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R. D. Van Deusen
Claude Lydell
Inst. for Fisheries Res.

INSTITUTE FOR FISHERIES RESEARCH
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ALBERT S. HAZZARD, PH.D.
DIRECTOR

ADDRESS
UNIVERSITY MUSEUMS ANNEX
ANN ARBOR, MICHIGAN

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A FISHERIES SURVEY OF LINCOLN, LITTLE LINCOLN,
BLACK, FRANT, AND BLUE LAKES, KENT COUNTY.

by

R. D. Van Deusen

Introduction

Location and drainage

The Lincoln Lake chain is located in the northeast corner of Kent County, approximately thirty-five miles from Grand Rapids. Its outlet drains southeast into the Flat River and thence into the Grand River drainage system. In order from south to north the lakes in this chain are as follows: Lincoln Lake (T. 10N., R. 9W., Sec. 15, 22, and 27), Little Lincoln (T. 10N., R. 9W., Sec. 15), Black (T. 10N., R. 9W., Sec. 15), Frant (T. 10N., R. 9W., Sec. 15), and Blue Lake (T. 10N., R. 9W., Sec. 10, 15). Good county roads (No. 601 and 510) lead to Lincoln Lake. Blue Lake is also reached by Kent County Rd. 601. The other lakes are accessible by boat from Lincoln and Blue Lakes but not by roads.

Acknowledgments

The Lincoln Lakes were mapped by Institute for Fisheries Research parties. Lincoln Lake and Blue Lake were mapped during March 1940*. Little Lincoln, Black, and Frant Lakes were mapped during January 1941*. The Fisheries survey* was made during June 1942. Cooperating individuals, throughout the inventory, were Roy Buzzard, Conservation Officer, Mr. Claude Finkbeiner, and Blue Lake Bill.

Past and present use

In the early lumbering days these lakes were used for floating logs. At present they have no industrial use. Lincoln Lake has its main cottage

*1940 mapping party consisted of Richard Bohland, leader; William Mason, and Frank Lydell, assistants.

*1941 mapping party consisted of Robert Matthews, leader; with N. Y. A. helpers.

*The fisheries survey party consisted of Fred Locke, and Hugo Kilpela, leaders; R. D. Van Deusen, Pat Galvin, and Stanley Lievens, assistants.

and resort development on the east side with scattered cottages on the west shore. Little Lincoln and Frant Lakes have no cottages. Black Lake has one, while Blue Lake is fairly well developed with a number of cottages scattered around its shores. These lakes have provided fairly good fishing in the past, for largemouth bass, and bluegills. Winter fishing for black crappie in Blue and Little Lincoln Lakes is reported as good. Fair numbers of northern pike are taken in Black, Little Lincoln and Frant Lakes. Walleye fishing in Lincoln Lake is receiving increased attention.

Physical characteristics

Geological origin

This chain of lakes is located in the interlobate area of the Lake Michigan and Saginaw lobes. The lakes lie in an outwash plain and are undoubtedly of glacial origin, although no detailed study has been made of their early history.

Shape of basin and extent of drainage

Lincoln Lake has an area of 411 acres, with two depressions each having a maximum depth of approximately 67 feet. The shoreline is irregular with several protected bays. The surrounding country is gently rolling, mostly under cultivation.

The immediate shore is swampy in places and backed by low ridges.

Little Lincoln, Black and Frant Lakes are small, relatively shallow lakes. They have a combined area of 28.2 acres. Black Lake, the deepest, has a maximum depth of 27 feet. The basins are connected by broad channels, and may be considered more or less as the embayments of a single lake. Blue Lake is of the marl type and is next in size to Lincoln Lake.

The following table provides a summary of certain physical features of these lakes.

Table I

	Lincoln Lake	Little Lincoln Lake	Black Lake	Frant Lake	Blue Lake
Area in acres	411	14.4	10.1	3.7	49
Maximum depth (feet)	67	25	27	12	39
Shore development	1.8	1.2	1.2	1.1	1.3
Dominant bottom types:					
Shallows (0-15 ft)	Marl and sand	Marl and pulpy peat	Marl and pulpy peat	Marl and pulpy peat	Marl
Depths (over 15 ft)	Marl and muck	Pulpy peat and muck	Pulpy peat and muck	....	Marl and muck
Color of water	Colorless to slightly brown	Slightly brown	Slightly brown	Slightly brown	Colorless to slightly brown
Transparency (Secchi disc in feet)	12	9	9	9	9

This chain of lakes has a drainage area of 6-8 square miles.

