The hypothesis can be tested. I suggest a continuous-tape recording of the suspected sound at a low-loss dam and playing it back at a high-loss dam. If the recording were played on a week-on-week-off schedule it would soon become apparent whether or not the sound was warning the fish. The greatest technical difficulty of such a test would lie in recording and playing back the sound with adequate fidelity.

Another test would be possible if a replaceable lip could be made that would produce a laminar flow at a wooden dam or a turbulent flow at the concrete dams. This would have to be installed and removed easily and used on a week-on-week-off schedule. This would not prove that it is sound that repels the fish but it would show whether something about the contour of the lip was a factor in escape of fish.

I believe the findings of this study have extreme practical importance. Reservoirs of all sizes are being constructed at an increasing rate and if shape of spillway is an important factor in fish loss, it would seem prudent to learn all we can about it before building new dams.

Future researches would best be directed at answering the following questions: (1) Is shape of spillway the most important factor in fish loss as the Maryland results seem to show? If so, (2) is it sound that is the causative agent?, and (3) is escape of fish an important factor in fish management? Fish spilling over a dam may be desirable—it may be one way of keeping overabundant populations in check. On the other hand, fish that go over a dam are not available to the lake's fishermen.

ACKNOWLEDGMENTS

It must be obvious that this study could not have been made without competent and willing field workers. These people were furnished by the Maryland Department of Game and Inland Fish and were ably supervised by Guy S. Rogers, regional fish manager for the area. I am beholden to them.

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RESULTS OF SAMPLING THE FISH POPULATION OF AN 88-ACRE POND BY ELECTRICAL, CHEMICAL AND MECHANICAL METHODS

By ALBERT E. SANDERSON, JR.
Maryland Game and Inland Fish Commission

A comparison of four different gear for fish sampling was conducted in the summer of 1959 as part of Maryland's federal aid to fisheries program F1OR.

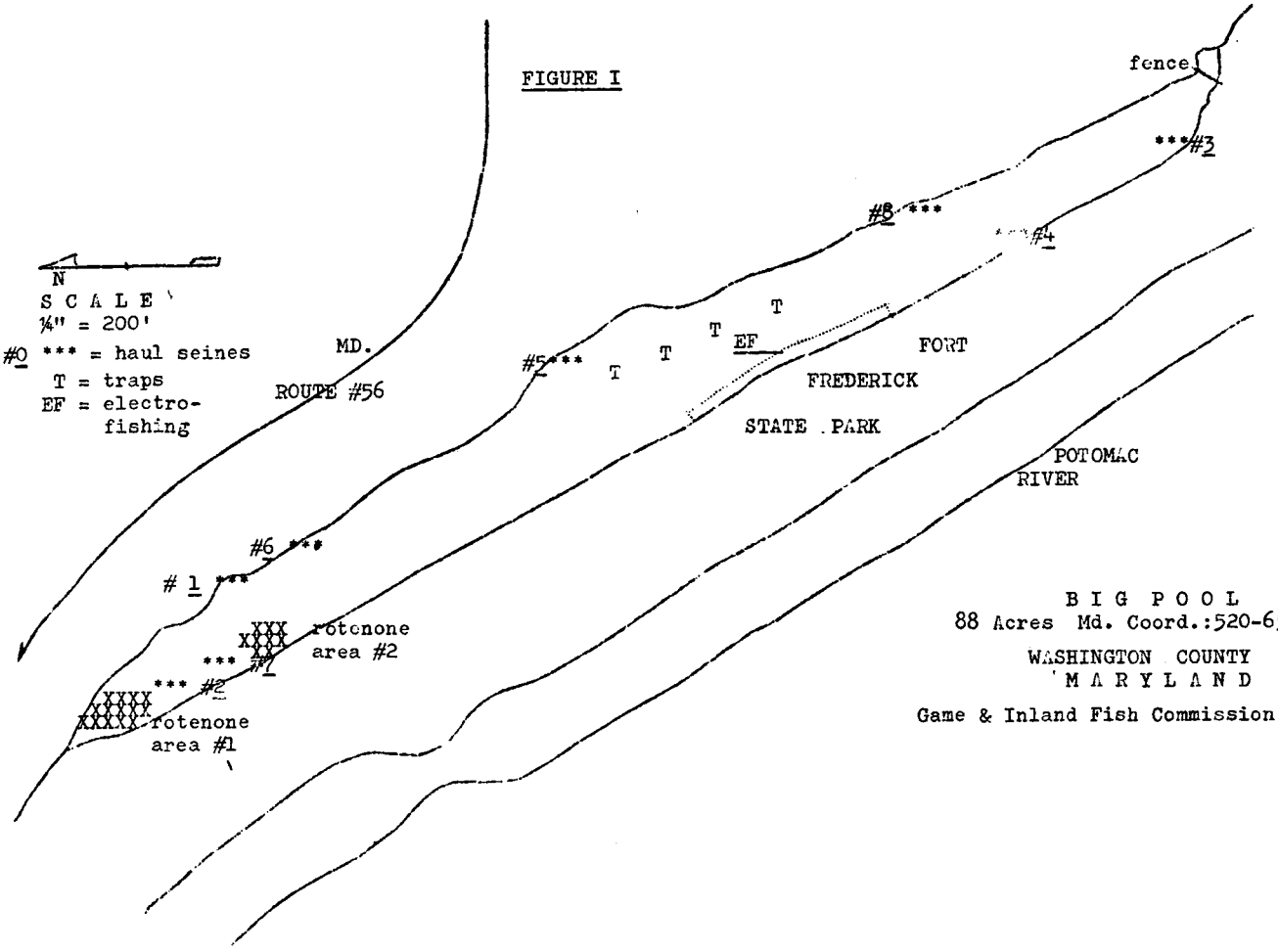
The tests were made at Big Pool, an 85 acre section of the Chesapeake and Ohio Canal which is land isolated from other watered sections. It is located 15 miles west of Hagerstown, Maryland. The average depth is 5½ feet, the maximum 14 feet.

