Influences of 3 Different Mesh and Hoop Size Configurations on Hoop Net Catches of Buffaloes in the Upper Yazoo River Basin

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Abstract: Three hoop net configurations were fished simultaneously to compare catch efficacy for bigmouth buffalo (*Ictiobus cyprinellus*) and smallmouth buffalo (*I. bubalus*) in 3 tributaries of the Yazoo River, Mississippi. Nets were small standard (4.3 m long with 1.1-m diameter hoops and 3.8-cm bar mesh), small commercial (4.3 m long with 1.1-m diameter hoops and 7.6-cm bar mesh), and large commercial (5.0 m long with 1.5-m diameter hoops and 7.6-cm bar mesh) hoop nets. Large commercial nets are the principal gear of commercial, artisanal, and subsistence fishers exploiting the resource. Small standard nets are typically used for agency-sponsored stock assessments. For bigmouth buffalo, mean ranked catch per unit of effort (MRCPUE kg/net-night) was not significantly different among gears for commercial-length fish (≥ 410 mm, total length (TL)) or fish of all lengths. For smallmouth buffalo, MRCPUE was not significantly different between the small standard and large commercial gear for fish of either length group, but length group-specific MRCPUE for both of these gears was significantly greater than for the small commercial gear. Size selective bias was attributed to mesh size and primarily reflected presence or absence of sub-commercial-length fish. Small standard hoop nets were logistically preferable to the large commercial gear, and provided similar data for commercial-length fish of both species and the opportunity to address pre-recruits in the stock.

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Floodplain rivers and their fisheries in the southeastern United States are integral to the identity of rural subcultures living in association with these ecosystems (Jackson 1991, Brown et al. 1996). Fisheries agencies generally focus most of their resources on stock dynamics and biopolitical realities of these systems (Miranda and Frese 1987, Jackson et al. 1993, Cloutman and Jackson 1997). However, other

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regionally- and culturally-specific fisheries such as hand grabbing (Jackson et al. 1997), and net fisheries under commercial license by both artisanal and subsistence fishers are also components in the suite of concerns surrounding protection, conservation, and management of these resources. In this last regard, buffaloes (*Ictiobus* spp.) are of particular importance because they are rarely components of recreational fish harvest, but are more often major components of fish assemblage biomass (Jackson et al. 1995, Ye 1996) and small-scale commercial, artisanal, and subsistence fisheries harvest (Brown et al. 1996).

Hoop nets are the principal gear used by commercial, artisanal, and subsistence fishers in the lower Mississippi River floodplain river ecosystem to catch bigmouth and smallmouth buffaloes (Jackson and Jackson 1989*a*, Fritchey 1992). In Mississippi, the minimum legal bar mesh is 7.6 cm. Fishers primarily use this size mesh with 1.5-m diameter hoops and secondarily with 1.1-m diameter hoops. Agency-sponsored riverine fish stock assessments in Mississippi typically employ hoop nets with 3.8-cm bar mesh and 1.1-m diameter hoops (Jackson and Jackson 1989*b*; Jackson et al. 1993, 1995; Ye 1996).

We therefore conducted a study to compare the 3 above-mentioned hoop net configurations with respect to mean length, length-frequency distributions, and catch rates of bigmouth and smallmouth buffaloes. Logistical considerations for using each gear were also addressed.

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Methods

Stock assessments for bigmouth and smallmouth buffaloes were conducted in 3 Yazoo River tributaries: the Coldwater, Tallahatchie, and Yalobusha rivers. These rivers collectively constitute a major component of the upper Yazoo River Basin in northern Mississippi. This ecosystem has been extensively modified by agricultural activities and flood control projects, including headwater impoundments and downstream channelization, clearing, dredging, and snagging (Jackson et al. 1993).

