Observations on Electrofishing Techniques for Three Catfish Species in Mississippi

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Abstract: Mississippi Office of Pollution Control staff collected catfish from 69 sites from 1991–1994 for contaminant monitoring. Of these, 12 sites were sampled 5 or more times per year. Environmental conditions varied dramatically between site and season facilitating observations for effects of both intersite variability (e.g., water conductivity and manipulation of pulsator settings) and intrasite seasonal variability (e.g., water temperature and river stage). Flathead catfish (*Pylodictis olivaris*) and blue catfish (*Ictalurus furcatus*) were most susceptible to the gear in water temperatures >22 C, while channel catfish (*I. punctatus*) were efficiently collected from cooler waters. Flathead catfish were susceptible to low pulse frequencies and these frequencies were necessary to collect this species from preferred deep water habitats. Channel and blue catfish were collected over a wide range of pulse frequencies. Catch per unit effort (CPUE) for settings and conditions considered optimum ranged from 1.6–2.1 fish per minute for the 3 species.

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The Mississippi Office of Pollution Control (OPC) routinely targets blue catfish, channel catfish, and flathead catfish for a variety of contaminant studies due to their ubiquitous distribution, status in sport and commercial fisheries, food habits, and proximity to bottom sediments. Catfish tissue also contains a relatively high lipid content and therefore tends to accumulate many lipophilic compounds.

From 1991–1994, staff collected catfish from 69 sites, 12 of which were at sampled a minimum of 5 times per year. The primary purpose of this sampling was to collect catfish for ongoing contaminant studies; however, sampling intensity provided staff the opportunity to develop efficient electrofishing methods for collection of the 3 catfish species. Much of this information was gathered in 3 south Mississippi streams, but numerous catfish collections have also been made on other rivers, lakes, and estuaries across the state.

Hale et al. (1984) documented an efficient method for shocking channel catfish and white catfish in Florida using unconventional equipment. Michaels and Williamson (1982) compared 5 qualitative sampling methods for collecting channel catfish including the military telephone and a Smith-Root Type VI pulsating DC unit. However, an effective regime of environmental conditions and pulsator settings for conventional electrofishing equipment has not been developed for either blue or channel catfish at this writing. Environmental conditions and electrical settings suitable for collecting flathead catfish are documented in the literature (Morris and Novak 1968, Corcoran 1979, Guier et al. 1981, Quinn 1986 and Gilliland 1987). However, the efficiency of equipment now being marketed has led to additional data and techniques to supplement existing flathead catfish data in the literature.

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Methods

In 1991 Mississippi OPC obtained a Smith-Root model GPP 7.5 pulsator and generator system along with Smith-Root booms, mounting hardware, and electrodes. Each electrode consisted of 4–4.75-cm diameter stainless steel cables suspended from an umbrella array having a diameter of 1 m. Approximately 1 m of each cable was submerged when in use. Electrical settings for each species—i.e., voltage, pulse frequency, and pulse percent range—were determined using the Smith-Root system. Only pulsed DC current was used, and the boat hull was used as the cathode. This system was mounted on a custom built 6-m × 1.3-m all-welded aluminum tunnel boat outfitted with a 90-hp outboard motor and hydraulic jack for navigating shallow shoals frequently encountered on rivers. The boat was also equipped with standard depth finding equipment.

Conductivity (μmhos/cm) and water temperature (C) were recorded prior to each sampling event. Sample log books was maintained and provided the information for this manuscript. More than 200 hours were spent electrofishing for blue, channel, and flathead catfish from 1991–1994.

While collecting fish for ongoing contaminant studies the effectiveness of the equipment was documented in 1991 and 1992 and standardized methods were established. Methods were further refined in 1993 and catch per unit effort (CPUE) was determined for pulsator settings considered optimum based on past collecting experience. Time was recorded as pedal time, in seconds, using the timer on the Smith-Root pulsator which records the actual time the pulsator is engaged. Time spent electrofishing ranged from 2–6 minutes and was dependent on the amount of available habitat. Fish incapacitated to the point of lethargy were counted as caught. Fish which were observed swimming and required chasing were not counted unless captured. Eight counts were made at 3 electrofishing sites for blue catfish, 16 counts were made at 7 sites for channel catfish, and 42 counts were made at 10 sites for flathead catfish. Mean catch and electrofishing time (minutes) were determined using all counts for each species.

Different habitat types were targeted when collecting blue and flathead catfish, but the same sampling techniques were used to collect the 2 species. After targeting a specific structure or area considered to be prime habitat, the boat was typically positioned as closely as possible to the habitat with the bow pointed downstream, and electrofishing continued for a minimum of 1.5 minutes as the boat was steered slowly through the habitat.

