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FURTHER STUDIES IN THE USE OF BRUSH SHELTERS  
BY FISH IN DOUGLAS LAKE, MICHIGAN<sup>1</sup>

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At the 1938 meetings of the Academy of Science the writer presented the results of studies made in 1934 and 1937 on the use of brush shelters by fish in six Michigan lakes (Rodeheffer, 1939). During the summer of 1938 the investigation was continued at Douglas Lake, Cheboygan County, Michigan, using the same shelters and the same methods of determining fish populations in or about the shelters and control areas as in 1937. Details of the methods employed and the purposes of the study were stated in the previous paper. Additional tests were needed to warrant the drawing of definite conclusions on several phases of the work undertaken in 1937.

Continuing the study of the repopulation of shelters after the removal of all fish, four additional brush shelters were placed in North Fishtail Bay of Douglas Lake. All fish taken in these shelters were released on the opposite shore of the bay, after the game fish of sufficient size had been marked with numbered jaw tags (Shetter, 1936).

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

In 1937 the fish populations by night and by day about the shelters showed differences that seemed to justify further day and night seining during the summer of 1938.

It has been realized for some time that additional study was needed to test the value of adding fertilizer to shelters in order to make them a more suitable habitat for fish. Therefore, in 1938 as well as in 1937, certain shelters at Grape Vine Point in Douglas Lake were fertilized with barnyard manure.

The results of the studies outlined above are treated in this second paper on the use of brush shelters by fish. A report on the use of brush shelters as a continuous summer habitat, as well as information regarding the movements of fishes (which it is hoped may be successfully determined by tagging and fin clipping) will be delayed, pending the completion of further investigations.

#### Acknowledgments

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### Installation of Shelters in 1938

In a further effort to ascertain the relation of the brush shelters to the concentration and localization of the fish populations in given parts of a lake, four additional shelters were placed in Douglas Lake just north of Hook Point in North Fishtail Bay. In this location the depth gradually increases to 8 to 12 feet at the drop-off, which lies 150 to 200 feet from shore. The bottom of the shoal, chiefly composed of sand, is covered by a layer of flaky marl varying in thickness from a small fraction of an inch to about 2 inches, and is almost devoid of rooted vegetation in water less than 8 feet deep. In deeper water on the shelf near the drop-off, and on the steep slope beyond, there is some submerged vegetation.

The shelters, constructed according to directions by Hubbs and Eschmeyer (1938) comprised a hollow-center square shelter (22 x 22 feet), a pole shelter (18 x 26 feet), a ladder shelter (14 x 16 feet) and a circular shelter (12 feet in circumference). With the exception of the square and pole shelters which were separated by a distance of 200 feet to provide a control area the structures were placed approximately 90 feet apart. They were made larger and less densely packed than those used at Grape Vine Point in 1937 and 1938. They were too large to be entirely pulled out of the lake during the seining, but the clarity of the water made it possible to see that no fish stayed in the brush when brought to the shore.

In the area where these shelters were later placed, four seine hauls made on July 20, 1938 with the 140 foot seine which had been used in 1937, caught 2 small-mouthed bass, 9 sand shiners, 3 spot-tailed shiners, 1 blunt-nosed minnow, 79 clams and 1 crayfish. The

results of this seining agree with those of similar seining at Grape Vine Point in 1937 in confirming the general observation that such shoal areas in Douglas Lake are relatively barren of fish life.

Results of Seining in 1937 and 1938  
at Douglas Lake, Michigan

Data were obtained on the number of fish of each species taken per seine haul about the shelters and in the control areas (Table I). The results for 1937 and 1938 are in essential agreement in both years at Grape Vine Point. Rock bass, perch, pumpkinseed sunfish, small-mouthed bass and large-mouthed bass were the common game species, and ranked in abundance in the order given. Considering together the results of the day and night seinings (as presented in Table I), it will be seen that the rock bass and pumpkinseeds displayed a very strong preference for the brush devices, whereas perch, small-mouthed bass and most other fishes did not show a consistent attraction to the shelters.

As would be expected (Hubbs and Bailey, 1938) the number of large-mouthed bass taken per seine haul in the quieter, weedier and more roily waters of North Fishtail Bay was greater than at the more exposed Grape Vine Point. All data indicate that this bass showed a decided preference for the brush rather than for the open shoals. The relative numbers of small-mouthed bass taken in the covers and in the control areas of the two habitats is not so easily explainable.