Each river experiences elevated flows in the winter and spring, with greatly reduced flows in summer and autumn. The 3 rivers have diverse habitats along their lengths, ranging from sections with deforested riparian zones recently dredged and rip-rapped, to relatively natural sections meandering through hardwood forests with abundant instream woody debris and opposing unstable sand bars and cut stream banks.

The 3 configurations of hoop nets used as treatments were: a) 4.3 m long with 7 1.1-m diameter fiberglass hoops and 3.8-cm bar mesh netting (small standard); b) 4.3

m long with 7 1.1-m diameter fiberglass hoops and 7.6-cm bar mesh netting (small commercial); and c) 5.0 m long with 7 1.5-m diameter fiberglass hoops and 7.6-cm bar mesh netting (large commercial).

The Coldwater and Tallahatchie rivers were partitioned into 3 linear sections, and the Yalobusha River into 2 linear sections for sampling. Sections were divided into 1.5-km long stream reaches (= experimental units).

Five nets per configuration were set and simultaneously fished on each sample date for a river in a randomly chosen stream reach of the selected section. Nets were set systematically in random series by configuration (e.g., small standard, followed by small commercial, followed by large commercial), approximately 100 m apart (in compliance with the minimum legal distance of 91.4 m between nets in Mississippi) on the bottom, along alternating banks when possible, with cod ends facing upstream at a depth that at least submersed the net throats. Nets were generally set at mid-day and checked the following morning.

Sampling effort was divided equally among sections in each river. Twelve overnight periods were fished/river (12 × 3 rivers = 36 replications), January–August 1993. Each river was sampled about every 2 weeks. Fish collected were identified to species, measured (TL, mm), weighed (g), and released.

The minimum legal length for commercially-harvested buffalo of either taxon was 410 mm TL. Therefore, species-specific mean lengths and daily mean catch per unit of effort (CPUE, kg/net-night) were calculated for all fish, and for commercial-length fish (≥ 410 mm TL) for each gear. Mean CPUE and length comparisons utilized a basin-wide level of resolution, which treated the rivers as blocks, stream reaches as experimental units, and days as replications.

Levine's test of the analysis of variance of residuals (Proc GLM, SAS Inst. 1990) and the Shapiro-Wilk test for normal distribution (Proc Univariate, SAS Inst. 1990) revealed heterogeneity of variance ($P < 0.05$) and non-normal distribution of CPUE means for both species, and of mean length for smallmouth buffalo. Log transformation of means did not remedy heteroscedasticity or distribution non-normality. Therefore, a 2-way analysis of variance by aligned ranks (Proc GLM, SAS Inst. 1990) was used to test for differences ($\alpha < 0.05$) among ranked means for CPUE and length. Fisher's Least Significant Difference test was used to illustrate ranked means distinctions.

Length-frequency distributions were also used as assessment parameters to evaluate efficacy among the 3 gear configurations. For this purpose, comparisons among gears combined data from all rivers and included all fish caught for each configuration over the study period

Results

No sub-commercial-length bigmouth buffalo and few sub-commercial-length smallmouth buffalo were caught in the commercial gears (Fig. 1). Sub-commercial-length buffaloes were more vulnerable, and larger, commercial-length buffaloes were less vulnerable, to capture in the small standard gear than in the commercial gears.

