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Operational Comparison of Three Electrofishing Systems[1]

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ABSTRACT

Three different electrofishing systems were compared to determine their relative efficiency with respect to species and numbers of fish collected. These results indicated that modifications or changes in electrofishing gear during a monitoring program should not be made unless it can be demonstrated that collecting efficiency is not altered.

During a long-term environmental monitoring program it often becomes necessary to replace electrofishing gear. In the case of the long-term fish monitoring program for Commonwealth Edison Company's Quad Cities Nuclear Generating Station near Cordova, Illinois, the manufacture of the Homelite Model 9 HY 1B generator that had been in use for the period 1971–1980 was discontinued. When one of the two remaining generators available for use failed, we realized that there was a need to compare several different models in the event the remaining generator could not be repaired or replaced. Consequently, the efficiency of two different but readily available alternating current (AC) systems were compared with the efficiency of the original AC system used in the monitoring program.

MATERIALS AND METHODS

Three electrofishing systems were compared at three locations during three separate time periods. The original system was powered by a Homelite Model 9 HY 1B, 3,000-watt, 3-phase, 230-volt AC, 7.5-ampere generator. The second was powered by a Homelite Model 90 HY 50, 5,000-watt, 3-phase, 230-volt AC, 12.5-ampere generator. The third system used was a Coffelt Model VVP 25 electrofisher powered by a 5,000-watt, single-phase, 240-volt AC, 7.5-ampere generator.

Both Homelite generators were used with the same 16-foot john boat. The electrode array consisted of three paired, 1.5-meter long, 9.8 mm-diameter stainless steel cables, arranged in line 1.5 meters apart and suspended perpendicular to the longitudinal axis of the boat 1.5 meters off the bow. Each of the three electrodes was powered by one of the phases.

The Coffelt electrofisher was a commercially manufactured system. The electrode array consisted of four 3.1-meter long, 9.5 mm-diameter stainless steel cables. Two electrodes were suspended from forward-projecting fiberglass booms spaced 2.5 m apart and 1.5 m in front of the bow of the boat. The two back electrodes were suspended (one from either side of the boat) 2.2 meters apart, and a 3.7 m behind the front electrodes.

The three sampling sites selected had similar cover. They were located in Pool 14 of the Mississippi River on the Iowa side along the west bank of Hanson Slough between River Mile 508 and 509. These stations were numbered 1, 2, and 3 in an upstream direction. Each sampling station was fished in an identical manner by shocking upstream for 20 minutes. Approximately 300 m of shoreline were covered at each location and about 90–150 m was not electrofished between the adjacent sites.

Electrofishing with the three units was conducted at the three locations on June 29, July 2, and July 6, 1981. Similar river conditions prevailed prior to all electrofishing. Water level at the three sampling stations varied less than 0.15 m among sampling dates. A boat operator and one person to dip the fish were used on all three dates. The same boat operator was used each time but two different dippers were used. In order to reduce site bias, each electrofishing unit was used once at each sampling location. Hence, each

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Table 1. Summary of water quality parameters and voltage/amperage output for Homelite and Coffelt systems tested at three locations in 1981.

	Electroshocking system									Water quality	
	Homelite 190 HY 50			Homelite 9 HY 1B			Coffelt VVP 25				
	Electrode number[a]	Voltage	Amperes	Electrode number[a]	Voltage	Amperes	Electrode number[b]	Voltage	Amperes	Conductivity (μmho)	Temperature (C)
June 29	1	230	9.0	1	190	7.5	1	240	3.5	300	23
	2	230	9.0	2	190	7.5	2	240	3.5		
	3	230	9.0	3	190	7.5	3	240	3.5		
							4	240	3.5		
July 2	1	220	8.0	1	190	8.0	1	220	3.8	298	24
	2	220	9.0	2	190	8.0	2	220	3.8		
	3	220	9.5	3	190	9.0	3	220	4.0		
							4	220	4.0		
July 6	1	240	9.0	1	190	7.5	1	NR[c]	NR[c]	300	26
	2	240	9.0	2	190	8.5	2				
	3	240	9.0	3	190	8.5	3				
							4				

[a] Electrodes numbered left to right in Homelite systems (1—left, 2—middle, 3—right).
[b] Electrodes numbered clockwise in Coffelt system (1 and 2—front; 3 and 4—side).
[c] NR = data not recorded.

location was sampled three different times (dates) but each time with a different unit. Temperature (C) and conductivity (μmho) were measured each time. Voltage and amperage output were measured with a hand-held voltage and ampere meter for each system each day of the study. All of the fish collected were identified and counted by species.

Results

Electrofishing efficiency of the three units was based on the total number of fish and fish species collected at each location. The operational and water quality parameters are listed in Table 1. Temperature and conductivity did not vary significantly during the study, the temperature ranging from 23 to 26 C and conductivity ranging from 298 to 300 μmhos. Voltage and amperage varied significantly between units, but there was little variation of a given unit's output among the three sampling dates.

