Presented - Michigan Academy of Science, Arts and Letters
March 27, 1943

Original: Michigan Academy
cc: Fish Division
Education-Game
Institute
L. A. Krumholz

March 24, 1943

REPORT NO. 859

A CHECK ON THE FIN-CLIPPING METHOD FOR ESTIMATING FISH POPULATIONS*

*Contribution from the Institute for Fisheries Research of the Michigan Department of Conservation.

Louis A. Krumholz

The first instance of marking fish for experimental purposes was recorded by Izaak Walton in "The Compleat Angler" (1653). According to Walton, Sir Francis Bacon, studied the age and homing instincts of salmon "by tying a riband, or some known tape or thread, in the tail of some young Salmons which have been taken in weirs as they have swimmed towards the salt water; and then by taking part of them again, with the known mark, at the same place, at their return from the sea, which is usually about six months after." From this method, there has evolved the use of button, strap, and belly tags as means of identification.

Calderwood (1902) indicated that Fraser marked salmon in 1829 by removing the adipose fin. Fin-clipping as a means of marking fish has been employed extensively in studies of salmon,

trout and other fresh water fish, mostly, however, in determining migration, growth and survival of plantings.

Recently, David H. Thompson of the Illinois Natural History Survey used fin-clipping as one of the procedures in making an estimate of the population of black crappies (Pomoxis nigro-maculatus Le Sueur)) in Lake Senachwine, a backwater of the Illinois River, near Henry, Illinois. It is unfortunate that the results of these experiments and a description of the technique used have not been published. Underhill (1941) used the same formula as Thompson, in determining the size of a breeding population of chub suckers, but marked the fish by removing two or three adjoining scales from the side.

Methods

The method of obtaining the data for the population estimate, as devised by Thompson, was modified slightly in our Michigan work. During the first part of the check on this method the anal fin was clipped. Later the left pectoral, instead of the anal fin was removed. The fins were cut about one-eighth inch from the flesh to mimimize infection and because the mark was intended to last only for the duration of the experiment. All fish taken in the nets each day were weighed, measured, marked and returned to the water at a central station, indicated by a buoy, (Thompson did not release the fish at a central station) thereby providing equal opportunity for the dispersal of marked fish in all directions. Marked fish

which were subsequently taken in nets were recorded as returns and again released at the central station. Those marked fish which died in the nets were recorded as returns and then subtracted from the total number of marked fish in the lake. Any marked fish which were found dead in the lake were not counted as returns but were subtracted from the number of marked fish. A complete circuit of the shoreline in quest of dead fish was made twice each day. No fish were marked during the last ten days of net operation.

Four different sizes of fyke nets, which are designated by letters on the map (Figure 1) and in the text, were used in the fish population study of the north basin of Twin Lake:

A), a special fyke net, developed in Wisconsin for trapping small fish, equipped with two galvanized pipe frames five feet wide and four feet deep at the front (Figure 2). The first such frame had a vertical center bar for attachment of the lead. The other four hoops were wooden and each had a diameter of four feet. The lead was 150 feet long and four feet deep. The entire net and lead was hung with three-eighths-inch square mesh and treated with copper oleate.

B), a large tarred fyke with a front hoop diameter of four feet hung with one-inch square mesh netting. Net B was equipped with wings twenty feet long and four feet deep of one and one-half-inch square mesh. A lead one hundred feet long and four feet deep with two-inch square mesh was used with this net.

C), a small tarred fyke of one-inch square mesh with a three-foot front opening, with twenty-foot wings of one and one-half-inch square mesh. A fifty-foot lead was used with this net.

D), a small fyke with a three-foot front opening equipped with twenty-foot wings. No lead was used with this net. The entire net was hung with three-eighths-inch square netting and treated with copper oleate.

Description of the lake where the check was made

Twin Lake which consists of two basins, is located in T. 25N., R. 2E., Section 25, about eight miles south and two miles west of Mio, Michigan. The north basin, which was used for the experiment, is about seven and three-quarters acres in extent and has a maximum depth of thirty-five feet (Figure 1). It has a fairly definite sandy shoreline and the deeper parts of the bottom are covered with pulpy peat. The slope of the basin is rather steep except at the south end. Many trees which have fallen into the water or were dropped there in lumbering have become watersoaked and are found nearly everywhere along the shoreline. These deadheads restricted the setting of nets to some extent and made seining impracticable. Aquatic plants were fairly abundant in the shallow areas.

