Evaluation of the Related Catch Rates of Hoop Nets for Sampling Channel Catfish[1]

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Abstract: Current standardized sampling procedures in Oklahoma call for the use of gill nets to collect relative abundance and size structure data on channel catfish *(Ictalurus punctatus)*. While gill nets are effective at catching channel catfish, their usefulness as a sampling tool is limited because of the variability of the resulting data. Furthermore, gill nets represent a lethal means of sampling channel catfish which can adversely affect channel catfish populations. Hoop nets have been found to be an effective alternative method for catching channel catfish, but little is known concerning seasonal effects on catch efficiency of hoop nets, especially in reservoirs. We sampled 2 Oklahoma reservoirs monthly from April through October 1999 using baited hoop nets. The data were analyzed for monthly differences in C/f (numbers of individuals captured per net night), C/f_S (numbers of individuals <280 mm total length captured per net night), and C/f_Q (numbers of individuals ≥410 mm total length captured per net night). Catch rates were greatest for both reservoirs from June through October. However, the data were highly variable and precision was low. In conclusion, protocols need to be developed that will decrease sampling variance and increase precision before hoop nets can be a viable sampling method.

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Channel catfish consistently rank among the more important sport fish in Oklahoma (Summers 1997). Consequently, the Oklahoma Department of Wildlife Conservation has been monitoring and managing its reservoir channel catfish population since 1977. Current standardized sampling procedures in Oklahoma call for the use of gill nets to collect relative abundance and length-frequency data on channel catfish

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(Erickson 1978). While gill nets are effective at catching channel fish, the resulting data are often highly variable, making it difficult or impossible to monitor changes in channel catfish populations (Wilde 1995). Furthermore, gill nets represent a lethal means for sampling channel catfish (Hubert 1983) which can adversely affect channel catfish abundances, especially in small reservoirs.

Hoop nets have been found to be an effective alternative method for catching channel catfish (Crumpton et al. 1988, Holland and Peters 1992, Walker et al. 1996). However, little is known concerning seasonal effects on catch efficiency of hoop nets, especially in reservoirs. Therefore, a need existed to determine the seasonal differences in catch data collected with hoop nets. This information would be vital to further evaluating gear biases associated with hoop and gill nets. Funding for this project was provided under Oklahoma Federal Aid in Sport Fish Restoration Grant F-50-R.

Methods

Burtschi Reservoir impounds a tributary of the Little Washita River, 16 km southwest of Chickasha in Grady County, Oklahoma. Burtschi was impounded by the Oklahoma Department of Wildlife Conservation in 1954 and covers 72 ha. It has a mean depth of 3.6 m, a maximum depth of 9 m, and a shoreline development ratio of 2.2. The lake is moderately turbid with midsummer secchi disk readings averaging 60 cm; turbidity is primarily from plankton. Major forage species include gizzard shad *(Dorosoma cepedianum)* and bluegill *(Lepomis macrochirus)*. Sport species include channel catfish *(Pylodictis olivaris)*, largemouth bass *(Micropterus salmoides)*, saugeye (walleye × sauger hybrids; *Stizostedion vitreum* × *S. canadense*), smallmouth bass *(Micropterus dolomieu)*, white bass *(Morone chrysops)*, and white crappie *(Pomoxis annularis)*.

Fort Cobb Reservoir impounds Cobb Creek 5 km north of Fort Cobb in Caddo County, Oklahoma. Fort Cobb was impounded by the U. S. Bureau of Reclamation in 1959 and covers 1,640 ha. It has a mean depth of 6 m, a maximum depth of 20 m, a water exchange rate of 0.4, and a shoreline development ratio of 5.0 The lake is moderately turbid with midsummer secchi disk readings averaging 75 cm; turbidity is primarily from plankton and sediment. Major forage species include gizzard shad and bluegill. Sport species include blue catfish *(Ictalurus furcatus)*, channel catfish, largemouth bass, striped bass × white bass hybrids *(Morone saxatilis* × *M. chrysops)*, walleye, white bass, and white crappie.

Burtschi and Fort Cobb reservoirs were sampled for channel catfish with 20 hoop nets with 2 different configurations: 1) 10 small hoop nets that were 2.2 m long and consisted of 6 61-cm diameter rings, 19-mm bar mesh, and a throat opening of 20 cm and 2) 10 large hoop nets that were 1.5 m long and consisted of 5 89-cm diameter rings, 13- or 19-mm bar mesh, and a throat opening of 9–11 cm. Burtschi Reservoir was sampled from April through October 1999. Water temperatures for both reservoirs were greatest (≥27 C) during July and August and lowest (<20 C) during April and October. Sampling was conducted at 20 randomly selected shoreline sites per reservoir and the net fished at each site was also randomly selected. Each net was baited with 2.3 kg of cheese trimmings prior to setting. Nets were set at water depths of approximately 3.7 m and were run after 4–6 days. The number and total lengths of channel catfish netted were recorded.