Water fluctuation

The water level of the Lincoln Lake chain varies with the amount of precipitation-runoff, and water from springs.

At the time of inventory the level was eight to ten inches higher than normal. Blue Lake has no inlets, but flows into Frant Lake and thence to Little Lincoln where Black Lake and Four Mile Creek (approximately 50 ft. wide by 3 ft. deep) likewise join. From Little Lincoln the water flows through a channel (about 20 ft. wide by 2 ft. deep) to Lincoln Lake which is also supplied by Black Creek, a tributary approximately 20 ft. wide and 3 ft. deep. At the time when these lakes were used to transport logs there was a dam in the outlet, where Clear Creek leaves the lake. This dam no longer exists. However, the present water level is somewhat above the original level as evidenced by partially submerged stumps. No explanation was found to account for this condition.

Wave and ice action

There is no evidence of serious wave or ice action on the Lincoln Lakes.

Discussion of physical factors in relation to fisheries

Lincoln Lake is of moderate size and depth and has a shoreline development of 1.8 which means that the shoreline is 1.8 times greater than if the lake were exactly circular and of the same area. A high shoreline development indicates the presence of protected bays which almost invariably means greater biological productivity. The transparency of the water is about average for southern Michigan lakes of this size. There is some organic matter in suspension but this is not excessive.

In general it may be said that the Lincoln Lakes have physical conditions which favor fair to good productivity.

Temperature and chemical characteristics

Temperature

The water temperatures in Lincoln Lake at the time of the survey ranged from 72.5° F. at the surface to 46.8° F. at the bottom. At a depth of 9 feet the temperature began to decrease rapidly down to 33 ft. from 72.1° F. to 50.4° F. in this zone. This is called a thermocline which separates the cold non-circulating water below from the warm circulating water above. This condition usually persists throughout the summer.

Little Lincoln, Black, Frant and Blue Lakes showed definite thermoclines located as follows: Little Lincoln (73.8° F. at 3 ft. to 54.1° F. at 18 ft.), Black (72.5° F. at 6 ft. to 49.6° F. at 24 ft.), Frant (72.3° F. at 9 ft. to 69.8° F. at 12 ft.), and Blue Lake (72.7° F. at 12 ft. to 50.5° F. at 30 ft.).

Chemical conditions

The amount of dissolved oxygen in the water is a very important factor. A fish population must have a continuous oxygen supply throughout the year in order to survive.

In Lincoln Lake the oxygen ranged from 7.9 ppm at the surface to 4.1 ppm at 63 feet. This determination was made June 15, 1942, and probably is not representative of climax summer conditions.

It may be expected therefore that there is not enough oxygen at the bottom through the late summer to support fish life. A check should be made on the bottom oxygen in late summer to verify this. The oxygen in Blue Lake ranged from 8.4 ppm at the surface to 2.3 ppm at 36 feet. This is indicative that oxygen conditions in the lower waters will become critical in late summer where in a large part, or all of the oxygen might disappear below the thermocline. Therefore, cold water fish would not be able to live in this zone because of lack of oxygen even though temperatures are favorable.

Little Lincoln, Black, and Frant Lakes are comparatively shallow. Frant Lake contains plenty of oxygen to the bottom. Little Lincoln Lake had 6.7 ppm above 15 feet, and 0.0 ppm of oxygen at the bottom. Black Lake had 7.4 ppm at the surface and 0.8 ppm of oxygen at the bottom. In these lakes also, only the upper layers are suitable for fish the year around.

The water of the Lincoln Lakes chain is hard (Methyl Orange alkalinity at surface, 150-161) and neutral to moderately alkaline (pH at surface, 7.0-8.2).

Usually, lakes of medium hardness and moderate alkalinity are more productive than those with soft, acid water.

The following table presents a summary of certain chemical and temperature data taken on these lakes by the fisheries survey party.

Table II
Chemical and temperature data of Lincoln, Little Lincoln,
Black, Frant and Blue Lakes, Kent County

	Lincoln Lake	Little Lincoln Lake	Black Lake	Frant Lake	Blue Lake
Date	6/15/42	6/22/42	6/22/42	6/21/42	6/21/42
Depth of station	66'	24'	26'	12'	39'
Temperature:					
Surface	72.5° F	74.1° F	72.5° F	75.4° F	74.1° F
Bottom	46.8° F	54.1° F	49.6° F	69.8° F	48.7° F
Oxygen (ppm)					
Surface	7.9	7.2	7.4	8.7	8.4
Bottom	4.1	0.0	0.8	7.2	2.3
M. C. Alkalinity	148-157	161-194	150-185	151-170	153-156
pH					

Pollution

There was no evidence of pollution in any of these lakes.

