Evaluation of Three Low Frequency Electrofishing Pulse Rates for Collecting Catfish in Two Florida Rivers

Richard L. Cailteux, *Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 5300 High Bridge Rd., Quincy, FL 32351*

P. Andrew Strickland, *Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 5300 High Bridge Rd., Quincy, FL 32351*

Abstract: We evaluated three low frequency electrofishing pulse rates (30, 15, and 7.5 pulses per second [pps]) for differences in relative abundance, size structure and species composition of catfish species in two north Florida rivers (Apalachicola and Suwannee). Three species of catfish were collected from each river: Apalachicola River–flathead catfish (*Pylodictis olivaris*), channel catfish (*Ictalurus punctatus*), and blue catfish (*I. furcatus*); Suwannee River–spotted bullhead (*Ameiurus serracanthus*), channel catfish, and white catfish (*I. catus*). In both rivers, the dominant catfish species (Apalachicola: flathead catfish; Suwannee: spotted bullhead) was collected similarly with all three pulse rates. However, significant differences occurred in relative abundance, size structure, and species composition of the less dominant species in both systems. Generally, 15 pps yielded the best representation of sizes over the spectrum of lengths expected for all species; however 7.5 and 30 pps appeared to sample the smaller catfish (<260 mm) more effectively in the two systems studied. The use of 15 pps should give the best representation of catfish (>260 mm) while 7.5 pps will sample the smaller catfish (<260 mm) more effectively. Sampling with a combination of these pulse rates may be constructive when designing sampling strategies for standard sampling of catfish species.

Key words: Low frequency electrofishing, pulse rates, catfish, standardized sampling

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As fish sampling evolves, standardization of fish collection methods becomes critical to the evaluation and monitoring of aquatic systems (Bonar and Hubert 2002, Hayes et al. 2003). The recent evolution of Florida's *Standardized Sampling Manual for Lentic Systems* (Bonvechio 2006) demonstrates the level of priority that standard methods will play in future sampling of Florida's fresh water aquatic resources. However, standard methods used for electrofishing scaled fishes (e.g., pulse rate) are not effective at adequately sampling ictalurids.

Catfish sampling in Florida has historically used traps and nets and focused on lentic systems where commercial fisheries exist (Crumpton et al. 1987). With the advent of cost-effective, low frequency electrofishing units (<60 pps), sampling for catfish has become much easier and less size-or species-selective than some passive gears (Pugh and Schramm 1998, Vokoun and Rabeni 1999). However, low frequency electrofishing for catfish is less effective at water temperatures below 16 to 19 C (Morris and Novak 1968, Quinn 1986, Justus 1996), and catch rates have been shown to improve with increasing temperatures (Quinn 1986). Catfish sampling with low frequency electrofishing, although in its infancy, has yielded many studies, although fish collection methodologies are not standardized. Due to the nature of lotic catfish sampling with electrofishing (usually sampling the deepest water), some standard methods for sampling lentic systems (Bonvechio 2006) will not apply (e.g., collecting fish behind the boat; pulse rate). Many of the studies reviewed have used electrofishing pedal time as the metric for relative abundance. However, fish per shoreline distance (m) sampled has been used more recently (McInerny and Cross 2000, Hansen et al. 2004) and may be a more consistent measure of abundance (S. Miranda, Mississippi State University, personal communication), which is important in standardization of fish sampling protocols.

Our objective in this study was to evaluate three low frequency electrofishing pulse rates for catfish sampling in two large Florida rivers to aid in determining the optimum frequency for estimating relative abundance, size structure and species composition of catfish species. Five major native species of catfish (Family: Ictaluridae) occur in Florida rivers, channel catfish (*Ictalurus punctatus*), white catfish (*I. catus*), yellow bullhead (*Ameiurus natalis*), brown bullhead (*A. nebulosus*), and spotted bullhead (*A. serracanthus*). Additionally, two non-native species to Florida, flathead catfish (*Pylodictis olivaris*) and blue catfish (*I. furcatus*) are becoming more common and in some cases dominating the river ictalurid populations (Cailteux et al. 2003). As is the case with most sampling gears, some species are easier to collect than others due to gear bias. Sampling in two rivers with different species composition and relative abundance will allow for comparisons of the best methodology for Florida's standard methods.

