6-1986

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Rodekohr, Donn A., "The Population Biology of Oak Middle Creek Structure 58-B After an Experimental Stocking with Adult Fish: a Three Year Evaluation" (1986). *Dissertations & Theses in Natural Resources*. 224.
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THE POPULATION BIOLOGY OF OAK MIDDLE CREEK STRUCTURE 58-B AFTER AN EXPERIMENTAL STOCKING WITH ADULT FISH: A THREE YEAR EVALUATION

by

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A THESIS

Presented to the Faculty of
The Graduate College in the University of Nebraska
In Partial Fulfillment of Requirements
For the Degree of Master of Science
Major: Forestry, Fisheries and Wildlife

Under the supervision of Professor Gary L. Hergenrader

Lincoln, Nebraska

June 1986

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ABSTRACT

Following a fish kill, a private pond was stocked with adult largemouth bass, bluegill, and black crappie, and advanced fingerling channel catfish and walleye. Goals of the stocking method were to restore the fishery to pre-kill conditions in a short time period and establish a self-sustaining gamefish population. Condition of the fishery was monitored by examining growth, population biomass, and population dynamics of three primary species. Largemouth bass and bluegill were successfully established and had good growth rates during the three years of the experiment. Black crappie were established and then declined rapidly, presumably because of predation. The stocking technique was successful in re-establishing the largemouth bass and bluegill populations; however, whether the long term balance of the population will be maintained is questionable.

ACKNOWLEDGEMENTS

The production of this thesis was truly a cooperative venture. First on the list of cooperators are the owners of the pond, Ray Fiala and J. Campbell. Next, Larry Zadina, Jeff Blazer, Randy Winter, and Dave Tunink of the Nebraska Game and Parks Division who salvaged fish and assisted with sampling. Fellow graduate students in the Department of Forestry, Fisheries, and Wildlife who helped collect data, sometimes during the most adverse weather. Richard Holland, Larry Angle, Jennifer Carr, Steve Schleiger and Nells Troelstrup each contributed significantly. Terri Short and the staff at the Water Resources Center (UN-L) put out the brush-fires back in the office I was out "torturing" the fish. And finally, my advisors, Drs. Gary Hergenrader, Ed Peters, and Ron Case, who always had time to help, review, edit, and recommend the best choice. A student couldn't have asked for a finer group.

I would be remiss if I did not mention my wife, Becky, and my sons, Chad and Andy, for their patience during the late nights, understanding during the grumpy times, and encouragement when I needed it the most. They are a real answer to prayer.

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INTRODUCTION

History

In October, 1980, Oak Middle Creek Structure 58-B incurred a major fish kill. Subsequent investigation showed that the kill was nearly complete. Only a 5 kg channel catfish (*Ictalurus punctatus*) was sampled. Prior to the kill, species present in the pond were largemouth bass (*Micropterus salmoides*), channel catfish, bluegill (*Lepomis macrochirus*), black bullheads (*Ictalurus melas*), and carp (*Cyprinus carpio*). An agreement with the pond owners allowed an attempt to re-establish pre-kill populations over a short time frame by stocking adult fish. Fish were salvaged from some of the Salt Valley reservoirs and stocked into structure 58-B, and population biology monitored for a three year period. Pond owners agreed to limit harvest to catch-and-release and grant access to the pond for sampling purposes. Fish were stocked in the fall of 1981 and early spring of 1982 (Table 1). The original stocking included total of 128 kg of largemouth bass, 23 kg of bluegill, and 5 kg of black crappie (*Pomoxis nigromaculatus*).

Goals of the stocking plan were to provide: (1) a population of fish that would be available to anglers in 1983; and (2) an appropriate ratio of species numbers so

Table 1. Fish stocked into Oak Middle Creek 58-B in 1981.

Species	Size Range (in mm)	Number
Largemouth Bass	201-550	200
Bluegill	50-200	416
Black Crappie (*Pomoxis nigromaculatus*)	100-200	50
Channel Catfish	150	400
Walleye (*Stizostedion viteum*)	100-150	1,325
Fathead minnows (*Pimephales promelas*)	50-55	20,000

that the population would be balanced. Swingle (1950a) experimented with the size and timing of fish stocking. In his experiments, stocking adult bass failed to produce a year class the following year because there was no forage for the young fish. Bluegill quickly filled the void and dominated the population thereafter. He concluded that stocking adult fish "does not appear to be a practical method for general use."

A normal stocking procedure for a private pond in eastern Nebraska would consist of fingerling largemouth bass, channel catfish, and bluegill stocked at the rate of 247, 247, and 1236 fish per hectare, respectively (Modde 1980). These rates are roughly equivalent to those developed by Swingle (1950a). Fish would be stocked according to their availability from the hatcheries (late summer and early fall) and as near to simultaneously as possible. That is, there is not a designed split stocking.

Site Description

Oak Middle Creek 58-B is located in the northeastern corner of Seward County, Nebraska in the northwest quadrant of Section 11, T12N, R4E. At conservation pool, the pond has a surface area of 4.3 ha (10.5 acres), a volume of 87,775 m^3, mean depth of 2.1 m, and a maximum depth of 8.8 m. The pond drains 296.4 ha of rolling hills, most of which are pasture land with some row crops and small grains. Pasture surrounds the pond which reduces surface runoff from cultivated fields. There are two major arms of the pond (Figure 1) with at least one erosion control or detention dam on each feeder stream. The pond has a very stable water level all year. Areas of the pond less than 1.5 m deep become thickly vegetated with rooted macrophytes, primarily *Potomogeton* species that are covered extensively with filamentous algae.

Study Objectives

The purpose of this study was to evaluate an experimental stocking procedure by answering the following questions:

1. For the species of interest, is the growth (in terms of total length) after stocking less than or greater than the growth before stocking?

H_o: Pre-stocking lengths at a given annulus = post-stocking lengths at a given annulus;

H_A: lengths at a given annulus are not equal.

2. Are published values for plumpness and for length/weight relationships from lakes proximal to Oak Middle Creek 58-B the same as the those found during the study?

