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Institute for Fisheries Research
I. A. Rodeheffer

INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

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UNIVERSITY MUSEUMS ANNEX
ANN ARBOR, MICHIGAN

September 27, 1945

REPORT NO. 1019

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Brush Shelter Investigation

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A detailed observation of a pile of brush placed to act as a fish shelter was made in the fall of 1931. This device consisted of loose brush placed over a shallow drop-off in Crystal Lake, Oceana County, Michigan. The number of fish taken from and around this pile of brush (6,941) by an Institute for Fisheries Research party, under the direction of Dr. Carl L. Hubbs, aroused enthusiasm for more work of this kind. Additional experimental brush shelters were constructed by Institute field parties during following summers.

Soon after the Civilian Conservation Corps was organized in 1933 lake improvement by means of brush shelters and spawning devices was accepted as one of the projects of the organization and in subsequent years hundreds of these structures were sunk in Michigan lakes. Sometimes such structures were built and placed under the direction of adequately trained personnel, but often not, with the result that many were built and sunk without regard to their need, placement, distribution or value to a given body of water.

While the construction and installation of brush shelters was carried on as one of the major fisheries activities of the Civilian Conservation Corps in Michigan, the Institute for Fisheries Research,

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Note: Maps mentioned herein are on file at the Institute for Fisheries Research.

Department of Conservation of Michigan continued to develop numerous types of shelters and made some studies of their value in attracting fish of various sizes and species in different depths and locations in Douglas Lake, Michigan. The effect of the size and shape of shelters was also determined in this particular lake.(Rodeheffer 1939, 1940, 1941, 1945).

To further determine how successful these structures were an Institute for Fisheries Research field party equipped with a diving helmet and water glass during the summer of 1944, was sent out to investigate some of the Michigan lakes that had been improved in 1933 and following years by the Civilian Conservation Corps.

The brush shelter survey party consisted of three members. The writer, who directed some of the building and installation of shelters in Michigan Lakes in 1933 by the Civilian Conservation Corps, Mr. Jason Day, who had former experience in brush shelter investigation work with the writer, and Mr. Walter Tiede with life saving training. This party visited the 30 Michigan lakes given in Table 1 during the summer of 1944. The lakes were checked for:

1. The condition of the brush shelters installed in 1933 and later years.

2. The fish life in and around the constructions.

3. The effectiveness of these devices in aiding to establish vegetation in a lake or a part of a lake where aquatic vegetation was lacking.

4. The presence of the larger organisms used as fish food on the brush.

A detailed study was made of Shupac Lake and Lake Margarethe, on both of which the writer had supervised the improvement work in 1933, to try to get some estimate of the amount of the original work still in good condition. Only limited checking was done on the other lakes, the purpose being to

Table 1

Brush Shelter Examination

Table indicating the lakes, their location, area in acres, and number of improvement devices inspected June to September, 1944

Lakes	Counties	Town	Range	Section	Area acres	Number of shelters examined
Gun	Barry	2, 3 N.	10 W.	1,4,5,6,8,9,19,28, 29,30,31,32,33,36	2,680	8
Pettits	Newaygo	12 N.	11 W.	19 & 20	170	4
Brooks	"	12 N.	12 W.	27, 28, 33, 34	300	4
Loon	"	16 N.	13 W.	17 & 20	40	15
Shupac	Crawford	28 N.	1 W.	21	160	85
Roberts (Bluegill)	"	28 N.	3 W.	6	(Est.) 29	10
Jones	"	28 N.	2 W.	31	40	8
K. P.	"	28 N.	2 W.	28	110	8
Howe	"	26 N.	4 W.	32	13	7
Bright	"	27 N.	3 W.	16	13	12
Glory	"	27 N.	3 W.	16	23	7
Margarethe	"	26 N.	4 W.	...	1,881	63
Island	Oscoda	24,25 N.	2 E.	1, 2, 36, 35	65	1
North Twin	"	25 N.	2 E.	25	8	3
South Twin	"	25 N.	2 E.	25	10	5
Loon	"	25 N.	2 E.	36	90	20
Wagner	"	25 N.	2 E.	13, 14	26	12
Fife	Grand Traverse	25 N.	9 W.	12, 13	575?	16
Fuller	"	25 N.	9 W.	12, 13	5	5
Pickerel	"	25 N.	9 W.	13, 24	(Est.) 32	5
Dowens	"	25,26 N.	9 W.	3, 34	15	8
Spring	"	25 N.	9 W.	14	11	6
Ocqueoc	Presque Isle	36 N.	3 E.	20	132	5
Orchard	"	36 N.	2,3 E.	19, 24	35	2
Tomahawk	"	33 N.	2 E.	22, 23	40	14
Black	"	35,36 N.	12 E.	...	10,130	13
Clear	Montmorency	32 N.	2 E.	27, 33, 34	133	21
Rush	"	32 N.	3 E.	31, 32	220	7
Bear	Kalkaska	27 N.	5 W.	17, 20	317	3
Big Guernsey	"	27 N.	8 W.	19, 20	52	10
TOTAL						387

cover as many lakes as possible with a variety of size, type of bottom, and exposure to wind, and etc.

Physical Condition of Lakes

The size of the 30 lakes in which brush shelters were examined varied from 5 acres to 10,130 acres in area. In some the bottom was hard where the shelters were found, in others the bottom was very soft and mucky. In certain lakes it was difficult to tell where the soft mucky bottom began except by the cooler temperature and the lack of light. In most instances shelters were found on a flat almost horizontal bottom, but in several the shelters were lodged on the steep drop-off.

Visibility readings with a Secchi disk varied from 6 1/2 feet to 36 feet in the various lakes.

Equipment used in Checking Brush Shelters

The 1944 field party used a water glass, which is a metal pipe about 30 inches long with a diameter of that of an ordinary stove pipe fitted with a sealed waterproof glass at one end. This could be held over the edge of a boat with the glass bottom below the surface of the water permitting the observer to put his face to the other end and look through the glass at objects under water undisturbed by light reflection or wave action. In fairly shallow, clear water this device is very satisfactory as it permits an over all picture of a brush shelter and makes it possible to observe the condition, the fish life, and the aquatic vegetation in and around the shelter.

For installations in deeper water or water that is more or less murky, the diving helmet was used. This helmet and equipment consisted of a hood resting on the divers shoulders. One end of a 50 foot rubber hose was attached to the helmet with the other end fastened to an air pump carried in the boat. When a diver was down, one man operated the

pump while the other handled the air hose and the safety rope. Numerous shelters were in such deep water that their location could not be spotted from the surface. Common procedure then was to mark the contours where they were thought to be and to use drag hooks to locate them. When a shelter was found an anchored marker was placed over it and the dragging continued until several were discovered. The marked locations were then examined and studied with the use of the diving helmet.

Checking deep shelters was often difficult because of poor visibility. On some it was impossible to see the entire structure at one time. This meant moving around on the bottom which stirred up loose sediment, thereby reducing the visibility. It was possible to get some index of the visibility to be expected by Secchi disk readings. Visibility was always good at the depth of the Secchi disk reading and fair at some distance below it.

Descriptions of the Methods Used in Gathering Data

To aid in recording when in the field and to have terms mean the same thing, nomenclature was developed in describing the condition of the brush piles. Small twigs 1/4 inch or less in diameter (the thickness of a lead pencil) were named "tips." Brush 1/4 to 1 inch in diameter was designated as "branches." Larger brush 1 inch to 3 inches in diameter were called "trunks." Wood 6 inches or more in diameter was known as "timber."

Brush shelters as a whole were inspected to determine if they held their original shape with the brush arranged approximately in the position as when sunk. If so found their condition was recorded as "good." If the brush was spread so that it no longer made a compact mass it was recorded as "scattered." The brush itself was tested for strength. If it would bend or was hard, and not showing signs of decay, but appeared similar to green brush it was recorded as "good." Brush that broke off short and

BRUSH SHELTER CHECK BLANK

Date of check up _____ No. _____

Name of lake _____ County _____ T. _____ R. _____ Sec. _____

Date when installed _____ Agency who installed _____

Check up made by _____

Type of shelter _____ Visibility reading _____

Size of shelter: Length _____ Width _____ Height _____

Depth of water _____ Type of bottom _____

Part of lake where shelter is located: Exposed _____ Sheltered _____

Vegetation - species _____

Abundance _____ Area covered _____

Location in respect to shelter: Shallow side _____

Deep side _____ North side _____ South side _____

Specimens taken for identification _____ Specimen No. _____

Remarks on vegetation _____

_____

_____

Visible food on shelter _____

Fish seen _____ Abundance _____ Size _____ Species _____

_____

Physical condition of shelter:

Condition of frame _____

Condition of larger brush _____

Condition of smaller (tips of) brush _____

Comparative condition of identifiable species of brush used _____

_____

Remarks about shelter _____

_____

_____

was easily broken was noted as "brittle." Efforts were made to identify the different kinds of wood and gather information on the condition of each variety used in shelter construction.

The type of shelter, classified by Hubbs and Eschmeyer (1938), the estimated size height, depth of water, the kind of bottom and location, whether exposed or sheltered, were recorded.

Aquatic vegetation was recorded as the amount growing in an area of approximately 100 square feet. If 1 to 10 plants were found in this area the vegetation was recorded as "sparse." From 10 to 30 plants were noted as "common." Thirty to 60 plants were considered as "abundant" and 60 or more plants as "profuse." Plants were identified as far as possible in the field. Specimens were also collected and preserved for future identification.

Fish life observed around a shelter was identified whenever possible. Young pumpkinseed sunfish or bluegills were often recorded as either because these two species are so easily confused when observed in the water. The number of fish and their size in and around a shelter were estimated. Since estimates were based on actual fish seen it is likely that they generally are too low because it is difficult to see all fish in and around a shelter. In former experimental work at Douglas Lake observations were made over shelters in 6 feet of water after a net had been placed around them. Inevery instance more fish were caught from the shelter than could be seen when checking from the surface. It is likely that this error becomes even greater as the depth increases because of the poorer visibility. However, it should be pointed out that fish, as far as could be determined, showed no fear of the diver and often came within his reach.

The brush was examined for various, larger aquatic forms of animal or plant life that might serve as fish food.

Condition of Brush Shelters

One of the major problems for the summer was to determine the condition of the brush shelters placed in Michigan lakes in 1933 and following years. Table 2 presents these data.

(described by Hubbs and Eschmeyer 1938, pp. 63-84)

Of the various types of shelters, the following percentages (based on actual numbers examined) were found in good condition; ladder and tree 94%, clump 75%, deadhead and green brush 73%, ladder (double frame) 70%[1], deadhead 66%, and circular 59%.

Careful notations were made of the height that the brush stood up in the water. It is not known how high individual shelters were originally made, but it was the practice of the writer to insist on building them to a height of 3 to 4 feet when such construction was under his supervision in 1933.

After 10 years it was found that the majority of these shelters were still standing up to approximately this height (Table 2). It is likely that even a larger number would have been recorded as standing up to 3 or 4 feet in height if the figures did not include shelters found in extremely soft-bottomed lakes like Howe and Roberts, where it was difficult to tell where the actual bottom began.

Tree shelters showed little indication of flattening out. However, usually the branches were quite sparse on the tree trunks.

Ladder shelters which were usually closely packed by alternating butts and tops stood up well.

Circular, deadhead and clump shelters showed a definite tendency to flatten out. Circular shelters are made by criss-crossing brush and binding such a pile together with wire. As time goes on the brush seems to shift enough so that the branches lie more or less parallel and resemble

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[1] Ladder, double frame shelters are like ladder shelters except that they have a framework both on the top and on the bottom.

Table 2

The number and condition, as observed in 1944, of different kinds of brush shelters, stating the years they were placed in 30 Michigan lakes with the kind of bottom on which they were found

Kind of shelter*	Ladder	Ladder	Ladder	Ladder	Circular	Tree	Ladder double frame	Dead-head	Deadhead and green brush	Clump
Year placed	1933	1937	1939& 1940	Unknown date++	1933	Unknown date	1933	1933	1933	1933
No. of shelters	132	24	27	54	46	16	17	9	41	20
Good condition	121	22	26	54	27	15	12	6	30	15
Scattered	11	2	1	0	19	+++1	5	3	11	5
Frame										
Good	95	21	25	46	..	..	10	..	..	..
Broken	8	2	1	1	..	..	7	..	..	..
Not noted	29	1	1	7	..	..	..	..	..	..
Large brush										
Good	119	22	27	54	35	16	17	9	41	19
Brittle	13	2	..	..	11	..	..	..	..	1
Tips										
Good	26	1	11	34	2	1	8	..	..	5
Gone	87	6	2	14	39	15	3	9	35	15
Brittle	19	18	14	6	5	..	6	..	6	..
Binding pole										
In place	28	4	8	18	..	..	..	..	..	..
Out of place	15	4	..	1	..	..	..	..	..	..
Gone	67	16	19	35	..	..	..	..	..	..
Height of brush in feet										
1	20	2	1	..	11	..	15	6	..	2
2	35	5	2	1	14	..	2	3	..	13
3	38	10	12	26	4	..	..	..	4	1
4	28	7	12	22	8	4	..	..	32	1
5	7	..	..	5	4	7	..	..	5	2
6	..	..	..	..	..	5	..	..	..	..
?	4	..	..	..	5	..	..	..	..	1
Bottom										
Soft	43	12	12	17	27	7	..	..	..	2
Hard	89	12	15	37	19	9	17	9	41	18

*One brush carpet laid down in 1933 was found in fair condition, quite flat, with brush pushed up against larger deadheads by wave action.

++Unknown date--sometime after 1933.

+++Washed up on shore.

a large bunch of flattened piled brush. Deadhead shelters are made by gathering waterlogged timbers found on the ground in fairly shallow water and making a pile of it by crisscrossing them. These also have a tendency to shift position so that the timbers lie parallel and do not stay on top of each other. A clump shelter is made by digging out 5 or 6 clumps of bushes, like tag-alder or willow, by the roots and running a strand of wire through the bases, weighting it and dropping it in the desired depth of water. When first placed this looks like a large bush standing up under water making an ideal shelter, but as time goes on it becomes waterlogged and falls over, flattening out on the bottom and probably is of little value as a fish protection device.

Deadhead and green brush shelters are made by crisscrossing green brush and weighting it with crisscrossed waterlogged timbers. All such shelters observed were found in a sheltered bay of Lake Margarethe. Some of the brush had a tendency to protrude upward between the crisscrossed waterlogged timbers, helping to hold them in position. Thirty out of 41 shelters checked were found well piled and in good condition after being submerged for 10 years.

The condition of the frame of ladder shelters was noted whenever possible (Table 2). Some of the frames were submerged in the bottom which made observation difficult. Generally they were in good condition. Often, particularly on the shelters that had been submerged for 10 years, the wires that had been used to bind the corners were gone. But they apparently had held long enough to permit the wood to become thoroughly waterlogged so that the frames remained together and in place. In practically every instance the notched part of the cross members rested on the notched part of the long timbers. On some of them the wire was still present but rusted in two, on others it was almost rusted through. Usually number 9 galvanized wire was used for wiring the frames. Rusting generally took

place where this wire had been twisted or sharply bent. Based on observations made in this survey it is safe to conclude that number 9 galvanized wire lasts sufficiently long for the shelter to become thoroughly waterlogged. In many instances the binding pole fastened to the frame with number 9 wire to hold the brush in position was gone or out of place. Generally the pole had remained in place long enough to permit the brush to become waterlogged because most of the ladder shelters were found in good condition and approximately as placed even if the binding poles were gone.

Kinds of Brush Used to Build Shelters

The general practice has been to use the brush immediately available. Little or nothing was known about what kinds of brush were most satisfactory for shelter construction. The survey party made an effort to identify different kinds of wood and to note its condition after having been submerged up to 10 years. Table 2 gives a summary of the condition of small and large brush in the shelters observed. As stated under methods, if small branches the diameter of a lead pencil or smaller (designated as tips) were present and tough their condition was recorded as good. If they broke easily they were recorded as brittle. If tips were not present they were recorded as gone. The same criteria was used on larger branches.

Jack pine, cedar, oak, maple, cherry, tag alder, birch, and poplar were definitely identified on numerous occasions so that comparisons are justified. We know that such woods as elm, ironwood, basswood, willow and Juneberry were frequently used when building shelters but definite identification of these woods was not possible. It may be stated that if it is desirable to have small branches present, jack pine and cedar retain them the longest of any of the woods mentioned above, however, they have a tendency to droop, closing the spaces between them so that they form a more or less solid mat. Oak (black oak?) commonly called

scrub oak, shows a remarkable tendency to retain its small branches or tips and they remain upright after 10 years of submergence. Maple and cherry are quite tough but are more brittle than oak. If tips were present on tag alder and birch they were very brittle after 10 years. Tips were absent on poplar submerged for this length of time and very brittle if present when under water for several years. Poplar becomes so water soaked after a year or two of submergence that one may take a piece of it and squeeze it between the fingers and make the water squirt out of it. However, after 10 years it seems to lose some of this water and becomes more solid, but it always remained very brittle. Slender submerged poplar poles if brought above the surface and held at one end would frequently break of their own weight.

It may be questionable if it is desirable that the small tips remain on the brush. Shelters generally do not seem to pack down and the breaking or disappearance of tips leaves many pockets in the brush which are inhabited by fish. It is quite likely that when ladder shelters are constructed it would be advisable to crisscross trunks at intervals between the brush to aid in making more usable pockets.