Methods

The Apalachicola River is the largest river in terms of discharge in Florida (Bass and Cox 1985) and is formed by the confluence of the Chattahoochee and Flint rivers in panhandle Florida. It is an alluvial river entrenched with sand and strongly influenced by large woody debris (Leitman et al. 1991). Mean depth is four to six meters with deeper holes greater than 20 meters. Mean conductivity ranges from 100 to 196 μmhos/cm with a median of 130 μmhos/cm (Florida Fish and Wildlife Conservation Commission [FWC], unpublished data).

The Suwannee River is the second largest river in terms of discharge in Florida (Bass and Cox 1985). This river is characterized by karst topography (Crane 1986). It is relatively shallow with an average depth of 1 to 4 m, although holes greater than 10 m are present (Mason and Clugston 1993). Mean conductivity ranges from 188 to 428 μmhos/cm with a median of 271 μmhos/cm (FWC, unpublished data). No aquatic vegetation was present within the sample reaches of either river. Both of these rivers have been sampled for catfish with low frequency electrofishing since the late 1990s (Cailteux et al. 2003).

Catfish species were collected from the two study rivers by low frequency electrofishing at three standard pulse rates (7.5, 15, and 30 pulses per second). Electrofishing gear consisted of a Smith Root GPP 7.5 with a generator, and sampling was conducted during June and July 2006 at water temperatures exceeding 26 C. The boat was configured with two booms, each with a Wisconsin ring as the anode and the boat hull as the cathode. Each sampling day, pulse rate was randomly chosen so that three transects of each pulse rate were completed each day. Transects containing similar habitats were sampled on continuous stretches of each river. No transect was sampled more than one time during the study. Each river was sampled a total of six sampling days within a two-week period for a total 18 samples per pulse rate per river. All transects were sampled for 15 minutes in duration.

Water temperature and conductivity were taken each sample day with a YSI-30 meter. All catfish were collected with the shock boat, and no chase boat was used. All catfish were measured for total length (TL; +1 mm). At the beginning and end of each transect, GPS coordinates were taken so that distance traveled could be calculated. Beginning and ending GPS coordinates were entered into an Excel spreadsheet to calculate shoreline distance sampled (m) (GPSWaypoints 2005). Catch per Unit Effort (CPUE) was calculated by both time (fish/minute) and distance (fish/meter). Species composition, CPUE, and length frequencies were then used to evaluate each pulse rate.

Log_{10} transformed CPUE by species was used to compare relative abundance of catfish populations between pulse rates using ANOVA and Tukey's multiple comparison tests. Differences among pulse rates in length frequencies of all ictalurid species collected were assessed with a Kolmogorov-Smirnov two-sample test. Chi-square analysis was used to test for differences in species composition based on total number data. Finally, correlation analysis was used to determine the best metric of relative abundance: pedal time or shoreline distance sampled. Significance of all statistical tests was assessed at $P < 0.05$.

Results

Relative Abundance

In the Suwannee River (average conductivity = 428 μmhos/cm; range 396 to 448), no significant differences ($P = 0.173$) in fish/minute were observed between pulse rates for any individual species or total catfish captures (Table 1). Mean shoreline distance electrofished per 15-min transect was 833 m and was not different between pulse rates ($P = 0.1203$). However, in terms of number of catfish collected per meter of shoreline electrofished, significantly more channel catfish ($P = 0.0317$) were collected using 7.5 pps than 30 pps. No other differences were observed for other species or total catfish collected per meter of shoreline ($P > 0.1629$).

Blue catfish, collected only in the Apalachicola River (average conductivity = 179 μmhos/cm; range = 170 to 186), were collected at a significantly higher fish per minute ($P = 0.0005$) and fish per meter ($P < 0.0001$) at 15 pps compared to either 7.5 or 30 pps (Table 1). No significant differences among pulse rates were observed for relative abundance of flathead catfish ($P > 0.0875$), channel catfish ($P > 0.5807$), or total catfish ($P > 0.6075$) as measured by CPUE in either pedal time or distance.

