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ANALYSIS OF THE GAME-FISH CATCH IN A MICHIGAN LAKE.

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A paper by G. H. Clark given at the Fisheries meeting in Montreal last year, and the discussion which followed, indicated not only that there is a real need for measuring and interpreting the angler's catch, but also that past attempts in this direction have been unsatisfactory. While that discussion was in progress in Montreal, crews of specially selected C.C.C. men were patrolling the shores of several Michigan lakes, to contact the fishermen as they reached the shore, and to obtain from them full data as to their day's fishing. The aim of the work was to secure as complete a record as possible of all fishing carried on throughout the year in these lakes. This project thus differed from the general Michigan creel census, which since 1927 has been attempting to obtain, by the method^{of} representative sampling only, an appreciation of the trend of fishing throughout the state.

The purpose of this paper is to indicate the method used in taking a complete creel census on a lake, and to show what sort of information, of value or interest to the Department of Conservation and to anglers, can be obtained by such a census. These points are illustrated by the discussion of the census taken on one of the several lakes where this work has been conducted, and is being continued.

Fife Lake Creel Census

Results of the creel census on this lake are available for a full year of fishing (December 21, 1933 to December 20, 1934). This lake is located in the upper part of the Lower Peninsula of Michigan, in Grand Traverse and Kalkaska counties, approximately 20 miles southeast of Traverse City. Since it is on a national highway (U.S. 27), the lake is readily accessible at all times. It has an area of 820 acres within the meander line, reduced by low water at the time of the census to about 800 acres.

Fife Lake has a considerable amount of shoal area and a moderate development of vegetation, and appears to be mediumly rich in food. If it were possible to select an average Michigan lake, Fife Lake might approach it in most respects.

The creel census was taken by the Fife Lake C.C.C. Camp under the supervision of Superintendent A. L. Ferris and Crew Foreman Erwin Moody. The Camp Superintendent, a technically trained man, was interested in the project, and was sufficiently familiar with his enrollees to place on the census-crew men best suited for the work. Foreman Moody had previously been engaged in fisheries work for the Department of Conservation. This personnel assured the reliability of the data.

Method of Taking the Census

The men were equipped with special blanks for recording the data and with suitable equipment for measuring the fish. In winter they were further equipped with portable headquarters,—a "shanty" which was kept in the vicinity of the most heavily fished area of the lake. In summer and fall the men patrolled the shore, each man being responsible for contacting the fishermen who reached his allotted section of the shore. The data were obtained only when the fishermen had concluded the day's fishing.

The census was taken every day from daylight to dark, except during the closed season in spring (April 30-June 25), when there was obviously no need for taking a census.

Each day the men prepared a list of the number of fishermen seen and the number actually contacted. Since the lake was relatively round and since the crew was of ample size (numbering up to 7 men), it is assumed that all of the fishermen were seen. In the fall and winter all those who were seen were also contacted; in the summer 149 records were missed, for anglers seen but not contacted. The 35 blanks that were incompletely filled out or lost were added to these 149 records to give a total of 184 fishermen-days for which full records were not available.

CREEL CENSUS—Michigan Department of Conservation

County _____ Fisherman's Name _____
 Township _____ City or Town _____
 Lake or Stream _____ Sex? _____ Approximate Age? _____

| SPECIES CAUGHT | LEGAL SIZE | | UNDERSIZE | |
|-----------------------|------------|-----------|-----------|-----------|
| | Number | Av. Lgth. | Number | Av. Lgth. |
| Brook Trout | | | | |
| Rainbow Trout | | | | |
| Brown Trout | | | | |
| Large Mouth Bass | | | | |
| Small Mouth Bass | | | | |
| Bluegills | | | | |
| Sunfish | | | | |
| Yellow Perch | | | | |
| Pike Perch (Walleyes) | | | | |
| Northern (Grass) Pike | | | | |
| | | | | |
| | | | | |
| | | | | |

Date _____ 193_____

Kind of Fishing:

Ice? _____ Still Fishing? _____

Boat? _____ Trolling? _____

Shore? _____ Casting? _____

Number of lines? _____

Bait (Check if only one kind of bait used)

How many fish caught with worms? _____

Minnows? _____ Spinner? _____

Plug? _____ Artificial Fly? _____

If taken with other bait, or by spear, dipnet or other means, state how _____

Weather: Clear? _____ Cold? _____

(Check) Cloudy? _____ Mild? _____

Rain? _____ Warm? _____

(Enter other kinds taken on blank spaces above)

| | | | | | | | | | | | | | | |
|-------------|--------|----|---|---|---|---|---|---|---|---|---|----|----|----|
| TIME FISHED | A.M. → | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| | P.M. → | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ |

Draw line through hours fished; double line when fishing was best; figure to quarter hours.
 Make separate report for every person fishing. Make out report whether fish are caught or not.

Fig. I Blank used for recording the creel census data. Actual size 4x6 inches. These perforated sheets are made up in books of 100.

The time of fishing was recorded to the nearest quarter hour; the length of the fish may be considered correct to the nearest half inch.

Data Obtained

Of the two forms of blanks employed, the one used in the early period of the survey differed from the one shown as Figure 1 primarily in that it lacked the address and approximate age of the fisherman. The form was prepared for use in the general creel census on lakes and streams, as well as for the intensive C.C.C. survey.

The information obtained for each day's fishing includes the name, address, sex, and approximate age of the fisherman; the kind, number, and size of fish caught; the date; the method of fishing; the bait used; the general weather conditions; the hours of the day fished, and the total hours fished; also the time of day when fishing was considered best.

The number, kind, and size of fish were checked by the census-takers and all information was recorded by them. It has been learned that the average angler finds the blank too detailed and too complicated, but that he is quite willing to furnish the desired information.

Summer Fishing

All fishing from the opening date of June 25th to September 30th inclusive has been considered as summer fishing. The extensive information obtained for this period, mostly indicated in detail in the tables and graphs, may be summarized as follows:

Number of fishermen, lines per fisherman, and fishermen taking no fish (see Table 1).--Census returns were obtained for 2,399 fisherman-days, 1,835 for men, 564 for women. A daily average of 24.5 persons fished the lake for the 98 day period; during the height of the fishing season the number of fishermen averaged about 37 daily. Although 2 lines per fishermen are legally permitted, 93% of the reports indicated the use of only 1 line (an example of the sort of fact-finding that should interest legislators).

Table 1. Number of fishermen, lines per fisherman, and fishermen taking no fish. Wife Lake, summer and fall of 1934. Each fisherman is listed separately for each day fished.

| Date | Number of fishermen | | | Ave. per day | Ave. lines per person | Fishermen taking no fish | | | |
|-------------------|---------------------|------------|-------------|--------------|-----------------------|--------------------------|------------|------------|-------------|
| | Male | female | total | | | male | female | total | % |
| June 25-30 | 103 | 18 | 121 | 20 | 1.2 | 22 | 4 | 26 | 21.5 |
| July 1-7 | 139 | 23 | 162 | 23 | 1.05 | 39 | 7 | 46 | 28.4 |
| July 8-14 | 168 | 56 | 224 | 32 | 1.0 | 59 | 15 | 74 | 33.0 |
| July 15-21 | 164 | 25 | 189 | 24.1 | 1.04 | 47 | 4 | 51 | 27.0 |
| July 22-28 | 191 | 50 | 241 | 34.4 | 1.08 | 29 | 10 | 39 | 16.2 |
| July 29-Aug. 4 | 215 | 49 | 264 | 37.8 | 1.05 | 71 | 8 | 79 | 29.9 |
| Aug. 5-11 | 204 | 54 | 258 | 37 | 1.09 | 54 | 6 | 60 | 23.2 |
| Aug. 12-18 | 180 | 79 | 259 | 37 | 1.09 | 32 | 13 | 45 | 17.4 |
| Aug. 19-25 | 82 | 36 | 118 | 17 | 1.1 | 22 | 9 | 31 | 26.2 |
| Aug. 26-Sept. 1 | 136 | 66 | 202 | 29 | 1.06 | 40 | 17 | 57 | 28.2 |
| Sept. 2-8 | 87 | 30 | 117 | 16.7 | 1.06 | 26 | 6 | 32 | 27.3 |
| Sept. 9-15 | 83 | 34 | 117 | 16.7 | 1.05 | 16 | 8 | 24 | 20.5 |
| Sept. 16-22 | 45 | 24 | 69 | 9.9 | 1.04 | 5 | 2 | 7 | 10.1 |
| Sept. 23-29 | 25 | 17 | 42 | 6 | 1.1 | 4 | 3 | 7 | 16.7 |
| Sept. 30 | 13 | 3 | 16 | 16 | 1.0 | 0 | 0 | 0 | 0.0 |
| Totals | 1835 | 564 | 2399 | 24.48 | 1.07 | 466 | 112 | 578 | 24.1 |
| October | 130 | 60 | 190 | 6.1 | 1.22 | 22 | 6 | 28 | 14.7 |
| November | 6 | 2 | 8 | .27 | 1.25 | 3 | 1 | 4 | 50.0 |
| Totals for | | | | | | | | | |
| Oct. & Nov. | 136 | 62 | 198 | 3.24 | 1.22 | 25 | 7 | 32 | 16.2 |

A total of 578 fishermen, 24.1% of all those fishing (each day's fishing considered separately), caught no legal-sized fish; 466 of these were men, 112 were women. The percentage taking no fish varied from about 10% to 33%. Of all the reports 23.5% were for women; of those indicating no fish caught 19.4% were for women. Proportionately fewer women than men took no fish. There appears to be very little correlation between the number of persons fishing any week and the number catching no fish at that time.

