

*RSL*

REPORT NO. 468

## THE USE OF BRUSH SHELTERS BY FISH<sup>1</sup>

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In the recent development of game fish management through lake improvement, artificial shelters of brush and other materials have been installed in the hope of improving the conditions for fish life (Hubbs and Eschmeyer, 1938). These installations have been made in large number, because such work has well met the favored qualifications of relief-labor projects—an abundance of unskilled labor and low expense for materials.

Although many thousands of brush shelters have been made and sunk in the inland lakes of the northern states, at a cost reported to be several hundred thousand dollars, very little effort or money has been expended in serious attempts to test the effectiveness of these structures. This very unfortunate circumstance may be ascribed to the urgency of finding employment for relief labor in the fields of public service, to the small number of competently trained and scientifically-minded supervisors and to the organization of relief work.

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<sup>1</sup>Contribution from the Biological Station of the University of Michigan and the Institute for Fisheries Research of the Michigan Department of Conservation.

The need for evaluations of the effectiveness and practicability of brush shelters occurred to me while supervising their construction on federal projects in Michigan and Idaho, in 1933 and 1934. It was therefore gratifying to have the cooperation of the Biological Station of the University of Michigan and the Institute for Fisheries Research of the Michigan Department of Conservation in conducting investigations toward this end, at Douglas Lake, during the summer of 1937, and in planning the continuation of the studies.

Thanks are particularly due Dr. George R. LaRue, Director of the Biological Station and Dr. A. S. Hazzard, Director of the Institute for Fisheries Research for aid, encouragement and equipment. CCC labor was provided by the Michigan Emergency Conservation Work. Dr. Carl L. Hubbs has given advice and help in the investigation, and in the preparation of this report.

Some data on the use of brush shelters by fish, obtained by Dr. R. W. Eschmeyer of the Institute for Fisheries Research in 1934, have kindly been made available for inclusion in this report.

#### Historical Introduction

So far as recorded, the first detailed observation on the effect of brush shelters was made on October 25, 1931, by Dr. Carl L. Hubbs and party, representing the Institute for Fisheries Research. A relatively small pile of brush had previously been placed by Mr. Eugene R. Kuhne in Crystal

Lake, Oceana County, Michigan, on the sandy shoal which was everywhere almost devoid of natural protection for fish. After a large minnow seine had been set around this shelter, the brush was removed and the net pulled to shore. The number of fish in this seine haul, 6,941, was astounding when compared with the 48 fish seined in a similar area where there was no brush (Hubbs and Hubbs, 1933: 617; Hubbs and Eschmeyer, 1938: 660, fig. 72).

*Pages to be  
added on  
9/1/37* →

During following summers lake survey parties of the Institute for Fisheries Research made and placed shelters in various Michigan lakes, as part of an experimental lake improvement program. Soon after the CCC was organized in 1933, lake improvement was accepted as one of the activities of the organization, and other temporary agencies took part in this work. As a result, lake improvement suddenly developed into a major fisheries activity in Michigan, Wisconsin, Iowa and other states. Most of this work consisted in the building and installing of brush shelters. Various types of shelters were devised (Hubbs and Eschmeyer, 1938: 63-86).

Removing shelters to test their effectiveness (Tarzwell, 1936<sup>432</sup>) was continued by Dr. R. W. Eschmeyer of the Institute for Fisheries Research during the summer of 1934, and by the writer in the summer of 1937. The discussion below represents a summary of the findings of these two summers' work.

### Tests in Douglas Lake

Brush shelters were installed in Douglas Lake, Cheboygan County, Michigan, in the summer of 1937 and were studied to determine:

1. The extent to which the introduced brush shelters are used by fish.
2. The size and species of game fish found in them.
3. Differences in the fish population thus sheltered by night and by day.
4. The value of adding fertilizers in the shelters.
5. The use of the shelter as a permanent summer habitat.
6. The extent to which they become repopulated after the removal of all fish.
7. The value of artificial shelters.