Although Douglas Lake has a fairly good reputation for pike fishing, no northern pike were obtained in the 1937 seinings. In 1938 only one was caught (with several recaptures) at Grape Vine Point,

TABLE I

NUMBER OF FISH OF EACH SPECIES PER SEINE HAUL ABOUT SHELTERS  
AND IN CONTROL AREAS TAKEN IN DOUGLAS LAKE

Numbers in parentheses indicate number of seine hauls.

	Grape Vine Point 1937		Grape Vine Point 1938		North Fishtail Bay 1938	
	Shelters (36)	Controls (23)	Shelters (40)	Controls (23)	Shelters (15)	Controls (4)
<b>Game Fishes</b>						
Rock bass	40.7	0.4	39.6	1.2	24.8	2.0
Perch	14.4	8.7	34.3	25.7	13.5	31.7
Pumpkinseed	7.0	1.0	7.6	0.9	17.6	2.8
Small-mouthed bass	4.4	3.1	3.0	1.9	3.9	6.5
Large-mouthed bass	0.6	0.1	0.2	tr.	4.3	0.8
Northern pike	...	...	0.1	...	0.2	...
Bluegill	0.1	...	...	...	...	...
<b>Coarse Fishes</b>						
White sucker	1.7	2.0	2.3	0.5	4.5	1.5
Brown bullhead	0.1	...	0.1	...	1.6	...
<b>Forage Fishes</b>						
Common shiner	0.7	0.7	3.6	2.3	0.9	11.5
Spot-tailed shiner	2.2	5.2	2.6	2.0	4.3	2.5
Log perch	1.6	2.5	3.0	1.0	1.3	0.8
Sand shiner	0.6	0.3	1.7	1.3	...	...
Blunt-nosed minnow	0.1	0.1	...	...	2.8	...
Johnny darter	0.3	0.8	0.3	0.2	0.5	0.8
Trout perch	0.1	...	tr.	...	...	...
Iowa darter	tr.	0.1	...	...	...	...
Muddler	...	...	...	...	0.1	...
<b>Total Fish</b>	<b>74.6</b>	<b>25.0</b>	<b>98.4</b>	<b>37.0</b>	<b>80.3</b>	<b>60.9</b>

and only 3 were seined at North Fishtail Bay. Apparently pike do not inhabit brush shelters at least when located in comparatively shallow water.

The total number of fish taken per seine haul in 1938 was greater in both shelters and control areas than in 1937. This result may largely be explained by the greater amount of night seining in 1938. In particular the large numbers of perch taken at night increased the total number of fish per haul.

#### The Repopulation of Brush Shelters

##### After the Removal of All Fish

To determine to what extent and how rapidly brush shelters become repopulated, all fish removed from the shelters and control areas north of Hook Point were carried a straight-line distance of about 0.6 mile across North Fishtail Bay and were released in the small sheltered bay which lies to the east of East Point. All game fish of sufficient size were tagged with jaw tags to determine if any would return to the artificial covers. These shelters were removed 15 times and the control area was seined 4 times between August 3 and 22, 1938. The number of fish per haul in North Fishtail Bay, as given in Table I, therefore represented new arrivals on the seining grounds. Nevertheless the indicated abundance of fish here compared favorably with the determinations for Grape Vine Point where the fish seined were not transported to another locality. Although the conclusion is weakened by the fact that the experiment and the control were performed in different parts of the lake, with distinctive conditions, it is suggested by the data that fish may concentrate to a certain degree in areas provided with brush protection,

and that if these fish are removed others will take their place until the original concentration is approximately duplicated. However, the number of rock bass taken in hauls following the initial removal was always less than in the first seining. Nineteen of the 497 fish tagged and planted across the bay were retaken in the shelters.

Game Fish Taken About Brush Shelters  
and In Control Areas By Day and By Night

By quantitative seining in Douglas Lake considerable data were gathered on the number and size of individuals of each species of game fish occurring in and about the brush shelters and in the control areas, by day and by night (Tables II and III). Marked differences were discovered, in comparing the species and in contrasting the data for shelters and control areas and that for day and night occurrences.

