Effectiveness of an Electrofishing System for Collecting Flathead Catfish

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Abstract: Three battery-powered pulsed DC electrofishing units were built and used to collect flathead catfish (*Pylodictis olivaris*) in a 50-km section of the Flint River, Georgia, to study the dramatic population expansion of that species following introduction. Peak collecting efficiency was achieved at 20 Hz frequency and pulse width of 0.4–0.5 ms. Power of 250–350 volts and 3 amps were needed to collect flathead catfish effectively in conductivities of 80–155 umhos/cm. Fishing downstream in a figure-S pattern with a 12-m anode wire hanging from the stern was effective in a variety of depth, substrate, and flow conditions. Efficiency was increased when a chase boat was deployed to net fish due to the large effective electric field. Efficiency was significantly reduced below 20° C. During 35 trips and 78.4 hours of electrofishing, 3,266 flathead catfish were collected. Catch rates increased from 18 fish per hour in May to 85 fish per hour in October and declined in November to 40 fish per hour. Catfish total length ranged from 39 to 1,107 mm and length-frequency analysis suggested that the method was not size selective for fish larger than young-of-the-year (>150 mm).

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Native distribution of the flathead catfish includes the larger rivers of the Mississippi, Missouri, and Ohio river basins from the Great Lakes south into Mexico (Glodek 1980). Introductions and subsequent movement have greatly increased its range in the last 30 years (e.g., Crossman and Leach 1979, Guier et al. 1981, Pisano et al. 1983). Flathead catfish were unofficially introduced into the Flint River in the Thomaston area in the 1950s and quickly became established in that section of the river as indicated by dominance in rotenone samples in 1971 (McSwain 1972). Flathead catfish were first captured below Albany Dam, approximately 200 km downstream from the site of original introduction in 1974 (Pasch 1976). Adult flathead catfish have recently been captured below Jim Woodruff Dam on the Apalachicola River and at Andrews Lock and Dam on the Chattahoochee River. Its rapid establishment in the river system, large size, and piscivorous food habits (Turner and Summerfelt 1970, Layher and Boles 1980, Guier et al. 1981) suggested a need for study of this species. Investigations of flathead catfish abundance, life history, and population dynamics in the Flint River, effects of traditional fisheries, and potential as a recreational fisheries resource were begun in 1985.

Flathead catfish have been notoriously difficult to collect with traditional sampling methods (Muncy 1957, Smith 1979). Various passive gears have been successful in certain situations, but an efficient active sampling gear was needed for large collections in this 50-km section of river. Susceptibility of catfish to relatively weak electric fields has been widely noted but clearly not understood (Peters and Bretschneider 1972, Peters and Buwalda 1972). As early as 1959, flathead catfish were collected in Nebraska with magneto telephone generators (Morris and Novak 1968). Since then, "telephones" or "monkey rigs" have been widely used to collect flathead catfish (Brown and Dendy 1961, Bamberg 1973, Guier et al. 1981) and other ictalurids (Michaels and Williamson 1982, Hale et al. 1984). Illegal use of these and other low voltage electrofishing devices has also been a significant law enforcement problem (Hensley 1981). However, output from these units is not electronically variable and they are fragile (Corcoran 1979; R. Michaels, pers. commun.). Results of field tests of prototype, pulsed DC electrofishing units are described in this paper with a description of technique as well as an evaluation of the flathead catfish sample collected.

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Methods

Three prototype pulsed DC electrofishing units were designed and built by James Paul, an electronics technician from Dawson, Georgia. The units were based on an earlier design for a medical electrical stimulator patented by Paul. The design utilizes both discrete components and integrated circuit technology. The first had a set frequency of 20 Hz and pulse fixed at 0.5 ms. The second unit had a frequency range of 20–57 Hz and pulse width range of 0.15–0.80 ms. The third had a range of 12–200 Hz and 0.1–0.8 ms. All were powered by 2 105-amp deep cycle batteries.

River width in the study area is 60 to 90 m. Substrate is primarily Ocala limestone outcroppings and rubble, with silt and sand deposits in many areas. The river is characterized by shallow limestone shoals alternating with longer reaches of deeper (5–10 m), slower moving water. Mean conductivity was 104 umhos/cm and ranged from 80–155 umhos/cm.

