Appendix D
Current Status of Sport Fish Populations in Lake of Egypt-1988

Current Status of Sport Fish Population in Lake of Egypt

by

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INTRODUCTION

The purpose of this document is to establish the present status of the largemouth bass, crappie, bluegill, and hybrid striped bass populations in Lake of Egypt. Historical information on the fish community has also been summarized.

Lake of Egypt is located in Williamson and Johnson counties, Illinois. It has a surface area of 2,300 acres and a maximum depth of 52 feet. The lake was impounded in 1962 by the Southern Illinois Power Cooperative to provide cooling water for the production of electrical energy. Management of the lake was under the control of the Illinois Department of Conservation from 1979 through 1982. The lake has species of fish normally associated with Southern Illinois reservoirs, including, but not limited to largemouth bass, white and black crappie, bluegill, green sunfish, longear, channel catfish, carp, gizzard shad, and spotted sucker. Threadfin shad have been in the lake since there introduction in 1971.

Land was sold around most of the lake for housing developments. Until recently, the waste water treatment associated with the homes has provided a source of both nitrogen and phosphorous nutrients to the lake. This has added fertility to the lake, especially since it is located in rather infertile, clay-based soil. Part of the excellent fishing reputation that the lake has enjoyed is probably due to this increased nutrient load. Since filling, Lake of Egypt has been known as an excellent largemouth bass lake.

Regulations

As of 1987 fishing regulations on Lake of Egypt were as follows:

1. The size limit on the largemouth bass was increased from 14-inches to 16 inches.
2. A 6 fish/day limit was placed on the largemouth bass.
3. A 14-inch length limit was placed on the walleye.
4. A 6 fish/day limit was placed on the walleye.
5. An 18-inch length limit was placed on the hybrid striped bass.
6. A daily limit of 3 was placed on the hybrid striped bass.
7. There is no size limit on the black or white crappie but there is a 30 fish/day limit on crappie.

Recent Introductions

Several species of fish have been introduced into Lake of Egypt in recent years (Table 1). Walleye were stocked in 1985 and the hybrid between the male striped bass and female white were stocked in 1986, 1987, and 1988. A forage species the inland silverside was stocked in 1987.

METHODS AND MATERIALS

In the spring and summer of 1988 a sample of crappie, largemouth bass, bluegill, and hybrid striped bass were collected from Lake of Egypt. Fish were collected by electrofishing, gill netting, and from the creel. Electrofishing was conducted with a 3000 watt, three phase (180 cycle), 240 volt boat mounted generator with a balanced electrode array (Novonty and Priegel 1974). The 100 yard long gill nets were 3-inch, 2-inch, 1.5-inch, and 1-inch bar mesh.

All sport fish collected were measured and weighed. The fish were sacrificed and the inner ear bone (otolith) were removed for age analysis. The age derived from the otolith tends to be more precise and accurate than age derived from the scales (Heidinger and Clodfelter 1987). Measurements for backcalculated size at age were taken from the otolith using a dissecting scope. A zero intercept was used in the back calculation (Heidinger and Clodfelter 1987).

RESULTS AND DISCUSSION

Threadfin Shad

New lakes and reservoirs are characterized by rapidly expanding fish populations with fast growth rates. Within several years, growth rates decrease and fishing success declines. Lewis (1967) summarized several studies which indicate that reduction in prey vulnerability was the principal factor in declining growth rates of predator populations. He suggested that the prey species responsible for the rapid growth rate are highly vulnerable to predation and thus are eliminated from the population.

In midwestern reservoirs the primary forage fish that is not eliminated is the gizzard shad (Dorosoma cepedianum) but because of its rapid growth rate it provides only a limited amount of forage to young sport species and a high standing crop of non-vulnerable gizzard shad often develops. In southern lakes threadfin shad (D. petenense) have been reported to be a desirable forage fish (Myhr 1971, Range 1973, Stevens 1959). Such findings have resulted in recommendations for stocking the threadfin shad where slow-growing crappie populations exist (Goodson 1966). However, since the threadfin shad dies at water temperatures below 50°F, they are found in Illinois streams only during the summer and fall. The warm water discharge created by the operation of fossil fuel electric generating plants offers a unique opportunity to establish warm water stenothemeric fishes in midwestern states.

Young-of-the-year threadfin shad reproduce at the latitude of southern Illinois (Heidinger and Imboden 1974). Thus only relatively few adult fish must be overwintered.

Threadfin shad were introduced into Lake of Egypt in 1971. Electrofishing in June 1988 indicated large numbers of adult and young of the year threadfin.

Crappie

White crappie have always been abundant in Lake of Egypt. However, until 1973-1974 most were very thin and did not exceed one-fourth-pound. It was only after the introduction of threadfish shad that the crappie reached desirable size (Heidinger 1977).

Historically both black and white crappie are found in Lake of Egypt. One sure way to tell these two species apart is to measure the distance from the eye to the beginning of the dorsal fin and the distance along the base of the dorsal fin. If these two distances are about equal it is a black crappie. If the distance from the eye to the dorsal fin is much greater than the length of the dorsal fin it is a white crappie. Male white crappie are very dark in color during the spring spawning season.

Black crappie were collected in the fall of 1964 by the Illinois Department of Conservation. The majority of these fish ranged from 7.0-7.5 inches in total length. These fish were not aged. In 1976, six years after the introduction of threadfish shad I obtained a sample of white crappie for age and growth analysis (Table 2). White crappie reach 12 inches between the forth and fifth year (Table 3). We did not collect any white crappie from the 1982 or 1983 year class. This may be a reflection of sample size or these two year classes may have been extremely weak. Two or three very weak year classes in a row would tend to reduce the catch rate of anglers in subsequent years. The 1985 and 1986 year class appears to be strong and should provide fairly good fishing. It is not unusual for crappie to have cyclic weak and strong year classes. The growth rate of crappie in Lake of Egypt compares favorably with those in other lakes at this latitude (Table 2).

Approximately 33 percent (19 out of 59) of the crappie collected were black crappie. Through their first four years of age the black crappie are growing at approximately the same rate as the white crappie (Table 4). In lakes such as Rend Lake the black crappie grows much slower than the white crappie.

In 1982 a creel census was conducted under the auspices of the Illinois Department of Conservation. The results of this census indicate that only 1.4% of the fisherman caught 30 or more crappie (Figure 1). In 1983 the management agreement between the IDOC and the Southern Illinois Power Cooperative (SIPC) was revoked. From 1983 to the present time, SIPC has placed a limit of 30 crappie per day on the lake.

Largemouth Bass

The growth rate of the 105 largemouth bass collected in 1988 are given in Table 5. The growth rate of bass in Lake of Egypt is just about the same as the average growth rate for bass found in Illinois ponds (Table 6).

Overharvest of largemouth bass has been a major problem in midwest impoundments. Ten of thirteen midwest fisheries management agencies felt that overharvest was a problem in their state. The other three (Minnesota, Ontario, and Wisconsin) primarily have populations of smallmouth bass, which do not have as great an influence on prey species as the largemouth bass, and therefore is less subject to problems due to overharvest (Hackney 1974). Redmond (1974) has reported that harvest of largemouth bass during the first four days of fishing after a new lake opens varies from 11 to 69% of the adult population in Missouri's public fishing lakes.

Overharvest can lead to conditions in which bass mortality is high with few bass reaching 1.5 pounds. Thus bass can be harvested before they reach a size considered desirable to most anglers, and inadequate number of bass may remain to control bluegill and crappie populations, causing them to become overabundant and stunted (Anderson 1974).

The purpose of minimum size limits is to reduce this overharvest. Indeed, with the application of limits, population (Rasmusen and Michaleson 1974) and weight (Ming and McDannold 1975) of largemouth bass may double in a year. Catch (including released fish) may double or triple (Novinger 1984). Catch rates by people fishing specifically for bass increased five to ten times after implementation of minimum length limits in some Missouri lakes (Novinger 1984). Increased predation on forage fish such as the bluegill decreases their populations, reducing competition for food and therefore increasing growth rates (Farabee 1974, Hickman and Congdon 1974, Ming and McDannold 1975, Rasmusen and Michaelson 1974).

Minimum length limits may have drawbacks. When recruitment is high, too many bass survive for the amount of forage available, causing a reduction in growth rate (Hickman and Congdon 1974, Novinger 1984, Rasmusen and Michaelson 1974). Also, the longer it takes for bass to reach legal size, the greater the losses will be to natural mortality (Novinger 1984). Elimination of the harvest of bass smaller than the limit can reduce the harvest (not the catch) by as much as 72 to 77% (Mense 1980). Reduced harvest displeases those anglers who would rather keep a number of small bass than a few large ones. High minimum size limits discriminate against less skilled anglers because they pay the price of releasing smaller fish, but lack the expertise needed to reap the benefits of catching larger bass (Novinger 1984). Bass learn to avoid anglers, or more vulnerable bass are harvested sooner, so that large bass are very difficult to catch (Aldrich 1939, Anderson and Heman 1969, Novinger 1984). Another weakness of minimum size limits is that they depend on angler compliance, which is often low. Gablehouse (1980) has reported non-compliance rates up to 63%; Glass and Maughn (1984) have reported rates of 67%. This non-compliance is due to a lack of knowledge of the regulation on a particular lake, lack of knowledge of the purpose of the regulation, and lack of sufficient enforcement (Glass and Maughn 1984). Novinger (1984) recommends the use of public meetings and the news media to inform anglers about the regulations. Minimum length limits cannot work if hood-and-release mortality is high. Anderson and Dillard (1968) and Farabee (1970) have shown that this is not the case under normal fishing conditions.

An alternative to minimum size limits, recommended by Martin in 1958, is a protected size range, or slot limit. This type of limit prohibits the harvest of bass within a specified size range (for example, between 14 and 18 inches). This type of limit permits the harvest of smaller bass, reducing the competition for forage, but prohibits the harvest of fish within the limit, so that they can grow to a large size, and thus keep the forage population under control.

In summary, minimum size limits may be effective for reducing harvest when recruitment is low to moderate and fishing pressure is heavy. When there is high recruitment and slow growth of intermediate sized bass, a slot length limit may be appropriate.

A 14-inch size limit was placed on largemouth bass in 1983. In 1987 a 16-inch size limit was placed on the bass. One important question that the 1988 fish survey was designed to answer was whether the bass were growing through the 16-inch length limit or were they piling up just under it. The 1985 data on the growth rate of largemouth bass (Table 7) indicated that they were not piling up below 14 inches. In 1985 the 14-inch size limit protected most bass until they were 3+ years old, while a 16-inch limit would have protected 77% of the fish until they were at least 4+ years of age. In 1988 a 14-inch size limit protected most of the bass until they were 3+ or 4+. A 16-inch size limit protects most of the bass (81%) until they reach an age of 5+.

The 1985 and 1988 data is not 100 percent comparable because in 1985 the bass were collected in November while in 1988 they were collected in June. Thus the bass collected in June could grow an inch by late fall. This would increase the number of 2+ fish that reached 12 inches etc. There is no strong indication that the bass are stacking up below 16 inches.

Bluegill

Lake of Egypt has never been noted for large bluegill. This was true even during the first five years after filling when the bass population was very strong. For most fishermen bluegill reach a desirable size somewhere between 0.33 and 0.40 pounds.

It could be argued that the 16-inch size limit on largemouth bass positively affects the size of the bluegill.

We lack the data to prove or disprove this. I have seen other lakes cycle between good bluegill fishing and good crappie fishing. No one knows exactly why this occurs.