Catch rates were expressed as the number of individuals netted per net night (*C/f*). In addition to monitoring overall population density, objectives of ODWC sampling procedures for channel catfish are to monitor stocking success and numbers of quality-sized individuals. Thus, catch rates were also expressed as the number of individuals <280 mm (C/f_S) and >410 mm (C/f_Q) collected per net night. Catch data were tested for normality and were found to be non-normally distributed. Attempts to normalize the data with log transforms proved unsuccessful, so non-parametric statistics were used for all analyses. A 2-way Kruskal-Wallis test was used to detect differences in catch rates for each size class by net type and month. Fisher's least significant difference test was used to illustrate differences in the means. Statistical significance was assessed at the $P = 0.05$ level.

Sampling precision was measured by determining the coefficent of variation of the sample mean ($CV\bar{x} = SE\bar{x}^{-1}$). Sampling precision was set at target levels of $CV\bar{x} = 0.25$ and 0.125, which correspond to $\pm 0.50\bar{x}$ and $\pm 0.25\bar{x}$, respectively. These values coincide with standards established for both preliminary surveys and management studies (Robson and Regier 1964). Since $SE = SDN^{-2,}$ rearranging the above equation, inserting the desired level of precision, and solving for N (number of samples) yields the following equations:

$$N_1 = 0.25^{-2}\bar{x}^{-2}SD^2$$

$$N_2 = 0.125^{-2}\bar{x}^{-2}SD^2,$$

where N_1 and N_2 are the numbers of samples (4–6 net nights) needed to obtain a $CV\bar{x} = 0.025$ and 0.125, respectively. These procedures were used to obtain minimum sample requirements for each size class by net type and month.

Results

A total of 144 channel catfish were captured on Burtschi Reservoir during 600 net nights of hoop netting. Mean length of captured channel catfish was 338 mm (SD = 79) and lengths ranged from 75–612 mm. A total of 806 channel catfish were captured on Fort Cobb Reservoir during 680 net nights of hoop setting. Mean length of captured channel catfish was 261 mm (SD = 78) and lengths ranged from 77–635 mm.

With the exception of C/f_Q for Burtschi Reservoir, catch rates for large hoop nets equaled or exceeded those for small hoop nets. However, no significant differences were detected between net type for Burtschi Reservoir (Table 1). For Fort Cobb Reservoir, significant differences were detected between net type for *C/f* ($P < 0.01$) and C/f_S ($P = 0.03$; Table 1).

Mean *C/f*, C/f_S, and C/f_Q for Burtschi Reservoir increased from April through June and then declined through August. Mean C/f_S continued to decline, but mean

Table 1. Mean catch rates for channel catfish collected with hoop net, by net type, from 2 Oklahoma reservoirs, 1999. Catch rates are expressed as mean number of individuals captured per net night (*C/f*), mean number of individuals less than stocked size (280 mm) captured per net night (C/f_S), and mean number of quality-sized (>410 mm) individuals captured per net night (C/f_Q). Although actual values are depicted in the table, values were ranked for all statistical analysis. Means with the same letter are not significantly different ($P < 0.05$).

Net type	*C/f*	SD	Fisher's grouping	C/f_S	SD	Fisher's grouping	C/f_Q	SD	Fisher's grouping
Burtschi Reservoir									
Small hoop	0.24	0.63	A	0.02	0.09	A	0.05	0.19	A
Large hoop	0.24	0.93	A	0.03	0.09	A	0.04	0.16	A
Fort Cobb Reservoir									
Small hoop	1.10	2.68	B	0.80	2.16	B	0.08	0.29	A
Large hoop	1.48	2.80	A	1.15	2.61	A	0.08	0.24	A

C/f and C/f_Q increased slightly in September (Table 2). Significant differences were detected for C/f_Q ($P < 0.01$), with the greatest differences occurring between the September sample and all preceding samples (Table 2). Mean *C/f*, C/f_S, and C/f_Q for Fort Cobb Reservoir were similar to trends for Burtschi Reservoir (Table 2). However, mean *C/f* and C/f_S peaked in July instead of June. Significant differences were detected for *C/f* and C/f_S ($P < 0.01$). The greatest differences in *C/f* occurred between

Table 2. Mean catch rates for channel catfish collected with hoop net, from 2 Oklahoma reservoirs, 1999. Catch rates are expressed as mean number of individuals captured per net night (*C/f*), mean number of individuals less than stocked size (280 mm) captured per net night (C/f_S), and mean number of quality-sized (>410 mm) individuals captured per net night (C/f_Q). Although actual values are depicted in the table, values were ranked for all statistical analysis. Means with the same letter are not significantly different ($P < 0.05$).