This work was started in Douglas Lake on a barren shoal area between Grape Vine Point and the boathouse of the Michigan Biological Station. In this area, the bottom of the shoal consists almost entirely of sand, with some stony patches near shore. The slope is gradual, attaining a depth of 8 to 12 feet at the sharp drop-off about 100 feet from shore. The shoal is almost devoid of vegetation but there is some submerged vegetation on the slope beyond the drop-off. In one of the control areas (D) a few dozen plants of Potamogeton heterophyllus were growing near shore and in places there was some water logged timber, partially covered with sand. The region studied is somewhat protected from the prevailing northwest winds.

The 140-foot seine used for all the test seining was made of  $\frac{1}{4}$  inch mesh in the bag, of  $\frac{3}{8}$  inch mesh next to the bag and of  $\frac{7}{8}$  inch mesh at the ends of the wings.

The total length of the fish was measured in millimeters. Fish that were preserved were placed in 10 per cent formalin.

To determine what fish were in the area before shelters were installed, five seine hauls were made at more or less regularly spaced intervals roughly estimated as 100 feet, in the afternoon of July 12, 1937. The results of this seining

TABLE 1

are shown in Table 1. The largest catch was taken in haul Number 1, made just south of a rather deep sheltered cove lying to the south of Grape Vine Point. Dr. Charles W. Creaser (personal communication) has found this cove a favorable spot for taking fish for his ichthyology classes at the Biological Station. Shelter 1 was later placed in this area. The small number of fish taken in these seining (Table 1) gives some indication of the barrenness of this area in fish life before improvement was attempted.

Following the seining, ten brush shelters were made and

TABLE 2

placed in this region. Table 2 summarizes basic information on these shelters. Shelters designated as green brush were made of poplar, tag alder, cherry, maple and scrub oak.

TABLE 1

SPECIES, NUMBER AND SIZE OF FISH TAKEN IN FIVE SEINE HAULS ON JULY 12, 1937, IN THE AREA  
WHERE BRUSH SHELTERS WERE LATER INSTALLED

Lengths estimated in centimeters

Species	Haul Number									
	1		2 <sup>1</sup>		3		4		5 <sup>2</sup>	
	Number of fish	Length	Number of fish	Length	Number of fish	Length	Number of fish	Length	Number of fish	Length
Small-mouthed bass ( <u>Micropterus dolomieu</u> )	3	3-15	4	3-8	-	-	-	-	1	9
Rock bass ( <u>Ambloplites rupestris</u> )	-	-	1	6	-	-	-	-	-	-
Pumpkinseed ( <u>Eupomotis gibbosus</u> )	1	6	1	6	-	-	-	-	-	-
Yellow perch ( <u>Perca flavescens</u> )	2	4	-	-	-	-	-	-	-	-
White sucker ( <u>Catostomus commersonii</u> )	6	2-6	-	-	-	-	-	-	-	-
Sand shiner ( <u>Notropis deliciosus</u> )	29	5-8	-	-	-	-	-	-	-	-
Common shiner ( <u>Notropis cornutus frontalis</u> )	2	8	-	-	-	-	-	-	-	-
Spot-tailed shiner ( <u>Notropis h. hudsonius</u> )	13	5-8	-	-	-	-	-	-	-	-
Blunt-nosed minnow ( <u>Hyborhynchus notatus</u> )	17	5-8	-	-	-	-	-	-	1	6

<sup>1</sup>Probably not a representative haul as the seine snagged on bottom.

<sup>2</sup>Four to five dozen small minnows (about 1 inch long) seen going through mesh of net.

TABLE 2

## SUMMARY OF INFORMATION ON TEN BRUSH SHELTERS PLACED IN DOUGLAS LAKE AND REMOVED AT INTERVALS

Control areas were as follows: A between Shelters 2 and 3; B between Shelters 4 and 5;  
C between Shelters 6 and 7; D between Shelters 8 and 9; E south of Shelter 10