Total hardness of Big Pool water was measured as 122 p.p.m. $CaCO_3$. The pH varied from 6.8 in the swampy northern end to 7.2 in mid-lake. Turbidity measurements using LaMotte standards were from 60 to 100 p.p.m. silica. Motorboating causes unusual wave action and resultant high turbidities along the immediate shoreline. (See Figure 1.)

Age and growth analyses revealed a stunted population of carp, white perch, crappie and bluegill (Sanderson, 1960)*

* Nomenclature from American Fish. Soc. Spec. Pub. No. 2, 1960.

FIGURE I



B I G P O O L
88 Acres Md. Coord.:520-650
WASHINGTON COUNTY
M A R Y L A N D
Game & Inland Fish Commission

METHODS AND MATERIALS

Electrofishing was conducted at night from a 15′ x 8′ barge having a standing platform equipped with railing against which crew members can safely lean while retrieving shocked fish with long-handled dipnets. The source of power was a 115-230 variable voltage combination A. C. generator rated at 2300 watts output. Five electrodes each 8 feet in length composed of ¾ inch outside diameter aluminum tubing were suspended from a boom mounted on the bow. A boom on the port and starboard sides of the boat supported the sixth and seventh electrodes. A 110 volt A. C. war surplus generator was used as a power source for illumination. Five swivel based flood lights served to light the electrified water. An 18 H. P. outboard was used to propel the electrofishing boat. A crew composed of four dipnetters and a boat operator handled electrofishing operations. The crew was protected from possible electrical shock by rubber boots and elbow-length rubber linemen's gloves. Safety switches for the generating units were mounted at the stern near the boat operator where they could be switched off immediately. Electrofishing was carried on at night because previous sampling (at Deep Creek Lake and other state waters) indicated that the number of fish collected per unit of effort is up to eleven times as great as during daylight. In Maryland waters the average length and weight of night-shocked fish is greater than that for those shocked during daylight. The area sampled by electrofishing was approximately ¾ acre and paralleled the shoreline. The average depth sampled by the shocker was 3 feet and the maximum 5½ feet.

Chemical sampling (rotenone) was conducted at two sites each ½ acre in size both near upper end of pool. The first sample was during daylight in water 3 feet deep; the second at night in water of 5½-foot average depth. (See Figure 1). In both instances nets were used to delimit the sample area and to prevent escape of fish. The net was hung from approximately one foot above the water line (on steel posts) to the bottom. Because the bottom contour of the two areas was level and had no obstructions, escape was prevented. Pronoxfish at a concentration of 1.5 p.p.m. was used. The chemical application was made by pumping, using a surface sprayer mounted on a 16-foot flat bottom barge. The nets were left in place for 24 hours following treatment to check for surviving fish. None were found. Because the chemical concentration was high and water temperatures were near 90° F. the kill was believed to be complete. Carp, which are quite resistant to rotenone, surfaced in distress within 15 minutes following application.

Four one-inch mesh "D"-frame modified catfish traps were employed as one of two mechanical type gear tested. The "D" traps are 6 feet in length and 2½ feet in width across the flat base. An outside funnel leads to an inside funnel which in turn leads to the pot. The opening of the inside funnel (9 inches in diameter), is equipped with a top-hinged slotted hardware-cloth door to minimize escape of fish once they have entered the pot. Traps were fished daily during June, July and August. Table I records the trap catches.

The other mechanical gear was a haul seine 100′ x 10′ with ⅜″ mesh. It was used to collect shoreline samples. Before seining it was necessary to remove sunken tree limbs, rusting oil drums, railroad ties and other debris from selected sites. Snag-free hauls only were used as samples. The area covered by 5 hauls was 2¼ acres.

TABLE I

RESULTS OF TRAPPING WITH MODIFIED, D-TYPE, CATFISH TRAPS: 1" WIRE MESH; DOUBLE FUNNEL

	JUNE					JULY				
Species	*No.*	*Total Wt. Lbs.*	*Av. Wt. Oz.*	*Av. Wt. Oz.*	*Av. Lgth. Inches*	*No.*	*Total Wt. Lbs.*	*Av. Wt. Oz.*	*Av. Wt. Oz.*	*Av. Lgth. Inches*
Bullhead	14	5	9.5	6.4	8.8	15	7	4.1	7.7	10.1
Crappie	565	42	9.2	1.2	5.4	623	49	1.0	1.3	5.1
Bluegill	14	1	7.8	1.6	5.1	87	7	3.4	1.3	4.8
Carp	2	1	1.3	8.6	10.6	3	1	11.5	9.1	11.2
Shiners	20	2	6.6	1.7	6.7	33	4	13.3	2.3	7.1
LM Bass	2	1	5.5	10.7	11.4	4	1	15.6	7.7	10.3
Pumpkinseed	..	..	..	..	..	1	0	0.8	..	..
White Perch	2	0	3.4	1.7	6.3	5	0	8.0	1.6	5.9
Sunfish	..	..	..	..	..	2	0	3.9	1.9	5.6
TOTALS	619	54	11.3	..	..	773	67	4.8	..	..