Fish Observed in and Around Brush Shelters

The average numbers of fish by species observed in and around the different kinds of brush shelters found in 30 Michigan lakes are given in Table 3. The depth of the shelters and the number of fish observed at each specified depth are also given. However, it is believed that the concentrations of fish at certain depths may be due to other factors than protection. It is likely that such factors as turbidity and temperature are important in concentrating fish at specified depths. Thirty lakes may offer considerable variation in turbidity and temperature, but since all observations were made in the summer months the findings are believed to indicate the most suitable depths for placement of shelters

Table 3

The average number of fish per shelter by species observed in and around the various kinds of shelters at the stated depths

Shelters	Depth in feet	No. of shelters	Large-mouth bass	Small-mouth bass	Blue-gill	Sun-fish	Bluegill or sunfish	Rock bass	Perch	Minnows	Average per shelter all species
Ladder shelters	1-5	25	1.0	0.2	2.0	3.7	22.0	32.2	3.1	43.8	108
	6-10	115	3.7	0.5	6.7	0.2	69.7	3.5	1.3	14.4	100
	11-15	55	4.1	1.3	7.1	0.2	0.4	4.7	1.2	7.2	26.2
	16-20	29	0.6	0.3	2.5	1.4	0.3	1.5	0.1	0.0	6.7
	21-25	11	9.1	0.2	0.0	0.2	0.4	3.8	0.4	0.6	14.7
	25-30	2	0.0	0.5	0.0	0.0	0.0	10.0	0.0	0.0	10.5
Circular shelters	1-5	14	1.4	0.0	0.0	0.0	10.8	1.4	0.0	26.8	40.4
	6-10	16	0.8	0.0	6.9	1.4	36.8	0.0	0.0	3.1	49.0
	11-15	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16-20	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25-30	1	0.0	0.0	15.0	0.0	0.0	0.0	4.0	0.0	19.0
Tree shelters	6-10	8	47.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.0
	11-15	7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
	16-20	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clump shelters	6-10	4	1.3	0.8	0.0	2.3	0.0	6.5	2.0	12.5	25.4
	11-15	8	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
	16-20	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21-25	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Double frame ladder shelters	1-5	17	1.2	0.1	0.0	0.0	13.6	0.1	0.0	0.4	15.4
Deadhead and green brush shelters	1-5	41	24.4	2.0	4.1	0.3	1.6	19.7	2.6	10.2	64.9
Deadhead shelters	1-5	9	8.5	0.2	3.5	1.2	25.3	11.8	0.0	0.7	51.2
Brush carpet	1 1/2-3 1/2	1	3.0	12.0	0.0	0.0	3.0	0.0	0.0	0.0	18.0

in an average lake to protect the young of desired species when fish like the bass are the most active and predaceous. Whether such protection is actually desirable and increases the fish crop can only be determined by sufficient "before and after" records.

Of the different kinds of shelters observed the ladder shelters were most used by fish. Ladder shelters were by far the most common and were found in the greatest variety of conditions. These installations were located in more of the lakes than any other type of shelter. In most lakes they harbored many fish but in some, only a few.

Circular shelters, when still in good condition, were effective in concentrating fish, but many of these were flattened out to such an extent that they were of little value as fish protection devices.

Tree shelters were found in only two lakes. They harbored few fish with the exception of young largemouth bass (Huro salmoides). Shelters were checked on Pettit Lake early in the summer when young largemouth bass were still in schools and some of these were observed in and around the tree shelters, particularly around those in the shallower water.

Almost all of the clump shelters found were lying flat on the bottom. A few had the clumps lying across each other, making a fair pile of brush. Around these, particularly those in fairly shallow water a limited number of fish were seen.

Small, double frame ladder shelters were located in Tomahawk Lake and Clear Lake. These were built in 1933 of jack pine brush. All were in shallow water. A few young fish were found around them.

Forty-one deadhead and green brush shelters were found in Lake Margarethe. These were in a bay along the western, protected shore of the lake. All were in shallow water. Largemouth bass and rock bass (Ambloplites rupestris) were found in large numbers around these shelters.

Several of these covers were near the mouth of an inflowing stream; around these schools of large common shiners (Notropis cornutus) and bluntnose minnows (Hyborhynchus notatus) were observed.

A total of 9 deadhead shelters were found in Lake Margarethe, most of these were scattered but still were used by fairly large numbers of young largemouth bass, bluegills or sunfish and rock bass.

One brush carpet covering approximately 250 X 350 feet was built under the writer's direction in 1933 in Lake Margarethe. Although the brush had shifted position it still offered a haven to small numbers of smallmouth bass (Micropterus dolomieu), largemouth bass, and bluegills or sunfish. Without doubt not all of the fish inhabiting this brush carpet were seen. It covered a considerable area and was in shallow water and numerous fish were seen darting to other parts of the cover. It is likely that many swam for cover in advance of the boat's approach and were not seen.

The young, about 2 inches in length, of largemouth bass were one of the species of fish found most consistently around shelters in shallow water. The 1944 season seems to have been particularly good for this species in certain lakes like Pettit and Margarethe. Large numbers of the young were observed in these lakes around shelters and weed beds. In Shupac and some of the other clear water lakes larger bass 10 to 15 inches in length were frequently seen around the shelters.

Smallmouth bass were never found in abundance around brush constructions. If present at all they were usually limited, even when small, to one, two, or three fish per shelter.

The writer knows of no way to definitely distinguish between the bluegill and the pumpkinseed sunfish by observation in the water until they have grown to a length of several inches. The length of the gill rakers is

a means of identifying the young, but the fish must be in hand to do this. Therefore, unless these species could definitely be identified as bluegills or pumpkinseeds they were listed as "either bluegills or sunfish." A few long-eared (Lepomis megalotis) and green sunfish (Lepomis cyanellus) were found around the shelters and are included under the heading "sunfish" in Table 3. Bluegill and sunfish, particularly the young, were the most numerous as well as the most consistently present species around brush shelters placed in shallow water.

Rock bass, mostly the young, seek shelters in large numbers particularly if placed in shallow water. They seem to prefer those that are quite densely packed. Ladder, deadhead and green brush, and deadhead shelters make a more compact mass in the water than the others and these harbored the most rock bass. Usually young fish were found in covers but in Black Lake, where the shelters which were located were in water over 20 feet deep, numerous adults were observed. It was not long before fishermen found out that the surface markers used in the brush shelter study marked a spot where fish could be caught and it was a common sight to see one or two boats anchored near each marker where good catches of rock bass were made.

In general yellow perch (Perca flavescens) were not common around brush constructions. Most of the perch seen were found around shelters in Lake Margarethe. In some of the others a few were observed but in many of the lakes perch were entirely absent in and around the shelters. In former brush shelter work done on Douglas Lake, perch were usually a common fish around the shelters, but this lake has many small perch and it is not known how abundant they were in comparison with other parts of the lake. Perch are also common in Lake Margarethe and their abundance, rather than their preference for this habitat may account for observing them around the shelters in this lake.

Minnows were common around many of the shelters in shallow water. By far the most common one observed in and around these devices was the bluntnose minnow. The bluntnose was found on many of the shallow shelters in most of the lakes visited. In Fife Lake and Lake Margarethe they were so abundant that it was never difficult to catch them with an umbrella net baited with bread. The survey party frequently caught them over shelters when minnows were needed for bait to do a bit of fishing. In a few instances the common shiner and the spot-tailed shiner (Notropis hudsonius) were definitely identified. On several occasions minnows were observed that could not be identified and were merely recorded as minnows.

The total number of all species of fish observed in and around the shelters was always greater from those in water 10 feet or less in depth.

Bluntnose minnows, bluegills or sunfish, and rock bass and large-mouth bass were the most frequently found in the vicinity of shelters.

Aquatic Vegetation In and Around Brush Shelters

A careful record was made of the abundance and kinds of aquatic vegetation growing in and around the brush shelters examined during the summer of 1944. Table 4 gives the number of shelters examined on the specified contours where aquatic vegetation was observed and the number of shelters at the depths at which the stated species of vegetation were found in the indicated abundance. The quantity of vegetation was expressed as sparse if from 1 to 10 plants were present in an area of approximately 100 square feet; as common if 10 to 30 plants were found; as abundant if there were from 30 to 60 plants; and as profuse if more than 60 plants were growing in an area of 100 square feet in and around a shelter. If aquatic vegetation was growing in or beside a shelter but not otherwise in the immediate vicinity, it was recorded as growing in or around the shelter. If it was growing in equal abundance in the general area so

that it did not appear as if the shelter had had any influence on its growth or concentration it was not recorded as growing at the shelter. An effort was made to discover to what extent shelters would act as a base for aquatic vegetation to get started. Since it was not known how often shelters had been placed in vegetation, it was necessary to try to decide if the shelter was a factor in starting the vegetation in the immediate area when the observation was made. The figures presented in Table 4 are the result of this kind of observation.

Fifteen varieties of Potamogeton, or pondweed, were found in the vicinity of shelters. Seven of these species were found growing in profusion around one or more shelters. Potamogeton natans occurred with greatest frequency in and around brush shelters. The most typical example of how shelters may furnish aquatic plants an opportunity to get started was found in Loon Lake, Oscoda County. Here 5 shelters at a 5 to 6 foot depth were completely covered and surrounded by Potamogeton tenuifolius. The vegetation formed a mat over and around the shelter and none of this species of plant was to be found any other place in the lake. Shelters that had this vegetation growing in them were along the north, west, and south sides of the lake. Some were in well exposed areas other shelters at the same depth and located under similar conditions did not have any vegetation around them.

More shelters at the 5 to 6 foot depth had one or more species of vegetation growing around them than at any other depth. Shallow shelters in general acted as a center for vegetation more often than the deeper ones.

Potamogeton praelongus, amplifolius, compressus, pectinatus and natans were the more common species of pondweed found around the shelters. In most instances these species were sparse although in some instances their abundance increased to many plants per 100 square foot area.

Table 4

The number of shelters examined on the specified contours where aquatic vegetation was found and the number of shelters at the depths at which the stated species of vegetation were found in the indicated abundance.

(Plants in 100 square feet--Sparse 1 to 10, Common 10 to 30, abundant 30 to 60, profuse over 60)

Depth in feet	1 & 2	3 & 4	5 & 6	7 & 8	9 & 10	11 & 12	19 & 20	25 & 26
No. of shelters	19	64	57	68	44	30	8	5
Potamogeton								
Praelongus								
Sparse	4	1	9	1	2	...	...	...
Abundant	...	...	2	...	...	...	...	...
Profuse	...	...	1	1	1	1	...	...
Amplifolius								
Sparse	5	14	14	4	1	...	...	...
Common	...	3	...	...	...	...	...	...
Abundant	...	...	1	...	...	...	...	...
Profuse	...	2	2	1	...	...	...	...
Compressus								
Sparse	1	11	7	3	...	...	...	...
Abundant	...	...	1	...	...	...	...	...
Profuse	...	...	1	1	...	...	...	...
Pectinatus								
Sparse	2	10	7	2	...	...	...	...
Common	...	...	...	3	...	...	...	...
Profuse	...	...	1	...	...	...	...	...
Natans								
Sparse	1	26	7	3	2	...	...	...
Common	...	...	1	1	...	...	...	...
Profuse	1	...	...	...	...	...	...	...
Gramineus								
Sparse	1	...	...	...	...	...	...	...
Richardsonii								
Profuse	...	...	1	...	...	...	...	...
Longiligulatus								
Sparse	...	1	...	...	...	...	...	...
Bechtoldii								
Sparse	1	...	...	...	...	...	...	...
Epihydrus								
Sparse	...	...	...	...	...	1	...	...
Angustifolius								
Sparse	...	...	2	...	...	...	...	...
Friesii								
Sparse	...	...	1	...	...	...	...	...
Zosteriformis								
Sparse	...	...	2	...	...	...	...	...
Tenuifolius								
Sparse	...	...	1	...	...	...	...	...
Profuse	...	...	5	...	...	...	...	...
Unnamed species								
Sparse	...	2	...	1	...	...	...	...
Chara								
Sparse	3	20	2	1	...	...	...	...
Common	...	1	5	2	...	...	...	...
Abundant	1	...	...	...	...	1	...	...
Profuse	1	1	...	...	...	...	...	...

Anacharis (Elodea)								
Sparse	1	10	4	...	...	...	2	...
Common	...	1	...	...	...	...	...	...
Abundant	...	1	...	...	1	...	...	...
Profuse	...	1	...	1	1	1	...	...
Myriophyllum								
Heterophyllum								
Sparse	...	2	2	2	2	...	1	1
Common	...	...	...	2	...	...	...	...
Abundant	...	...	1	...	...	...	...	...
Profuse	...	...	...	...	1	1	1	1
Najas								
Flexilis								
Sparse	1	2	3	1	...	...	...	...
Common	...	...	3	...	...	...	...	...
Utricularia								
Vulgaris								
Sparse	...	25	9	...	1	...	...	...
Profuse	...	...	...	...	1	1	...	...
Nymphia								
Odorata								
Sparse	...	...	1	...	...	...	...	...
Profuse	2	1	1	...	...	...	...	...
Vallisneria								
Spiralis								
Common	...	...	...	...	...	1	...	...
Profuse	...	...	...	...	...	1	...	...
Isoetes								
Common	1	...	...	...	...	...	...	...

Chara was frequently found around shallow shelters. Often it was also seen in other parts of the lake, usually in deeper water. Shelters seemed to offer these plants an opportunity to get started in shallow water.

Anacharis, formerly known as Eleodea, was often present in and around shallow shelters and sometimes found around those in deeper water.

Myriophyllum was more often observed around brush constructions in deeper water than any other species of plant.

Najas, growing around a few shelters, usually made a dense mat on one side of the shelter but only covered a small area, frequently not more than a foot or two in diameter.

Utricularia or bladderwort, if present, was usually very sparse, with but one to a few plants found in the area of a shelter.

Nymphia, or white water lily, was found around covers in Pickerel Lake, Grand Traverse County. Around 3 of these this plant was so profuse that the location of the shelters was plainly marked.

Vallisneria (wild celery) and Isoetes were seldom found growing in the vicinity of a shelter.

Fish Food on the Brush

A careful check was made of the brush used in the shelters to see what forms of fish organisms might be present. Examination was made only for forms that could be seen with the naked eye. No microscopic work was attempted.

Shelters that were sunk in 1939 and 1940 were frequently covered with filamentous algae. In some cases, this formed almost a solid mat over the device. The brush of many of those placed in 1933 or a year or two later was covered with a grey crustaceous algae, sometimes one-half inch thick. Occasionally the brush was barren of all algae. It is possible that these algae harbored and developed various small food organisms that are of value as food to fish. None of the macroscopic aquatic forms of animal life, used by fish for food, were found on the brush.

Summary of Brush Shelter Investigations, Summer 1944

The results of the brush shelter investigations during the summer of 1944 when 30 lakes were checked, pointed out pretty definitely that if shelters are properly constructed and placed they will stay in position for a considerable number of years.

Ladder shelters are usually still in place and acting as satisfactory fish shelters after 10 years. The small tips of the brush may be gone but the larger brush remains are well pocketed and these pockets are used by fish. Generally, the brush does not flatten out as many shelters still stand up to a height of 3 feet or more after being submerged for 10 years.

Circular shelters have a tendency to flatten out since there is no support under the extremities of the brush. This condition greatly reduces their effectiveness as fish shelters after a few years.

Tree shelters are probably not packed enough to be very satisfactory. As they remain submerged, the small branches tend to break off, leaving only the larger branches and trunk of the tree. This leaves many large open spaces. The limited number of tree shelters under observation did not harbor any fish except schools of young largemouth bass.

Clump shelters are probably the least satisfactory of any of the installations observed. When first submerged they look like an ideal shelter, but as they become waterlogged they fall flat and offer little protection to fish.

The double frame ladder shelters examined were all small and made of jack pine brush which had packed down into a compact mass. All were in shallow water and harbored some fish.

Deadhead and green brush shelters stood up well and were in very serviceable condition after 10 years. The protruding ends of brush had a tendency to hold the waterlogged timbers used as weights in place.

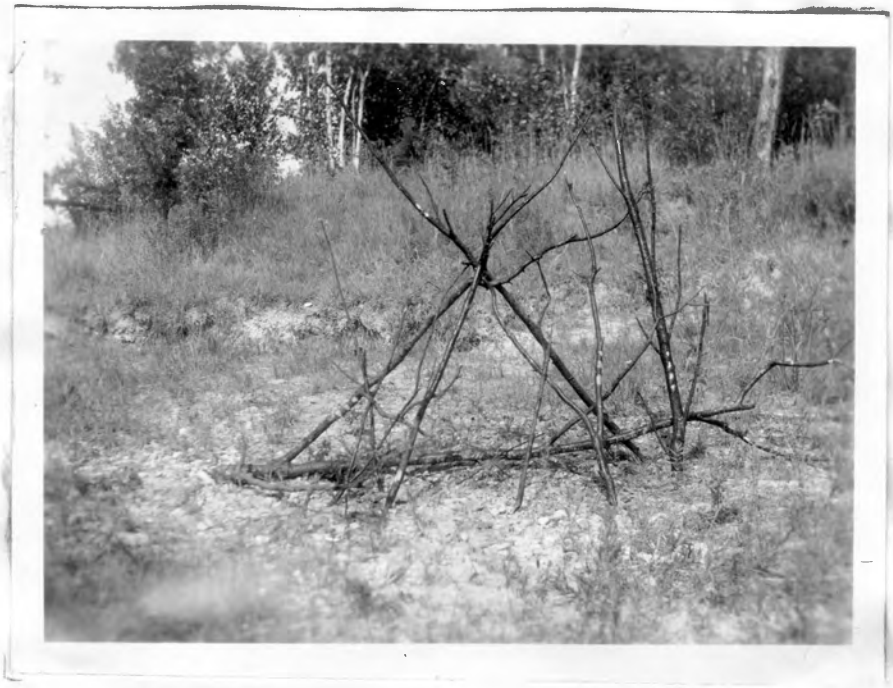
The deadhead shelters observed after being placed for 10 years had been rearranged so that the logs in almost every instance were lying on the bottom and parallel to each other. However, numerous fish were seen around them, most of which were bluegill or sunfish.