Shelter Number	Size of Shelter	Date of Placement	Material Used	Condition of Shelter	Dates of Removal	Distance from shore	Depth of Shelter
1 <sup>1</sup>	10' x 10' x 1½'	7-14-'37	Green brush	Compact Untrimmed	Aug. 2,4,6,23,25	90'	5'-6'
2	10' x 10' x 1½'	7-14-'37	Green brush	Compact Untrimmed	July 20, Aug. 2,23	80'	5'-6'
3	12' x 3' x 2'	7-14-'37	Two tree tops	Loose Untrimmed	July 19, Aug. 2,4,6,23,24,25	102'	5'-6'
4 <sup>1</sup>	10' x 6' x 2'	7-14-'37	Evergreens on hardwood frame	Compact Untrimmed	Aug. 2,4,6,23	88'	5'-6'
5	6' x 6' x 1'	7-16-'37	Rock pile in wire basket	4 wire baskets of rocks	Aug. 4, 24	78'	5'-6'
6	8' x 12' x 2'	7-16-'37	Water logged timbers	Loosely piled	Aug. 4, 24	75'	5'-6'
7 <sup>1</sup>	10' x 10' x 1'	7-16-'37	Dry dead wood	Compact Untrimmed	Aug. 4, 23	89'	5'-6'
8 <sup>1</sup>	10' x 10' x ½'	7-19-'37	Green brush	Compact Untrimmed	Aug. 6,23,24,25	92'	5'-6'
9 <sup>1</sup>	8' x 10' x 1'	7-19-'37	Green brush	Compact Untrimmed	Aug. 4,6,24	79'	5'-6'
10	8' x 10' x 1'	7-19-'37	Green brush	Compact Untrimmed	Aug. 4, 24	92'	5'-6'

<sup>1</sup>Two burlap bags of barnyard manure placed on Shelter 1, one bag each placed on Shelters 4, 7, 8 and 9.

Number 3 was made by taking two green tree tops, placing butts opposite each other and ~~mixing~~<sup>wiring</sup> both together. Number 4 was a compact mass of evergreen branches (pine) fastened to a hardwood frame. Rocks placed in a basket formed of wire fencing comprised Shelter number 5. Water logged timber removed from the bottom of the shoal area was used for Shelter 6 and dry dead wood, cherry and tag alder brush made up Shelter number 7.

These shelters were placed about 80 feet apart except when control areas were designated. Here the installations were approximately 180 feet apart, thus permitting the use of a section where a shelter might have been placed as a control area.

The shelters were removed by laying a net from a boat around the shelter to form a semicircle with the open part toward the shore. Shelters were then pulled shoreward, bringing the net carefully along behind.<sup>1</sup> Fish captured were counted, measured, identified and fins clipped, after which they were returned to the lake near shore to determine if these fish remained in the area. Each shelter was returned to its original position before others were removed. Control areas were seined to note what number and species of fish lived in the open areas.

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<sup>1</sup>Shelter 5, made of rocks, could not be moved. The net was set as usual, after which efforts were made to drive all fish from the shelter. Following this the net was carefully lifted over the rocks. It is possible that numerous fish escaped.



Some seining and removing of shelters was done at night in an effort to discover to what extent the fish population inhabiting the shelter and control areas differed between night and day.

#### Tests in Lakes of Presque Isle and Montmorency Counties

Shelters were placed in Clear, Jackson, Rush and Tomahawk Lakes of Montmorency County, Michigan and in Ess Lake in Presque Isle County, Michigan, during the summer of 1934. Later in the season studies were made by Dr. Eschmeyer of the fish inhabiting these shelters, by methods similar to those mentioned above. The purpose was to determine the fish population in and immediately about these shelters.

A total of 26 experimental shelters, varying in size from 3 x 5 x 1 feet to 6 x 6 x 2 feet, were placed in these lakes, at a depth of 2 to 6 feet. They were made smaller than usual to facilitate removal. Green brush of tag alder, willow, poplar, cherry, oak, hawthorne and jack pine was used.

The 15 shelters in Clear Lake were placed on a sandy or gravel bottom free of all vegetation on August 14 to 17 and were removed on August 30 and September 4.

Two shelters were placed in Jackson Lake on August 24 on a sand, gravel and marl- bottom; one where there was no vegetation, the other in abundant vegetation. These shelters were removed on September 5.

In Rush Lake 3 shelters were put among sparse vegetation on a sand and marl bottom on August 27, and were removed on September 6.

Three shelters were placed in Tomahawk Lake on August 22 on a pulpy peat and sandy bottom devoid of vegetation. They were taken out on September 5.