	AUGUST					SEASON TOTALS				
Species	*No.*	*Total Wt. Lbs.*	*Av. Wt. Oz.*	*Av. Wt. Oz.*	*Av. Lgth. Inches*	*No.*	*Total Wt. Lbs.*	*Av. Wt. Oz.*	*Av. Wt. Oz.*	*Av. Lgth. Inches*
Bullhead	8	5	8.0	11.1	13.1	37	18	5.6	7.9	10.9
Crappie	494	46	9.1	1.5	6.0	1,682	138	13.3	1.3	5.5
Bluegill	11	1	0.1	1.5	5.2	112	9	11.3	1.4	5.0
Carp	3	5	5.6	28.5	18.5	8	8	2.4	16.3	13.4
Shiners	3	0	6.7	2.3	7.1	56	7	10.6	2.2	7.0
LM Bass	2	0	9.1	4.5	7.6	8	3	4.2	6.5	9.8
Pumpkinseed	..	..	..	..	..	1	..	..	..	..
White Perch	5	0	7.2	1.4	5.8	12	1	2.6	1.6	6.0
Sunfish	..	..	..	..	..	2	..	3.9	2.0	5.6
TOTALS	526	59	13.8	..	..	1,918	181	13.9	..	..

RESULTS OF SAMPLING WITH THE FOUR GEAR

NUMERICAL DISTRIBUTION

Figure 2 shows the number of each species, by percent, taken by the four gear. White perch made the greatest contribution to the electrofishing catch. Carp was second. Third place in abundance was shared by bluegills and crappies.

Carp were first, in rotenone samples, comprising more than twice the number of crappies, which were second. Pumpkinseeds were third, followed closely by golden shiners and bluegills.

Black crappie dominated the "D"-trap catches, forming 88 percent of the total. The seven other species formed only 12 percent.

Black crappie were first in haul seine catches, followed by bluegill, golden shiner and white perch in that order.

WEIGHT DISTRIBUTION

Figure 3 shows the relative weight distribution of Big Pool species by percent for the four gear. For electrofishing, carp formed 55 percent of the weight, followed by largemouth bass, 16 percent. Black crappie and white perch each formed 8 percent of the total.

Carp formed almost three-fourths of the weight of rotenone samples (73%). Largemouth bass were second (12%) and golden shiners third (6.5%).

Black crappies dominated the weight of trap catches (72%). Brown bullheads (9.5%) and bluegills (6%) were second and third. Carp, which were fourth, formed only 4 percent of the weight.

Carp dominated the weight of haul seine samples (35%), with golden shiner second (23%). Crappie were a close third (22%). Bluegill and white perch were fourth and fifth (7.5% and 7%, respectively).

It was intended to reclaim Big Pool in late summer 1959 to check efficiency of the sampling methods but budgetary limitations prevented this until October 11, 1960. The Big Pool population was eradicated with rotenone powder (5%)

