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A COMPARISON OF FISH POPULATION SAMPLING TECHNIQUES ON LAKE RAYMOND GARY, OKLAHOMA[1] [2]

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ABSTRACT

Five types of fish population sampling gear were intensively fished in a 263 acre Oklahoma reservoir. The relative species compositions are compared, both between and within sampling methods and with bag seine samples taken at draining.

A method using accumulative percentages for determining the length of time necessary to sample a population with specific gear to estimate species composition is described.

Bated and unbaited nets had similar catch rates and species composition. Bluegill were more vulnerable to seine hauling during daylight hours than seine hauling at night. Gill nets failed to produce sufficient numbers of fish for statistical analysis, but larger mesh sizes captured flathead catfish and freshwater drum missed by most of the other types of gear. Small mesh gill nets revealed essentially the same species composition as rotenone and shocker samples. Trap nets caught white crappie in greater proportion than their numbers in the population. Shocker collections exhibited nocturnal increases in catch rates of redear sunfish, but not of bluegill, warmouth, or largemouth bass.

INTRODUCTION

A planned drawdown of Raymond Gary Lake, Oklahoma, provided an unusual opportunity to evaluate selectivity of gear used to sample reservoir fish populations. From March to August, 1967, intensive samples were taken with a variety of gear and the results compared with bag seine samples taken during draining.

General lake surveys are conducted by fishery biologists to obtain basic data from which management recommendations can be drawn. Reliable data can provide the basis for opening dates, restriction or liberalization of creels, correction of fish population imbalance, and needed research.

Some state and federal agencies have standard procedures for general fish population surveys and further standard procedures for interpreting data collected. In Oklahoma, standardization is limited to sampling gear. It is not known to what extent data is duplicated within the types of gear utilized. This report is intended to point out where overlapping of data occured in this study and suggests a method to determine the length of time necessary to sample a population with specific gear to estimate species composition. Also, it is hoped these data will be helpful in establishing standard lake sampling procedures in Oklahoma.

[1]Prepared for presentation to the 22nd Annual Meeting of the Southern Division, American Fisheries Society, Baltimore, Maryland.
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DESCRIPTION OF STUDY AREA

Raymond Gary Lake is a 263 acre impoundment located in Southeast Oklahoma (Figure 1). This lake was constructed in 1955 with recreation as the primary purpose.

The lake was formed by impounding Gates Creek in Section 31, Township 6 South, Range 20 East, Choctaw County, three miles southeast of Ft. Towson, Oklahoma. Gates Creek is a spring fed tributary which joins the Kiamichi River three miles south of the Raymond Gary dam. Annual rainfall for this area is forty-four to forty-six inches and the watershed consists of fifty-six square miles. Reservoir water levels normally flucuate two feet during spring rains.

Approximately seventy-five percent of the reservoir area is less than twelve feet in depth with a maximum depth of twenty-two feet (Figure 1). Prior to inundation, most trees within the basin were felled and remain in the reservoir.

MATERIALS AND METHODS

Fish were collected by the use of gill nets, trap nets, cylindrical traps, rotenone, seines, and a boat mounted electro-fishing device. The common and scientific names of the fishes collected, as accepted by the American Fisheries Society (1960), are given in Table 1.

All fish collected were identified to species, total length taken to the nearest one-tenth inch, and weighed to the nearest one-tenth pound. In samples with large numbers of fish of the same species, aggregate weights by inch class groups were taken.

Gill Nets

Standard 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, and 5.0 inch square mesh, sinking nylon gill nets were used. All gill nets were hung on a 3/5-basis, with eight-foot webbing hobbled to six feet in depth. All gill nets were three-hundred feet in length with the exception of 1.5 inch mesh nets, which were one-hundred feet in length.

Eleven stations representing virtually all habitats were selected and maintained as gill net sampling stations throughout the study (Figure 1). All net sets were perpendicular to and as near the shoreline as possible. Each mesh size was fished a total of thirty net-days between March 15 and May 15; a net-day being a twenty-four hour set. Generally, the nets were fished four net-days, then removed for cleaning and repair during the weekend. Nets were reset the following Monday at different stations. In this manner all mesh sizes were fished at each sampling station.

Trap Nets

Two 4-foot and two 10-foot trap nets were used for this study. They were similar in design to that described by Crowe (1950) but were constructed with only one "pot". Trap net stations were selected prior to and maintained throughout the study (Figure 1).

Both sizes were fished a total of thirty net-days; a trap net-day being one twenty-four hour set. Trap nets were unattended on weekends and Monday lifts were considered to represent three net-days catch. The sampling period was March 15 to May 5 inclusive.

One-half of the trap nets were baited to determine if this practice would increase catches. Baiting consisted of inserting pressed cottonseed cake into the "pot" section of the traps and broadcasting cake along the "leader". Approximately ten pounds of cake was used at each set; however, additional cake was added as needed. One trap of each size was baited for one week (four trap net-days). At the end of this period any remaining bait was removed and the alternate traps baited.

Cylindrical Traps

Collapsible nylon fish traps (Houser, 1960) were set at stations that were selected prior to and maintained throughout the study (Figure 1).

Traps were set parallel to the shoreline and in depths ranging from three to six feet. Five traps were baited daily with approximately five pounds of pressed cotton seed cake and five traps were fished unbaited. A net-day was a twenty-four hour set. Sampling by this method began March 16, and concluded May 9.