Legal limit catches of bass or pan fish (5 bass, 25 pan fish), or over-limit catches, were indicated in less than 2% of the reports. Only 10 limit catches of pan fish and only 25 limit catches of bass (mostly of smallmouth bass) were made. All limit catches except one were taken on natural bait. No limit catches of 5 northern pike or of 5 walleyes were made.

Number of fish, catch per hour, fish per fisherman, and average size of all fish (see Table 2).--The 2,399 fisherman-days yielded a total of 10,656 fish having an average length of 8.33 inches, caught at the rate of 1.72 per hour. The fishermen averaged approximately 4.5 fish each per day's fishing; Wile Lake produced, on the average, more than 100 fish per day for the 98 day period.

The per-hour catch as well as the total numbers of fish taken, varied from week to week. It was poorest for the week when most people fished (July 29th to August 4th). Since there was some correlation between the catch per hour and the catch per fisherman, the average fisherman tended to fish for a more or less uniform average time without regard to his luck (also shown by Table 4).

The fish caught had a total length of 88,828 inches (about 1.4 miles).

Analysis of the catch by species (see Table 3 and Fig. 2).--The 12 or 13 species taken, were, in the order of abundance in the catch: perch (Perca flavescens), rockbass (Ambloplites rupestris), bluegill (Lepomis macrochirus), pumpkinseed (Lepomis gibbosus), smallmouth bass (Micropterus dolomieu), bullhead (Ameiurus, either nebulosus or natalis or both), largemouth bass (Micropterus salmoides), walleye

or pike-perch (Stizostedion vitreum), northern pike (Esox lucius), black crappie (Pomoxis sparoides), sucker (Catostomus commersonii), and shiner (probably Notemigonus crysoleucas.) The average size for any one species remained relatively constant from week to week as the season progressed. The per-hour catch of each species fluctuated from week to week but the weekly fluctuations in the per-hour catch of any one species was not accompanied by a similar fluctuation in the per-hour catch of the other species. The four largest game fish, largemouth bass, smallmouth bass, northern pike and walleye, represented 12.6% of the entire catch. The catch of smallmouth bass totaled 992 fish, of an average length of 12.25 inches. They represented 9.31% of the total catch and were taken at the rate of 1 fish per 6 hours of all fishing. The per-hour catch was best during the first week of the season, possibly because spawning had recently been completed and the males were feeding heavily. The total largemouth bass catch was 294 fish, of an average length of 13.5 inches. They represented 2.76% of the total catch and were taken at the rate of 1 fish per 25 hours of fishing. Smallmouth bass outnumbered the largemouths almost 10 to 3. It therefore appears that the lake might best be classed as a smallmouth bass lake.

The total bluegill catch was 1,970 fish, of an average length of about 7.2 inches. The bluegills represented almost one fifth of the total catch and were taken at the rate of approximately one fish per three hours of fishing. They were biting best in mid-summer and for several weeks during the height of the tourist season they ranked first in the catch. A total of 1,016 pumpkinseeds was taken. These had an average length of less than 7 inches, and represented 9.5% of the total catch. The catch was decidedly inferior to the bluegill catch in number and in catch per hour; and the sunfish averaged somewhat smaller than the bluegills.

A total of 2,129 rock bass with an average length of almost 8 inches was caught. They represented 20% of the total catch and were caught at the rate of 1 fish per 3 hours of fishing. Over a third (35.2%) of the fish caught were perch. They had an

Table 2. Number of fish, fish per hour, fish per fisherman, and average size of all fish. Five Lake, summer and fall of 1934.

| Date | No. of fish taken | Fish per hour | Fish per angler | Average size of fish (in.) |
|---|-------------------|---------------|-----------------|----------------------------|
| June 25-30 | 629 | 2.0 | 5.2 | 8.95 |
| July 1-7 | 847 | 2.25 | 5.2 | 8.7 |
| July 8-14 | 896 | 1.66 | 4.0 | 8.4 |
| July 15-21 | 980 | 2.03 | 5.2 | 8.7 |
| July 22-28 | 1302 | 1.95 | 5.4 | 8.3 |
| July 29-Aug. 4 | 918 | 1.24 | 3.5 | 8.4 |
| Aug. 5-11 | 1143 | 1.77 | 4.5 | 8.1 |
| Aug. 12-18 | 1083 | 1.7 | 4.2 | 7.85 |
| Aug. 19-25 | 488 | 1.78 | 4.1 | 7.8 |
| Aug. 26-Sept. 1 | 683 | 1.44 | 3.4 | 8.3 |
| Sept. 2-8 | 370 | 1.29 | 3.2 | 8.0 |
| Sept. 9-15 | 535 | 1.56 | 4.6 | 7.9 |
| Sept. 16-22 | 464 | 1.9 | 6.7 | 8.2 |
| Sept. 23-29 | 208 | 1.81 | 4.5 | 8.5 |
| sept. 30 | 110 | 2.0 | 6.9 | 8.8 |
| Total or Average | 10656 | 1.72 | 4.44 | 8.33 |
| October | 1275 | 2.46 | 6.7 | 8.4 |
| November | 31 | 1.8 | 3.9 | 7.7 |
| Total or Average for October and November | 1306 | 2.43 | 6.6 | 8.0 |

Table 3. Analysis of the catch. Fife Lake, summer and fall of 1934*

| Date | Smallmouth bass | | | Largemouth bass | | | Bluegill | | | Sunfish | | |
|-----------------|-----------------|-----------|---------|-----------------|-----------|---------|-----------|-----------|---------|-----------|-----------|---------|
| | No. taken | Ave. size | Per hr. | No. taken | Ave. size | Per hr. | No. taken | Ave. size | Per hr. | No. taken | Ave. size | Per hr. |
| June 25-30 | 80 | 12.3 | .25 | 37 | 13.2 | .12 | 67 | 7.1 | .21 | 37 | 7.1 | .12 |
| July 1-7 | 73 | 12.0 | .19 | 37 | 13.5 | .10 | 136 | 7.2 | .36 | 40 | 7.2 | .11 |
| July 8-14 | 76 | 12.2 | .14 | 14 | 15.3 | .03 | 110 | 7.0 | .20 | 62 | 6.7 | .11 |
| July 15-21 | 86 | 12.1 | .18 | 32 | 15.1 | .07 | 231 | 7.5 | .47 | 76 | 6.9 | .16 |
| July 22-28 | 162 | 12.1 | .24 | 19 | 15.1 | .03 | 251 | 7.2 | .38 | 133 | 6.8 | .20 |
| July 29-Aug. 4 | 128 | 12.1 | .17 | 14 | 14.3 | .02 | 141 | 7.3 | .19 | 131 | 7.2 | .18 |
| Aug. 5-11 | 82 | 12.3 | .13 | 28 | 12.2 | .04 | 306 | 7.6 | .48 | 148 | 6.7 | .24 |
| Aug. 12-18 | 60 | 12.3 | .09 | 40 | 12.8 | .06 | 346 | 7.1 | .54 | 114 | 6.7 | .18 |
| Aug. 19-25 | 25 | 11.3 | .09 | 15 | 11.7 | .05 | 85 | 7.0 | .30 | 46 | 6.9 | .16 |
| Aug. 26-Sept. 1 | 72 | 11.8 | .15 | 21 | 13.7 | .05 | 70 | 7.3 | .15 | 74 | 6.8 | .16 |
| Sept. 2-8 | 36 | 11.8 | .13 | 6 | 12.3 | .03 | 18 | 7.1 | .06 | 23 | 6.5 | .08 |
| Sept. 9-15 | 40 | 13.2 | .12 | 9 | 12.9 | .03 | 55 | 6.8 | .16 | 24 | 7.0 | .07 |
| Sept. 16-22 | 41 | 13.0 | .17 | 12 | 11.4 | .05 | 103 | 7.0 | .47 | 48 | 6.8 | .20 |
| Sept. 23-29 | 19 | 13.8 | .17 | 7 | 14.1 | .06 | 31 | 7.6 | .27 | 28 | 6.5 | .24 |
| Sept. 30 | 12 | 14.8 | .22 | 3 | 14.7 | .05 | 20 | 6.8 | .36 | 32 | 6.3 | .58 |
| Total or Ave. | 992 | 12.25 | .16 | 294 | 13.48 | .04 | 1970 | 7.22 | .32 | 1016 | 6.83 | .16 |
| Per day | 10.1 | | | 3.0 | | | 20.1 | | | 10.4 | | |
| October | 49 | 14.5 | .09 | 23 | 13.7 | .04 | 79 | 7.5 | .15 | 8 | 7.1 | .02 |
| November | 1 | 10.0 | .06 | .. | .. | .. | 1 | 7.0 | .06 | 2 | 7 | .12 |
| Total or Ave. | 50 | 14.4 | .09 | 23 | 13.7 | .04 | 80 | 7.5 | .15 | 10 | 7.1 | .02 |