Of the various kinds of brush used to construct the shelters that could be definitely identified, jack pine and cedar were the toughest and jack pine, cedar, and oak retained most of the small branches after being submerged for 10 years. In general, cherry, maple, birch, and tag alder seemed very serviceable. Poplar was very brittle and easily broken.

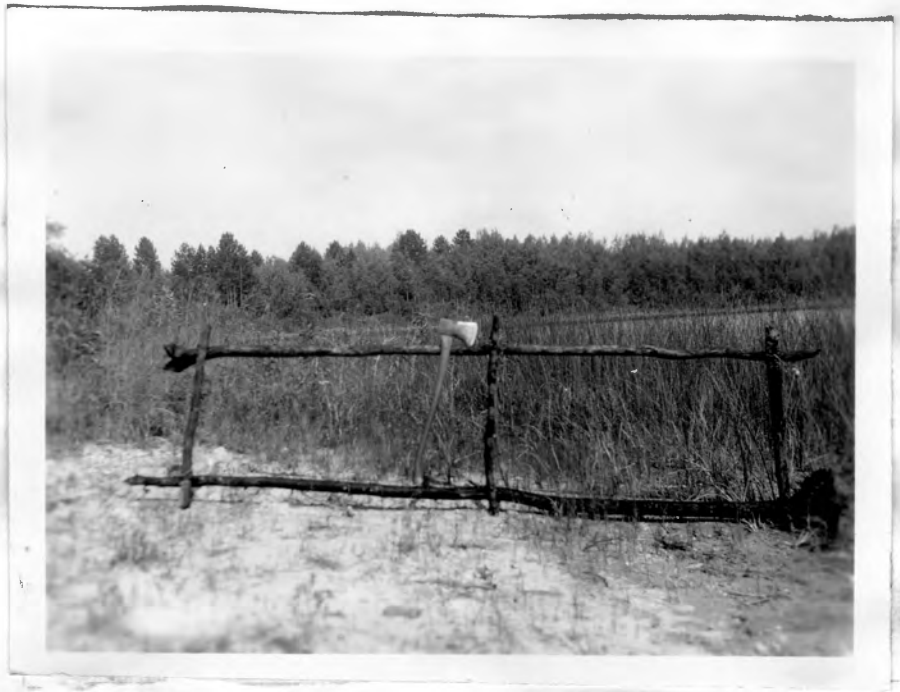
The most frequently observed, and the most abundant species of fish around the shelters in shallow water were largemouth bass, bluntnose minnows, bluegills or sunfish, and rock bass. Shelters in water from one to 10 feet in depth harbored the most fish although some fish were seen around shelters as deep as 30 feet. Most of the fish were juveniles although mature rock bass were sometimes observed.

Potamogetons were found growing sparsely around many of the brush constructions located in shallow water and more abundantly in a few. Anacharis and Myriophyllum were observed growing in and around shelters lying in deep as well as shallow water.

Few macroscopic fish food organisms, except minnows, were observed in and around the brush shelters examined.



Brush taken from a ladder shelter that had been submerged for 10 years
1 notch (knife cutting)= birch
2 notches (knife cuttings)= poplar
3 notches (knife cuttings)= oak
4 notches (knife cuttings)= cherry



Frame of ladder shelter submerged for 10 years. Cross members still wired. This frame is too narrow, shelter had turned over and brush was scattered.

Pictures of Potamogeton tenuifolius growing in and around brush shelters in Loon Lake, Oscoda County, Michigan. Pictures show different shelters.

Pictures of Potamogeton tenuifolius growing in and around brush shelters in Loon Lake, Oscoda County, Michigan.

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Brush Shelter Examination
June 20, 1944
Gun Lake, Barry County, Michigan

Part of the shore-line of Gun Lake in Barry County lies within the former Yankee Springs Project of the National Parks Service but which is now operated by the State Parks Division of the Conservation Department. In the bay immediately south of the swimming beach of this project 8 shelters were inspected. These were installed in 1937 under the supervision of the writer by the W. P. A. connected with the Yankee Springs Project.

The shelters were ladder-type constructions approximately 10 x 12 feet in size. Five of them lay at depths of about 5 feet, two at 8 feet and one at 11 feet. The frames, in good condition, were visible on all shelters and the wire baskets containing rocks for weights were present on two of them. One of the baskets, however, was broken and some of the rocks scattered about. The condition of large brush was good in all cases but the small brush was missing. The shelters stood up 2 to 4 feet above the flakey marl bottom.

In all the shelters at the 5 foot depth and in the one at a depth of 11 feet Potamogeton pectinatus, praelongus and amplifolius grew sparsely but in both shelters at the 8 foot depth these plants grew profusely. Potamogeton was not present outside the shelters in any abundance. Chara, however, grew profusely in and about the shelters. Crustaceous algae was present in abundance on all the shelters except the one at the 11 foot depth.

On one shelter at a depth of 5 feet 45 bluegills or sunfish 1 1/2 to 3 inches in length were observed. Three others at the same depth disclosed an abundance of various species: rock bass, bluegills, sunfish, smallmouth and largemouth bass, in numbers from 200 to 300, ranging in size from 1 1/2 to 7 inches. The larger fish, comparatively few in number, were hidden in holes in the shelters. One shelter at a depth of 8 feet was identically populated.

A large turtle occupied the fifth shelter at a depth of 5 feet and few fish were observed. The second shelter at 8 feet harbored some smallmouth bass and bluegills or sunfish 1 1/2 to 3 inches in length, the number not determined.

In the shelter at the 11 foot depth a largemouth bass of 3 to 4 pounds occupied its center. No other fish were seen in the shelter at the time of observation.

Brush Shelter Examination
June 21, 1944
Pettits Lake, Newaygo County, Michigan
(T. 12N. R. 11W. Sec's 19-20-29-30)

Pettits Lake is located in Newaygo County. It is near and easily accessible to a truck highway. There is an excellent camping ground where boats may be rented. The surrounding country is hilly, and covered with second growth hardwoods. The lake covers about 170 acres, with a shoreline of 3 3/4 miles including the two islands. (See map) The water is generally shallow with the exception of three 10 foot holes and one spot which measures 20 feet in depth. The visibility was poor on June 21, 1944 when brush shelters were checked in Pettits Lake. Submerged and emerged aquatic vegetation covers most of the shallow parts of the lake.

In 1941 five tree shelters and 27 spawning boxes were placed in Pettits Lake by the W. P. A. under the supervision of the Manistee National Forest.

Shelters

The five tree shelters were all black (scrub) oak, placed over a mucky bottom in 3 to 6 feet of water with the butt end anchored in shallow water and the tops extending perpendicularly to the shore into the deeper water. Examination of these found four of them in place and well located. The larger brush which was in good condition was covered with algae. The tips and smaller brush were practically all broken off. This left many wide spaces between the brush. The fifth shelter was found washed up on the shore.

From 1 to 12 plants per shelter of Potamogeton angustifolius and praelongus were found growing around and between the branches of the trees. It is questionable, however, if the shelters were a factor in this growth as these plants were also spread in other parts of the lake.

Young largemouth bass were the only fish observed around the shelters. They were 1 to 2 inches in length and were found in an estimated abundance of about 10 to 200 per shelter.

A check of the shore line where the 27 spawning boxes had been placed revealed 14 in good position. One was washed up on shore. These boxes were made of 2 x 4 lumber, 2 1/2 feet square with a bottom of 1 inch boards. Eleven of these were in good condition, well placed and flat on the bottom in water 2 1/2 to 4 1/2 feet in depth. Three of the boxes were badly tilted. Nine showed definite signs of use this season. On seven of these young largemouth bass were observed swimming over the nests on the date of examination, June 21, 1944. The 5 boxes not showing signs of use had lost all or nearly all of the gravel.

Observations and Comments

Local inhabitants stated that Pettits Lake is a good bass lake. Northern pike are also caught. They also mentioned that about 30 years ago the lake had frozen out, killing many fish.

The wide spaces between the larger brush remaining on the tree shelters makes it questionable if these shelters serve as real protection devices for young fish.

Evidences of natural spawning were noted in a limited area along the southeast shore.

Young largemouth bass were the only young fish seen. Observations in places near shore and among the aquatic vegetation, where one would expect to find schools of minnows, did not reveal any forage fishes in the lake.

Brush Shelter Examination
June 22, 1944
Brooks Lake, Newaygo County, Michigan
(T. 12N. R. 12W. Sec's 27-28-33-34)

Brooks Lake in Newaygo County is easily accessible from a main highway with a good trail leading to Brooks Resort. There are about a dozen cottages on the lake. It covers an area of almost 300 acres and has a shoreline of about 5 1/2 miles. In general the lake is shallow with a few holes the deepest of which is 22 feet. The bottom is mucky. The visibility reading was 8 feet on June 22, 1944 when brush shelters were checked.

The lake supports an abundance of aquatic vegetation consisting of numerous kinds of Potamogeton, Myriophyllum, and Chara over much of the bottom in shallow water.

In February 1941 eighteen ladder-shaped brush shelters were placed in 7 to 18 feet of water by the W. P. A. under the supervision of the Manistee National Forest. These shelters were regularly spaced over the lake about 660 feet apart apparently without any consideration as to the need in the part of the lake where they were placed. (See map) A total of 25 gravel spawning boxes were placed along different parts of the shore.

Four ladder-shaped shelters 10 x 10 feet and placed in 6 to 9 feet of water on the mucky bottom were found and checked in Brooks Lake. Green and blue-green algae grew in abundance on the brush of these shelters. The frame, larger brush and small brush were all in good condition, with most of the small brush intact. The bottom was mucky, in places not offering any solid footing for 3 or 4 feet but the shelters had not sunk into the muck to any extent as the 4 examined stood up to a height of 3 to 5 feet. No vegetation was found growing among the brush although vegetation was abundant at these depths in the lake. A school of sunfish or bluegills and a gar pike were observed but no fish were seen in or around the shelters.

Examination of the shore where 13 of the 25 spawning boxes had been

placed found only 4 of them in place. These boxes were about one-half full of gravel, with a little Chara growing in the corners. They showed signs of having been used earlier in the spring of 1944 but were not in use at the time of examination.

Brush Shelter Examination
June 23, 1944
Loon Lake, Newaygo County, Michigan
(T. 16N. R. 13W. Sec's 17-20)

Loon Lake, embracing an area of about 40 acres, is located in Newaygo County about three miles northwest of Lilly. It lies among deeply wooded hills which drop in places somewhat precipitously to the shoreline, so that little swamp area is included, except at the south end where a mucky marl deposit is observed in contrast to the generally marl bottom of the lake. The water has a bluish green tinge characteristic of a marl bottom. The lake supports little vegetation except on the narrow shoals which surround it almost completely. Visibility of the Secchi disk was 26 feet.

Twelve tree shelters, 25 ladder shelters,and 22 minnow spawning devices were placed in this lake between February and June of 1941 by the C. C. C. under the direction of the Manistee National Forest.

Locals report good fishing in the lake, mentioning large perch, although none were seen in the observations of fish life during the partial check-up of these installations on June 23, 1944.

Of the 12 tree shelters and 6 ladder shelters placed along the east shoreline, 9 tree and 5 ladder constructions were inspected. The shelters were placed in an harmonious order following the first tree, a ladder placed at the general depth of the tips of the trees was followed by two trees, all being spaced approximately equidistant along the shoreline. One of the three shelters lying within the south bay was inspected as it lay on the mucky marl bottom partly submerged, with large and small brush in good condition but with wires and weights missing. The shelter was covered with crustaceous algae. No fish life was observed. In the deeper

part of the lake no effort was made to locate the 16 ladder shelters placed there, inasmuch as the wind was strong and rain falling.

Two of the five ladder shelters, one 7 x 7 feet, the other 10 x 10 feet, each 3 1/2 feet in depth and apparently made of oak, lay in 3 1/2 to 5 1/2 feet of water and were covered with crustaceous algae. The former supported Potamogeton profusely throughout its whole area, the latter none. Some Potamogeton amplifolius grew sparsely in the waters about both shelters. The heavily vegetated shelter at the 3 1/2 foot depth was inhabitated by about 25 green sunfish 3 to five inches in length; the other, supporting no vegetation, was occupied by approximately 35 of the same species of equal size.

The remaining three ladder shelters, all 10 x 10 x 3 1/2 feet lay in depths of 10 to 12 feet. The condition of the large and small brush was good and was covered with crustaceous algae. The shelter at the 12 foot depth with no vegetation protected 2 green sunfish of 5 to 6 inches in length. The one at 10 feet harbored 5 such fish of equal size. A few Potamogeton plants grew on the shallow side of it. The third showed neither fish nor vegetation.

All ladder shelters were well located on the marl bottom, made of oak with large and small brush in place and in good condition except that the wires were gone.

The tree shelters, of oak, were placed with butts toward shore. The larger branches, covered with algae, were present but the twigs and smaller branches were missing. Three trees 30 feet long with branches standing up 5 to 6 feet lay with the tip ends in 10 feet of water, two of them sheltering Potamogeton sparsely. Some Potamogeton also grew in the area around them. No vegetation was observed in or about the other seven. Three trees sheltered fish: one, 2 largemouth bass of approximately 8 inches, another a largemouth of about 8 inches and the last a smallmouth of nearly 12 inches. Potamogeton grew sparsely in the tree occupied by the smallmouth.

About 12 of the star and gate minnow spawning devices, one of which was washed up on shore, were checked as they lay in the shallow water on the west side of the lake. Nearly all of them showed evidence of recent use. No fish were seen on these structures.

The area of the south bay in which wild celery was planted in October of 1941 was devoid of any signs of this plant.

Brush Shelter Examination
June 28, 1944
Shupac Lake, Crawford County, Michigan
(T. 28N. R. 1W. Sec. 21)

Shupac Lake located in the northeast corner of Crawford County is one of Michigan's picturesque lakes. Its general shape resembles that of a boot. Clear water (visibility reading 36 feet on July 29, 1944) with a marl bottom gives the lake a beautiful bluish-green tinge that is quite distinctive. It covers an area of about 160 acres and reaches a depth of 98 feet. Only about a dozen cottages are spotted around the shore for most of the shoreline is owned by just a few people. One of these, Dr. Shannon, permits the public to use a bathing beach on his land. There is no camping site or boat livery, with the result that the lake is not heavily fished. During the 4 days that we spent on the lake 3 boats were the highest number observed fishing at any one time. Most of the fishing was done towards evening and fly casting for bass and bluegills was the principal type of angling observed. Much of this was being done in the bay known as the toe of the boot and in the small bay along the east shore just south of this bay. Much of the fishing is done over and around the brush shelters which are easily visible in the clear shallower water. Fishermen report that fishing for bass and bluegills is at times good at other times very poor.

The narrow shallow shoreline and particularly the shallow bay making the toe of the boot, harbors an abundance of bluntnose minnows. Largemouth and smallmouth bass 5 to 6 inches long are frequently seen in this shallow

water

Shupac Lake is almost barren of vegetation with some rushes (Scirpus) growing along the shore and occasional plants of Potamogeton amplifolius. Chara was the only plant commonly found and that only on parts of the bottom.

Rainbow trout (supplied by the state) have been planted in reported numbers of 400 by Dr. Shannon and 3,500 by Mr. Woods, both residents on the lake. To date they knew of no authentic records of any rainbow having been caught.

In 1933 the C. C. C. placed 79 ladder shelters, 42 clump shelters, and 14 minnow spawning devices in this lake. In a detailed check for these shelters in July, 1944, 56 of the ladder and 15 of the clump shelters were found in water ranging from 7 to 23 feet in depth. Twelve of the 14 minnow spawning devices were also found. In addition, fifteen ladder shelters installed at a later date were checked. Local inhabitants and Mr. Roberts, the game warden of Crawford County and Mr. Peterson, the district fisheries supervisor could not give us any information about when these shelters were installed.

Condition of Brush Shelters

Shupac Lake with its clear water and comparatively firm light-colored bottom presented ideal conditions for a detailed examination of brush shelters.

Old Ladder Shelters:

Fifty-six, or seventy-one per cent of the 79 ladder shelters placed in the lake during the summer of 1933 were found and checked in 1944. Of the number found, 52, or 93% had the frames in good condition and 45, or 80% still had the wires or some of the wires in place although often these were rusted through where they had been twisted.

Twenty-two, or 40% of these ladder shelters had the long pole (binding pole) laid over the top of the brush and wired to the bottom frames to hold the brush in place either entirely gone or out of place. However, only 6 or 11% of the shelters had the large brush disarranged or scattered off of the frame. On 50 of the observed shelters the larger brush was in place and in good condition.