Size Structure

A total of 1,063 ictalurids of three species were collected from the Suwannee River during this study. Kolmogorov-Smirnov tests indicated that significant differences in length frequencies occurred for spotted bullhead (Fig. 1) and white catfish (Fig. 2) between pulse rates. In general, a greater proportion of smaller spotted bullheads were collected with 15 pps than 30 pps ($P = 0.0106$). No differences in size structure were observed between 7.5 and15 pps ($P = 0.5114$) or 7.5pps and 30 pps ($P = 0.2259$). Smaller white catfish were collected with 7.5 pps than 15 pps ($P = 0.0416$) and 30 pps than 15 pps ($P = 0.0031$). No differences in size distribution were observed between 7.5 pps and 30 pps ($P = 0.3315$). No differences in size structure were observed with any pulse rate studied for channel catfish ($P > 0.28$; Fig. 3).

A total of 2,448 ictalurids of three species were collected from the Apalachicola River during this study. Kolmogorov-Smirnov tests indicated that significant differences in length frequencies

Table 1. Catch per unit effort (CPUE) by both time (ictalurids/minute) and distance (ictalurids/kilometer) collected by low frequency electrofishing (7.5, 15, and 30 pps) from the Suwannee and Apalachicola rivers. *n* = Number of transects.

			7.5 pps		15 pps		30 pps	
			Mean	S.E	Mean	S.E	Mean	S.E
River	Species	CPUE	Fish/min		Fish/min		Fish/min	
			n=18		*n*=18		*n*=18	
Suwannee	Spotted bullhead	Time	1.16	0.20	0.75	0.13	1.03	0.37
	Channel catfish	Time	0.30	0.10	0.22	0.08	0.10	0.05
	White catfish	Time	0.22	0.06	0.37	0.11	0.15	0.04
	Total Catfish	Time	1.69	0.27	1.34	0.22	1.28	0.41
Apalachicola	Flathead catfish	Time	2.34	0.13	2.05	0.18	2.23	0.18
	Channel catfish	Time	0.49	0.09	0.72	0.14	0.78	0.31
	Blue catfish	Time	0.10	0.05	0.32	0.08	0.02	0.01
	Total Catfish	Time	2.93	0.2	3.12	0.26	3.01	0.41
Suwannee	Spotted bullhead	Distance	31.0	8.2	14.8	3.2	22.2	8.7
	Channel catfish	Distance	11.1	7.2	3.6	1.3	1.6	1.0
	White catfish	Distance	6.1	2.5	7.2	2.6	2.9	1.0
	Total Catfish	Distance	48.3	17.0	25.6	5.2	26.7	9.9
Apalachicola	Flathead catfish	Distance	42.4	3.0	33.4	3.9	36.3	3.3
	Channel catfish	Distance	9.4	2.0	11.9	2.8	12.4	4.5
	Blue catfish	Distance	2.0	0.9	5.9	1.4	0.3	0.2
	Total Catfish	Distance	53.9	4.7	51.1	6.1	49.0	6.4

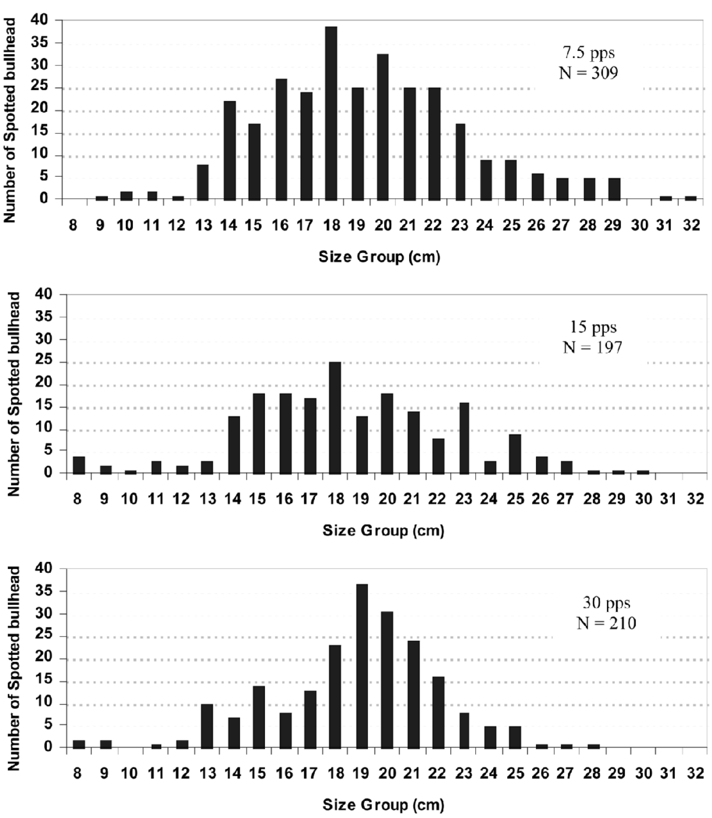

Figure 1. Length frequencies of spotted bullhead collected with 7.5, 15, and 30 pps low frequency electrofishing, Suwannee River, July 2006.