The 1988 fish survey was designed to collect baseline data on the bluegill. In general, the growth rate of bluegill in Lake of Egypt is relatively slow. Most fish only reach 6 inches in length, or approximately 0.13 pounds by age 6 or 7. The average for Illinois ponds for 6 year old fish is 0.47 pounds (Illinois Department of Conservation 1984).

Striped Bass Hybrid

In 1986, 1987, and 1988 the hybrid between the female white bass and the male striped bass were stocked into Lake of Egypt (Table 1). This hybrid is not sterile, but in the hundreds of reservoirs in which it has been stocked throughout the United States it is not known to have reproduced. Therefore, if a fishery is to be maintained it will have to be on a stock-grow-take basis.

The striped bass hybrid tends to be a midwater predator. It feeds heavily on gizzard shad, which are very abundant in most southern Illinois reservoirs. Thus the idea is to convert the tremendous production of gizzard shad into something useable by the fishermen.

Some fisherman erroneously believe that the stocking of hybrid striped bass may be detrimental to largemouth bass.

This has not been the case in other lakes such as Crab Orchard. There is usually a tremendous over-abundance of intermediate and large gizzard shad in a reservoir. Studies have shown that neither the striped bass (which gets larger and has a larger mouth), nor the striped bass hybrid feeds heavily on largemouth bass. In Lake Texoma, since 1981 the stomachs of 1,845 striped bass have been examined. No largemouth bass were found in any of these stomachs. In other studies only one or two largemouth bass have been found in thousands of stomachs examined. Thus we tend to find more largemouth bass in largemouth bass stomachs than in striped bass or hybrid striped bass stomachs.

Eighteen hybrid striped bass were collected in 1988. Fish were from both the 1986 and 1987 year class were found in the sample (Table 9). Fish from the 1987 year class that were collected in 1988 at age 1+ had a mean weight of 0.97 pounds. Fish from the first stocking in 1986 averaged 3.10 pounds at age 2+. These fish reach the legal size of 18 inches during their second year.

In 1986 only 500 fingerlings were stocked along with 250,000 fry. Based on the number of 3 to 4 pound hybrid striped bass that have been caught and reported to boat dock operators some fry survival must have occurred.

Walleye

Walleye are not native to Lake of Egypt. Eight thousand fingerlings were stocked in 1985, and should reach several pounds between their second and third year of age. The stocked fish are not expected to reproduce. I do not expect that this single stocking will produce a fishery, but that a few walleye will be caught as a bonus by people fishing for crappie and bass. No walleye were taken in the 1988 fish sample, however, a number have been reported creeled to the boat dock owners.

Channel Catfish

Channel catfish were not aged in the study but many individuals of all ages were observed in the gill nets and electrofishing. The channel catfish are reproducing in Lake of Egypt. The very strong population is probably underharvested.

Population Structure

Another way of looking at balance in a fish population is to calculate the proportional stock density (PSD) for bluegill, largemouth bass, and crappie. The PSD is the number of quality size fish divided by the number of stock size fish in the sample. Stock size for largemouth bass, crappie, and bluegill is 8, 5, and 3 inches respectively. Quality size is 12, 8, and 8 inches respectively. Largemouth bass in Lake of Egypt have a PSD of 51%. The range of balance is 40 to 70%. Their RSD15 is 14%. The PSD for white crappie is 83%. Balanced population range is from 30 to 60%. Their RSD10 is 33%. The higher than normal PSD for crappie probably reflects the fact that most of the fish were obtained from fishermen. Bluegill in Lake of Egypt have a PSD of 24%. Balanced populations range from 20 to 40%.

SUMMARY

The results of the study indicate that the largemouth bass, black crappie, white crappie, and hybrid stripe bass are growing well in Lake of Egypt. Crappie densities tend to be very cyclic and it is likely that the population in Lake of Egypt is near a low point. Several stronger year classes should enter the fishery next year.

The bluegill are continuing to grow slowly in the lake. This indicates a lack of large invertebrates for them to feed on. Redear sunfish in Lake of Egypt were not aged but much larger redear were collected than bluegill. This reflects the redear's rather unique ability among the sunfish to eat clams and snails.

All management procedures in effect should be continued. Every effort should be made to encourage catch and release (Heidinger 1986).

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Table 1

History of Recent Fish Introduction into Lake of Egypt

Taxa	Year	Size	Number
Threadfin shad	1971	Adults	2,300
Walleye	1985	4-6 inches	8,000
Hybrid striped bass	1986	1-2 inches	500
Hybrid striped bass	1986	Fry	250,000
Hybrid striped bass	1987	1.5 - 2 inches	15,000
Inland Silverside	1987	Adults	500
Hybrid striped bass	1988	1.5 - 2 inches	15,000

Table 2

Comparison of White Crappie Growth Rates in Lake of Egypt (1976) and in Selected Midwestern Lakes that do not Contain Threadfin Shad

Inpoundments	Calculated Average Total Length Inches at each annulus						
	1	2	3	4	5	6	7
Lake of Egypt[1] (Heidinger 1977)	2.5	6.0	8.1	10.1	13.9	16.2	
Lake of Egypt 1988	4.5	8.3	9.9	9.7	12.3	13.2	13.8
Dale Hallow, TN (Range 1973)	3.1	6.0	7.4				
Horseshoe Lake, IL (Gunning 1954)	2.6	6.1	8.5	10.1	11.7	13.0	
Crab Orchard, IL (1976)[2]	4.2	6.1	7.0	7.9	8.4	9.4	11.0
Red Haw, IA (Lewis 1950)	3.1	7.6	8.4	9.9	11.2	12.1	
Clear Lake, IA (Neal 1963)	2.8	5.7	7.3	8.2	9.2	10.7	12.7

[1]Six years after threadfin shad stocking.

[2]Before the threadfin shad was introduced.

Table 3

Age and Total Length (Inches) of White Crappie

Collected from Lake Egypt in 1988

Year/Class	Number	Calculated Average Total Length Inches at each annulus						
		1	2	3	4	5	6	7
1987	5	6.9						
1986	17	4.1	8.6					
1985	15	4.1	8.3	10.1				
1984	2	3.8	6.0	8.2	9.1			
1983	0	0	0	0	0	0		
1982	0	0	0	0	0	0	0	
1981	1	4.4	8.3	10.1	11.1	12.3	13.2	13.8
Mean Length		4.5	8.3	9.9	9.7	12.3	13.2	13.8
Mean Weight (lbs)		.04	.26	.44	.42	.88	1.06	1.25
Number		40	35	18	3	1	1	1

Table 4

Age and Total Length (Inches) of Black Crappie

Collected from Lake Egypt in 1988

Year/Class	Number	Age 1	Age 2	Age 3	Age 4
1987	0	0			
1986	17	3.7	7.5		
1985	0	0	0	0	
1984	2	3.8	6.2	8.4	9.6
Mean Length (inches)		3.7	7.3	8.4	9.6
Mean Weight (lbs)		.03	.20	.29	.43
Number		19	17	2	2

Table 5

Age and Total Length (Inches) of Largemouth Bass

Collected from Lake Egypt in 1988

Year/Class	Number	Age 1	2	3	4	5	6
1987	25	6.1					
1986	35	7.0	10.4				
1985	20	5.8	10.2	12.1			
1984	18	6.1	10.6	13.2	14.6		
1983	6	5.0	9.8	12.5	14.6	15.6	
1982	1	4.8	10.2	13.3	15.4	17.3	18.1
Mean Length (inches)		6.3	10.3	12.6	14.6	15.8	18.1
Mean Weight (lbs)		.10	.48	.92	1.46	1.88	2.89
Number		105	80	45	25	7	1

Table 6

Age and Total Length (Inches) of Largemouth Bass collected from Lake Egypt in 1978, 1984, and 1985 by SIUC Fishery Research Personnel

Year/Class	Age 1	2	3	4	5	6	7	8
1978[1]	5.5 (33)[2]	8.6 (26)	10.9 (18)	13.0 (5)	14.3 (3)	16.0 (2)	16.0 (1)	16.5 (1)
1984[3]	6.7 (4)	10.4 (15)	12.3 (12)	13.5 (11)	11.9 (2)	----	----	----
1985[3]	6.8 (1)	10.1 (28)	13.1 (28)	14.4 (26)	14.7 (8)	19.2 (3)	---- ----	21.2 (1)
1988[1]	6.3 (105)	10.3 (80)	12.6 (45)	14.6 (25)	15.8 (7)	18.1 (1)	----	----
1988[4]	6.5	10.5	12.3	14.8	15.5	18.3	----	----
IL average Lopinot (1967)	6.3	9.0	11.6	13.6	15.8	17.4	18.9	19.8

[1]Backcalculated age and growth.

[2]Numbers in parentheses equal sample size. Fish were not dipped up in proportion to their relative abundance, therefore, mortality rates can not be estimated from theses data.

[3]Actual length at capture. These fish were collected in the fall, therefore in order to make the 1978 data comparable to the 1984 and 1985 data a 1+, 2+ etc., fish in 1984 and 1985 was assigned an age of 2, 3 etc., respectively.

[4]Actual length of capture in June 1988.

Table 7

Percentage of Largemouth Bass of Each Age Group Collected from Lake of Egypt in 1985 and 1988 that Would be Legal under Various Potential size limits. The 1988 Data is in Parenthesis[1]

Size Limit (inches)	0+	1+	2+	3+	4+	5+	6+	7+	8+
12	0(0)	4(0)	75(3)	100(70)	100(100)	100(100)	(100)	100	100
13	0(0)	0(0)	64(0)	85(25)	88(76)	100(100)	(100)	100	100
14	0(0)	0(0	25(0)	58(0)	75(57)	100(88)	(100)	100	100
15	0(0)	0(0)	7(0)	27(0)	50(33)	100(63)	(100)	100	100
16	0(0)	0(0)	0(0)	12(0)	13(19)	100(38)	(100)	100	100
17	0(0)	0(0)	0(0)	0(0)	0(5)	100(0)	(100)	100	100
18	0(0)	0(0)	0(0)	0(0)	0(0)	67(0)	(100)	100	100

[1]The 1985 fish were collected in November and the 1988 fish were collected in June.