Discussion of temperature and chemical factors in relation to fisheries

Lincoln, Little Lincoln, Black, Frant, and Blue Lakes contain relatively warm water, and are best suited for warm water fish. Lincoln Lake is much larger than the others and may contain a zone of water suitable for cold water fishes, providing there is sufficient dissolved oxygen below the thermocline throughout the summer.

Biological Characters

Vegetation

A list of the aquatic vegetation from the Lincoln Lakes follows:

Table III

List of species and relative abundance of plants collected
in Lincoln, Little Lincoln, Black, Frant,
and Blue Lakes, Kent County

*Symbols for abundance (average for entire lake)
D-dense, M-medium, and S-sparse.

Common name	Scientific name	Lincoln	Little	Black	Frant	Blue
		Lake	Lincoln Lake	Lake	Lake	Lake
		Relative abundance*				
Waterweed (<i>Anacharis canadensis</i>)		S	S	S	S	S
Coontail (<i>Ceratophyllum demersum</i>)		S-M	M	M	M	M
Swamp Loosestrife (<i>Decodon verticillatus</i>)		S	S	S	S	-
Spike rush (<i>Eleocharis calva</i>)		S	-	-	-	-
Horsetail (<i>Equisetum fluviatile</i>)		S	-	-	-	-
Water milfoil (<i>Myriophyllum</i> sp.)		S-M	M	M	M	M
Bushy pondweed (<i>Najas flexilis</i>)		M	M	M	M	M
Water cress (<i>Nasturtium officinale</i>)		-	-	-	-	S
White water lily (<i>Nymphaea odorata</i>)		S	S	S	S	M
Yellow water lily (<i>Nuphar variegatum</i>)		M	M	M	M	M
Arrow Arum (<i>Peltandra virginica</i>)		S	S	S	S	S
Pickerel weed (<i>Pontederia cordata</i> var. <i>augustifolia</i>)		S	S	S	S	S
Large-leaf pondweed (<i>Potamogeton amplifolius</i>)		-	M	M	M	-
Pondweed (<i>Potamogeton augustifolius</i>)		M	S	S	S	S-M
Clasping-leaf pondweed (<i>P. Richardsonii</i>)		S	-	-	-	-
Pondweed (<i>Potamogeton Friesii</i>)		S	S-M	S-M	S-M	S
Variable-leaved pondweed (<i>P. gramineus</i> var. <i>graminifolius</i>)		-	-	-	-	-
Gloating-leaf pondweed (<i>P. natans</i>)		-	M	M	M	M
Sago pondweed (<i>P. pectinatus</i>)		M	M	M	M	M
Whitestem pondweed (<i>P. parelongus</i>)		M	-	-	-	-
Flat-stemmed pondweed (<i>P. zosteriformis</i>)		D	M-D	M-D	M-D	S-M
Water buttercup (<i>Ranunculus longirostris</i>)		-	S	S	S	S
Arrowhead (<i>Sagittaria latifolia</i>)		-	-	-	-	S
Hardstem Bulrush (<i>Scirpus acutus</i>)		M	M	M	M	-
Softstem Bulrush (<i>Scirpus validus</i>)		-	-	-	-	S
Duckweed (<i>Spirodela polyrhize</i>)		S	-	-	-	S
Common cattail (<i>Typha latifolia</i>)		M	S	S	S	M
Bladderwort (<i>Utricularia vulgaris</i> var. <i>americana</i>)		S-M	M	M	M	-
Wild celery (<i>Vallisneria americana</i>)		M-D	-	-	-	-
Wild Rice (<i>Zizania aquatica</i>)		S	-	-	-	-
Stonewort (<i>Chara</i> sp.)		D	M-D	M-D	M-D	D
Musk grass (<i>Nitella</i> sp.)		S-M	-	-	-	-

The aquatic vegetation in Lincoln Lake and Blue Lake is very sparse. The limited plant beds are restricted mostly to the narrow drop-off zone and in the protected bays. The shoals of marl are very unproductive due mainly to the presence of marl accumulations. Little Lincoln, Black, and Frant Lakes have good plant growths. The narrow shoal as well as the drop-off supports a good growth of vegetation.