H_o: Weights at a given length of fish from the Salt valley lakes = weights at a given length of fish from Middle Creek 58-B;

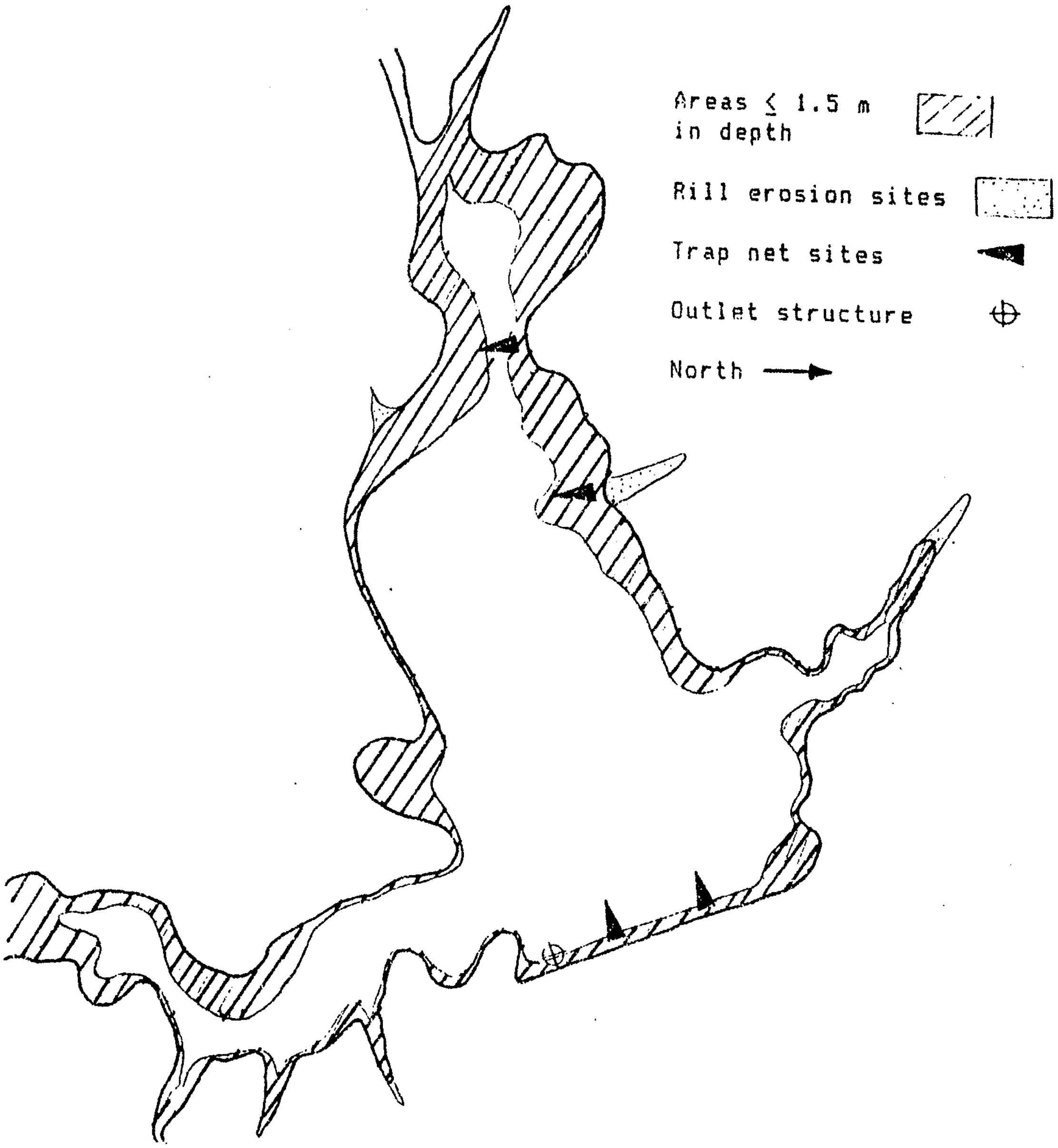

Figure 1. Oak Middle Creek 58-B showing areas of excessive vegetation and trap net locations.

H_A: weights at a given length are not equal;

3. Is the pond balanced?

H_o: Biomass relationships in Oak Middle Creek 58-B meet or exceed balance criteria;

H_A: Biomass relationships in Oak Middle Creek 58-B are less than recommended balance critera.

Time frame

The fish kill took place in October, 1980, and stocking commenced in late fall of that year. Sampling was done in the fall of 1981, 1982, 1983, and the spring of 1984.

Assumptions

Assumptions made at the onset of this investigation were:

1. The fish kill of 1980 was total;
2. The toxic material that caused the fish kill was detoxified;
3. The pond had a closed population, immigration and emigration were zero; and,
4. Angler harvest was insignificant.

LITERATURE_REVIEW

Fish growth patterns are different at different population levels. Centrarchid growth generally improves in response to population thinning, either naturally or through management efforts (Swingle and Smith 1939, Bennett 1943, Beckman 1948, Parker 1958). The effect of thinning forage populations was measured by comparing calculated length at each annulus between the pre and post-thinning populations. Scales were taken from fish after selectively thinning forage fish population. Second degree polynomial regressions of calculated total length on year of life were fitted on the growth data prior to thinning against which the post-thinning growth could be compared. Mean weights at a given length were compared from pre- and post-thinning populations as well. Bluegill and largemouth bass both responded positively in terms of length and weight (Parker 1958). However, following a winterkill that significantly reduced the total fish population, largemouth bass growth was slower after the kill while bluegill growth increased (Beckman 1948).

Ponderal index values must be compared to published values or established standards. Standards for the state of Illinois for largemouth bass are: 0.97 to 1.25 are classified as in poor condition, 1.26 to 1.54 are average, and 1.53 to 1.80 are classified as good condition. Generally, there is an increase in condition factor with length with the lowest values in the 190 to 300 mm size range (Carlander 1977). Colle and Shireman (1980) used the ponderal index to evaluate fish growth in the presence of excessive *Hydrilla* infestation. Their analysis showed that largemouth bass less than 200 mm grew rapidly in the presence of excessive vegetation while fish of greater size were inhibited in growth by excessive vegetation (excessive vegetation cover was defined as having the lake covered with *Hydrilla* by more than 20%). Condition factor values increased linearly with total length and chronologically within the year. Condition factors were lowest in summer and highest in fall and winter. Mean September K(TL) values for 75-150 mm bass were 0.99, 150-250 mm K(TL) was 0.95, and fish greater than 251 mm had a K(TL) of 1.42.