| Date | Rock bass | | | Perch | | | Northern Walleye | | | pike | | Bullhead | |
|-----------------|-----------|-----------|---------|-----------|-----------|---------|------------------|-----------|---------|-----------|-----------|-----------|-----------|
| | No. taken | Ave. size | Per hr. | No. taken | Ave. size | Per hr. | No. taken | Ave. size | Per hr. | No. taken | Ave. size | No. taken | Ave. size |
| June 25-30 | 140 | 8.7 | .44 | 239 | 7.4 | .76 | 14 | 19.0 | .04 | 2 | 21.0 | 9 | 10.0 |
| July 1-7 | 148 | 8.2 | .39 | 349 | 7.3 | .93 | 26 | 19.9 | .07 | 3 | 24.7 | 35 | 11.0 |
| July 8-14 | 152 | 7.9 | .28 | 418 | 7.3 | .77 | 28 | 20.8 | .05 | 6 | 19.5 | 30 | 9.9 |
| July 15-21 | 178 | 8.8 | .37 | 330 | 7.6 | .68 | 19 | 17.8 | .04 | 3 | 23.0 | 25 | 9.2 |
| July 22-28 | 267 | 7.5 | .40 | 358 | 7.6 | .54 | 3 | 16.2 | .. | 2 | 21.5 | 107 | 10.5 |
| July 29-Aug. 4 | 197 | 7.6 | .27 | 287 | 7.6 | .39 | 6 | 23.9 | .01 | 2 | 18.5 | 12 | 11.6 |
| Aug. 5-11 | 276 | 7.6 | .43 | 265 | 7.4 | .41 | 8 | 21.6 | .03 | 9 | 19.1 | 21 | 10.5 |
| Aug. 12-18 | 247 | 7.5 | .39 | 220 | 7.1 | .34 | 7 | 18.9 | .01 | 2 | 18.0 | 42 | 11.2 |
| Aug. 19-25 | 114 | 8.0 | .40 | 199 | 7.2 | .70 | 2 | 23.0 | .01 | .. | .. | 1 | 12.0 |
| Aug. 26-Sept. 1 | 184 | 8.1 | .39 | 253 | 7.5 | .53 | 2 | 24.5 | .. | 2 | 23.5 | 5 | 9.6 |
| Sept. 2-8 | 74 | 7.9 | .26 | 204 | 7.5 | .71 | 1 | 28.0 | .. | 6 | 24.5 | 2 | 11.5 |
| Sept. 9-15 | 87 | 7.6 | .25 | 299 | 7.1 | .87 | 1 | 18.0 | .. | 4 | 18.7 | 9 | 10.5 |
| Sept. 16-22 | 47 | 7.6 | .20 | 207 | 7.7 | .88 | 1 | 25.0 | .. | 3 | 27.3 | 1 | 10.0 |
| Sept. 23-29 | 14 | 7.8 | .13 | 95 | 7.9 | .83 | 1 | 18.0 | .01 | .. | .. | 3 | 12.0 |
| Sept. 30 | 4 | 7.0 | .07 | 34 | 7.8 | .61 | .. | .. | .. | 4 | 26.0 | 1 | 12.0 |
| Total or Ave. | 2129 | 7.9 | .34 | 3757 | 7.4 | .61 | 119 | 20.1 | .02 | 48 | 21.8 | 303 | 10.5 |
| Per day | 21.7 | | | 38.33 | | | 1.2 | | | .49 | | 3.1 | |
| October | 68 | 8.0 | .13 | 1035 | 8.0 | 1.99 | 4 | 20.0 | .01 | 6 | 22.2 | 3 | 11.3 |
| November | 3 | 8.0 | .18 | 23 | 7.4 | 1.35 | .. | .. | .. | 1 | 14.0 | .. | .. |
| Total or Ave. | 71 | 8.0 | .13 | 1058 | 8.0 | 1.97 | 4 | 20.0 | .01 | 7 | 21.0 | 3 | 11.3 |

*Black crappies, suckers, and shiners were also caught but were taken in such small numbers that they constituted an insignificant portion of the total catch.

Table 4. Total hours fished and average hours fished, Fife Lake,
Summer and fall of 1934

| Date | Total hours fished | Hours fished, A.M. | Hours fished, P.M. | Time not given | Hours per fisherman-day |
|---|-----------------------|-----------------------|-----------------------|-------------------|----------------------------|
| June 25-30 | 316.5 | 88.5 | 228 | ... | 2.6 |
| July 1-7 | 376.0 | 213.0 | 161.5 | 1.5 | 2.25 |
| July 8-14 | 539.5 | 184.0 | 353.5 | 2.0 | 2.4 |
| July 15-21 | 484.0 | 224.0 | 260.0 | ... | 2.6 |
| July 22-28 | 665.5 | 300.75 | 360.75 | 4.0 | 2.8 |
| July 29-Aug. 4 | 739.25 | 279.0 | 455.75 | 4.5 | 2.8 |
| Aug. 5-11 | 644.5 | 207.0 | 437.5 | ... | 2.5 |
| Aug. 12-18 | 628.0 | 233.0 | 396.0 | ... | 2.4 |
| Aug. 19-25 | 284.25 | 112.25 | 170.0 | 2.0 | 2.4 |
| Aug. 26-Sept. 1 | 474.75 | 179.5 | 291.75 | 3.5 | 2.35 |
| Sept. 2-8 | 286.75 | 90.0 | 196.75 | ... | 2.45 |
| Sept. 9-15 | 342.0 | 66.5 | 275.5 | ... | 2.9 |
| Sept. 16-22 | 235.0 | 104.0 | 131.0 | ... | 3.4 |
| Sept. 23-29 | 115.25 | 53.75 | 61.5 | ... | 2.7 |
| Sept. 30 | 55.5 | 18.5 | 37.0 | ... | 3.5 |
| Totals or averages | 6187.75 | 2353.75 | 3816.5 | 17.5 | 2.6 |
| October | 519.0 | 135.5 | 383.5 | ... | 2.7 |
| November | 17.0 | 3.5 | 13.5 | ... | 2.1 |
| Totals or averages for Oct. and Nov. | 536.0 | 139.0 | 397.0 | ... | 2.7 |

average length of about 7.5 inches and were taken at the rate of .61 per hour. The catch, in terms of fish per hour, dropped decidedly during mid-summer (Fig. 2).

Most of the few walleyes (pike-perch) caught were taken during the first four weeks; few were taken after mid-July. On the average only one northern pike was taken from the lake every two days. A total of 303 bullheads were taken. They had an average length of 10.5 inches. The catch included 15 black crappies, 9 suckers and 4 shiners.

Total hours fished and average hours fished (see Table 4 and Fig. 3). --

The fishermen fished for a total of 6187.75 hours; 38% of the fishing was in the morning, 62% in the afternoon and evening. The daily fluctuation between morning and afternoon fishing was pronounced. Weather apparently was the chief factor responsible for this fluctuation. The average fishing day, 2.6 hours, varied relatively little from week to week. Obviously fishing on this lake did not occupy the major portion of the fisherman's time.

There were two daily peaks in fishing intensity (Fig. 3), one from 8:00 to 11:00 A.M., the other late in the afternoon. Over 10% of all fishing was between 6 and 7 P.M. Fishing was best, however, about daybreak and about dusk. Relatively few persons fished at the time of day when fishing was best (this is a sample of the information of value to anglers).

