of variation were 618%, 242%, and 316% for LH, SH, and SM configurations, respectively. Coefficients of variation for CPUE (g/net-night) also were high (LH = 576%, SH = 230%, and SM = 310%). Using the coefficients of variation to determine sample size, the number of sample days needed to detect a 50% difference in mean daily CPUE (fish/net-night) with 95% confidence was 612, 94, and 160 for LH, SH, and SM configurations, respectively.

Mean daily CPUE values (fish/net-night and g/net-night) of the fully-recruited stock were not significantly correlated between the LH and SH configurations. Correlations between the LH and SM configurations and the SH and SM configurations were statistically significant. However, these associations were weak, as indicated by low correlation coefficients (LH-SM: $r = 0.38$ for fish/net-night and $r = 0.32$ for g/net-night; SH-SM: $r = 0.24$ for fish/net-night and $r = 0.23$ for g/net-night).

Mean seasonal CPUE values (fish/net-night and g/net-night) of the fully-recruited stock were not significantly correlated between LH and SH configurations or between LH and SM configurations. However, correlations between SH and SM configurations were statistically significant. Moderate mean seasonal CPUE associations existed, with correlation coefficients of 0.69 (fish/net-night) and 0.67 (g/net-night).

Table 2. Mean daily CPUE of channel catfish ≥35 cm total length collected with 3 hoop net configurations in the Yockanookany River, Mississippi, 1994–1996. Means in both rows are not significantly different ($P > 0.05$). N = number of nights hoop nets were set.

CPUE	LH[a]			SH[b]			SM[c]		
	N	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
fish/net-night	107	0.4	0.3	108	0.3	0.1	108	0.9	0.3
g/net-night	107	251	140	108	166	37	108	475	142

a. Large hoop net (4.3 m long with 7 1.07-m diameter hoops and 3.81-cm bar mesh netting).
b. Small hoop net (1.3 m long with 4 0.51-m diameter hoops and 3.81-cm bar mesh netting).
c. Small hoop net (1.3 m long with 4 0.51-m diameter hoops and 2.54-cm bar mesh netting).

Discussion

Hoop net catch composition and size selectivity are influenced by hoop diameter and mesh size. In a study of hoop net catches on the lower Platte River, Nebraska, 25-mm bar mesh nets caught significantly more fish (82% of total catch) than 32- and 38-mm bar mesh nets (Holland and Peters 1992). In addition, channel catfish comprised 94% of the catch in 25-mm bar mesh nets compared to 38% in the 38-mm bar mesh nets. Channel catfish were significantly more numerous in catches on the upper Mississippi River fished with 3.8-cm bar mesh netting and 0.9-m diameter hoop nets than with 7.6-4.4-cm bar mesh netting and 1.2-m diameter hoop nets (Hubert and Schmitt 1982). Additionally, hoop net catches with 7.6-cm bar mesh netting produced no channel catfish on the Coldwater, Tallacatchie, and Yalobusha rivers in the upper Yazoo River basin, Mississippi (Stopha 1994).

In our study, the LH configuration was 3 m longer and 0.56 m greater in diameter than SH and SM configurations. Additionally, the SM configuration had a 1.27-cm smaller bar mesh size than LH and SH configurations. The SM configuration collected 2.5 times more channel catfish than LH and SH configurations combined. Therefore, a larger sample size of channel catfish was available to estimate the stock structural characteristics using catches from the SM configuration.

Hoop net configuration influence on size selectivity can be expressed through estimates of stock structural characteristics. Holland and Peters (1992), and Stopha (1994) reported that channel catfish mean length decreased and CPUE increased with smaller bar mesh size. A similar pattern was observed in our study. Mean TL and mean weight decreased with smaller bar mesh size as did length at full recruitment. However, these differences among net configurations were reduced when comparing the fully-recruited segment of the samples, thereby helping to correct for mesh size bias.

Catch rates of channel catfish have been shown to be greater in baited (cheese or soybean cake) hoop nets than in unbaited nets (Pierce et al. 1981, Gerhardt and Hubert 1989). Additionally, Gerhardt and Hubert (1989) found that baited hoop nets had greater catch rates than unbaited nets for both adult (> 30 cm TL) and subadult (≤ 30 cm TL) channel catfish. In our study, the LH configuration was unbaited and SH and SM configurations were baited with cheese. Since a complete complement of baited and unbaited hoop net configurations were not fished, the influence of bait on the channel catfish catch could not be discerned. However, based upon the total number of channel catfish collected in each configuration, bar mesh size was likely the primary factor that influenced the number of fish collected. In that regard, mean daily CPUE values were similar for the LH and the SH configurations despite the fact that only the SH configuration was baited. Therefore, it appears that hoop net configuration characteristics other than bait had a greater influence on channel catfish catches.

On a daily basis, channel catfish CPUE (fish ≥ 35 cm TL) produced either no significant correlations or significant correlations with low associations among hoop net configurations. This indicated that, given the same environmental conditions, the

3 hoop net configurations did not equally sample the population on a given day. Therefore, CPUE was addressed as overall seasonal means to consolidate within-season variation and allow a larger-scale comparison. Both SH and SM configurations produced no significant correlation when compared with the LH configuration. In contrast, a significant correlation with moderate association was observed between SH and SM configurations.

These differences demonstrated the influence hoop diameter has on sampling channel catfish populations. Comparisons of relative abundance, using CPUE as an index from different hoop net configurations, should be used with caution due to lack of consistent correlation among different configurations. Additionally, due to high CPUE variation, a large number of samples must be collected to detect significant differences in relative abundance.

The SM configuration was an efficient gear for sampling channel catfish in this small river. The smaller mesh size collected a broader range of length groups, by including smaller fish, while still collecting larger individuals in the population. Additionally, stock structural characteristics (e.g., mean TL, mean weight, and length-frequency distribution) of the fully-recruited stock tended to be similar to that of hoop nets with larger mesh size and hoop diameter. The compact size of SH and SM hoop net configurations would allow a large number of nets to be set using a small boat, canoe, or backpack in shallow water or low flow conditions commonly encountered in small rivers and streams, thereby addressing sample size considerations and logistical challenges described above for monitoring changes in channel catfish abundances.

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