As previously noted, rock bass (Table II) congregated in notable abundance about the brush, but only during the day. At night about three-fourths of the rock bass deserted the cover, but at no time were seined commonly in the control areas. Therefore at night they must either have scattered over the shoals (as suggested by the greater number there at night), or have moved into deep water. The rock bass seined by day averaged larger than those taken at night, in the control areas as well as about the brush. Less than 7 per cent of the 3,345 rock bass from about the brush were of legal size (6 inches or more). The rock bass is considerably dwarfed in Douglas Lake.

Pumpkinseeds (Table II) were less abundant than rock bass but showed about the same differences in abundance between night and day and between shelters and control regions. They were very strongly

TABLE II

NUMBER, NUMBER PER SHINE HAUL AND SIZES (TOTAL LENGTHS IN CENTIMETERS)  
 OF ROCK BASS AND PUMPKINSEED SUNFISH TAKEN IN BRUSH SHELTERS AND CONTROL AREAS  
 BY DAY AND BY NIGHT IN DOUGLAS LAKE IN 1937 AND 1938

		Rock bass				Pumpkinseed			
		Shelters		Controls		Shelters		Controls	
		Day	Night	Day	Night	Day	Night	Day	Night
Grape Vine Point, 1937	Min. size	2.2	3.0	2.5	...	2.5	5.2	9.0	10.5
No. of hauls	Ave. size	9.4	8.6	5.9	...	10.5	10.8	11.7	12.5
Shelters - Day 33	Mod. size	9-10	6-7 ?	2-3 ?	...	10-11	10-11 ?	?	?
Night 3	Max. size	21.2	16.0	12.4	...	20.0	16.0	17.0	16.0
Controls - Day 21	No. of fish	1349	74	9	0	221	23	17	7
Night 2	No. per haul	40.7	24.7	0.4	0.0	6.7	7.7	0.8	3.5
Grape Vine Point, 1938	Min. size	1.4	2.3	3.0	2.4	2.6	3.2	3.0	6.9
No. of hauls	Ave. size	10.1	6.6	4.8	5.2	9.0	9.3	10.6	11.0
Shelters - Day 31	Mod. size	12-13	6-7	?	5-4 ?	6-7	6-7	?	?
Night 9	Max. size	24.0	14.6	5.9	13.5	18.0	18.4	14.5	17.0
Controls - Day 19	No. of fish	1476	74	3	20	279	24	8	11
Night 4	No. per haul	47.6	8.2	0.2	5.0	9.0	2.7	0.4	2.8
North Fishtail Bay, 1938	Min. size	2.5	3.2	4.6	3.7	3.5	3.0	10.0	6.0
No. of hauls	Ave. size	11.1	10.4	6.5	7.0	7.7	7.5	13.8	10.8
Shelters - Day 12	Mod. size	7-8	?	6-7	7-8	6-7	6-7 ?	?	?
Night 3	Max. size	23.1	17.1	12.8	9.0	18.9	16.5	16.9	13.9
Controls - Day 3	No. of fish	364	8	2	6	243	20	8	3
Night 1	No. per haul	30.3	2.7	0.7	6.0	2.3	6.7	2.7	3
Combined data	Min. size	1.4	2.3	2.5	2.4	2.5	3.0	3.0	6.0
No. of hauls	Ave. size	9.9	7.7	5.8	5.6	9.0	9.3	12.0	11.5
Shelters - Day 76	Mod. size	9-10	6-7	6-7 ?	3-4 ?	6-7	6-7	?	?
Night 15	Max. size	24.0	17.1	12.8	13.5	20.0	18.4	17.0	17.0
Controls - Day 43	No. of fish	3189	156	14	26	743	67	33	21
Night 7	No. per haul	42.0	10.4	0.3	3.7	9.8	4.5	0.8	3.0

Note to Editor:

Tables II and III should be placed on opposite pages.



TABLE III

NUMBER, NUMBER PER SHINE HAUL AND SIZES (TOTAL LENGTHS IN CENTIMETERS)  
 OF PERCH AND SMALL-MOUTHED BASS TAKEN IN BRUSH SHELTERS AND CONTROL AREAS  
 BY DAY AND BY NIGHT IN DOUGLAS LAKE IN 1937 AND 1938

