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Sampling Statistics and Size Distributions for Flathead Catfish Populations in Four Missouri Rivers

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Abstract.—Flathead catfish *Pylodictis olivaris* are native to Missouri and comprise one of the most important recreational and commercial fisheries in Missouri. Our specific study objective was to describe catch statistics for flathead catfish populations in moderate-large rivers in Missouri to provide sampling guidance for fisheries managers where a paucity of information existed. We used low-frequency (15 Hz) DC electrofishing and hoop nets in segments of the Grand, Lamine, and Platte rivers and pools 20–22 of the upper Mississippi River (UMR) during April–July 2006–2007. Electrofishing mean catch per unit effort (CPUE) ranged from 13.1 (Lamine) to 116.6 (UMR) fish/h while hoop-net mean CPUE ranged from 0.131 (Lamine) to 0.694 (Grand) fish/hoop-net-night. Length distributions showed that hoop nets caught a higher relative abundance of flathead catfish over 40 cm total length (TL) compared to electrofishing, most notably in the Grand and Platte rivers, whereas electrofishing caught relatively more flathead catfish under 35 cm TL in all rivers compared to hoop nets. Our results indicate that a combination of low-frequency (15 Hz) electrofishing and hoop nets should be used during the period of April 15 through July 15 to best represent length structure and relative abundance of flathead catfish populations in these rivers. More specifically, we found low-frequency electrofishing to be most effective for stock size and larger flathead catfish during mid-April to mid-June; however, these results were not as conclusive in 2007. As popularity and angling pressure of these fisheries increases, our results will provide managers with sampling guidance and baseline information in efforts to develop high-quality flathead catfish populations in selected rivers.

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Introduction

Catfish have been popular among anglers for decades, especially in the Midwestern and southern United States (Michaletz and Dillard 1999); however, until recently, limited effort has been directed towards catfish management across the United States. Intensive management has primarily been focused on channel catfish *Ictalurus punctatus* put-grow-take and put-take fisheries in small impoundments, despite the importance and trophy potential of flathead catfish *Pylodictis olivaris* and blue catfish *I. furcatus* in large rivers and reservoirs (Michaletz and Dillard 1999; Arterburn et al. 2002; Reitz and Travnichek 2006).

Flathead catfish, blue catfish, and channel catfish are native to Missouri, listed as game (or sport) fish in the Wildlife Code of Missouri, and comprise one of the most important recreational and commercial fisheries in the state. Popularity of catfish in Missouri is evident. A recent survey of resident and nonresident recreational sportfishing anglers (at least 16 years old) showed that catfish (including bullheads) ranked first in both total number of anglers and days spent fishing (USDI, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2006).

Major constraints to catfish management in lotic systems identified by Michaletz and Dillard (1999) include low agency priority, unsuitable habitat, inadequate sampling methods, and limited data. Natural resource agencies and biologists have historically been reluctant to focus much effort on managing catfish populations in lotic systems, primarily due to the inability to representatively sample catfish and obtain basic population data (Vokoun and Rabeni 1999; Arterburn et al. 2002; Brown 2007).

Recognizing that catfish are highly valued by Missouri anglers (Reitz and Travnichek 2004), the Missouri Department of Conservation (MDC) developed a framework and strategies for evaluating and providing a diversity of catfish angling opportunities in Missouri (Dames et al. 2003). According to a 2006 survey of 21 state agencies, Missouri was one of only five responding states that were either preparing or had already prepared formalized catfish management plans (H. Schramm, Jr., Mississippi State University, unpublished data). Missouri's Catfish Management Plan indicated that flathead catfish provided the best opportunity in moderate- to large-sized rivers to develop high-quality fisheries (Dames et al. 2003).