Illinois and Minnesota have established K(TL) standards for bluegill. Illinois standards are: less than 1.39 poor; 139-2.22 average; and greater than 2.22 good. Values increase with increasing total length. Minnesota standards are: less than 1.66 poor, 1.83-2.24 average, and greater than 2.24 good. The central 50% of values throughout the midwestern states ranged from 1.78 to 2.05 (Carlander 1977). In *Hydrilla* infested waters, bluegill K(TL) values ranged from 1.39 to 1.97. September values for all sizes of bluegills averaged 1.47 (Colle and Shireman 1980). Minnesota standards for K(TL) values for black crappie are: less than 1.05 poor, 1.22-1.50 average, and greater than 1.50 good (Carlander 1977).

Relative weight (W_r) values are comparisons of observed fish length/weight relationships against a standard length/weight relationship. One advantage of relative weight over condition factor is comparability. Relative weight values will be comparable regardless of measurement system, species measured, or age of the fish. Fish with a W_r value of $\geq$ 1.00 are considered to be in the 75th percentile of growth, while values between 0.93 and 0.99 indicate fish growth in the 50th percentile. Values between 0.95 and 1.00 indicate that the population is in equilibrium with other populations in the community (Wege and Anderson 1978, Gabelhouse 1984).

Comparative information: Information gathered by the Nebraska Game and Parks Commission on lakes proximal to Oak Middle Creek 58-B provide comparable age and growth data. Standard survey information was examined for Yankee Hill Lake (Blaser 1982), Conestoga Lake (Tunink 1982a, and Tunink 1983), Wagontrain Lake (Tunink 1982b), Wildwood Lake (Winter 1981b), and Stagecoach Lake (Winter 1981a).

A table of the average calculated lengths and weights at each annulus for largemouth bass, bluegill, and crappie (both white crappie, *Pomoxis annularis*, and black crappie) is shown in the Appendix.

All condition factors of largemouth bass reported in the standard surveys were in the average to good range according to the Illinois standards (See appendix for a complete listing of the condition factors by year class). Condition factors for bluegill were in the average range. Age 0 and 1 fish were near the lower end of the range, however. Condition factors were consistent within a year class and age. Condition factors of black crappie were classified as poor. There was wide variability from lake to lake. Relative weight values from the standard surveys ranged from 0.964 to 1.083 for largemouth bass, 0.812 to 0.985 for bluegill, and 0.783 to 0.977 for black crappie (Blaser 1982, Tunink 1981a and 1981b, and Winter 1981a and 1981b).

Balance in a fishery is not a statistic but a result of dynamic rate functions of reproduction, growth, and mortality at the community level (Reynolds and Babb 1978, Hackney, 1979). A balanced pond can be broadly classified as having mortality that is low (50% to 30%) under conditions of no harvest, a relatively stable reproductive rate, and an adequate growth rate. More specifically, a balanced largemouth bass population in the central United States during late summer can be characterized by having (1) at least 50 adults/hectare; (2) 45 kg/ha of biomass; (3) no more than 50% annual mortality for ages 2 through 5; (4) no missing year classes from age 0 through 5; (5) a growth rate going from 200 mm to 310 mm in one year; and (6) a Proportional Stock Density of 40% to 60% (Reynolds and Babb 1978, Redmond 1974).

In his classic study of small pond population dynamics, Swingle (1950b), classified numerous small ponds as balanced or unbalanced depending upon the values of different biomass criteria. When the F/C (Forage to Carnivore), Y/C (Young forage to total Carnivore), and A_t (total Available for harvest) ratios are examined for all of the balanced ponds, the F/C ratio fell within the limits of acceptable values (3.0 to 6.0) 55% of the time, the Y/C ratio fell with the limits of acceptable values (1.00 to 3.00) 49% of the time and the A_t proportion fell within acceptable values (30% to 90%) 100% of the time. When acceptable limits for all three criteria were applied to the list of balanced ponds, only 17 (31%) of the balanced ponds met all three criteria. The probability of making an error (calling a balanced pond unbalanced through examination of the F/C, Y/C, and A ratios) would be 69%.

On the other hand, the probability of making the opposite error (calling an unbalanced pond balanced) was 19% for the F/C ratio, 16% for the Y/C, and 31% for the A_t. When all three relationships were considered, unbalanced ponds were categorized correctly 100% of the time. (NOTE: the Y/C ratio requires a complete census of the fish population, i.e., draining of the pond, in order to have the proper data for calculation. The Available Prey per Predator ratio (AP/P) is roughly equivalent to the Y/C ratio and is easier to calculate (Jenkins 1979).)

Regier (1963) monitored the growth and population dynamics of newly stocked farm ponds in New York. Peak production occurred in the third year of growth after stocking, coinciding with the maximum harvest of fish, especially the bluegill. The original stock carried the brunt of the harvest for five years. Growth of the fish spawned in these ponds was significantly slower than the original stock. It was suggested that the growth of the original stock was dependent upon the physical parameters of the pond (e.g., water temperature, size and depth, length of growing season) while the growth of the progeny was density dependent. The estimated mean weight of bass 256 mm long were 236 g, 250 g, 245 g, and 218 g, in the second through the fifth year after stocking. The mean weight of the progeny bass in the fifth year is nearly the same as the average for the northern tier of states: 217 g (Carlander 1977). Relative weight values for largemouth bass 256 mm long were 1.010, 1.070, 1.048, and 0.933 in the second through the fifth year after stocking, respectively, in New York (Regier 1963). The New York ponds did not meet the F/C ratio criteria for being balanced (between 3.0 to 6.0) until the third year on the average (Regier 1963).

In his analysis of the data, Regier (1963) chose not to use Swingle's methods of assessing balance using instead a measure of plumpness and crowding. The two parameters were considered to be related in that if a fish population is considered to be more plump than the study average, the predator population is less crowded, i.e., there is more forage per individual than in a crowded pond. The same situation is true for the prey species. This implies a density dependent relationship between individual fish weight and population density.