Table 5. General data on methods of fishing. Fife Lake, summer of 1934.

| Method | Reports covering each method | | Fish taken by each method | Fish per day's fishing | Ave. length of fish (in.) | Reports indicating no fish caught | |
|---------------|------------------------------|----|---------------------------|------------------------|---------------------------|-----------------------------------|------|
| | No. | % | | | | No. | % |
| Trolling | 221 | 10 | 193 | .87 | 14.1 | 102 | 46 |
| Casting | 66 | 3 | 58 | .88 | 12.5 | 28 | 42.4 |
| Still-fishing | 1919 | 87 | 9504 | 4.95 | 8.2 | 380 | 19.8 |

*This computation does not include the 189 records indicating the use of several methods of fishing in one day or not indicating which method was used. These 189 reports gave a total catch of 901 fish, 4.8 fish averaging 8.7 inches long per fishing day. It therefore appears that most of these reports refer to still fishing.

Methods of fishing and kinds of bait used (see Tables 5, 6 and 7, and Figs. 4, 5 and 6).--More than 90% of the records indicated one method of fishing, either still-fishing, casting, or trolling; 87% of the fishing by a single method was done by one method, still-fishing, which yielded a daily average per person of about 5 fish averaging 8.2 inches long. About one-fifth of the reports on still-fishing showed no catch. The 10% of the fishing which was by trolling produced on the average less than 1 fish per fishing day; almost half of the trolling days yielded no fish at all, but the fish that were caught averaged 14.1 inches in length. Only 3% of the fishing was by casting, and resulted in an average catch of less than one fish, averaging 12.5 inches long, per fishing day; 42.4% of the reports for casting indicated no fish caught. Obviously the method which produced most fish per fisherman yielded fish averaging the smallest. This was not unexpected: a method which produces numerous large fish would soon be used almost universally.

Table 6. General data on effectiveness of various kinds of bait used, Wife Lake, summer of 1934.

| Bait used | No. of records | % getting no fish | Hrs. per fishing day | No. of fish taken | Fish per hour | Ave. size of all fish (in.) |
|--------------------|----------------|-------------------|----------------------|-------------------|---------------|-----------------------------|
| ARTIFICIAL: | | | | | | |
| Spinner | 102 | 33 | 2.3 | 197 | 0.9 | 12.5 |
| Plug | 75 | 39 | 2.4 | 86 | 0.5 | 14.5 |
| Artificial fly | 10 | 50 | 2.1 | 23 | 2.3 | 8.2 |
| NATURAL: | | | | | | |
| Minnows | 857 | 17 | 2.7 | 4336 | 1.9 | 8.4 |
| Worms | 832 | 17 | 2.5 | 3936 | 1.9 | 7.8 |
| Grasshoppers | 27 | 33 | 3.1 | 140 | 1.7 | 9.3 |

Six kinds of bait were listed, 3 artificial (spinner, plug, and artificial fly), and 3 natural (minnows, worms, and grasshoppers). Spinners, indicated as used exclusively by 102 reports, produced per hour, on the average, almost one fish; the fish so caught had an average length of 12.5 inches; a third of the spinner-fishing records

showed no catch. Plugs, used exclusively on 75 fishing days, yielded only one-half fish per hour, but these average^d 14.5 inches; more than one-third of the fishing records for plugs listed no fish at all. Artificial flies were used so little, that the figures available have little significance.

Minnows, used exclusively on 857 fishing days, produced per hour 1.9 fish, having an average length of 8.4 inches. Worms were almost identical with minnows in effectiveness, except that they produced fish of a slightly smaller average size (7.8 inches). Grasshoppers, used very little as bait, were almost as effective as worms or minnows and produced fish of a larger average size. As expected, the number of fish taken per hour by different types of bait was inversely proportional to the average size of fish taken, and the larger the average size of fish taken, the less was the chance of getting any fish at all.

Table 8. Comparison of line fishing and spearing on Five Lake, Dec. 21 to Apr. 4, 1933-1934 and Dec. 1-20, 1934.
(To accompany p. 15)

| | Line fishing | Spearing | Total or average |
|------------------------------|--------------|----------|------------------|
| Hours fished | 715.5 | 1382.75 | 2098.25 |
| No. of fishermen | 142 | 332 | 474* |
| Ave. hours per fisherman-day | 5.0 | 4.2 | 4.5 |
| Fish caught | 154 | 132 | 286 |
| Fish per hour | .215 | .095 | .13 |
| Hours per fish | 4.6 | 10.4 | 7.3 |
| Fish per fisherman-day | 1.1 | .4 | .6 |
| Perch | 133 | ... | 133 |
| Walleyes | 5 | 1 | 6 |
| Northern pike | 13 | 103 | 116 |
| Bullheads | ... | 17 | 17 |
| Common suckers | ... | 11 | 11 |
| Shiners | 3 | ... | 3 |
| Average size of all fish | 11.8 | 22.8 | 16.9 |

*7 used both lines and spears and were considered separately under each. The actual number of fisherman-days was 467.

Largemouth bass were most successfully taken on artificial^a bait; on the average, spinners yielded most largemouths per unit time, plugs took the largest (results on grasshoppers and artificial flies are not considered in this statement or in subsequent remarks). Smallmouth bass were taken with almost equal success on natural and

Table 7. Analysis of catch (by species) on various kinds of bait.
Pife Lake, summer of 1934.

| | All species | Largemouth bass | Smallmouth bass | Rock bass | Bluegills | Sunfish | Perch | Walleyes | Northern pike | Bullheads |
|------------------------|-------------|-----------------|-----------------|-----------|-----------|---------|-------|----------|---------------|-----------|
| ARTIFICIAL BAIT | | | | | | | | | | |
| Spinner: | | | | | | | | | | |
| Number caught | 197 | 41 | 44 | 35 | 20 | 10 | 12 | 27 | 8 | - |
| Average size | 12.5 | 13.4 | 13.1 | 9.0 | 7.6 | 7.7 | 9.8 | 19.1 | 20.1 | - |
| Catch per hr. | .9 | .18 | .19 | .15 | .09 | .04 | .05 | .12 | .03 | - |
| Plug: | | | | | | | | | | |
| Number caught | 86 | 20 | 22 | 6 | 2 | - | 14 | 18 | 4 | - |
| Average size | 14.5 | 15.2 | 13.3 | 8.3 | 10.0 | - | 7.8 | 21.7 | 20.0 | - |
| Catch per hr. | .5 | .11 | .12 | .03 | .01 | - | .08 | .10 | .02 | - |
| Artificial Fly: | | | | | | | | | | |
| Number caught | 23 | - | 2 | 2 | 12 | 1 | 4 | - | - | - |
| Average size | 8.2 | - | 11.0 | 8.0 | 8.6 | 7.0 | 7.5 | - | - | - |
| Catch per hr. | 2.3 | - | .10 | .10 | .57 | .05 | .19 | - | - | - |
| NATURAL BAIT | | | | | | | | | | |
| Minnows: | | | | | | | | | | |
| Number caught | 4336 | 110 | 459 | 724 | 603 | 336 | 1943 | 18 | 22 | 101 |
| Average size | 8.4 | 13.0 | 12.5 | 7.9 | 7.4 | 6.8 | 7.6 | 19.7 | 23.0 | 9.7 |
| Catch per hr. | 1.9 | .05 | .20 | .31 | .26 | .14 | .84 | .01 | .01 | .04 |
| Worms: | | | | | | | | | | |
| Number caught | 3936 | 47 | 234 | 901 | 926 | 672 | 1106 | 5 | 6 | 137 |
| Average size | 7.8 | 12.2 | 11.8 | 8.0 | 7.1 | 6.9 | 7.2 | 20.8 | 18.8 | 11.4 |
| Catch per hr. | 1.9 | .02 | .11 | .44 | .45 | .28 | .54 | trace | trace | .07 |
| Grasshoppers: | | | | | | | | | | |
| Number caught | 140 | 11 | 14 | 48 | 53 | - | 14 | - | - | - |
| Average size | 9.3 | 16.9 | 11.6 | 8.8 | 7.7 | - | 8.4 | - | - | - |
| Catch per hr. | 1.7 | .13 | .17 | .58 | .64 | - | .17 | - | - | - |

artificial bait, although artificial bait took fish of a larger average size. Large-mouth and smallmouth bass showed a decided difference in their response to the several kinds of bait (see Fig. 4). Perch were mostly taken on minnows; walleyes responded chiefly to artificial bait; northern pike were taken also most frequently on artificial bait, but the largest ones, on the average, were caught on minnows (Fig. 5). Rock bass, bluegills and sunfish were most successfully fished for with worms as bait (Fig. 6).