The total number of fish collected by each unit was 85, 67, and 32, with means of 28.3, 22.3, and 10.7 fish for the 5,000-watt Homelite, the 3,000-watt Homelite and the Coffelt unit, respectively (Table 2). An analysis of variance indicated a highly significant difference in the number of fish collected by the three units ($F = 12.11$, $P = 0.0078$). A Duncan's Multiple Range Test indicated no significant difference between the 5,000-watt and 3,000-watt Homelite units, but there was a signifiicant difference between the Homelite units and the Coffelt unit ($P \leq 0.05$).

A total of 24 species of fish were collected at the three sampling locations on the three sampling dates (Table 2). Twenty species were collected with the 5,000-watt Homelite, 14 species with the 3,000-watt Homelite, and 11 species with the Coffelt unit. An analysis of variance indicated no statistically significant difference ($F = 1.62$, $P = 0.2744$) among the three units.

Discussion

The data indicate there were substantial differences in efficiency between the systems tested. It was apparent that both Homelite systems were more efficient than the Coffelt unit, with the Homelite units yielding more fish (85 and 67) and species (20 and 14) than the Coffelt shocker (32 fish and 11 species). Although not statistically different, these data also suggested that the 5,000-watt Homelite was more effective in sampling than the 3,000-watt Homelite unit.

Because the amperage was essentially the same, the difference between the two Homelite units appears to be due to the voltage output. Evidently, due to the electrode design and the conductivity, the governor on the 3,000-watt Homelite was reducing the motor's rpm which, in turn, reduced the voltage output of this unit from the

Table 2. Fishes collected by three different electrofishing units at three sampling locations on Pool 14 of the upper Mississippi River.

Species	Homelite 190 HY 50				Homelite 9 HY 1B				Coffelt VVP 25				All systems
	6/29/81 Location 1	7/2/81 Location 2	7/6/81 Location 3	Totals	6/29/81 Location 2	7/2/81 Location 3	7/6/81 Location 1	Totals	6/29/81 Location 3	7/2/81 Location 1	7/6/81 Location 2	Totals	
Bowfin						1		1					1
Gizzard shad		6	1	7			2	2					9
Common carp	3	6	6	15	8	9	7	24	4	3	5	12	51
Silver chub			1	1									1
Notropis sp.							1	1					1
Emerald shiner							1	1					1
Spottail shiner	1			1									1
Spotfin shiner			2	2									2
River carpsucker	3	3	2	8	2		1	3	5		1	6	17
Quillback	1			1									1
Smallmouth buffalo	2	2	2	6	1	1	5	7	1			1	14
Bigmouth buffalo		4		4	2		2	4			2	2	10
Silver redhorse	2			2					1	1		2	4
Channel catfish	1			1									1
White bass	1	2	2	5	2		1	3			1	1	9
Rock bass										1		1	1
Orangespotted sunfish	1			1					1		1	2	3
Bluegill	5		5	10	1	1	1	3			1	1	14
Largemouth bass	1		1	2						1	1	2	4
White crappie			1	1									1
Black crappie		2	1	3	1		4	5	1		1	2	10
Sauger		2		2	2			2					4
Walleye		1		1		2		2					3
Freshwater drum	7	3	2	12	2	3	4	9					21
Total number of individuals	28	31	26	85	21	17	29	67	13	6	13	32	184
Average number of individuals				28.3				22.3				10.7	20.4
Standard deviation (n − 1)				2.5				6.1				4.0	
Total number of species	12	10	12	20	9	6	11	14	6	4	8	11	24
Average number of species				11.3				8.7				7.7	9.2
Standard deviation (n − 1)				1.3				6.3				12.3	

normal 230 volts to 190 volts. In theory, if the voltage output of the 3,000-watt unit was the same as that of the 5,000-watt unit, the amperage draw would be the same and the sampling efficiency would be the same. This would occur only when the 3,000-watt unit could operate at near maximum rpm. It cannot be ascertained from this study whether the difference between the Coffelt system and the Homelite systems was a function of electrode array (single vs. three-phase current) or amperage. It probably was attributable to a combination of electrode array and amperage drawn. However, efficiency is not necessarily highest at the greatest current strength (Novotny and Priegel 1974).

We do not intend to give the impression that the Coffelt unit is inherently less efficient than the other two units. We chose to use the AC mode of this unit with approximately 230 volts of output and the designer's electrode array for our comparison. The amperage output under this configuration was approximately one-half that of the other two units. Had we increased the voltage or used pulsed DC, the relative efficiency between the three units might have been different (Novotny and Priegel 1974).

There are many uncontrollable parameters that affect the efficiency of electrofishing (Sullivan 1956; Kirkland 1965). However, it is essential in long-term monitoring programs to refrain from changing the electrofishing equipment unless relative efficiencies are known.

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