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INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
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REPORT NO. 475

SUMMARY OF INVESTIGATIONS ON LITTLE LONG LAKE, OSCEOLA COUNTY

Part 1. Survey, Improvements and Fish Yield

A number of brief investigations have been made on Little Long Lake since early in 1936, when the owner, Mr. Paul Travis, suggested that the Institute use it as an experimental laboratory. Much of the work on this lake has not been carried to completion, but the available information is included in this report so that the record may be kept complete.

Selection of this lake for intensive study is especially desirable because (1) all fishing is controlled by the owner and complete records of the catch together with scale and stomach collections as desired by the Institute are taken, (2) the lake is acid, a condition not uncommon in Michigan, but one with which the Institute is not very familiar, since most of its lake work has been on alkaline waters, and (3) environmental changes recommended by the Institute are made by the owner without cost to the Department.

Survey

A preliminary survey of Little Long Lake by plane table method was made by L. A. Woodbury and W. F. Carbine on September 8 and 9, 1937. According to their outline, the lake has an area of 37 acres. A resurvey early in March (1938) by O. H. Clark indicates the area as 34.5 acres.

The latter survey was made on the ice by actual measurement and is more reliable. Soundings were taken both at the time of the original survey and recently through the ice. According to the earlier depth determinations, 63 per cent of the lake has a depth of 5 feet or more, 31 per cent has a depth of 10 feet or more, and 8 per cent has a depth of 20 feet or more. Maximum depth found (by sounding through the ice in March, 1938) was 27 feet, 8 inches. It is possible, of course, that the actual maximum depth of the lake is slightly greater than the maximum depth found.

The bottom was found to be pulpy peat except along the extreme margin, where it is fibrous peat and sand. Small amounts of gravel are present at the north end and along the southeast margin. A small intermittent outlet (it was flowing in March, 1938) is present at the south end.

Chemical analyses were made (October 22, 1936) at four stations. These are shown on the map. The water was invariably acid, varying from 6.8 at the surface at Station I to 5.9 near the bottom at the same station. The surface water was almost neutral.

Oxygen was adequate for fish life except very near the bottom in deep water. At 21 feet in depth (Station I) the sample showed 6.1 parts per million, at 24 feet it was 1.0 part per million. The latter is generally considered inadequate for fish life. Slightly less oxygen was present near the bottom in Station III, where 3.1 ppm. were found at 21 feet and 0.5 ppm. at 24 feet. So far as oxygen is concerned, almost the entire volume of water is apparently suitable for fish life.

The water is extremely soft. Free carbon dioxide is present in limited quantities at all depths. The water is relatively clear. On November 22, 1936, the surface temperature was 68 degrees Fahrenheit, bottom temperature at Station III was 60 degrees.

Surface acidity was again tested on May 9, 1937. At the four stations it was 5.7, 6.0, 5.8 and 6.1 respectively. It was slightly more acid than on the previous examination. Another examination was made in September, 1937. Information on methyl orange alkalinity and pH are listed below for the three examinations. The methyl orange alkalinity was apparently slightly higher in 1937 after lime was added.

MO Alkalinity and pH

Date	Station	Depth	MO	pH
9/22/36	I	Surface	6	6.8
		21'	8	6.2
		24'	11	5.9
	II	11'	7	6.1
	III	21'	8	6.0
		30'	27	6.0
	IV	5'	4	6.4
	10 tons (approx.) lime added - March, 1937			
5/9/37	I	Surface	7	5.7
	II	"	8	6.0
	III	"	8	5.8
	IV	"	8	6.1
9/7/37	I	Surface	8	6.3
		20'	10	5.6
		25'	26	5.9
	II	9'	10	6.7
	III	20'	12	5.3
	IV	Surface	10	...

Plankton samples were taken on May 9, 1937. A single vertical haul with a Birge closing net was taken at each station. The volume of the samples at the time were:

Station	Length of Haul	Volume of Sample
I	15'	0.40 cc.
II	5'	0.25 cc.
III	24'	0.55 cc.
IV	6'	0.20 cc.

