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DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
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ESTIMATES OF THE POPULATIONS OF SIX SPECIES OF FISH IN FIFE LAKE, GRAND TRAVERSE AND KALKASKA COUNTIES

By Kenneth E. Christensen

A fish population study employing three different methods of capture was made at Fife Lake, Grand Traverse and Kalkaska counties, in 1958. Fish for marking were taken in trap nets or a seine; the population estimates were based on the ratios between marked and unmarked fish caught in the trap nets, in the seine, or by public angling.

The population study was begun by nine days of trap netting (May 10-19) with six 6-foot trap nets. In selecting the trap-net sites, Fife Lake was first arbitrarily divided into a "north" and a "south" half along the deep trough which passes through the center of the lake (in a southeast to northwest direction), to assure a good distribution of net stations in the extensive shallows located in each half of the lake (Figure 1). A numbered transparent grid was then placed over the hydrographic map of the lake, and approximately equal numbers of stations (total of 49, all in water less than 15 feet deep) were selected in the north and south halves, by reference to a table of random numbers. The trap nets (three in each half of the lake) were lifted daily and reset at different predetermined locations, except on May 18, when strong winds prevented the movement of five of the nets and thus extended the netting period at stations 43 and 45-48 to 2 days.

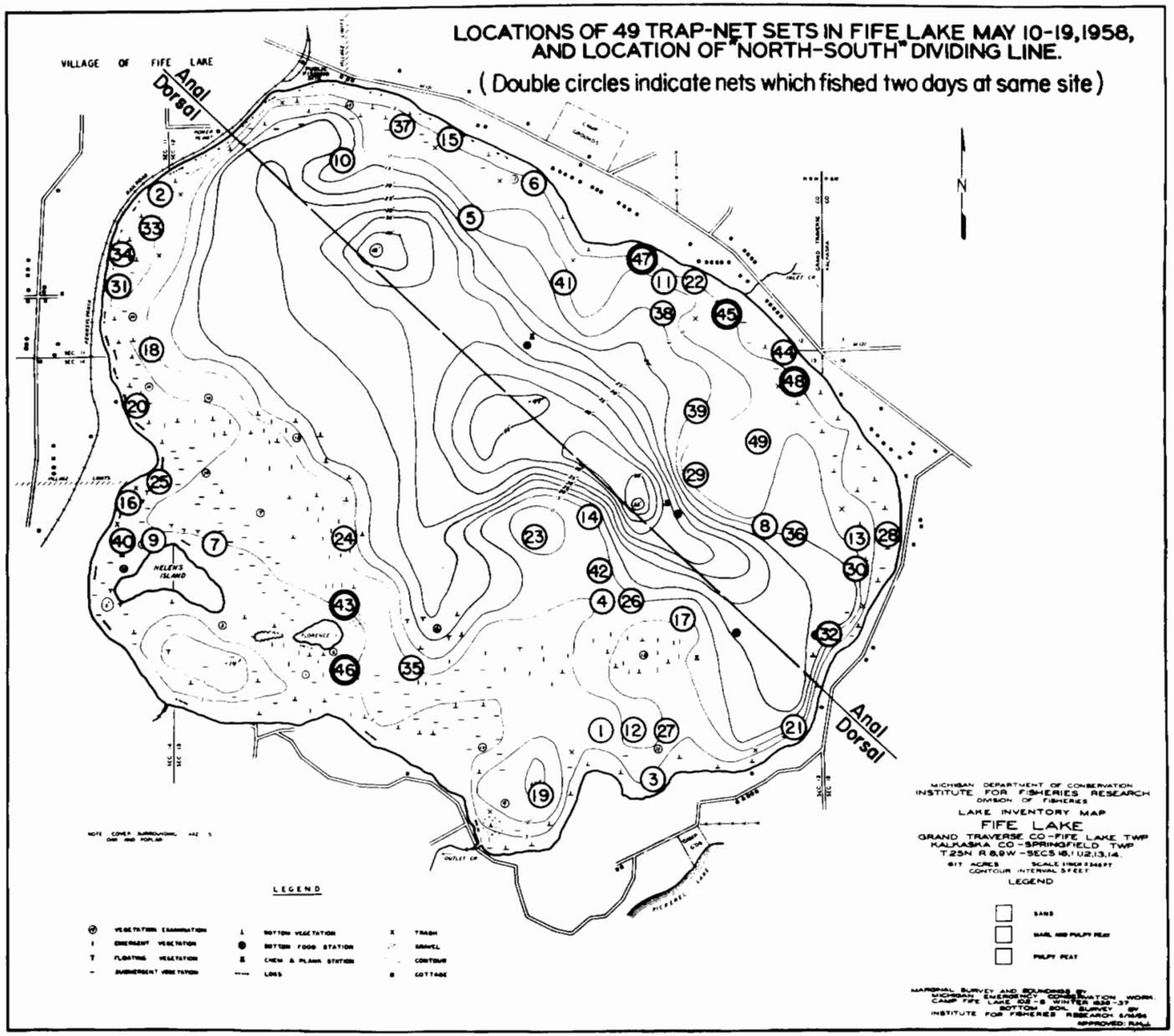
LOCATIONS OF 49 TRAP-NET SETS IN FIFE LAKE MAY 10-19,1958,
AND LOCATION OF "NORTH-SOUTH" DIVIDING LINE.
. (Double circles indicate nets which fished two days at same site)
VILLAGE OF FIFE LAKE
Anal
Dorsal
Anal
Dorsal
N
HELEN'S ISLAND
FLORENCE
PICKEREL LAKE
LEGEND
MICHIGAN DEPARTMENT OF CONSERVATION
INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
LAKE INVENTORY MAP
FIFE LAKE
GRAND TRAVERSE CO-FIFE LAKE TWP
KALKASKA CO-SPRINGFIELD TWP
T 25N R 8,9 W-SECS 18,1 1,12,13,14.
617 ACRES
CONTOUR INTERVAL 5 FEET
LEGEND
SAND
MARL AND MUCKY PEAT
MUCKY PEAT