Month	*C/f*	SD	Fisher's grouping	C/f_S	SD	Fisher's grouping	C/f_Q	SD	Fisher's grouping
Burtschi Reservoir									
Apr	0.01	0.04	A	0.00	0.00	A	0.00	0.00	B
May	0.04	0.19	A	0.01	0.04	A	0.01	0.04	B
Jun	0.68	1.70	A	0.08	0.17	A	0.03	0.12	B
Jul	0.20	0.34	A	0.03	0.08	A	0.06	0.23	B
Aug	0.13	0.28	A	0.03	0.08	A	0.01	0.06	B
Sept	0.38	0.68	A	0.01	0.06	A	0.18	0.31	A
Fort Cobb Reservoir									
Apr	0.28	0.42	B	0.13	0.27	C	0.03	0.07	A
May	0.24	0.38	B	0.15	0.23	B C	0.02	0.05	A
Jun	1.55	1.90	A	0.96	1.63	A B C	0.33	0.61	A
Jul	2.49	4.67	A	2.13	4.49	A	0.09	0.23	A
Aug	1.71	3.30	A B	1.30	2.46	A B	0.00	0.00	A
Sept	1.09	1.30	A	0.84	1.28	A	0.05	0.10	A
Oct	1.69	3.49	A B	1.31	2.87	A B C	0.03	0.08	A

Table 3. Mean catch rates for channel catfish collected with hoop net samples, by net type and month, from 2 Oklahoma reservoirs, 1999. Catch rates are expressed as mean number of individuals captured per net night (C/f), mean number of individuals less than stock size (280 mm) captured per net night (C/f_S), and mean number of quality-sized (>410 mm) individuals captured per net night (C/f_Q), N_1 and N_2= number of samples (4–6 net nights) to obtain a $CV\bar{x}$=0.25 and 0.125, respectively.

Net type	Month	C/f	$CV\bar{x}$	N_1	N_2	C/f_S	$CV\bar{x}$	N_1	N_2	C/f_Q	$CV\bar{x}$	N_1	N_2
Burtschi Reservoir													
Small hoop	Apr	0.00				0.00				0.00			
	May	0.00				0.00				0.00			
	Jun	0.62	0.58	53	213	0.10	0.57	51	205	0.02	1.00	160	640
	Jul	0.10	0.55	49	196	0.00				0.00			
	Aug	0.10	0.67	71	284	0.00				0.00			
	Sept	0.63	0.44	31	123	0.03	1.00	160	640	0.30	0.41	27	107
Large hoop	Apr	0.02	1.00	160	640	0.00				0.00			
	May	0.08	1.00	160	640	0.02	1.00	160	640	0.02	1.00	160	640
	Jun	0.75	0.93	138	550	0.07	0.76	93	373	0.05	1.00	160	640
	Jul	0.30	0.46	34	136	0.05	0.67	71	284	0.13	0.80	103	412
	Aug	0.15	0.71	81	324	0.05	0.67	71	284	0.03	1.00	160	640
	Sept	0.13	0.68	75	299	0.00				0.05	0.67	71	284
Fort Cobb Reservoir													
Small hoop	Apr	0.32	0.46	34	136	0.22	0.51	42	169	0.02	1.00	160	640
	May	0.22	0.44	32	127	0.13	0.55	49	196	0.02	1.00	160	640
	Jun	1.58	0.46	33	133	1.02	0.57	51	205	0.35	0.60	57	227
	Jul	1.23	0.65	67	270	0.98	0.75	90	359	0.10	1.00	160	640
	Aug	1.60	0.80	103	411	1.15	0.80	102	407	0.00			
	Sept	0.80	0.63	65	258	0.58	0.86	118	471	0.05	0.67	71	284
	Oct	1.98	0.73	86	345	1.55	0.77	96	383	0.03	1.00	160	640
Large hoop	Apr	0.23	0.52	44	176	0.05	0.71	81	324	0.05	0.51	41	166
	May	0.27	0.68	60	238	0.14	0.57	41	165	0.02	1.00	128	512
	Jun	1.52	0.32	17	67	0.90	0.53	45	181	0.32	0.58	54	215
	Jul	3.75	0.51	41	165	3.28	0.57	51	204	0.08	0.51	41	166
	Aug	1.83	0.44	31	125	1.45	0.45	33	130	0.00			
	Sept	1.38	0.21	7	28	1.10	0.27	12	46	0.05	0.67	71	284
	Oct	1.40	0.47	36	144	1.08	0.50	39	158	0.03	1.00	160	640

June, July and September samples and the April and May samples (Table 2). The greatest differences in C/f_S occurred between the July and September samples and the April sample (Table 2).