The electrofishing technique involved fishing downstream in a figure-S pattern. When manpower was available, a chase boat followed the electrofishing boat to net incapacitated fish. The anode was a 12-m length of 11-mm coaxial cable with the last meter stripped of insulation and a section of chain clamped on the end to keep the electrode deep in strong current. The aluminum boat hull was the cathode. The anode wire was attached to a 4-m fiberglass boom which extended 2 m behind the stern of the electrofishing boat to enlarge the electric field and keep the anode away from the outboard motor. A 7.5-m length of anode wire extended into the water. Water depth and flow rate determined fishing speed. Shallow areas (<2 m) with rapid flow were quickly trolled through; in moderate depths (2–5 m), the electrofishing boat operated at approximately river speed; in deep water (>5 m), reverse gear was used to slow the downstream movement of the boat, thus keeping the anode as close to the bottom as possible. A boat-mounted depth sounder and graph recorder unit was used to determine depth and bottom configuration.

Efforts were made to collect all fish that were incapacitated by the electric field. Electrofishing was continued until the 484-liter holding tank reached capacity. All fish were weighed and measured.

Results

Peak collecting efficiency for flathead catfish with the pulsed DC units was achieved at 20 Hz frequency and a pulse width of 0.4–0.5 ms. Voltages of 250–350 and 2.5–3.5 amps were generally needed to bring flathead catfish to the surface and hold them until they could be netted. The effective electric field apparently extended 10 to 20 m on both sides of the electrodes in water 1.5 to 3.0 m deep. Field width was reduced in deep water, but fish were brought to the surface from at least 10 m. Battery life at the effective settings was approximately 50 hours due to the low duty cycle of the units (0.3%–1.6% at 20 Hz).

The first electrofishing unit was relatively ineffective since its small filament transformer produced only 80 volts and 2 amps in the Flint River. The second unit produced effective voltage and current, but output fluctuated frequently as the anode contacted various substrates. The more powerful filament transformer of the third unit produced constant output which resulted in an evenly proportioned electric field and higher catch rates. Individual pulses produced by the 3 units were identical in shape as determined by an oscilloscope, Pulses were rectangular with a rise time of approximately 30 microseconds.

During 35 trips from 21 May to 20 November 1985, 3,266 flathead catfish were collected with the custom electrofishing units. Length-frequency distribution of all flathead catfish collected showed a peak from 150 to 229 mm and a gradual decline followed by a minor peak at 470 to 589 mm (Fig. 1). Total electrofishing time was 78.4 hrs. Monthly catch per unit effort (numbers per hour of electrofishing) for fish ≥305 mm increased over the first 6 months of sampling and decreased in November (Table 1). Catch rates for smaller fish peaked in September (Table 1). Monthly catch per unit effort for all sizes of flathead catfish ranged from 18 to 85

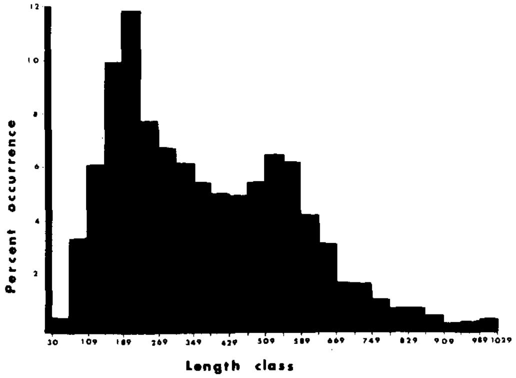

Figure 1. Length-frequency histogram (percent occurrence) of flathead catfish collected in the Flint River, 21 May–20 November. 1985.

Table 1. Monthly catch summary and catch per unit effort (CPUE) of flathead catfish (number per hour) in the Flint River, 21 May–20 November 1985.

Month	Number <305 mm	Number ≥305 mm	Total	CPUE <305 mm	CPUE ≥305 mm	Total CPUE
May	72	80	152	8.5	9.4	17.9
June	127	122	249	10.7	10.3	20.9
July	272	251	523	14.1	13.0	17.1
August	157	181	338	18.5	21.3	39.8
September	313	312	625	38.7	38.6	77.4
October	360	582	942	32.4	52.4	84.9
November	172	265	437	15.6	24.0	39.5
TOTAL	1,473	1,793	3,266	18.8	22.9	41.6

fish per hour. Daily catch rates ranged from 11 to 103 fish per hour. Catch rates for individual samples (calculated when the 484-liter holding tank was full) ranged from 7 to 144 flathead catfish per hour. Catch per unit effort by weight for a sample peaked at 534 kg per hour for a sample in September. The catch rate for the entire season was 42 flathead catfish per hour.

The electrofishing technique was species selective. Flathead catfish comprised 94% of the total catch. Channel catfish (*Ictalurus punctatus*) comprised 5%, and 5 other ictalurid species were poorly represented. No scaled fish were visibly affected by the electric field at the pulse width and frequency described.