		Perch				Small-mouthed bass				
		Shelters		Controls		Shelters		Controls		
		Day	Night	Day	Night	Day	Night	Day	Night	
Grape Vine Point, 1937		Min. size	3.5	4.5	3.5	4.2	1.4	5.2	4.0	4.5
No. of hauls		Ave. size	11.3	9.3	11.3	9.7	9.5	13.4	7.8	6.3
Shelters - Day 33		Mod. size	13-14	9-10	4-5	4-5 ?	6-7	13-14 ?	5-6	?
Night 3		Max. size	18.5	19.0	18.0	14.3	22.5	16.2	16.0	12.0
Controls - Day 21		No. of fish	388	112	179	21	143	8	65	5
Night 2		No. per haul	11.8	37.2	6.5	10.5	4.3	2.7	3.1	2.5
Grape Vine Point, 1938		Min. size	2.4	3.0	4.1	4.2	4.0	4.6	4.5	4.1
No. of hauls		Ave. size	12.0	10.1	9.3	9.9	9.6	11.5	10.0	10.9
Shelters - Day 31		Mod. size	11-12	9-10	?	9-10	6-7	4-6	6-7	?
Night 9		Max. size	19.7	19.5	13.5	14.2	29.3	39.2	36.3	15.4
Controls - Day 19		No. of fish	813	548	6	584	106	12	38	5
Night 4		No. per haul	26.2	60.9	0.3	146	3.4	1.3	2.0	1.3
North Fishtail Bay, 1938		Min. size	3.5	7.5	5.0	4.5	4.2	4.9	4.2	5.0
No. of hauls		Ave. size	10.7	11.2	5.0	9.0	7.9	5.9	6.2	6.2
Shelters - Day 12		Mod. size	12-13	9-10 ?	?	5-6	6-7	5-6 ?	6-7	?
Night 3		Max. size	15.7	15.4	5.0	14.3	24.0	7.0	12.8	6.5
Controls - Day 3		No. of fish	171	32	1	125	50	7	23	3
Night 1		No. per haul	14.3	10.7	0.3	125.0	4.2	2.3	7.7	3.0
Combined data		Min. size	2.4	3.0	3.5	4.2	1.4	4.6	4.0	4.1
No. of hauls		Ave. size	11.6	10.0	11.2	9.5	9.3	10.6	8.2	8.0
Shelters - Day 76		Mod. size	11-12	9-10	4-5	9-10	6-7	5-6 ?	6-7	?
Night 15		Max. size	19.7	19.5	18.0	14.3	29.3	39.2	36.3	15.4
Controls - Day 43		No. of fish	1378	692	186	750	299	27	126	13
Night 7		No. per haul	18.1	46.1	4.3	107.1	3.9	1.8	2.9	1.9

attracted to the brush, but not so strongly as the rock bass. Almost three-fifths of those inhabiting the covers by day deserted them at night, when a marked increase in the always low numbers occurring on the open shoals was noted. Less than 5 per cent of the 800 pumpkinseeds from the shelters exceeded the minimum legal size (6 inches).

The most interesting item in the data for the perch (Table III) contrasting with the information on the rock bass is the increased abundance of this species on the shoals at night, particularly in the control areas. Here the perch were indicated to be 24.9 times as numerous by night as by day. About the shelters, they were taken 2.6 times more frequently at night than during the day. The shelters proved the more attractive in daylight when the indicated abundance in the brush was 4.2 times that in the open. At night, in contrast the abundance in the shelters was less than half that found in the control areas. Obviously the perch which abound in the offshore weed beds in Douglas Lake tend to move onto the shoals at night, and largely desert the shallows during the day, particularly when there is no cover. About the brush constructions the perch averaged somewhat larger by day than by night, and the same relation held for the control areas except at one day seining when large numbers of small perch were secured. Almost 3 per cent of the perch seined about the brush were of legal size (6 inches or more), but it should be recalled that the perch in Douglas Lake are markedly dwarfed (Weller, 1938).

Small-mouthed bass (Table III) were not taken in the shelters as commonly as the three species already mentioned and were not much commoner in the brush than on the open shoals. In both areas they were seined even less frequently at night than by day. Only 2 of the 326 small-mouths seined from the shelters were more than 10 inches long.

Large-mouthed bass were taken in even smaller numbers but showed a greater preference for the shelters. Of the 102 seined 95 were from the brush, 81 by day and 14 by night; 7 were taken in the control areas, 5 by day and 2 by night. The numbers per seine haul under these four conditions were 1, 1, 0.1 and 0.3 respectively. None of legal size were caught.