FIGURE 2

Numerical Distribution of Species in Big Pool Samples

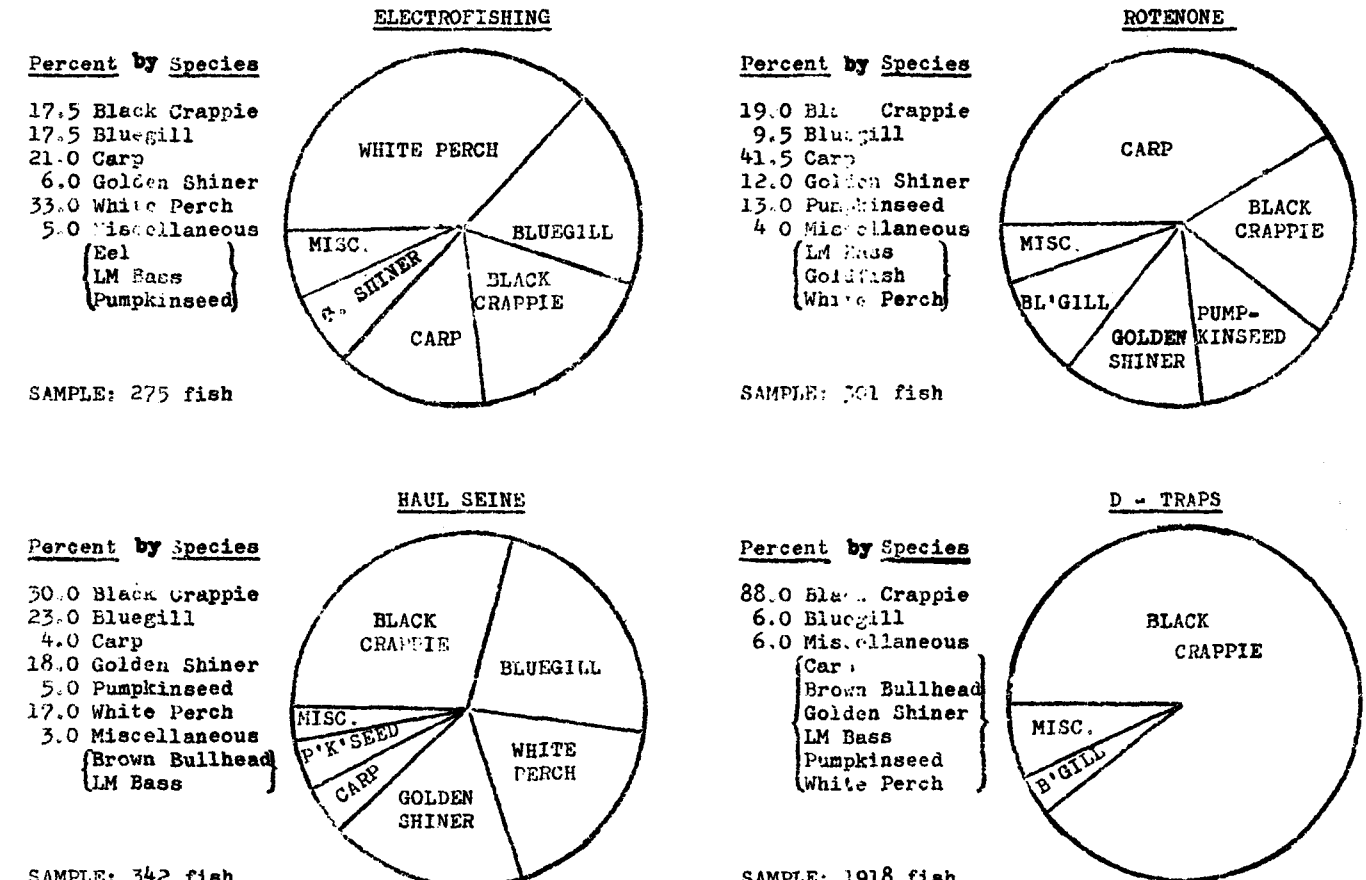


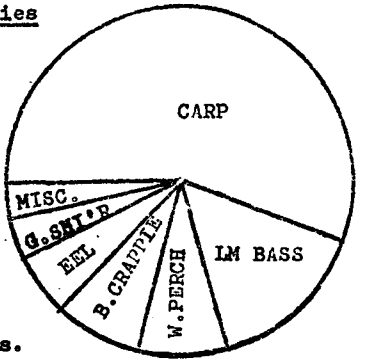
FIGURE 3

Weight Distribution of Big Pool Samples

ELECTROFISHING

Percent by Species

8.0 Black Crappie
55.0 Carp
5.0 Eel
4.0 Golden Shiner
16.0 Largemouth Bass
8.0 White Perch
4.0 Miscellaneous
{Bluegill
{Pumpkinseed

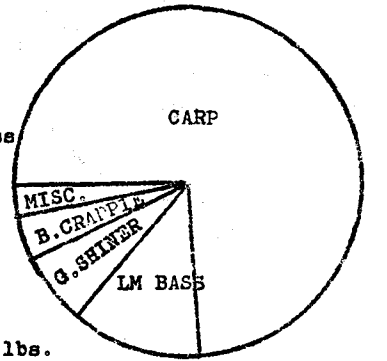


SAMPLE WEIGHT: 50 lbs.

ROTENONE

Percent by Species

5.0 Black Crappie
73.0 Carp
6.0 Golden Shiner
12.0 Largemouth Bass
4.0 Miscellaneous
{Bluegill
{Goldfish
{Pumpkinseed
{White Perch

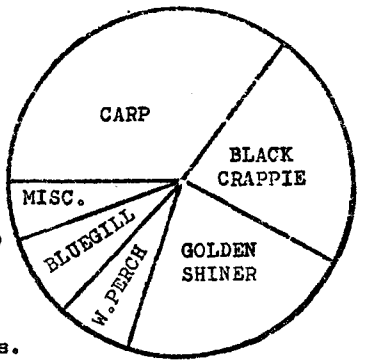


SAMPLE WEIGHT: 146 lbs.

HAUL SEINE

Percent by Species

22.0 Black Crappie
7.0 Bluegill
35.0 Carp
23.0 Golden Shiner
7.0 White Perch
6.0 Miscellaneous
{Brown Bullhead
{Largemouth Bass
{Pumpkinseed

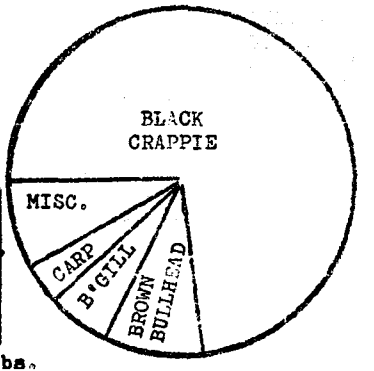


SAMPLE WEIGHT: 51 lbs.

D - TRAPS

Percent by Species

72.0 Black Crappie
6.0 Bluegill
4.0 Carp
9.5 Brown Bullhead
8.5 Miscellaneous
{Catfish
{Golden Shiner
{Largemouth Bass
{Pumpkinseed
{White Perch
{Yellowbelly
{Sunfish



SAMPLE WEIGHT: 182 lbs.

at a concentration of about 0.5 p.p.m. Table II is the estimated weights of fish taken on the first day only.† Length frequencies of Pool species were very much like those from the previous chemical sampling in 1959. The rank by weight for the 1959 sample and the 1960 reclamation was the same—carp first, largemouth second and golden shiner third.

Table III indicates rank by weight for the four samples and the reclamation.

TABLE II

BIG POOL—RECLAMATION

ESTIMATED WEIGHTS OF FISH TAKEN BY ROTENONE, TUESDAY, OCTOBER 11, 1960

Species	*Total Pounds*	*Percent*
Carp	10,818	94.4
Largemouth Bass	280	2.4
White Perch	79	.7
Golden Shiners	116	1.0
Black Crappies	97	.8
Bluegills	6	.1
Pumpkinseed	1	*
Yellowbelly Sunfish	2	*
Brown Bullheads	9	.1
Chain Pickerel	19	.2
Eel	33	.3
White Suckers	1	*
Goldfish	6	.1
TOTALS	11,467	100.1

TABLE III

RANK BY WEIGHT

-	*Chemical*	*Electro-fishing*	*D Traps*	*Seine*	*Reclamation*
First	Carp	Carp	BC	Carp	Carp
Second	LMB	LMB	BB	GS	LMB
Third	GS	WP=BC	Bg	BC	GS

ABBREVIATIONS:

BB—Brown Bullhead
BC—Black Crappie
Bg—Bluegill
GS—Golden Shiner
LMB—Largemouth Bass
WP—White Perch
Carp—Carp

LENGTH FREQUENCIES

Lengths of fishes taken by the various sampling methods were compared. For black crappie all four methods indicated the strongest class was the 5.5 to 6.0 inch group. There was a noticeable lack of harvestable size crappies in all four samples. Reclamation of the lake revealed there were very few harvestable size crappie over 8.0 inches in length. (See Figure 4.)