In Ess Lake shelters were set on a sand, marl and pulpy peat bottom where vegetation flourished abundantly, on August 30 and 31. Three of these shelters were removed on September 6.

These statements refer only to the shelters which were later removed.

#### Results of Seining Operations for 1934 and 1937

Table 3 summarizes the data obtained in the seine hauls

TABLE 3

made about the shelters as they were removed and in the hauls made in the control areas.

It was found that rock bass were the most common fish in and around shelters in Douglas Lake, and that this fish also occurred in or about the small shelters installed in other lakes. Very few rock bass were taken in control areas.

Perch, found commonly in all six lakes, were second in abundance around the shelters in Douglas Lake where more of this species than of any other were taken in the control areas.

TABLE 3

NUMBER AND KIND OF FISH FOUND IN SHELTERS (S) AND CONTROL AREAS (C) IN SIX MICHIGAN LAKES

Figures in parentheses indicate number of seinings about given shelters or in control areas

Kind of fish (and crayfish)	Name of Lake												Total in all lakes	No. fish per seine haul in shelters	No fish per seine haul in controls	
	Clear Lake		Jackson Lake		Rush Lake		Tomahawk Lake		Ess Lake		Douglas Lake					S(62) C(47)
	S(15)	C(13)	S(2)	C(2)	S(3)	C(3)	S(3)	C(3)	S(3)	C(3)	S(36)	C(23)	S(62)	C(47)		
Small-mouthed bass	106	23	4	0	80	17	2	2	1	2	157	71	350	115	5.65	2.45
Large-mouthed bass	-	-	11	0	4	0	4	8	5	0	22	3	46	11	.74	.23
Rock bass	35	0	1	0	53	0	-	-	72	7	1465	9	1626	16	26.23	.34
Pumpkinseed	-	-	5	0	3	0	52	4	106	4	253	24	419	32	6.75	.68
Sunfish <sup>1</sup>	-	-	2	0	-	-	-	-	8	0	-	-	10	0	.16	0
Bluegill	-	-	3	0	15	0	8	0	-	-	2	0	28	0	.45	0
Yellow perch	114	0	7	1	23	22	14	7	56	63	517	200	731	293	11.79	6.23
Pike	-	-	-	-	0	2	-	-	-	-	-	-	0	2	0	.04
Total game fishes	255	23	33	1	178	41	80	21	248	76	2416	307	3210	469	51.79	9.98
Coarse fish <sup>2</sup>	1	0	-	-	3	0	-	-	135	4	64	46	203	50	3.27	1.06
Forage fish and darters <sup>3</sup>	69	2	1	0	0	3	137	24	579	104	198	222	984	355	15.87	7.55
Total fish	325	25	34	1	181	44	217	24	962	184	2678	575	4397	874	70.92	18.59
Crayfish	357	13	343	5	134	6	48	8	34	51	-4	-4	916	18	14.77	.38
Total fish and crayfish	682	38	377	6	315	50	265	32	996	235	2678	575	5313	892	-	-

<sup>1</sup>Sunfish not identified<sup>2</sup>White suckers and bullheads<sup>3</sup>Includes blunt-nosed minnow, black-nosed shiner, spot-tailed shiner, sand shiner, common shiner, mud minnow, Johnny darter, Iowa darter, log perch and trout-perch.<sup>4</sup>No definite count kept here. Very few taken.

Pumpkinseed sunfish ranked third in numbers among the pan and game fish taken around the shelters in Douglas Lake, and were taken commonly in the other lakes, excepting Clear Lake.

Small-mouthed bass were taken about the shelters in all of the lakes. In Douglas Lake this species ranked fourth in number among the pan and game fishes around the shelters, and ranked next to perch in control areas.

More work is needed to prove whether these data are indicative of the use by fish of shelters in general,<sup>1</sup> but the results of seining 62 shelter areas and 47 control areas quite definitely indicate that rock bass will congregate in and around shelters to a very considerable extent. Rock bass tend also to become stunted in growth in northern lakes. For these reasons, shelters may at times prove detrimental to fishing (Eschmeyer, 1936<sup>1376</sup>). The ratio of pumpkinseeds in shelters and control areas show that this species prefers shelters, while perch and small-mouthed bass apparently are of more free-swimming habits, as they were taken in comparatively large numbers in the control areas as well as about the shelters.