The above procedures were standard for collecting blue and flathead catfish in low conductivity water most often encountered in Mississippi. When high conductivity (>350 μmhos/cm) was encountered, collections were made with the electrofishing equipment in constant use. This was done while navigating downstream in an "S" configuration as described by Quinn (1986).

While electrofishing for channel catfish the boat was typically oriented perpendicular to the current and allowed to float at ambient stream velocity while the equipment was in constant use.

Results and Discussion

Table 1 lists the range of water temperatures, water conductivities and river stages, or those environmental conditions OPC considers relevant to electrofishing efficiency. Also provided in Table 1 are Smith-Root pulsator ranges effective for collecting blue, channel and flathead catfish. From the ranges listed in Table 1, OPC has established optimum ranges for environmental factors and pulsator settings for which optimum catch rates would be expected based on past experience (Table 2). The mean time spent electrofishing varied from 2.5–3.3 minutes for the 3 species. Mean catch varied between 4.8 and 5.9 fish. CPUE for all 3 species were relatively high when compared to CPUE's reported in the literature (Table 2).

Conditions and pulsator settings listed for these species are successful in Mississippi; however, gear effectiveness may differ in other localities which have different conditions. For instance, conductivities >400 μmhos/cm rarely occur in Mississippi fresh water and optimum collections may occur in other regions at higher ranges than those listed here. Also, Mississippi OPC normally electrofishes from mid-April through October and data for water temperatures <20 C is limited. As a consequence, ranges for parameters considered here do not preclude that efficient collections may be made in other areas outside of those ranges listed. Techniques are discussed below on a species by species basis.

Table 1. Range of relevant environmental conditions and Smith-Root pulsator settings for which OPC has made successful catfish collections.

Species	Water Temp. (C)	Water Cond. (μmhos/cm)	River stage	Pulse freq. (pps)	Pulse range (%)	Voltage
Blue catfish	20–31	50–6,500	low-med	15–120	20–100	170–1,000
Channel catfish	19–31	30–250	low-med	15–120	20–100	170–1,000
Flathead catfish	20–31	30–6,500	low	15–30	20–50	170–1,000

Table 2. Optimum environmental conditions and Smith-Root pulsator settings for collecting 3 catfish species in Mississippi streams.

Species	Water Temp. (C)	Water Cond. (μmhos/cm)	River stage	Pulse freq. (pps)	Pulse range (%)	Voltage	CPUE (fish/minute)
Blue catfish	27–31	200–450	low	15	20	1,000	2.1
Channel catfish	22–27	50–250	low	60	45	1,000	1.9
Flathead catfish	27–31	100–450	low	15	20	1,000	1.6

Blue Catfish

Blue catfish were collected over a wide range of environmental conditions and pulsator settings, and the collection of blue catfish when using pulsator settings ideal for channel catfish or flathead catfish was not uncommon (Table 1). In fact, the occurrence of this species was often incidental while attempting to collect other catfish species.

There was much habitat overlap between blue catfish and flathead catfish, particularly in small order streams, channelized streams and lakes. Habitat partitioning was observed in larger streams where large, deep, eddied pools were preferred by this species. There also appeared to be a relationship between water depth and fish size. Small blue catfish were collected at all depths; however, larger fish were most frequently collected from depths 4–13 m.

Successful blue catfish collections were made over a wide range of water conductivities (Table 1), but the most successful blue catfish collections were made on the Mississippi River and its tributaries which are very conductive by Mississippi standards (~400 μmhos/cm). It is not known if this was related to conductivity or to species abundance because of the limited amount of data gathered from other sites having similar conductivities.

Blue catfish were also collected over a wide range of pulse frequencies but because large numbers of blue catfish inhabited deep water habitats during OPC's sampling window, and were effectively attracted to the boat using low pulsator settings, low pulse frequencies and ranges were considered optimum for collection of this species (Table 2). A necessary disadvantage of collecting the species with low pulse frequencies was that blue catfish often required chasing, and escape occurred more frequently with low frequencies than when higher pulse frequencies were used. OPC has had no success, however, attracting catfish from deep water habitats using high pulse frequencies. When targeting blue catfish in shallow water, high pulse frequencies have been used successfully and fish were easier to net with little or no chasing necessary.

Blue catfish and flathead catfish electrofished from deep water were sometimes slow to surface and often floated downstream some distance before surfacing. Chasing was necessary under these circumstances and pointing the bow downstream often allowed personnel additional collection time before the fish revived and submerged.

Seasonality played a role in electrofishing efficiency for blue catfish when using low pulse frequencies. Optimum environmental conditions (Table 2) favoring the collection of this species were present in most Mississippi streams by mid-summer and extended through fall. While using low pulse frequencies under optimum conditions, hundreds of blue catfish have been observed at the surface simultaneously in areas with dense blue catfish populations.