Relation between fishing and weather (chart omitted).--Such creel census may also be used to test the relationship between fishing and weather, and this was done for the Fife Lake census. For each day of July and August, the per-hour catch data for all fish and for each of 5 species were plotted on a chart. Barometric pressure for each day, prevailing wind direction, temperature at 6:00 P.M. and median daily temperature, condition of sky (whether clear, partly cloudy, or cloudy), and precipitation, were then plotted on the same graph. A preliminary examination of this chart fails to indicate a close relationship between fishing and any one of the several meteorological factors which were considered, and therefore apparently fails to lend any considerable support for any one of these theories, although it does not alone and conclusively disprove these supposed relations.

Relation between fishing by residents and visitors.--Although the Fife Lake creel census of 1934 did not involve the necessary data, such a census can be used to compare the fishing by local and visiting anglers. Such comparisons, now being made on census for Fife and other lakes, will provide data bearing on the frequent local controversies between these two groups of fishermen.

Fall Fishing

Fall fishing, which is here considered as restricted to the months of October and November, and data for which are included in some of the preceding tables for summer fishing, are shown by the creel census to be characterized by the following features, among others. Less fishing was done in Fife Lake during the entire fall than in almost any one week in mid-summer; only 190 fishing days in October and 8 in November were

listed. Fewer fishing days yielded no fish at all in the fall than in the summer, but as in the summer, fewer women than men, proportionally, had complete failures. No limit catches were made in the fall, but on a fish per hour basis, fall fishing was much better than summer fishing. Perch, constituting 80% of the total fall catch, were then taken at the average rate of 2 fish per hour. Fall fishing was all still-fishing, with the exception of a very few hours of trolling, and was concentrated in the late morning and the early and mid-afternoon, probably because of warmer air temperature at those hours.

Winter Fishing (Table 8)

The winter records, taken for the fishing from December 21, 1933, to April 1, 1934, and December 1 to 20, 1934, thus covering one full winter period though taken in two winters, yielded a number of important conclusions regarding fishing at that season. Winter fishing consisted chiefly of spearing, only one-third of line-fishing. The total winter fishing covered 2098.25 hours, on 474 fishing days, an average of 4.5 hours per day. The 142 line fishing days yielded 154 fish, while the 332 spear fishing days produced only 132 fish. Fish were taken at the rate of about 1 every 5 hours with lines and 1 every 10 hours with spear. Each day of line fishing yielded an average of one fish; each day of spearing an average of less than half a fish. Seventy percent of all the winter reports showed no fish caught. The spearing chiefly produced northern pike, while line fishing mostly yielded perch. The average length of all fish caught with lines was 11.8 inches, with spear 22.8 inches, while the average length for all winter-caught fish was about 17 inches. There were no limit catches. All fishing was between 9:00 A.M. and 5:00 P.M. The catch was so meager that a "best fishing" curve could not be made. Only 14 of the winter reports were for women, who caught a total of one fish, a northern pike.

Comparison of the Fishing in Different Seasons (Table 9, first 3 columns).--Of the total of 9,318.5 fisherman-hours in Fife Lake for the year, ending December 20, 1934, 22.5% was in winter, 71.6% in the summer, and 5.9% in fall. The records show 467

fisherman-days in the winter (14.4%), 2,570 in the summer (79.4%), and 201 in the fall (6.2%). The average number of hours per fisherman-day was 4.5 for the winter, almost twice as many as in summer (2.6) or fall (2.7): people fished longest at a season when the weather was the least pleasant and when there was the least probability of catching fish. Of the total of 13,072 fish caught (not including 74 fish for which the lengths were not given), 2.2% were taken in winter, 87.7% in summer and 10.1% in the fall. Almost a fourth of the fishing was in winter but only a little more than one-fiftieth of the fish were caught during that season. The average catch per person per day was 0.6 in the winter, 4.4 in the summer and 6.6 in the fall; the average catch per hour was 0.13 in the winter, 1.72 in the summer and 2.43 in the fall. The fish caught, in the winter, however averaged approximately twice as long as those taken in the other seasons.

Perch, which constituted 2 out of every 5 [taken] of the fish were caught most commonly in the fall, very seldom in the winter; rock bass, mostly taken in the summer; bluegills were decidedly summer-caught fish. No comparison of the winter and summer fishing for smallmouth and largemouth bass was obtained, because the season is closed for these species in the winter. Northern pike were mostly caught in the winter. Fishing for both pike and perch was poor during the heat of summer.

Winter fishing was extensive in terms of hours fished. Shanties on the ice and men fishing with 4 or 5 ice lines each are conspicuous. It is not to be wondered at that many resorters feel that the winter fishing is responsible for poor summer fishing. When the actual catch records are taken into consideration, however, it is obvious that the winter fishing in Mife Lake could not have been injurious to fishing during the following summer.

The annual fish crop (see Table 9, last 2 columns).--The creel census being reported upon gives us perhaps the most reliable data on the fishing intensity and on the annual fish crop, available for any public lake in America devoted to sport fishing. On this 800-acre average Michigan lake, a total of more than 9,300 hours of fishing were spent in one year, an average of 11.65 per acre (since most of the lake area was

Table 9. Comparison of fishing in different seasons, and for the whole year (Dec. 21, 1933-Dec. 20, 1934).

| | Winter Dec. 1-Apr. 4 | Summer June 25-Sept. 30 | Fall Oct. and Nov. | Entire Year | Per Acre |
|-----------------------------|-------------------------|-------------------------------|-----------------------|---------------------|-------------|
| Hours fished | 2098.25 | 6187.75 (+488.5) ¹ | 536 (+8) ¹ | 9318.5 ¹ | 11.65 |
| % of total | 22.5 | 71.6 | 5.9 | ... | ... |
| No. of fisherman-days | 467 | 2399 (+181) | 198 (+3) | 3248 | 4.06 |
| % of total | 14.4 | 79.4 | 6.2 | ... | ... |
| Hours per fisherman-day | 4.5 | 2.6 | 2.7 | 2.9 | ... |
| No. of fish | 286 | 10656 (+804) | 1306 (+20) | 13072 ² | 16.33 |
| % of total | 2.2 | 87.7 | 10.1 | | ... |
| Fish per fisherman-day | .6 | 4.4 | 6.6 | 4.0 | ... |
| Fish per hr. | .13 | 1.72 | 2.43 | 1.4 | ... |
| Ave. size of all fish (in.) | 16.9 | 8.33 | 8.4 | 8.5 | ... |
| PERCH³ | | | | | |
| Number | 133 | 3757 (+283) | 1058 (+16) | 5247 | 6.55 |
| % total catch | 46.5 | 35.24 | 80 | 40.1 | ... |
| Perch per hour | .06 | .61 | 1.97 | .56 | ... |
| Ave. size | 9.0 | 7.4 | 8.0 | 7.6 | ... |
| ROCK BASS | | | | | |
| Number | ... | 2129 (+160) | 71 (+1) | 2361 | 2.95 |
| % total catch | ... | 20.0 | 5.4 | 18.1 | ... |
| Rock bass per hr. | ... | .34 | .13 | .25 | ... |
| Ave. size | ... | 7.9 | 8.0 | 7.9 | ... |
| BLUEGILL | | | | | |
| Number | ... | 1970 (+148) | 80 (+1) | 2199 | 2.75 |
| % total catch | ... | 18.49 | 6.2 | 16.8 | ... |
| Bluegills per hr. | ... | .32 | .15 | .24 | ... |
| Ave. size | ... | 7.2 | 7.5 | 7.2 | ... |
| SMALLMOUTH BASS | | | | | |
| Number | ... | 992 (+74) | 50 (+1) | 1117 | 1.40 |
| % total catch | ... | 9.31 | 3.8 | 8.5 | ... |
| Smallmouth bass per hr. | ... | .16 | .09 | .12 | ... |
| Ave. size | ... | 12.25 | 14.4 | 12.3 | ... |
| SUNFISH | | | | | |
| Number | ... | 1016 (+76) | 10 | 1102 | 1.38 |
| % total catch | ... | 9.53 | .8 | 8.4 | ... |
| Sunfish per hr. | ... | .16 | .02 | .12 | ... |
| Ave. size | ... | 6.8 | 7.1 | 6.8 | ... |
| BULLHEAD | | | | | |
| Number | 17 | 303 (+23) | 3 | 346 | 0.43 |
| % total catch | 5.9 | 2.84 | ... | 2.6 | ... |
| Bullheads per hr. | .008 | .05 | ... | .03 | ... |
| Ave. size | 12 | 10.5 | 11.3 | 10.6 | ... |
| LARGEMOUTH BASS | | | | | |
| Number | ... | 294 (+22) | 23 | 339 | 0.42 |
| % total catch | ... | 2.76 | 1.8 | 2.6 | ... |
| Largemouth bass per hr. | ... | .04 | .04 | .03 | ... |
| Ave. size | ... | 13.5 | 13.7 | 13.5 | ... |
| NORTHERN PIKE | | | | | |
| Number | 116 | 48 (+4) | 7 | 175 | 0.22 |
| % total catch | 39.9 | .45 | ... | 1.3 | ... |
| Pike per hr. | .05 | .01 | ... | .015 ³ | ... |
| Ave. size | 25.4 | 21.8 | 21 | 24.1 | ... |
| WALLEYE | | | | | |
| Number | 6 | 119 (+9) | 4 | 138 | 0.17 |
| SUCKER | | | | | |
| Number | 11 | 9 (+1) | ... | 21 | 0.03 |
| BLACK CRAPPIE | | | | | |
| Number | ... | 15 (+1) | ... | 16 | 0.02 |
| SHINER | | | | | |
| Number | 3 | 4 | ... | 7 | 0.01 |