Figure 1

The trap nets caught 3,182 fish (initial captures) and recaptured 423 fish (Table 1). Some fish may have been recaptured more than once (recaptured fish were not identified by a second mark before release). Rock bass were taken most frequently in the trap nets, followed by bluegills, black crappies, largemouth bass, smallmouth bass, northern pike, common sucker, pumpkinseeds, bullheads, yellow perch, and walleyes, in that order.

All fish taken in the trap nets were marked by removal of part of either the anal fin (north half of the lake) or dorsal fin (south half of the lake) and most were scale sampled, before they were released near the point of capture. Of the initial captures, 1,293 fish were taken in the north half of the lake (of which 280 were later recaptured) and 1,890 in the south half (143 recaptured). Of the recaptures, 304 were taken in the north half (269 originally caught in the north half and 35 in the south), and 119 were taken in the south half (108 originally from the south half and 11 from the north).

After the trap nets had been removed, the Department's Lake and Stream Improvement Section operated a 2,700-foot seine at Fife Lake on May 20-27. The seine had a bag at one end, 400 feet long by 15 feet deep, of 1/2-inch mesh (bar measure). The dimensions of other sections of the seine were as follows (in sequence, between the bag and the opposite end of the net): 600 feet by 16 feet (tapered to 24 feet) of 1-inch mesh, 600 feet by 24 feet of 1 1/2-inch mesh, 600 feet by 24 feet (tapered to 16 feet) of 1 1/2-inch mesh, and 500 feet by 16 feet of 1 1/2-inch mesh. In operation, the seine was set in a semicircle from shore and reefed by a gasoline-powered winch at the end opposite from the bag. The fish captured were examined for previous marks, measured, marked by removal of a pelvic fin, and released at the point of capture.