Table 8

Age and Total Length (Inches) of Bluegill

Collected from Lake Egypt in 1988

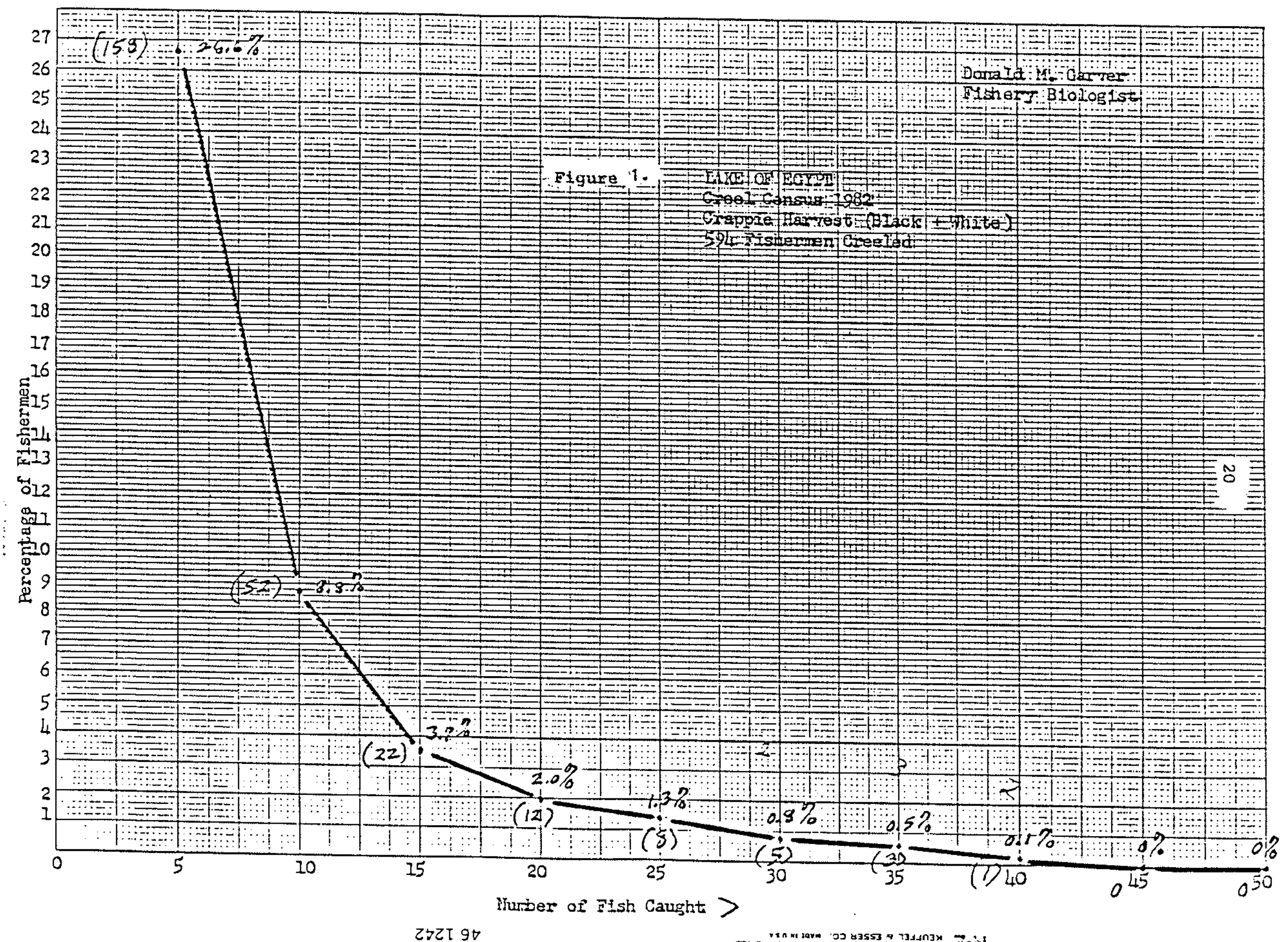
Year/Class	Number	Calculated Average Total Length Inches at each annulus						
		1	2	3	4	5	6	7
1987	4	2.8						
1986	19	2.7	3.8					
1985	42	2.8	3.9	4.8				
1984	23	2.5	3.8	4.5	5.2			
1983	20	2.4	3.5	4.4	4.9	5.5		
1982	6	2.6	3.6	4.3	4.9	5.4	5.9	
1981	2	2.5	3.4	4.0	4.6	5.2	5.5	5.7
Mean Length (inches)		2.6	3.8	4.6	5.0	5.4	5.8	5.7
Mean Weight (lbs)		.01	.03	.06	.08	.10	.13	.12
Number		116	112	93	51	28	8	2

Table 9

Age and Total Length (Inches) of Striped Bass X White

White Bass Collected from Lake of Egypt in 1988

Year/Class	Number	Age 1	Age 2
1987	7	10.0	
1986	11	10.4	17.7
Mean Length (inches)		10.2	17.7
Mean Weight (lbs)		.49	2.57
Number		18	7


Donald M. Garver
Fishery Biologist
Figure 1.
LAKE OF EGYPT
Creel Census 1982
Crappie Harvest (Black + White)
594 Fishermen Creeled
Percentage of Fishermen
Number of Fish Caught
(158) 26.6%
(52) 8.8%
(22) 3.7%
(12) 2.0%
(8) 1.3%
(5) 0.8%
(3) 0.5%
(1) 0.1%
0 0%
0 0%
46 1242
K+E 20 X 20 TO THE INCH • 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

Appendix E
Status of Sport Fish Populations in Lake of Egypt and Management Recommendations-1990

Status of Sport Fish Populations in Lake of Egypt and Management Recommendations

by

Roy Heidinger

September 1990

INTRODUCTION

The purpose of this document is to establish the present status of the largemouth bass, crappie, bluegill, and hybrid striped bass populations in Lake of Egypt. Historical information has also been summarized on the fish community.

Lake of Egypt is located in Williamson and Johnson counties, Illinois. It has a surface area of 2,300 acres and a maximum depth of 52 feet. The lake was impounded in 1962 by the Southern Illinois Power Cooperative to provide cooling water for the production of electrical energy. Management of the lake was under the control of the Illinois Department of Conservation from 1979 through 1982. The lake has species of fish normally associated with southern Illinois reservoirs, including, but not limited to largemouth bass, white and black crappie, bluegill, green sunfish, longear, channel catfish, carp, gizzard shad, and spotted sucker. Threadfin shad have been in the lake since their introduction in 1971.

Land was sold around most of the lake for housing developments. Until recently, the waste water treatment associated with the homes and from the town of Goreville has provided a source of both nitrogen and phosphorous nutrients to the lake. This has added fertility to the lake, especially since it is located in rather infertile clay-based soil. Part of the excellent fishing reputation that the lake has enjoyed is probably due to this increased nutrient load. Since filling, Lake of Egypt has been known as an excellent largemouth bass lake.

Regulations

As of 1987 fishing regulations on Lake of Egypt were as follows:

1. The size limit on the largemouth bass was increased from 14 inches to 16 inches.
2. A 6 fish/day limit was placed on the largemouth bass.
3. A 14-inch length limit was placed on the walleye.
4. A 6 fish/day limit was placed on the walleye.
5. An 18-inch length limit was placed on the hybrid striped bass.
6. A daily limit of 3 was placed on the hybrid striped bass.
7. There is no size limit on the black or white crappie but there is a 30 fish/day limit on crappie.

Recent Introductions

Several species of fish have been introduced into Lake of Egypt in recent years (Table 1). Walleye were stocked in 1985 and the hybrid between the male striped bass and female white were stocked in 1986, 1987, 1988, 1989, and 1990. A forage species, the inland silverside was stocked in 1987.

METHODS AND MATERIALS

In the spring and summer of 1988 a sample of crappie, largemouth bass, bluegill, and hybrid striped bass were collected from Lake of Egypt. Fish were collected by electrofishing, gill netting, and from the creel. Electrofishing was conducted with a 3000 watt, three phase (180 cycle), 240 volt boat mounted generator with a balanced electrode array (Novonty and Priegel 1974). The 100 yard long gill nets were 3-inch, 2-inch, 1.5-inch, and 1-inch bar mesh. A sample of 101 largemouth, 100 bluegill, 78 crappie, and 7 hybrid striped bass was collected in 1990.

All sport fish collected were measured and weighed. The fish were sacrificed and the inner ear bones (otolith) were removed for age analysis. The age derived from the otolith tends to be more precise and accurate than age derived from the scales (Heidinger and Clodfelter 1987). Measurements for back calculated size at age were taken from the otolith using a dissecting scope. A zero intercept was used in the back calculation (Heidinger and Clodfelter 1987).

RESULTS AND DISCUSSION

Threadfin Shad

New Lakes and reservoirs are characterized by rapidly expanding fish populations with fast growth rates. Within several years, growth rates decrease and fishing success declines. Lewis (1967) summarized several studies which indicate that reduction in prey vulnerability was the principal factor in declining growth rates of predator populations. He suggested that the prey species responsible for the rapid growth rate are highly vulnerable to predation and thus are eliminated from the population.

In midwestern reservoirs the primary forage fish that is not eliminated is the gizzard shad (Dorosoma cepedianum) but because of its rapid growth rate it provides only a limited amount of forage to young sport species and a high standing crop of non-vulnerable gizzard shad often develops. In southern lakes threadfin shad (D. petenense) have been reported to be a desirable forage fish (Myhr 1971, Range 1973, Stevens 1959). Such findings have resulted in recommendations for stocking the threadfin shad where slow-growing crappie populations exist (Goodson 1966). However, since the threadfin shad dies at water temperatures below 50° F, they are found in Illinois streams only during the summer and fall. The warm water discharge created by the operation of fossil fuel electric generating plants offers a unique opportunity to establish warm water stenothemeric fishes in midwestern states.

Young-of-the-year threadfin shad reproduce at the latitude of southern Illinois (Heidinger and Imboden 1974). Thus only relatively few adult fish must be overwintered.

Threadfin shad were introduced into Lake of Egypt in 1971. Electrofishing in June 1988 indicated large numbers of adult and young-of-the-year threadfin. Adult threadfin shad were again found in the May 1990 electrofishing sample.

Crappie

White crappie have always been abundant in Lake of Egypt. However, until 1973-1974 most were very thin and did not exceed one-fourth-pound. It was only after the introduction of threadfin shad that the crappie reached desirable size (Heidinger 1977).

Historically both black and white crappie are found in Lake of Egypt. One sure way to tell these two species apart is to measure the distance from the eye to the beginning of the dorsal fin and the distance along the base of the dorsal fin. If these two distances are about equal it is a black crappie. If the distance from the eye to the dorsal fin is much greater than the length of the dorsal fin it is a white crappie. Male white crappie are very dark in color during the spring spawning season.

Black crappie were collected in the fall of 1964 by the Illinois Department of Conservation. The majority of these fish ranged from 7.0-7.5 inches in total length. These fish were not aged. In 1976, six years after the introduction of threadfin shad, I obtained a sample of white crappie for age and growth analysis. At that time crappie reached 8.1, 10.1, and 13.9 inches in 3, 4, and 5 years, respectively (Table 2). In 1988 they reached 9.5, 9.7, and 12.3 inches at age 3, 4, and 5 (Table

2 and Table 3). In the 1990 sample they attained a length of 9.5, 10.1, and 12.1 at ages 3, 4, and 5 (Table 2 and Table 4).

The growth rate in length of white crappie in Lake of Egypt is similar to that found in many other lakes in the Midwest (Table 2). However, the length at age does not provide any information about the condition (sometimes called relative plumpness) of a fish. Standard relative weight curves have been developed for a number of species including the white crappie, bluegill, and largemouth bass. Basically, these curves give the theoretical ideal weight of the fish at each length. Fish biologists consider the fish to have acceptable weight relative to their length if the fish are within 10% of the ideal weight. Too high of weight for the length usually means relatively few fish in the population which is not desirable from a fish population structure point of view.

In Lake of Egypt white crappie longer than 8 inches weighed less than their standard relative weight in both 1988 and 1990 (Figure 1). In addition, the trend appears to be negative and in 1990 white crappie longer than 10 inches were more than 10% below their respective standard weight. In part, I believe that this is due to the fact that many of these fish had just spawned out, but the general trend is not desirable.

As was not the case in 1988, fishermen reported fair catches of white crappie in 1990. In both 1988 and 1990 the majority of the desirable size crappie (greater than 8 inches) are made up of

2, 3, and 4 year old fish (Table 5). It is not unusual for crappie to have cyclic weak and strong year classes.

In 1988, approximately 33% (19 out of 59) of the crappie collected were black crappie. Through their first four years of age, the black crappie were growing at approximately the same rate as the white crappie (Table 6). In some lakes such as Rend Lake, the black crappie grows much slower than the white crappie.