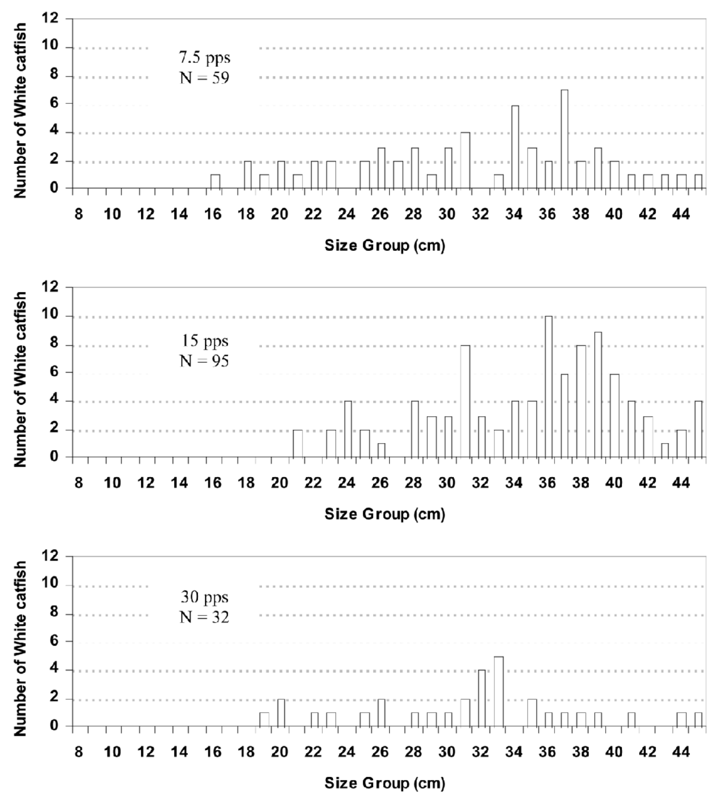

Figure 2. Length frequencies of white catfish collected with 7.5, 15, and 30 pps low frequency electrofishing, Suwannee River, July 2006.

occurred for flathead catfish (Fig. 4) and channel catfish (Fig. 5) among pulse rates. Smaller flathead catfish were collected with both 7.5 pps ($P < 0.0001$) and 30 pps ($P < 0.0001$) at significantly higher rates when compared to 15 pps. No differences in capture rates were observed between 7.5 pps and 30 pps ($P = 0.3281$). Smaller channel catfish also were collected with both 7.5 pps ($P < 0.0001$) and 30 pps ($P < 0.0001$) than 15 pps. Smaller channel catfish were also collected at a greater rate with 30 pps than 7.5 pps ($P = 0.0001$). No differences in size structure were observed between 7.5 pps and 15 pps ($P = 0.2469$) for length frequencies of blue catfish (Fig. 6). Only four blue catfish were collected with 30 pps, so no comparisons could be made with this pulse rate.

Composition

Species composition varied among the three pulse rates studied in each river (Fig. 7). In the Suwannee River, spotted bullhead comprised 67% of all catfish collected; however, no significant differences occurred between pulse rates ($P > 0.06$). Significantly more ($P < 0.0003$) channel catfish were collected with both 7.5 and 15 pps than with 30 pps. White catfish were collected more frequently with 15 pps ($P < 0.0001$) than either 7.5 or 30 pps.