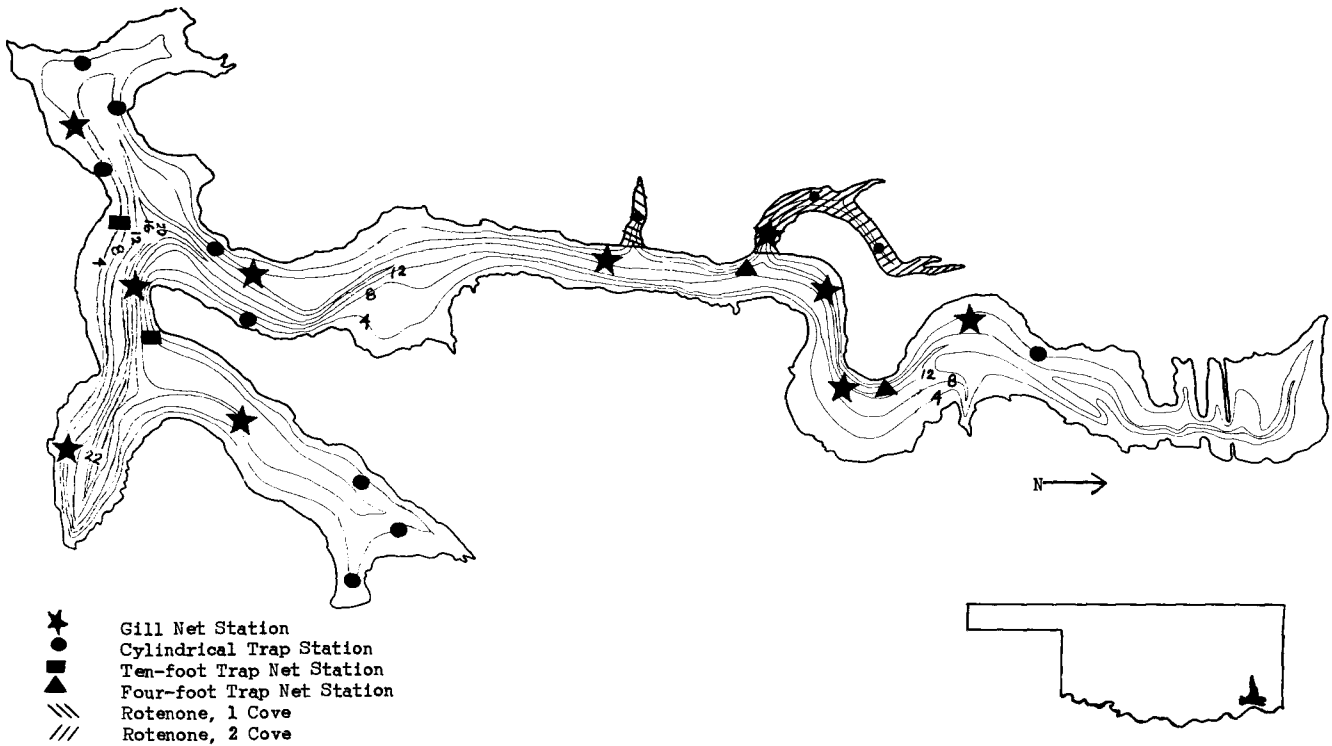

Figure. 1. Raymond Gary Lake.

TABLE 1.
A checklist of fishes, Raymond Gary Lake, 1967.

Common Names	*Scientific Names*
Grass pickerel	*Esox americanus vermiculatus* LeSueur
Goldfish	*Carassius auratus* (Linnaeus)
Carp	*Cyprinus carpio* Linnaeus
Golden shiner	*Notemigonus crysoleucas* (Mitchill)
Redfin shiner	*Notropis umbratilis* (Girard)
Fathead minnow	*Pimephales promelas* Rafinesque
Spotted sucker	*Minytrema melanops* (Rafinesque)
Redhorse sucker sp.	*Moxostoma* sp.
Black bullhead	*Ictalurus melas* (Rafinesque)
Yellow bullhead	*Ictalurus natalis* (LeSueur)
Channel catfish	*Ictalurus punctatus* (Rafinesque)
Tadpole madtom	*Noturus gyrinus* (Mitchill)
Flathead catfish	*Pylodictis olivaris* (Rafinesque)
Blackstripe topminnow	*Fundulus notatus* (Rafinesque)
Mosquitofish	*Gambusia affinis* (Baird and Girard)
Pirate perch	*Aphredoderus sayanus* (Gilliams)
Warmouth	*Chaenobryttus gulosus* (Cuvier)
Green sunfish	*Lepomis cyanellus* Rafinesque
Bluegill	*Lepomis macrochirus* Rafinesque
Longear sunfish	*Leopmis megalotis* (Rafinesque)
Redear sunfish	*Lepomis microlophus* (Günther)
Spotted sunfish	*Lepomis punctatus* (Valenciennes)
Largemouth bass	*Micropterus salmoides* (Lacépéde)
White crappie	*Pomoxis annularis* Rafinesque
Black crappie	*Pomoxis nigromaculatus* (LeSueur)
Log perch	*Percina caprodes* (Rafinesque)
Freshwater drum	*Aplodinotus grunniens* Rafinesque
Brook silversides	*Labidesthes sicculus* (Cope)

Rotenone

The two coves selected for rotenone samples were 1.2 and 2.9 surface acres (Figure 1). A block-off net (Lambou, 1959), 210-feet long was used to delimit the sample areas.

Pro-Noxfish rotenone (2½ percent active) was applied at the rate of one part per million to each study area. The toxicant was dispensed in the prop-wash of an outboard motor to insure even distribtuion.

Fish picked up on the first and second days were identified and treated as in other methods. Third day efforts were confined to visual counts due to decomposition of fish. Sampling on Cove 1 began June 27, and concluded June 29. Cove 2 sampling began June 29, and concluded July 1.

Seines

Two types of nylon seines were utilized in this study: one 40' x 4' with 3/16 inch Delta mesh, straight seine, and a 50' x 6' with 1/4 inch King mesh, bag seine with a 6' x 6' bag.

All seine hauls were made by the quadrant method. A total of ninety-six hauls were made with each seine, representing four hauls per seine for every hour of a twenty-four hour period. The purpose was to determine if daily periodicities were evident. Sampling by this method began June 19, and concluded June 23.

Electrofishing

The electro-fishing device used in this study was boat mounted with three flexible conduit electrodes suspended from booms mounted on the bow of the boat as described by Ming (1964). The electrical current was produced by a Homelite, 180

cycle, three-phase generator. Two-hundred and twenty volts at 6.5 amps were used in collecting fish. A total of ninety-six hours shocking time was conducted. This represented four hours shocking for every hour of a twenty-four hour period to determine daily periodicities. Sampling by this method began May 30, and concluded June 14.

Draining

An expanded metal grate was placed over the forty-eight inch outlet tunnel on the lake side of the dam. This allowed passage of the water from the lake and prevented all but very small fish from emigrating. Thirteen days were required to drain the lake into the original creek channel. Samples were taken with the fifty foot bag seine described above. Fish were removed as they concentrated at the outlet structure. A total of 1,249.7 pounds of fish were removed from the lake in a period of six hours (Table 14).

RESULTS

Gill Nets

The species taken in gill nets and their relative abundance varied with mesh size of the net. Nets smaller than three inches caught a wide range of the species numerically most abundant in the lake (Table 2). Spotted suckers were taken in large numbers by two inch mesh nets early in the study. This was related to spawning activities in the headwaters of the lake. Nets with mesh size of two inches and larger were effective in capturing channel catfish, flathead catfish, carp, and largemouth bass (Tables 3, 4). All of the gill nets captured relatively few fish (Table 5). The 1.5 and 2.0 inch nets caught an abundance of sunfish; however, this segment of the population was also adequately sampled by shocking and trap nets. The combined gill net samples gave a good indication of species composition, but this was accomplished only with a large expenditure of effort. There was no significant correlation (Kendall's tau, Wilcoxin and Wilcox, 1964) between the relative ranks of the species taken among different net sizes. More redear sunfish than bluegill were caught by gill nets in the study. It is felt this was due to the larger size and deep water preference of redear sunfish.

TABLE 2.
Catch composition and summary of 1.5 and 2.0-inch gill nets, Raymond Gary Lake, 1967.