Numerous methods have been used to collect flathead catfish in lotic systems (Vokoun et al. 1997; Vokoun and Rabeni 1999). Brown (2007) reported that low-frequency (15–30 pulses/s or Hz) electrofishing and hoop nets were the most commonly used sampling gears in lotic systems for capturing flathead catfish. When standardized, using field personnel time as unit of effort, previous studies showed that catch per unit effort (CPUE) of flathead catfish using hoop nets approached that of low-frequency electrofishing in lotic systems (Pugibet and Jackson 1989; Pugh and Schramm 1998). Stauffer and Koenen (1999) evaluated a variety of gears in the Minnesota River, Minnesota and recommended low-frequency (7.5 Hz) DC boat electrofishing with a chase boat in combination with trotlines for gathering information on flathead catfish. Gelwicks (2006) demonstrated effectiveness of using low-frequency (15 Hz) electrofishing coupled with unbaited or baited (with live flathead catfish) hoop nets during mid-May to mid-July to sample flathead catfish populations representatively in Iowa rivers.

A variety of electrofishing gears have been used during various seasons of the year, but variable voltage pulsator (VVP) or generator powered pulsator electrofishers using pulsed DC are most common (Robinson 1994; Stauffer and Koenen 1999; Gelwicks 2006; Cailteux and Strickland 2007). Further, utility of a chase boat in conjunction with a single electrofishing boat to capture flathead catfish has been demonstrated in several riverine systems (Quinn 1986; Robinson 1994; Daugherty and Sutton 2005; Gelwicks 2006). Studies have indicated that electrofishing to collect flathead catfish in lotic systems was most effective at surface water temperatures above 20°C (Quinn 1986; Justus 1994; Robinson 1994). Catch rates of flathead catfish from the Missouri River were less variable in September, once water temperatures decreased below 24°C, than during May through August (Travnichek 2011).

The purpose of this research stemmed from catfish data gaps in lotic systems that were identified as information needs to better manage flathead catfish in Missouri's rivers and listed as objectives in Missouri's Catfish Management Plan (Dames et al. 2003). This study was part of a comprehensive Missouri Catfish Harvest Evaluation Project (CHEP) initiated by MDC in 2005 to evaluate exploitation rates, movement, spawning behavior in conjunction with nest success (Brandes 2008), and fecundity (Colehour 2009) of flathead catfish. Our specific study objective was to describe catch statistics for flathead catfish populations in selected rivers in Missouri during 2006–2007 to provide sampling guidance for fisheries managers. This was a secondary objective of the CHEP.

Study Areas

Segments of three interior rivers in Missouri that drain watersheds in the Central Plains aquatic ecoregion (Sowa et al. 2007) and pools 20–22 of the upper Mississippi River (UMR) were sampled in this study. Interior rivers ranging from seventh- to eighth-order included the Platte, Grand, and Lamine rivers (Figure 1). We selected these rivers and associated river segments based on existing knowledge about flathead catfish in each river, habitat quality, accessibility, and because we were interested in exploitation rates of flathead catfish in these systems as part of the CHEP. River segments (including the UMR) averaged 75 contiguous river kilometers, and interior river characteristics are included in Table 1.

These rivers drain primarily rural watersheds dominated by agricultural land use (Nigh and Schroeder 2002). The Platte, Grand, and Lamine rivers are principal tributaries of the Missouri River, and they are turbid prairie rivers dominated by sandy-silt and clay substrates. All rivers had an abundance of woody snags and debris piles.

Methods

Electrofishing

Flathead catfish were sampled with low frequency and low-amperage pulsed DC boat electrofishing during daytime between April 15 and July 15, 2006–2007. Sampling crews each used boat-mounted electrofishing units equipped with a Smith-Root VVP-15B electrofisher powered by a 5,000-W (or larger) generator with the aluminum boat hull as the cathode and dropper anode arrays extending approximately 2 m beyond the bow of the boat. Standardized output throughout the study included a pulse frequency of 15 Hz and a duty cycle of 30–40%. Electrofisher DC output ranged from 1 to 7 A and 100–400 V. Minimum target effort for electrofishing was 2 h/week from April 15 to July 15 during each year to evenly distribute effort throughout the sampling period.