After being submerged for 10 years brush shelters lose much of their small brush. Small brush is composed mostly of the tips of the larger branches used in brush shelter construction. Of the shelters checked in Shupac Lake 33 or 59% had lost practically all of their small brush while 8 or 14% still had some of it present. On fifteen or 27% of the constructions much of the small brush was still present although usually brittle and easily broken. In general it may be stated that the deeper shelters still had more of the smaller brush.

There appears to be little noticeable difference in the condition of different species of wood. Oak (black oak?) keeps many of its small branches and they do not break too easily. Birch, poplar and tag alder keep few if any of the small branches and if present are very brittle. However, there is so little difference in these species from shelter to shelter that comparisons are difficult.

New Ladder Shelters

Fifteen ladder shelters that had been placed in Shupac Lake at a later date were examined. These were easily distinguished from the old by the kind of frames and binding poles that were used, and by the fact that the brush was more densely packed. The small brush was also present in a much greater amount. All 15 of these had a heavy mat of filamentous algae growing on them. This was not true of the old shelters.

The frames and binding poles were all wired and in place with the large brush and small brush intact. All shelters were well located and

lying flat on the bottom with the exception of one which was turned over, having the binding pole on the bottom.

Clump Shelters

Fifteen clump shelters were found and examined in Shupac Lake. These had been made by wiring 5 or 6 clumps of tag alder together which had been dug up by the roots to keep the clumps of brush together. When such clumps are wired together at the butt end, attached to a sand bag and dropped into the water the brush stands almost perpendicular in the water appearing as a large, dense bush below the surface. Such a shelter looks ideal for offering protection to fish when placed. Observations of such shelters after they had been submerged for 10 years showed that this brush had become waterlogged and the brush was lying on the bottom, usually not extending upward more than the diameter of a clump which was about a foot, with small brush broken off, and the parts remaining offering little or no protection for fish.

The 15 clump shelters examined were found in water ranging in depth from 10 to 23 feet. The large brush was in good condition. Five had some of the small brush remaining while 10 had lost practically all of it. The wire used to hold the clumps together was still present on 5 while 8 were still lying with the butts together, 7 having the tops spread out in the shape of a fan. Only one had the clumps lying on top of each other, simulating a brush pile. Two had the clumps scattered over a considerable area.

No evidence of the burlap bags filled with sand, used to anchor the ladder and clump shelters placed in 1933 remained.

Vegetation

Vegetation, other than the marginal forms growing near the shore is very sparse in Shupac Lake. There are places where individual plants of Potamogeton are growing singly in the lake. From one to 5 or 6 such

plants were found growing in 10 of the 56 old ladder shelters observed. Single plants of the same Potamogeton species were found growing in the vicinity of 3 of these shelters. Two of the 15 clump shelters had a few plants of this Potamogeton growing through them. None of the new shelters had any Potamogeton growing around them.

Crustaceous algae was abundant on all of the old shelters, in fact there was little exposed wood that was not covered with it. The shelters more recently placed were covered with a heavy layer of filamentous algae which in some cases was so thick that it was difficult to see the brush.

Spawning Beds

Spawning nests were seen under and at the side of 14 shelters placed in 7 to 16 feet of water. Largemouth bass were seen on the nests of 4 shelters in 10 to 16 feet of water on July 28 and 29, 1944. It is possible that some of the nests were smallmouth bass nests but no smallmouths were seen on them. A favorite place for a bed seemed to be under the binding pole or under some protruding part of the shelter. Bluegill nests were noted under two of the 14 shelters having spawning nests under or to the shallow side of them. Sixteen nests were counted under and around one of these shelters in 16 feet of water and 27 nests were grouped about the other. Bluegills were seen over some of these nests.

Fish Observed In and Around Brush Shelters

In Tables 5, 6, and 7 are given the estimated number of fish and their sizes observed around brush shelters of different kinds in Shupac Lake. The numbers presented are estimated numbers based on actual counts. It is difficult to get actual counts of moving fish and to judge their size with a water glass and even more difficult to get such a count with the diving helmet. Visibility is usually restricted, particularly at greater depths with the helmet which makes the counting of fish difficult. Because of restricted vision due to the limited area that may be observed at any one

Table 5

Fish observed in and around ladder-shaped shelters at stated depths, placed in Shupac Lake in 1933, indicating the average number per shelter and total number by species.

No. of shelters	20			17		12		✓50	
Depth in feet	7 to 11			11 to 15		15 to 19			
Fish seen	Ave. No. per shelter		Total No.	Ave. No.	Total No.	Ave. No.	Total No.	Ave. total	Total fish
Largemouth bass	Under 3"	.15	3	.07	1	.00	0	.08	4
	3" to 6"	.15	3	.07	1	.25	3	.14	7
	Over 6"	.10	2	.23	4	.17	2	.16	8
	Total	.40	8	.37	6	.42	5	.38	19
Smallmouth bass	Under 3"	.90	18	.29	5	.33	4	.54	27
	3" to 6"	1.15	23	1.06	18	.25	3	.88	44
	Over 6"	.20	4	.07	1	.00	0	.10	5
	Total	2.25	45	1.42	24	.58	7	1.52	76
Bluegill	Under 3"	.00	0	.00	0	.33	4	.08	4
	3" to 6"	1.95	39	.71	12	.00	0	1.02	51
	Over 6"	.00	0	.18	3	.00	0	.06	3
	Total	1.95	39	.89	15	.33	4	1.16	58
Sunfish	Under 3"	.00	0	.00	0	.00	0	.00	0
	3" to 6"	.15	3	.00	0	.00	0	.06	3
	Over 6"	.00	0	.00	0	.00	0	.00	0
	Total	.15	3	.00	0	.00	0	.06	3
Sunfish or Bluegills	Under 3"	.25	5	.00	0	.00	0	.10	5
	3" to 6"	.00	0	.00	0	.00	0	.00	0
	Over 6"	.00	0	.00	0	.00	0	.00	0
	Total	.25	5	.00	0	.00	0	.10	5
Perch	Under 3"	.00	0	.00	0	.00	0	.00	0
	3" to 6"	.05	1	.71	12	.17	2	.30	15
	Over 6"	.25	5	.18	3	.00	0	.16	8
	Total	.30	6	.89	15	.17	2	.46	23
Minnows	Under 3"	1.25	25	.00	0	.00	0	.50	25
Grand total		6.55	131	3.57	60	1.50	18	4.18	209

✓ No fish found on one shelter at the depth of 19 to 23 feet.

Table 6

Fish observed in and around ladder-shaped shelters at stated depths placed in Shupac Lake in about 1941 indicating the average number per shelter and total number by species

No. of shelters		5		6		4		15	
Depth in feet		11 to 15		15 to 19		19 to 23			
Fish seen	Ave. No. per shelter		Total No.	Ave. No.	Total No.	Ave. No.	Total No.	Ave. Total	Total fish
Largemouth bass	Under 3"	.40	2	.50	3	.00	0	.33	5
	3" to 6"	1.40	7	.00	0	.00	0	.46	7
	Over 6"	1.00	5	.50	3	.00	0	.53	8
	Total	2.80	14	1.00	6	.00	0	1.32	20
Smallmouth bass	Under 3"	.00	0	.00	0	.00	0	.00	0
	3" to 6"	1.00	5	.00	0	.00	0	.33	5
	Over 6"	.00	0	.33	2	.50	2	.26	4
	Total	1.00	5	.33	2	.50	2	.59	9
Bluegills or Sunfish	Under 3"	.00	0	.00	0	.00	0	.00	0
	3" to 6"	.60	3	.00	0	.00	0	.20	3
	Over 6"	.60	3	1.33	8	1.00	4	1.00	15
	Total	1.20	6	1.33	8	1.00	4	1.20	18
Perch	Under 3"	.00	0	.00	0	.00	0	.00	0
	3" to 6"	.00	0	1.17	7	.00	0	.46	7
	Over 6"	.00	0	.00	0	.00	0	.00	0
	Total	.00	0	1.17	7	.00	0	.46	7
Grand total		5.00	25	3.83	23	1.50	6	3.57	54

Table 7

Fish observed in and around clump shelters at stated depths placed in Shupac Lake in 1933 indicating the average number per shelter and total number by species.

No. of shelters		3		5		✠15	
Depth in feet		7 to 11		11 to 15		✠	
Fish seen	Ave. No. per shelter		Total No.	Ave. No.	Total No.	Ave. Total	Total fish
Smallmouth bass	Under 3"	.00	0	.00	0	.00	0
	3" to 6"	.66	2	.40	2	.26	4
	Over 6"	.00	0	.40	2	.13	2
	Total	.66	2	.80	4	.39	6

✠ No fish were observed in or around 6 clump shelters found at the depth of 15 to 19 feet nor in one at the depth of 19 to 23 feet.

time with either the water glass or the helmet it is likely that the estimates of the fish on a shelter are too low. However, such an error, if it is an error, would be rather constant in all cases and therefore should not greatly influence a comparison of figures from shelters at various depths and shelters of different kinds.

In Shupac Lake shelters were divided into 3 groups, ladder shelters that were placed in the lake in 1933, clump shelters that were put in the lake in 1933, and ladder shelters added at a later date (about 1941). Each of these groups of shelters were divided into groups according to depth, the range being 7 to 11 feet for the shallowest shelters found, 11 to 15 feet, 15 to 19 feet, and 19 to 23 feet for each successive group. Fish were grouped into estimated sizes of under 3 inches, from 3 to 6 inches, and those over 6 inches.

Ladder shelters placed in the lake in 1933 were found at the time of checking to be more effective in concentrating fish than clump shelters. The old ladder shelters averaged 4.18 fish per shelter, newer ladder shelters averaged 3.57 fish per shelter while the clump shelters averaged 3.90 fish per shelter. Largemouth and smallmouth bass, bluegill, sunfish, perch, and minnows were represented in the old ladder fish populations with only largemouth and smallmouth bass, bluegills or sunfish and perch observed in the newer ones. Only smallmouth bass were seen around the clump shelters.

Largemouth bass over 6 inches in length were more often seen around shelters in water 11 or more feet in depth.

Smallmouth bass were more common around shelters in 7 to 11 feet of water with few seen around shelters placed at greater than 15 foot depths.

Bluegill and sunfish were most heavily concentrated in shelters lying in 7 to 15 feet of water.

Perch were more often observed around shelters located between the 11 and 19 foot contours.

The heaviest concentration of all species of fish were seen around shelters lying on the 7 to 15 foot contours. Of the shelters at these depths the shallower ones in 7 to 11 feet of water were the more heavily populated.

Minnow Spawning Slabs

Twelve of the 14 star-shaped minnow spawning slabs placed in the lake in 1933 were still in position in 2 to 2 1/2 feet of water. Only 2 of these showed signs of use, with bluntnose eggs deposited on the under sides of a board. All were covered with algae growth. Two were partly broken although still fastened to the stakes. One was gone with the exception of the stakes that were used to hold the slabs in place. Five others were still held in position by the stakes driven to hold them. Two of these still had the wires going from stake to stake as originally placed to hold the slabs to the bottom.

The remaining 4 were in good condition, waterlogged and resting on the bottom.

Brush Shelter Examination
June 27, 1944
Roberts Lake, Crawford County, Michigan
(T. 28N. R. 3W. Sec. 6)

Roberts Lake is located about five miles north of Frederick and lies just east of highway U.S. 27. A group of over-night cabins is associated with it, although situated on the highway. The lake is known locally as Bass Lake and Bluegill Lake. Its shoreline is heavily wooded and in places low and swampy. In addition to being accessible from the group of cabins the lake may be approached from highway U.S. 27 over a county road one-half mile north of the resort. This road leads to an excellent camp site from which a boat is easily launched.

Visibility on the date of examination was read at 9 feet 6 inches. In the investigation of shelters only 10 of the 27 placed in the lake in 1933 by the C. C. C. were found. These were located by dragging the

exceedingly mucky bottom. Sufficient time was expended in this dragging to assure the reliability of the assumption that most of the shelters were not where they had been placed. They may have disappeared into the muck or changed position before becoming waterlogged. Divers, sinking so low that even the helmet was submerged, were unable to find solid bottom near several shelters. In one instance a diver came up under the shelter.

In the southeast part of the lake a gravel and sand bottom is overlaid with from 6 to 12 inches of muck. On this bottom, four shelters, at depths of 6 to 8 feet, were found with frames and large brush in good condition. The poles were lying across each other where they had been notched and the larger brush was arranged alternately butts and tips, the way they were placed when the shelter was built. Small brush was missing. These structures were about 12 by 12 feet and stood above the bottom nearly 3 feet.

Three shelters at depths of 7 to 8 feet, approximately 10 by 12 feet in size, were completely submerged in the muck. Large brush seemed to be in good shape and one shelter was intact. The condition of the frames on the other two could not be determined.

The remaining 3 shelters, in 7, 8, and 10 feet of water, were about 10 by 12 feet in size. One stood up 1 foot while 2 extended 3 feet above the bottom. Two were in good condition but the third was broken apart and scattered. The one in 10 feet of water was still wired.

The four shelters lying on the muck and gravel bottom displayed crustaceous algae and two of them, in addition, some aquatic vegetation, one a few plants of Potamogeton, the other five small lily plants. All other shelters, above the muck, were covered with a slimy algae.

No fish life was observed on any of the shelters, but schools of bluntnose minnows were noted in shallow water along the northeast shore.

This lake is considered a largemouth bass and bluegill lake and several boats were out on the lake during the time of checking. The catching of one largemouth bass about a foot long was observed.

Brush Shelter Examination
June 27, 1944
Jones Lake, Crawford County, Michigan
(T. 28N. R. 2W. Sec. 31)

In Jones Lake, Crawford County, were placed a total of 64 shelters--42 circulars and 22 ladders. These installations were made in 1933 by the C. C. C. under M. E. C. W. supervision.

The lake encompasses an area of about 40 acres and lies in the valley of the east branch of the Au Sable River into which an outlet from the lake flows. A resort is situated at the north end and an excellent swimming beach and camp site is located on the southeast side, evidently open to the public. A good county road makes these recreational points easily accessible. The owner of the resort, Mr. Snyder, reported good walleyed pike and northern pike fishing. He also stated that he had given permission to the C.C.C. in 1940 to cut brush on his land for building additional shelters to be placed in the lake.

The visibility on June 24, 1944 was 15 feet.

Seven circular shelters about 10 x 10 and standing up 2 to 4 feet were checked. They were lying on the marl bottom in a sheltered area with 3 located in depths of 8 feet, one at 12 feet, and another at a depth of 14 feet. Two others lay at 16 and 18 feet respectively. The condition of the large and small brush in the shelters at the 8 foot depth was good but in other depths the small brush was missing. Wires were broken and scattered on all structures and specimens taken showed the #9 wire used had rusted to the thickness of a paper clip. Four shelters were broken apart and scattered, one at a depth of 8 feet, one at 12 feet, and the two at the depths of 16 and 18 feet.

Only one of the shelters showed any vegetation--6 plants of Potamogeton growing on the shallow side of it in about 7 feet of water. Filamentous algae was observed on two shelters at the 8 foot depth and crustaceous algae on all shelters up to and including the one at the 12 foot depth. On shelters in depths of 14 and 16 feet the amount of algae decreased sharply and was entirely absent on the one at the 18 foot depth.

On the shelter which showed plants of Potamogeton about 40 unidentified minnows were observed. These were the only fish noted in or about the shelters.

The single ladder shelter found was evidently a new one. It was about 6 x 10 feet in area and 2 feet in depth. It lay over the drop-off with the edge toward the center of the lake buried in the marl so that the opposite or shore-ward side was erected above the slope of the drop-off and facilitated inspection of the bottom of the shelter. It was wired and in good condition with large and small brush present. The position of this shelter might indicate that any shelters placed on the slope of the drop-off may have slid into the depths of the lake. Two frames typical of the new shelter were found washed ashore with all brush missing.

Brush Shelter Examination
July 19, 1944
Howe Lake, Crawford County, Michigan
(T. 26N. R. 4W. Sec. 32)

Howe Lake lies about four miles west of Grayling north of M-72 and is easily accessible by two plains roads cut through the Hanson State Game Refuge which lies immediately south of it.

The shore line is low but not swampy. It is forested by Jack pine and a few birches and poplars growing on a level plain. It has a narrow shoal of sand mixed with muck which slopes gradually toward deeper water. The shoal supports the lake's only vegetation--reeds and some Potamogeton growing along the shore line. There are no cottages but two trailers were observed.

Much improvement work was done on this lake by the C. C. C. presumably about 1933. Seventeen circular shelters, 13 ladder shelters and 6 semi-shore shelters, to protect water lilies from carp which then infested the lake, were installed. Nineteen minnow spawning devices and 140 gravel piles were also put in the lake.

At the time of inspection visibility was limited by the tea-like color of the water and was read at 9 feet.

Five circular and two ladder shelters were checked as well as they could be under the difficulties encountered in the muck bottom and the low visibility. When divers descended it was impossible to determine where the bottom began. It was thought that they immediately dropped into several feet of muck. This conclusion was reached because of the extreme coldness of the water at that depth. As a result of the difficulties enumerated very unsatisfactory data were obtained.