Of particular interest is the number of crayfish taken in shelters in the five lakes in Montmorency and Presque

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<sup>1</sup>The available data on each type of shelter used is not reported upon in this paper. It is hoped that a more intensive study of this phase of the work may be made in the future.

Isle Counties. Here crayfish congregated in or under shelters in large numbers. No definite count of crayfish in Douglas Lake was kept but the number was not large. A total collected in one day's seining of shelter and control areas netted only 32.

#### Size and Species of Game Fish Taken

In Douglas Lake the total length of the game fish caught was recorded (Table 4), to determine the size of the fish which lived in or near shelters.

TABLE 4

It may be noted that rock bass are most abundant in two sizes (age-groups?), namely, those from 6 to 7 centimeters long (about  $2\frac{1}{2}$  inches) and from 9 to 10 centimeters long ( $3\frac{1}{2}$  to 4 inches). Only 55 of the 1465 rock bass taken were of legal size (6 inches or longer).

Twelve and 13 centimeter perch (about 5 inches) were more common than those of other sizes. Of these, only 9 of the 517 taken were of legal size, but this species like the rock bass is greatly dwarfed in Douglas Lake.

Of the 253 pumpkinseed sunfish taken, 112 measured between 9 and 11 centimeters ( $3\frac{1}{2}$  to  $4\frac{1}{4}$  inches) and 11 were of legal size.

Small-mouthed and large-mouthed bass taken about the shelters were small. Seventy-three of the 157 small-mouthed bass taken ranged from 5 to 8 centimeters (2 to 3 inches) and

TABLE 4  
 LENGTH IN CENTIMETERS OF GAME FISHES TAKEN IN BRUSH SHELTERS (S)  
 AND CONTROL AREAS (C) IN DOUGLAS LAKE

Size in cm	Rock bass		Perch		Pumpkinseed		Small-mouthed bass		Large-mouthed bass	
	S	C	S	C	S	C	S	C	S	C
1-2	---	-	---	-	---	-	1	-	---	-
2-3	16	3			4	-	---	-	---	-
3-4	42	1	4	2	18	-	1	-	---	-
4-5	9	-	63	79	2	-	5	14	2	-
5-6	53	-	24	59	1	-	22	17	6	3
6-7	217	2	1	2	3	-	26	13	4	-
7-8	68	1	1	-	7	-	25	8	5	-
8-9	147	-	6	1	5	-	11	3	-	-
9-10	381	1	58	10	49	4	4	1	2	-
10-11	207	-	30	7	57	7	1	1	-	-
11-12	86	-	35	7	29	3	3	1	-	-
12-13	57	1	103	9	26	3	5	2	-	-
13-14	52	-	103	14	15	3	15	4	-	-
14-15	14	-	40	6	12	2	11	2	-	-
15-16	19	-	18	1	5	-	8	2	-	-
16-17	29	-	2	1	6	1	7	1	1	-
17-18	10	-	2	1	2	1	2	-	1	-
18-19	7	-	4	1	1	-	1	-	-	-
19-20	3	-	1	-	1	-	-	-	-	-
20-21	5	-	-	-	1	-	-	-	-	-
21-22	1	-	-	-	-	-	-	-	-	-
22-23	-	-	-	-	-	-	3	-	-	-
26-27	-	-	-	-	-	-	1	1	-	-
Mean Average Size	9.4	5.9	11.0	7.1	10.1	12.0	9.6	7.7	7.5	5.5

only 1 was over 10 inches. Of the 22 large-mouthed bass taken, 15 measured from 5 to 8 centimeters (2 to 3 inches), the largest 7 inches long.

In the investigations on the five other lakes during the season of 1934 only 1 of the 161 rock bass taken in shelters was of large size. Eight of the 214 perch were listed as "half-grown" and all others were small. Only 1 pumpkinseed of the 166 taken is listed as "half-grown." Five of the 193 small-mouthed bass were listed as "half-grown." Of the large-mouthed bass taken all were listed as young.