Table 1.--Species and numbers of fish caught in 54 overnight trap-net sets at Fife Lake, May 10-19, 1958

Species	Initial capture[1]			Recapture				Total
				Marked in North half		Marked in South half		
	North half	South half	Total	North half	South half	South half	North half	
Largemouth bass	83	116	199	8	...	4	...	12
Smallmouth bass	106	57	163	14	1	1	2	18
Northern pike	40	71	111	1	...	1	...	2
Walleye	1	...	1	...	...	...	...	...
Bluegill	71	263	334	2	...	2	...	4
Yellow perch	1	10	11	...	...	1	...	1
Pumpkinseed	15	55	70	...	...	...	...	...
Black crappie	53	162	215	12	1	5	...	18
Rock bass	834	1,102	1,936	229	8	90	32	359
Bullhead	9	33	42	1	...	3	1	5
Common sucker	80	21	101	3	...	1	...	4
All species	1,293	1,890	3,183	270	10	108	35	423

[1] Fish were marked by removal of a portion of the anal fin if caught in the North half of the lake, and a portion of the dorsal fin if caught in the South half.

Nine seine hauls were made during the 8-day period, at different locations along the lake shore (Figure 2). When more than one haul was made in a day, only part of the seine was used for one or both of the hauls. Seining was made difficult and slowed by narrow shoals, sawmill debris, and submerged obstacles. Of the 2,367 bluegills captured in the second seine haul, 1,691 were weak from handling and were released without being marked. The recaptured fish in this group (7 dorsal clip and 2 anal clip) were not returned to the lake.

The seining yielded a total of 11,552 fish, of which 219 had been marked after original capture in trap nets or earlier seine hauls (Table 2). Far more bluegills (8,603) were taken than all other species combined. Other species caught, in descending order of abundance, were pumpkinseeds, yellow perch, largemouth bass, black crappies, rock bass, northern pike, and smallmouth bass.

Population estimates

The data from netting and seining at Fife Lake, and from an intensive creel census[1] during the 3 months following the netting (See Table 3), were used to calculate the populations of various species, by several methods or variations of methods.

The data were collected primarily to be used for a direct-proportion estimate.[2] Data were adequate for estimates of the population of six species by this method: bluegill, northern pike, largemouth bass, smallmouth bass, rock bass, and black crappie. The different estimates were made for fish of the following minimum lengths: bluegills, rock bass and crappies, 6 inches; bluegills, 4 inches; bass, 10 inches; and northern pike, 14 inches. Among the six separate estimates of the number of bluegills 6 inches long or longer, the four based on the ratio of bluegills marked by trap nets and included in the catch by seine varied from