Some of the required data were obtained on two ladder shelters which lay at 13 and 14 feet respectively. The condition of one ladder frame was determined by feeling and considered good. The other was upside down and the data on the frame incomplete. The condition of large brush on all shelters was good wherever found but small brush was mostly gone.

Of the 5 circular shelters inspected 3 were 15 by 15 feet and one 10 by 10 feet. Their height above the bottom (?) seemed to approach 2 feet.

There appeared to be no vegetation in or about the shelters. Blue-green algae was found on only two structures, one in 8 feet of water, the other at a depth of 9 feet. It was either absent or not observed on the other 5 shelters.

Two bluegills or sunfish 3 to 4 inches long were observed on one shelter at the depth of 9 feet. No other fish life was noted about the shelters. Young largemouth bass and young bluegills and sunfish were seen in the emergent vegetation along the shore.

The entire shore line of Howe Lake was waded at a depth of 2 to 3 feet to check for gravel spawning beds, minnow spawning slabs, and water lilies.

Gravel piles as distinct piles could not be found. There were places where a mixture of sand and gravel was found. In two such areas bluegills spawning beds were noted, one group of nests covering an area of about 10 by 10 feet, the other a group of 6 nests.

Mr. H. L. Peterson, the District Fisheries Supervisor, reported that several years ago the water level dropped so that the gravel piles were on dry land and that cars were driven over the exposed shoal. This may have flattened the gravel piles.

Six of the minnow spawning slabs were found in 2 1/2 to 3 feet of water. From all appearances these were not being used.

Sixteen water lily plants, several of which were displaying yellow blossoms, were found growing in the area where they had been planted in 1933.

Brush Shelter Examination
July 18, 1944
Bright and Glory lakes, Crawford County, Michigan
(T. 27N. R. 3W. Sec. 16)

Bright and Glory Lakes, formerly known as Alexander Lakes, are within the boundaries of the Hartwick Pine State Forest in Crawford County, Michigan. They are easily accessible and may be seen from highway M-93. The two lakes are connected by a small shallow stream which does not permit boat passage and is teeming with shiners and chubs. There is a small outlet from Bright Lake, which is the lower lake of the two, that flows into the east branch of the Au Sable River. Both lakes are typical pot hole and muck bottom lakes. Glory, the upper lake, covers an area of about 23 acres and has a depth of 45 feet. The visibility reading on the date of checking was 14 feet. Bright Lake is about 13 acres in area and goes down to a depth of 40 feet. Its

visibility reading was 16 feet on July 18, 1944. The two lakes are known locally for their big largemouth bass. Glory Lake displayed 5 of these bass slowly swimming back and forth along the rather sharp drop-off apparently waiting to catch the adult common shiners that were hiding under an old boat and in the vegetation. Rock bass and bluegills were also present. In Bright Lake largemouth bass were observed at the drop-off around sunken deadheads.

Condition of Shelters

Bright Lake

Twelve shelters were found and checked in Bright Lake. Nine of these were clump shelters placed in the lake in 1933 by the C. C. C. Two tree shelters and one ladder shelter were put in the lake at a later date.

The clump shelters were made of 5 or 6 clumps of tag alder which had been dug out by the roots, wired together at the base, weighted, and dropped into the lake. They were found at depths of 8 to 22 feet and in eight of them the clumps were scattered. The ninth shelter was still wired, with the wire and part of the burlap sack used to sink the shelter fastened to the base of the clumps which were buried in the bottom mud. All were well sunken into the muck. Several had only one branch standing above the soft bottom. The small branches were broken off from these larger branches which were above the muck. Many of the small branches were present, though brittle, on the large tough branches that were in the muck.

The ladder shelter, about 10 by 10 by 1 1/2 feet in size, was compact and in good condition with wires in place lying at a depth of 13 feet. The tips of the brush (1/4 inch or less in diameter) were almost all gone. The shelter had not sunken into the muck.

The two tree shelters, wired to a stake above the drop-off and lying on it with the tips down into deep water, were of cedar, with small and

large brush present and in good condition. The smaller branches did not show any signs of decay.

Glory Lake

Seven shelters were found in Glory Lake in water from 6 to 22 feet in depth. Only two of these were clump shelters placed in the lake in 1933. Four were ladder shelters and one was a cedar tree resting on the drop-off with the butt in shallow water. The two clump shelters were tag alder, with the clumps scattered and almost all below the muck in water 17 to 22 feet in depth. The small twigs were all gone from the branches above the muck. The 4 ladder shelters were approximately 4 by 6 by 1 feet in water on the drop-off from 6 to 12 feet in depth. The brush was small and closely packed making the shelters appear like sunken rafts. Wires were in place but no weights could be found.

Vegetation

Vegetation was sparse in both lakes, a few water lilies, a small amount of marginal growth, and some Chara was all that was observed.

No vegetation was found in or near any of the shelters in Bright Lake. In Glory Lake two of the shelters had Chara growing in and around the shelters as well as in the general area. A few plants of Potamogeton praelongus were also growing near these two shelters. These plants were found in limited numbers in other parts of the lake.

Fish Observed

No fish were observed in or around any of the shelters in Bright Lake. In Glory Lake fish were seen on 3 ladder shelters. Young largemouth bass, estimated under 3 inches in length, were present on all three of these, one sheltering 25, another 12, and the other 5. The one on which 5 largemouth were found also sheltered 2 bluegills between 3 and 6 inches in length, and 26 rock bass, 24 of which were less than 3 inches long, and 2 that were between 3 and 6 inches in length.

Minnow Spawning Slabs

Two star-shaped minnow spawning slabs were found along the south shore of Bright Lake. They were in position and in good condition but were not being used.

Brush Shelter Examination
July 7, 1944
K. P. Lake, Crawford County, Michigan
(T. 28N. R. 2W. Sec. 28)

K. P. Lake is located south of the county highway running east from Frederick and is about four miles west of Lovells. There is a summer resort at the north end of the lake with cabins and boats available to the public. It has a good swimming beach.

The lake is surrounded by high hills heavily forested with small trees following a fire of ten years ago. A few privately owned cottages are located on the west shore. The resident of one of these reported that the water about a shelter was their favorite fishing spot for bluegills. Aquatic vegetation is scattered along the edge and slope of the drop-off. The maximum depth of the lake is 25 feet and visibility on the date of examination was 15 feet.

Nine ladder shelters were installed in this lake by the C. C. C. in 1933. Eight of these were found in depths of 7 to 8 feet. All were about 10 by 10 feet and stood up 3 to 5 feet. Only one complete frame could be inspected and its condition was good for although the wires were gone, the notches of the cross timbers were in position over the notches of the long poles. The end of another could be observed also in good condition. The other frames were buried in from 2 to 12 inches of muck over sand. It was especially noted that in all these shelters, the condition of large and small brush was good. Although the wires were broken the brush here seemed to be in better condition than in other lakes where shelters had been examined. This was particularly true as far as

small brush was concerned. Many of the tips were still present. Five of the shelters observed were about in the original position, with the brush arranged in an orderly fashion with tips and butts alternated. One of the shelters had been torn apart and the brush was disarranged. Another was tipped, probably resting on a sloping bottom so the brush pointed upward. Brush which was identified was of oak.

Potamogeton amplifolius grew sparsely in all shelters but one where none was found and was observed in about the same concentration all about the area. In one shelter at a depth of 8 feet and standing up 3 feet, 4 bluegills or sunfish 3 to 6 inches in length were observed. On another, in 7 feet of water and standing up 5 feet, were seen 36 bluegills or sunfish 1 1/2 inches in length, 5 bluegills or sunfish 3 to 5 inches in length, a largemouth bass 5 inches in length and a smallmouth bass 3 inches long. No fish life was noted on the other seven shelters.

Although 3 shore shelters were installed in this lake none were found by the field party.

Brush Shelter Examination
July 21, 1944
Lake Margarethe, Crawford County, Michigan
(T. 26N. R. 4W.)

Lake Margarethe, formerly known as Portage Lake, lies about 3 1/2 miles west of Grayling. It is a popular resort lake with many cottages and numerous fishermen. It covers an area of 1881 acres and has 5 deep holes, varying from 45 to 65 feet in depth. The shore is wooded with balsam, cedar, poplar, jack pine, oak, birch, maple, and pine. The bottom in shallow water is sandy changing to pulpy peat in deeper water. The visibility reading on July 31, 1944 was 14 feet.

Brush Shelters Installed in 1933

Brush shelters were installed by the C. C. C. in 1933 under the direction of I. A. Rodeheffer. At that time shelters were built of materials easily available, with the result that different kinds of devices were made.

Where waterlogged logs and deadheads were found on the shoal, shelters were made by gathering this material together and piling it in a criss-cross fashion. Where green brush was present the shelter was built in the form of a circular brush pile which was taken out into 4 to 5 feet of water and weighted with sunken timbers. Where small brush was available and larger poles were lacking circular shelters were built and weighted with sand bags. When larger poles were to be had, ladder shelters were made. Bushy clumps, like tag alder were dug up, 5 or 6 of these were wired together, weighted and dropped into the water. In one shallow bay a brush carpet was installed. This was made by sticking the butt ends of the brush into the bottom and weighting the tops with waterlogged timbers. Brush was placed as close together as possible and covered an area of about 22,000 square feet being roughly 300 by 75 feet in size lying in water from 1 1/2 to 2 1/2 feet deep. Several marginal shelters were placed next to the shore in sheltered areas in water up to 1 foot in depth by using the shore as one side and deadheads along the 3 other sides. Brush was placed in these inclosed areas and weighted with deadheads. A total of 236 shelters of these various types were placed in Lake Margarethe in 1933.

Condition of Brush Shelters in 1944

The brush shelters placed in the lake in 1933 were examined during the summer of 1944 to see in what condition they were after being submerged for 10 years. Six deadhead, or waterlogged timber shelters, were checked, 4 in the sheltered bay between Big and Little Bear Points and 2 on the exposed shoal northwest of Big Bear Point. Three of the shelters in the protected bay were in good condition, with the timbers criss-crossed and in a heap. One was scattered. The 2 on the exposed shoal were badly scattered.

Forty-one green brush shelters weighted with waterlogged timber were checked. Eighteen were in sheltered areas and 23 in exposed water.

All were found in 3 to 5 feet of water. Of the 18 shelters on the protected shoal only 3 were scattered. The others were in good condition with the waterlogged timbers still on the brush. Thirteen of the 23 shelters on the exposed shoal were badly scattered, the remaining 10 were in good condition and well pocketed, with deadhead timbers in place.

Only one circular shelter was found, in 26 feet of water. Although no longer wired it was in good condition with the brush lying in a pile, simulating a large brush pile.

Eleven ladder shelters were found, 4 in 4 feet of water, 4 in 6 to 11 feet, and 3 at 23 to 25 foot depths. All 11 shelters were in good condition, with the brush arranged in an orderly fashion. Two resting on the drop-off in 10 and 11 feet of water were in the heavy vegetation growing on this contour. Little was visible of these shelters because of the profuse plant growth. It is likely that numerous shelters were hidden in this vegetation. The eleven shelters were estimated to be about 25% tips (1/4 inch or less in diameter), 35% branches (1/4 to 1 inch in diameter), and 40% poles (1 to 3 inches in diameter).

Three clump shelters were found in 8 feet of water. One was weighted with deadheads. Another was broken apart and scattered while the third was well bunched but no longer wired.

The brush carpet was still intact covering an area approximately 75 by 300 feet in water 1 1/2 to 2 1/2 feet deep. Some of the branches had moved a short distance until they lodged up against another branch or deadhead, thus making the carpet somewhat unequal in density.

Nothing remained of the marginal shore shelters at the time of examination in 1944.

Vegetation

Only 3 of the 63 shelters examined in Lake Margarethe were barren of all vegetation. When vegetation grew in and around a shelter only, it was recorded as being in the shelter. If vegetation grew in the

general vicinity so its growth apparently was not dependent upon the protection that the shelter might offer the vegetation was not recorded for that shelter. If it appeared that the shelter may have acted as a base for the vegetation to get started and it also grew in the area near the shelter it was recorded as being in and around the shelter. On this basis the kinds of vegetation recorded for the shelters are presented in Table 8

Table 8

Plants, the specimen collection number, and the number of shelters harboring each species of plant in the stated abundance in Lake Margarethe, Crawford County, Michigan

Name	Preserved specimen number	Number of shelters where plant was: Sparse	Common	Abundant	Profuse
Narrow leaf Potamogeton (Sp?)	4 & 6	23	...	...	...
Medium leaf Potamogeton tenuifolius	5	3	...	...	...
Broad leaf Potamogeton amplifolius	2	11	...	...	...
Potamogeton natans	...	3	1	...	...
Potamogeton compressus	...	14	...	...	1
Potamogeton pectinatus	7	11	...	...	...
Potamogeton praelongus	8	2	...	...	2
Utricularia	1	32	...	...	...
Chara	...	18	10	...	...
Elodea	...	13	...	1	1
Myriophyllum	3	4	...	...	...
Najas flexilis	...	3	...	...	...

Plants were recorded as sparse (1 to 10 plants in 100 square feet), common (10 to 30 plants per 100 square feet), abundant (30 to 60 plants per 100 square feet), and profuse (over 60 plants in 100 square feet).

Fish Observed Around Shelters

Careful observations and fish estimates were made of 63 brush shelters in Lake Margarethe. Six different types of shelters were studied in water from 1 1/2 to 26 feet in depth. The average number of each species of fish observed per shelter in and around the different kinds of shelters found at the stated depths are presented in Table 9.

Table 9

Average number of fish per shelter observed in and around the different kinds of shelters at the stated depths in Lake Margarethe, Crawford County, Michigan

Kind of shelter	Deadhead & brush	Dead-head	Brush carpet	Ladder	Ladder	Ladder	Ladder	Circular	Clump
Number of shelters	41	6	1	4	2	2 [+]	3	1	3
Depth, feet	1 to 5	1 to 5	1 1/2 to 2 1/2	1 to 5	5 to 10	10 to 15	20 to 25	26	5 to 10
Species									
Largemouth bass	24.4	8.5	3.0	0.0	17.0	103.0	33.3	0.0	1.7
Smallmouth bass	2.0	0.2	12.0	0.0	0.0	0.0	0.0	0.0	0.0
Bluegills	4.1	3.5	0.0	0.0	0.0	0.0	0.0	15.0	0.0
Sunfish	0.3	1.2	0.0	1.8	1.0	0.0	0.7	0.0	3.0
Bluegills or sunfish	1.6	25.3	3.0	1.0	0.0	0.0	0.0	0.0	0.0
Rock bass	19.7	11.8	0.0	12.5	25.5	0.0	0.0	0.0	8.7
Perch	2.6	0.0	0.0	16.3	9.5	3.5	6.7	4.0	2.7
Minnows [++]	10.2	0.7	0.0	59.8	18.5	13.0	2.0	0.0	17.7
Total per shelter all species	64.9	51.0	17.0	91.4	61.5	119.5	42.7	19.0	33.8

[+] Shelters were in heavy vegetation, on the contour where vegetation normally grows in the lake.

[++] Minnows represent bluntnose minnows, common shiners, and spottail shiners.

Young largemouth bass 0 to 2 inches in length were one of the most abundant as well as most frequently found species in the shelters. This species was also seen in large numbers over weed beds and even in open water during the investigation on this lake. Young largemouth bass were seen more often and in larger numbers in Lake Margarethe than in any of the other 30 lakes visited during the summer. Young bluegills or sunfish 2 to 3 inches in length were common around the shallower shelters but few about 1 inch in length, which would possibly represent this year's young, were seen. Perch and rock bass were also found frequently around the shelters. It is of interest to note that on one of the shelters in 24 feet of water a number of legal-sized perch were observed by the diver. When he arrived at the surface he informed nearby fishermen about the perch and invited them to come over and fish. The fishermen anchored over the shelter and caught not only perch but also rock bass which had not been observed. Rock bass often swim near the bottom and in the pockets of the brush and on a mucky bottom the diver frequently stirs up the muck which clouds the water so that visibility is greatly reduced. Reduced visibility may in part explain the fewer fish recorded for deeper shelters.

Brush Shelter Examination
August 11, 1944
Island Lake, Oscoda County, Michigan
(T. 25N. R. 2E. Sec. 36)

Island Lake is within the Huron National Forest and it covers an area of 65 acres. The bottom is a soft pulpy peat, with a little marl in places and sand along a narrow margin of some of the shoreline. In general the lake is shallow with one hole where the water is 25 feet deep.

The records supplied by the Huron National Forest stated that 8 shelters had been placed in this lake in 1938. A days work of looking and dragging disclosed only 1 shelter. This was made of oak and was somewhat scattered lying in 6 feet of water. No frame or binding pole or wire could be found and it looked as if the brush had been placed

here without being tied together. Some Najas flexilis and a few plants of Potamogeton natans were found in this brush. Six largemouth bass, less than 3 inches in length, were observed around this shelter. The brush was estimated to be about 70% branches and 30% tips.

When talking to Ranger Brayton of the Mack Lake Ranger Station about Island Lake he questioned if any shelters had ever been placed in Island Lake. He failed to find any records of improvement work. Cottage owners living around the lake did not know of any brush shelters having been placed in it.