Another study that examined fish growth rates in small ponds following initial stocking was done Missouri (Graham 1974). In this study, 0.2 ha ponds were stocked with a simulated second year bass-bluegill-channel catfish population. Total biomass for largemouth bass and channel catfish remained relatively constant over three years of study while the bluegill population expanded rather rapidly. Comparing the biomass values for largemouth bass and bluegill with Regier's data shows that the two experiments produced similar largemouth bass populations but bluegill populations had much lower biomasses in Missouri than in New York. One factor may have been that the lower bluegill population was a result of channel catfish predation that was present in the Missouri ponds. Another factor could have been cooler water temperatures in New York that would favor bluegill production over largemouth bass predation.

Graham's populations differed considerably from Regier's populations with respect to the F/C ratio. After the second year, Regier's ponds could be categorized as balanced using the F/C ratio while Graham's ponds had an acceptable F/C ratio (between 3.0 and 6.0) only once when the channel catfish were excluded from the calculations. Available prey/predator ratios were close to the ideal value of 1.00 when channel catfish were included. Proportional Stock Densities for both largemouth bass and bluegill were within acceptable ranges. This substantiates Swingle's statement that more information than just the F/C ratio is necessary to determine if a pond is balanced (Swingle 1950b).

METHODS AND PROCEDURES

Data were collected and analyzed to test if annual fish growth in Oak Middle Creek 58-B was significantly different from annual fish growth from the source lakes. Growth was analyzed in terms of total length and in terms of weight at a given length. As a means of validating growth analysis, biomass and balance relationships were calculated.

Field sampling

The pond owners agreed to allow data aquisition if capture methods were non-lethal, if no fish were removed from the population, and if any marks would not restrict fish movement or growth. Pond morphology presented some restrictions on sampling methods and few sites could be used that were not affected by vegetation. Electrofishing boats with boom mounted electrodes were selected as the primary sampling method supplementing the sample with trap nets when vegetation did not hinder their use.

Upon capture, all fish were identified, measured to the nearest millimeter (total length), weighed to the nearest gram, examined for previous marks, and, if unmarked, fin clipped. Scale samples were taken from a representative sample of all scaled fish sampled. The mark chosen was to clip the upper or lower caudal fin, depending upon the year. A caudal clip has been show to be the mark least frequently missed by examiners (Lewis *et al.* 1962, Stott 1968) and to have less impact on fish behavior than other fin clips (Ricker 1949). An example of data recording forms is shown in the Appendix.

Curves developed by Robson and Regier (1964) were used to estimate number of fish to be marked and recaptured for a Peterson type population estimate. Marking or recapturing the appropriate number of fish would signal the end of the sampling season.

The 1983 sample year was shortened by inclement weather. Also, one of the landowners closed approximately 25% of the pond to sampling. If random distribution of marked fish is assumed, then reduction of sample area would have no effect. However, sexually mature largemouth bass are territorial and do not re-distribute themselves randomly throughout a pond, but return to their established territory if possible. Therefore, largemouth bass estimates for fish greater than 300 mm were multiplied by a factor of 1.25 to compensate for the inability to sample territorial adults. All other estimates were calculated as normal assuming random distribution of smaller bass and forage fish (Carline *et al.* 1984). The 1984 sample was a divergence from the sampling procedure in that sampling was performed in spring as opposed to fall. This was necessary to meet our agreement with the landowner and have all field work completed within three years of re-stocking. A fall sample would not have met that obligation. Also, because the 1983 sample could not be used for estimating balance, a third sample was required to be able to note any trends over time.

Age and Growth Analysis

Scales were used to age and back-calculate previous growth of largemouth bass, bluegill, and black crappie. Scales were pressed between two pieces of acetate and then read using a commercial scale projector. Scale radius and the distance to each annulus from the focus was measured to the nearest millimeter. The Fraser-Lea formula was used to calculate respective lengths at each annulus. Standard intercepts were used so that the calculated lengths could be compared to lengths calculated from fish taken in different years, different times of year, different waters, and different stocks. Recommended intercepts are 20 for largemouth bass and bluegill, and 35 for black crappie (Carlander 1982, Carlander 1977, Tesch 1973, Jearld 1983)

Statistical analysis: To determine if calculated lengths at each annulus were significantly different between pre-stocking and post-stocking populations, a second degree polynomial regression of calculated total length (L) on year (Y) of life ($L = b0 + b1Y + b2Y^2$) was fitted to the data on growth which took place before stocking. A 95% confidence interval was fitted about the regression line. To analyze the effect of the stocking technique on fish growth, mean lengths at each annulus were calculated by grouping samples according to sample year, and then by year classes within the year sampled. These results were compared to model values from the pre-stocking growth curves. If a mean length for a year class fell outside the 95% confidence intervals, then growth was considered to be significantly less than or greater than the model (Parker 1958, Carlander 1956).

Growth in terms of weight was analyzed in a similar manner. The length/weight relationships of the originally stocked fish were calculated and plotted with 95% confidence intervals. Points at 25 mm (for largemouth bass) and 10 mm (for bluegill and black crappie) intervals were then plotted using the length/weight relationships for each species for each year. If points calculated using post-stocking samples fell outside the 95% confidence interval, then the weights at a given length were considered to be significantly less than or greater than the original ratio (Parker 1958).

Population Balance Analysis

Peterson type population estimates were made to supplement statistical analysis of age and growth information. When using the Peterson method, the population is commonly underestimated by a factor of 100 $e^{(-MC/N)}$ percent, where M is the total number of fish marked, C is the number of fish captured in a given sample, and N is the estimated population. This factor was used to correct estimates with less than seven recaptures. Bias can be considered to be absent if the size group has at least seven recaptures (Robson and Regier 1964). Biomass was estimated by using the calculated length/weight relationship and the population estimate for each year of sampling. Chi-squared contingency analysis was performed to determine if the sampling was biased toward larger size groups (Cooper and Lagler 1956, Robson and Regier 1973).

Measurements from individual fish were used to calculate the ponderal index (K(TL)) and relative weight (W_r). Standard weight regression equations were used to calculate the relative weight (Wege and Anderson 1978, Newcomb personal comm., Gablehouse 1984, Tesch 1973, Weatherly 1972).