In 1990, only 7% of the crappie collected were black crappie (6 out of 84). This was not a large enough sample for age and growth analysis.

In 1982 a creel census was conducted under the auspices of the Illinois Department of Conservation. The results of this census indicate that only 1.4% of the fishermen caught 30 or more crappie (Figure 2). In 1983 the management agreement between IDOC and the Southern Illinois Power Cooperative (SIPC) was revoked. From 1983 to the present time, SIPC has placed a limit of 30 crappie per day on the lake.

Largemouth Bass

The growth rate of the 105 largemouth bass collected in 1988 are given in Table 7 and the growth rate of 101 largemouth collected in 1990 are given in Table 8. The growth rate of largemouth bass in terms of length in Lake of Egypt is very close to the Illinois state average (Table 9). There appears to be a slight decrease in their growth rate from 1988 to 1990. On average, bass in Lake of Egypt reach 15 inches between their 4 and 5 years of age. The weight of largemouth bass at various lengths captured in 1988 and 1990 was compared to the theoretical ideal weight at length curve (Figure 3). In 1988, the weight of the bass was slightly below ideal, but essentially within the desired 10%. In 1990, the largemouth bass longer than 12 inches were well below 10% of their ideal weight.

Overharvest of largemouth bass has been a major problem in Midwest impoundments. Ten of thirteen Midwest fisheries management agencies felt that overharvest was a problem in their state. The other three (Minnesota, Ontario, and Wisconsin) primarily have populations of smallmouth bass, which do not have as great an influence on prey species as the largemouth bass, and therefore is less subject to problems due to overharvest (Hackney 1974). Redmond (1974) has reported that harvest of largemouth bass during the first four days of fishing after a new lake opens varies from 11 to 69% of the adult population in Missouri's public fishing lakes.

Overharvest can lead to conditions in which bass mortality is high and few bass reaching 1.5 pounds. Thus, bass can be harvested before they reach a size considered desirable to most anglers, and inadequate number of bass may remain to control bluegill and crappie populations, causing them to become overabundant and stunted (Anderson 1974).

The purpose of minimum size limits is to reduce this overharvest. Indeed, with the application of limits, numbers (Rasmusen and Michaelson 1974) and weight (Ming and McDannold

1975) of largemouth bass may double in a year. Catch (including released fish) may double or triple (Novinger 1984). Catch rates by people fishing specifically for bass increased five to ten times after implementation of minimum length limits in some Missouri lakes (Novinger 1984). Increased predation on forage fish such as the bluegill decreases their populations, reducing competition for food and therefore increasing growth rates (Hickman and Congdon 1974, Ming and McDannold 1975, Rasmusen and Michaelson 1974).

Minimum length limits may have drawbacks. When recruitment is high, too many bass survive for the amount of forage available, causing a reduction in growth rate (Hickman and Congdon 1974, Novinger 1984, Rasmusen and Michaelson 1974). Also, the longer it takes for bass to reach legal size, the greater the losses will be to natural mortality (Novinger 1984). Elimination of the harvest of bass smaller than the limit can reduce the harvest (not the catch) by as much as 72 to 77% (Mense 1980). Reduced harvest displeases those anglers who would rather keep a number of small bass than a few large ones. High minimum size limits discriminate against less skilled anglers because they pay the price of releasing smaller fish, but lack the expertise needed to reap the benefits of catching larger bass (Novinger 1984). Bass learn to avoid anglers, and more vulnerable bass are harvested sooner, which makes large bass very difficult to catch (Aldrich 1939, Anderson and Heman 1969, Novinger 1984). Another weakness of minimum size limits is that they depend on angler compliance, which is often low. Gabelhouse (1980) has reported non-compliance rates up to 63%; Glass and Maughn (1984) have reported rates of 67%. This non-compliance is due to a lack of knowledge of the regulation on a particular lake, lack of knowledge of the purpose of the regulation, and lack of sufficient enforcement (Glass and Maughn 1984). Novinger (1984) recommends the use of public meetings and the news media to inform anglers about the regulations. Minimum lengths work if hook-and-release mortality is low. Anderson and Dillard (1968) and Farabee (1970) have shown that survival of released fish is high under normal fishing conditions.

An alternative to minimum size limits, recommended by Martin in 1958, is a protected size range, or slot limit. This type of limit prohibits the harvest of bass within a specified size range (for example, between 14 and 18 inches). This type of limit permits the harvest of smaller bass, reducing the competition for forage, but prohibits the harvest of fish within the limit, so that they can grow to a large size, and thus keep the forage population under control.

In summary, minimum size limits may be effective for reducing harvest when recruitment is low to moderate and fishing pressure is heavy. When there is high recruitment and slow growth of intermediate sized bass, a slot length limit may be appropriate.

In 1983, a 14-inch size limit was placed on largemouth bass in Lake of Egypt. In 1987, a 16-inch size limit was placed on the bass. One important question that the 1988 and 1990 fish surveys were designed to answer was - are the bass growing through the 16-inch length limit or are they piling up just under it? The 1985 data on the growth rate of largemouth bass (Table 10) indicated that they were not piling up below 14 inches. In 1985, the 14-inch size limit protected most bass until they were 3+ years old, while a 16-inch limit would have protected 73% of the 3+ year old fish. In 1988, a 14-inch size limit protected 43% of the bass at 4+ years of age. A 16-inch size limit protected most of the bass (81%) at age 4+. In 1990, a 14-inch size limit protected 100% of the bass at age 4+. A 16-inch size limit protects 75% of the bass at age 5+ (Table 10).

The 1985 and 1988 data is not 100% comparable because in 1985 the bass were collected in November while in 1988 they were collected in June and in 1990 they were collected in May. Thus the bass collected in May or June could grow an inch by late fall. This would increase the number of 2+ fish that reached 12 inches, etc. The 1988 and 1990 data are comparable. The data indicates that in 1990, the bass are growing through the 16-inch size limit, but not as fast as they were in 1988.

Bluegill

Lake of Egypt has never been noted for large bluegill. This was true even during the first five years after filling when the bass population was very strong. For most fishermen bluegill reach a desirable size somewhere between 0.33 and 0.40 pounds.

It could be argued that the 16-inch size limit on largemouth bass has increased the growth rate of the bluegill. We lack the data to prove or disprove this. I have seen other lakes cycle between good bluegill fishing and good crappie fishing. No one knows exactly why this occurs.

The 1988 fish survey was designed to collect baseline data on the bluegill. In general, the growth rate of bluegill in Lake of Egypt was relatively slow (Table 11). Most fish only reach 6 inches in length, or approximately 0.13 pounds by age 6 or 7. The average for primarily small Illinois ponds for 6 year old fish is 0.47 pounds (Illinois Department of Conservation 1984).

In 1990 five to six year old bluegill reached 6 inches in length and averaged 0.25 pounds (Table 12). Numerous bluegill between one-third and one-half pound were collected in 1990, whereas only a few one-third pound bluegill were collected in 1988. Growth of the bluegill in Lake of Egypt now compares favorably with other area lakes. The weight of bluegill at various lengths is essentially the same as the theoretical ideal weight at length (Figure 4).

<u>Striped Bass Hybrid</u>

In 1986, 1987, 1988, 1989, and 1990 the hybrid between the female white bass and the male striped bass were stocked into Lake of Egypt (Table 1). This hybrid is not sterile, but in the hundreds of reservoirs in which it has been stocked throughout the United States, it is not known to have reproduced. In a few bodies of water the hybrid has crossed back to the white bass. If a fishery of hybrids is to be maintained it will have to be on a stock-grow-take basis.

The striped bass hybrid tends to be a midwater predator. It feeds heavily on gizzard shad, which are very abundant in most southern Illinois reservoirs. Thus, the idea is to convert the tremendous production of gizzard shad into something usable by the fishermen.

Some fishermen erroneously believe that the stocking of hybrid striped bass may be detrimental to largemouth bass. This has not been the case in other lakes such as Crab Orchard. There is usually a tremendous over-abundance of intermediate and large gizzard shad in a reservoir. Studies have shown that neither the striped bass (which gets larger and has a larger mouth), nor the striped bass hybrid feeds heavily on largemouth bass or crappie. In Lake Texoma, the stomachs of 1,845 striped bass were examined. No largemouth bass were found in any of these stomachs. In other studies only one or two largemouth bass have been found in thousands of stomachs examined. Thus, we tend to find more largemouth bass in largemouth bass stomachs than in striped bass or hybrid striped bass stomachs.

Eighteen hybrid striped bass were collected in 1988. Fish from both the 1986 and 1987 year classes were found in the sample (Table 14). Fish from the 1987 year class that were collected in 1988 at age 1+ had a mean weight of 0.97 pounds. Fish from the first stocking in 1986 averaged 3.10 pounds at age 2+. These fish reach a legal size of 18 inches during their second year.

In 1986, only 500 fingerlings were stocked along with 250,000 fry. Based on the number of 3 to 4 pound hybrid striped bass that have been caught and reported to boat dock operators, some fry survival must have occurred. In 1990, we did not use any gill nets which tend to capture larger numbers of hybrid striped bass than electrofishing. As a result, we only captured 7 hybrid striped bass. Three were from the 1989 year class and two each were from the 1988 and 1987 year class (Table 15). The mean weight of these fish at age 1, 2, and 3 was 0.7, 2.3, and 5.4 pounds, respectively. No fish were collected from the 1986 year class (4 year old). We know they are present in the lake because we collected them in 1988.

<u>Walleye</u>

Walleye are not native to Lake of Egypt. Eight thousand fingerlings were stocked in 1985. The stocked fish are not expected to reproduce. I do not expect that this single stocking will produce a fishery, but that a few walleye will be caught as a bonus to people fishing for crappie and bass. No walleye were taken in the 1988 fish sample, however, a number had reported them creeled to the boat dock owners.

In 1990, two walleye were collected. One measured 24.2 inches and weighed 5.75 pounds and the other was 24.5 inches long and weighed 6.38 pounds. Walleye reach 9.7 inches at age 1, 14.2

at age 2, 20.5 at age 3, 22.7 at age 4, and 24.4 inches in total length at age 5. This is comparable to the growth rate in length of walleye in Heidecke Pond, IL which is among the most rapid in the United States.

<u>Channel Catfish</u>

Channel catfish were not aged in the study, but many individuals of all ages were observed in the gill nets and electrofishing in 1988 and by electrofishing in 1990. The channel catfish are reproducing in Lake of Egypt. The very strong population is underharvested.

<u>Population Structure</u>

Another way of looking at balance in a fish population is to calculate the proportional stock density (PSD) for bluegill, largemouth bass, and crappie. The PSD is the number of quality size fish divided by the number of stock size fish in the sample (Anderson 1980). Stock size for largemouth bass, crappie, and bluegill is 8, 5, and 3 inches, respectively. Quality size is 12, 8, and 6 inches, respectively. Largemouth bass in Lake of Egypt have a PSD of 51% in 1988 and 58% in 1990. The range of balance is 40 to 70%. In 1988, 14% of the largemouth bass collected were longer than 15 inches, 15% were longer than 15 inches in 1990 (RSD15). RSD15 of 10 to 25 are considered to be in balance. In 1988, the PSD for white crappie was 83% and the RSD10 was 33%. In 1990, the PSD was 68% and the RSD was 13%.