¹ The figures in parenthesis, for fishermen seen but not directly contacted, for those whose fishing was incorrectly recorded and for those whose records were lost, were used in the total catch and in the percentage computations, on the assumption that these fishermen made average catches.

² Seventy-four additional fish were recorded, for which the length was lacking. These included smallmouth bass (1), rock bass (16), bluegills (19), sunfish (9), perch (25) and bullheads (4); and were not included in the calculations.

³ Species taken in order of their abundance in the catch.

of unsuitable depth, the fishing intensity on the actual fishing grounds was of course much greater). The fisherman days numbered 3,248 (about 4 per acre). This fishing yielded more than 13,000 fish averaging 8.5 inches,--1.75 miles of fish laid end to end. The average yield of fish per hour was 1.4, or 4.0 per fishing day averaging 2.9 hours. Perch (5,247 taken) constituted about 40% of the annual harvest, rock bass 18%, bluegills 17%, smallmouth bass and sunfish about 8.5% each, bullheads and largemouth bass 2.6%, northern pike 1.3%, walleyes 1.1%; suckers, black crappies and shiners in insignificant proportion. The fish crop of this lake is therefore a diversified one. The yield per acre was 6.55 for perch, and proportionately less for the other species taken. The total yield of all fish was 16.3 per acre, perhaps about 10 pounds per acre, considering the entire area of the lake (the poundage per acre will be computed after the length-weight relation has been established for the various species caught).

Creel Census as an Aid in Fish Management

It is obvious that the information determined by such a creel census is potentially of great value in fish management. An adequate inventory will surely be required before fish management can be placed on a business-like basis. A few of the ways by which fish management of inland lakes could be benefitted by a thorough creel census are:

1. Determinations of the trend of the fishing returns for the various species caught, determined over a period of years, will indicate what needs be done to maintain or increase the fish crop, and the maximum annual crop which may be harvested without injury to the future fishing.

2. The determination of the number of undersized fish taken, coupled with the growth rate studies, will allow predictions to be made of the catch which may be expected for the following few years.

3. The creel census can be used to determine the effectiveness of existing legal restrictions and, in over-fished waters, would help to indicate what restrictions will be of greatest benefit to the lake and the least objectionable to the fisherman. It

is entirely possible that the present size limits and bag limits on some species are definitely injurious to the fishing as a whole.

4. A creel census coupled with fish-marking would indicate the number of adult fish in the lake, and the percentage of adult fish removed annually.

5. Coupled with planting and tagging experiments, the census could provide data sufficient to evaluate the benefits derived from stocking.

6. Coupled with lake improvement, the census could similarly be made to indicate, in time, what benefits if any are derived from the improvement work in general, and from improvement devices of different sorts.

7. If carried out on a representative number of lakes of various types and sizes, and if the area of the lakes of a state is determined, the creel census could be used to indicate the approximate annual catch of game fish for the state. If acreage determinations for Michigan lakes are correct, and if Fife Lake fishing was exactly average, the inland lakes of Michigan produced in 1934 a total of 13,500,000 legal-sized fish. If the fish taken from all the lakes averaged the same as for Fife Lake, they have a total length of 1800 miles, approximately equal to the air line distance from southwestern Michigan to Los[^] Angeles, California. Obviously this estimate of total production can not be determined with any reasonable accuracy from the census on one lake, but is mentioned to indicate the sort of inventory of the total game fish catch of the inland lakes in the state which could be made with considerable accuracy provided the creel census was materially expanded.

8. The investigations of the Institute for Fisheries Research lead us to believe that a reasonably sound stocking policy for inland lakes, including a stocking budget, could be formulated by a combination of an extensive creel census with an inventory and classification of the lakes and with biological studies, especially with the determination of the growth rates of the different species in various lakes.