	1.5 – INCH GILL NET				*2.0 – INCH GILL NET*			
Species	*Number*	*Percent*	*Pounds*	*Percent*	*Number*	*Percent*	*Pounds*	*Percent*
Carp	2	.3	4.6	2.2	2	.9	14.7	2.8
Golden shiner	2	.3	tr	tr	–	–	–	–
Spotted sucker	7	1.2	13.2	6.4	90	41.0	324.5	62.5
Redhorse sp.	1	.1	3.2	1.5	4	1.9	17.6	3.4
Black bullhead	3	.5	1.9	1.0	16	7.3	32.0	6.8
Yellow bullhead	6	1.1	3.5	1.7	5	2.2	3.4	.6
Channel catfish	1	.1	2.4	1.1	16	7.3	58.4	11.2
Flathead catfish	–	–	–	–	1	.4	2.5	.4
Warmouth	2	.3	.9	.4	–	–	–	–
Bluegill	223	37.6	55.2	27.2	17	7.7	4.2	.8
Longear sunfish	1	.1	.2	.1	–	–	–	–
Redear sunfish	321	54.1	98.3	48.4	22	10.0	6.5	1.2
Largemouth bass	5	.8	10.1	4.9	5	2.2	17.0	3.3
White crappie	19	3.2	10.0	4.9	39	17.8	36.4	7.1
Black crappie	–	–	–	–	2	.9	2.0	.3
Totals	593	100.0	203.5	100.0	219	100.0	519.2	100.0

TABLE 3.
Catch composition and summary of 2.5 and 3.0-inch gill nets, Raymond Gary Lake, 1967.

	2.5 – INCH GILL NET				*3.0 – INCH GILL NET*			
Species	*Number*	*Percent*	*Pounds*	*Percent*	*Number*	*Percent*	*Pounds*	*Percent*
Goldfish	2	2.3	3.6	1.2	1	5.0	3.4	4.4
Carp	5	5.7	47.7	15.8	2	10.0	17.2	22.6
Spotted sucker	16	18.4	56.9	18.8	–	–	–	–
Redhorse sp.	1	1.4	3.5	1.2	1	5.0	4.4	5.8
Black bullhead	4	4.6	9.3	3.1	–	–	–	–
Channel catfish	27	31.0	126.8	42.0	6	30.0	30.3	39.8
Flathead catfish	5	5.7	18.1	6.0	2	10.0	11.7	15.3
Warmouth	–	–	–	–	1	5.0	.1	.1
Bluegill	5	5.7	.9	.3	–	–	–	–
Redear sunfish	1	1.1	.3	.1	–	–	–	–
Largemouth bass	2	2.3	7.4	2.4	2	10.0	4.8	6.3
White crappie	17	19.5	21.3	7.1	5	25.0	4.3	5.6
Black crappie	1	1.1	.8	.3	–	–	–	–
Freshwater drum	1	1.1	5.4	1.8	–	–	–	–
Totals	87	100.0	302.0	100.0	20	100.0	76.2	100.0

TABLE 5.
Catch composition and summary of all gill nets, Raymond Gary Lake, 1967.

Species	*Number*	*Percent*	*Pounds*	*Percent*
Goldfish	5	.52	14.7	1.00
Carp	20	2.05	240.7	15.59
Golden shiner	2	.20	tr.	tr.
Spotted sucker	116	11.88	404.8	26.24
Redhorse sucker	7	.71	28.7	1.86
Black bullhead	24	2.46	45.4	2.94
Yellow bullhead	11	1.12	6.9	.44
Channel catfish	68	6.96	340.8	22.08
Flathead catfish	14	1.43	85.1	5.51
Warmouth	3	.31	1.0	.07
Bluegill	245	25.08	60.3	3.90
Longear sunfish	1	.10	.2	.01
Redear sunfish	344	35.20	105.1	6.81
Largemouth bass	24	2.46	98.2	6.36
White crappie	87	8.90	77.9	5.04
Black crappie	3	.31	2.8	.18
Freshwater drum	3	.31	30.4	1.97
Totals	977	100.00	1,543.0	100.0

Trap Nets

When trap nets are used by fishery management biologists to estimate species composition in lakes, there is always a question of when an adequate sample has been taken. Jenkins (1958) discussed a similar problem in connection with population estimates and presented graphs showing the stabilizing of the Schnabel type estimate with increasing samples. To determine if this graphical method would be useful for analysis of species composition, the accumulative percent for species composition was plotted against time for all four trap net methods used. In each case, a leveling off of the estimates occurred. This suggests that a fishery manager, desirous of

TABLE 4.
Catch composition and summary of 3.5, 4.0 and 5.0 gill nets, Raymond Gary Lake, 1967.

	3.5 – INCH GILL NET				*4.0 – INCH GILL NET*				*5.0 – INCH GILL NET*			
Species	*No.*	*Percent*	*Lbs.*	*Percent*	*No.*	*Percent*	*Lbs.*	*Percent*	*No.*	*Percent*	*Lbs.*	*Percent*
Goldfish	1	3.0	3.8	2.2	1	5.0	3.9	1.9	–	–	–	–
Carp	1	3.0	12.8	7.4	6	30.0	98.7	50.0	2	40.0	45.0	60.9
Spotted sucker	3	9.0	10.2	5.9	–	–	–	–	–	–	–	–
Black bullhead	1	3.0	2.2	1.2	–	–	–	–	–	–	–	–
Channel catfish	11	33.3	63.1	37.0	6	30.0	54.0	27.7	1	20.0	5.8	7.8
Flathead catfish	2	6.0	12.0	7.0	3	15.0	22.2	11.2	1	20.0	18.6	25.1
Largemouth bass	6	18.1	36.5	21.3	3	15.0	17.8	9.0	1	20.0	4.6	6.2
White crappie	6	18.1	5.2	3.1	1	5.0	.7	.4	–	–	–	–
Freshwater drum	2	6.0	25.0	14.1	–	–	–	–	–	–	–	–
Totals	33	100.0	170.8	100.0	20	100.0	197.3	100.0	5	100.0	74.0	100.0

estimating species composition by trap netting, plot such a relationship and cease netting when the accumulative percent composition appears to have stabilized (Figures 2, 2-A, 3, 3-A). There is a relationship between the numbers of fish caught, the percentage a species represents in the population, and the amount of netting effort needed to estimate species composition.

Baited and unbaited traps provided an opportunity to determine if baiting changed the species composition or improved the catch. In terms of total numbers and pounds caught, the ten-foot trap net catches were nearly identical. The baited traps produced 10,241 fish weighing 1,980 pounds and unbaited traps produced 10,197 fish weighing 1,939 pounds (Table 6). Catches with the four-foot trap nets

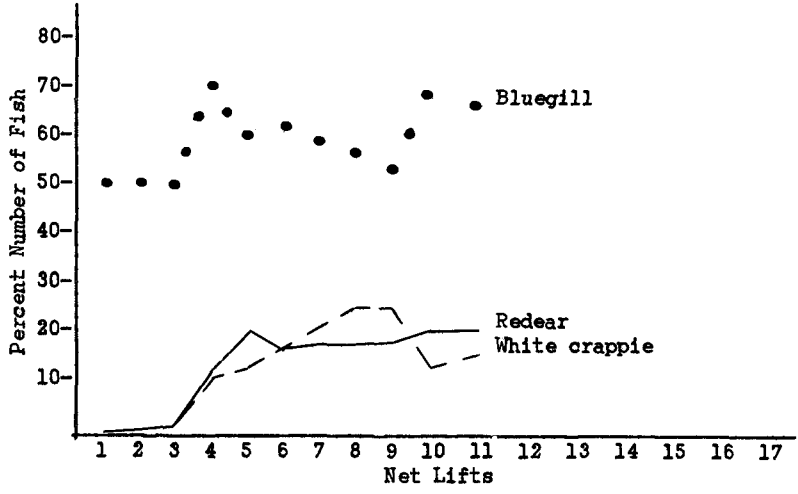

Figure 2. Accumulative percentages of catch versus time for baited, four foot trap net, Raymond Gary Lake, 1967.