Models from small midwestern impoundments suggest that PSD's should be between 30 and 60 and RSD10 between 10 and 20 (Gabelhouse 1984). The higher than normal PSD for crappie in 1988 probably reflects the fact that most of the fish were obtained from fishermen. In 1988, the bluegill sampled in Lake of Egypt had a PSD of 24% and in 1990 it was 54%. Balanced populations range from 20 to 40%. In 1988 the RSD8 was 0 reflecting that no fish 8 inches or longer were collected. In 1990 this RSD8 was 7%. Balanced populations tend to range from 5 to 20%

SUMMARY

I indicated in the summary of the 1988 report that:

> "The results of the study indicate that the largemouth bass, black crappie, white crappie, and hybrid striped bass are growing well in Lake of Egypt. Crappie densities tend to be very cyclic and it is likely that the population in Lake of Egypt is near a low point. Several stronger year classes should enter the fishery next year.
>
> The bluegill are continuing to grow slowly in the lake. This indicated a lack of large invertebrates for them to feed on. Redear sunfish in Lake of Egypt were not aged, but much larger redear were collected than bluegill. This reflects the redear's rather unique ability among the sunfish to eat clams and snails.
>
> All management procedures in effect should be continued. Every effort should be made to encourage catch and release (Heidinger 1986)."

There have been some rather dramatic changes in the fish community in Lake of Egypt since 1988. Please note that overall the fish community is Lake of Egypt is in fairly good shape and in balance.

The crappie, bluegill, walleye, and hybrid striped bass are all growing at an acceptable to excellent rate. The numbers of white crappie creeled have increased because several moderately strong year classes are in the fishery. Bluegill have greatly accelerated their growth rate and now provide a very strong bluegill fishery.

The only dark cloud on the horizon is the slow down of the growth rate of largemouth bass. Although I cannot absolutely prove why these events have taken place, I am going to outline what I believe has happened.

The two major changes that have taken place in the last five years on Lake of Egypt are:

1. The nutrient loading (fertilization versus pollution) has been eliminated from the septic systems and from the Goreville wastewater treatment plant.
2. In 1987, the size limit on largemouth bass was increased from 14 inches to 16 inches.

The length limit has reduced the number of largemouth bass removed from the lake (fishing mortality) which has increased the number of bass especially 12 to 15.75 inch fish in the lake. At the same time that their numbers have increased, the nitrogen and phosphate inputs to the lake have been reduced. This has reduced the plant plankton and the animal plankton that small fish use as food. Probably the shad were hit the hardest because they feed heavily on plankton. I believe that a reduction in shad (postulated) and an increase in bass has caused a reduction in the growth rate of the bass and the corresponding decrease in their plumpness. At the same time, the increased number of 12 to 16 inch bass has decreased the number of small bluegill which gives the ones that do survive more food. Hence, their increased growth rate.

MANAGEMENT RECOMMENDATIONS

After considering the biological data on the fish community in Lake of Egypt and the interest of the individuals that attended the informational meetings, my recommendations are as follows:

1. Maintain the 16-inch size limit and 6 fish/day limit on the largemouth bass. The data indicates it would be desirable to fine tune these regulations in order to remove some small bass from the population. However, it has taken several years for anglers to accept the 16-inch size limit and changing it would require a similar period of adjustment. Enforcement of a slot limit, season limit, or a so called 5-1 limit is more difficult than enforcing a straight size limit. In addition, it is difficult under any limit to control the number of small bass that are removed. If too many are removed detrimental effects will occur in the catch per hour of bass and in the growth of the bluegill. This recommendation of continuing the existing 16-inch size

limit is based on the assumption that there is no further reduction in the growth rate or plumpness (relative weight) of the largemouth bass. If further reduction in these parameters does occur, I would strongly recommend a change in the regulations concerning the largemouth bass.

2. Maintain the 14-inch size limit and 6 fish/day limit on the walleye.
3. Maintain the 18-inch size limit and 3 fish/day limit on the hybrid striped bass
4. Maintain the stocking of hybrid striped bass, but reduce it from 15,000 fingerlings per year to 10,000 per year. I do not believe that the numbers of hybrid striped bass in the Lake of Egypt at this time are detrimentally affecting the fish community, but since the nutrient loading has been reduced and I suspect a corresponding reduction in the pounds per acre of shad produced each year, it seems prudent to reduce the numbers of hybrids that are stocked. The justification for stocking hybrids was to produce a "trophy" fishery and not a "bread-and-butter" fishery. Every attempt should be made to stock the cross that uses the female striped bass.
5. Maintain the 30 fish/day limit on crappie (black and white in aggregate). We do not know yet if the high water levels in the spring of 1990 lead to a strong year

class of crappie, however, three modest year classes of 2, 3, and 4 year old crappie will be in the fishery in 1991.

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Table 1. History of recent fish introduction into Lake of Egypt.

Taxa	Year	Size	Number
Threadfin shad	1971	Adults	2,300
Walleye	1985	4-6 inches	8,000
Hybrid striped bass	1986	1-2 inches	500
Hybrid striped bass	1986	Fry	250,000
Hybrid striped bass	1987	1.5-2 inches	15,000
Inland silverside	1987	Adults	500
Hybrid striped bass	1988	1.5-2 inches	15,000
Hybrid striped bass	1989	1.5-2 inches	15,000
Hybrid striped bass	1990	1.5-2 inches	15,000

Table 2. Comparison of back calculated mean total lengths (inches) at age of white crappie in Lake of Egypt with selected midwestern lakes that do not contain threadfin shad.

Impoundments	Age 1	2	3	4	5	6	7
Lake of Egypt[1] (Heidinger 1977)	2.5	6.0	8.1	10.1	13.9	16.2	--
Lake of Egypt 1988	4.5	8.3	9.5	9.7	12.3	13.2	13.8
Lake of Egypt 1990	4.5	7.8	9.5	10.1	12.1	--	--
Dale Hallow, TN (Range 1973)	3.1	6.0	7.4	--	--	--	--
Horseshoe Lake, IL (Gunning 1954)	2.6	6.1	8.5	10.1	11.7	13.0	--
Crab Orchard, IL (1976)[2]	4.2	6.1	7.0	7.9	8.4	9.4	11.0
Red Haw, IA (Lewis 1950)	3.1	7.6	8.4	9.9	11.2	12.1	--
Clear Lake, IA (Neal 1963)	2.8	5.7	7.3	8.2	9.2	10.7	12.7

[1]Six years after threadfin shad stocking.

[2]Before threadfin shad were introduced.

Table 3. Age and total length (inches) of white crappie collected from Lake of Egypt in 1988.

Year/ Class	Number	Back Calculated Average Total Length (inches) at Each Annulus						
		1	2	3	4	5	6	7
1987	5	6.9						
1986	17	4.1	8.6					
1985	15	4.1	8.3	10.1				
1984	2	3.8	6.0	8.2	9.1			
1983	0	0	0	0	0	0		
1982	0	0	0	0	0	0	0	
1981	1	4.4	8.3	10.1	11.1	12.3	13.2	13.8
Mean Length		4.5	8.3	9.9	9.7	12.3	13.2	13.8
Mean Weight (lbs)		.04	.26	.44	.42	.88	1.06	1.25
Number		40	35	18	3	1	1	1

Table 4. Back calculated mean total length (inches) at age of white crappie collected from Lake of Egypt in 1990.

Year/Class	Number	Age 1	2	3	4	5
1989	3	6.7				
1988	37	4.8	7.9			
1987	34	4.0	7.7	9.5		
1986	3	3.2	7.2	9.0	9.6	
1985	1	4.0	8.2	10.1	11.5	12.1
Mean length		4.5	7.8	9.5	10.1	12.1
Mean weight (lbs)		0.05	0.23	0.41	0.49	0.85
Number		78	15	38	4	1

Log(weight) = -3.2590 = 2.9371 (log(length))

r^2 = 0.9759

Table 5. Number of white crappie from various year classes collected in the 1988 and 1990 sample.

Year Spawned	Year of Sample	
	1988	1990
1989		3
1988		37
1987	5	34
1986	17	3
1985	15	1
1984	2	0
1983	0	0
1982	0	0
1981	1	0

Table 6. Back calculated mean total length (inches) at age of black crappie collected from Lake of Egypt in 1988.

Year/Class	Number	Age 1	2	3	4
1987	0	0			
1986	17	3.7	7.5		
1985	0	0	0	0	
1984	2	3.8	6.2	8.4	9.6
Mean length	3.7	7.3	8.4	9.6	
Mean weight (lbs)		.03	.20	.29	.43
Number		19	17	2	2

Table 7. Back calculated mean total length (inches) at age of largemouth bass collected from Lake of Egypt in 1988.

Year/Class	Number	Age 1	2	3	4	5	6
1987	25	6.1					
1986	35	7.0	10.4				
1985	20	5.8	10.2	12.1			
1984	18	6.1	10.6	13.2	14.6		
1983	6	5.0	9.8	12.5	14.6	15.6	
1982	1	4.8	10.2	13.3	15.4	17.3	18.1
Mean length		6.3	10.3	12.6	14.6	15.8	18.1
Mean weight (lbs)		.10	.48	.92	1.46	1.88	2.89
Number		105	80	45	25	7	1

Table 8. Back calculated mean total length (inches) at age of largemouth bass collected from Lake of Egypt in 1990.

Year/ Class	Number	Age 1	2	3	4	5	6	7	8
1989	5	5.2							
1988	13	6.6	9.8						
1987	31	6.8	10.1	11.7					
1986	35	7.6	10.5	12.1	12.8				
1985	8	6.8	10.7	12.7	14.0	14.6			
1984	6	6.4	10.8	13.6	14.8	15.7	16.5		
1983	1	7.4	11.3	13.5	14.3	14.8	15.5	16.3	
1982	2	9.3	14.8	16.5	17.8	18.9	19.7	20.3	21.0
Mean length		7.0	10.4	12.2	13.5	15.5	17.1	19.0	21.0
Mean weight (lbs)		0.16	0.50	0.81	1.07	1.63	2.16	3.42	3.99
Number		101	96	83	52	17	9	3	2

Log(weight) = −3.2965 + 2.9456 (log(length))

$r^2 = 0.96360$

Table 9. Age and total length (inches) of largemouth bass collected from Lake of Egypt in various years by SIUC Fishery Research Personnel.

Year/ Class	Age 1	2	3	4	5	6	7	8
1978[1]	5.5 (33)[2]	8.6 (26)	10.9 (18)	13.0 (5)	14.3 (3)	16.0 (2)	16.0 (1)	16.5 (1)
1984[3]	6.7 (4)	10.4 (15)	12.3 (12)	13.5 (11)	11.9 (2)	---	---	---
1985[3]	6.8 (1)	10.1 (28)	13.1 (28)	14.4 (26)	14.7 (8)	19.2 (3)	--- ---	21.2 (1)
1988[1]	6.3 (105)	10.3 (80)	12.6 (45)	14.6 (25)	15.8 (7)	18.1 (1)	---	---
1988[4]	6.5	10.5	12.3	14.8	15.5	18.3	---	---
1990[1]	7.0 (101)	10.4 (96)	12.2 (83)	13.5 (52)	15.5 (17)	17.1 (9)	19.0 (3)	21.0 (2)
IL average (IDOC 1984)	6.3	9.0	11.6	13.6	15.8	17.4	18.9	19.8

[1]Back calculated age and growth.

[2]Numbers in parentheses equal sample size. Fish were not dipped up in proportion to their relative abundance, therefore, mortality rates can not be estimated from these data.

[3]Actual length at capture. These fish were collected in the fall, therefore in order to make the 1978 data comparable to the 1984 and 1985 data a 1+, 2+, etc., fish in 1984 and 1985 was assigned an age of 2, 3, etc., respectively.