Samples taken on September 7, 1937 were 0.4 cc., 0.1 cc. and 0.5 cc. for Stations I, II and III respectively.

Four net sets were made at the time of the original survey. Experimental gill nets were invariably used. All were overnight sets. Data on these sets are given below:

No.	Date Set	Time Set	Total Hours Net Was Set	Location
1	9/20/36	4:00 p.m.	17	West shore (N. central part)
2	9/20/37	4:15 p.m.	17½	" " (S. " ")
3	9/21/36	10:15 a.m.	23	N. E. corner
4	9/21/36	10:30 a.m.	22½	East shore (central part)

The fish taken in these net sets were as follows: No. 1--5 perch, 5 bluegills; No. 2--1 sucker, 3 bullheads, 5 bluegills, 1 large-mouthed bass; No. 3--1 large-mouthed bass; No. 4--7 perch.

Net sets were again made by Woodbury and Carbine in 1937 on September 7 and 8. Data on these sets are as follows:

Collection	Date Set	Total Hours Net Was Set	Location	Length of Net	Mesh
A	9/7/37	13	W. shore	150'	2 3/4"
B	"	13	E. shore	300'	1 3/16"
C	"	13	"	125'	Varied
D	9/8/37	24	W. shore	150'	2 3/4"
E	"	24	Middle	300'	1 3/16"
F	"	24	1600' S. of landing	115'	Varied
G	"	11	Middle	116'	Varied
H	"	11	S. Bay	300'	1 3/16"
I	"	11	Near S. Bay	150'	2 3/4"
K	9/9/37	12	" " "	300'	1 3/16"

The take in these gill nets was as follows: A--4 bluegills; B--2 bluegills; C--8 perch, 8 bluegills; D--4 bluegills; E--3 perch, 2 bluegills; F--1 perch, 1 bluegill; G--2 bluegills; H--1 large-mouthed bass; I--1 bluegill; K--6 bluegills, 4 shiners.

The 14 net sets yielded a total of 3 large-mouthed bass, 24 perch, 40 bluegills, 1 sucker, 3 bullheads and 4 golden shiners. The nets averaged about 5 fish each, which seems considerably lower than for netting in general

in other lakes. The relative abundance of species in the nets is not an indication of the relative abundance of fish in the lake because some species "gill net" much more readily than do others. Bass are not easily taken in gill nets and bluegills apparently do not net as easily as perch. The percentage of perch in the lake is therefore probably considerably lower than the netting indicates.

Seinings were made on several occasions:

On September 23, 1936, Shetter and Leonard took 1 large-mouthed bass, 96 bluegills and 5 Iowa darters with a 15 foot common sense seine.

On July 24-25, 1937, Shetter and Cooper took large-mouthed bass, bluegills, perch, bullheads, fat-headed minnows and Iowa darters. The numbers taken were not recorded. Shetter indicates that the fish were dominantly bluegills.

The specimens were used to determine the rate of growth of the fish.

Forage Fish

Forage fish were almost entirely absent when the lake was examined. Rather extensive netting and seining yielded only 4 golden shiners and a small number of Iowa darters. Since food appeared to be relatively scarce, forage fish were introduced in the hope that they would become established. Data on the planting of these fish are recorded by Mr. Carbine in Report No. 444. Two plants were made in 1937, one in May and the second in June. An estimated 15,466 fish consisting of fat-headed minnows and red-bellied dace were introduced. The fat-heads are reported to have been much the more abundant of the species stocked.

Late in July Shetter and Cooper seined the shore in an attempt to determine whether or not these fish had spawned. They found no fry and took only two of the planted fish. Bluegills and bass were collected for stomach analysis to determine whether or not these fish were feeding on

the minnows which had been planted.

Later examination of these stomachs by Dr. Leonard failed to indicate that the minnows had been eaten.