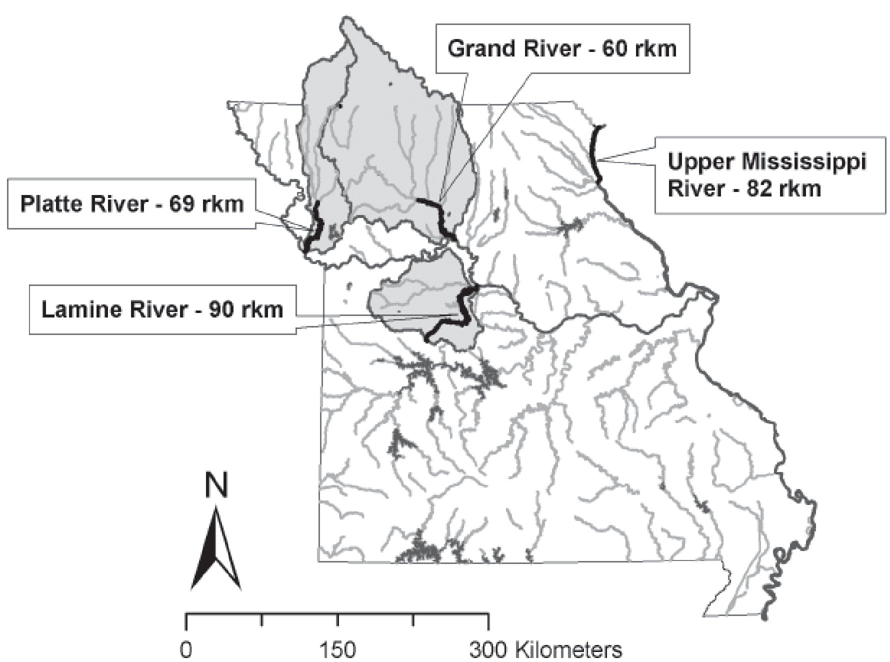

FIGURE 1. Location of rivers and associated watershed boundaries in this study. The river segments in bold encompass the river kilometers (rkm) that were sampled at stationary sites throughout. The upper Mississippi River watershed is not shown due to scale. Watershed boundaries were derived from the U.S. Geological Survey National Elevation and Hydrography Datasets in ArcGIS v9.2.

Table 1. Characteristics of interior study rivers, including watershed area, land cover types, stream order, and mean monthly discharges.

River characteristic	Interior rivers in Missouri: Grand	Lamine	Platte
Aquatic subregion	Central Plains	Central Plains	Central Plains
Land cover types[a]	Crop, grass, forest	Crop, grass, forest	Crop, grass, forest
Total watershed area (km^2)	20,428	6,880	6,326
Stream order at mouth	8	7	8
Study segment length (river km)[b]	60	90	69
U.S. Geological Survey stream gage station	#06902000	#06906800	#06821190
Year	Grand mean of monthly discharge (m^3/s) for the period of April to July		
Historic (earliest year–2004)	183	24	82
2006	39	2	23
2007	252	16	94

[a] Ranked in descending order (grass = hay and pasture).
[b] From river mouth to most upstream point of sampling segment.

Effort was distributed as evenly as possible at predefined sites chosen subjectively throughout each study river segment.

Sampling crews used a modified-predator strategy (Vokoun and Rabeni 1999) that included a chase boat to pursue surfacing flathead catfish in the electrical field. Electrofishing runs were conducted with the boat moving downstream or held stationary for extended periods adjacent to areas with visible woody cover or deep water. Fish were netted from electrofishing and chase boats, transferred to aerated holding tanks, measured for total length (TL, mm) and weighed (g). Pedal time of each run was recorded and used to calculate CPUE as number of flathead catfish collected per hour. Surface water temperature (°C) and water conductivity (μS/cm) were also measured and recorded at each sampling run.

Hoop Nets

Hoop nets were used in conjunction with electrofishing in all rivers between May 15 and July 15, 2006–2007, with exception of the UMR in 2007. Each hoop net was 3.66 m in length, had seven fiberglass hoops ranging from 68.9 cm in diameter at the cod end to 90 cm at the mouth, and had a bar mesh size of either 25.4 or 38.1 mm. Two finger-style throats extended toward the cod end of the net from the second and fourth hoops. All nets were treated with Netcoat to darken the color of the net and ease the removal of catfish.