[4]Actual length of capture in June 1988.

Table 10. Percentage of largemouth bass of each age group collected from Lake of Egypt in 1985, 1988, and 1990 that would be legal under various size limits.[1]

Size Limit (inches)	Age 0+ 1985	0+ 1988	0+ 1990	1+ 1985	1+ 1988	1+ 1990	2+ 1985	2+ 1988	2+ 1990	3+ 1985	3+ 1988	3+ 1990	4+ 1985	4+ 1988	4+ 1990	5+ 1985	5+ 1988	5+ 1990	6+ 1985	6+ 1988	6+ 1990	7+ 1985	7+ 1988	7+ 1990
12	0	0	0	4	0	0	75	3	0	100	70	32	100	100	83	100	100	100	100	100	100	100	100	100
13	0	0	0	0	0	0	64	0	0	85	25	0	85	76	43	100	100	88	100	100	100	100	100	100
14	0	0	0	0	0	0	25	0	0	58	0	0	75	57	23	100	88	50	100	100	100	100	100	100
15	0	0	0	0	0	0	7	0	0	27	0	0	50	33	6	100	63	50	100	100	100	100	100	100
16	0	0	0	0	0	0	0	0	0	12	0	0	13	19	0	100	38	25	100	100	67	100	100	100
17	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	100	0	13	100	100	33	100	100	100
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	0	0	100	100	0	100	100	100

[1] The 1985 fish were collected in November, the 1988 fish in June, and the 1990 fish in May.

Table 11. Back calculated mean total length (inches) at age of bluegill collected from Lake of Egypt in 1988.

Year/ Class	Number	Age 1	2	3	4	5	6	7
1987	4	2.8						
1986	19	2.7	3.8					
1985	42	2.8	3.9	4.8				
1984	23	2.5	3.8	4.5	5.2			
1983	20	2.4	3.5	4.4	4.9	5.5		
1982	6	2.6	3.6	4.3	4.9	5.4	5.9	
1981	2	2.5	3.4	4.0	4.6	5.2	5.5	5.7
Mean length		2.6	3.8	4.6	5.0	5.4	5.8	5.7
Mean weight(lbs)		.01	.03	.06	.08	.10	.13	.12
Number		116	112	93	51	28	8	2

Table 12. Back calculated mean total length (inches) at age of bluegill collected from Lake of Egypt in 1990.

Year/ Class	Number	Age 1	2	3	4	5	6	7	8
1989	1	2.4							
1988	4	3.3	4.5						
1987	17	3.0	4.5	5.8					
1986	37	3.3	4.5	5.7	6.7				
1985	33	3.1	4.2	5.2	6.1	6.9			
1984	6	3.0	4.3	5.2	6.2	7.0	7.5		
1983	1	2.4	3.3	4.2	4.8	5.3	6.0	6.4	
1982	1	2.9	3.5	4.1	5.0	5.4	5.9	6.5	7.1
Mean length		3.1	4.4	5.4	6.3	6.8	7.1	6.5	7.1
Mean weight (lbs)		0.02	0.05	0.11	0.20	0.25	0.29	0.21	0.28
Number		100	99	95	78	41	8	2	1

Log(weight) = -3.5054 + 3.4775 (log(length))

$r^2 = 0.9627$

Table 13. Comparison of bluegill back calculated mean total lengths (inches) at age in Lake of Egypt and selected Illinois lakes.

Impoundments	Age 1	2	3	4	5	6	7	8
Lake of Egypt 1988	2.6	3.8	4.6	5.0	5.4	5.8	5.7	
Lake of Egypt 1990	3.1	4.4	5.4	6.3	6.8	7.1	6.5	7.1
Horseshoe Lake (Gunning 1954)	2.4	3.9	5.2	6.1	6.9			
Grassy Lake (Walker 1951)	2.0	4.1	5.3	6.0	6.6			

Table 14. Back calculated mean total length (inches) at age of striped bass x white bass collected from Lake of Egypt in 1988.

Year/Class	Number	Age 1	Age 2
1987	7	10.0	
1986	11	10.4	17.7
Mean length		10.2	17.7
Mean weight (lbs)		0.49	2.6
Number		18	7

Table 15. Back calculated mean total length (inches) at age of striped bass x white bass collected from Lake of Egypt in 1990.

Year/Class	Number	Age 1	Age 2	Age 3
1989	3	11.6		
1988	2	10.2	17.1	
1987	2	11.6	18.5	22.9
Mean length		11.7	17.8	22.9
Mean weight (lbs)		0.7	2.3	5.4
Number		7	4	2

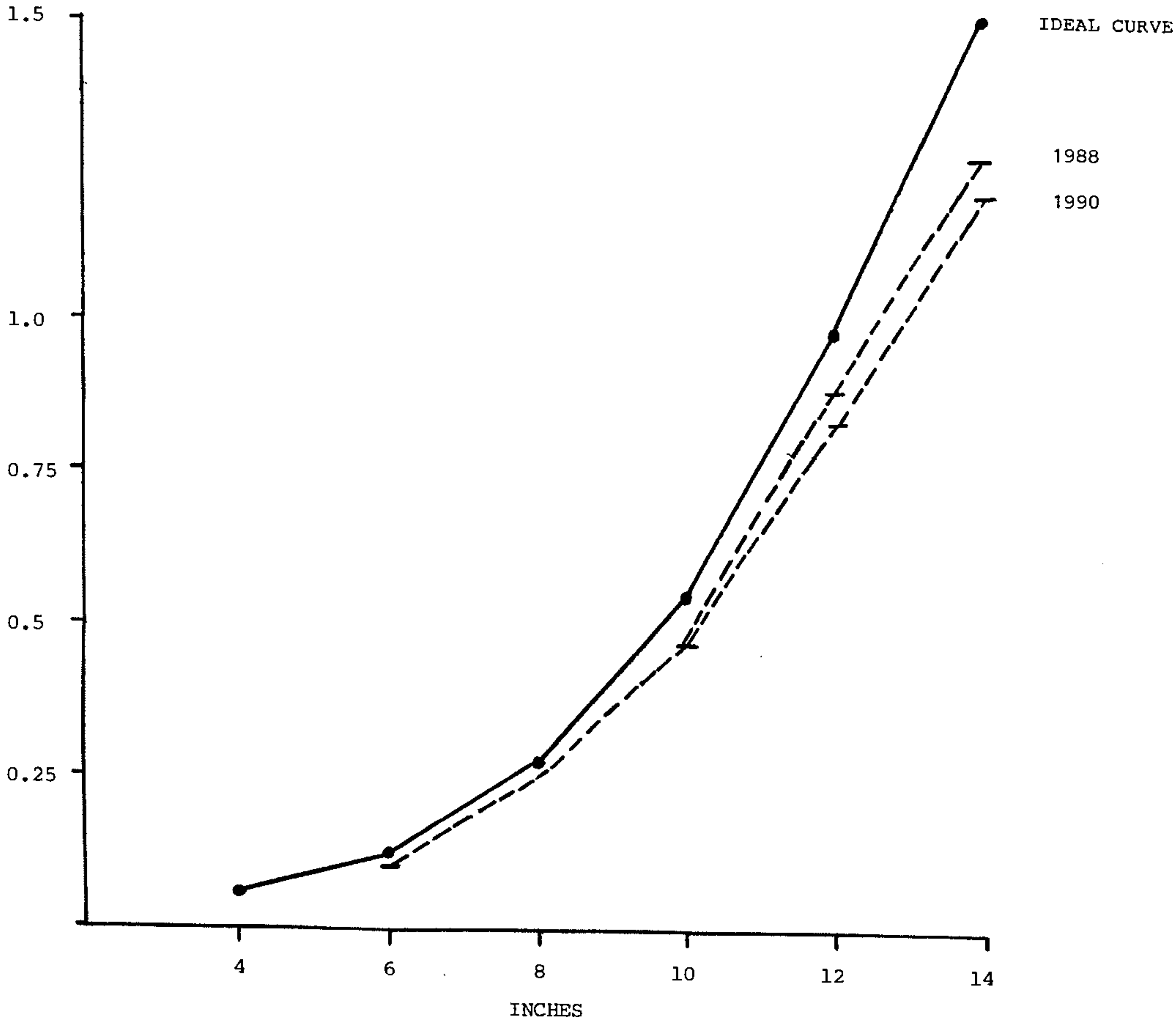

Figure 1. Relative weight of white crappie collected in 1988 and 1990 from Lake of Egypt compared to the ideal weight at length curve.

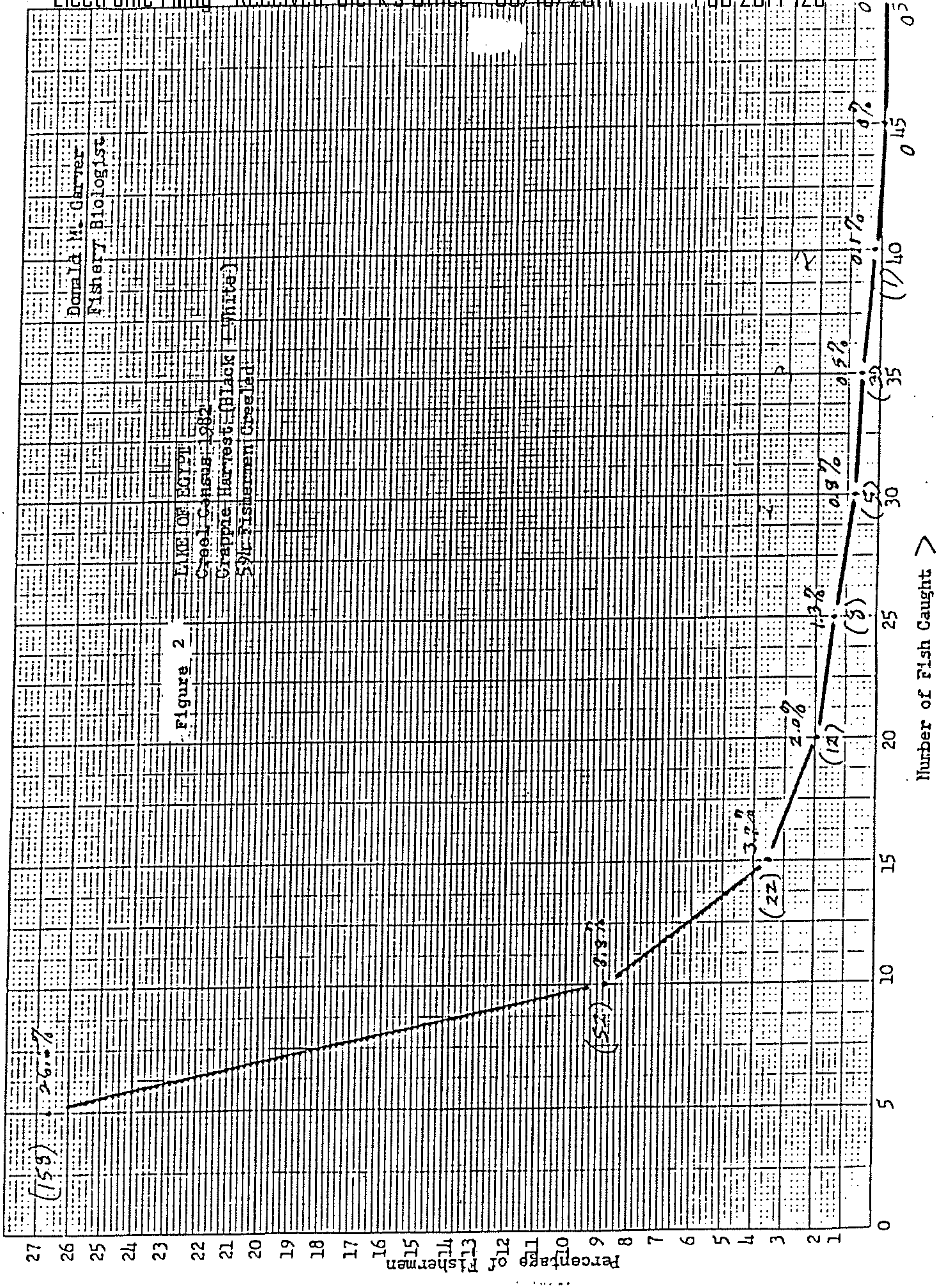
Figure 2
LAKE OF EGYPT
Creel Census 1982
Crappie Harvest (Black + White)
Fishermen Creeled
Donald M. Garver
Fishery Biologist
Number of Fish Caught
Percentage of Fishermen