Population and biomass estimates were used to determine the balance of the pond. As defined by Swingle (1950b), a population is satisfactorily balanced if "the populations yield, year after year, crops of harvestable fish that are satisfactory in amount when basic fertilities of the body of water containing these populations are considered." Values used to validate the statistical analysis were the F/C ratio, A_t value, AP/P ratio, and the PSD value (Swingle 1950b, Hackney 1979, Anderson 1976, and Carline *et al.* 1984).

RESULTS

Age and Growth Analysis: Linear body-scale relationships for the three species of fish had correlation coefficients of 0.93 for largemouth bass, 0.88 for bluegill, and 0.80 for black crappie. The Frazer-Lea method was used for back calculating growth of black crappie with the understanding that the body length-scale length correlation was not strong (Gabelhouse 1984, and Willis *et al.* 1984).

The model quadratic regression equation for largemouth bass was $L = -48.8 + 153.1\ Y + (-11.5)\ Y^2$, with a correlation coefficient of 0.92 and a coefficient of variation of 15.99. The model quadratic regression equation for bluegill was $L = -14.3 + 72.2\ Y + (-6.1)\ Y^2$, with a correlation coefficient of 0.84 and a coefficient of variation of 20.70. The model black crappie regression equation was $L = -6.2 + 84.4\ Y + (-6.8)\ Y^2$, with a correlation coefficient of 0.83 and a coefficient of variation of 19.03. Table 2 is model lengths at each annulus with 95% confidence intervals at the annulus. Table 3 is the length/weight relationship for each species by year.

To determine if the pre-stocking growth was different from the post-stocking growth, tables were prepared listing the average calculated length at each annulus for each year class sampled by sample year. If the growth took place after 1981, it was compared to the pre-stocking growth standard for each species. The results of these comparisons are shown in Tables 4, 5, and 6. Average calculated lengths at an annulus that were significantly less than the pre-stocking standard, were flagged as negative (-). Lengths that were significantly greater than the pre-stocking standard were flagged as positive (+), while lengths that were not significantly different were given a neutral flag (0).

Of 47 largemouth bass length comparisons, nearly half (23) have lower average lengths than the original stock, ten had

Table 2. Model lengths of fish at each annulus as calculated from quadratic regression equations on the growth at each annulus from before fish were stocked.

Largemouth Bass:

Annulus	Length	Lower Limit	Upper Limit
1	92.8	88.6	97.0
2	211.5	208.3	214.6
3	307.1	303.1	311.2
4	379.9	375.2	384.6
5	429.7	423.0	436.4
6	456.5	444.8	468.2
7	460.4	440.8	479.9

Bluegill:

Annulus	Length	Lower Limit	Upper Limit
1	51.8	48.6	55.0
2	105.9	101.0	110.8
3	147.7	141.9	153.8
4	177.7	163.7	191.7

Black Crappie:

Annulus	Length	Lower Limit	Upper Limit
1	71.4	67.3	75.5
2	135.5	127.4	143.7
3	186.1	176.0	196.3
4	223.2	194.8	251.6

Table 3. Length-weight (log-log) relationships for fish sampled in Oak Middle Creek 58-B, 1981 through 1984.

Year	Size Range	Intercept	Slope	r^2	Number Measured
Largemouth Bass:					
1981*	201-550	-6.886	3.804	0.91	84
1981**	253-502	-4.900	3.056	0.99	38
1982	62-528	-4.567	2.888	0.99	72
1983	58-420	-5.667	3.332	0.97	66
1984	74-537	-5.324	3.189	0.99	75
Bluegill:					
1981*	50-200	-4.552	2.953	0.92	26
1982	52-223	-4.855	3.082	0.95	42
1983	28-206	-5.216	3.230	0.98	127
1984	50-229	-4.666	2.999	0.97	102
Black Crappie:					
1981*	100-169	-5.320	3.202	0.98	8
1982	69-164	-2.206	1.817	0.95	7
1983	61-218	-5.108	3.087	0.92	62
1984	57-202	-5.108	3.113	0.95	46

* Initial stocking

** Sampled in first population estimate

Table 4. Length at annulus and occurrence of significant differences from mean total lengths at each annulus formed in successive years after stocking for largemouth bass (+ indicates a significant increase from pre-stocking calculated lengths, 0 no change, and - a significant decrease).

Sample Year	Year Class	Annulus 1	2	3	4	5	6	7
1981:	1974							489 (+)
	1975						463 (0)	
	1976					422 (-)		
	1977				367 (-)			
	1978			308 (0)				
	1979		227 (+)					
	1980	127 (+)						
1982:	1975						467 (0)	493 (+)
	1976					417 (-)	455 (0)	
	1977				349 (-)	401 (-)		
	1978			202 (-)	318 (-)			
	1979		207 (-)	316 (+)				
	1980	82 (-)	181 (-)					
	1981	75 (-)						
1983:	1978			249 (-)	320 (-)	359 (-)		
	1979		204 (-)	360 (+)	380 (0)			
	1980	78 (-)	214 (0)	384 (+)				
	1981	79 (-)	193 (-)					
	1982	77 (-)						
1984:	1978			341 (+)	416 (+)	444 (+)	466 (0)	
	1979		236 (+)	330 (+)	378 (0)	423 (0)		
	1980	86 (-)	198 (-)	298 (-)	357 (-)			
	1982	91 (0)	182 (-)					
	1983	113 (+)						

Table 5. Length at annulus and occurrence of significant differences from mean total lengths at each annulus formed in successive years after stocking for bluegill (+ indicates a significant increase from pre-stocking calculated lengths, 0 no change, and - a significant decrease).

Sample	Year	Annulus			
Year	Class	1	2	3	4
1981:	1977				187 (0)
	1978			120 (-)	
	1979		128 (+)		
	1980	35 (-)			
1982:	1978			148 (0)	176 (0)
	1979		105 (0)	144 (0)	
	1980	63 (+)	112 (+)		
	1981	51 (0)			
1983:	1981	59 (+)	128 (+)		
	1982	52 (0)			
1984:	1980	67 (+)	110 (0)	155 (+)	174 (0)
	1981	49 (0)	103 (0)	155 (+)	
	1982	46 (-)	98 (-)		
	1983	69 (+)			

Table 6. Length at annulus and occurrence of significant differences from mean total lengths at each annulus formed in successive years after stocking for black crappie (+ indicates a significant increase from pre-stocking calculated lengths, 0 no change, and - a significant decrease).