Considering fish in the control areas, only 9 rock bass were taken in Douglas Lake, of which 6 were less than 7 centimeters long (less than 3 inches). Of the 200 perch, 138 were from 4 to 6 centimeters long (about  $1\frac{1}{2}$  to  $2\frac{1}{2}$  inches). Ninety-three of this size range were taken in 1 seine haul. Of the 24 pumpkinseeds taken only 2 were over legal size and the 70 small-mouthed bass included only 1 that was over 10 inches in length. The 3 large-mouthed bass taken were all 5 centimeters in length.

#### Comparison of the Fish Populations about the Shelters by Day and by Night

In order to obtain a preliminary idea of the differences in the fish populations by night and by day, 3 shelters were removed and 2 control areas seined in Douglas Lake between 7:45 and 10:45 P.M. on August 4. By day during the summer the same 3 shelters were removed from 3 to 6 times (a total of 13

removals), and the control areas were seined 10 times. The comparative results are shown in Table 5.

TABLE 5

Many rock bass and perch were taken about the shelters, both by night and during the day. The rock bass and probably the small-mouthed bass were commoner about the shelters during the day. The number of perch as well as pumpkinseed sunfish taken in the control areas was greater by night than by day. The log perch was more frequently taken at night in both shelters and control areas than during the day.

An interesting result of this seining was the seining of 2 trout-perch (Percopsis omiscomaycus), which was never taken in the daytime. This observation confirms the results of seinings in Douglas Lake in prior years, when trout-perch were seined on the bare shoals by night but never by day.

As in previous years, it was only during the night seining that any large ( $3\frac{1}{2}$  to 4 inch) common shiners (Notropis cornutus frontalis) and spot-tailed shiners (Notropis h. hudsonius) were taken. These shiners were frequently seined during the daytime but at a much smaller size (averaging about 2 inches).<sup>1</sup>

#### The Value of Fertilizing Shelters

To learn whether fish would congregate more heavily in shelters that were fertilized, 2 burlap sacks full of barnyard manure were added to Shelter 1, and one sack was added to each

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<sup>1</sup>This observation may prove of some value to the fisherman desiring these larger minnows for bait.



TABLE 5

DIFFERENCES IN FISH POPULATION BY NIGHT AND BY DAY ABOUT SHELTERS AND IN  
CONTROL AREAS OF DOUGLAS LAKE

Species	Fish per haul about Shelters		Fish per haul in Control Areas	
	Night (3 hauls)	Day (13 hauls)	Night (2 hauls)	Day (10 hauls)
Small-mouthed bass ( <u>Micropterus dolomieu</u> )	2.7	5.0	2.5	2.7
Large-mouthed bass ( <u>Huro salmoides</u> )	0.7	0.6	0.0	0.0
Rock bass ( <u>Ambloplites rupestris</u> )	24.7	57.8	0.0	0.5
Pumpkinseeds ( <u>Eupomotis gibbosus</u> )	7.7	7.4	3.5	0.4
Yellow perch ( <u>Perca flavescens</u> )	35.3	16.2	10.1	0.7
White sucker ( <u>Catostomus commersonii</u> )	0.3	1.2	0.0	1.3
Brown bullhead ( <u>Ameiurus nebulosus</u> )	0.0	0.2	0.0	0.0
Sand shiner ( <u>Notropis deliciosus</u> )	1.0	1.0	0.5	0.1
Common shiner ( <u>Notropis cornutus</u> )	4.3	0.8	0.0	0.0
Spot-tailed shiner ( <u>Notropis hudsonius</u> )	14.7	1.6	0.2	0.5
Blunt-nosed minnow ( <u>Hyborhynchus notatus</u> )	0.0	0.4	0.0	0.2
Iowa darter ( <u>Poeciliichthys exilis</u> )	0.0	0.0	0.0	0.1
Johnny darter ( <u>Boleosoma nigrum</u> )	0.3	0.5	0.0	0.9
Log perch ( <u>Percina caprodes</u> )	4.3	1.0	0.0	0.4
Trout-perch ( <u>Percopsis omiscomaycus</u> )	0.7	0.0	0.0	0.0

of Shelters 4, 7, 8 and 9, on July 21. Shelters 2, 3, 5, 6 and 10, serving as controls, were not fertilized.