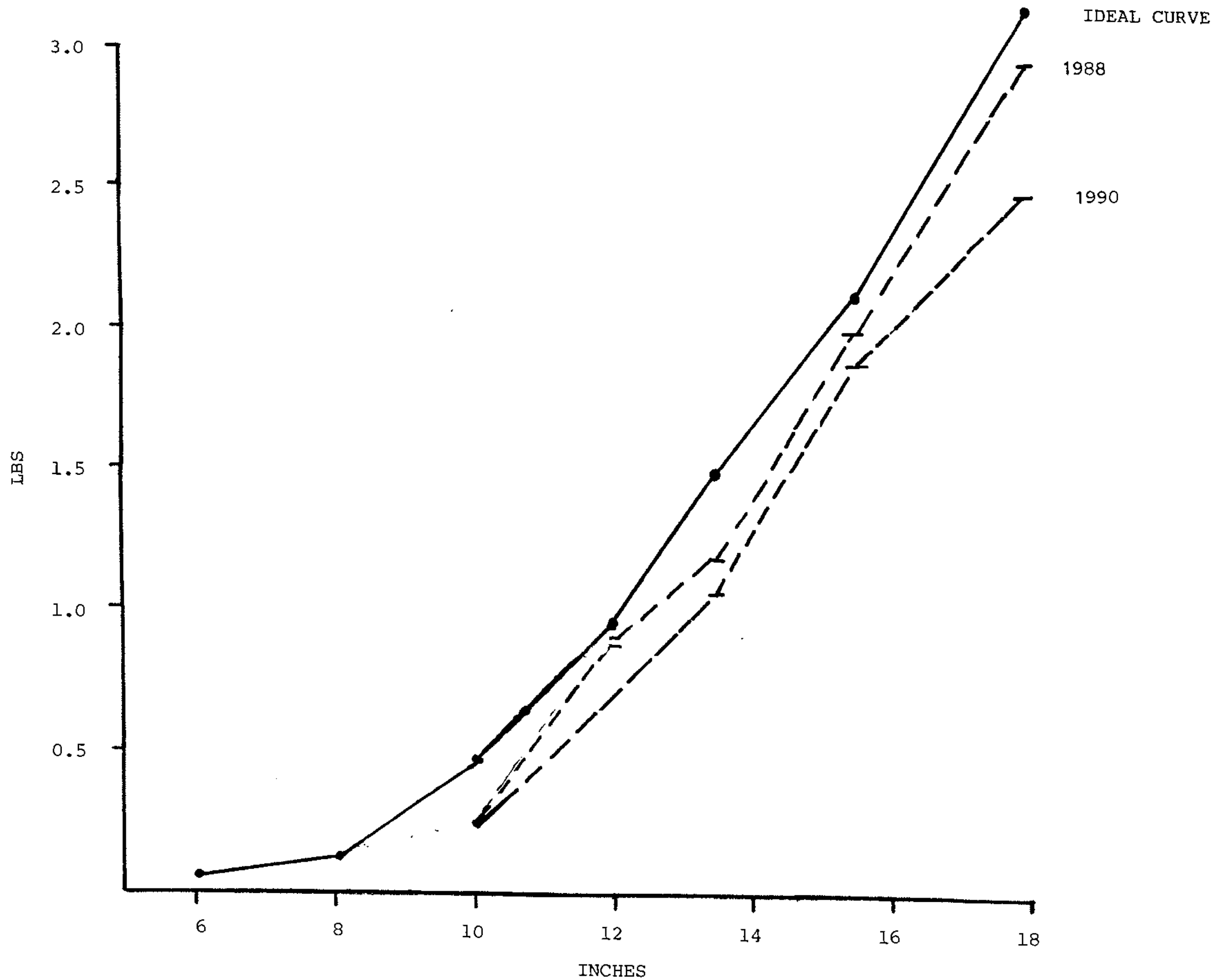

Figure 3. Relative weight of largemouth bass collected in 1988 and 1990 from Lake of Egypt compared to the ideal weight at length curve.

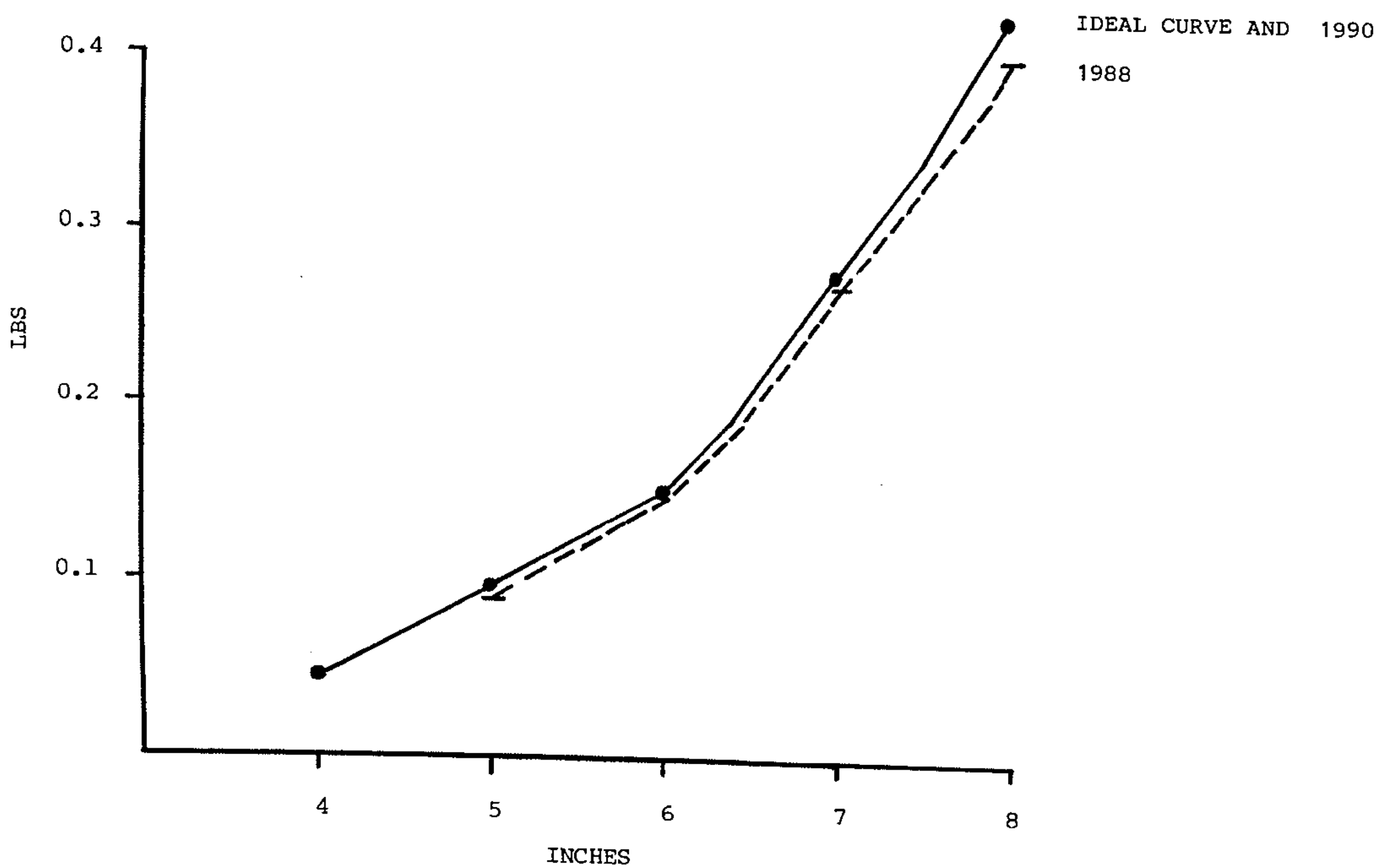

Figure 4. Relative wieght of bluegill sunfish collected in 1988 and 1990 from Lake of Egypt compared to the ideal weight at length curve.

Appendix F
Supplemental Spring and Fall Hydrothermal Modeling

PROJECT MEMORANDUM

DATE:	**02-06-13**
FROM:	**Wayne Ingram and Chris Everts**
SUBJECT:	**SIPC – Supplemental Spring and Fall Hydrothermal Modeling**
TO:	**File (3250115515); Project Team**

Prepared by: DWI Date: 02/06/13
Checked by: CJE Date: 02/06/13

Purpose: Summary of results from supplemental hydrothermal modeling of Lake of Egypt water temperatures for April – May (spring) and October – November (fall) time periods.

INTRODUCTION

Following establishment of summer and winter lake water temperatures for a stressed condition for proposed regulatory criteria, it was determined that regulatory criteria be proposed for four periods of the year. This memorandum provides a summary of lake temperature modeling results for the spring and fall transition periods. The spring and fall transition periods were defined as April through May and October through November, respectively. Since the transition periods are when the lake water temperatures are changing from annual lows to highs or highs to lows, establishing regulatory criteria for maximum water temperatures focuses attention on specific days at the end of the spring transition period and at the beginning of the fall period.

STATISTICAL ANALYSES OF EQUILIBRIUM TEMPERATURE PARAMETER FROM CLIMATIC RECORDS

A primary input variable for the hydrodynamic model LLGVHT is the equilibrium temperature (T_{eq}). This value is calculated from incident solar radiation, dew point temperature, and wind speed. When surface water temperature is greater than the equilibrium temperature, the water temperature in the lake is increasing. If equilibrium temperature is less than lake temperature the lake is losing heat to the atmosphere. T_{eq} and the calculated coefficient of surface heat exchange (CSHE) are applied as the model time-steps through a simulation period with the resulting hydrodynamics dictating the water temperature distribution throughout the water body. Experience with the model has shown T_{eq} to be the parameter to which lake temperature calculated by the model is most sensitive.

The T_{eq} parameter was calculated from a daily time series of the three climatic parameters (wind speed, dew point temperature, and solar radiation). Solar radiation and dew point temperature vary continuously and in a cyclical manner over the course of a year. Based on the approximately 22-year period of record available at the SIU climate station (Illinois State Water Survey's Illinois Climate Network), The daily 95th and 100th (maximum) percentile T_{eq} values were calculated and are presented in Figure F-1. Statistics for selected days for each of the three climatic parameters and the T_{eq} value are provided in Table F-1. The T_{eq} values in Table F-1 are the percentile values from the calculated daily T_{eq} series from the raw climatic data and not calculated from the percentile values of the three climatic parameters. The percentile values in both Figure F-1 and Table F-1 are identified as non-exceedance values.