In conclusion it may be stated that great changes occur from day to night in the fish populations around the shelters and on the unprotected shoals. When the young and half-grown fish desert the cover, we can only wonder where they go. If the legal-sized fish of these species show as much fluctuation in their habitats, is it surprising that fishermen often complain of not being able to catch fish? Most assuredly little is known of the movements or the habits of our game fishes.

#### The Value Of Fertilizing Shelters

To learn whether fish congregate more heavily in shelters that are fertilized, 2 burlap sacks full of barnyard manure were added to shelter 1 and one sack was added to each of shelters 4, 7, 8, and 9 on July 21, 1937, and again on July 15, 1938. Shelters 2, 3 and 10, serving as controls, were not fertilized. These structures, all located at Grape Vine Point in Douglas Lake, were described in the previous report (Rodeheffer, 1939).

In 1937 filamentous algae grew in profusion on the recently placed fertilized shelters. There was some algae on the unfertilized covers, but not so much. In 1938 no algal growth was noticeable on any of the shelters. Some quantitative study (unpublished) was made by Mr. O. W. Young on the organic growths on the brush of the fertilized and unfertilized shelters.

The results of the experiment (Table IV) are not very conclusive, though the fish population seemed to be somewhat greater in the fertilized shelters. The difference was chiefly evident for the rock bass and pumpkinseeds, which most consistently inhabit the brush structures. It was not determined whether the fish in the fertilized shelters showed an increased rate of growth, (or indeed whether individual fish inhabit a given shelter continuously enough to allow a test as to effects of the fertilizer on their growth).

#### The Value Of Brush Shelters In Fish Management

The second summer's study of brush shelters in Douglas Lake has contributed evidence to support the views that:

1. Young and half grown fish of certain species seek the protection of brush shelters, especially during the day.
2. Fish continue to repopulate the shelters as those inhabiting the cover are removed.
3. The fish population about the shelters, as well as on the open shoals, is subject to great individual changes, which need be considered in checking on the use of the shelters by fish.
4. Fertilizing shelters with barnyard manure, although appearing to be of some value in attracting certain species of fish, may not prove effective enough in this respect to justify the cost.

TABLE IV

SUMMARY OF FISH TAKEN PER SEINE HAUL IN THE FERTILIZED  
AND UNFERTILIZED SHELTERS IN DOUGLAS LAKE IN 1937 AND 1938

	In fertilized shelters (41 hauls)	In unfertilized shelters (25 hauls)
<b>Game Fishes</b>		
Rock bass	50.8	38.2
Yellow perch	28.7	25.9
Pumpkinseed	8.9	6.8
Small-mouthed bass	3.7	3.8
Large-mouthed bass	0.6	0.4
Bluegill	...	0.1
Northern pike	0.1	...
<b>Total, game fishes</b>	<b>92.8</b>	<b>75.2</b>
<b>Coarse Fishes</b>		
White sucker	1.6	3.8
Brown bullhead	0.1	0.1
<b>Total, forage fishes</b>	<b>11.4</b>	<b>12.2</b>
<b>Grand total</b>	<b>105.9</b>	<b>91.3</b>

List Of Common and Scientific  
Names Of Fishes Mentioned In This Report

<u>Catostomus c. commersonii</u>	Common White Sucker
<u>Notropis cornutus frontalis</u>	Northern Common Shiner
<u>Notropis h. hudsonius</u>	Great Lakes Spot-tailed Shiner
<u>Notropis deliciosus stramineus</u>	Northern Sand Shiner
<u>Hyborhynchus notatus</u>	Blunt-nosed Minnow
<u>Ameiurus n. nebulosus</u>	Northern Brown Bullhead
<u>Esox lucius</u>	Northern Pike
<u>Percopsis omiscomaycus</u>	Trout-perch
<u>Perca flavescens</u>	Yellow Perch
<u>Percina caprodes semifasciata</u>	Northern Log-perch
<u>Boleosoma n. nigrum</u>	Central Johnny Darter
<u>Poecilichthys exilis</u>	Iowa Darter
<u>Micropterus d. dolomieu</u>	Northern Small-mouthed Bass
<u>Huro salmoides</u>	Large-mouthed Bass
<u>Lepomis macrochirus</u>	Bluegill
<u>Lepomis gibbosus</u>	Pumpkinseed
<u>Ambloplites rupestris</u>	Rock Bass
<u>Cottus bairdii</u>	Northern Muddler

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