The length frequencies of blugills captured by the four methods reveals the effect of the one-inch mesh size of the "D" traps. Small bluegills (under 4.0 inches) were not represented in the proportions in which they were found in the other samples. (See Figure 5.) Haul seining produced the largest proportion of young-of-the-year bluegills. Bluegills were affected by electrofishing and rotenoning, but their recovery, which was dependent upon sight, was proportionately less. High turbidities frequently make sighting of small fishes difficult and thus affects the proportion of small to larger fish in the sample. With a haul seine of proper mesh all small fishes caught by the gear can be recovered. Electrofishing gear, which can cover extensive areas in a short space of time can often be used to locate concentrations of young-of-the-year fishes.

† Courtesy Harold J. Elser, Maryland Department of Research and Education.

FIGURE 4
Length frequencies for Black Crappie, Pomoxis nigromaculatus.

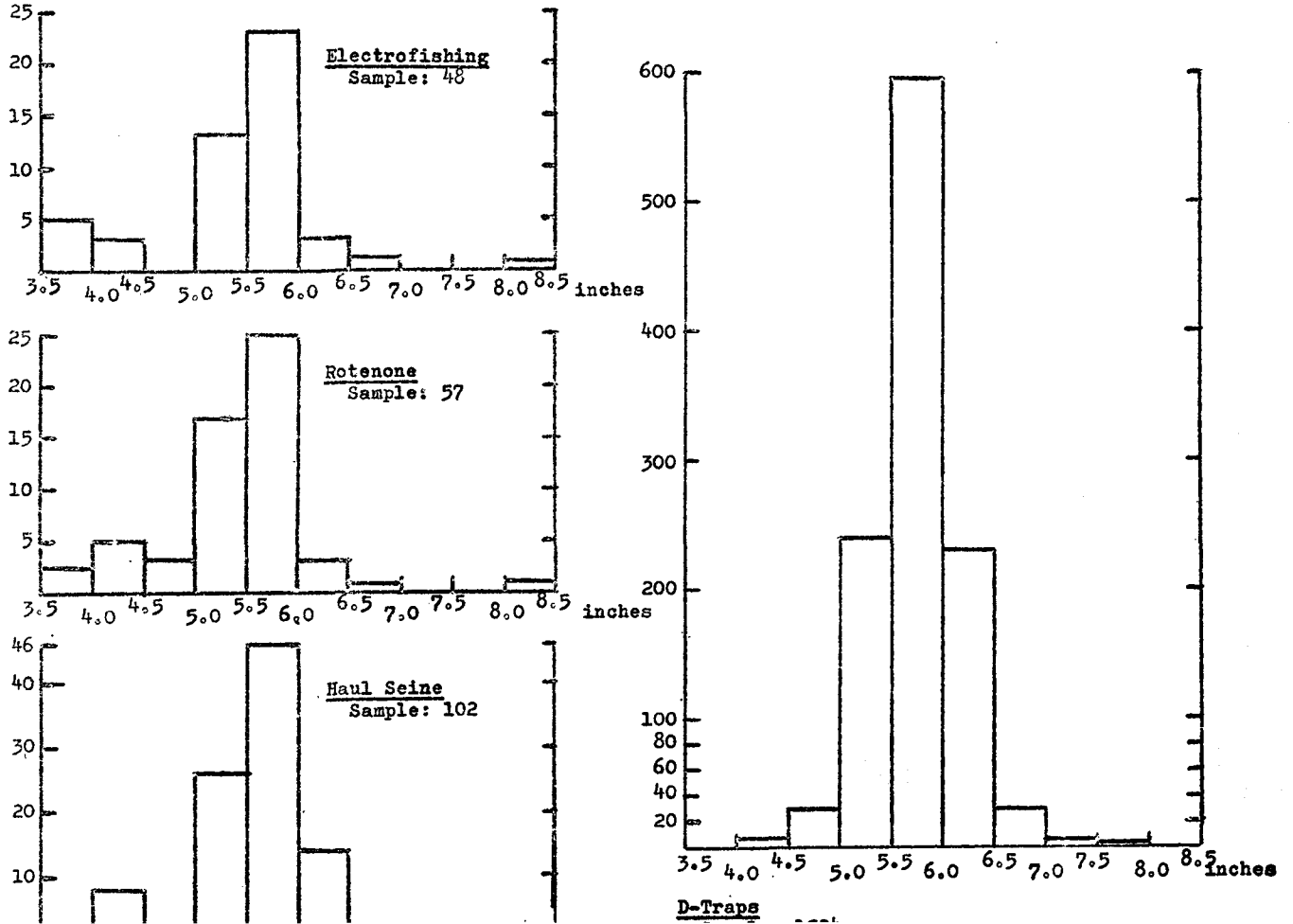
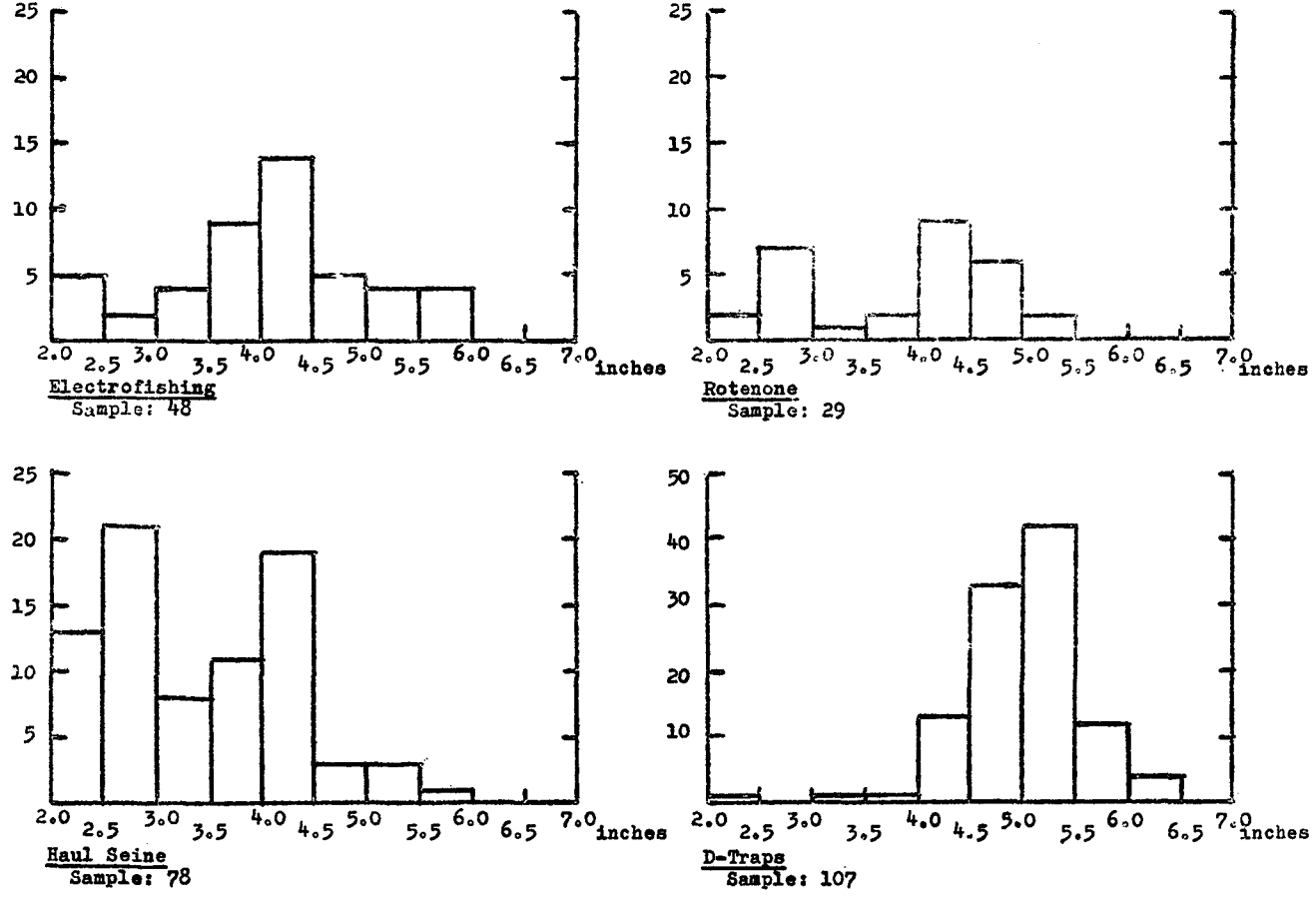