The forage fish question in Little Long Lake needs further study. Whether or not the minnows planted survived or reproduced has not been decided. Their value as food for the game fish likewise needs investigation. The bluegills are growing rather slowly (see below) and it might prove desirable not to have the forage fish become abundant because of danger of over-population by bluegills. It is assumed that more small bluegills will be eaten by the bass if minnows are sparse.

Food

The food of the fish as indicated by an examination of stomachs is discussed by Dr. Leonard in Section 2 of this report.

Creel Census

A creel census was taken during the complete 1937 fishing season by George Travis. All fishing for the year presumably is included in the record. A summary of the data indicates that the lake was fished for 35 fisherman-days, that those who fished invariably caught one or more legal-sized fish, that 410 legal-sized fish were taken in 88½ hours of fishing and that these fish had an average length of 8.4 inches (see Table 1). The catch represented 4.6 fish per hour's fishing or 11.7 fish per average fishing day (2.5 hours). The average catch for the state as a whole, for non-trout waters, in 1936 was 1.7 fish per hour. Fishing in Little Long Lake was very decidedly better than in Michigan lakes in general. As experience has shown, the 1937 figure for lake fishing for the state as a whole will not differ greatly from those for 1936.

The 410 fish represent a catch of 12 fish per acre, a very small crop. It should be possible to remove several times this number of fish without injury to subsequent fishing. There is a definite tendency to underfish private waters. Increased fishing in Little Long Lake would probably be beneficial, for food is apparently limited and the growth of the fish is not rapid.

The fishing is analyzed in Tables 1 to 4.

Table 1

General Data on Fishing in Little Long Lake, Osceola County, 1937

Month	Number of Fisherman-days	Number of Fishermen Taking No Fish No.	Number of Fishermen Taking No Fish %	Number of Legal Fish Caught	Number of Hours Fished	Catch Per Hour	Number of Fish Per Fisherman	Average Size of All Fish Caught	Number of Hours Per Fisherman-day
May 12 & 31	4	...	...	12	7.50	1.6	3.0	7.8	1.9
June 1-28	9	...	...	134	23.00	5.8	14.9	8.1	2.6
July 3-31	16	...	...	146	42.25	3.5	9.1	9.1	2.6
August 1-12	6	...	...	118	15.75	7.5	19.7	7.9	2.6
Totals or Averages	35	...	...	410	88.50	4.6	11.7	8.4	2.5

Table 2

Kind of Bait Used

Bait	May 12 & 31	June 1-28	July 3-31	August 1-12	Total
Natural Bait					
Worms	4	7	7	3	21
Minnows	...	...	1	...	1
Artificial					
Plug	...	...	1	...	1
Combinations or Unknown	...	2	7	3	12
Total	4	9	16	6	35

Table 3

Residence of Anglers

County	May 12 & 31	June 1-28	July 3-31	August 1-12	Total
Osceola	4	9	8	4	25
Jackson	...	...	1	...	1
Oakland	...	...	...	1	1
Washtenaw	...	...	7	1	8
Total	4	9	9	6	35

Table 4

Number and Average Size of Fish Caught, by Species

Month	Largemouthed Bass		Bluegills		Yellow Perch		Bullheads		Total	
	No.	Ave. Size	No.	Ave. Size	No.	Ave. Size	No.	Ave. Size	No.	Ave. Size
May 12 & 31	...	...	8	7.1	4	9.0	...	...	12	7.8
June 1-28	16	11.2	114	7.6	4	8.8	...	...	134	8.1
July 3-31	33	12.9	107	7.3	5	10.4	1	10.5	146	9.1
Aug. 1-12	16	11.7	102	7.3	...	...	...	...	118	7.9
Total and Average Size	65	12.2	331	7.5	13	9.5	1	10.5	410	8.4

Stocking

In addition to the forage fish planted, 2,000 small-mouthed bass were introduced in 1936 and 5,000 were planted in 1937. These were obtained from the U. S. Bureau of Fisheries and, according to George Travis, were from 1 to 2 inches long when stocked. As sexual maturity is not attained until from 4 to 6 years, this more desirable species of bass will probably not become abundant for some time assuming that part of those planted will survive to maturity.