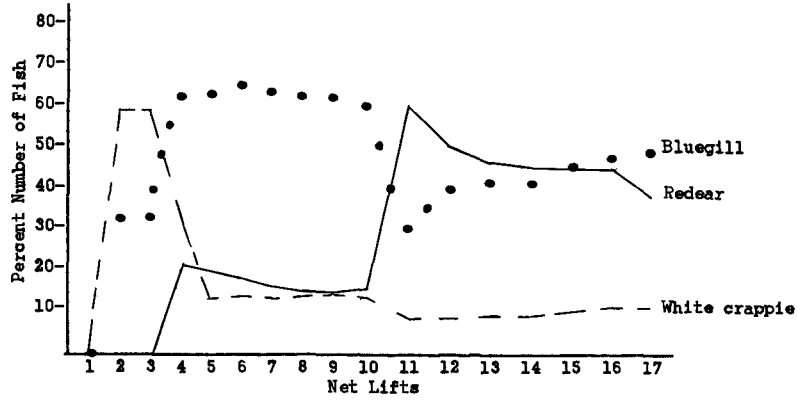

Figure 2-A. Accumulative percentages of catch versus time for unbaited, four foot trap net, Raymond Gary Lake, 1967.

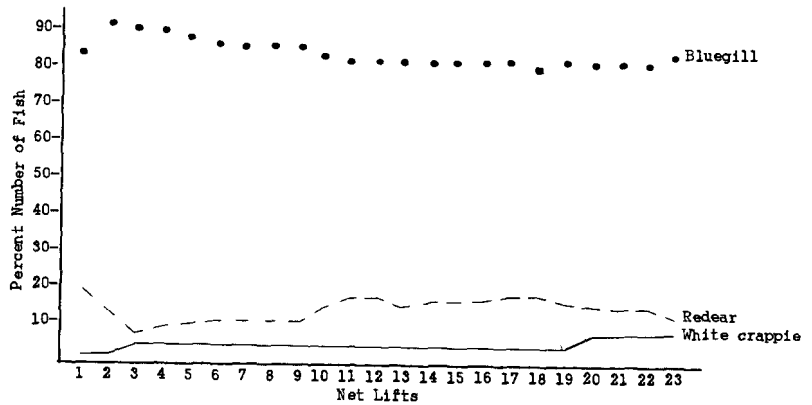

Figure 3. Accumulative percentages of catch versus time for baited, ten foot trap net, Raymond Gary Lake, 1967.

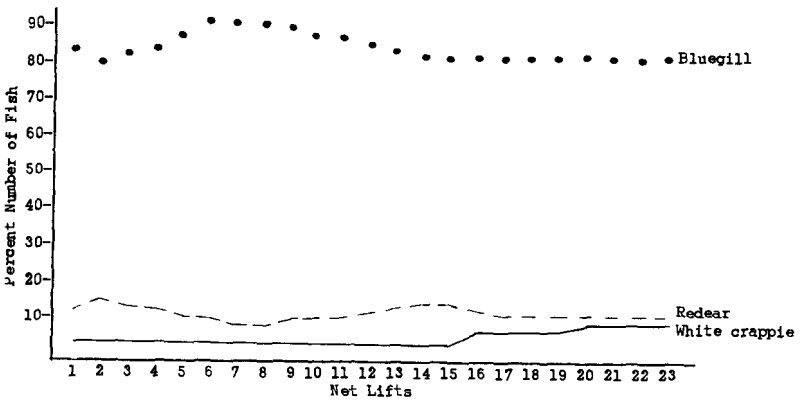

Figure 3-A. Accumulative percentages of catch versus time for unbaited, ten foot trap net, Raymond Gary Lake, 1967.

differed considerably. The baited traps produced 247 fish weighing 48 pounds while 664 fish weighing 157 pounds were captured in unbaited traps (Table 7). The daily catches of bluegill, redear sunfish, and white crappie from both net sizes were compared using Wilcoxin matched pairs signed-ranks test (Wilcoxin and Wilcox, 1964). In both cases the baited and unbaited traps were not significantly different at the .05 percent level. Kendall's tau was used to compare ranks of major species between baited and unbaited nets and between the two net sizes. No significant difference was noted. Approximately equal numbers of redear and bluegill were taken in the four-foot trap nets, while bluegill were twenty times as numerous as redear in the ten-foot nets (Table 15). Channel catfish entered the catch in reasonable numbers in the ten-foot nets but were absent in the four-foot nets.

When compared with the samples taken at draining the major discrepancy in trap net data was the overestimation of the white crappie population. The four-foot trap net catch data also overestimated the abundance of redear sunfish. For the conditions on this particular lake, the four-foot net did not appear to add to the data collection

TABLE 6.
Catch composition and summary of baited and unbaited ten foot trapnets, Raymond Gary Lake, 1967.

	BAITED				*UNBAITED*			
Species	*Number*	*Percent*	*Pounds*	*Percent*	*Number*	*Percent*	*Pounds*	*Percent*
Carp	1	tr.	4.1	tr.	—	—	—	—
Golden shiner	2	tr.	tr.	tr.	2	tr.	tr.	tr.
Spotted sucker	3	tr.	5.3	tr.	8	.1	17.5	.1
Redhorse sp.	2	tr.	7.7	tr.	3	tr.	10.2	.1
Black bullhead	3	tr.	4.8	tr.	2	tr.	1.6	tr.
Yellow bullhead	4	tr.	1.2	.1	2	tr.	1.4	tr.
Channel catfish	19	.2	99.6	5.1	14	.1	83.7	4.3
Flathead catfish	1	tr.	6.1	tr.	2	tr.	12.1	.1
Warmouth	21	.2	3.2	.1	35	.3	5.9	tr.
Green sunfish	1	tr.	.3	tr.	1	tr.	.1	tr.
Bluegill	8,694	85.0	1,498.7	75.6	8,599	84.3	1,464.2	75.4
Longear sunfish	1	tr.	.1	tr.	—	—	—	—
Redear sunfish	450	4.4	115.8	5.9	313	3.1	78.6	4.0
Largemouth bass	5	tr.	8.9	.5	4	tr.	5.1	tr.
White crappie	1,029	10.2	222.7	11.3	1,207	11.8	227.3	11.7
Black crappie	5	tr.	1.9	.1	4	tr.	3.1	tr.
Freshwater drum	—	—	—	—	1	tr.	28.7	1.4
Totals	10,241	100.0	1,980.4	100.0	10,197	100.0	1,939.5	100.0

TABLE 7.
Catch composition and summary of baited and unbaited four foot trapnets, Raymond Gary Lake, 1967.