Brush Shelter Examination
August 10, 1944
Twin Lakes, Oscoda County, Michigan
(T. 25N. R. 2E. Sec. 25)

Twin Lakes are located in the Huron National Forest. They are two almost identical lakes connected by a narrow channel. A dam was put across this channel to separate the two lakes for trout planting experiments by the Institute for Fisheries Research. The larger of these lakes covers an area of slightly over 10 acres and is 40 feet deep. The smaller is almost 8 acres in area and is 35 feet deep. Both lakes are surrounded by hills with steep wooded slopes. Mr. S. L. Gowing of the Mack Lake Ranger Station supervised the building of shelters for these lakes. They were placed on the ice during the winter and left there to sink when the ice melted.

Five ladder shelters averaging about 10 by 10 by 3 feet in size were found in the larger lake in from 7 to 14 feet of water. They were resting on the rather sharp drop-off on the pulpy peat bottom. All but one were in good condition, wired, with binding pole and rocks used as weights in place. Rocks were tied to the shelters with ropes about 1/4 inch in diameter and these were still holding the rocks on the shelters. According to the forestry records these shelters were built and placed in 1938. One shelter was broken apart with the brush scattered on the drop-off.

These constructions averaged about 20% poles (1 to 3 inches in diameter), 45% branches (1/4 to 1 inch in diameter), and 35% tips or twigs (1/4 inch or less in diameter).

Chara was common (10 to 30 plants per 100 square feet) around 2 of the shelters. Potamogeton natans was sparse (1 to 10 plants per 100 square feet) on one and Potamogeton natans was sparse on another. A few of the shelters had green fresh-water sponges growing on the branches. Crustaceous and filamentous algae was present on the brush.

The fish seen on the shelters were all less than 6 inches in length. A total of 8 young largemouth bass were seen. About 370 bluegills or sunfish between 2 and 3 inches in length were seen on the 5 shelters. On 3 of the constructions estimated concentrations of 600, 800, and 2,000 young bluegills or sunfish about 1 inch long were observed. These young fish, probably of this year's crop, have seldom been noted on the shelters examined.

In the smaller Twin Lake only 3 shelters were found. They averaged about 10 by 12 by 3 feet in size and were lying on the drop-off in about 10 feet of water. All were in good condition averaging about 40% tips, 50% branches, and 10% poles.

One of the shelters harbored a few plants of Potamogeton natans and a few plants of Myriophyllum.

A total of 5 young largemouth bass and about 220 young bluegills or sunfish were seen in and around these shelters. One brook trout about 3 inches long was also seen swimming over one of the structures.

The shelters in these 2 lakes were all lying on the slope of a rather sharp drop-off. They seemed to be well located and anchored in place. Possibly the pulpy peat bottom helped to hold them. It is likely that more shelters were in deeper water. Mr. Gowing did not know how many had been put in these lakes. Dragging for more of the devices was not successful

because of the numerous waterlogged deadheads resting on the bottom.

About 25 bluegills or sunfish under 3 inches in length were noted swimming near the east shore of the smaller lake. These were so misshapen that they attracted our attention. Three of them were captured and inspection disclosed their bodies to be full of parasites.

Brush Shelter Examination
August 9, 1944
Loon Lake, Oscoda County, Michigan
(T. 25N. R. 2E. Sec. 36)

Loon Lake is a very attractive lake set among wooded hills within the environs of the Huron National Forest. The water is unusually clear (visibility reading 29 feet on August 9, 1944). Most of the bottom is marl with pulpy peat in the deeper holes and sand along the shore. The maximum depth of the lake is 50 feet and it covers an area of 90 acres. Numerous cottages dot the shore and there is one boat livery and a U. S. Forest camp ground.

The clearness of the water made the location of brush shelters exceedingly easy and a total of 37 were found. According to the original records some of these were placed in the lake in 1937. Mr. S. L. Gowing whom we met with Ranger Brayton at the Mack Lake Ranger Station informed us that he had supervised the placing of several shelters on the ice during the winter of 1939. These shelters were put on the ice, weighted, and left to sink when the ice melted in the spring.

Twenty shelters were carefully examined in Loon Lake, 5 of which were placed in the lake in 1937, 5 in 1939, 5 with vegetation which had been in the lake since 1937, and 5 found in deeper water.

The shelters put into Loon Lake in 1937 could be distinguished from those placed there in 1939 by the general size, the size of the brush used, and the construction. The 1939 shelters were small, about 6 by 8 by 3 feet, and made of smaller brush. The binding poles were also cut off at each end. This description of the shelters installed in 1939 was

given by Mr. Gowing who supervised the building of them. The 1937 shelters were larger, about 10 by 15 by 3 feet and made of larger brush with the tips left on the binding pole. On the 5 shelters checked, 4 had the binding pole in place, and the larger brush was in good condition forming many pockets. The tips were mostly gone. These shelters averaged an estimated proportion of 10% twigs (1/4 inch or less in diameter), 70% branches (1/4 to 1 inch in diameter), and 20% poles (1 to 3 inches in diameter). Wires were gone but the brush was in place. Two of them were resting on the sharp drop-off. The depth of these shelters varied from 5 to 11 feet.

Shelters put on the ice in 1939 averaged about 6 by 8 by 3 feet and were found in water 7 to 10 feet deep, resting on the sand or sand and marl bottom. Three of the 5 shelters checked were still wired and all were in place with the brush held in position. Two were resting on the slope of the drop-off. These shelters averaged about 20% tips, 70% branches, and 10% poles.

Five shelters in water from 16 to 20 feet deep were checked. One of these undoubtedly was put in the lake in 1939, the others had been placed in 1937. Two were still wired, one was upside down, and one was broken apart and scattered. Three were on the steep incline of the drop-off. The estimated percentage of different sizes of brush was 20% tips, 60% branches, and 20% poles.

The other 5 shelters were chosen for study because they had aquatic vegetation growing around them. They were all placed at a depth of 5 to 7 feet on the marl and sand bottom in exposed parts of the lake. These shelters and weed beds averaged about 15 by 15 by 3 feet. The dense mats of vegetation in, over and around these constructions prevented accurate analysis of them but as nearly as could be determined they averaged about 50% branches and 50% poles. The brush in 2 of them was somewhat scattered but still acting as a satisfactory base for the vegetation.

Vegetation

Two species of Potamogeton grew in these devices, the one profusely, the other somewhat scattered. Specimens were taken for identification. Potamogeton tenuifolius was so profuse that it formed a mat of vegetation so thick that it was almost impossible to find the brush. This plant was in seed with the heads above water. The other, Potamogeton natans, has been noted around shelters in other lakes. This plant was also in seed. Bushy pondweed (Najas flexilis) was found growing around the outside edge of 4 of the vegetated shelters. Chara was sparse around one of them. In every instance where this vegetation was found in and around a shelter there was none growing in the vicinity. In fact, these were the only places where vegetation grew profusely in the lake. Potamogeton natans as well as some other species of Potamogeton were seen in sheltered parts of the lake but in no case did they make such thick beds as in the shelters.

Two shelters were checked in water of approximately the same depth as were the shelters with vegetation. One of these had a few plants of the narrow leaf Potamogeton natans of the same kind found on those where the vegetation was profuse. In the other there were a few plants of Potamogeton natans. Others of the 37 shelters seen in the lake were at approximately this depth but did not harbor vegetation. It is worthy of note that some of these shelters were profusely vegetated and others not at all. The bottom may be the partial answer, for where the vegetation grew the bottom seemed to be a soft flaky marl from a few inches to a foot or more in depth, while around those not supporting vegetation the bottom was sand or a layer of what appeared as silt over sand. Exposure could scarcely be a factor here because some of the shelters with heavy vegetation were in the most exposed part of the lake.

Fish Observed Around Shelters

The fish observed around the brush shelters were carefully checked and an attempt was made to count them. This was done for the 5 shelters

in each group which were divided as follows: Shelters placed in the lake in 1937, shelters placed in 1939, the vegetated shelters, and the deep shelters.

The results of these observations are presented in Table 10. It should be remembered that these figures are estimated.

Table 10

Table showing the total estimated number of fish seen by species around 5 shelters in each group examined in Loon Lake, Oscoda County, Michigan

	1937 shelters	1939 shelters	Vegetated shelters	Deep shelters
Average depth	8 feet	8 feet	6 feet	18 feet
Largemouth bass	23	19	21	7
Bluegills	62	125	179	67
Bluegills or sunfish	203	105	10	0
Perch	2	0	2	0
Bluntnose minnows	0	0	450	0
Total all species	290	249	662	74

It may be noted that the fish seen on the shelters placed in the lake in 1937 and 1939 are nearly the same. Shelters put in the lake in 1939 were smaller than those built in 1937. This may in part explain the slight difference in these figures. The numbers given for the vegetated shelters are estimates of the fish actually seen. It was difficult to see fish in the heavy vegetation and there may have been many more than recorded. Of particular interest are the numerous bluntnose minnows among the vegetation. These were not seen on any of the other shelters.

A total of 1,275 fish were observed around the shelters. Of this number 825 were game fish and 450 minnows. Only 12 of the 825 game fish were estimated to be over 6 inches long. Three hundred and seventy-seven

were classified as between 3 and 6 inches in length and 436 less than 3 inches long.

Brush Shelter Examination
August 8, 1944
Wagner Lake, Oscoda County, Michigan
(T. 25N. R. 2E. Sec's. 13, 14)

Wagner Lake lies within the boundaries of the Huron National Forest. It is surrounded by low wooded hills. There are 2 U. S. Forest Service camp grounds and a summer home site with several cottages on the lake. The Saginaw Y. M. C. A. has a boy's camp on the west end. This lake covers an area of 26 acres with a shore line of almost 1 1/2 miles. Its maximum depth is given as 25 feet. The Secchi disk was visible in 20 feet of water, the deepest water found by the party. The bottom along the shore is sandy but changes to a soft muck in deeper parts of the lake.

Brush Shelters

According to U. S. Forest Service records shelters were sunken in the lake in 1937 and from information supplied by Mr. S. L. Gowing of the Mack Lake Ranger Station, additional shelters were left on the ice in February and March of 1939. These had been built under his supervision. Mr. Gowing pointed out the kind of shelters he put in the lake which made it possible to distinguish between the 1937 and 1939 shelters. Some of the brush in the older shelters was laid the long way, crisscross over the other brush, to form pockets. This was not true with the newer ones. Six shelters of each group were examined. An additional 12 or a total of 24 shelters were counted in the lake.

The 1937 constructions averaged about 12 by 12 by 4 feet in size and were found in 7 to 10 feet of water. Those built in 1939 averaged about 8 by 10 by 4 feet, and those examined were in 6 to 8 foot depths. All were resting on the bottom composed of 8 to 12 inches of pulpy peat over sand.

The frames of 3 of the 1937 shelters were in good condition. The

other three were in the muck and the water became so roiled when trying to find them that it was impossible to determine their condition. All but one of the frames of the 1939 shelters were visible and in good condition. One was in the muck and could not be seen. The larger brush on all shelters was tough and strong. The tips were mostly present but brittle. The older shelters averaged an estimated 20% tips (1/4 inch or less in diameter), 50% branches (1/4 to 1 inches through), and 30% poles (1 to 3 inches in diameter). The newer shelters were considered to be 25% tips, 60% branches, and 15% poles.

Vegetation

No vegetation was found around any of the shelters in Wagner Lake. With the exception of the west end where Chara grew profusely and along the north shore where some rushes were growing, there was little vegetation in the lake. Filamentous algae was common on the older shelters and so profuse on the newer ones that it formed what appeared like a mat over parts of them.

Fish Around Shelters

Largemouth bass, bluegills,and bluntnose minnows were seen in and around these shelters. Around the 1937 shelters 57 largemouth bass were seen. Fifty of these were estimated less than 3 inches in length, 5 between 3 and 6 inches, 1 was between 6 and 10 inches and another over 10 inches long. Numbers judged to be about 1,500 bluegills or sunfish and 170 bluntnose minnows were also observed around these shelters.

The estimated number of fish around the newer shelters was even greater. A total of 72 largemouth bass, of which 69 were less than 3 inches long, one between 3 and 6 inches and 2 over 10 inches in length were seen. About 2,000 young bluegills or sunfish and about 300 bluntnose minnows less than 3 inches long were also recorded for these constructions. Many of the bluegills or sunfish were about 1 inch in length, undoubtedly the young of this season.

Wagner Lake is a popular lake with fishermen and has the reputation of being a good bass and bluegill or sunfish lake. Cottage owners and local fishermen are very favorably impressed with the brush shelters. They commented that fishing had improved since the installation of these devices.

Brush Shelter Investigation
July 12, 1944
Fife Lake, Grand Traverse and Kalkaska Counties, Michigan
(T. 25N. R. 9W. Sec's. 12, 13 and T. 25N. R. 8W. Sec. 18)

Fife Lake is located within the Fife Lake State Forest near the southeast corner of Grand Traverse County. The town of Fife Lake is situated on the northwest shore. Over-night cabins and many cottages are available to the tourist. At the time of the shelter examination the lake was being heavily fished. As many as 28 boats were counted in one evening. A boat livery is operated on the north shore where live bait and motors may be obtained. The lake lies within a hilly part of the country and many smaller lakes are found in the area. It is connected with several of these by either an inlet or outlet. Of especial note is the inlet from Spring (or Cedar) Lake through which a large rowboat may be punted. This inlet enters Fife Lake near the two small islands, Helen and Florence, in the southwest bay.

Definite information could not be obtained as to the number of shelters placed in the lake by the C. C. C. in 1936 or 1937 under Fife Lake State Forest supervision.

Sixteen ladder shelters were examined, 11 off the north shore and 5 off the east shore. Those on the north shore were all 10 by 12 feet in size, stood up 3 feet above the bottom, and were at a depth of either 6 or 7 feet. They lay about 100 feet apart on a bottom of soft marl which was approximately 6 inches in depth over hard sand. All frames were in place and resting on the bottom with the wires missing. The five shelters lying off the east shore line stood up above the bottom either

4 or 5 feet and were 10 by 12 feet in size. These lay at depths of 7, 8, and 9 feet. The frames of two of these were in good condition, with the corners still crossed at right angles as originally put in, but with wires and weights missing. Two other shelters were sunken into the soft bottom to the extent that frames could not be seen. The frame of one structure was broken apart and scattered.

In all 16 shelters the large brush was found to be in good condition with poles (1 to 3 inches in diameter) and their branches (1/4 to 1 inch in diameter) tough and flexible so that they resisted breaking. Trunks (3 to 6 inches) were also strong. No timbers (trees, etc. over 6 inches in diameter) were used. The twigs and branches under 1/4 inch through were mostly missing but those present showed signs of decay and broke easily with the thumb and fingers.

In 6 of the 11 north shore shelters Potamogeton pectinatus grew sparsely (1 to 10 plants in 100 square feet) and was common (10 to 30 plants in 100 square feet) in one. Myriophyllum was sparse in 4 shelters and Potamogeton praelongus was equally sparse in 7. Myriophyllum was abundant with 30 to 60 plants in an area of 100 square feet in one structure and sparse in another. One shelter protected 4 plants of Potamogeton natans which also grew around it. In all other instances here mentioned the vegetation was found only in the shelters themselves.

Of the 5 shelters off the east shore the two at the depths of 7 feet each supported Potamogeton pectinatus commonly. A specimen of Potamogeton Robbinsii was taken from the shelter at the depth of 8 feet where it grew sparsely. One structure at the depth of 9 feet grew Potamogeton (sp?) sparsely and the other at the same depth harbored a few plants of Potamogeton natans. These plants were found both in and outside these two 9-foot shelters.

Crustaceous algae was found in abundance on all shelters examined and filamentous algae was common on 4 of them.

The 11 shelters at the depths of 6 to 7 feet off the north shore harbored an estimated 24 rock bass, 5 under 3 inches in length and 19 between 3 and 6 inches; 71 largemouth bass all under 3 inches; 1 sunfish under 3 inches and 92 bluegills or sunfish, 15 under 3 inches and 77 between 3 and 6 inches in length. It is interesting to note that in the shelter examination no legal sized rock bass were observed but when some of the same shelters were later fished an average of about 4 legal fish of that species were taken.

The 5 shelters on the east shoal provided shelter for 38 largemouth bass, 25 bluegills or sunfish, and 4 perch all less than 3 inches in length. Four of these shelters harbored about 500 bluntnose minnows that were less than 3 inches long.

Fishing Data

Four shelters at the depth of 6 to 9 feet and the immediate area between them used as controls were fished by the party in its investigation. Bluntnose minnows were taken in an umbrella net over two shelters and used as bait. Fly rods were used with a light sinker at the end of the line and the bait on a snelled hook was suspended about a foot from the bottom. The party of 3 men spent eighty minutes fishing on the 4 shelters (20 minutes per shelter) and an equal length of time in fishing the adjacent control areas. The results of this activity were as indicated in Table 11.

Table 11

Table showing the number of fish caught in and around 4 shelters and in 4 control areas during 8 man-hours of fishing

		Depth of 6 to 9 feet	
		4 shelters*	4 controls
Rock bass	Under 6 inches	5	0
	6 inches or over	15	0
	Total	20	0
Perch	Under 6 inches	1	5
	6 inches or over	0	15
	Total	1	20

*One bluegill and 1 smallmouth bass 6 inches in length were also caught in the shelters.