A modified-predator approach was also used during deployment of hoop nets in each river. Nets were attached to woody snags or limbs or anchored offshore and fished undisturbed for 48 h; target effort for each river was 48 hoop-net-nights per week each year. Both mesh sizes of hoop nets were distributed in equal proportions during each sampling occasion. Catch per unit effort was calculated as number of flathead catfish/hoop-net-night. Surface water temperature (°C) was measured and recorded at each net location. Net locations were subjectively selected by crew leaders throughout each study site in habitats likely to attract flathead catfish. We acknowledge that net deployment in this manner might have influenced our CPUE, as compared to random deployment at a site.

Data Analyses

Electrofishing and hoop-net mean CPUE was calculated annually (2006 and 2007) for each river. We also calculated mean CPUE for the following incremental total length categories, as defined by Anderson and Neumann (1996): substock (<356 mm), stock (356–507 mm), quality (508–711 mm), preferred (712–863 mm), memorable (864–1,015 mm), and trophy (≥1,016 mm). Mean CPUE for each length category was calculated for each week by site; weekly averages were then used to calculate a mean CPUE for each site. Finally, all sites were averaged for an estimate of mean CPUE for each river and year.

We analyzed mean CPUE for each incremental total length category by month as defined with the following 4-week intervals: April 15 to May 15 (April–May), May 16 to June 15 (May–June), and June 16 to July 15 (June–July). Mean CPUE for each month was first calculated for each week by site; then from weekly averages, we calculated a mean CPUE for each site, and finally, all sites were averaged for an estimate of mean CPUE for each river and month. Due to issues of nonnormality, we compared mean monthly CPUE's via a weighted ranking procedure using the nonparametric Quade test (Conover 1980) blocked by river for each length category and year. When the Quade test found a difference ($P < 0.10$), we ran multiple comparisons (Conover 1980) to determine which mean monthly CPUEs were significantly different from each other.

Length-frequency distributions were constructed for electrofishing and hoop-net gears by pooling flathead catfish into 5-cm-TL groups for each river. Some sites within a river were sampled more than others (especially with electrofishing); thus, we used a weighted average of the number of flathead catfish caught during each sampling event to estimate average number of fish caught by total length group for that site. The number of fish caught by size-group was then summed across sampling sites to develop relative length distributions for each river.

Results and Discussion

Electrofishing mean CPUE ranged from 13.1 (Lamine) to 116.6 (UMR) fish/h while hoop net mean CPUE ranged from 0.131 (Lamine) to 0.694 (Grand) fish/hoop-net-night (Table 2). High flathead catfish catch with electrofishing in the UMR is likely attributed to the sheer size and amount of inhabitable water compared to the smaller interior rivers.

Length distributions showed that hoop nets caught a higher relative abundance of flathead catfish over 40 cm TL than electrofishing, most notably in the Grand and Platte rivers during both 2006 and 2007 (Figure 2). This disparity was less evident in the Lamine River and UMR. Electrofishing caught relatively more flathead catfish under 35 cm TL compared to hoop nets in all four rivers during both years.

We examined flathead catfish mean CPUE by month for each length category to provide additional insight about length structure of these populations as assessed with both gears. With exception of the UMR, monthly electrofishing catch rates for flathead catfish of preferred size and larger were much lower than other size categories with mean CPUEs ≤1.3 fish/h (Table 3). Further, total electrofishing mean monthly CPUEs were influenced most by substock size flathead catfish caught in June–July, especially in the Grand and Platte rivers. Conversely, the Grand and Platte rivers had the highest hoop-net mean CPUE for quality and larger size flathead catfish most months compared to the other rivers when hoop nets were used (Table 4). Ultimately, both gears sampled relatively few flathead catfish of preferred size and larger in each river, which could potentially be attributed to low abundance, varying spatial distribution, or size selectivity of our gears against these

TABLE 2. Flathead catfish mean catch per unit effort (CPUE), standard error (in parentheses), and total catch (*N*) for low-frequency electrofishing (fish/h) and hoop nets (fish/hoop-net-night) in 2006 and 2007.