Sampling precision for Burtschi Reservoir was poor. For small nets, required number of samples to obtain a $CV\bar{x}=0.125$ for C/f, C/f_S, and C/f_Q were ≥ 31, ≥ 51, and ≥ 27, respectively (Table 3). Precision was greatest for C/f and C/f_Q during September and for C/f_S, during July. For large nets, required number of samples to obtain a $CV\bar{x}=0.125$ for C/f, C/f_S, and C/f_Q were ≥ 34, ≥ 71, and ≥ 71, respectively (Table 3). Precision was greatest for C/f, C/f_S, and C/f_Q during June, July, and August, and September, respectively. Sampling precision was somewhat higher for Fort Cobb Reservoir. For small hoop nets, required number of samples to obtain a $CV\bar{x}=0.125$ for C/f, C/f_S, and C/f_Q were ≥ 32, ≥ 42, and ≥ 57, respectively (Table 3). Precision was greatest for C/f, C/f_S, and C/f_Q during May, April, and June, respectively. For large hoop nets, required number of samples to obtain a $CV\bar{x}=0.25$ for C/f, C/f_S, and C/f_Q were ≥ 7, ≥ 12, and ≥ 41, respectively; to obtain a $CV\bar{x}=0.25$ for C/f and C/f_S, required sample sizes were ≥ 28 and $\geq$ 46, respectively (Table 3). Precision was greatest for C/f and C/f_S during September and for C/f_Q during April and July.

Discussion

Significant differences in total catch rates and catch rates for stock-sized channel catfish were noted between large and small hoop nets on Fort Cobb Reservoir but not Burtschi Reservoir. Other authors have noted differences in catch rates for hoop nets with differing configurations, but these are usually related to differences in mesh sizes (Walker et al. 1996). Crumpton et al. (1998) found significant differences in catch rates of 2 types of wire catfish traps. Those fish traps with a close-up door over the throat opening caught significantly more channel catfish than traps with no close-up door. The small hoop nets used in this study had a much larger throat opening than the large hoop nets. Because these nets were fished for 4–6 net nights, it is possible some channel catfish may have escaped from the small hoop nets. Channel catfish are most active during spring or early summer months and fall months (Duncan and Myers 1978, Coon and Dames 1991, Pellit et al. 1998). Channel catfish activity during late-spring early-summer months is tied closely to pre-spawning activity and is usually triggered by rising water temperatures and water levels (Crawford 1958, Ziebell 1973, Helms 1975). During later summer months, channel catfish are sedentary (Muncy 1958, Pellit et al. 1998) and can be found in water depths from 1–3 m (Ziebell 1973, Coon and Dames 1991). Channel catfish become active again during fall months (Coon and Dames 1991, Pellit et al. 1998), and then move to deeper water where they overwinter (Newcomb 1989, Pellit et al. 1998). These types of behaviors might explain the trends we observed in channel catfish catch rates on Burtschi and Fort Cobb reservoirs, especially from April through June. Therefore, sampling with hoop nets should not be considered before June.

Several authors have noted the low level of precision associated with several types of fisheries sampling techniques. Boxrucker (1998) found precision estimates associated with saugeye electrofishing to be low. Wilde (1995) found similar results when examining gill-net precision estimates for several fish species. For our study, we used a study design based on simple random sampling. One drawback to this type of probability sampling method is that sample variance increases and precision decreases because nonpreferred or little-used habitat is sampled (Wilde and Fisher 1996). We undoubtedly sampled such habitat on both Burtschi and Fort Cobb reservoirs and this may have been at least partially responsible for the low level of precision we noted for hoop nets. In the future, stratified random sampling should be explored as a means of increasing the precision of hoop nets.

In conclusion, hoop nets should be considered when sampling small waterbodies where sampling mortality might be adversely affect a fishery, or result in adverse publicity. While hoop nets appear to be most effective after May, the overall precision is low. Before hoop nets can be considered a viable sampling alternative to gill nets, protocols need to be developed that will decrease sampling variance and increase precision.

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