The south basin (10.1 acres), somewhat larger than the north basin, has a maximum depth of forty feet. The shoreline is more irregular than that of the north basin but the bottom types of the two depressions are quite similar. There are many deadheads around the shore of the south basin also but the aquatic vegetation was not as abundant as in the north basin.

The Huron National Forest kindly provided Civilian Conservation Corps labor, under the direction of Mr. Gifford Adams, to construct a barrier dam between the two basins during March and April, 1941.

An eight-foot opening, was left in the middle of the dam to allow free passage of the fish from one basin to the other prior to the poisoning. The central opening of the dam was filled in on August 28.

Procedure

The nets were set in the locations indicated in Figure 1. All sets were made with the lead running diagonally from the shore. The nets were moved and reset as follows: the original set was made on July 29 (A_1, B_1, C_1, and D_1 on the map); the second set was made on August 6 (A_2, etc.), allowing the nets to dry before resetting; the second change was made on August 13 (A_3, etc.) again allowing the nets to dry before resetting. An additional change was made with net D on August 20.

The number of fish caught, the number of fish marked and the number of returns are shown in Table I. These data furnished the material for an estimate of the population of the fish over 45 millimeters in total length. Fish of a smaller size passed through the meshes of the nets and therefore could not be included in the population estimate.

The mathematics of the method of making an estimate of the total fish population which Thompson used has been described by Schnabel (1938) as formula (2). It can be proved algebraically that this formula gives yields which are high but correction for this error is too laborious to be considered practicable. The formula (modified from Schnabel) is $P = \frac{\Sigma . A.B}{\Sigma .C}$ in which $\underline{P}$ is the

population, A is the number of fish examined on any one day, B is the number of marked fish in the lake and C is the number of returns.

Investigations which involve the use of marked fish in netting operations are subject to certain uncontrollable errors. Some of the more frequent possible errors are: 1) fish marked during the experiment may die or may be caught by anglers; 2) the gear may be so selective as to limit the size of the fish taken; 3) the duration of the experiment may be so limited as to give misinformation; and 4) if the investigation is extended over a considerable time, small fish will grow to a size large enough to be taken by the nets, and there may be some undiscovered natural mortality.

The opening in the middle of the dam between the two basins allowed fish to pass freely from either basin to the other. Observations at various times during the investigation showed that fish actually passed both out of and into the north basin and it is assumed that the movement was approximately equal and did not have any marked effect on the population estimate.

An intensive creel census, during which the entire catch of each fisherman was examined at the end of the day's fishing, was in operation on both basins of Twin Lake during the entire summer. The census clerk was instructed to take added precaution in checking the fish in order that accurate records of any fish marked during the experiment taken by anglers might be accounted for in the compilation of the population data. Inasmuch as no marked fish were recorded in the anglers' catches, there was no loss by this means. No allowance was made in the population estimate for unmarked fish

caught by anglers or for unmarked fish found dead in the lake.

The nets used were very selective. Nets A and D caught many small fish but only a few large ones. On the other hand, nets B and C could not retain fish as small as A and D but caught about 80 per cent of all fish taken during the study. Net B, although the mesh size was considerably larger than that of net A, caught more fish than the combined catches of the other three nets. It has been suggested by Van Oosten (1935) that fishes may react negatively to darkness and therefore avoid an impounding net darkened by small meshes. The data from the fish taken in all nets were lumped together with the assumption that the differences in the catches of the individual nets would counteract each other and would give a fairly reliable estimate of the population.

On August 29, 1941, the waters of the north basin of Twin Lake were treated with powdered derris root (5% rotenone). The powder was mixed into a thin suspension and poured over the surface waters in the wake of an outboard motor following the technique developed by the Michigan Institute for Fisheries Research (Eschmeyer, 1937; Greenbank, 1941). In addition to the derris applied to the surface waters, a new method of introducing the chemical into the deeper waters was tried with satisfactory results. The apparatus consisted of a ten-inch funnel attached by the small end to a five-eighths-inch garden hose. Two ten-pound sash weights were used to keep this end of the hose well under water. A fifteen-gallon drum fitted with a five-eighths-inch spigot was set in the middle

of the boat and the hose attached. The drum was filled with a suspension of derris and the boat was moved over the deeper parts of the lake. The suction caused by the inverted funnel and the forward motion of the boat pulled the suspension out of the drum into the deep water. The process of dispersion in deep water was rather slow due to the small diameter of the hose and the relatively great amount of friction. A hose three-fourths to one inch in diameter would be more satisfactory than the one used in the experiment.