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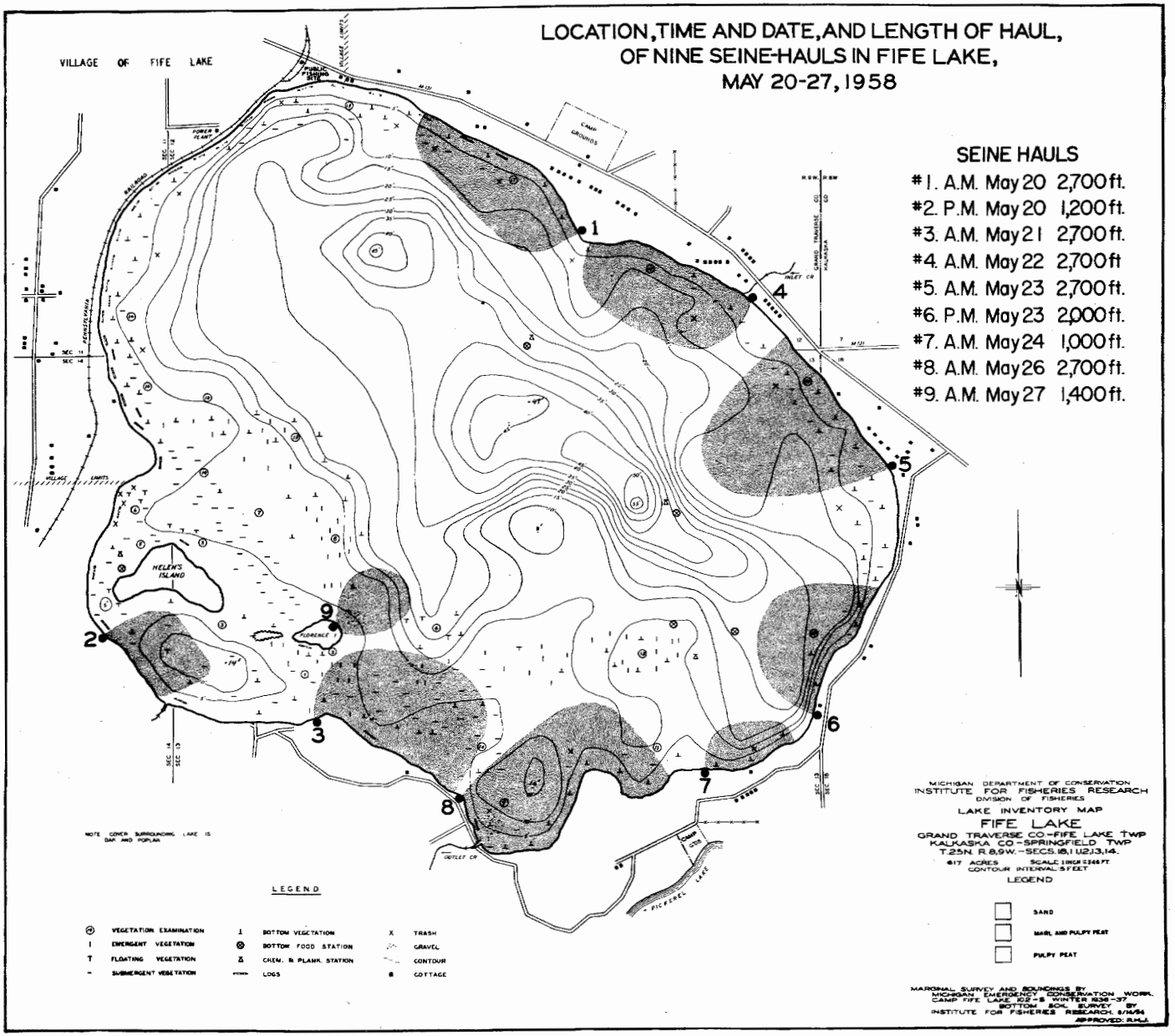
[1] A year-round stratified random creel census was in operation at Fife Lake from 1954-1958, to study experimental changes in fishing regulations. Records for this census provided data for the present study.

[2] This type of population estimate is based essentially on the following formula:

$$\frac{\text{Number of marked fish recaptured}}{\text{Total number of fish captured}} = \frac{\text{Total number of marked fish in the lake}}{\text{Total population in lake}}$$


LOCATION, TIME AND DATE, AND LENGTH OF HAUL,
OF NINE SEINE-HAULS IN FIFE LAKE,
MAY 20-27, 1958
VILLAGE OF FIFE LAKE
SEINE HAULS
#1. A.M. May 20 2,700 ft.
#2. P.M. May 20 1,200 ft.
#3. A.M. May 21 2,700 ft.
#4. A.M. May 22 2,700 ft
#5. A.M. May 23 2,700 ft.
#6. P.M. May 23 2,000 ft.
#7. A.M. May 24 1,000 ft.
#8. A.M. May 26 2,700 ft.
#9. A.M. May 27 1,400 ft.
HELEN'S ISLAND
FLORENCE
PICKEREL LAKE
LEGEND
VEGETATION EXAMINATION
EMERGENT VEGETATION
FLOATING VEGETATION
SUBMERGENT VEGETATION
BOTTOM VEGETATION
BOTTOM FOOD STATION
CHEM. & PLANK. STATION
LOGS
TRASH
GRAVEL
CONTOUR
COTTAGE
MICHIGAN DEPARTMENT OF CONSERVATION
INSTITUTE FOR FISHERIES RESEARCH
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LAKE INVENTORY MAP
FIFE LAKE
GRAND TRAVERSE CO-FIFE LAKE TWP
KALKASKA CO-SPRINGFIELD TWP
T.25N. R.8,9W.-SECS.18,1 1,12,13,14.
817 ACRES
SCALE 1 INCH = 2346 FT.
CONTOUR INTERVAL 5 FEET
LEGEND
SAND
MARL AND PULPY PEAT
PULPY PEAT
MARGINAL SURVEY AND SOUNDINGS BY
MICHIGAN EMERGENCY CONSERVATION WORK
CAMP FIFE LAKE F-8 WINTER 1936-37
BOTTOM SOIL SURVEY BY
INSTITUTE FOR FISHERIES RESEARCH, 1/1954
APPROVED: R.H.J.