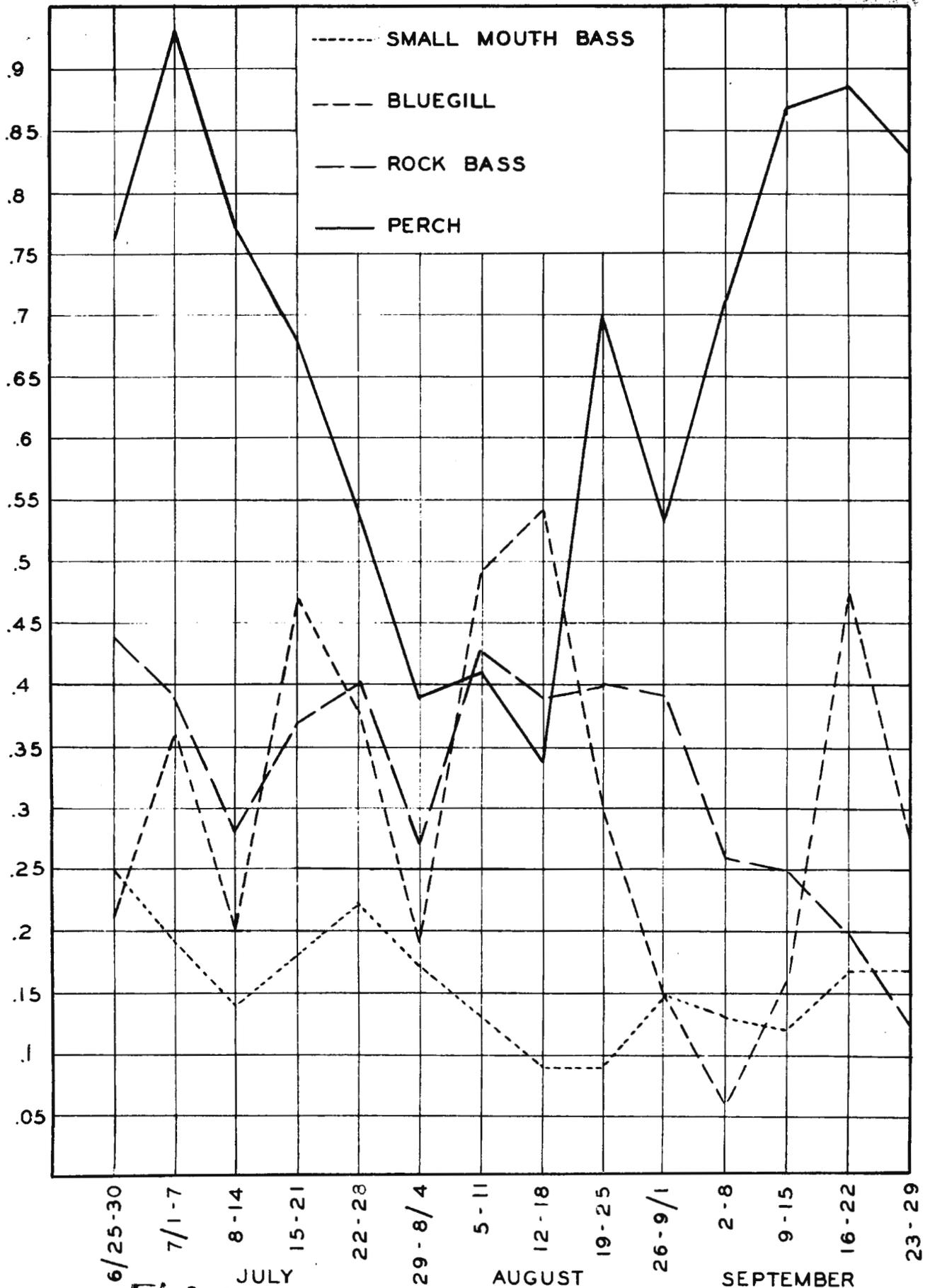
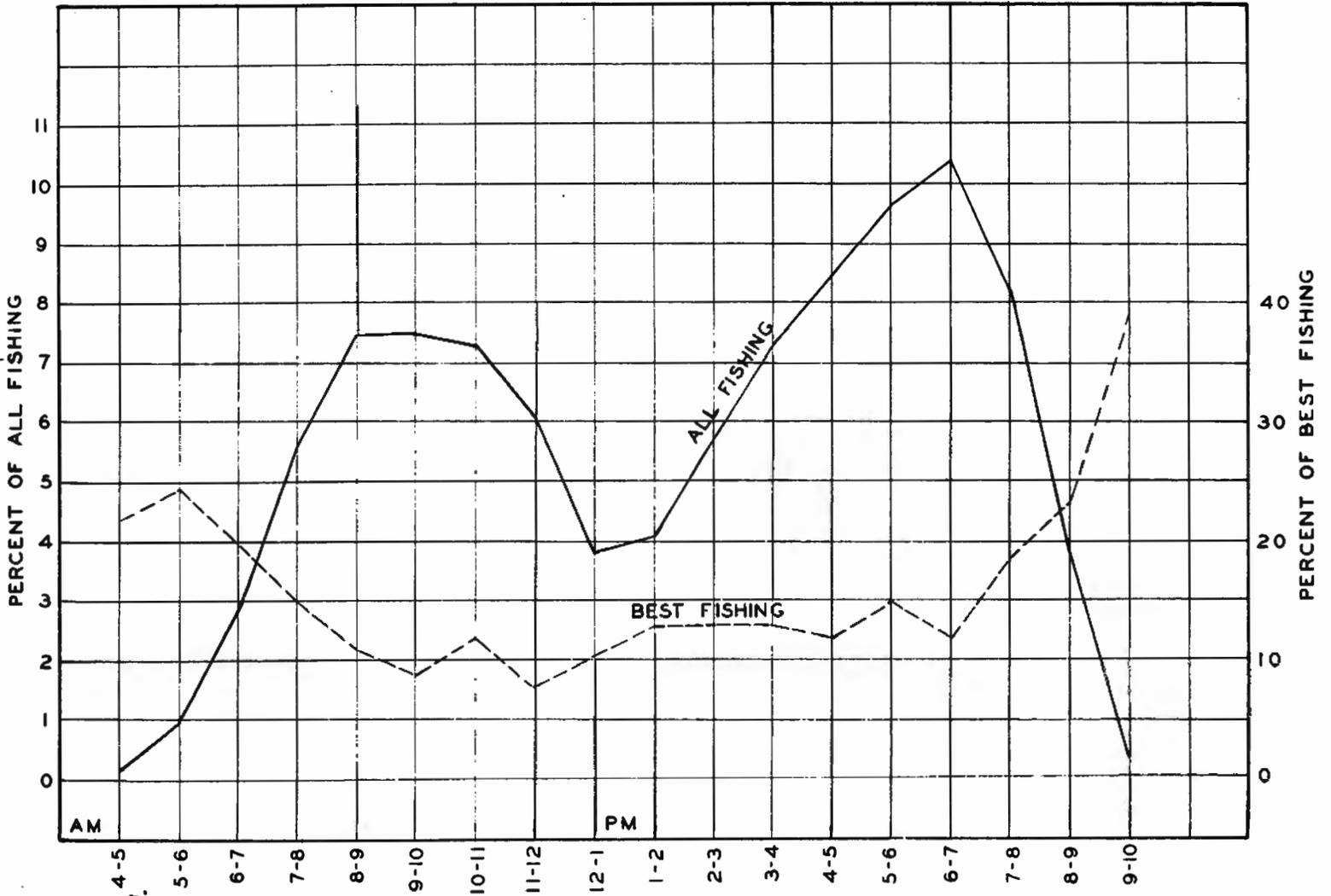
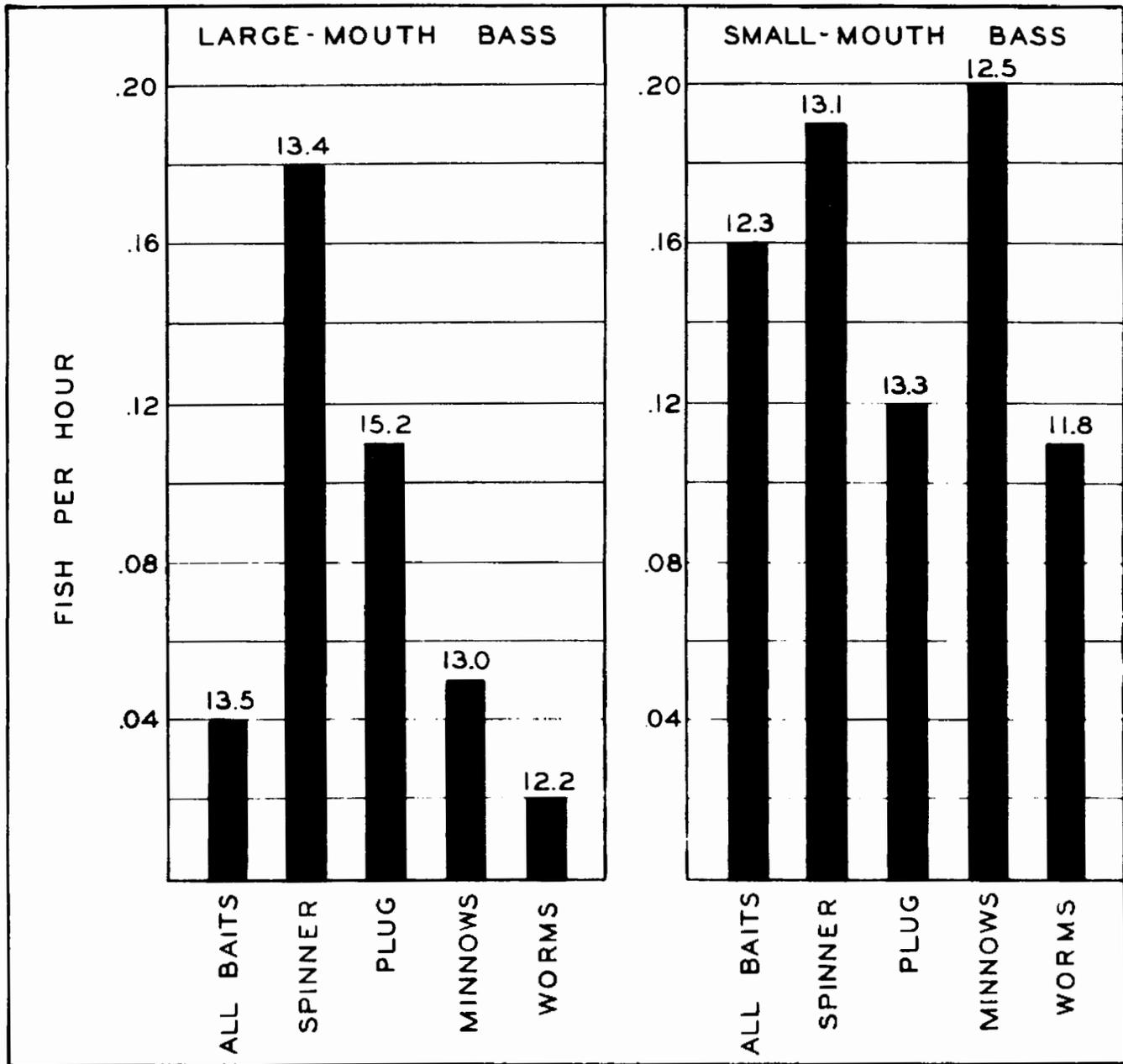


Fig. 2
 GRAPH NO. 3 FISH PER HOUR CALCULATED TO THE NEAREST
 .01 HOUR FOR THE ABOVE SPECIES ON A WEEKLY BASIS
 FIFE LAKE SUMMER OF 1934