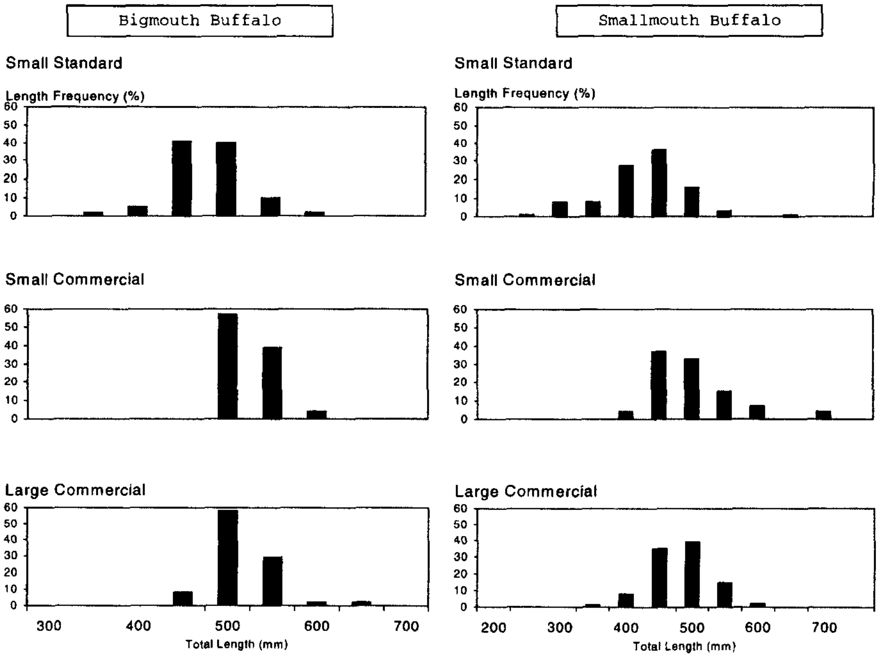

Figure 1. Length-frequency distributions of bigmouth and smallmouth buffaloes caught in 3 configurations of hoop nets in the upper Yazoo River Basin, Mississippi, January–August 1993. Small standard gear was 4.3 m long with 7 1.1-m diameter fiberglass hoops and 3.8-cm bar mesh netting. Small commercial gear was 4.3 m long with 7 1.1-m diameter fiberglass hoops and 7.6-cm bar mesh netting. Large commercial gear was 5.0 m long with 7 1.5-m diameter fiberglass hoops and 7.6-cm bar mesh netting.

Ranked mean length (RML) for both length groups of bigmouth and smallmouth buffaloes did not differ significantly between the 2 commercial gears; however, RML for both commercial gears and for both length groups were significantly greater than for the small standard gear for both species (Table 1).

MRCPUE for bigmouth buffalo was not significantly different among gears for either length group (Table 1). MRCPUE for smallmouth buffalo was not significantly different between the small standard and large commercial gears for either length group; MRCPUE for both of these gears was significantly greater than MRCPUE in the small commercial gear.

By weight, smallmouth buffalo contributed 44% and bigmouth buffalo contributed 22% to the catch of all commercial species [including flathead catfish (*Pylodictis olivaris*), blue catfish (*I. furcatus*), and channel catfish (*I. punctatus*)] in the small standard gear. For the small commercial gear, bigmouth and smallmouth buffaloes comprised 28% and 26% of the catch, respectively. For the large commercial

Table 1. Comparisons of mean total length and catch per unit of effort (CPUE) of bigmouth and smallmouth buffaloes caught with 3 hoop net configurations for all lengths of fish and commercial-length fish (TL ≥410 mm) in the upper Yazoo River Basin, Mississippi. Means followed by the same letter are not significantly different ($P > 0.05$). Small standard (SS) gear was 4.3 m long with 7 1.1-m diameter fiberglass hoops and 3.8-cm bar mesh netting. Small commercial (SC) gear was 4.3 m long with 7 1.1-m diameter fiberglass hoops and 7.6-cm bar mesh netting. Large commercial (LC) gear was 5.0 m long with 7 1.5-m diameter fiberglass hoops and 7.6-cm bar mesh netting.

			Mean total length (± SE)			Mean CPUE (kg/net-night ± SE)	
Species	Gear	*N*	All lengths	Commercial length	*N*	All lengths	Commercial length
Bigmouth buffalo	SS	52	479±6B	483±5B	36	0.52±0.18A	0.51±0.18A
	SC	28	522±6A	522±6A	36	0.35±0.16A	0.35±0.16A
	LC	83	516±4A	516±4A	36	1.04±0.34A	1.04±0.34A
Smallmouth buffalo	SS	155	425±5B	458±4B	36	1.01±0.16A	0.81±0.13A
	SC	28	500±12A	500±12A	36	0.33±0.09B	0.30±0.08B
	LC	107	481±4A	487±4A	36	1.06±0.18A	1.01±0.17A

gear, bigmouth and smallmouth buffaloes comprised 43% and 42% of the catch, respectively.