In the Apalachicola River, flathead catfish comprised 72% of all catfish collected and were collected in similar composition with

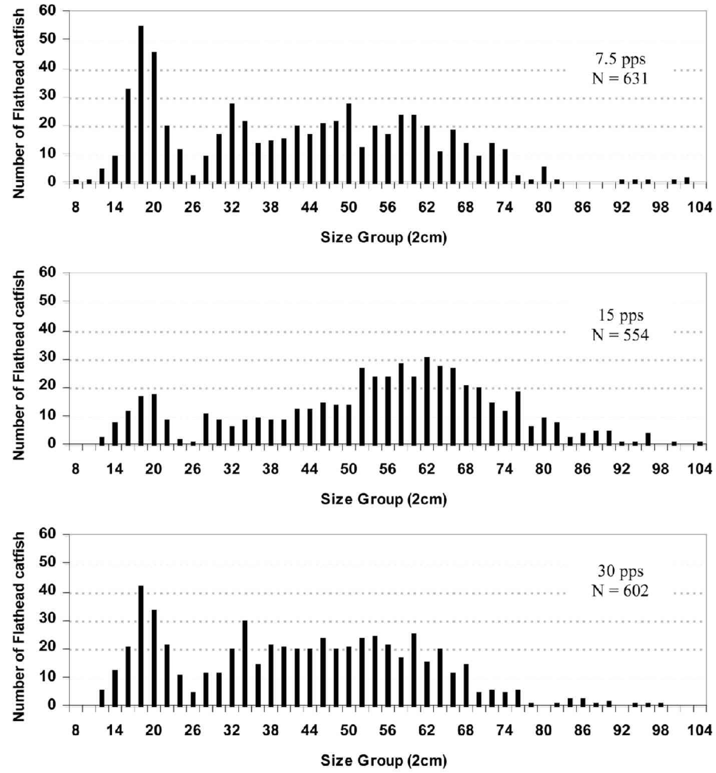

Figure 4. Length frequencies of flathead catfish collected with 7.5, 15, and 30 pps low frequency electrofishing, Apalachicola River, July 2006.

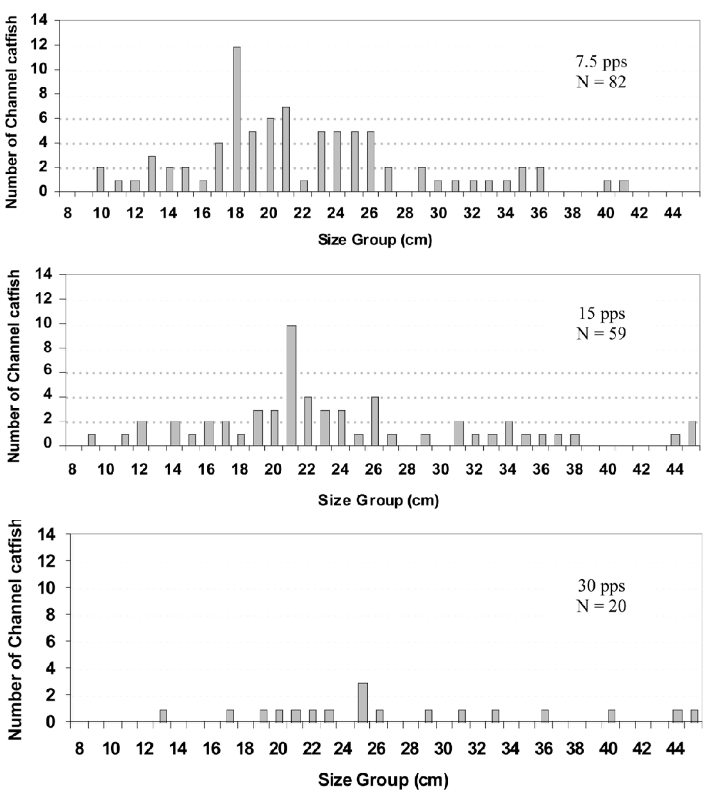

Figure 3. Length frequencies of channel catfish collected with 7.5, 15, and 30 pps low frequency electrofishing, Suwannee River, July 2006.