The water temperature at the surface was 70° F. at 8:45 A.M. when the application of derris was begun and distressed fish were seen rising at various points within fifteen minutes. Two-thirds of the derris was applied to the surface and one-third was put into the deeper water. The application of the derris was completed by 12:45 P.M.

Individual lengths, weights and scale samples were taken from all the largemouth black bass, Huro salmoides (Lacépède) recovered and from representative samples of bluegills, Lepomis m. macrochirus Rafinesque, pumpkinseeds, Lepomis gibbosus (Linnaeus) and bluegill x pumpkinseed hybrids. These were the only kinds of fish present in the lake. The remaining fish were counted and weighed. A complete pick-up of all dead fish was continued for ten days following the poisoning. Table II shows the numbers and weights of the fish recovered.

Discussion

Table III gives the numbers and percentages of the fishes of different size groups taken during the netting and poisoning operations. The figures for netting operations are the aggregate catches of all four nets. It is evident that the nets were selective since most of the fish taken were more than 100 millimeters in total length.

Estimates of the populations of the individual species and the numbers of each taken during the poisoning are given in Table IV. The numbers of fish taken during the poisoning do not corroborate the individual population estimates in any case. Had the nets been fished for a longer time and had special effort been made to catch only one species, the individual estimates would probably have been much closer. The investigation was intended for a total population estimate of only those fishes over forty-five millimeters in total length.

The total population as estimated from the netting operations was 9,698 fish as compared with 9,605 taken in the poisoning. There is no way of knowing how complete the recovery of poisoned fish was inasmuch as many fish, particularly small ones, may sink at once to the bottom and disintegrate there. Fortunately the preferred habitat of small fish is along shore so that recovery of a large percentage is possible if care is taken. Some dead fish are eaten by reptiles, birds and mammals. In this investigation 86 per cent of all marked fish assumed to be alive in the lake were recovered in the poisoning. Prior to the poisoning some of the marked fish might have escaped through the open channel into the south basin and some marked fish

might have died without being recovered. The total population of fish more than 45 millimeters in total length as estimated in Table I is only one per cent higher than that found in the poisoning.

The estimate from netting operations was very close to that found by poisoning in this first check on the fin-clipping method for estimating fish populations. Further studies of this type are needed to definitely prove the accuracy of the method. At the present time the supply of rotenone-containing roots has been drastically curtailed due to the war and no suitable substitute has been found. Other checks of this method will be carried on when conditions permit.

INSTITUTE FOR FISHERIES RESEARCH

By Louis A. Krumholz

Report approved by: A. S. Hazzard

Report typed by: Mary Manville

TABLE I

DATA AND ESTIMATE OF THE TOTAL POPULATION OF FISH OVER 45 MILLIMETERS IN LENGTH OF NORTH BASIN, TWIN LAKE, OSCODA COUNTY, MICHIGAN, JULY 29 - AUGUST 23, 1941

	A		B			C			
Date	Number of fish examined	Number of fish marked	Number of marked dead fish	Number of marked fish in lake	Product A . B	Sum of Products	Number of Returns	Sum of Returns	Estimated Population
July 30	53	53							
July 31	55	53		53	2915	2915	2	2	1458
August 1	67	64		106	7102	10017	3	5	2003
August 2	59	55		170	10030	20047	2	7	2864
August 4	85	75	3	225	19125	39172	6	13	3013
August 5	94	79		297	27918	67090	3	16	4193
August 6	53	50		376	19928	87018	1	17	5119
August 7	115	109	15	426	48990	136008	5	22	6182
August 8	59	56	3	520	30680	166688	4	26	6411
August 9	53	49	13	573	30371	197059	4	30	6567
August 11	53	46	51	609	32277	229336	5	35	6552
August 12	68	63	1	604	41074	270410	2	37	7308
August 13	45	41	2	666	29970	300380	4	41	7326
August 14	38	37		705	26790	327170		41	7980
August 15	45			742	33390	360560	3	44	8195
August 16	28			742	20776	381336		44	8667
August 18	40		1	741	29640	410976	2	46	8934
August 19	20			741	14820	425796		46	9256
August 20	30			741	22230	448026	5	51	8785
August 21	27			741	20007	468033	1	52	9001
August 22	42			741	31122	499155	1	53	9418
August 23	20			741	14820	513975		53	9698