Brush Shelter Examination
July 12, 1944
Fuller Lake, Grand Traverse County, Michigan
(T. 25N. R. 9W. Sec's. 23, 26)

Fuller Lake is located about 1 1/4 miles southwest of Fife Lake and immediately west of the Fife Lake State Forest Headquarters. It has an area of about 4 or 5 acres and its shore is thickly forested on the west side with poplars, birches, oak, and pine. The east shore forest is mostly poplar. Off the north and south shores large areas of pond lilies, both white and yellow, were noted. The lake has both an inlet and an outlet located at the north end. The bottom where shelters were inspected was found to be soft marl. Visibility on the date of the inspection was read at 18 feet.

According to work-map records 4 circular shelters were placed in the lake in 1933 by the C. C. C. under Fife Lake State Forest supervision but the party checking shelters found 5. They also found 3 of the 4 bluegill spawning boxes and 9 of the 12 bass spawning devices, installed at the same time. None of the 20 minnow spawning slabs installed by the Fife Lake C. C. C. along the east and west shores could be found.

Four of the 5 shelters were approximately 15 by 15 feet in size and stood up from the bottom about 4 or 5 feet. The fifth was 25 by 25 feet in size and its height was about 3 feet. All were submerged in depths of 5 to 7 feet on a soft marl bottom.

The largest shelter was still wired but disorganized enough so that large pockets were noted. Of the other 4 structures wires were found upon only one and in this case they were broken. The brush upon all shelters was considered to be in good condition except that the small tips of branches were mostly gone. Poles 1 to 3 inches in diameter were still flexible and resisted breaking as did the branches, 1/4 to 1 inch through. On 3 shelters some of the brush was identified as poplar and its condition was as noted immediately above. Oak brush was conspicuous for the large number of tips

present. In two of the shelters the brush was somewhat scattered.

In 4 shelters Potamogeton angustifolius was growing sparsely, 1 to 10 plants, in an area of 10 by 10 feet in each structure. Potamogeton Friesii grew in 4 structures in about the same concentration. In no case were there plants found in the areas immediately around the brush piles. Potamogeton natans, however, was common (10 to 30 plants in 100 square feet) in and around one shelter and Potamogeton pectinatus grew commonly in another but not around it. Chara was common in and around all structures. Filamentous and crustaceous algae were observed to be abundant upon the brush of all the shelters.

Each of the 5 shelters harbored from about 25 to 100 bluegills or sunfish under 3 inches in length and two of them sheltered larger fish of the same species, one, 6 fish 3 to 6 inches in length, the other, one fish, 3 to 6 inches long. Eleven largemouth bass were counted in 4 of the structures, 4 fish were 3 to 6 inches in length, the others under 3 inches. About two hundred bluntnose minnows 1 to 3 inches in length were seen over one of the shelters and approximately 50 of the same species and size over another. Two rock bass were observed in one of the shelters, one 8 inches long, the other 5 inches in length.

Of the three bluegill spawning boxes inspected all were 7 by 7 feet in size and about 4 inches deep. They lay submerged in about 2 to 3 feet of water. Two of them on the west shore had been used this season, 1944, one showing 12 nests, the other 3. Nests were also observed outside the structures. The third box lying off the east shore, had not been used and was 3/4 full of gravel which was covered with Chara.

The 9 bass spawning boxes were 2 1/2 by 2 1/2 feet in size and about 4 inches in depth. Evidently all had been used during the 1944 spawning season. Six of them were 2/3 full of gravel while 3 were 1/2 full. Although considerable time was spent in the effort no minnow spawning devices could be found.

Brush Shelter Examination
July 12, 1944
Pickerel Lake, Grand Traverse County, Michigan
(T. 25N. R. 9W. Sec's. 13, 24)

Pickerel Lake lies immediately south of Fife Lake near the Grand Traverse-Kalkaska County line. Access is gained by means of a road approaching the shore at the north end of the lake. There are no cottages along its shore line but several lie near the north side probably identified with Fife Lake. Three boats were found at the north shore landing on the date of the examination. The shore line is mostly low and is wooded with evergreens and hardwoods. The lake is shallow and mucky-bottomed and grows much vegetation throughout a large part of its area although some parts are completely devoid of it. Some sand and gravel is found on the east and southeast shoal. The southwest shoal is particularly notable because of the mass of lilies present. In two instances shelters were located easily because of the growth of lilies they protected.

The C. C. C. in 1933 under the Fife Lake Forest supervision installed in the lake 10 marginal shelters, 6 circular shelters, 6 bass spawning boxes, and 11 slab minnow spawning devices.

Visibility on the date of inspection was read at the maximum depth of the lake which was 10 feet.

The 5 circular shelters found lay in depths of 1 1/2 to 3 feet of water. Three were 10 by 10 feet in size and stood up 1 1/2 to 2 feet above the bottom. The other two were scattered, one over an area of 15 by 15 feet while the other covered a space 20 by 20 feet. These two structures stood up 1 1/2 to 2 feet respectively.

Although the shelters were scattered in two instances the condition of the brush of all of them was considered good with the exception of the tips which were gone. Poles, 1 to 3 inches through, were still strong and flexible and this was also true of their branches, 1/4 to 1 inch in diameter.

It should be noted, however, that all brush inspected had a tendency to become comparatively less strong as it approached fineness. Decay became most evident as the size of brush decreased, with the twigs disappearing first. All brush was covered with blue or blue-green algae.

Three shelters harbored water lilies (Nymphaea odorata) profusely (over 60 plants in 100 square feet) and Chara was also profuse in one of them. Potamogeton amplifolius and Potamogeton pectinatus grew sparsely (from 1 to 10 plants in 100 square feet) in another of the three. Of the remaining two shelters one of them displayed Potamogeton natans profusely and Chara commonly (11 to 30 plants per 100 square feet). The other grew Potamogeton amplifolius sparsely.

Of 3 shelters examined, one at a depth of 2 feet harbored a largemouth bass under 3 inches in length and about 50 bluntnose minnows of equal size. Another sheltered 4 largemouth bass of the same length and a third protected 1 largemouth bass, 1 bluegill or sunfish, and approximately 25 bluntnose minnows all under 3 inches. No fish were observed in the other 2 shelters.

None of the spawning devices installed could be found but two areas along the south shore line displayed an accumulation of brush that may be the remains of marginal shelters. They could not, however, be positively identified as such.

Brush Shelter Examination
July 13, 1944
Dowen Lake, Grand Traverse County, Michigan
(T. 25, 26N. R. 9W. Sec's. 3, 34)

Dowen Lake lies two miles northwest of Fife Lake. It is accessible by means of two roads, one entering at the southeast side, the other at the north end. There are no cottages, but five boats evidently owned by various persons were found along the east shore.

The shore line is forested on the east and west sides by hardwoods and tag alders and shrubs. The south shore is swampy and low while the north end shore displays open fields behind a narrow shelf of tag alders

and shrubs. The lake bottom is extremely mucky except on the shoals along the northeast side. The shoals of the west and south sides support large masses of white and yellow water lilies.

The lake has an area of about 15 acres and a maximum depth of 28 feet. On the date of examination the Secchi disk reading was 26 feet.

Seven circular shelters were installed in the lake in 1933 by the C. C. C. They lay partly sunken in the muck in 4 to 5 feet of water. The size of 5 of the constructions above the muck was approximately 10 by 10 by 2 feet while the other two were nearly 15 by 15 by 2 feet. The condition of the large brush identified as tag alder and poplar was fair, branches 1/4 to 1 inch in diameter were present and the tag alder was tough and not easily broken. The poplar branches were brittle with most of the small branches gone.

Potamogeton amplifolius grew sparsely in two shelters, profusely in one, and was absent in the other. It was common in two structures and entirely absent in two others at the depth of 4 feet. Vegetation was confined to the shelters to the extent that they could be located by the concentration of plants showing above the surface of the water.

Water lilies, Nymphaea odorata, were observed growing profusely in the two shelters noted as supporting Potamogeton sparsely. No water lilies grew in the immediate area.

In the two shelters supporting an abundance of lily pads one harbored 2 largemouth bass 3 inches in length and the other 5 of the same species, 3 to 6 inches long. The shelter which was heavily vegetated with Potamogeton was also occupied by 2 largemouth bass about 4 inches in length. Large numbers of these fish were observed among the lily pads along the shore line.

Brush Shelter Examination
July 11, 1944
Spring Lake, Grand Traverse County, Michigan
(T. 25N. R. 9W. Sec. 14)

Spring Lake lies partly within the southeast quarter of Section 14 and immediately southwest of Fife Lake to which it is connected by a turgid and mucky-bottomed outlet about 1/4 mile long, through which one may punt a row boat with little difficulty. The shore is forested with pines and hardwood growing on a level approach to the lake from rolling hills. On the west shore a camp site has been established by the Fife Lake State Forest of which the lake is a part.

The lake has an area of 11 acres, a mucky-marl bottom with a sharp drop-off all around, and a maximum depth of 20 feet. On the date of examination the Secchi disk could be seen on the bottom in the deepest point found which was 16 feet of water.

Under the supervision of the Fife Lake State Forest authorities the C. C. C. in 1933 installed one marginal structure, 6 circular shelters, 12 bass spawning boxes, and 12 slab minnow spawning devices.

All 6 of the circular constructions were found by the investigating party. Two lay at depths of 6 feet, 2 at 7 feet, and 2 at 8 feet. The shelters were comparatively large ones, 2 being 20 by 20 feet in size, 3 about 15 by 20 feet, and one was spread out over an area of 25 by 25 feet. One shelter stood up above the bottom 5 feet, 4 stood up 4 feet, and the one designated as spreading was 2 feet in depth.

The shelters were composed of a large percentage of poles, probably 75%. These were strong and difficult to break and ranged in diameter from 1 to 3 inches. Branches, 1/4 to 1 inch in size, were also strong and made up about 20% of the shelter. Twigs up to 1/4 inch were brittle and broke easily and those which remained made up about 5% of the structure. Brush which was identified was poplar, cherry, and birch. Poplars were brittle and the branches were mostly gone.

The shelters lay on the drop-off and in two instances were still wired to stakes to prevent sliding down the slope. Wires were still found about two others but the stakes were not noted.

In one of the structures at the depth of 6 feet Potamogeton amplifolius and Potamogeton zosteriformis were sparse (1 to 10 plants per 100 square feet), while in the other shelter at the same depth these plants grew profusely (60 plants or over per 100 square feet).

In one shelter at the depth of 7 feet Potamogeton zosteriformis was sparse and Potamogeton natans was common (10 to 30 plants in 100 square feet). In the other structure at the same depth Potamogeton amplifolius was profuse while Potamogeton zosteriformis was sparse. Both shelters at the 8 foot depth displayed Potamogeton amplifolius, one sparsely, the other profusely. Chara was common both in and about the shelters and crustaceous algae was abundant on all the brush. Green and blue-green algae was noted on one structure at a depth of 7 feet.

Of the two shelters at the depth of 6 feet, one harbored 3 largemouth bass 1 to 3 inches in length, 4 bluegills 3 to 6 inches long, and approximately 100 bluegills or sunfish 1 to 3 inches in length. The other gave shelter to 3 sunfish 6 to 10 inches long and 7 sunfish 3 to 6 inches in length, about 75 bluegills or sunfish 1 to 3 inches long, and 8 crappies 6 to 10 inches in length.

One of the two shelters at the depths of 7 feet protected 5 bluegills of 3 to 6 inches in size, an estimated 100 bluegills or sunfish 1 to 3 inches in length, and 1 crappie about 8 inches long. The other structure at the depth of 7 feet harbored 3 sunfish 3 to 6 inches long, 100 bluegills or sunfish, 3 crappies 1 to 3 inches in size, and 1 crappie approximately 5 inches long.

In one of the two havens at the depths of 8 feet a bluegill or sunfish about 5 inches long was observed while in the other shelter 3 sunfish 6 to 10 inches in length and 6 sunfish 3 to 6 inches long were seen. This

structure also acted as a refuge for a number judged to be 100 bluegills or sunfish 1 to 3 inches long, 2 crappies of 3 to 6 inches in size, and 3 crappies 6 to 10 inches long.

Of the 12 bass spawning boxes 6 were found along the north shoal near the drop-off lying in depths of 2 to 3 feet. All 6 structures were still nailed and in good condition. Three were full and 3 were half-full of gravel. Three were still fastened to the stakes used to keep the boxes from sinking in the mucky marl. Three others had the stakes missing but the boxes were still lying well placed on the bottom although two were about 1/2 sunk in the mud. Five of the boxes had evidently been used this year for spawning but the sixth was covered with Chara and algae and showed no use this season.

None of the 12 slab devices for minnow spawning could be located although an extended effort to find them was made along the whole shore line.

Brush Shelter Examination
August 14, 1944
Ocqueoc Lake, Presque Isle County, Michigan
(T. 36N. R. 3E. Sec. 19)

Ocqueoc Lake lies 14 miles northeast of Onaway and about 2 miles from the shore of Hammond Bay in Lake Huron. It is situated within the boundaries of the Black Lake State Forest and was formerly the location of C. C. C. camp No. 1667, now in charge of the U. S. Coast Guard. The Ocqueoc River empties into the lake near the south end and an outlet to Hammond Bay drains from the northeast shore. The lake, which is a little over a mile long, also has an inlet on the west side from Orchard Lake. A small, timbered island lies near the north end. There is a sharp drop-off along the shore line except in the north and south ends and wherever this drop-off was seen it was heavily vegetated. Much vegetation was also observed in the shallower north and south ends.

On the shore of the bay east of the island a resort of about 4 cabins

is situated where boats may be rented. Another small resort is located in the southeast bay opposite the mouth of the Ocqueoc River. These resorts are accessible over a good road extending from Presque Isle County Road No. 646.

The lake gives the impression of lying in a sunken river valley and its clay bottom is overlaid with sand and muck in places. Visibility on the date of the shelter inspection was 14 feet. The maximum depth is 33 feet.

All shelters found were about 10 by 12 feet in dimension and 3 stood up 2 to 3 feet, one 2 1/2 feet, and another 1 foot. Three of the frames were observed in good position, two of them still wired. The frames on the other two shelters could not be seen. Two structures were composed of about 50% poles and 50% branches, two were 10% poles, 85% branches and 5% tips; one was 70% poles, 25% branches, and 5% tips.

The brush identified was oak, birch, and poplar. Poplar was characteristically brittle with most of the tips gone. The oak retained many of its tips but the birches were found to be mostly poles and branches.

In a shelter at a depth of 7 feet vegetation was so profuse that only a little brush could be seen. The vegetation consisted of Potamogeton epihydrus and Vallisneria spiralis. These plants were also profuse along the drop-off where the shelters lay. Myriophyllum was found growing sparsely in a structure at the depth of 10 feet. Of two shelters lying at a depth of 12 feet one harbored Vallisneria spiralis, Potamogeton epihydrus, and two other Potamogetons (Sp?), the other none. In a shelter at the depth of 16 feet no vegetation was observed.

No algae were noted upon any of the brush except in the shelter at the depth of 7 feet and here only where the brush was exposed in the heavy vegetation.

Six rock bass 3 to 6 inches in length were seen upon the shelter at the depth of 7 feet and 2 bluegills of about equal size in the structure

at the 10 foot depth. No fish were observed upon the other shelters but innumerable large shiners were noted swimming along the drop-off in various places.

As was often observed when brush was raised from the shelters, many aquatic worms were noted. These seemed to tunnel under the bark which remained.

Brush Shelter Examination
August 16, 1944
Orchard Lake, Presque Isle County, Michigan
(T. 36N. R. 2, 3E. Sec's. 19, 24)

Orchard Lake is a long and crooked lake, possibly a part of an old river bottom. It covers an area of 35 acres and is 35 feet deep. An outlet at the lower end which is swampy flows into Ocqueoc Lake. The upper part of the lake is surrounded by higher ground which is timbered with second growth woods, mostly poplar and birch. The bottom on the narrow shoal, particularly on the upper half of the lake is sand and gravel. In deeper water the bottom is a deep soft muck, and in several places where tested by pushing a pole 6 feet into the muck there appeared to be no firm bottom. This muck was exceedingly cold. On the date of examination the visibility was 6 1/2 feet. The water had the color of weak tea.

Records showed that ladder shelters were placed in this lake in 1933. A thorough checking of the shallower water up to 8 feet in depth along the entire shore line did not disclose a single shelter. However, 6 beaver homes were found and brush cut by the beaver was under water to a depth of 10 feet in the vicinity of these houses. The branches were small, less than 1 inch in diameter at the butt end, with bark and tips intact.

A brush pile of spruce about 5 by 5 by 3 feet was found standing above the surface near shore in 2 feet of water where some woodsman had cut down a large spruce and apparently piled the small branches in the lake.

Five hours of dragging, which was difficult because of many deadheads,

between the 8 and 20 foot contours revealed only one ladder shelter at a depth of 13 feet. The brush which was above the muck was scattered. The frame, lying on top of some of the brush, was still hanging together by nails but was not wired.

No vegetation was noted around the beaver cuttings or the ladder shelter. Around the brush pile of spruce there were a few plants of Najas flexilis and Potamogeton bechtoldii.

The only fish observed were a few small perch and young largemouth bass which were seen where the boat was put in the lake from the east shore. No fish were in or around the beaver cuttings, the spruce brush pile, or the ladder shelter.

Brush Shelter Examination
August 18, 1944
Tomahawk Lake, Presque Isle County, Michigan
(T. 33N. R. 2E. Sec's. 22, 23)

Tomahawk Lake in Presque Isle County lies in Allis Township and within the confines of the Presque Isle State Forest. It is about 14 miles south of Onaway and is accessible from M-33 over an improved county road leading to the two camp sites established on the north and east ends of the lake by the State Forest. A forest fire has destroyed most of the larger trees on the hills surrounding the lake.