	BAITED				UNBAITED			
Species	*Number*	*Percent*	*Pounds*	*Percent*	*Number*	*Percent*	*Pounds*	*Percent*
Spotted sucker	1	tr.	.4	.8	1	tr.	.5	.3
Black bullhead	—	—	—	—	2	tr.	1.3	.8
Yellow bullhead	—	—	—	—	1	tr.	.3	.2
Tadpole madtom	—	—	—	—	1	tr.	tr.	tr.
Pirate perch	—	—	—	—	1	tr.	tr.	tr.
Warmouth	5	2.1	.8	1.6	2	tr.	.1	.1
Green sunfish	1	tr.	.1	.2	1	tr.	.3	.2
Bluegill	146	59.1	25.5	52.4	314	47.0	56.0	36.0
Redear sunfish	55	22.2	10.4	21.3	274	41.0	72.9	46.4
Largemouth bass	1	tr.	tr.	tr.	2	.3	6.5	4.2
White crappie	38	15.3	10.9	22.3	64	9.5	18.7	12.0
Black crappie	—	—	—	—	1	tr.	.7	.4
Totals	247	100.0	48.2	100.0	664	100.0	157.3	100.0

process. Even if the specific desire had been to collect redear, the actual numbers of redear captured were greatest in the ten-foot nets. In addition, the ten-foot nets collected a greater variety of species.

Cylindrical Traps

Comparison between baited and unbaited cylindrical traps is complicated since baited traps were fished first (March 16 to May 9) and unbaited traps were fished

later (May 10 to May 31). Also, there were 147 observations on baited traps and only 37 on unbaited traps. The ratio of numbers caught by baited versus unbaited traps (1:0.20) and the ratio of pounds caught in baited versus unbaited traps (1:0.24) were very similar to the ratio of the observations on baited versus unbaited traps (1:0.26). The association as measured by Kendall's tau between the ranks of the species caught by the two methods were significant. The percentage distribution of the major species by numbers were compared using a Wilcoxin singed-rank test and there was no significant difference between baited and unbaited cylindrical traps (Table 8). Table 8 summarizes catch composition of baited and unbaited cylindrical traps.

When compared to trap net catches, the cylindrical traps were not found to be an effective means of capturing white crappie. The species composition of fish caught in cylindrical traps approached the proportion of the species sampled at draining reasonably well although several species, such as flathead catfish and carp, were missing entirely. Cylindrical traps were not found to be effective in capturing large numbers of fish during this study. The average number of fish per net-day was eleven.

TABLE 8.

Catch composition and summary of baited and unbaited cylindrical traps, Raymond Gary Lake, 1967.

	BAITED				*UNBAITED*			
Species	*Number*	*Percent*	*Pounds*	*Percent*	*Number*	*Percent*	*Pounds*	*Percent*
Grass pickerel	1	.17	.1	tr.	–	–	–	–
Golden shiner	1	.17	tr.	tr.	–	–	–	–
Black bullhead	4	.65	5.6	1.6	–	–	–	–
Yellow bullhead	30	4.83	15.9	4.5	9	2.7	12.5	15.1
Channel catfish	10	1.60	52.5	15.0	–	–	–	–
Warmouth	47	7.56	7.6	2.2	16	4.9	1.9	2.3
Green sunfish	6	.94	.8	.2	3	.9	.4	.5
Bluegill	291	46.79	212.0	60.6	252	77.0	57.6	69.9
Redear sunfish	216	34.72	51.6	14.8	41	12.5	9.1	11.0
Largemouth bass	5	.81	.4	.1	1	.3	.1	.1
White crappie	11	1.76	3.0	.8	5	1.5	.7	.8
Totals	622	100.00	349.5	100.0	327	100.0	82.3	100.0

Rotenone

Rotenone samples were very effective in collecting all species occuring in shallow water areas. All centrarchid species in the lake were represented with the exception of black crappie (Table 9). Channel catfish and flathead catfish were missing from the samples. Kendall's tau indicated no correlation between ranks of abundance of the species. A Wilcoxin signed-rank test demonstrated a significant difference between the numerical percentages composition of the major species. The main difference between the two samples was the greater abundance of warmouth in Sample 1 and the greater proportion of redear in Sample 2. Compared to the composition at draining (Table 16), bluegill were underestimated and redear sunfish overestimated in both rotenone samples and the warmouth overestimated in Sample 1. Rotenone samples collected several species of minnows not recovered at draining due to the 1/4-inch mesh of the bag seine.

Seines

The 1/4-inch bag seine captured primarily bluegill, redear sunfish, largemouth bass fingerlings and warmouth (Table 10). When compared with the results at draining (Table 14) it can be seen that a seine of this size completely missed several species and was primarily useful in obtaining samples of intermediate size sunfish and young-of-year largemouth bass.

TABLE 9.
Species composition of two cove rotenone samples, Raymond Gary Lake, 1967.

	SAMPLE 1 (1.2 surface acres)				SAMPLE 2 (2.9 surface acres)			
Species	*Number*	*Percent*	*Pounds*	*Percent*	*Number*	*Percent*	*Pounds*	*Percent*
Grass pickerel	9	.6	.5	.3	16	.3	.8	tr.
Carp	—	—	—	—	3	.1	7.1	1.0
Golden shiner	1	.1	tr.	tr.	54	1.5	tr.	tr.
Red shiner	3	.2	tr.	tr.	—	—	—	—
Fathead minnow	2	.1	tr.	tr.	—	—	—	—
Spotted sucker	—	—	—	—	2	tr.	1.0	tr.
Black bullhead	—	—	—	—	4	.1	2.3	.3
Yellow bullhead	5	.3	.8	.5	16	.3	2.5	.3
Tadpole madtom	2	.1	tr.	tr.	2	tr.	tr.	tr.
Blackstripe topminnow	—	—	—	—	2	tr.	tr.	tr.
Mosquitofish	1	.1	tr.	tr.	—	—	—	—
Pirate perch	1	.1	tr.	tr.	—	—	—	—
Warmouth	292	18.8	15.6	10.0	181	3.7	13.4	2.0
Green sunfish	46	2.9	2.1	1.3	19	.3	1.5	tr.
Bluegill	761	49.2	70.2	45.4	2,314	47.7	226.5	32.5
Longear sunfish	3	.2	tr.	tr.	4	.1	.2	tr.
Redear sunfish	215	13.9	31.2	20.1	1,743	35.9	355.6	50.8
Spotted sunfish	10	.7	.9	.5	32	.6	2.8	.4
Largemouth bass	84	5.4	22.3	14.4	256	5.2	65.2	9.3
White crappie	98	6.4	11.3	7.2	198	4.0	20.0	2.8
Log perch	11	.7	tr.	tr.	—	—	—	—
Brook silversides	2	.1	tr.	tr.	2	tr.	tr.	tr.
Totals	1,546	100.0	154.9	100.0	4,848	100.0	698.8	100.0

TABLE 10.
Catch composition and summary of 1/4-inch bag and 3/16-inch straight seine samples, Raymond Gary Lake, 1967.