Sample Year	Year Class	Annulus 1	Annulus 2	Annulus 3	Annulus 4
1981:	1977				207 (0)
	1978			198 (+)	
	1979		149 (0)		
1982:	1980	54 (-)	136 (0)		
	1981	71 (0)			
1983:	1980	55 (-)	113 (-)	154 (-)	
	1981	76 (+)	116 (-)		
1984:	1981	64 (-)	108 (-)	161 (-)	
	1982	80 (+)	141 (0)		
	1983	83 (+)			

no difference, and 14 were longer than the orginal stock (Table 4). Age 1 through 3 generally had poor growth in terms of length with 15 of the 23 negative values occurring in these age groups. Length/weight ratios for all four sampling years and the pre-stocking ratio are not significantly different until largemouth bass exceed 375 mm (Table 7). Beyond that point the 1981, 1982, and 1984 weights are all significantly less than the original ratio. The 1983 ratio closely follows the lower confidence interval.

Of 22 bluegill length comparisons, 18 show significantly longer total lengths or show no significant change when compared with the pre-stocking growth standard. Only four comparisons are significantly shorter than the pre-stocking growth standard (Table 5). Bluegill weights were greater in Oak Middle Creek 58-B than in the source lakes for fish longer than 140 mm as well (Table 7).

As with largemouth bass, there was a plurality of negative results (8 of 17) when comparing growth of black crappie with the pre-stocking model (Table 6). Poor sampling effectiveness and poor distribution of size classes of black crappie resulted in few comparisons. Back calculated lengths at each annulus was consistently longer in earlier sampling years, older year classes, and in the Salt Valley

Table 7. Weights calculated at length intervals using length/weight relationships from originally stocked fish, fish sampled in 1982, 1983, 1984, average relationship from five Salt Valley lakes, and the standard length/weight relationship as proposed by Gabelhouse (1984).

Largemouth Bass:

T.L.	Pre-Stocking Weight	1982	1983	1984	Average Salt Valley	Standard Weight
50	0.3	2.1	0.9	1.2	1.2	1.2
100	5.2	16.1	9.9	11.3	10.6	11.5
150	24.6	52.1	38.3	41.2	37.0	42.2
200	73.6	119.7	100.0	103.2	90.0	105.8
250	172.0	228.1	210.3	210.3	179.3	215.6
300	344.3	386.3	386.1	376.3	314.7	385.9
350	618.9	602.9	645.4	615.2	506.3	631.1
400	1028.5	886.6	1007.0	941.8	764.4	966.4
450	1609.9	1245.8	1491.0	1371.1	1099.4	1407.3
500	2403.7	1688.9	2118.2	1918.7	1521.6	1969.7

Bluegill

T.L.	Pre-Stocking Weight	1982	1983	1984	Average Salt Valley	Standard Weight
40	1.5	1.2	0.9	1.3	0.6	0.8
60	5.0	4.2	3.3	4.6	2.6	3.3
80	11.6	10.2	8.5	11.0	7.1	8.6
100	22.5	20.3	17.5	21.4	15.4	18.1
120	38.7	35.7	31.6	37.1	29.0	33.1
140	61.0	57.4	52.0	58.9	49.5	55.2
160	90.5	86.7	80.0	87.9	78.6	86.0
180	128.1	124.6	117.0	125.1	118.3	127.2
200	174.9	172.4	164.5	171.7	170.4	180.3
220	231.8	231.3	223.8	228.5	237.2	247.4

Black Crappie

T.L.	Pre-Stocking Weight	1982	1983	1984	Average Salt Valley	Standard Weight
40	0.6	5.0	0.6	0.7	0.2	0.9
60	2.3	10.5	2.4	2.6	1.1	3.2
80	5.9	17.8	5.8	6.5	3.1	7.8
100	12.1	26.7	11.6	13.1	6.7	15.5
120	21.7	37.3	20.4	23.1	12.7	27.0
140	35.6	49.3	32.8	37.4	21.6	43.3
160	54.6	62.9	49.6	56.6	34.1	65.1
180	79.6	77.9	71.4	81.7	51.2	93.3
200	111.6	94.4	98.9	113.5	73.6	128.7
220	151.5	112.2	132.7	152.7	102.1	172.2

lakes. Comparisons of length/weight ratios are based on a small number of data points (Table 7). The 1982 ratio is based upon lengths and weights from seven fish with a length range of 77 to 159 mm. Extrapolating this information into a curve over the entire range of fish sampled is not advisable. Weights of this sample year are consistently heavier than those of black crappie for other years possibly indicating a systematic error.

Weight at each annulus was calculated by using the length/weight relationship for each sample year and the average length at each annulus for each species for each year. Results of these calculations are shown in the Appendix.

Population enumeration and biomass estimates: In 1981, 1982, 1983, and 1984 population estimates were computed using the Peterson method. Appendix Table A-1 shows sampling dates and the number of fish captured for each year of sampling. Chi-squared analysis of all size increments for each year of sampling showed that the sampling was unbiased for largemouth bass and black crappie in all years but 1982, and unbiased for bluegill for all years but 1984. In the years when biased results were found, only one size increment had an unusually high recapture rate, therefore no adjustments were made to compensate. No contingency table was generated for 1983 bluegill or black crappie samples because of low recapture rates. Populations were estimated on the entire sample, not on pre-defined size groupings (Cooper and Lagler 1956).

In 1981, no population estimate was attempted on bluegill because less than ten bluegill greater than 150 mm were sampled. No black crappie were collected. Numerous bluegill and bass were observed that were too small to be netted. Other species sampled were carp, black bullhead, redear sunfish (*Lepomis microlophus*), and channel catfish.

The 1982 sample was the most precise of all the population estimates having the lowest coefficients of variation. Species collected other than largemouth bass, bluegill, and black crappie were carp, black bullhead, and white sucker (*Catostomus commersoni*).