Fish foods

The fish food can be divided into three groups; first, the plankters which are very small organisms that float freely in the water; second, bottom organisms or small invertebrate animals, living on the aquatic plants and in the bottom soils and the forage fish, such as minnows and the young of other fishes.

Plankton was most abundant in Little Lincoln and Lincoln Lakes, and only fair in abundance in Frant and Black Lakes. However, because plankton varies greatly from day to day in kinds and numbers no great significance can be placed in one series of samples.

Bottom organisms found in the bottom soils and on aquatic plants were moderately numerous in Lincoln and Little Lincoln Lakes. Black, Frant and Blue Lakes showed a poor supply of these organisms. The common forms found in the bottom samples were: midge larvae, dragon and damsel fly nymphs, scuds, mayfly nymphs and snails. The vegetation samples produced such organisms as: damsel fly nymphs, scuds, dragon fly nymphs, mayfly nymphs, caddis larvae, midge larvae, and snails.

The forage fish in the Lincoln Lake chain were not very abundant, and in Black and Frant Lakes the supply was especially poor. The most abundant supply of forage fish was found in Lincoln Lake and Blue Lake. Lincoln Lake contained 10 species as follows: common shiner, blunt-nosed minnow, Iowa darter, brook silversides, mimic shiner, black-nosed shiner, least darter, Johnny darter, black-shinned shiner, and mud minnow. The other lakes had only three or four of the above species.

Fish present

Eight different species of game fish were found present in the Lincoln Lakes. Northern pike were common in all lakes. Walleye and muskellunge are reported as present in Lincoln Lake. Claude Finkbeiner of Gowen, Michigan supplied the Institute with scales from ten walleyes taken after the survey was made.

From the stocking records it is noted that nearly half as many bluegills were planted in Blue Lake, as were stocked in Lincoln Lake. Blue Lake has a retarded population of bluegills, while this same species is doing better than average in Lincoln Lake. Little Lincoln, Black, Frant, and Blue Lakes provide good pan-fishing during the winter.

Growth rate of game species

Table V, which follows, shows the age and size of game species taken in the Lincoln Lake chain. Average weights, and total lengths by age groups are given in comparison with tentative state averages.

The growth rate for fishes in Lincoln Lake is above average for the bluegill, rock bass, and walleye; average for the black crappies, northern pike, and yellow perch; and below average for largemouth bass, and pumpkin-seeds. However, in the case of the yellow perch, walleye, smallmouth bass and possible largemouth bass the samples are too small to give very significant information

On Little Lincoln, Black, Frant and Blue Lakes the growth was below average except for the northern pike which appears to be normal for all lakes. Samples taken from these lakes, however, were also small.

The slow growth of these fish is not uncommon in marl lakes. The shoals will not support food and shelter in sufficient quantities for a very large fish population.

Natural propagation

Young of the year were found for all game species with the exception of yellow perch, northern pike, and walleye. These species probably reproduce in these lakes in spite of the fact that no small fish were taken. From what little information we have on the natural propagation of walleye it must be concluded for the present that they do reproduce in Lincoln Lake to some degree because collections contained fish ranging in ages from four to eleven years and the last recorded planting was in 1930. Spawning facilities are adequate in the lakes for all species except smallmouth bass, and possibly walleye. Conditions in general do not favor the increase of smallmouth bass.

Management proposals

Designation of lakes

Lincoln, Little Lincoln, Black, Frant, and Blue Lakes have been in the "all other lakes" classification and information secured by this survey favor this designation.

Stocking

It is suggested that all plantings be discontinued for the time being at least. These lakes are already abundantly supplied with the most suitable game fish and spawning facilities are adequate for these species.

We are not certain about the status of walleyed pike in these lakes. The survey party failed to take any of this species and it was necessary to rely on a few reports supplied by fishermen. It would be desirable to refrain from planting this species until further investigations can be made by more intensive fishing or creel census. If largemouth bass and bluegills are to be the favored species in the lake, which seems logical

in the light of these studies, then the increase in walleye pike may be decidedly harmful. This has been demonstrated in other small inland lakes.

Predator and parasites

No severe concentration of predators or parasites infestations were found. Black-spot (*Neascus*) was present in moderate numbers. This is not infectious to man. No practical control measures are known.