Electrofishing CPUE's for blue catfish are not documented in the literature. However, when comparing the blue catfish CPUE of 2.1 fish/minute to CPUE's established in the literature for channel catfish and flathead catfish, this value is higher than those reported for other catfish species (Gilliand, 1987, Guier et al. 1981, Hale et al. 1984, Michaels and Williamson 1982, Morris and Novak 1968, and Quinn 1986).

Channel Catfish

Channel catfish were consistently collected from narrow river channels deeper than the remainder of the river transect, and especially where obstructions in the current created turbulent water. Channels were most productive when the majority of the river transect was very shallow (e.g., <1 m) and the channel itself was ≥ 2 m deep. Channels along banks in bends of the river were very productive, an observation also made by Hale et al. (1984).

Like the blue catfish, channel catfish were collected under a wide range of environmental conditions and pulsator settings (Table 1). Several differences exist in channel catfish sampling protocols, however, compared to protocols developed for blue and flathead catfish: OPC collected fewer channel catfish at water temperatures exceeding 27 C, optimum pulse frequencies for channel catfish were higher than for the other species, and shallow water habitats were targeted. Optimum collections of channel catfish were made at depths ≤ 4 m, but this seemed to be an upper limit when using standard Smith-Root electrodes suspended ~1m below the water surface and high pulse frequencies.

A distinctive characteristic of the channel catfish was that small fish (<0.75 kg) were attracted by weak electrical currents which apparently had little or no effect on larger fish. Small channel catfish were consistently collected using low pulse frequencies and pulse ranges, and hundreds of young of the year channel catfish could be observed swimming listlessly around the boat while electrofishing deep pools for flathead and/or blue catfish in the fall. Using higher pulsator settings considered optimum for channel catfish (Table 2), all size ranges were sampled from shallow water habitats. Michaels and Williamson (1982) also observed that channel catfish exhibit size-specific susceptibility when comparing the efficiency of various electrofishers producing different electrical currents.

The relative inefficiency of electrofishing in low conductivity water (<100 μmhos/cm) is well documented in the literature (Bruschek 1967, Reynolds 1983, and Zalewski 1986). However, OPC personnel have consistently collected large numbers of channel catfish in water with conductivities between 30 and 100 μmhos/cm. This efficiency supports the use of electrofishing equipment with a large voltage range (170 V–1000 V). Effective distance of the electrical field increases in size (Vibert 1967) with increasing voltage. Data collected from waters with conductivities >250 μmhos/cm were limited, hence no determinations were made as to the efficiency of electrofishing for channel catfish under those conditions.

The channel catfish's susceptibility to electrofishing at relatively cool water temperatures facilitated semiannual sampling windows in Mississippi. OPC typically begins sampling in mid April and has collected this species efficiently through July. The second window begins in mid September and extends into winter. Because OPC normally begins annual sampling in the spring and concludes sampling in the fall, no determination was made of the lower temperature limit in which channel catfish collections can be made effectively. Personnel from the Missouri Department of Conservation have used electrofishing to collect channel catfish from the Missouri River in mid-winter when water temperatures approach freezing (John Robinson, pers. commun.).

Catch rates for channel catfish (1.9 fish/minute) were relatively high for these methods when compared to CPUE's generated from other studies (Michaels and Williamson 1982, Hale et al. 1984).

Flathead Catfish

Small flathead catfish can be collected from diverse habitats at all depths within ranges listed in Table 1. However, like large blue catfish, large flathead catfish prefer deep water habitats, and Pfleiger (1975) noted that time habitats were usually >3.5 m. Habitat availability also plays an important role in locating this species (Skains 1992), and habitats preferred by large flathead catfish such as drifts, root wads, tree tops, deep water points and abrupt changes in bottom contour, commonly offer the fish some protection from the current.

Flathead catfish may be the most susceptible of all ictalurids to weak electrical currents (McSwain 1988), but a narrow range of pulse frequencies are best suited for collecting this species efficiently (Table 1). Flathead catfish were susceptible to electrofishing in a relatively narrow temperance range as well (Table 1). For these reasons, the species rarely was collected unless exclusively targeted.

Past publications have documented that low pulse frequencies are necessary to efficiently collect flathead catfish (Gilliand 1987, Guier et al. 1981, Morris and Novak 1968, and Quinn 1986), and 20 pulses per second (pps) is the pulse frequency cited most often. The 7.5 Smith-Root pulsator has pulse frequency increments of 7.5, 15, 30, 60, and 120 pps. OPC has effectively used 15 and 30 pps, but consider the lower of the 2 settings to be more effective (Table 2).