Coefficients of variation are the highest for 1983 of all three population estimates. The black crappie population estimate was based on so few recaptures that the 90% confidence interval includes zero. As such, balance estimates would be exessively inaccurate and imprecise. Species that were collected in 1983 other than bass, bluegill, and black crappie were northern pike (*Esox* *lucius*), carp, black bullhead, and walleye. Walleye were stocked by the Nebraska Game and Parks Commission and the northern pike presumably entered Oak Middle Creek 58-B through an overflow from the pond upstream of the north arm.

Population estimates for 1984 were considerably more reliable than the 1983 estimates with coefficients of variation of 11.91, 25.82, and 40.75 for largemouth bass, bluegill, and black crappie, respectively. As noted previously, 25% of the pond was closed to sampling in 1983 and 1984. Therefore, estimates of largemouth bass of greater than 300 mm were multiplied by a factor of 1.25 to correct for the inability to sample that portion of the pond. Numerous small bluegill and largemouth bass were observed but not collected. Other speciesd sample were northern pike, walleye, black bullhead, and carp.

Largemouth bass estimates: Largemouth bass were recaptured more efficiently than the forage species. In 1981, the population estimate had a recapture efficiency of 14.8% (8 recaptures of 54 marks), in 1982, the recapture efficiency was 12.7% (88 recaptures of 694 marks), 1.2% in 1983 (2 recaptures of 161 marks), and 15.9% in 1984 (44 recaptures of 276 marks). Effectiveness of recapture is reflected in the confidence intervals (90% C.I.) for each

Table 8. Estimated number and biomass of largemouth bass in Oak Middle Creek 58-B from 1981 through 1984 broken down by 25 mm size class.

Size	1981		1982		1983 *		1984 *	
Class (mm)	Number	Biomass (kg)	Number	Biomass (kg)	Number	Biomass (kg)	Number	Biomass (kg)
62	0	0.00	106	0.43	129	0.26	0	0.00
87	0	0.00	437	4.74	1205	7.53	9	0.07
112	0	0.00	148	3.32	1980	28.70	72	1.17
137	0	0.00	118	4.76	818	23.20	28	0.87
162	0	0.00	1359	88.74	43	2.13	3	0.17
187	0	0.00	1158	114.46	258	20.66	28	2.35
212	5	0.86	148	20.98	387	47.07	47	5.85
237	0	0.00	0	0.00	732	128.90	295	52.28
262	27	8.25	0	0.00	689	169.45	176	42.89
287	74	30.50	12	4.02	86	28.70	34	11.27
312	32	16.88	53	23.05	86	37.90	9	4.01
337	48	32.04	136	73.60	86	49.00	9	5.13
362	69	57.59	260	173.13	43	31.10	16	10.74
387	11	10.87	136	109.76	172	155.40	81	69.08
412	11	13.16	12	11.44	215	239.30	25	25.95
437	11	15.75	0	0.00	0	0.00	16	19.57
462	11	18.67	0	0.00	0	0.00	0	0.00
487	16	32.90	12	18.54	0	0.00	9	16.59
512	0	0.00	6	10.71	0	0.00	3	6.49
537	0	0.00	0	0.00	0	0.00	3	7.55
Totals:	315	237.47	4101	661.68	6929	969.30	863	282.03
90% C.I.								
Lower	169		3474		579		696	
Upper	459		4728		13279		1034	
Total/ ha	74	55.74	963	155.32	1627	227.53	203	66.20
C.V.	28.30		9.32		55.88		11.91	

* corrected by a factor of 1.25

year and in the coefficient of variation (C.V.) (Table 8). Estimates marked with an asterisk (*) have been multiplied by a factor of 1.25 to compensate for a 25% reduction of the pond that was closed to sampling in 1983 and 1984. Analysis of data for each year yielded very low correlations of length to recapture efficiency (r^2 of less than 0.20 for each year); therefore no correction factor is required to compensate for capture/recapture bias by size (Cooper and Lagler 1956).

Bluegill estimates: Recapture efficiency for bluegill was 3.0% in 1982 (33 recaptures of 1099 marks), 0.7% in 1983 (6 recaptures of 833 marks), and 5.5% in 1984 (26 recaptures of 477 marks) (Table 9).

Black Crappie estimates: The ratio of recaptures to marks was 10 recaptures to 526 marks (1.9%), 1 recapture to 105 marks (1.0%), and 5 recaptures to 182 marks (2.8%) in 1982, 1983, and 1984, respectively. The low number of recaptures allows for neither accurate nor precise population estimate (Table 10).

Ponderal index and Relative weight: The ponderal index (K(TL) was calculated for each species for each age for each year (Table 11). Age zero (0) K(TL) was not determined because of inaccuracies of weighing small fish

Table 9. Estimated number and biomass of bluegill in Oak Middle Creek 58-B from 1982 through 1984 broken down by 10 mm size class.

Size Class (mm)	1982		1983		1984	
	Number	Biomass (kg)	Number	Biomass (kg)	Number	Biomass (kg)
25	0	0.00	66	0.01	0	0.00
35	0	0.00	659	0.39	0	0.00
45	0	0.00	53	0.07	0	0.00
55	74	0.24	79	0.20	27	0.10
65	221	1.19	316	1.38	53	0.32
75	197	1.65	1159	8.03	533	4.84
85	1426	17.57	1923	19.97	1200	15.85
95	3982	69.15	1739	25.86	1573	29.02
105	7325	173.17	1423	29.23	1573	39.18
115	4744	148.44	685	18.88	1093	35.77
125	2851	115.36	211	7.61	1066	44.81
135	2458	126.07	132	6.10	187	9.88
145	1450	92.70	277	16.12	240	15.74
155	1229	96.49	645	46.66	426	34.17
165	614	58.50	514	45.45	1226	118.50
175	221	25.25	527	56.37	1706	196.69
185	49	6.66	342	43.85	1413	192.43
195	49	7.83	171	25.99	373	59.53
205	0	0.00	53	9.40	0	0.00
215	74	15.87	0	0.00	0	0.00
225	49	12.17	0	0.00	27	6.53
Totals	27013	968.31	10974	361.57	12716	803.36
90% C.I.						
Lower	19456		5255		7331	
Upper	34589		16691		18099	
Total/ ha	6282	225.18	2552	84.08	2957	186.82
C.V.	17.06		31.77		25.82	

Table 10. Estimated number and biomass of black crappie in Oak Middle Creek 58-B from 1982 through 1984 broken down by 10 mm size class.