Shelter

The aquatic vegetation in Lincoln and Blue Lakes only offers a fair amount of shelter, however, stumps and deadheads are common in both. Vegetation in the other lakes supplies adequate shelter for the existing species. However, it is suggested that a few hollow-square brush shelters be constructed and placed near the drop-off on the east shoal of Lincoln Lake, and two or three of the same type of shelter be placed on the east shoal of Blue Lake. If these shelters are found to be of value additional ones might be installed on other barren shoals in these lakes.

Regulation of water level

In 1938 an investigation was made with regard to the flooding of Lincoln Lake. The project was abandoned, however, mainly because for financial reasons. Raising the water level would increase the shoal area and would no doubt increase productivity proportional to the increased size of the lake.

Other suggestions

1. To find out more about the walleye population in Lincoln Lake, it is suggested that checks and nettings be carried out at convenient times of the year when these fish would be most apt to be taken and that the conservation officer in that district be instructed to make special effort to secure creel census records of walleye catches.

2. A check should be made in Lincoln Lake to find the amount of dissolved oxygen near the bottom, in late summer, since this lake may be suitable for cold-water species.

Report 481 "Lincoln Lake Flooding Project", and Report 495 "Conference on Lincoln Lake Improvement Associations."

INSTITUTE FOR FISHERIES RESEARCH

by R. D. Van Deusen

Report approved by: A. S. Hazzard

Report typed by: T. Maki

Table IV

Kinds and relative abundance, and stocking (1933-1941 and walleyes only, for 1929-1941)
of fishes collected from Lincoln, Little Lincoln, Black,
Frant, and Blue Lakes, Kent County

Species	Lincoln		Little Lincoln		Black		Frant		Blue	
	abundance	stocking	abundance	stocking	abundance	stocking	abundance	stocking	abundance	stocking
Game Fish										
Northern Pike	C	....	C	....	C	....	...	....	C	....
Perch	F	36,950 6-8 mos.	...	....	F	....	...	....	F	20,545 6-8 mos.
Walleye	F	150,000 fry (1929-30)	...	....	...	....	...	....	...	....
Smallmouth Bass	F	6,800 1-5 mos.	...	....	...	....	...	....	...	....
Largemouth Bass	C	20,807 2 mos. to yr.	F	....	F	....	...	....	C	12,299 1 mo. to 1 yr.
Bluegill	C	78,045 3 mos. to 1 yr.	C	....	C	....	C	....	A	36,650 5 mo. to 1 yr.
Pumpkinseed	F	....	F	....	C	....	F	....	F	....
Rock Bass	C	....	F	....	...	....	F	....	C	....
Black Crappie	C	....	F	....	R	....	C	....	F	....
Muskallunge	R	....	...	....	...	....	...	....	...	....
Coarse Fish										
Common Sucker	C		C		F		F		C	
Black Bullhead	F		...		...		...		F	
Brown Bullhead	F		F		F		...		...
Yellow Bullhead	F		F		F		...		F	
Warmouth Bass	F		C		F		...		F	
Green Sunfish	C		F		F		F		C	
Long-eared Sunfish	C		...		C		F		A	
Golden Redhorse	F		...		...		...		...
Obnoxious Fish										
Long-nose Gar	C		F		...		...		F	
Dogfish	F		...		F		...		...
Carp	...		...		...		...		R	
Forage Fish										
Black-nosed Shiner	F		...		...		...		...
Black-chin Shiner	F		F		F		C		F	
Mimic Shiner	F		...		...		...		...
Central Stone Roller	F		...		...		...		...
Common Shiner	C		...		...		...		...
Blunt-nosed Minnow	C		...		F		F		C	
Minona Killfish	...		...		...		...		F	
Johnny darter	F		...		...		...		F	
Iowa darter	C		...		...		...		F	
Least darter	F		...		...		...		C	
Silversides	C		...		...		F		A	
Tadpole madtom	F		...		...		...		...
Fug-nosed Shiner	F		F		...		C		F	
Creek Chub	F		
Food										
Crayfish		9,000 5 mos.								

Symbols: A=abundant, C=common, F=few, R=reported.

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Table V.