Growth of the Fish

Since the growth of fish depends, within limits, on the amount of food consumed, a determination of the rate of growth gives, indirectly, an indication of the food supply--whether or not it is adequate to support the number of fish present and to permit the reasonable growth of these fish.

Two factors may be expected to effect the growth of fishes in Little Long Lake: Few fish have been removed in the last several years and, with an increased population of fish, a retardation in the rate of growth may be expected as a result of greater population density. However, lime has been added, which presumably may be expected to increase the food and therefore cause increased growth of the fish.

Scale samples taken in 1936 and 1937 have been studied. Since the ages are determined only to the last "winter mark," neither group will indicate the effect of the lime which was first added in March, 1937. The scales will be used as a check for examination of scales collected later and a comparison will indicate whether or not an increase in growth has resulted.

Scales taken from the large-mouthed bass are especially difficult to read and will require considerable further study. For bluegills and perch the growth has been determined from 140 and 28 specimens respectively.

For bluegills the calculated growth was a follows:

Year	No. of Fish	Age	Total Length in Inches
1936	17	I	1.1
	13	II	2.2
	13	III	3.5
	10	IV	4.8
	3	V	6.4
1937	129	I	1.1
	93	II	2.1
	77	III	3.2
	73	IV	4.6
	50	V	6.4
	25	VI	8.4

Growth was similar for each group of scales and in both was relatively slow. It required almost 5 years for the bluegills to reach a legal length of six inches.

For comparison, the growth of bluegills in Wintergreen Lake, Kalamazoo County, as determined by G. P. Cooper was as follows:

I	2.0 inches
II	...
III	7.5 inches
IV	8.7 inches
V	8.8 inches
VI	9.4 inches

The fish in this relatively fertile southern Michigan lake were considerably larger at the end of 3 years than the Little Long Lake fish were at the end of five years.

The perch had a reasonably rapid growth. Calculated lengths were:

Year	No. of Fish	Age	Total Length in Inches
1936	13	I	2.7
	13	II	4.7
	13	III	7.1
	8	IV	9.2
	4	V	10.3
	2	VI	10.7
	1	VII	10.9
	1	VIII	11.1

Year	No. of Fish	Age	Total Length in Inches
1937	15	I	2.9
	15	II	4.5
	14	III	6.4
	14	IV	8.4
	12	V	9.4
	3	VI	11.2
	1	VII	12.0

The perch had exceeded the minimum legal length of six inches by the end of their third year.

Lake Improvement

A variety of attempts have been made to improve the environment for the desirable species of fishes. The following suggestions were made by Dr. Hazzard on February 23, 1937:

"1. Scatter at least 10 tons of crushed limestone over the ice, preferably while the ice is rather wet on top. This could all be concentrated in either half of the lake if the ice is not firm enough to distribute it more evenly. The amount indicated is probably not sufficient to change the lake from acid to alkaline but should show some measurable result and should give us an indication of how much will actually be required to do the job. It is impossible to figure out accurately the amount required inasmuch as we do not know the neutralizing power of the humic acid which is present. The exact amount of lime used should be recorded, whether it is more or less than the 10 tons recommended.

2. Sink six of the large, open type, rectangular brush shelters in water between 10 and 15 feet deep at various points on the lake and mark each of these clearly by an anchored buoy. If these shelters work here as they do in most lakes, you will find these choice fishing spots. The shelters should be like No. 4 of the enclosed diagram.

3. Install twelve spawning boxes built according to diagram No. 17, and fill these boxes with clean gravel from 1/2 inch to 4 inches in diameter. These should be placed in water about 3 1/2 feet deep and preferably pretty well distributed around the lake. In no case should two boxes be less than 10 feet apart.