Two-thirds of the lake is less than 9 feet in depth and its deepest part lies in the east one third where the water was found to be 32 feet deep by Camp Presque Isle C. C. C. in 1935-36. The bottom is muck over sand and the visibility on the date of the examination was 15 feet.

Condition of Brush Shelters

Fourteen shelters were inspected in this lake. Six of these were about 10 by 12 feet in size and stood up about 1 foot above the bottom in 3 to 6 feet of water. The other 8 were small double-framed shelters which stood up about 1 foot in 2 to 2 1/2 feet of water. Five of these 8 constructions were 8 by 3 feet in size and 3 were 5 by 5. Of these last

3, one frame was triangular in shape, another was a square, and the third was made by crisscrossing the brush without a frame. In the double-framed shelters the brush which was mostly jack pine branches was placed lengthwise between the frames and these were wired together.

The six typical ladder shelters had their binding poles in place and three of the poles were still wired to the frame. In the double-ladder constructions no binding pole was used as the top frame was wired to the bottom one. Six of these were still wired in this manner although in one the top frame was off to one side. In one shelter of this group the top frame was missing.

The six single ladder shelters were made up mostly of oak and some jack pine. Ten per cent of the brush in the shelters was poles (1 to 3 inches in diameter), 80% was branches (1/4 to 1 inch in diameter), and 10% tips (1/4 inch and smaller).

The brush in the other shelters was jack pine, the average percentages being 10% poles, 70% branches, and 20% tips. The jack pine in all the shelters found in the lake was extremely tough and was broken with considerable effort. Many of the seed cones were still attached to the branches. Other brush examined was strong and this was especially true of the oak which retained many of its tips.

Vegetation

About 1/3 of the western end of the lake is scattered with white pond lilies (Nymphaea odorata) growing in small groups. The western arm also grows these plants along with Scirpus and Potamogeton natans.

Of the 14 shelters examined Potamogeton amplifolius was found growing sparsely (1 to 10 plants in 100 square feet) in four, commonly (10 to 30 plants) in one, and profusely (60 plants and up in 100 square feet) in another. Potamogeton natans was also sparse in one. Chara was sparse in seven and common in three. This plant also grew outside the shelters. A grass-like plant (Potamogeton (Sp?) was found growing sparsely

in and around 6 of the shelters. One shelter at a depth of 4 feet was especially notable because of the concentration of pond lily plants, Nymphaea odorata, in it along with Potamogeton amplifolius mentioned above. Green or blue-green algae was sparse on all of the shelters and filamentous algae was common on two.

Fish Observed

A total of 43 largemouth bass were seen on 7 of the shelters. All were under 3 inches in length except 10 which were between 3 and 6 inches long. Thirty sunfish or bluegills were seen in and around the single frame ladder constructions. Seven of these fish were 3 to 6 inches long, 8 were over 6 inches in length and 15 were under 3 inches.

The total number of bluegills or sunfish seen was approximately 700. Of all these only 2 were between 3 and 6 inches in length, the rest were under 3 inches. About 500 bluntnose minnows were observed on 1 shelter, 1 each on 2 structures, and 6 on another. All these forage fish were under 3 inches in length.

Although C. C. C. records show the installation of minnow spawning beds in this lake, no structures that could be identified as such were found.

Brush Shelter Examination
August 15, 1944
Black Lake, Cheboygan and Presque Isle Counties, Michigan
(T. 35, 36N. R. 1, 2E.)

Black Lake is one of Michigan's larger lakes and lies partly within the boundaries of the Black Lake State Forest about 5 miles north of Onaway. The lake is popular with resorters and many cottages dot its shore line. A state park is also located on this lake.

The shore is heavily forested with pines and hardwoods growing on the hills and in the swamps which approach the lake at varied intervals. Improved roads run almost completely around the lake. The lake has good bathing beaches because of the sandy shoal which is found all along the

shore line. This shoal is a mile wide in the northwest bay and lies under water up to 20 feet in depth. In other parts of the lake the deepest point along the shoals averages about 10 feet in depth and it has a width of about 1/4 mile. In nearly all parts of the lake except most of the northwest bay the drop-off is very sharp. The bottom is mucky below depths of about 20 feet. Visibility on the date of the shelter inspection was 14 feet.

A number of shelters were placed in Black Lake by the C. C. C. under the direction of Ralph C. Janes in 1933. Careful and intensive check of the lake where these shelters were supposedly placed failed to find any of the structures. Inquiries of local people revealed that many shelters had floated in on their shore in the spring of 1934. However, 13 shelters which the C. C. C. had placed in the lake through the ice in about 1936 or 1937 (according to Mr. John Adair, a former conservation officer) were found on the drop-off in 19 to 28 feet of water.

Eleven of the shelters were about 10 feet by 15 feet, one was 15 by 20 feet and the last was about 20 by 20 feet in size. Nine structures stood up above the bottom 3 feet, one was 2 feet high, and 3 were 4 feet high. Two shelters lay at the depths of 19 feet, one was submerged in 20 feet of water, 4 were at a depth of 22 feet, 3 lay at 24 feet, and three lay at depths of 25, 26, and 28 feet, respectively. These shelters averaged about 20% tips or twigs (up to 1/4 inch in diameter), 50% branches (1/4 to 1 inch in diameter), and 30% poles (1 to 3 inches in diameter).

Seven of the 13 shelters were still wired. Frames were noted under 9 of them. No frames were seen under the other 4. Rocks used as weights to sink the shelters were found on 2 of the structures.

One plant of Elodea was the only vegetation found around any of the shelters. However, all shelters were found in water deeper than where vegetation normally grows in the lake. Some filamentous algae were found on 9 of the structures observed.

Rock bass made up most of the fish population of these shelters. Three perch and a smallmouth bass were the only other fish noted.

Of the 105 rock bass observed all were legal sized (6 inches) or over excepting 2. Eighty-nine were from 6 to 10 inches in length, 4 were over 10 inches long, and 2 were from 3 to 6 inches in length. Two perch were from 6 to 10 inches long and 1 was under 6 inches in length. The smallmouth was between 3 and 6 inches long.

It is interesting to note in connection with the fish that the markers used by the party to indicate the presence of a shelter below were used as fishing spots by anglers. These spots are difficult to find without the markers and the fishermen were observed to be getting good catches of legal fish in these areas.

Brush Shelter Examination
August 20, 1944
Clear Lake, Montmorency County, Michigan
(T. 32N. R. 2E. Sec's. 27, 33, 34)

Clear Lake lies just west of highway M-33 about 12 miles north of Atlanta, Michigan. The name well describes the lake as its unusually clear water (visibility reading 28 feet on August 20, 1944) makes it easy to see objects and fish in deep water. One fisherman explained how he was trying to outsmart smallmouth bass which he could see bunt his hooked night crawler around. However if he dropped an unhooked night crawler into the water it was immediately gobbled up as it sank to the bottom. As far as is known he is still trying to solve this problem. The lake covers an area of 133 acres and is 92 feet deep. The bottom is composed of sand and gravel along the shore, with marl where the water is 10 to 50 feet deep, and in the deeper parts it changes to a pulpy peat.

Condition of Brush Shelters

According to our records brush shelters were installed in Clear Lake in 1933. Two types of ladder shelters were found. Numerous small

double frame ladder shelters were found in 3 to 4 feet of water. These shelters were about 4 by 4 by 1 feet in size with a ladder frame on the top and bottom and jack pine branches used for brush. Some of these frames were still wired and all 5 examined were still nailed. Jack pine brush seems to stand up remarkably well and many small tips were present. These shelters averaged about 30% twigs (1/4-inch or less in diameter), 60% branches (1/4 to 1 inch in diameter), and 10% poles (1 to 3 inches in diameter). One of these small shelters was found wrapped in 1 inch mesh chicken wire. The wire was rusted and brittle and broke when punched with the oar. The brush (jack pine) was intact and in very good condition with many tips present.

Fifteen larger shelters averaging about 10 by 12 by 3 feet in size were checked. Five of these were in 4 feet of water, 5 at 6 to 8 foot depths, and 5 in water 11 to 13 feet deep. All had undoubtedly been placed in the lake in 1933. These shelters averaged about 10% tips, 65% branches, and 25% poles. Most of the brush was oak. Four of these shelters were still wired and four had the binding pole in place. All shelters examined were in good condition with the brush in place on the frames. Two of the shelters had spawning beds under the binding poles.

Many other shelters were seen in the lake, some of which had been placed at a later date.

Vegetation

All shelters examined were entirely devoid of all vegetation. The only vegetation observed any place was a little Chara near one of the shelters. Filamentous algae was found growing so profusely on 3 of the shelters that the top appeared like a solid mat and the branches were almost entirely covered on the others.

Fish Seen Around Shelters

The estimated number of fish by species seen in and around brush shelters at different depths in Clear Lake are given in Table 12.

Table 12

Estimated number of fish by species seen around 5 brush shelters at each stated depth in Clear Lake, Montmorency County, Michigan

Kind of shelter	Ladder	Ladder	Ladder	Double frame ladder
Depth in feet	1 to 5	6 to 10	11 to 15	3 to 4
Smallmouth bass	4	5	12	11
Rock bass	4	1	1	0
Perch	30	97	37	0
Bluntnose minnows	50	275	30	0

Of the fish observed around the shelters only one smallmouth bass, 3 rock bass, and 2 perch were estimated to be legal fish. All other fish were less than 6 inches in length with the exception of 5 smallmouth bass that were between 6 and 10 inches long.

Brush Shelter Examination
August 20, 1944
Rush Lake, Montmorency County, Michigan
(T. 32N. R. 3E. Sec's. 31, 32)

Rush Lake lies about 15 miles northeast of Atlanta within the confines of the Presque Isle State Forest. It has a low swampy shore line on all sides except the south. Mowery's resort is located on this side and is reached over a plains road from a point on M-33 about 6 miles north of Atlanta. The lake has many inlets draining from the surrounding swamps and an outlet leading to the north branch of the Thunder Bay River. This outlet was reported by local people as being an important spawning ground for pike, bluegills, and sunfish. Visibility on the date of examination was 8 feet, but the water was considerably roiled by strong winds. The bottom is sand along the shores and muck in deeper water. Rushes are scattered over a large part of the lake.

Condition of Brush Shelters

Through the generous assistance of Mr. Howard Schartzer, 4 large ladder shelters were found in deeper water and the party found 3 double-frame ladder constructions nearer shore.

The 4 ladder shelters were about 15 by 15 feet and stood up above the bottom from 1 to 4 feet. Three were in 6 feet of water and one was lying at a depth of 2 feet. The double-frame structures were about 4 by 5 feet and stood up 6 inches to 1 foot in 1 1/2 to 2 feet of water. These 3 consisted of about 10% poles (1 to 3 inches in diameter) and 90% branches (1/4 to 1 inch in diameter). The percentages could be determined in only two of the others due to thick vegetation. This was estimated to be 10%, 70%, and 20% in one for poles, branches, and twigs, and 50% poles and 50% branches in the other. Brush identified was oak, tag alder, and willow all of which was tough and difficult to break with the exception of the smaller twigs which were brittle.

Vegetation

Of the 4 larger structures, 3 harbored the broad leaf Potamogeton amplifolius profusely (over 60 plants in 100 square feet). Potamogeton gramineus was common (10 to 30 plants per 100 square feet) in one shelter and Potamogeton pectinatus as well as Potamogeton Richardsonii were sparse (1 to 10 plants per 100 square feet) in another shelter. Chara was found in all 4 shelters as well as in the immediate vicinity. Elodea was also present in two of these shelters, profusely in one and sparsely in the other.

Fish Observed

On the larger shelters about 25 bluegills or sunfish under 3 inches in length, 2 perch 3 to 6 inches long, and 65 bluntnose minnows were seen. The bluegills or sunfish were all concentrated on one shelter while perch and bluntnose minnows were observed on 2 of the 4 shelters checked. One rock bass about 3 inches long was noted on one of the three double-frame shelters examined.

Brush Shelter Examination
July 30, 1944
Bear Lake, Kalkaska County, Michigan
(T. 27N. R. 5W. Sec's. 17, 20)

Bear Lake lies about 14 miles north and west of Grayling, approximately one mile north of M-76. It is easily accessible from this state highway over several plains roads. The lake has a marl bottom and therefore visibility should be good through the bluish-green water but on the day of inspection the Secchi disk was read at only 11 feet, the low reading being possibly caused by several days of windy weather. The area of the lake is about 317 acres.

Because of the special method of construction, Mr. Peterson, District Fisheries Supervisor, was especially anxious that the party check some of the shelters which had been installed under his supervision through the ice by Camp Kalkaska C. C. C. in 1940. This method consisted of placing larger poles in layers through the brush so that pockets would be formed. Mr. Peterson reported that cottagers on the lake were very pleased with the success of the shelters in bettering fishing.

High winds made the finding of shelters difficult, but by the use of the drag and water glass along with directions of cottagers, 3 shelters were found.

Two of the structures lay in 14 and 15 feet of water and each stood up above the bottom 3 feet. The size was 9 by 6 feet. The shelters had the appearance of boxes as they lay compactly held together by their binding poles and frames which were still wired and in place. The brush of which the shelters were composed was mostly 1 inch or under in diameter with larger poles placed in horizontal layers at intervals of about 1 foot. The brush itself was in good condition with most of the tips present and was not easily broken. Branches identified were birch.

The third shelter found consisted of two birches and a cedar lying parallel to each other with butts together but not wired in 12 feet of

water. It was about 12 by 5 by 2 feet in size and most of the branches and tips were still present.

No vegetation was found around any of the shelters. On the two box-like structures filamentous algae profusely covered the top so that the appearance of a mat was formed. The shelter of trees was covered with crustaceous algae.

One of the shelters displaying the mat of algae protected 2 smallmouth bass under 3 inches in length while the other harbored a smallmouth bass 2 inches long. The third shelter disclosed no fish upon inspection from the diving helmet but one fish about 12 inches long and unidentified was noted later from the surface of the water.

Brush Shelter Examination
July 14, 1944
Big Guernsey Lake, Kalkaska County, Michigan
(T. 27N. R. 8W. Sec's. 19, 20)

Big Guernsey Lake, embracing an area of 52 acres, is located in the Fife Lake State Forest just east of the Grand Traverse-Kalkaska County line. The north and south bays and west shore have marl bottom. The east shore bottom is sand along the edge and marl toward deeper water. The bottom over the drop-off is pulpy peat. The adjacent country is hilly and heavily forested with hardwoods and some conifers. Access is gained by plains roads entering to the north and south ends. Two State Forest camping sites have been established near the south end. Steep slopes lead down to the lake at these points and the launching of a boat is extremely difficult. Three boats were found there and one of them, not locked, was used by the party in its investigation. There are no cottages or cabins. The lake has a maximum depth of about 50 feet and the visibility on the date of examination was 18 feet.

Sixteen ladder shelters and 9 shore shelters were put in the lake in 1933 by the C. C. C. Ten of the ladder structures in the southern part of the lake were inspected by the party but none of the shore shelters in that area were found.

Six shelters about 10 by 12 feet lay at depths of 15 to 17 feet on the slope of the drop-off and stood up 2 to 4 feet. The wires used to surround two of the shelters and hold them to stakes, thereby preventing sliding, were observed in place, but the stakes themselves were missing. At the shallow side of one of these structures the depth was 10 feet while the opposite or deep side lay at 20 feet, an angle of about 45 degrees. The bottom under this shelter was mucky marl. The conditions of the frames of these six shelters were as follows: 3 were not visible beneath the muck; 1 was broken and scattered; 1 was upside down with frame in place but wires missing; and the last was in place with wires also gone.

Three shelters lay at depths of 6 to 10 feet, were approximately 7 to 10 feet in size, and stood up 1 to 2 feet above the slope of the drop-off. In two of these the frames were in place but not wired; the other frame was scattered on the drop-off.

The last of the 10 shelters lay on a hard bottom in 20 feet of water and stood up about 4 feet. It was approximately 15 by 15 feet in size. The frame was in place with corner wires missing but the wire holding the binding pole was still present.

In all of these shelters the condition of the larger brush was considered good: poles, 1 to 3 inches in diameter, were strong and pliable; branches, described as brush 1/4 to 1 inch in diameter, were flexible and tough; twigs under 1/4 inch, most of which were gone, were brittle, easily broken, and displayed evidence of much decay.

In two of the shelters, one at a depth of 6 feet, the other at 15 feet, Chara grew sparsely. In a structure lying at a depth of 10 feet Potamogeton amplifolius grew sparsely through the brush. Chara was common in, and about, this shelter.

Blue or blue-green algae was found on the shelters and filamentous algae hung like Spanish Moss from the poles and branches of four shelters, three at depths of 16 feet and one at a depth of 11 feet.

In the shelter which was broken apart and lying at a depth of 6 feet a largemouth bass and 2 bluegills were observed, all under 3 inches in length. In a structure at an 11 foot depth, 5 bluegills under 3 inches were seen. A shelter at a depth of 16 feet harbored 25 sunfish under 6 inches. Six largemouth bass occupied a shelter at a depth of 17 feet and 15 sunfish under 6 inches were found in another at a 20 foot depth.

INSTITUTE FOR FISHERIES RESEARCH

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