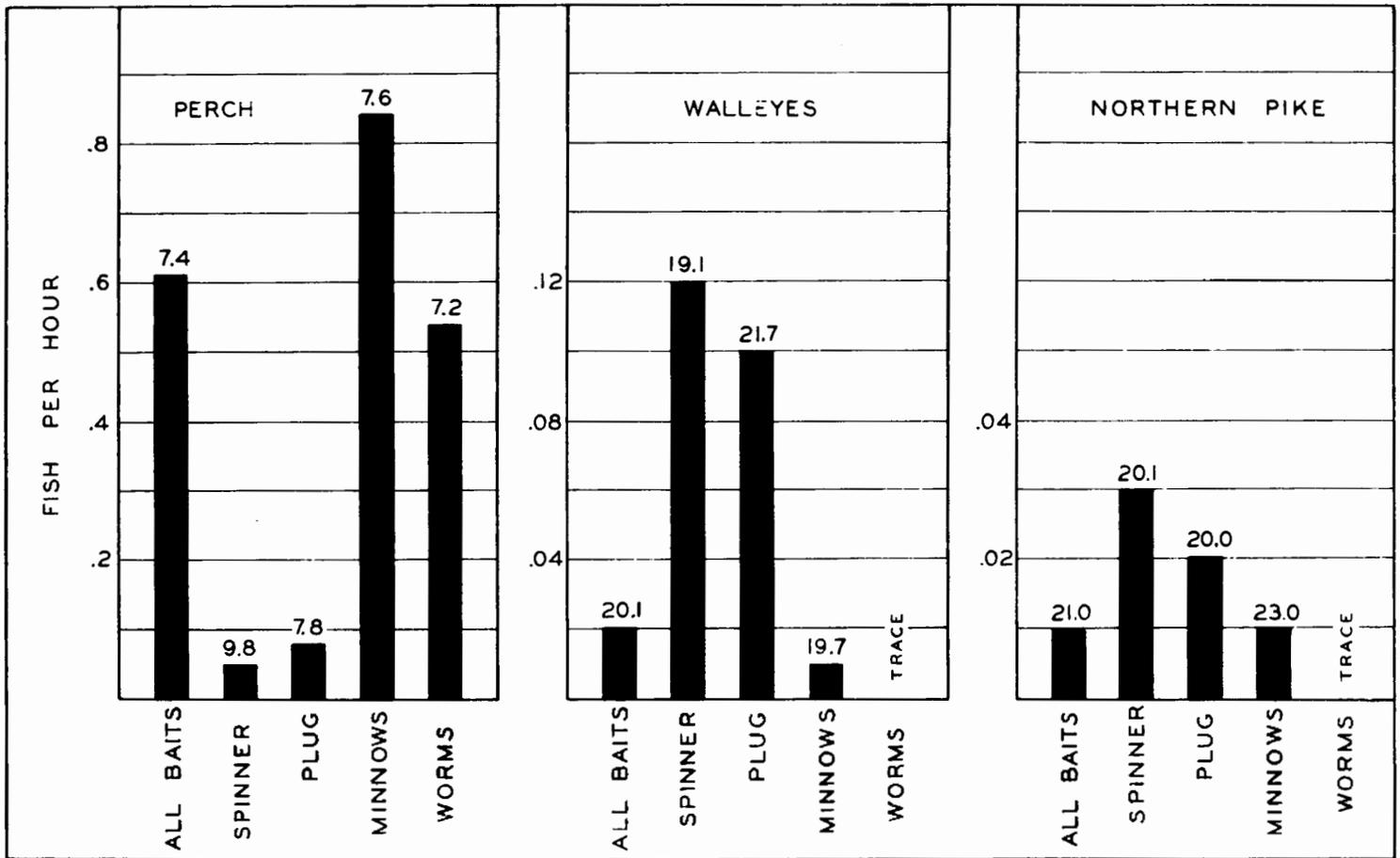


GRAPH NO. 3 ALL FISHING AND BEST FISHING FOR EACH HOUR. FIFE LAKE IN SUMMER OF 1934



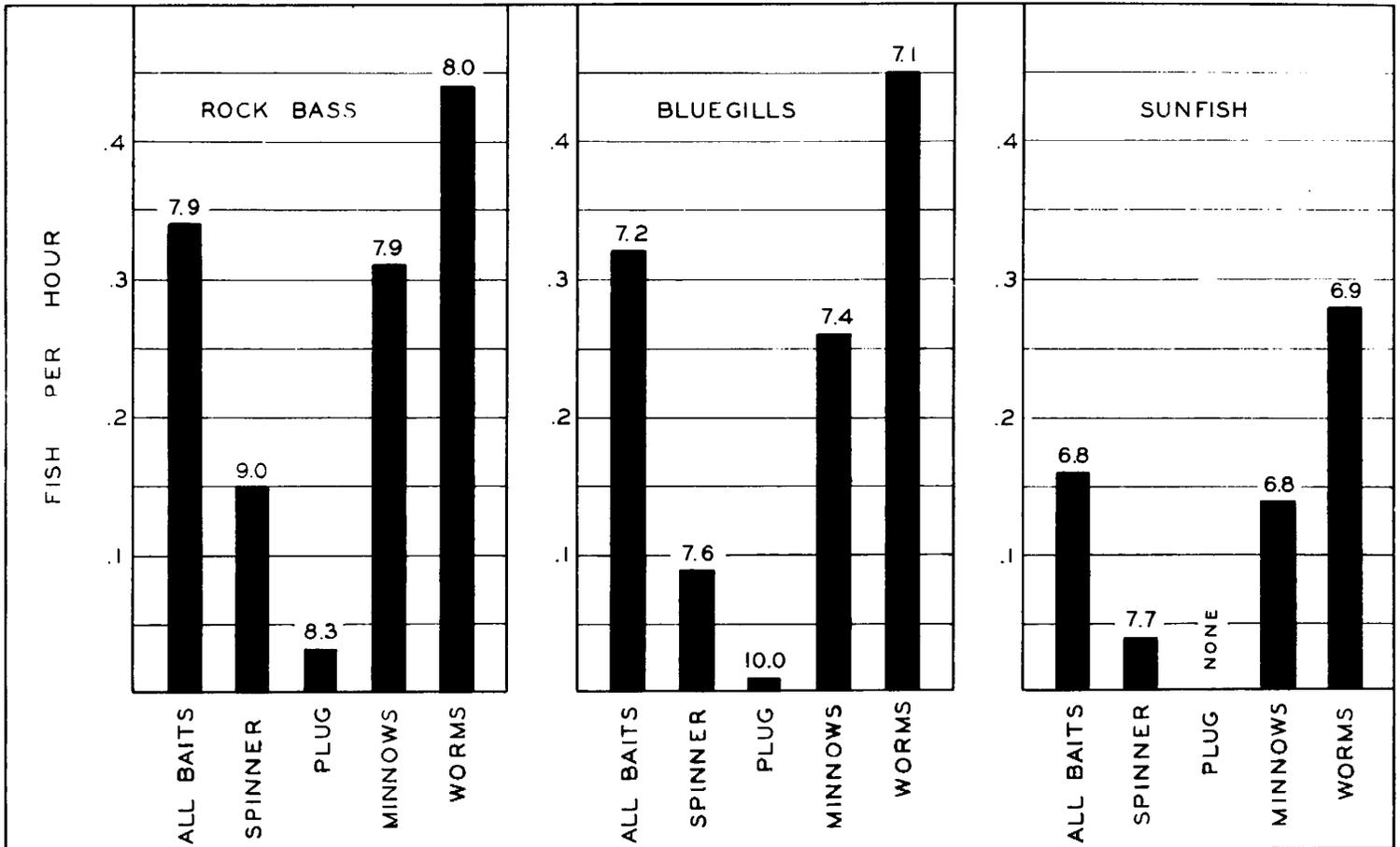
CATCH, IN TERMS OF FISH PER HOUR, OF LARGE-MOUTH BASS AND SMALL-MOUTH BASS ON ALL BAITS AND ON EACH OF FOUR DIFFERENT KINDS OF BAIT. SUMMER OF 1934, FIFE LAKE. FIGURES AT THE TOP OF EACH COLUMN SHOW THE AVERAGE SIZE, IN INCHES, OF FISH CAUGHT.

Fig. 4



CATCH, IN TERMS OF FISH PER HOUR, OF PERCH, WALLEYES, AND NORTHERN PIKE ON ALL BAITS AND ON EACH OF FOUR DIFFERENT KINDS OF BAIT, FIFE LAKE, SUMMER OF 1934. FIGURES AT THE TOP OF EACH COLUMN SHOW THE AVERAGE SIZE, IN INCHES, OF FISH CAUGHT.

Fig 5



CATCH, IN TERMS OF FISH PER HOUR, OF ROCK BASS, BLUEGILLS, AND SUNFISH ON ALL BAITS AND ON EACH OF FOUR DIFFERENT KINDS OF BAIT. FIFE LAKE, SUMMER OF 1934. FIGURES AT THE TOP OF EACH COLUMN SHOW THE AVERAGE SIZE IN INCHES OF FISH CAUGHT.

Fig. 6