Discussion

Low frequency was most effective for collecting flathead catfish and also resulted in a large effective electric field. Catfish which surfaced far from the electrodes were apparently affected at that distance and were not attempting to flee the electric field around the boat due to the positive galvanotactic characteristics of the pulsed DC field (Vibert 1967). The large electric field made deployment of a chase boat desirable to increase collecting efficiency. Effectiveness with low frequency is contrary to the results of Novotny and Priegel (1974) who found the effective zone to be larger with high frequency, and Edwards and Higgins (1973) who found lower frequencies less effective in experiments with 3 species of scaled fish and channel catfish. Lamarque (1967), Vibert (1967) and Novotny and Priegel (1974) noted that optimal frequency varies with target species. Telephone generators generally produce 16 to 30 Hz, apparently depending on cranking speed (Corcoran 1979, Hale et al. 1984). Successful collection of flathead catfish with generator-powered units has been achieved at 20 to 40 Hz (Corcoran 1979; J. W. Robinson, pers. commun.; G. Zuerlein, pers. commun.). Flint River poachers commonly increase the frequency of electric fence chargers up to approximately 20 Hz with a rubber band and collect large numbers of flathead catfish. Thus it appears that this frequency range is crucial for efficient collection of flathead catfish.

Affected flathead catfish exhibited a variety of reactions. Anodic curvature (Vibert 1967) was often observed in smaller fish which surfaced near the anode. The body assumed a C-shape with the head and tail closest to the anode. This reaction reportedly results from direct catelectrotonic excitation of the motor neurons of only 1 side of the body (Vibert 1967). Anodic and cathodic taxes as defined by Lamarque (1967) both occurred frequently as fish swam rapidly with their heads partly out of the water toward either electrode, reportedly in response to electrical stimulation of medullary pathways. Forced swimming as defined by Lamarque (1967) was a common reaction; flathead catfish on the surface would rush ahead with exaggerated swimming movements. Fish netted during forced swimming were active and swam normally after release in the holding tank. If fish were not netted during forced swimming, galvanonarcosis frequently developed and fish would float or sink slowly with muscles relaxed, due to extreme inhibition of medullary pathways. In the holding tank, fish resumed normal activity after several minutes. Tetanus, as defined by Vibert (1967), was noted only when voltage and current were experimentally increased beyond what wat optimal for flathead catfish collection. Variation in behavior with different pulse widths, such as Corcoran (1979) described, was not noted in this study.

The increase in catch rates over the 6 months of sampling was attributed to improved design of each electrofishing unit, progressive determination of optimal electric parameters, improved electrofishing technique, and increased use of a chase boat during the final 3 months of sampling. Reduced catch rates in November seemed directly related to water temperature which ranged from 24–29° C until November when it dropped below 20° C. There was a significant difference in catch between samples collected above and below 20° C during the fall when flow, river stage, conductivity, and electric parameters were similar and a chase boat was used (*t*-test, $P \leqslant 0.05$). Reduced flathead catfish catch rates below approximately 24° C and complete lack of effectiveness below 16° C have been reported with telephone generators (Morris and Novak 1968, Bamberg 1973), electronically similar microshockers (Hensley 1981) and gas generator-powered units (J. W. Robinson, pers. commun.; G. Gilliland pers. commun.). Hale et al. (1984) found a similar relationship between catch rates of principally white catfish (*Ictalurus catus*) with a telephone generator and water temperature. Effects of water temperature on electrofishing success for other species have been noted (Vibert 1967, Lamarque 1967), but there is no information on how it affects catfish vulnerability.

Length-frequency analysis of flathead catfish collected (Fig. 1) suggests that this electrofishing system was rather non-selective for size, except for young-of-the-year fish. The smallest flathead catfish inhabit shallow shoals were currents are swift. Boat operation was difficult in such areas and small stunned fish were quickly swept under the surface. Small fish were also more difficult to see, generally clumped in distribution, and quicker to recover from electrical stimulation and escape. The size distribution of fish >150 mm is thought to approximately reflect the true distribution of the population.

Edwards and Higgins (1973) outlined the potential of boat-mounted, battery-powered electrofishing units with very low duty cycles. This type of electrofisher is potentially more economical to acquire and operate than generator-powered ones. Portability of the units facilitates their use in the small boats sometimes required in shallow water. Wide selection of frequency, pulse width, and output power allowed efficient collection of flathead catfish in this study. Preliminary field investigations indicate that these prototype units are effective for collecting other species as well, when electrical parameters and electrode arrays are altered. Quietness of the system permits more communication among personnel, allows splashing of surfacing fish to be heard and does not threaten the hearing of the operators (Edwards and Higgins 1973). Further development of similar electrofishing systems should result in more efficient and economical collection of many species of fish in a variety of situations.

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