TABLE 6  
SUMMARY OF FISH TAKEN PER SEINE HAUL IN THE  
FERTILIZED AND UNFERTILIZED SHELTERS

Species	Fertilized hauls (18)	Unfertilized hauls (16)
Small-mouthed bass ( <u>Micropterus dolomieu</u> )	3.3	6.1
Large-mouthed bass ( <u>Huro salmoides</u> )	0.9	0.4
Rock bass ( <u>Ambloplites rupestris</u> )	53.2	31.8
Pumpkinseed ( <u>Eupomotis gibbosus</u> )	9.1	5.6
Bluegill <sup>1</sup> ( <u>Helioperca macrochira</u> )	-	.1
Yellow perch ( <u>Perca flavescens</u> )	18.8	11.2
White sucker ( <u>Catostomus commersonii</u> )	1.4	2.4
Brown bullhead ( <u>Ameiurus nebulosus</u> )	.1	-
Sand shiner ( <u>Notropis deliciosus</u> )	.2	.8
Common shiner ( <u>Notropis cornutus</u> )	1.2	.2
Spot-tailed shiner ( <u>Notropis hudsonius</u> )	3.5	.9
Blunt-nosed minnow ( <u>Hyborhynchus notatus</u> )	-	.3
Iowa darter ( <u>Poecilichthys exilis</u> )	.1	-
Johnny darter ( <u>Boleosoma nigrum</u> )	.3	.3
Log perch ( <u>Percina caprodes</u> )	1.8	1.4
Trout-perch ( <u>Percopsis omiscomaycus</u> )	.1	-
Total game fishes . . . . .	85.3	55.2
Total coarse fishes . . . . .	1.5	2.4
Total forage fishes . . . . .	7.2	3.9
Grand total . . . . .	94.0	61.5

<sup>1</sup>Bluegills are very scarce in Douglas Lake.

From Table 6 it may be observed that more fish were taken per seine haul from fertilized shelters than from unfertilized shelters. Notable examples are rock bass, pumpkinseeds, perch and some forage fishes. More small-mouthed bass were taken in

the unfertilized than in the fertilized shelters, but the numbers involved are too small to warrant definite conclusions.

#### Use of Shelters as a Permanent Summer Habitat

By clipping the pelvic fins from all fish of sufficient size, seined in the removal of the shelters and in the control areas, on various dates in August, they were definitely marked to determine to what degree they were making use of the brush shelters as a permanent summer habitat. On August 2, 4 and 6, the right pelvic fin was clipped, and the marked fish recovered during these days were merely so recorded and released. On August 23, 24 and 25, the left pelvic fin was clipped, whether or not the right pelvic fin had previously been removed.

The tendency of the fish to remain about the shelters was illustrated on the first day when the fins were clipped. Thirty-nine of the 160 fish seined at 1 P.M. in Shelter 2 had been marked at 10 A.M. when seined from Shelter 1, and 17 of the 132 fish seined in Shelter 3 at 2:50 P.M. had been marked in the two other shelters or in control area B earlier in the day.

#### TABLE 7

Table 7 gives data showing the per cent of fish taken with fins clipped during August. Only 7 of the 16 species of fish taken from the brush shelters in Douglas Lake were