FIGURE 5

Length frequencies for Bluegill, Lepomis macrochirus.



For golden shiner, shown in Figure 6, the four methods indicated a scarcity of young-of-the-year and yearling golden shiner which might serve as forage for Big Pool's predaceous fish. There were also very few young-of-the-year and yearling golden shiners when the Pool was reclaimed.

Chemical sampling and electrofishing produced larger numbers of carp than haul seining and "D" traps. Length frequencies, for the four methods shown in Figure 7, indicated the absence of young-of-the-year carp. Carp had extremely poor condition factors in 1959 and in 1960. Based upon time units, more carp were taken by electrofishing than by the other gears. While rotenone is believed to have killed all the carp in the sample areas tested, it is known that some shocked carp, still alive, escaped capture in the electrofishing area.

Figure 8 reveals the problem biologists face when taking samples from small areas (two one-half acre samples in this test) with rotenone or other fish toxicants. Wandering school fishes like white perch, gizzard shad, striped bass, white bass and yellow perch may not be represented in proportion to their abundance because they may or may not be present at the time. Electrofishing and haul seining produced more white perch than rotenone or "D" traps.

Figures 9 and 10 give length frequencies for pumpkinseed and brown bullhead. These species were not abundant in Big Pool as shown by the sampling gears nor were they found to be abundant upon reclamation.

In this trial of four gear the weight percentages for major ranking species varied according to the sample method used. The rotenone sample was most like the reclaimed population. Electrofishing was second in similarity, haul seining third and "D" traps fourth.

Length frequencies recorded from the different samples showed variations attributable to the design, structure and operation of the individual gear.

The numerical composition by species varied greatly among the four gear.

DISCUSSION

Surber (1959) and Carter (1958) have stated reasons for collecting fish population data by rotenone sampling. They are: (1) determination of species composition, (2) standing crop, (3) abundance of adult fish, (4) success of natural reproduction and (5) knowledge of year class strength.

Jenkins (1958) stated the need for refinements of estimates of the size and composition of fish populations. Jenkins also stressed the need for statistical treatment and presentation. Surber (1959), representing the Reservoir Committee of the Southern Division, Am. Fish. Soc. has suggested a standard method for summarizing fish population data for reservoirs.

The importance of determining the ratios of game fishes to rough fishes in impoundments has been emphasized by Eschmeyer, Stroud and Jones (1944), Larrywell (1945) and Hall (1951).