Figure 2

Table 2.--Species and numbers of fish caught in nine seine hauls at Fife Lake, May 20-27, 1958[1]

Seine haul number[1]	Mark				Mark			
	Unmarked	Anal	Dorsal	Pelvic	Unmarked	Anal	Dorsal	Pelvic
	Largemouth bass				Smallmouth bass			
1	2	1	...	...	5	...	...	...
2	120	2	2	...	...	...	...	...
3	144	...	1	1	3	...	...	...
4	11	7[2]	...	1[2]	21	7	3	...
5	115	8[2]	...	3[2]	17	1	...	...
6	22	...	1	...	28	1	...	...
7	5	...	...	2	12	2	...	1
8	110	...	2	6	21	2	2	...
9	12	...	...	3	...	...	...	...
Total	541	18[2]	6	16[2]	107	13	5	1
	Northern pike				Bluegill			
1	...	...	...	...	23	...	...	...
2	44	...	2	...	2,354	2	11	...
3	31	...	...	1	452	...	1	...
4	10	...	...	...	20	...	...	...
5	77	3	...	...	1,472	...	1	7
6	1	...	...	...	174	...	...	8
7	...	...	...	...	31	...	...	1
8	67	...	1[3]	3[3]	3,741	2	10	23
9	22	...	1	4	255	...	3	12
Total	252	3	4[3]	8[3]	8,522	4	26	51
	Black crappie				Rock bass			
1	...	...	...	...	...	...	...	...
2	204	...	14	...	147	1	2	...
3	1	...	...	...	38	2	5	...
4	...	...	...	...	...	...	...	...
5	50	1	2	1	5	3	3	...
6	...	...	...	...	7	...	2	...
7	...	...	...	...	1	...	...	...
8	6	...	...	1	54	4	12	...
9	6	...	...	...	5	...	1[3]	2[3]
Total	267	1	16	2	257	10	25[3]	2[3]

[1] Species of fish caught but not listed were: yellow perch (648 unmarked, 2 pelvic), pumpkinseed (740 unmarked, 2 anal, 1 dorsal, 6 pelvic), bullhead (2 unmarked), walleye (1 unmarked), common sucker (12 unmarked, 3 anal, 1 dorsal).

Seine hauls were made on the following dates: Nos. 1 and 2--May 20; No. 3--May 21; No. 4--May 22; Nos. 5 and 6--May 23; No. 7--May 24; No. 8--May 26; and No. 9--May 27.

[2] One anal and pelvic listed in both columns.

[3] One dorsal and pelvic listed in both columns.

Table 3.--Species and numbers of fish from anglers' creels examined by the creel census clerk at Fife Lake, May 27-August 20, 1958

Species	Type of mark				Total number of fish
	Unmarked	Anal	Dorsal	Pelvic	
Largemouth bass	5	1	...	...	6
Smallmouth bass	...	...	...	...	...
Northern pike	11	...	...	...	11
Bluegill	423	1	1	10	435
Yellow perch	52	...	...	...	52
Pumpkinseed	218	1	2	3	224
Black crappie	12	...	1	...	13
Rock bass	141	3	4	...	148

12,114 to 18,405 (Table 4). The confidence limits (one standard error) ranged from 23 to 46 percent of the estimate (13,536 ± 3,171 and 18,405 ± 8,525). The narrowest limits (presumably the most accurate estimate) resulted from treating all seine hauls as one sample of the population (Estimate A, Table 4). The estimates based on the ratio of marked to unmarked fish in the anglers' creel were 33,818 (±10,473) and 31,734 (±8,935), or approximately double the above-mentioned values. Mortality of the marked fish, and recruitment of bluegills 6 inches or more in length to the population throughout the three months of the census, probably account for the larger estimates obtained from marked fish in the anglers' creels. The estimate of the population of bluegills 4 inches long or longer (101,072) was calculated by 1-inch size groups from data based on fish caught in trap nets, marked, and later recovered by seining. Three Petersen-type estimates were made for each of the other five species of fish (Table 4).