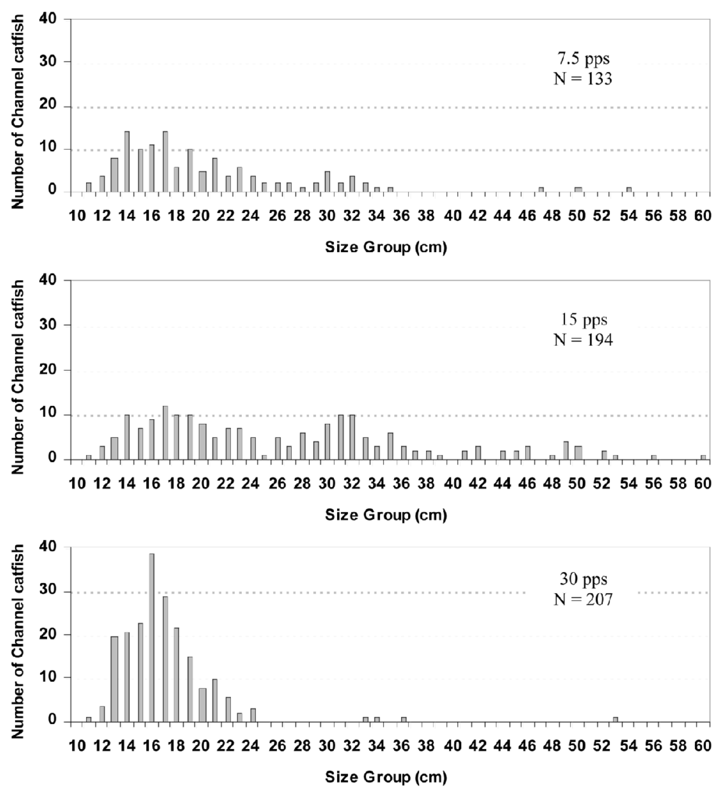

Figure 5. Length frequencies of channel catfish collected with 7.5, 15, and 30 pps low frequency electrofishing, Apalachicola River, July 2006.

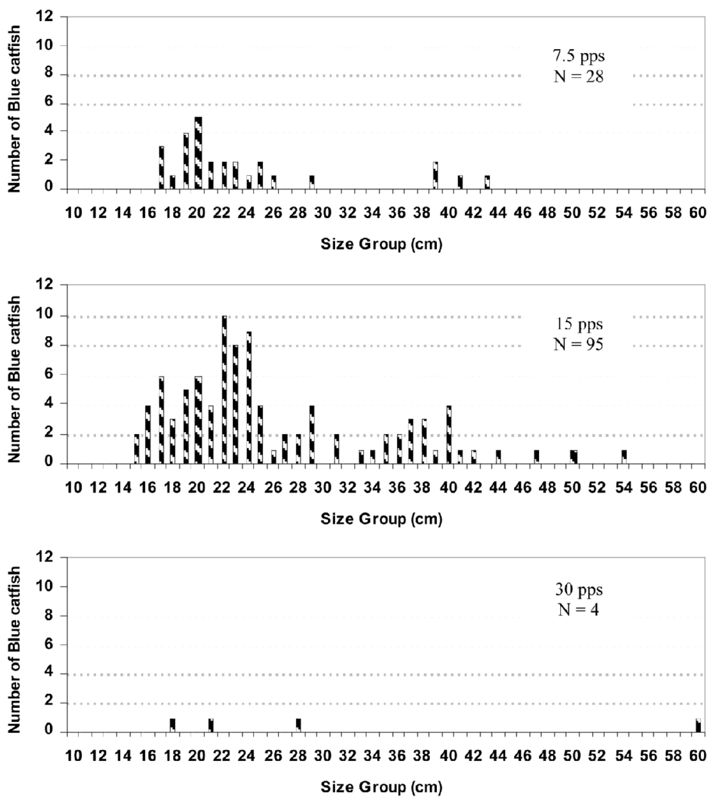

Figure 6. Length frequencies of blue catfish collected with 7.5, 15, and 30 pps low frequency electrofishing, Apalachicola River, July 2006.

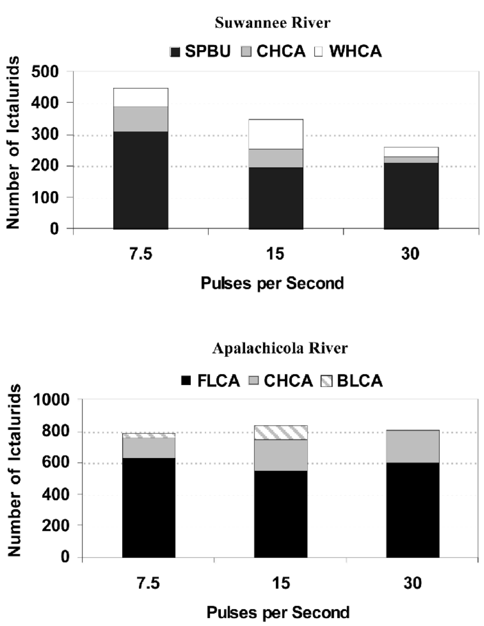

Figure 7. Composition of ictalurids collected with 7.5, 15, and 30 pps low frequency electrofishing, Suwannee and Apalachicola rivers, July 2006. SPBU = spotted bullhead; CHCA = channel catfish; WHCA = white catfish; FLCA = flathead catfish; BLCA = blue catfish.