	Low-frequency electrofishing				Hoop-nets			
	2006		2007		2006		2007	
River	CPUE	*N*	CPUE	*N*	CPUE	*N*	CPUE	*N*
Grand	28.86 (3.93)	503	27.49 (5.83)	624	0.298 (0.069)	127	0.694 (0.147)	171
Lamine	13.13 (3.26)	402	14.39 (3.73)	584	0.148 (0.044)	54	0.131 (0.074)	41
Platte	31.23 (8.96)	568	32.79 (9.41)	643	0.495 (0.219)	125	0.537 (0.149)	141
Upper Mississippi	104.30 (5.63)	4,248	116.61 (8.82)	5,938	0.314 (0.099)	125	N/A	N/A

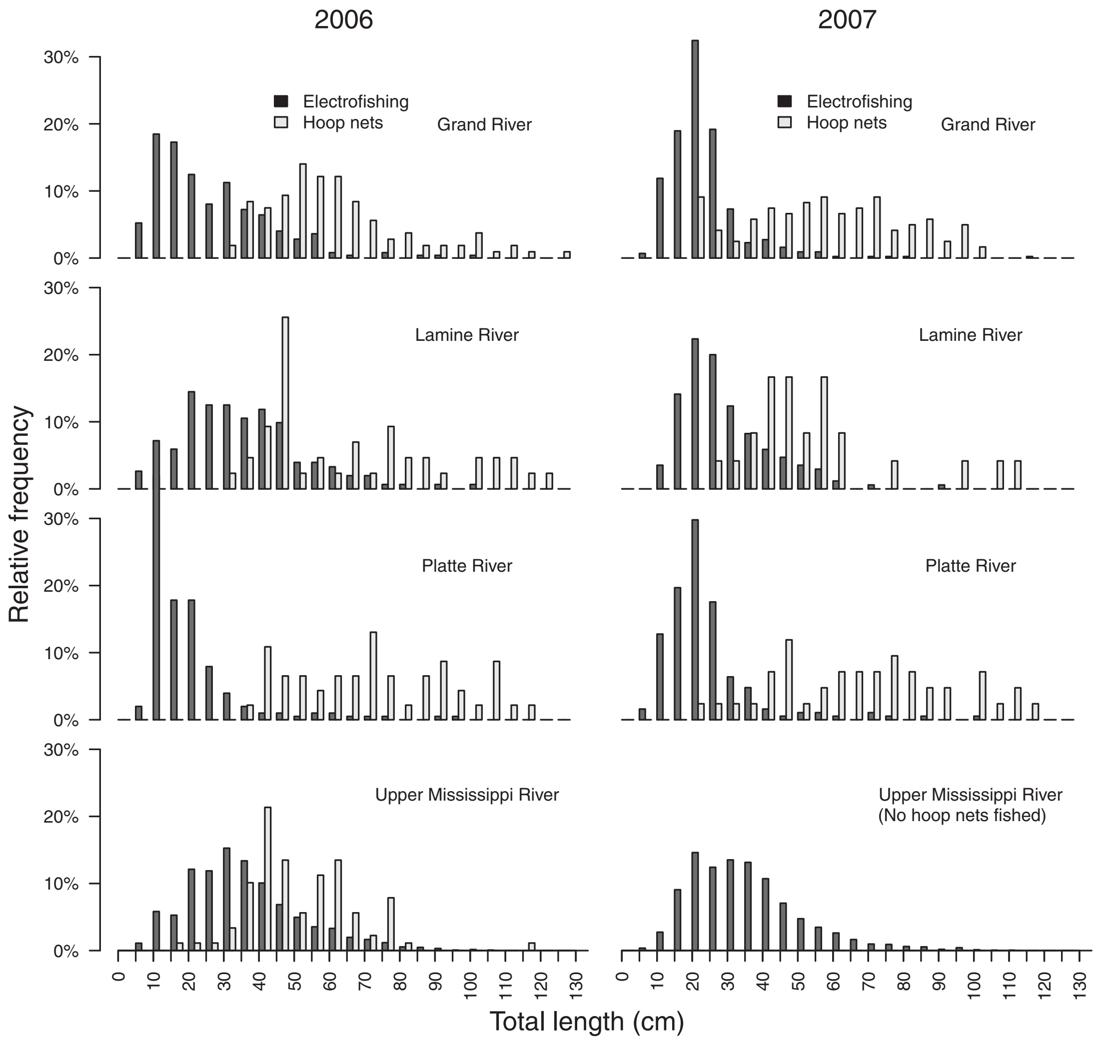

FIGURE 2. Relative length-frequency distributions for flathead catfish collected with low-frequency electrofishing (dark bars) and hoop nets (light bars) in each study river that was sampled in 2006–2007.