	1/4-INCH STRAIGHT SEINE				3/16-INCH BAG SEINE			
Species	*Number*	*Percent*	*Pounds*	*Percent*	*Number*	*Percent*	*Pounds*	*Percent*
Grass pickerel	—	—	—	—	1	tr.	tr.	.1
Redfin shiner	—	—	—	—	5	.2	tr.	tr.
Blackstripe topminnow	2	.2	tr.	tr.	40	1.6	tr.	tr.
Mosquitofish	—	—	—	—	53	2.2	tr.	tr.
Warmouth	53	6.2	4.2	6.5	17	.6	1.7	10.3
Green sunfish	15	1.7	.4	.7	15	.6	.2	1.5
Bluegill	425	49.4	17.2	28.0	366	14.6	5.7	34.5
Longear sunfish	17	1.9	1.2	1.6	3	.1	.1	.6
Redear sunfish	176	20.4	27.6	45.0	50	2.0	5.4	32.7
Spotted sunfish	3	.3	.4	.6	4	.2	.5	3.2
Y-O-Y sunfish	3	.3	tr.	tr.	1,258	50.6	tr.	tr.
Largemouth bass	110	12.8	9.9	16.0	71	2.8	2.5	15.4
White crappie	2	.2	.3	.4	2	.1	.3	1.5
Log perch	1	.1	tr.	tr.	—	—	—	—
Brook silversides	54	6.3	tr.	tr.	606	24.4	tr.	tr.
Totals	861	100.0	61.2	100.0	2,491	100.0	16.4	100.0

The 3/16-inch seine produced large numbers of silversides, topminnows, and young-of-year sunfish in addition to the species captured by the bag seine (Table 10). When the above species are omitted, the 3/16-inch seine captured a larger percentage of bluegill (68 percent compared to 49 percent) and a lesser percentage of redear sunfish (9 percent compared to 28 percent) than the 1/4-inch bag seine. However, if harvestable size redear are omitted from consideration, the remaining percentages are very close (5.6 percent compared to 7.5 percent) as are the percentages of bluegill (54 percent compared to 57 percent). Evidently, the larger seine sampled more effectively the areas inhabited by the larger redear sunfish.

Seine haul catches were examined for daily periodicity information. No distinct trends were indicated for warmouth, redear sunfish, and largemouth bass captured. However, data definitely suggests that more largemouth bass and redear sunfish were taken in the daylight hours with the 1/4-inch seine. Each day was divided into two periods, one from 6:00 a.m to 6:00 p.m. and other from 6:00 p.m. to 6:00 a.m. A Wilcoxin rank sum test was used to test whether a significant difference existed between these periods. Such a difference did exist for numbers of redear sunfish, but not for largemouth bass.

A plot of the numbers of bluegill captured indicated a peak in collection success during the late afternoon with lowest catches occurring at night for the 1/4-inch seine (Figure 4). The 3/16-inch seine data did not indicate this peak and a Wilcoxin rank sum test indicated no significant difference between day and night seining. A plot of the numbers of young-of-year sunfish collected in the 3/16-inch seine indicated two peak periods, one at 6:00 a.m. to 12:00 noon and the other from 6:00 p.m. to 10:00 p.m. A plot of a moving average of threes demonstrates the previously indicated peaks (Figure 4-A). No trends were apparent for the silversides or topminnows collected.

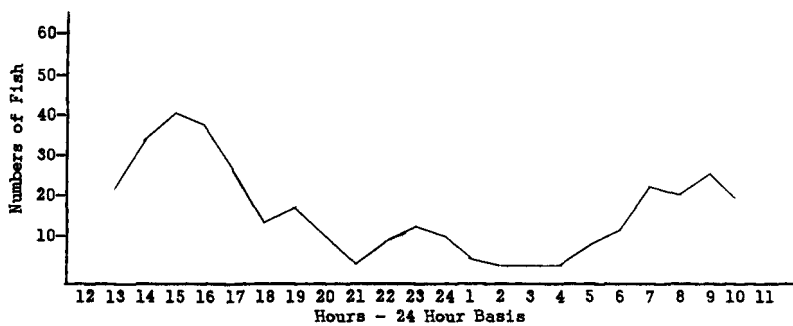

Figure 4. Moving average of threes of the bluegill collected by 1/4 inch seine versus time, Raymond Gary Lake, 1967.

Electrofishing

Resistivity, depth and transparency of the lake water were conducive to effective electrofishing. Largemouth bass, bluegill, redear sunfish, and warmouth were captured in sufficient numbers to determine possible differences in catch during different time periods (Tables 11, 12). The data was separated into the six hour quarters of a twenty-four hour day. Within each quarter the weights and the natural logarithms of the numbers caught during each hour were compared by analysis of variance. There was only one significant difference at the .05 probability level (Table 13). Therefore, the catches for each quarter were combined and the differences between quarters tested by an analysis of variance. Tests were conducted both on weights and on a natural logarithmic transformation of the numbers. Only the values for redear sunfish were statistically significant at the .05 probability level. (Table

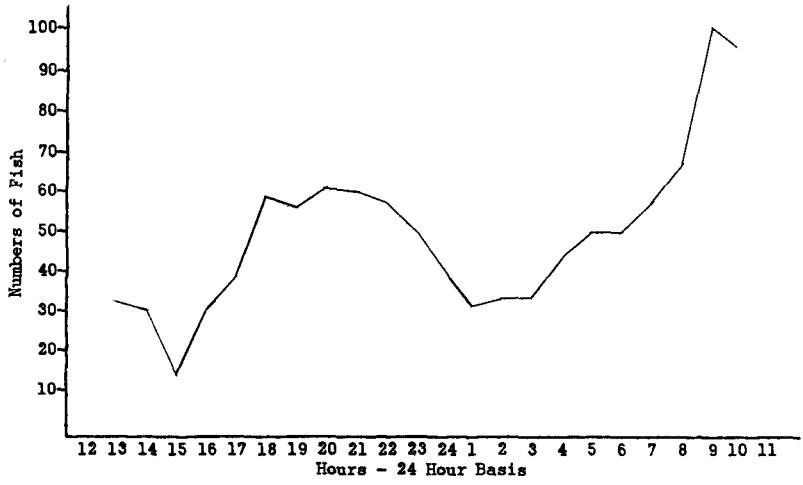

Figure 4-A. Moving average of threes of the young-of-year sunfish collected by 3/16 inch seine versus time, Raymond Gary Lake, 1967.

TABLE 11.
Catch composition and summary of 96 hours shocking, Raymond Gary Lake, 1967.