Species	Tentative state average Ave. T. L. (in)	Actual age	Lincoln Lake			Little Lincoln Lake			Black Lake			Frant Lake			Blue Lake			
			No. in sample	Ave. wt. lb. oz.	Ave. T. L. (in)	No. in sample	Ave. wt. lb. oz.	Ave. T. L. (in)	No. in sample	Ave. wt. lb. oz.	Ave. T. L. (in)	No. in sample	Ave. wt. lb. oz.	Ave. T. L. (in)	No. in sample	Ave. wt. lb. oz.	Ave. T. L. (in)	
Northern Pike		I	2	- 9.95	14.14	1	- 6.4	13.25	2	- 9.6	14.31	1	1 3.0	18.0	2	- 15.0	16.5	
		II	8	1 8.6	19.25	4	1 2.5	17.39	3	1 0.3	17.04				4	1 3.7	18.5	
		III	7	2 2.1	21.19	3	2 3.0	18.27										
		IV	3	3 3.3	24.58	2	3 ...	23.56								1	2 13.0	24.0
		V	1	5 9.0	30.18													
Yellow Perch	4.7	I													2	- 0.25	3.21	
	6.2	II	3	- 0.73	4.75										1	- 0.9	5.18	
	7.1	III	1	- 3.9	7.75										1	- 3.1	8.0	
	7.8	IV	2	- 4.4	8.44										1	- 3.6	8.38	
Walleye Pike		IV	3	3 14.0	22.75													
		V	2	4 ...	22.75													
		VI	2	5 8.0	25.63													
		VIII	2	8 1.8	28.68													
		XII	1	8 9.0	30.00													
Smallmouth Bass	6.0	I	3	- 0.26	3.10													
	8.8	II	-	- ...	...										1	- 3.1	7.38
	10.7	III	1	- 4.9	8.38													
	13.3	V	1	1 8.0	14.75													
Largemouth Bass	5.5	I	2	- 0.35	3.59	1	- 0.5	4.0							4	- 0.55	4.20	
	8.4	II	4	- 2.7	7.07	1	- 1.2	5.5							5	- 2.18	6.91	
	10.8	III	5	- 8.56	10.21	1	- 6.8	9.25	1	- 5.9	9.25				5	- 4.80	8.38	
	12.1	IV	3	- 8.9	9.20										2	- 9.0	10.78	
	13.3	V	3	- 14.0	12.07	1	1 8.0	14.38				2	- 15.95	13.0	3	1 1.0	14.18	
	14.4	VI																
	16.8	VII													1	1 10.0	14.75	
		VIII	1	2 1.0	16.25													
Bluegill	3.0	I																
	4.3	II	1	- 0.9	4.25	2	- 0.6	3.25				3	- 0.3	3.14	2	- 0.3	3.38	
	5.6	III	14	- 2.24	5.9	3*	- 1.27	4.66	4	- 1.22	4.54				8	- 0.47	3.86	
	6.7	IV	11	- 4.1	6.99	12*	- 2.18	5.85	4	- 3.58	6.51				20	- 1.97	5.76	
	7.1	V	9	- 6.62	8.13	3*	- 2.6	6.26				5	- 2.24	5.80	23	- 2.23	6.37	
	7.8	VI										2	- 4.50	7.25	6	- 2.83	6.33	
	7.9	VII													1	- 3.1	7.0	
	8.3	VIII													1	- ...	8.25	
Pumpkinseed	4.4	II	1	- 0.6	3.68	1	- 0.5	3.38				1	- 0.4	3.25	1	- 0.3	3.25	
	5.8	III	12	- 2.18	5.38	4	- 1.8	5.04	1	- 2.1	5.38				1	- 3.1	6.18	
	6.4	IV	-	- ...	...	-	- ...	...	1	- 2.2	5.38						
Rook Bass	4.3	II	2	- 0.75	3.06													
	4.9	III	7	- 1.9	4.19													
	5.6	IV	12	- 3.39	6.37	2	- 2.35	6.53				1	- 0.7	3.88				
	6.6	V	4	- 4.35	7.18										7	- 1.79	5.31	
	8.3	VI	1	- 5.2	7.75										5	- 3.32	6.48	
	8.7	VII				1	- 4.8	7.75							4	- 4.0	7.01	
	9.6	VIII													1	- 6.3	7.88	
															2	- 5.5	7.83	
Black Crappie	5.9	II	6	- 1.7	6.0	3*	- 1.5	5.75										
	8.7	III	20	- 5.09	8.23	3	- 3.26	7.33				2	- 3.85	7.75	3	- 3.37	7.28	
	9.2	IV	4	- 9.05	9.8													
	9.7	V	2	- 11.75	11.0													
Bluegill x Pumpkinseed		II							1	- 0.6	3.88							
		III	1	- 3.9	6.38	2	- 2.45	5.69										
		IV										1	- 4.6	6.38	1	- 0.9	4.38	