larger fish. We used the Quade test to further compare flathead catfish mean monthly CPUEs for both gears each year. With rivers as blocks in the analysis, mean CPUE for electrofishing was significantly different among months for stock ($P = 0.004$), quality ($P = 0.060$), preferred ($P = 0.027$), and memorable ($P = 0.027$) sizes in 2006 but only for substock ($P = 0.005$) size in 2007. No significant differences among months were found with all lengths combined. Multiple comparisons found that mean CPUE for electrofishing in 2006 was always significantly greater in April–May compared to June–July. Further, mean CPUE was significantly greater in May–June compared to June–July (with exception of quality size) for electrofishing in 2006. In contrast, for substock size flathead catfish in 2007, mean CPUE for electrofishing in June–July was significantly greater compared to all other months. Mean monthly CPUE for hoop nets was significantly different only for substock ($P = 0.031$) size flathead catfish in 2006, with a significantly greater CPUE in May–June compared to June–July.

A combination of bank poles and trotlines were the third method initially evaluated during a pilot year (2005) in this study. Due to excessive personnel effort required to fish this gear and very low catch rates, set lines were not used after 2005 and no formal analysis was done.

TABLE 3. Mean and range (in parentheses) surface water temperature (°C), mean water conductivity (µS/cm), and flathead catfish mean catch per unit effort (fish/h) for low-frequency electrofishing by incremental-size groups during each monthly (4 week) interval for the period of April 15 to July 15. UMR = upper Mississippi River.

River	2006			2007		
	April–May	May–June	June–July	April–May	May–June	June–July
Grand						
Water temp	18 (16–20)	25 (24–27)	26 (24–29)	15 (13–18)	24 (22–26)	26 (24–27)
Conductivity	513	520	449	449	356	502
Substock	14.7	19.0	42.3	6.2	23.9	45.8
Stock	6.4	3.4	3.3	2.2	2.1	2.4
Quality	3.0	1.1	0.2	0.4	0.7	0.6
≥ preferred	0.6	0.5	0.2	0.0	0.3	0.2
Total	24.8	23.9	45.9	8.8	27.0	48.9
Lamine						
Water temp	18 (16–21)	20 (17–22)	26 (25–26)	18 (12–21)	22 (21–22)	26 (24–29)
Conductivity	468	521	428	400	345	404
Substock	7.1	6.4	3.2	3.4	8.4	11.6
Stock	5.0	3.7	1.8	2.0	2.2	1.8
Quality	1.7	2.4	0.3	0.6	1.5	0.9
≥ preferred	0.7	1.1	0.4	0.6	0.4	0.3
Total	14.5	13.6	5.7	6.6	12.5	14.5
Platte						
Water temp	19 (17–20)	25 (24–27)	26 (25–28)	18 (16–19)	22 (21–24)	25 (23–27)
Conductivity	564	395	466	540	451	457
Substock	12.8	14.7	43.3	15.8	19.3	47.5
Stock	2.3	0.8	0.8	2.5	1.3	2.8
Quality	1.6	0.2	0.3	2.9	0.5	0.2
≥ preferred	1.3	0.7	0.0	0.8	0.4	0.4
Total	17.9	16.5	44.5	22.0	21.6	50.9
UMR						
Water temp	15 (14–16)	20 (13–25)	25 (23–27)	16 (13–20)	21 (19–25)	25 (24–28)
Conductivity	513	511	469	509	552	582
Substock	45.0	49.0	64.8	59.0	59.2	71.0
Stock	40.8	36.9	15.7	43.4	40.9	18.
Quality	20.2	17.9	6.6	18.6	17.2	6.3
≥ preferred	7.5	6.2	2.0	4.6	5.7	1.9
Total	113.5	110.1	89.1	125.6	123.1	97.2