By number, smallmouth buffalo contributed 52% and bigmouth buffalo contributed 17% to the catch. For the small commercial gear, bigmouth and smallmouth buffaloes each comprised 40% of the catch. For the large commercial gear, smallmouth buffalo contributed 52% and bigmouth buffalo contributed 40% to the catch.

Discussion

Structural characteristics in passive entrapment gear such as hoop nets are known to influence catch efficiency (Grinstead 1968, Hubert and Schmitt 1982, Hesse et al. 1982, Hubert 1983, Crumpton et al. 1987, Holland and Peters 1992) and to be selective regarding the structural and functional composition of the catch (Starrett and Barnickol 1955, Yeh 1977, Bohling and Lehtonen 1991, Bernard et al. 1991). We showed that the small standard gear catches both pre-recruit and commercial-length buffaloes, whereas the 2 commercial configurations catch larger, commercial-length buffaloes. Catch rates of buffaloes from the small standard gear and the large commercial gear (the principal gear among riverine fishers in the systems addressed) were similar, as were general trends in length-frequency distributions for larger buffaloes. Small standard nets can therefore address recruitment of buffaloes to the commercial fishery. However, fisheries managers should use caution when comparing commercial catch data to data collected with the small standard gear. The commercial gears caught a much larger proportion of larger buffaloes (>550 mm TL) than the small standard gear. Comparing sample catch data of small standard gear to commercial catch data could lead managers to conclude that the commercial fishery is over-harvesting larger buffaloes, when in fact the lack of larger fish in the sampled catches may be due solely to gear selectivity of the small standard nets.

In the field, both mesh and hoop size influenced operation of the gears. The mesh of the small standard gear tended to collect leaf litter, but this litter could easily be cleared with vigorous shaking. This was preferable to the 2 commercial gears, which were more prone to collecting large floating debris. In our study, tears from such encounters often occurred, creating holes in the nets through which fish could escape.

Also with the commercial gear, fish approaching minimum vulnerability size to the 7.6-cm mesh tended to become wedged within the mesh at the midline of the body, causing stress or death to both targeted (buffaloes) and bycatch species [e.g., common carp (*Cyprinus carpio*), grass carp (*Ctenopharynagodon idella*), blue sucker (*Cycleptus elongatus*), and freshwater drum (*Aplodinotus grunniens*)]. Removal of these fish could be very time-consuming. With the 3.8-cm mesh, this problem only occurred with gar (*Lepisosteus* spp.), which were also laborious to remove.

With respect to safety considerations, the larger-meshed gear tended to entangle feet of field personnel when setting the gear. This was not a problem with the smaller-meshed gear.

Hoop size also influenced field utility. The 1.5-m diameter hoops of the large commercial gear were awkward to handle from a boat due to the large arm reach needed to control the gear when setting and retrieving it. The large diameter hoops also prevented compact storage in boats during operations and, due to their weight and bulk, could require additional logistical considerations to ensure appropriate sample sizes (i.e., fewer large-diameter hoop nets can be transported within a boat than small-diameter hoop nets). The small hoop configurations were easier to set and retrieve; the small commercial gear was the lightest of the 3 gears due to its larger mesh size.

Efficient, logistically practical, and quantitatively defensible stock assessment techniques are important components of fisheries management. Our study indicates that the small standard hoop net is appropriate for tracking the dynamics of buffalo fisheries in floodplain river ecosystems and relates to aspects of commonly used harvest strategies of fishers.

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