4. Install a small, circular brush shelter (No. 12) about 6 feet in diameter within 5 feet of each spawning box and out toward deeper water from the box. I would also suggest that a water-logged log or stump (of which there are a number along the west shore) be placed across each of 6 of the boxes, leaving 6 boxes exposed. The logs will help to hold the boxes in place and will enable us to tell which arrangement the bass prefer in your lake. The logs used should be rather small so that they will not obscure the gravel entirely.

5. Install twenty of the star-shaped slab minnow spawning devices No. 19 as illustrated in the diagram. These should be placed in water about 2 feet in depth and preferably on bottom which is quite firm. The areas indicated on the map as sand or gravel bottom will be most suitable. Unless you can secure water-logged slabs, it will probably be necessary to anchor the devices in place.

6. Plantings of blunt-nosed minnows, fathead minnows and northern red-bellied dace should be made in the lake early this summer. The stock for these plantings will be furnished by the Institute.

7. If possible secure from 3,000 to 5,000 small-mouthed bass fingerlings from the U. S. Bureau of Fisheries for planting again this summer."

The improvement program was carried out about as suggested. George Travis indicates that 10 tons of lime were added. In 1937, 6 large brush shelters (10' x 5'), 12 small, circular shelters, 20 minnow spawning devices and 6 bass spawning beds (3' x 3') were installed.

The effectiveness of the shelters and spawning beds and devices has not been determined.

Discussion

Vegetation apparently was much more abundant in 1937 than in 1936, possibly because of the introduction of lime. It seems preferable to add a limited amount of lime annually rather than to introduce a large amount at one time, especially if the vegetation continues to increase. Further suggestions regarding the addition of lime will probably be made after the lake has received further study.

Creel census should be continued and efforts should be made to catch out a minimum of a thousand fish during the 1938 season. Emphasis should be on catching bluegills. These fish are now growing slowly and a reduction in their number seems desirable. Perch are growing at a reasonably rapid rate and appear not to be especially abundant. Bass are quite common in the lake and they will very probably aid in reducing the number of bluegills

(by eating them) to a point where the bluegills will grow more rapidly. If, in another year, the bluegills show a decided increase in rate of growth (suggesting that they are much fewer in number) emphasis should be on bass fishing. A very large percentage of the 1938 take should consist of bluegills. Studies in growth will indicate what species might best be concentrated on during the 1939 season.

The study in rate of growth should be continued. Knowledge of the rate of growth will help indicate how extensively the lake should be fished and what species should be primarily removed. It is mentioned again that there is a definite tendency to underfish private waters.

Examination should be made to determine the fate of the small-mouthed bass--both the growth and survival of those which were planted and the success of their natural reproduction when they have matured.

Further efforts should be made to determine whether or not the forage fish planted by Mr. Carbine have become established.

A check should be made to determine how extensively the spawning beds are used by bluegills and bass.

It is anticipated that the creel census will be continued by Mr. Travis and that the Institute will investigate the other items briefly mentioned in this discussion.

INSTITUTE FOR FISHERIES RESEARCH

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Part 2. Notes on the Bottom Food Organisms in Little Long Lake, Osceola County, With Remarks on the Feeding Habits of its Fishes

J. W. Leonard

In connection with other studies of the conditions affecting fish life in Little Long Lake, it was considered desirable to make some investigation of the numbers and kinds of fish food organisms inhabiting the lake, and of the extent to which they were being utilized by the game fishes.

Some information as to the species and numbers of invertebrates normally inhabiting the lake bottom was gained by bottom sampling with the Ekman dredge. A small series of samples from different depths was taken on September 23, 1936, and on September 8, 1937, the results and accompanying data for which are listed in Tables 1 and 2. It will be noticed at once that the 1936 samples yielded measurably greater quantities of organisms than did those for the following year, especially midge larvae (Chironomidae). This may be due to a difference in sampling technique, since there was not enough seasonal variation to account for the disparity. The small number of species found is probably due to elimination of narrowly-tolerant forms by the bog conditions obtaining in the lake. It will be noted that the entire order of mayflies is absent from both bottom samples and fish stomachs. Considering the large amount of lake bottom composed of pulpy or fibrous peat, the samples, especially those of 1936, indicate a rather larger food supply than might be expected from a lake of this character, although the bulk of the production appears to lie between shore and the 8-foot contour.