Our findings are similar to those of Gelwicks (2006), who reported that hoop nets caught fewer but larger (>43 cm TL) flathead catfish in the Iowa River compared with low-frequency electrofishing. In contrast, Stauffer and Koenen (1999) found that hoop nets (19 mm mesh) baited with live flathead catfish during mid-June to early July were unsuccessful at capturing flathead catfish in the Minnesota River. However, they reported low-frequency (7.5 Hz) electrofishing captured a wide size range of flathead catfish with most being less than 60 cm TL. Perhaps our inability to sample larger flathead catfish with low-frequency electrofishing, especially in the Grand and Platte rivers, was due in part to presence of available spawning habitats (e.g., logjams, woody snags, and debris piles) where flathead catfish could more easily evade the electrical field, as suggested by Justus (1994).

Considering our objective to evaluate exploitation rates as part of another project, hoop nets were necessary in most rivers to capture larger flathead catfish. This was not the case, however, in pools 20–22 of the UMR where low-frequency electrofishing

TABLE 4. Mean and range (in parentheses) surface water temperature (°C) and flathead catfish mean catch per unit effort for hoop nets (fish/hoop-net-night) by incremental-size groups during each monthly (4 week) interval for the period of May 15 to July 15. Missing data exists when hoop nets were not fished. UMR = upper Mississippi River.

	2006		2007	
River	May–June	June–July	May–June	June–July
Grand				
Water temp	23 (19–26)	26 (24–31)	24 (24–25)	27 (27–27)
Substock	0.014	0.000	0.207	0.083
Stock	0.088	0.069	0.110	0.208
Quality	0.077	0.301	0.178	0.583
≥ preferred	0.019	0.140	0.171	0.167
Total	0.199	0.510	0.665	1.042
Lamine				
Water temp	22 (15–26)	26 (26–29)	22 (21–24)	
Substock	0.008	0.000	0.005	
Stock	0.076	0.042	0.062	
Quality	0.039	0.021	0.038	
≥ preferred	0.083	0.031	0.027	
Total	0.205	0.094	0.131	
Platte				
Water temp	22 (18–26)	28 (24–31)	22 (20–23)	25 (22–27)
Substock	0.021	0.000	0.051	0.033
Stock	0.058	0.136	0.135	0.067
Quality	0.116	0.151	0.148	0.092
≥ preferred	0.169	0.329	0.251	0.258
Total	0.363	0.617	0.584	0.450
UMR				
Water temp	20 (14–24)	26 (24–27)		
Substock	0.033	0.000		
Stock	0.158	0.065		
Quality	0.133	0.087		
≥ preferred	0.038	0.022		
Total	0.363	0.175		

was consistently effective at capturing all sizes of flathead catfish.

Our lack of conclusive results in 2007 is possibly related to higher river discharges that year compared to 2006. Travnichek (2011) examined monthly (May–September) sampling of flathead catfish in the lower Missouri River using pulsed (<20 Hz) DC boat electrofishing with a chase boat and found an inverse relationship between river stage and catch rate. Further research in this area is needed.

Management Implications

Depending on information needs and sampling objectives, our results indicate that a combination of low-frequency (15 Hz) electrofishing and hoop nets will likely be successful during the period of April 15 through July 15 to best represent length structure and relative abundance of flathead catfish populations in these rivers. More specifically, we found low-frequency electrofishing to be most effective for stock size and larger flathead catfish during mid-April to mid-June; however, these results were not as conclusive in 2007. Other studies also indicated a combination of active and passive gears were needed to adequately sample and represent riverine flathead catfish populations (Pugibet and Jackson 1989; Stauffer and Koenen 1999; Vokoun and Rabeni 1999).

While our findings provide some insight about gear bias, additional work is needed that specifically examines size bias, efficiency, and capture probabilities when sampling flathead catfish in moderate to large rivers (Brown 2007). Our results (along with a concurrent exploitation study) will provide managers with sampling guidance and baseline information to model and evaluate future management strategies in efforts to develop high-quality flathead catfish fisheries.

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