Temperature range for effectively collecting flathead catfish in Mississippi was above 22 C and this was also observed by Quinn (1986). Catch rate increased noticeably as water temperature increased with 1 notable exception. The occurrence of gravid females in our catch coincides with a decline in electrofishing success. Flathead catfish typically spawn in late spring and early summer in Mississippi, and reduced catch for this period has been observed for 3 consecutive seasons. The preferred habitats of spawning adults, such as hollow logs and cavities in stream banks and bottoms, may serve to exclude the fish from the electrical field. Morris and Novak (1968) noted that flathead catfish were easily collected with a 5-bar telephone generator when water temperatures were >24 C. Our experience has been that a noticeable increase in catch also occurs from 27 to 31 C. A possible explanation for this phenomenon was provided by Whitney and Pierce (1967). They concluded that fish conductivities decrease as water temperatures increase and that fish receive maximum shock when water and fish conductivity are most similar.

Environmental conditions determined boat velocity and amount of boat movement used for flathead catfish collections. If the boat was propelled too slowly, fish often sensed the weaker outer perimeter of the electrical field and evaded samplers. If propelled too fast, the boat often did not remain in the area of the fish long enough for it to be sufficiently stunned and float to the surface. Flathead catfish shocked in low conductivity and low temperature situations were slower to surface than flathead catfish shocked in ideal conditions, and manipulating boat velocity compensated for this phenomena. This was most obvious under extreme situations. Low conductivity (<50 μmhos/cm) situations required personnel to focus on specific habitats, to position the boat as proximal to the habitat as possible before engaging the electrofishing system, and to electrofish the targeted habitat a minimum of 2 minutes. Conversely, high conductivity situations observed in estuaries in southern Mississippi (e.g., >1,000 μmhos/cm at surface) permitted increased boat velocity and constant use of the system. Navigating speed for these conditions was much faster, and the boat was typically moved a hundred meters during a 2-minute electrofishing interval. Similar effects were observed as water temperatures fluctuated from low extremes (<22 C) to high extremes (>27 C).

Suitable conditions for collecting flathead catfish in Mississippi exist from early summer through fall (Table 1). Ideal conditions exist from mid August through October and this is considered to be related most to water temperature. At this time, the species can be collected from deep habitat using these methods. We do not know the maximum depth for collecting either blue or flathead catfish with a Smith-Root 7.5, but flathead catfish have been collected from depths up to 15 m in low conductivity situations that were less than optimal.

Conclusions

Blue catfish, channel catfish, and flathead catfish responded differently when exposed to different pulse frequencies, and this determined electrofishing efficiency more than any other pulsator variable. Voltage and percent pulse range were manipulated to different degrees but had less overall effect on electrofishing effectiveness.

Although blue catfish may be effectively collected over a wide range of pulse frequencies, low pulse frequencies were considered optimum. Fish could be attracted to the boat from deep water habitats using low pulse frequencies but were not attracted while using high pulse frequencies. The same was true for flathead catfish which were also targeted from deep water habitats with low pulse frequencies. Channel catfish were effectively collected using higher pulse frequencies because of their preference for shallow water habitat.

The efficiency of shocking for blue and flathead catfish was affected by water temperature; productive collections were made above 22 C. Electrofishing efficiency increased progressively for these 2 species as water temperature increased, and was very productive above 27 C. Channel catfish were effectively collected at 20 C and electrofishing efficiency declined as water temperatures increased above 27 C.

Electrofishing boat speed was important when shocking for flathead catfish. In the presence of conductivities <100 μmhos/cm and/or water temperatures <25 C, it was necessary to maintain proximal position to the habitat for at least 2 minutes before moving. These methods were not necessary for collecting flathead catfish in higher water conductivities and water temperatures. These same procedures were used when collecting blue catfish; however, the relevance of boat speed to success was not conclusively determined for this species. Channel catfish were collected with the electrofishing system in constant use as the boat was maintained at ambient stream velocity.

The efficiency of these methods in Mississippi is attested to by CPUE values which are higher than those reported in past publications, and also by OPC's past and present capabilities. In fall 1990, prior to developing these methods, personnel collected 170 catfish weighing 264 kg with >120 man hours expended for an ongoing contaminant study. For the same study in the fall of 1992, after using the Smith-Root system for 2 years, personnel collected 212 catfish weighing 344 kg with <40 man hours expended. OPC has benefited from the development of standard species-specific sampling procedures because the agency can now obtain comparable samples more efficiently.

The information provided in this paper is not intended to be the final word in electrofishing efficiency for these catfish species, but rather to provide research and field personnel with practical information that may aid them when collecting catfish.

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