Species	*Number*	*Percent*	*Pounds*	*Percent*
Grass pickerel	27	.3	4.4	.3
Carp	5	tr.	10.8	.6
Spotted sucker	1	tr.	.8	tr.
Yellow bullhead	3	tr.	1.7	.1
Channel catfish	21	.2	116.6	7.3
Flathead catfish	2	tr.	.1	tr.
Warmouth	711	8.7	83.6	5.2
Green sunfish	92	1.1	8.5	.5
Bluegill	2,565	31.6	271.9	16.9
Longear sunfish	53	.6	4.0	.2
Redear sunfish	2,859	35.1	611.9	37.8
Spotted sunfish	13	.2	1.5	.1
Largemouth bass	1,775	21.8	487.8	30.4
White crappie	14	.2	3.3	.2
Totals	8,141	100.0	1,606.9	100.0

13-A). A Duncan multiple range test (Steele and Torrie, 1966) grouped these values into two groups with quarters one (12:00 to 6:00 a.m.) and four (6:00 p.m. to 12:00 p.m.) having higher values than quarters two (6:00 a.m. to 12:00 a.m.) and three (12:00 a.m. to 6:00 p.m.) for redear sunfish. Averages for each quarter are presented in Table 12. Although the other species were captured in limited quantities too small for statistical analysis, persual of the data indicates that all species were present in each quarter. The fact that redear sunfish in this study was the only species collected in greater quantities at night contradicts the commonly held opinion that nighttime shocking is more productive than daytime shocking. These differences have been reported by Loeb, 1967, Witt and Campbell, 1959 and Dorris and Summerfelt, 1967. Specific conditions which influence the effectiveness of electrofishing and the behavior of the fish need to be considered before a general statement can be made.

TABLE 12.
Mean catches per hour with shocker, Raymond Gary Lake, 1967.

Species	*Time Period*	*Ave. no. caught per hour*	*Ave. wt. caught per hour*
Largemouth bass	12:00 p.m. – 6:00 a.m.	23	8.3
	6:00 a.m. – 12:00 a.m.	23	6.8
	12:00 a.m. – 6:00 p.m.	16	5.8
	6:00 p.m. – 12:00 a.m.	18	7.4
Bluegill	12:00 p.m. – 6:00 a.m.	38	5.4
	6:00 a.m. – 12:00 a.m.	19	2.8
	12:00 a.m. – 6:00 p.m.	21	5.4
	6:00 p.m. – 12:00 p.m.	28	3.7
Redear sunfish	12:00 p.m. – 6:00 a.m.	44	10.5
	6:00 a.m. – 12:00 a.m.	22	4.9
	12:00 a.m. – 6:00 p.m.	20	5.0
	6:00 p.m. – 12:00 p.m.	37	8.6
Warmouth	12:00 p.m. – 6:00 a.m.	9	2.0
	6:00 a.m. – 12:00 a.m.	7	1.8
	12:00 a.m. – 6:00 p.m.	10	3.4
	6:00 p.m. – 12:00 p.m.	8	1.8

TABLE 13-A.
Analyses of variance for shocker catches between quarter day periods, Raymond Gary Lake, 1967.

Species	*Treatment Degrees of Freedom*	*Error Degrees of Freedom*	*F Ln. Numbers*	*F Weights*
Largemouth bass	3	95	1.168 NS	.582 NS
Bluegill	3	95	1.498 NS	1.308 NS
Redear sunfish	3	95	4.651*	7.498 NS
Warmouth	3	95	0.925 NS	1.314 NS

NS = Not significant at .05 probability level.
* = Significant at .05 level.

Generally, electrofishing gave a reliable picture of the species composition in the lake. When compared with results at draining (Table 16), electrofishing appears to be selective for redear over bluegill This is possibly a result of the greater vulnerability of redear to nighttime shocking. Largemouth bass of all sizes were highly vulnerable to the shocker during all quarters of the day. It should be noted that shocking samples were taken several weeks following bass spawning activities. White crappie, carp, channel catfish and flathead catfish were represented in the shocker samples.

Draining

Twelve species captured by other methods were not present in samples taken at draining (Tables 14, 16). Several cyprinid species were missed entirely due to the 1/4 inch mesh seine used. Persual of a larger sample would have probably included those species missed.

Redear Sunfish – Bluegill Ratios

The ratios between redear sunfish and bluegill, the two main sunfish species in the lake, were computed for each type of sampling gear as well as the draining results (Table 15). The ten foot trap net was the only method to have a greater ratio than

TABLE 13.

Analyses of variance for shocker catches between hours within quarter day periods, Raymond Gary Lake, 1967.

Time Period	*Treatment Degrees of Freedom*	*Error Degrees of Freedom*	*Largemouth Bass F Lbs.-In. nos.*	*Bluegill F Lbs.-In. nos.*	*Redear Sunfish F Lbs.-In. nos.*	*Warmouth F Lbs.-In. nos.*
12:00 p.m. 6:00 a.m.	5	19	0.441NS–.0384NS	0.482NS–0.776NS	0.138NS–0.109NS	0.399NS–0.907NS
6:00 a.m. 12:00 a.m.	5	19	0.956NS–2.063NS	1.876NS–0.911NS	1.743NS–0.851NS	1,432NS–1.772NS
12:00 a.m. 6:00 p.m.	5	19	1.563NS–0.717NS	0.987NS–2.237NS	0.464NS–0.346NS	0.759NS–0.694NS
6:00 p.m. 12:00 p.m.	5	19	0.910NS–0.980NS	1.283NS–0.670NS	4.042* –2.013NS	0.241NS–0.941NS

NS = Not significant at .05 probability level.

* = Significant at .05 probability level.

TABLE 14.

Catch composition and summary of 1/4-inch seine samples taken at draining, Raymond Gary Lake, 1967.

Species	*Number*	*Percent*	*Pounds*	*Percent*
Grass pickerel	5	.1	.9	.1
Carp	12	.2	196.7	15.7
Golden shiner	19	.3	tr.	tr.
Spotted sucker	1	tr.	.9	.1
Black bullhead	1	tr.	2.0	.2
Yellow bullhead	3	tr.	.8	.1
Channel catfish	21	.4	108.9	8.7
Flathead catfish	16	.3	165.9	13.3
Warmouth	417	8.2	45.3	3.6
Green sunfish	5	.1	.3	tr.
Bluegill	4,160	82.5	594.6	47.6
Longear sunfish	2	tr.	.1	tr.
Redear sunfish	315	6.2	61.8	5.0
Spotted sunfish	5	.1	.6	tr.
Largemouth bass	33	.6	67.5	5.4
White crappie	23	.4	3.3	.3
Totals	5,038	100.0	1,249.6	100.0

TABLE 15.

Redear sunfish — bluegill catch ratio, Raymond Gary Lake, 1967.

Method	Ratio
Trapnet, ten-foot, unbaited	1:27.47
Trapnet, ten-foot, baited	1:19.32
Draining	1:13.20
Seine, 3/16-inch, straight	1: 7.32
Cylindrical trap, unbaited	1: 6.14
Gill net, 2.5-inch mesh	1: 5.00
Rotenone, Sample 1	1: 3.53
Trapnet, four-foot, unbaited	1: 2.65
Seine, 1/4-inch, bag	1: 2.41
Gill net, 2.0-inch mesh	1: 1.41
Cylindrical trap, baited	1: 1.35
Rotenone, Sample 2	1: 1.32
Trapnet, four-foot, baited	1: 1.14
Shocker	1: .89
Gill net 1.5-inch mesh	1: .69

draining. Gill nets of 1.5 and 2.0 inch mesh sizes were the most biased in favor of redear sunfish. The ratios do not provide an understandable pattern when considered from a gear standpoint. Exact placement of the gear in the lake may be the over-riding factor.