To aid in checking on the feeding habits of the game fishes, several lots of stomachs collected by angling during June and July, 1937, were preserved and forwarded to the Institute for examination. Species represented were: yellow perch, large-mouthed bass, and bluegill. One bullhead stomach was included, but proved to be empty. On September 9, 1937, a small collection of fishes was made by means of a graded gill net set. Included were one yellow perch, one large-mouthed bass, four golden shiners, and six bluegills. The perch and golden shiner stomachs were empty. That of the bass contained only a few fragments of fish bones.

Results of detailed stomach examinations, together with data on size and numbers of fish, are recorded in Tables 3 to 7. One question of particular interest, whether the game fish had utilized any of the fathead minnows (Pimephales promelas) introduced to serve as forage, was answered in the negative so far as these stomachs were concerned.

Table 3, summarizing contents of the first lot of bluegill stomachs, is of interest chiefly for indicating a wide range of food selection, there being 20 separate groups entered; for the important position in the diet taken by vegetable material; for showing the large amount and variety of food material of terrestrial origin which may become available to lake fish in summer; and for showing that while some feeding was undoubtedly done in open water, the bulk of the food was taken in the shallows.

On the other hand, the fish whose diet is recorded in Table 4 probably were feeding in open water, since they were gorged with plankton (represented by the Cladocera), and contained relatively small amounts of such shoal dwellers as caddis larvae, dragonfly nymphs, and snails. The unbalanced sex ratio, 4 females:1 male, probably is not significant.

Table 5 shows the food of six small bluegills taken in a gill net set. It is probable that they too had been feeding in deeper water prior to capture, since the Cladocera so far outweigh all other organisms encountered.

Table 6 lists the food taken by 12 large-mouthed bass taken on July 24-25, 1937. The fact that the Odonata, or dragonflies, overshadow all other food organisms may in this instance have been due to temporary conditions. Over half of the volume made up by this group is produced by adult insects (Celithemis elisa). In some instances male and female individuals still linked in tandem position were found in stomachs. It is likely that this species was emerging, mating, and ovipositing in large numbers, during the first and last of which operations it would be brought near the surface and within easy jumping distance of a feeding bass. The fish taken were determined by Mr. M. B. Trautman, and found to comprise eleven darters and one small bluegill. All the caddisflies taken were adults, which, together with the dragonflies, indicates that on these dates much of the feeding was done at the surface.

Table 7, recording the diet of three yellow perch, allows of little discussion, owing to the very small size of the sample. It may be pointed out, however, that according to this the perch were the only fish of the series to depend heavily on midge larvae (Chironomidae), the organisms usually considered to be the backbone of the fish food supply in inland lakes and streams.

In comparing the food taken with the food available, it may be pointed out that the only free-moving items of aquatic origin taken by the fish but not taken in the Ekman samples were the group of aquatic Coleoptera, which occurred in the stomachs of two bluegills and three bass, and the aquatic Hemiptera, whose agility might enable them to avoid the dredge. On the other hand an item of common occurrence in the bottom samples, the larva of an aquatic moth, was not encountered in any of the stomachs examined.

It is almost certain that the number and variety of food organisms in Little Long Lake would increase if the acidity of its water could be neutralized.