Variability, or randomness, of the non-exceedence values for the maximum daily values during the 22-year period of record is apparent on Figure F-1. The 95 percent daily non-exceedance values have less variability than the maximum values and the longer averaging period (e.g., 45-day) has less variability than the shorter (15-day) averaging period.

TEMPERATURES FOR TRANSITION MONTHS

Proposed regulatory criteria include four periods of the year. The annual maximum summer period has been defined as the four-month period from June 1 – September 30. The annual winter period has been defined as the four-month period from December 1 through March 31. The two transition month periods have been defined as April 1 through May 31 for the spring season and October 1 through November 30 for the fall period.

Because these transition months have clearly defined and regular water temperature increases during the spring and water temperature decreases during the fall, regulatory maximum temperatures must be based on the conditions at the end of the spring period and beginning of the fall season. The 30-day period and the 95th percentile values of the three climatic parameters, solar radiation, dew point temperature, and wind speed, were used to estimate the equilibrium temperature, T_{eq}, as it was for prior analyses for the summer and winter stressed condition temperatures.

Model inputs for spring (May 31) and fall (October 1) conditions are provided in Table F-2. Heat loads used for the simulations are based on the 50th percentile for winter and summer heat load, 650 MW. Maximum surface temperature resulting from the spring condition simulation for a May 31 date was 29.9 °C (85.8 °F). Under fall conditions (October 1) a maximum surface temperature of 32.6 °C (90.7 °F) was simulated from the model.

At the edge of the proposed mixing zone, the spring water temperature is 29.8 °C (86 °F) and the fall water temperature is 32.5 °C (91 °F).

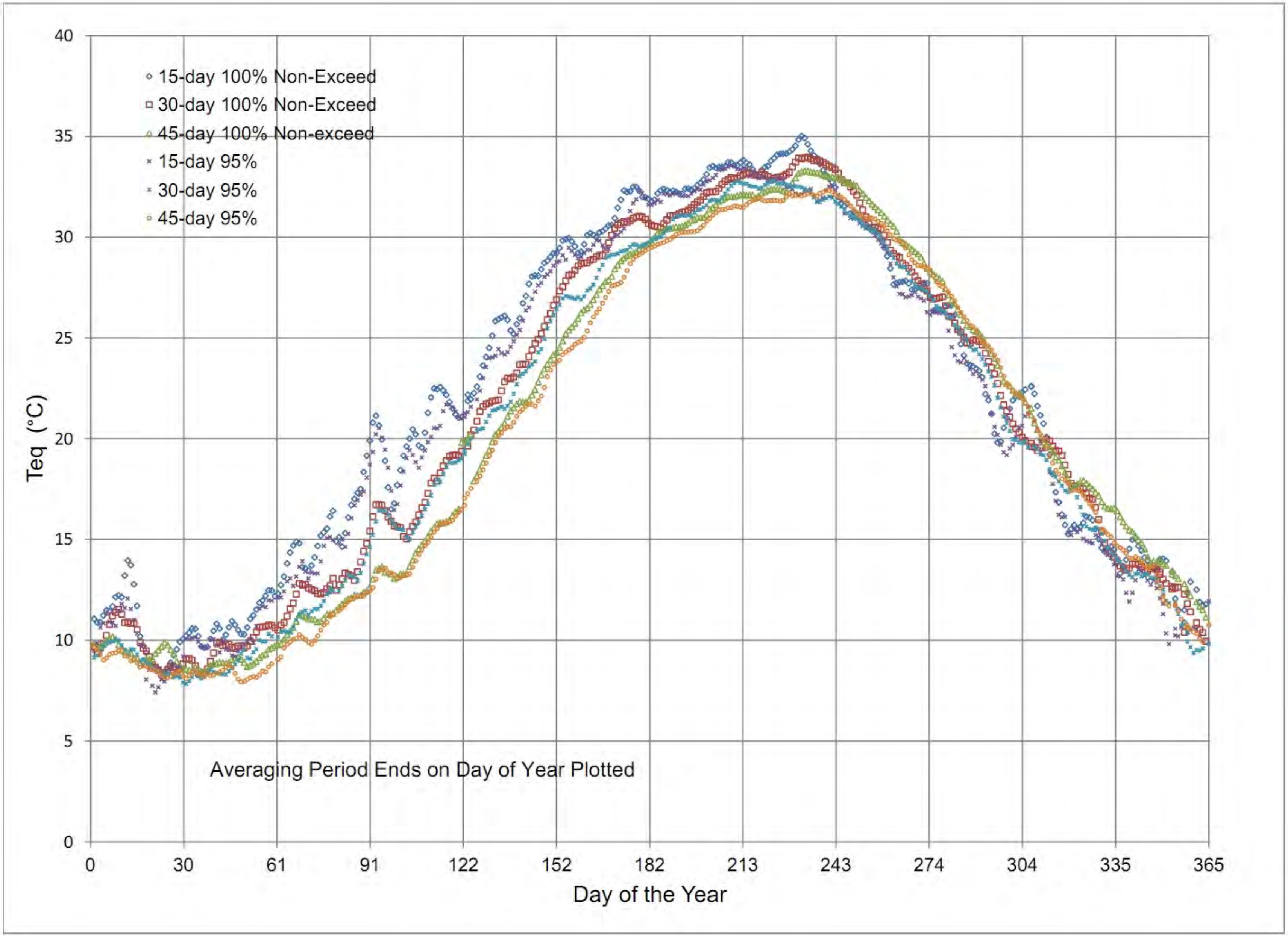

Figure F-1. Calculated Daily T_{eq} Percentile Values (15-, 30- and 45-Day Average) (SIU Climate Station Period of Record)

Table F-1. Percentile Values for Equilibrium Temperature and Three Climatic Parameters for 15-, 30-, and 45-Day Running Average Periods

Day of Year	Non-Exceed %	Average Wind Speed (m/s)			Solar Radiation (W/m^2)			Dew Point Temperature (°C)			Equilibrium Temperature (°C)		
		15-day	30-day	45-day	15-day	30-day	45-day	15-day	30-day	45-day	15-day	30-day	45-day
Winter (end - March 31)													
90	100	4.70	4.07	4.01	221.17	194.43	177.21	11.04	5.87	3.35	19.17	14.80	12.46
90	95	4.29	4.01	3.72	199.94	186.03	166.74	10.78	5.72	3.35	18.72	14.63	12.45
90	90	3.89	3.71	3.69	194.96	180.20	165.15	7.80	4.18	3.30	14.72	13.09	12.26
90	80	3.56	3.53	3.59	188.37	177.25	160.22	5.04	3.18	3.01	13.96	12.48	11.70
90	50	3.11	3.29	3.32	170.39	162.78	150.96	3.83	2.84	0.95	12.85	11.40	9.89
Spring (end - May 31)													
151	100	3.23	3.23	3.50	323.85	293.72	272.55	20.59	17.68	15.38	29.22	26.62	24.17
151	95	3.05	3.07	3.40	295.46	288.21	269.40	19.82	17.11	14.97	28.76	26.45	23.81
151	90	2.88	2.96	3.10	293.81	274.85	259.90	18.78	16.69	14.05	27.78	25.71	23.57
151	80	2.61	2.87	2.90	286.25	254.88	244.30	16.40	15.28	13.22	26.20	24.40	22.69
151	50	2.21	2.43	2.63	251.57	239.68	226.23	14.54	13.64	12.68	24.42	23.36	21.75
Summer (peak - August 18)													
230	100	2.29	2.16	2.32	279.65	286.44	292.02	25.51	24.51	23.27	34.54	33.74	32.95
230	95	2.21	2.05	2.02	277.30	279.01	286.03	22.59	22.66	22.34	32.09	32.51	32.09
230	90	1.97	1.98	1.95	272.61	274.30	277.24	21.79	22.38	22.30	31.54	31.94	31.94
230	80	1.89	1.95	1.91	269.41	267.13	275.77	21.45	21.89	21.64	31.27	31.56	31.52
230	50	1.73	1.76	1.82	255.26	261.69	264.62	20.19	20.41	20.53	29.83	30.46	30.69
Summer (end - September 1)													
244	100	2.31	2.02	1.99	266.26	276.30	276.97	22.17	23.62	23.44	32.01	33.19	33.00
244	95	2.07	1.96	1.99	263.29	262.28	271.49	22.15	22.29	22.42	31.79	31.53	32.00
244	90	1.98	1.93	1.96	257.48	259.97	264.62	21.89	21.59	21.79	30.93	30.92	31.43
244	80	1.91	1.90	1.91	247.78	255.61	259.43	21.42	21.04	21.39	30.71	30.72	30.86
244	50	1.67	1.73	1.79	232.40	242.56	251.71	20.09	19.96	20.52	29.39	29.46	30.29
Fall (begin October 1)													
274	100	2.49	2.48	2.16	222.66	228.35	240.41	17.79	17.48	18.96	26.99	27.01	28.28
274	95	2.34	2.11	2.02	218.10	218.69	223.69	17.02	17.31	18.34	26.33	26.87	28.09
274	90	2.16	2.04	1.99	210.44	212.42	218.45	16.52	16.90	18.23	25.81	26.26	27.62
274	80	2.06	1.95	1.93	203.38	207.30	216.93	15.20	16.62	17.73	24.41	25.98	27.21
274	50	1.95	1.79	1.76	189.03	198.90	207.82	12.42	14.89	16.58	22.02	24.51	26.20

ISWS ICN SIU Station for Period of Record (December 1989 through October 2012)

Table F-2. Summary of Model Inputs for Lake of Egypt Thermal Simulations

Input Parameter	Spring Conditions (May 31)		Fall Conditions (October 1)	
	Value	Source	Value	Source
Wind Direction (from)	Southwest	Prevailing spring wind direction	South	Prevailing fall wind direction
Wind Speed	2.16 m/s (4.8 mph)	30-day average	1.68 m/s (3.76 mph)	30 day average
Cooling Water Discharge	8.19 m^3/s (186.8 MGD)	Winter flow conditions	12.744 m^3/s (290.6 MGD)	Summer Flow Conditions
Temperature Rise in Discharge Water - ΔT	19.1 °C (34.4 °F)	Winter flow conditions	12.22 °C (22 °F)	Summer Flow Conditions
Heat Load Added to Lake	652 MW	50th percentile for 30-day average of winter heat load	649 MW	50th percentile for 30-day average for summer heat load
Coefficient of Surface Heat Exchange - CSHE	25.0 W/m^2	Estimated from previous 30 days (May 1-May 31)	23.62 W/m^2	Estimated from previous 30 days (Sept 1-Sept 30)
Lake Equilibrium Temperature T_{eq}	26.4 °C (78.8 °F)	Estimated from previous 30 days (May 1-May 31)	26.8 °C (79.5 °F)	Estimated from previous 30 days (Sept 1-Sept 30)
Model Simulation Time	30 days	steady state model	30 days	steady state model
Horizontal Grid Size	500 ft x 500 ft	Allows model to include entire lake	500 ft x 500 ft	Allows model to include entire lake
Vertical Layers	28 layers (18 inches deep)	Maximum Lake depth 12.2 m (40 ft)	28 layers (18 inches deep)	Maximum Lake depth 12.2 m (40 ft)
Initial Lake Temperature Conditions	15.0 °C (surface) 12.1 °C (bottom)	Estimated from plant inlet temperature on May 1	28.0°C (surface) 27.1°C (bottom)	Estimated from plant inlet temperature September 1