TABLE II

NUMBER AND WEIGHT IN POUNDS BY SPECIES OF FISHES HAVING A TOTAL LENGTH GREAT THAN 45 MILLIMETERS RECOVERED FROM THE NORTH BASIN OF TWIN LAKE, FOLLOWING TREATMENT WITH DERRIS*

Date	Largemouth Bass		Bluegill		Pumpkinseed		Bluegill x Pumpkinseed Hybrids		All Fish	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
August 29	107	31.56	3470	247.25	155	11.63	83	13.38	3815	303.82
August 30	20	3.88	1320	54.31	50	3.25	17	2.00	1407	63.44
August 31	24	5.63	3002	99.56	94	6.56	34	5.19	3154	116.94
September 1	3	0.88	638	38.88	10	0.88	5	1.25	656	41.89
September 2	1	0.31	374	21.75	6	0.50	5	1.31	386	23.87
September 3	3	0.56	78	6.63	2	0.25			83	7.44
September 4	1	0.12	46	4.00	1	0.12			48	4.24
September 5			33	2.12					33	2.12
September 6			11	0.75					11	0.75
September 7			11	0.94	1	0.12			12	1.06
Totals	159	42.94	8983	476.19	319	23.31	144	23.13	9605	565.57

* In addition there were 1773 miscellaneous fry less than 45 mm. long having a total weight of 11.88 pounds.

TABLE III

NUMBER AND PERCENTAGES OF FISHES OF DIFFERENT SIZES

TAKEN BY NETTING AND POISONING, NORTH BASIN,

TWIN LAKE, OSCODA COUNTY, MICHIGAN

		Netting		Poisoning	
Total Length Millimeters	Mean Length Inches	Number of Fish	Percentage	Number of Fish	Percentage
Bluegills					
0-50	1.6	15	2.3	87	6.7
51-100	3.1	97	14.7	274	21.1
101-150	5.0	235	35.8	614	47.3
151-200	6.7	287	43.6	286	22.1
201-250	8.2	22	3.3	36	2.8
251-300	10.4	2	0.3		
Pumpkinseeds					
0-50	1.3	1	0.4	8	2.5
51-100	3.1	19	7.5	121	38.5
101-150	5.0	177	70.2	141	44.9
151-200	6.5	54	21.4	38	12.1
201-250	8.4	1	0.4	6	1.9
Largemouth Black Bass					
51-100	2.9	3	12.0	21	11.5
101-150	4.5	5	20.0	26	14.4
151-200	6.6	13	52.0	38	20.9
201-250	9.0	4	16.0	82	45.0
251-300	10.5			11	6.0
301-350	13.2			4	2.2
Bluegill x Pumpkinseed Hybrids					
51-100	3.1	3	3.2	12	9.0
101-150	5.4	23	24.8	19	14.2
151-200	6.7	67	72.0	99	73.8
201-250	8.1			4	3.0
All Fish					
0-50	1.6	16	1.5	95	4.9
51-100	3.1	122	11.9	428	22.2
101-150	5.0	440	42.8	800	41.5
151-200	6.7	421	41.0	461	23.9
201-250	8.9	27	2.6	128	6.7
251-300	10.5	2	0.2	11	0.6
301-350	13.2			4	0.2
Totals		1028		1927	

TABLE IV

ESTIMATES OF POPULATIONS OF INDIVIDUAL KINDS AND THE NUMBERS OF EACH RECOVERED DURING THE POISONING, NORTH BASIN TWIN LAKE, OSCODA COUNTY, MICHIGAN. (ONLY FISH OVER 45 MILLIMETERS INCLUDED)

Species	Estimated Population	Fish Recovered During Poisoning
Largemouth black bass	51	159
Bluegills	16,832	8,983
Pumpkinseeds	1,360	319
Bluegill x pumpkinseed hybrids	837	144
Totals	19,080	9,605