Table 1

Ekman Dredge Samples Collected September 23, 1936

Sample No.	Organism	No. Species	No. Individuals	Volume
Sample No. 1. 30 feet deep pulpy peat SE bay	Diptera (Midges)			
	Culicidae			
	Chaoborus (Corethra) sp.	1	4	trace
Sample No. 2. 8 feet deep pulpy peat NW bay	Lepidoptera (Moths)			
	Pyralidae			
	Nymphulinae-aquatic larvae	1	2	0.050 cc.
	Diptera (Midges)			
	Chironomidae	2	18	0.025
				Total 0.075 cc.
Sample No. 3 4 feet deep woody peat, between NW bay and west fence	Mollusca (Snails)			
	Planorbidae			
	Helisoma sp.	1	5	0.500 cc.
	Amnicolidae	1	1	trace
	Odonata (Dragonflies)			
	Gomphus sp.	1	1	0.175
	Libelluline genus	1	2	0.050
	Lepidoptera (Moths)			
	Pyralidae			
	Nymphulinae, larva	1	1	trace
	Diptera (Midges)			
	Chironomidae	2	20	0.025
				Total 0.700 cc.
Sample No. 4 SE bay, just offshore, sand & fibrous peat	Annelida (Worms)			
	Oligochaeta	1	4	0.050 cc.
	Odonata (Dragonflies)			
	Libelluline genus	1	5	0.100
	Trichoptera (Caddisflies)			
	Sericostomatidae	1	3	trace
	Diptera			
	Chironomidae (Midges)	2	25	0.050
	Tabanidae (Deerflies)	1	2	0.050
				Total 0.250 cc.

Table 2

Ekman Dredge Samples Collected September 8, 1937

Sample	Organism	No. Species	No. Individuals	Volume
Station #1	Diptera (Midges)			
15 feet deep	Chironomidae	1	1	trace
Station #2	Annelida (Worms)			
4 feet deep	Tubificidae	1	1)	
	Mollusca (Snails)		)	
	Amnicolidae	1	1)	0.050 cc.
	Crustacea (Scuds)		)	
	Hyalella	1	1)	
	Odonata (Dragonflies)			
	Gomphus sp.	1	1	0.100
	Lepidoptera (Moths)			
	Pyralidae			
	Nymphulinae, larvae	2	4	0.050
	Diptera (Midges)			
	Chironomidae	1	1	trace
			Total	0.200 cc.
5 feet deep	Annelida			
	Tubificidae (Worms)	1	2	0.025 cc.
	Hirudinea (Leech)	1	1	0.050
	Trichoptera (Caddisfly)			
	Sericostomatidae	1	1	trace
	Lepidoptera (Moths)			
	Pyralidae			
	Nymphulinae	1	3	0.025
	Diptera (Midges)			
	Chironomidae	1	1	trace
			Total	0.100 cc.

Table 3

Stomach Contents of 21 Bluegills, July 24, 1937

Size Range: Std. L. 3.5 - 6.25 inches, Ave. 5.2
Tot. L. 4.5 - 8.00 " " 6.6
Weight 20 - 140 grams, " 57.4

Sex Ratio: 11 Females; 8 Males; 2 Immature.

Organism	Per Cent of Stomachs Containing Organism	Per Cent by Volume	Average No. of Organisms in Stomachs Containing Them
Plant debris	19.0	20.0	x
Animal debris	47.6	15.1	x
Aquatic Diptera (Midges)	90.0	12.7	74.0
Algae	23.8	11.0	x
*Trichoptera (Caddisflies)	57.1	11.0	52.6
Mollusca (Snails)	57.1	8.6	10.5
Odonata (Dragonflies)	38.0	6.9	1.6
**Hymenoptera (Wasps)	42.8	3.8	17.5
**Orthoptera (Grasshoppers)	9.5	2.1	1.0
**Coleoptera (Beetles)	4.7	2.1	9.0
Hemiptera (Water Bugs)	19.0	1.7	1.2
Coleoptera (Beetles)	14.2	1.7	1.3
**Araneae (Spiders)	28.5	1.4	2.5
Cladocera (Plankton)	4.7	0.7	?
**Hemiptera (Land Bugs)	4.7	0.4	2.0
**Homoptera (Leafhoppers)	19.0	0.4	4.2
**Diptera (Flies)	4.7	0.4	1.0
Amphipoda (Scuds)	4.7	tr.	1.0
**Rhynchophora (Weevils)	4.7	tr.	1.0
**Psocoptera (Psocids)	4.7	tr.	1.0

* Trichoptera represented by one adult caddisfly, all remainder larvae. The large average number per stomach is partially explainable by the occurrence in one stomach of 437 larvae of the Hydroptilidae, or Microcaddisflies.