SUMMARY

This trial of four gear suggests that rotenone sampling gave the best results in Big Pool.

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Sanderson, Albert E. 1960. Age and Growth Rates of Big Pool Fishes. Job No. 2, Proj. F1OR2, Game and Inland Fish Commission, Annapolis, Md.

Suber, Eugene W. 1959. Standard Methols of Reporting Fish Population Data for Reservoirs. Branch of Federal Aid, Bureau of Sport Fisheries and Wildlife, Atlanta, Ga., pp. 19.

FIGURE 6

Length frequencies for Golden Shiner, Notemigonus crysoleucas.

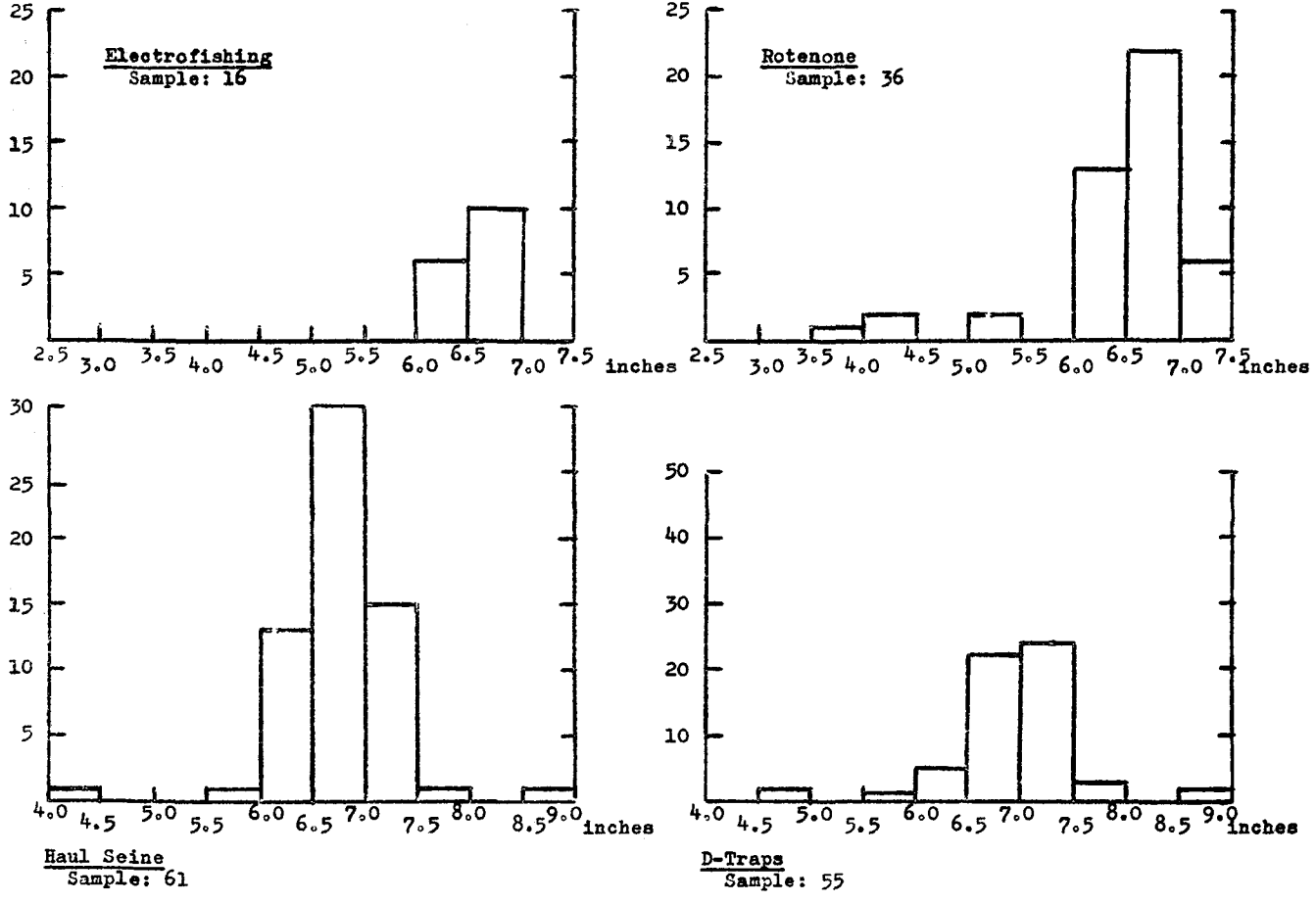
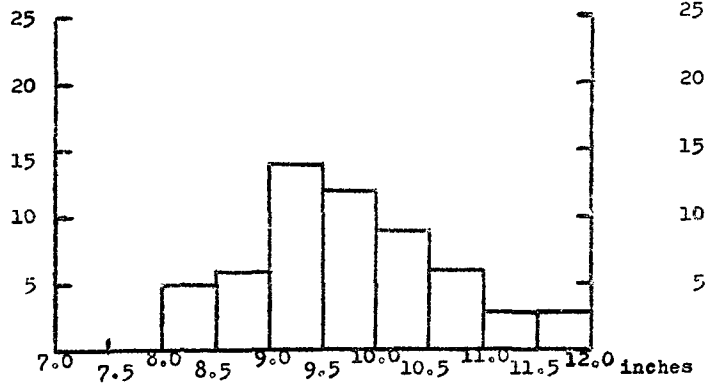
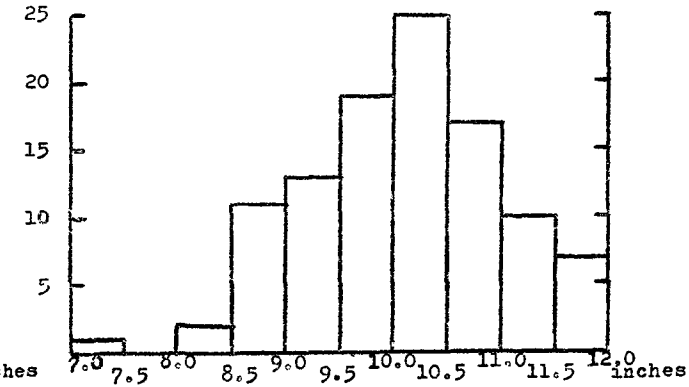