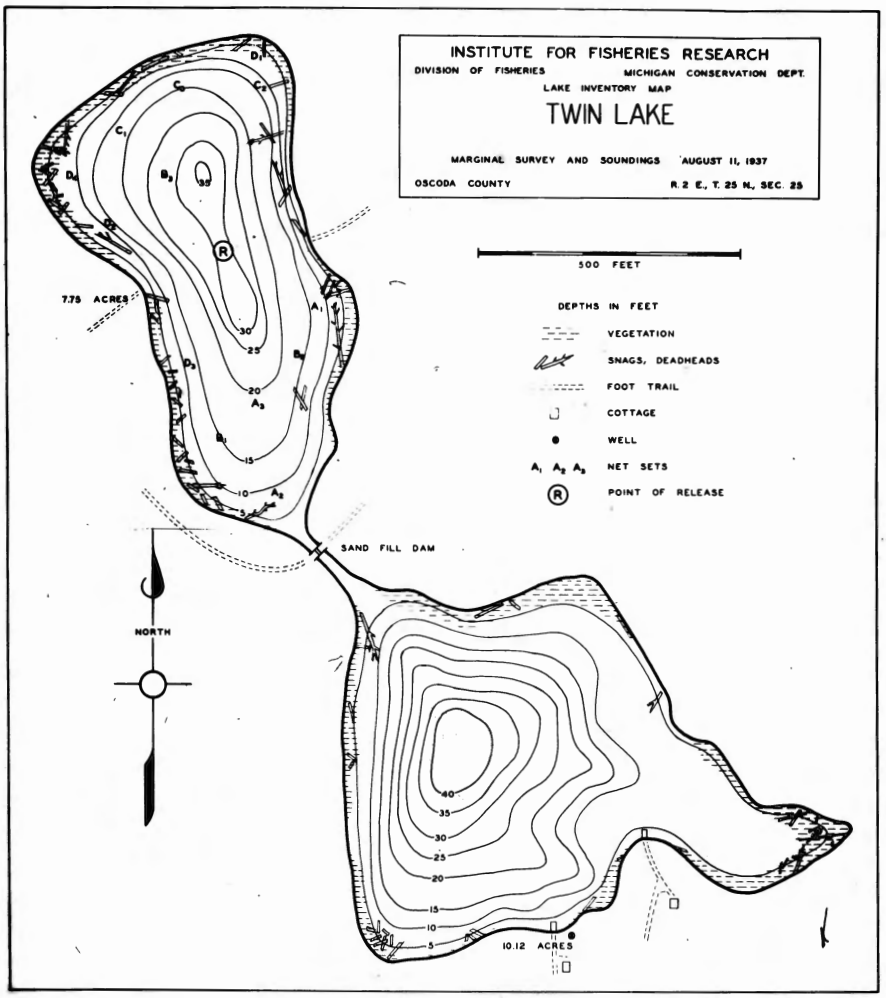

Figure 1

Map of Twin Lake, Oscoda County, Michigan

Figure 2

Net A.

Special Fyke Net for Trapping Small Fish

LITERATURE CITED

Calderwood, W. L. 1902. A Contribution to the Life History of the Salmon, as Observed by means of Marking Adult Fish. 20th Am. Rept. Fish. Board Scotland, 1901, Part II: 55-100.

Eschmeyer, R. William. 1937. Some Characteristics of a Population of Stunted Perch. Pap. Mich. Acad. Sci. Arts, and Letters, 22 (1936): 613-630.

Greenbank, John. 1941. Selective Poisoning of Fish. Trans. Am. Fish. Soc. 70 (1940): 80-86.

Schnabel, Zoe Emily. 1938. Estimation of Total Fish Population of a Lake. Amer. Math. Jour. 45 (1938): 348-352.

Underhill, A. Heaton. 1941. Estimation of a Breeding Population of Chub Suckers. Trans. Fifth N. A. Wildlife Conf. (1940): 251-256.

Van Oosten, John. 1935. Logically Justified Deductions Concerning the Great Lakes Fisheries Exploded by Scientific Research. Trans. Am. Fish. Soc. 65 (1935): 71-75.

Walton, Izaak. 1653. The Compleat Angler or the Contemplative Man's Recreation. London. 1653.

The above have been checked against the original sources.