** This symbol designates members of groups normally terrestrial in habit which became available to the fish by falling into the water.

Table 4

Stomach Contents of 15 Bluegills, July 25, 1937

Size Range: Std. L. 5.375 - 7.25 Inches, Ave. 6.4
Tot. L. 6.75 - 9.00 " " 8.0
Weight 76 - 201 grams, Ave. 152.5

Sex Ratio: 12 Females; 3 Males

Organism	Per Cent of Stomachs Containing Organism	Per Cent by Volume	Average No. of Organisms in Stomachs Containing Them
Cladocera (Plankton)	93.3	50.0	?
Annelida (probably bait) (Worms)	33.3	22.0	3.2
**Orthoptera (Grasshoppers)	13.3	9.5	1.0
Plant debris	23.3	6.0	x
Trichoptera (Caddisflies)	33.3	5.5	18.0
Algae	33.3	2.8	x
Odonata (Dragonflies)	13.3	2.0	1.0
**Hymenoptera (Wasps)	13.3	0.8	1.5
Animal debris	23.3	0.6	x
Mollusca (Snails)	53.3	0.5	3.0
Coleoptera (Beetles)	6.6	0.3	3.0
Diptera (Midges)	46.6	0.3	8.6
**Araneae (Spiders)	6.6	tr.	1.0

** Indicates terrestrial organisms.

Table 5

Stomach Contents of 6 Bluegills, September 9, 1937

From Gill Net Set

Size Range: Std. L. 2.375 - 3.25, Ave. 3.1
Tot. L. 3.50 - 4.00, Ave. 3.8

Organism	Per Cent of Stomachs Containing Organism	Per Cent by Volume	Average No. of Organisms in Stomachs Containing Them
Cladocera (Plankton)	100.0	80.0	x
Odonata (Dragonflies)	16.5	tr.	1.0
Trichoptera (Caddisflies)	66.0	5.0	1.5
Diptera (Midges)	16.5	tr.	1.0
Hymenoptera (Wasps)	33.0	tr.	1.3
Algae	33.0	15.0	x

Table 6

Stomach Contents of 12 Large-mouthed Bass, July 24-25, 1937

Size Range: Std. L. 6.375 - 9.125 Inches, Ave. 8.5
Tot. L. 7.75 - 11.125 " , Ave. 10.4
Weight 77 - 230 grams, Ave. 194.0

Sex Ratio: 6 Males; 5 Females; 1 Immature

Organism	Per Cent of Stomachs Containing Organism	Per Cent by Volume	Average No. of Organisms in Stomachs Containing Them
Odonata (Dragonflies)	75.0	52.7	4.9
Fish	66.6	27.8	1.5
Trichoptera (Caddisflies)	17.0	14.1	4.0
Colcoptera (Beetles)	25.0	1.8	1.7
**Orthoptera (Grasshoppers)	17.0	1.5	1.0
Hemiptera (Bugs)	17.0	0.7	8.5
Animal debris	8.3	0.6	x
Nematomorpha (Hairworms)	8.3	0.4	1.0
Mollusca (Snails)	8.3	0.4	6.0
Diptera (Midges)	17.0	tr.	1.5

**Group of terrestrial origin.
The Odonata, or dragonflies, were about equally represented by adults and nymphs.
All of the Trichoptera, or caddisflies, were adult.

Table 7

Stomach Contents of 3 Yellow Perch, June 23 & July 25, 1937
No Size or Sex Data

Organism	Per Cent of Stomachs Containing Organism	Per Cent by Volume	Average No. of Organisms in Stomachs Containing Them
Diptera (Midges)	66.6	58.7	111.0
Odonata (Dragonflies)	66.6	20.7	3.0
Mollusca (Snails)	33.3	13.8	4.0
Animal debris	33.3	6.8	x