Table 2. Correlations of pedal time and distance CPUE estimates by catfish species from the Suwannee and Apalachicola Rivers, July 2006.

		7.5 PPS		15 PPS		30 PPS	
River	Species	r^2	*P*	r^2	*P*	r^2	*P*
Suwannee	Spotted bullhead	0.6962	0.0013	0.9442	<0.0001	0.9969	<0.0001
	Channel catfish	0.9085	<0.0001	0.9832	<0.0001	0.9978	<0.0001
	White catfish	0.6892	0.0016	0.9746	<0.0001	0.9774	<0.0001
	Total catfish	0.7648	0.0002	0.9485	<0.0001	0.9961	<0.0001
Apalachicola	Flathead catfish	0.7775	0.0001	0.8187	<0.0001	0.8746	<0.0001
	Channel catfish	0.9868	<0.0001	0.9705	<0.0001	0.9905	<0.0001
	Blue catfish	0.9972	<0.0001	0.8501	<0.0001	0.9956	<0.0001
	Total catfish	0.8924	<0.0001	0.8720	<0.0001	0.9392	<0.0001

all of the pulse rates. Significantly more ($P < 0.0001$) blue catfish were collected with 15 pps than either 7.5 or 30 pps. Also, channel catfish were collected more frequently with 30 pps than 7.5 pps ($P < 0.0001$).

Pedal time vs. distance CPUE

Significant correlations ($P < 0.0017$) existed for all pairwise comparisons of pulse rate between time and distance (Table 2) for both rivers. Correlations ranged from 0.6892 to 0.9978 with a median of 0.9183.

Discussion

Standardized monitoring of fish populations is extremely important for fish management agencies, and efficient sampling methods are critical to standardized monitoring programs. Ictalurid populations are not as susceptible to normal electrofishing frequencies and using the correct frequency range is crucial to the efficient collection of catfish (Quinn 1986). Low frequency electrofishing has made catfish sampling much easier, less species- and size-restrictive (Vokoun and Rabeni 1999), and more cost effective (Pugh and Schramm 1998). Consequently, this sampling approach should be included in standardized monitoring programs in Florida.

The three major catfish species from each study river (Cailteux et al. 2003) were collected with all pulse rates studied. However, species composition differed significantly with pulse rate. In each river, the dominant catfish species was collected with similar frequency with each of the pulse rates. Collection of similar numbers or significantly more of minor species with 15 pps would suggest that this pulse rate would give a better representation of the ictalurid population in these two rivers. In terms of size structure, 15 pps appears to provide the best range of sizes collected for each river and species. Small fish (<200 mm) were not encountered as frequently with 15 pps when compared to 7.5 or 30 pps. However, it should be noted that small fish probably are not efficiently sampled with electrofishing gear at any sampling frequency (Bayley and Austen 2002). Samples conducted with 30 pps did not provide adequate collection of blue catfish in the Apalachicola River or channel catfish in the Suwannee River and should probably not be used to conduct standard ictalurid samples. Sampling with a combination of low frequency pulse rates probably would adequately sample an ictalurid assemblage as a whole. We suggest that half of the sample be obtained with 7.5 pps (to give good representation of small fish) and half with 15 pps (to give good representation of larger fish), but this may depend on the objective of each project.

Water conductivity can have an impact on electrofishing catch rates (Hill and Willis 1993) and may have influenced our results as the waters of the Suwannee River are more conductive than that of the Apalachicola River, although both are in the intermediate range. However, no significant variation in the electric field experienced for individual fish should have occurred (Lines and Kestin 2004), because both rivers fall into the intermediate category of water conductivities.

The differences between relative abundance estimates in terms of pedal time and distance appear to be minimal for collecting catfish species in these Florida rivers. However, data collection and calculation of either metric is simple. Consequently, collection of both metrics should be conducted as standard protocol in river sampling.

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