KINDS, NUMBER AND PER CENT OF FISH WITH FINS CLIPPED, TAKEN  
DURING AUGUST FROM 10 SHELTERS AND 5 CONTROL AREAS

Kind	August 1937	Shelters			Control Areas		
		Number fish taken	% fish not marked	% of fish <sup>1</sup> previously marked	Number fish taken	% fish not marked	% of fish previously marked
Small-mouthed bass	2	33	85	15	6	100	-
	4	24	88	12	19	95	5
	6	14	79	21	22	86	14
	23	27	93	7	7	86	14
	24	38	87	13	13	92	8
	25	11	82	18	6	83	17
Rock bass	2	394	92	8	0	-	-
	4	199	70	30	3	33	67
	6	247	44	56	0	-	-
	23	392	58	42	1	100	-
	24	113	55	45	2	100	-
	25	79	51	49	3	33	67
Pumpkin-seed	2	54	81	19	3	67	33
	4	55	75	25	15	93	7
	6	47	64	36	0	-	-
	23	59	92	8	0	-	-
	24	21	62	38	2	100	-
	25	14	100	0	3	67	33
Perch	2	120	93	7	-	-	-
	4	143	94	6	65	97	3
	6	112	72	28	19	100	-
	23	78	63	37	1	100	-
	24	26	50	50	99	97	3
	25	15	47	53	14	86	14
Large-mouthed bass	2,4,6	13	100	0	-	-	-
	23,24,25	9	89	11	-	-	-
White sucker	2,4,6	22	100	0	-	-	-
	23,24,25	12	83	17	-	-	-
Log perch	2,4,6	36	100	0	-	-	-
	23,24,25	19	90	10	-	-	-

<sup>1</sup>Only fish with 1 fin removed are given in this table. Thirty-two rock bass, 6 perch and 1 small-mouthed bass were taken with both pelvic fins clipped.

seined more than once. Of these, rock bass, yellow perch, pumpkinseeds and small-mouthed bass seemed to prefer brush shelters for a summer home, in the order mentioned. It may also be noted that the percentage of marked perch and rock bass taken increased as more fins were clipped. This may indicate, for these species at least, that these fish quite definitely made the shelters their place of abode during the month of August.

The number of clipped fish seined in control areas is small in comparison with those taken from shelters and is hardly indicative of any results, with the possible exception of the small-mouthed bass. It might be inferred that these fish used the general area as well as the immediate vicinity of the shelters.

The large number of perch taken in the control areas was, to a certain extent, a matter of happenstance, since schools of small perch were taken in several hauls. It is possible that these fish were migrating in the area at the time the seining was done.

#### Repopulation of a Shelter from which Fish had been Removed

On August 23, the complete catch from Shelter 1 was preserved to determine to what extent this shelter, replaced at once, would soon become repopulated, from deep water, bare shoals or other shelters. The check (see Table 8) was made

two days later, when 83 fish were found to have taken up their abode in or about the shelter.

TABLE 8  
FISH POPULATION BY SPECIES IN A SHELTER BEFORE AND  
AFTER REMOVAL OF FISH

Species	August 23	August 25
Small-mouthed bass ( <u>Micropterus dolomieu</u> )	3	4
Large-mouthed bass ( <u>Huro salmoides</u> )	1	2
Rock bass ( <u>Ambloplites rupestris</u> )	140	50
Pumpkinseeds ( <u>Eupomotis gibbosus</u> )	7	4
Yellow perch ( <u>Perca flavescens</u> )	26	8
Common shiner ( <u>Notropis cornutus</u> )	-	4
Spot-tailed shiner ( <u>Notropis hudsonius</u> )	5	9
Johnny darter ( <u>Boleosoma nigrum</u> )	1	2
Log perch ( <u>Percina caprodes</u> )	3	-
Totals . . . . .	186	83

On August 23, the total fish population was 186, and the number varied from 113 to 247 on 3 previous seining, on August 2, 4 and 6. More bass and forage fish were taken on August 25 than on August 23, but the numbers on each were too limited for definite conclusions. Rock bass and perch out-numbered other game fishes in this shelter.

### Value of Improved Areas

From the data here presented perhaps one may conclude that the young of game fish seek the protection of shelters of the forage fishes, the blunt-nosed minnow shows a decided preference for the shelters. Suckers were the largest fish taken, ranging from 35 to 40 centimeters in length (14 to 16 inches), but the young of this fish also sought the protection of the shelters.

This study merely indicates the effectiveness of shelters in concentrating fish in a given area in a lake. It has not been determined to what extent brush shelters may increase the fish population of an entire lake.

In connection with the protection of fish in shelters, many problems may be presented. The effect of the induced concentrations on food supply, stunting of growth, parasitization and disease are among questions in need of study.

It may be supposed that brush shelters attract large fish in search of smaller fish for food. The value of large brush shelters, from the angler's point of view, in attracting big fish to fishing grounds of moderate depth is being investigated on another lake in Michigan. The problem arises as to whether such shelters render the catch of fish so easy as to lead to overfishing and the depletion of the stock.

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