Estimate of White Crappie Numbers

During trap netting operations, white crappie were fin clipped and released. Recaptures in good condition were released with a second clip. This enabled a Schnabel type estimate to be made of the population. Formulas used to make the estimate and assign confidence limits are those described by Ricker (1958) under Method 1. Marking fish by fin clips were conducted between March 17 and May 30. A total of 1,416 marked individuals were released and 253 were recaptured. The

TABLE 16.

Catch composition and summary of combined data by all methods, Raymond Gary Lake, 1967.

Species	*Number*	*Percent*	*Pounds*	*Percent*
Grass pickerel	69	.15	7.8	.08
Goldfish	7	.01	16.5	.17
Carp	41	.08	459.4	4.63
Golden shiner	104	.21	tr.	tr.
Redfin shiner	9	.02	tr.	tr.
Fathead minnow	1	tr.	tr.	tr.
Spotted sucker	133	.24	431.2	4.35
Redhorse sp.	12	.02	46.6	.47
Black bullhead	42	.08	63.5	.64
Yellow bullhead	107	.21	35.4	.36
Channel catfish	153	.31	796.2	8.02
Tadpole madtom	6	.01	tr.	tr.
Flathead catfish	37	.09	269.3	2.71
Blackstripe topminnow	44	.09	tr.	tr.
Mosquitofish	54	.11	tr.	tr.
Pirate perch	2	tr.	tr.	tr.
Warmouth	1,901	3.92	191.6	1.93
Green sunfish	402	.81	25.7	.26
Bluegill	30,556	62.73	4,563.3	54.99
Longear sunfish	90	.18	6.4	.06
Redear sunfish	7,138	14.63	1,554.6	16.57
Spotted sunfish	74	.16	6.9	.07
Y-O-Y sunfish	1,762	3.69	tr.	tr.
Largemouth bass	2,402	4.92	778.0	7.84
White crappie	2,801	5.72	602.7	6.07
Black crappie	13	.02	8.5	.09
Log perch	24	.04	tr.	tr.
Freshwater drum	4	tr.	59.1	.60
Brook silversides	705	.14	tr.	tr.
Totals	48,703	100.00	9,922.7	100.00

white crappie population was estimated to be 5,326 fish with lower and upper confidence limits of 5,117 and 5,551. This represents an estimated fourteen crappie per acre. The trap nets captured 2,039 crappie or thirty-eight percent of the estimated number in the lake, which indicates a high degree of efficiency of this gear for crappie.

SUMMARY

A 263 acre Southeast Oklahoma reservoir was intensively sampled from March to August, 1967, with a variety of sampling gear. Results were compared between and within sampling methods and with seine samples taken at draining.

Gill nets caught relatively few fish for the effort expended, however, a good indication of species composition was obtained by this method. Larger mesh sizes provided data on large individuals in the population missed by other methods.

Ten foot trap nets collected a greater variety of species than four foot trap nets. Ten foot trap nets overestimated white crappie and four foot trap nets overestimated redear sunfish numbers. Baiting did not improve the trap net catch. A relationship was found between the numbers of fish caught, the percentage a species represents in the population, and the amount of netting effort needed to estimate species composition.

Cylinderical traps were not effective in capturing large numbers of fish and several species were missed. The percentage distribution of white crappie collected by this method approached the proportion found a draining. Baiting did not improve cylindrical trap catches.

Rotenone samples differed between samples in numerical percentage composition of the major species. When compared to draining, bluegill were underestimated and redear sunfish overestimated in both rotenone samples. The catfish species were missed entirely by this method; however, several species of minnows were collected that were not represented at draining.

The 1/4 inch bag seine missed several species and primarily sampled intermediate size sunfish and young of year largemouth bass. The 3/16 inch seine caught the same species as the 1/4 inch seine but in addition took large numbers of silverside, topminnows, and young of year sunfish. More largemouth bass and redear sunfish were taken during daylight hours as opposed to night hours, and bluegill catch peaked in late afternoon in the 1/4 inch seines. Two peaks were observed for young of year sunfish catches in the 3/16 inch seine; one between 6:00 a.m. and 12:00 noon and one between 6:00 p.m. and 10:00 p.m.

The electrofishing data, when separated in quarters of a twenty-four hour day, showed increased catch rates only for redear sunfish during night quarters. All species were collected in each quarter but, when compared to draining, the shocker appears selective for redear over bluegill. The shocker gave a generally reliable picture of the species composition in the lake.

Redear sunfish–bluegill ratios were computed for each type of gear as well as draining. The ten foot trap net was the only method to have a greater ratio of redear sunfish to bluegill than draining. The 1.5 and 2.0 inch gill nets were the most biased for redear sunfish (Table 15).

A Schnabel type population estimate was made for white crappie taken in trap nets. It was estimated that thirty-eight percent of the crappie population was captured in trap nets, indicating a high degree of efficiency of this gear for crappie.

RECOMMENDATIONS

1. The use of accumulative percentages for determining length of time necessary to sample a population with specific gear to estimate species composition, should be tested thoroughly to determine its value in fishery management.
2. Gill nets smaller than 2.5 inch are not recommended for fish population studies when conditions are favorable for trapnetting and electrofishing.
3. Additional evaluation of baiting traps with cottonseed cake to increase catches is needed.
4. Further evaluation of electrofishing is needed to determine daily periodicities.

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COMPARISON OF VARIOUS DESIGNS OF WISCONSIN-TYPE TRAP NETS IN TVA RESERVOIRS[1]

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ABSTRACT

Wisconsin-type trap nets were investigated to determine methods necessary to adapt this gear to TVA reservoirs, to establish the best operational procedure, and to determine the potential of this gear in an expanded commercial fishery. The study was conducted primarily in Wheeler Reservoir, Alabama. Three trap nets, modified in amount of flooring, mesh size, and floatation, were fished in combination with three lengths of lead. The lead of intermediate length was constructed of a smaller mesh size (4- instead of 5-inch) than the shorter and longer leads.

Modifications which resulted in larger commercial catches were a floor constructed in both cribs and the heart, a smaller mesh size in the heart (4- instead of 5-inch), and a 400-foot lead of 4-inch mesh. The smaller mesh in the heart resulted in a larger catch of industrial size freshwater drum, while the smaller mesh in the lead resulted in a larger catch of gizzard and threadfin shad.

The most abundant species in the catch were freshwater drum, smallmouth buffalo, and shad. Commercial fish made up 79 percent of the catch. White crappie was both the most common and abundant game fish, occurring in 79 percent of the lifts and accounting for approximately 95 percent of the game fish harvested.

INTRODUCTION

The Tennessee Valley Authority is currently investigating the commercial fisheries potential of TVA reservoirs. The objective is to determine the means by which the total fishery can be expanded to realize the greatest benefits for both sport and commercial fisheries. Investigations of the commercial fishery of the Tennessee River system have been conducted periodically since 1941 (Bryan and Tarzwell, 1941; Tarzwell, 1944; Bryan and White, 1958; Carroll, Hall, and Bishop, 1963). Current investigations include (1) evaluation of commercial fishing gear used successfully in other regions of the county, (2) development of ways to concentrate desired species for more effective harvest, (3) quarterly surveys of commercial fishermen to determine the annual harvest of commercial fish, and (4) life history studies of the more important commercial fish.

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