FIGURE 7

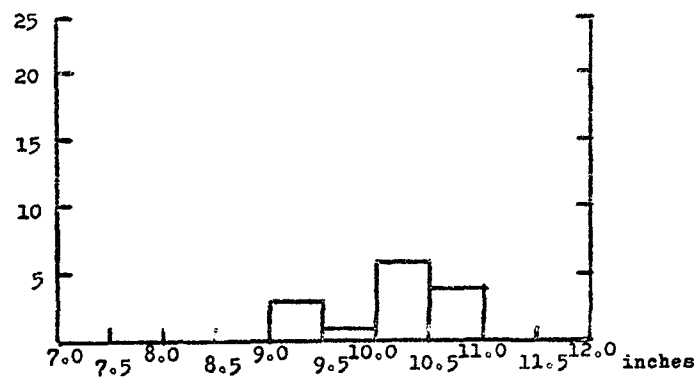
Length frequencies for Carp, Cyprinus carpio.



Electrofishing
Sample: 58

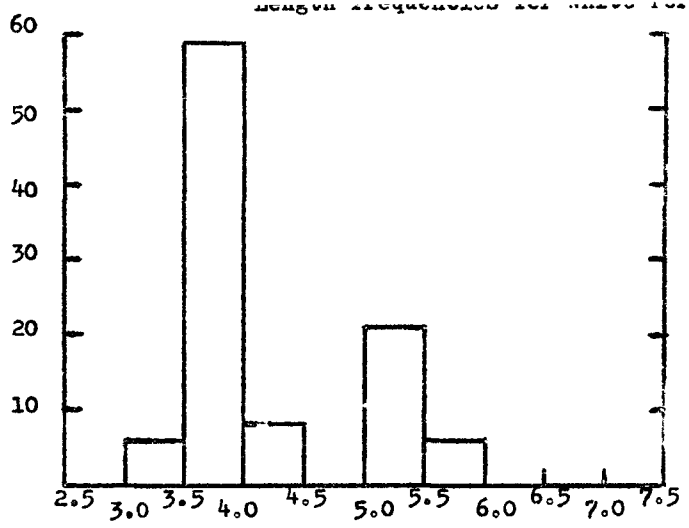


Rotenone
Sample: 125



Haul Seine
Sample: 14

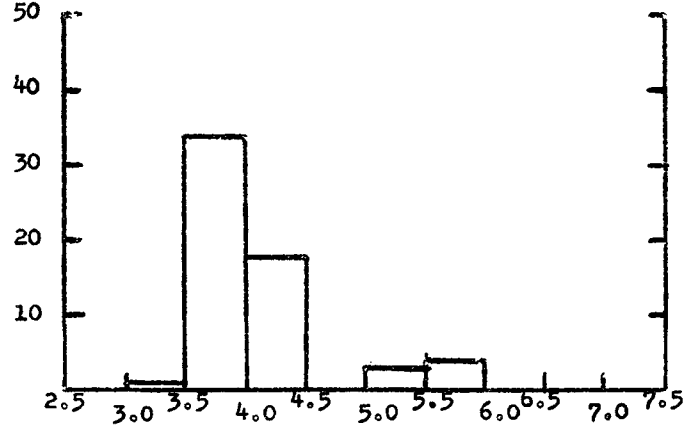
D-Traps
Sample: 11 Range: 9.6-20.0+ inches



Rotenone
Sample: 1 Range: 4.6-5.0 inches

D-Traps
Sample: 9 Range: 5.1-6.5 inches

Electrofishing
Sample: 92



Haul Seine
Sample: 60

FIGURE 9

Length frequencies for Pumpkinseed, Lepomis gibbosus.

Electrofishing
Sample: 9 Range: 2.6-5.0 inches

Haul Seine
Sample: 17 Range: 2.8-5.0 "

D-Traps
Sample: 3 Range: 4.1-4.5 "

Rotenone
Sample: 40

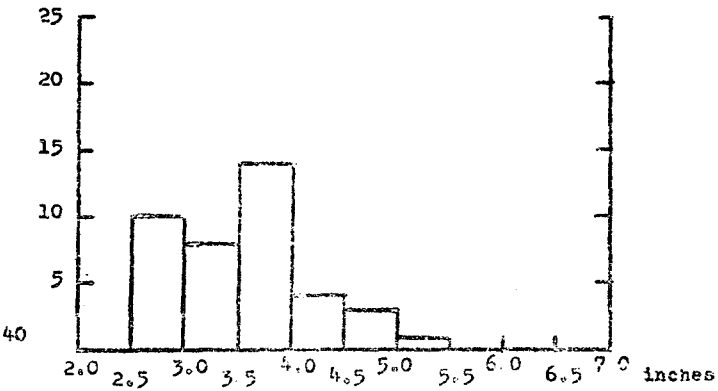


FIGURE 10

Length frequencies for Brown Bullhead, Ameiurus nebulosis.

Electrofishing
Sample: none

Haul Seine
Sample: 3 Range: 4.1-9.0 inches

Rotenone
Sample: none

D-Traps
Sample: 36