Some data were available to attempt "Schnabel"-type estimates for all species except northern pike. The Schnabel method is somewhat more complex than the Petersen approach and is based on continuous marking and intensive fishing for a short period of time (and thus often involves a relatively small number of recoveries). The estimate is based on the proportion of recaptured marked fish in the catch, related in turn to the number of marked fish known to be at large in the lake when each catch is made. In the present study, the catches in seines were used for estimates of the bluegill population by the Schnabel method, and trap-net data were used for estimates of largemouth bass, smallmouth bass, rock bass, and black crappie.

It is not possible to accurately evaluate the different methods of estimation used here, because the total population of fish in Fife Lake at the time of the study is not known. The Schnabel estimates were based on only small numbers of recaptures, with the exception of the estimates for smallmouth bass and rock bass (recapture of 11 and 19 percent, respectively). The estimate of the smallmouth

Table 4.--Summary of population estimates by different methods, for six species of fish in Fife Lake, spring of 1958

Method of estimate[1]	Bluegill		Northern pike	Largemouth bass	Smallmouth bass	Rock bass	Black crappie
	6 inches or over	4 inches or over	14 inches or over	10 inches or over	10 inches or over	6 inches or over	6 inches or over
A	13,536 ±3,171	...	3,936 ±1,466	3,236 ±719	543 ±107	11,519 ±1,801	3,537 ±831
B	18,405 ±8,525	...	4,247 ±2,110	5,588 ±3,002	784 ±364	16,796 ±19,755	3,948 ±3,884
C	16,587 ±7,383	...	3,691 ±1,994	5,388 ±7,263	774 ±364	16,657 ±19,713	3,478 ±1,105
D	12,114 ±4,423	101,072 ±29,306	...	...	...	...	...
E	33,818 ±10,473	...	...	...	...	...	...
F	31,734 ±8,935	...	...	...	...	...	...
G	...	...	...	1,230 ±280	560 ±85	4,430 ±610	870 ±250
H	35,800 ±12,300	429,160 ±184,250	...	...	...	...	...

[1] Methods of estimation:

1. Petersen for "direct proportion" method (methods A to D are based on original capture in trap nets and recapture by seine)
   - A. Data for nine seine hauls combined for one estimate.
   - B. Average of nine or fewer estimates made for separate seine hauls. Hauls with no marked fish were combined with a seine haul which contained one or more marked fish.
   - C. Average of nine or fewer estimates made for separate seine hauls. Hauls with no marked fish were ignored.
   - D. Combined estimates from 1-inch groups, for data from nine seine hauls.
   - E. Estimate based on fish marked after capture by seine and subsequently caught by anglers, May 27-August 20.
   - F. Estimate based on fish marked after capture by trap net or seine and subsequently caught by anglers.
2. Schnabel method
   - G. Fish marked after being caught in a trap net, and recaptured by trap net.
   - H. Fish marked after original capture by seine and recaptured by seine.

bass population was in fair agreement with the three Petersen estimates, but the rock bass estimate was far smaller than those made by the Petersen method.

Estimates based on trap-net captures and recaptures were much lower for three out of four species than estimates based on trap-net captures and seine recaptures. It seems probable that the estimates based on trap nets alone are far less reliable, with at least two contributing factors: (1) relatively few trap-net stations fished for a short period during which the effort was not effectively sampling the entire population, and (2) in the use of different methods for initial capture and recapture, the second method can be expected to sample both that portion of the population sampled by the first method, and that portion which was not, and to do this proportionately.

The best approximation of the population of fish in Fife Lake on May 10-27, 1958 probably was provided by the method for which the present study was originally designed--Petersen estimates based on recoveries by seine of fish marked from trap nets. These estimates were as follows: 1,200 to 5,600 largemouth bass; 540 to 780 smallmouth bass; 3,700 to 4,200 northern pike; 14,000 to 18,000 bluegills (6 inches long or longer); 3,500 to 3,900 black crappies; and 4,400 to 17,000 rock bass.

INSTITUTE FOR FISHERIES RESEARCH

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