	1982		1983		1984	
Size Class (mm)	Number	Biomass (kg)	Number	Biomass (kg)	Number	Biomass (kg)
45	0	0.00	0	0.00	96	0.20
55	0	0.00	873	2.69	144	0.49
65	37	0.45	873	4.19	24	0.13
75	1368	21.71	873	6.17	0	0.00
85	4659	92.83	109	1.09	0	0.00
95	8430	205.59	0	0.00	96	1.46
105	2514	73.54	109	1.96	335	6.79
115	185	6.38	109	2.53	982	25.77
125	111	4.45	764	22.50	838	27.95
135	370	17.07	2620	96.19	862	35.91
145	887	46.66	2730	123.10	335	17.19
155	666	39.50	1310	71.67	168	10.44
165	222	14.75	437	28.65	192	14.33
175	0	0.00	218	17.00	168	14.91
185	0	0.00	0	0.00	0	0.00
195	0	0.00	218	23.34	120	14.65
205	0	0.00	218	27.04	0	0.00
Totals:	19449	522.93	11461	428.12	4360	170.22
90% C.I.						
Lower	9731		0		1445	
Upper	29165		23423		7269	
Total/ ha	4565	122.75	2690	100.49	1023	39.95
C.V.	30.47		63.61		40.75	

Table 11. Condition factors (K) for fish sampled in Oak Middle Creek 58-B from 1981 to 1984.

Largemouth Bass:

	Age							
Year	1	2	3	4	5	6	7	mean
1981	1.41	1.42	1.43	1.43	1.44	--	1.46	1.42
(95% confidence interval about the mean -->								1.39-1.46)
1982	1.41	1.43	1.44	1.46	1.47	--	1.50	1.44
(95% confidence interval about the mean -->								1.39-1.48)
1983	1.23	1.32	1.40	--	1.58	--	--	1.32
(95% confidence interval about the mean -->								1.26-1.37)
1984	1.27	1.33	--	1.43	1.49	--	--	1.34
(95% confidence interval about the mean -->								1.30-1.39)

Bluegill:

	Age				
Year	1	2	3	4	mean
1981	2.15	--	2.26	2.73	2.35
(95% confidence interval about the mean -->					1.93-2.77)
1982	2.02	2.03	2.21	2.43	2.10
(95% confidence interval about the mean -->					2.00-2.20)
1983	1.79	1.99	--	--	1.87
(95% confidence interval about the mean -->					1.82-1.92)
1984	2.37	2.08	2.22	2.22	2.18
(95% confidence interval about the mean -->					2.11-2.24)

Black Crappie:

	Age				
Year	1	2	3	4	mean
1982	1.77	1.64	--	--	1.74
(95% confidence interval about the mean -->					1.54-1.95)
1983	--	1.21	1.29	--	1.22
(95% confidence interval about the mean -->					1.18-1.26)
1984	1.32	1.38	1.41	--	1.38
(95% confidence interval about the mean -->					1.34-1.42)

Table 12. Relative weight values for fish sampled in Oak Middle Creek 58-B from 1981 to 1984.

Largemouth Bass:

	Age							
Year	1	2	3	4	5	6	7	mean
1981	1.06	0.98	0.95	1.00	0.94	--	0.95	0.98
(95% confidence interval about the mean -->								0.95-1.00)
1982	1.11	0.94	0.94	0.99	0.94	--	0.94	1.02
(95% confidence interval about the mean -->								0.98-1.07)
1983	0.98	0.95	1.09	--	1.05	--	--	0.96
(95% confidence interval about the mean -->								0.93-1.00)
1984	0.96	1.01	--	0.94	0.89	--	--	0.98
(95% confidence interval about the mean -->								0.95-1.00)

Bluegill:

	Age				
Year	1	2	3	4	mean
1981	1.03	--	1.05	1.20	1.08
(95% confidence interval about the mean -->					0.96-1.21)
1982	1.08	1.01	1.04	1.07	1.07
(95% confidence interval about the mean -->					1.01-1.12)
1983	0.99	0.92	--	--	0.96
(95% confidence interval about the mean -->					0.94-0.99)
1984	1.40	1.12	1.04	1.00	1.12
(95% confidence interval about the mean -->					1.08-1.16)

Black Crappie:

	Age					
Year	1	2	3	4	5	mean
1982	1.12	1.04	--	--		1.10
(95% confidence interval about the mean -->						0.97-1.24)
1983	--	0.77	0.81	--		0.77
(95% confidence interval about the mean -->						0.75-0.80)
1984	0.84	0.87	0.88	--		0.87
(95% confidence interval about the mean -->						0.85-0.89)

in the field. Relative weights (W_r) were calculated using standard length-weight relationships (Table 12) (Wege and Anderson 1978).

Balance criteria: Balance criteria that were calculated were the Forage/Carnivore (F/C) ratio, total fish available for harvest in terms of biomass (A_t), available prey to predator ratio (AP/P), and the proportional stock density (PSD) (Figures 2, 3, 4, and 5).

The F/C ratio for the initial stocking was 0.21. In 1982, the ratio was estimated to be 1.60, 1.75 in 1983, and 2.00 in 1984. The plot of the last three years is linear (r^2 = 0.980) with a regression equation of F/C = 1.183 + 0.200 Y(t) where Y(t) is the number of years after stocking. Total biomass available for harvest (A_t) was 94.4% when stocked. In 1982 through 1984 A_t was 40.0%, 61.7%, and 76.7%, respectively. The relationship was linear (r^2 = 0.989) with a regression equation of A_t = -22.773 + 18.340 Y(t). Proportional stock densities (PSD) for the initial stocking were 68.5% for largemouth bass and 40.0% for bluegill. Values for largemouth bass were 15.0%, 8.7%, and 19.8% in 1982, 1983, and 1984. Values for bluegill were 8.5%, 20.5%, and 40.7% for the same years.

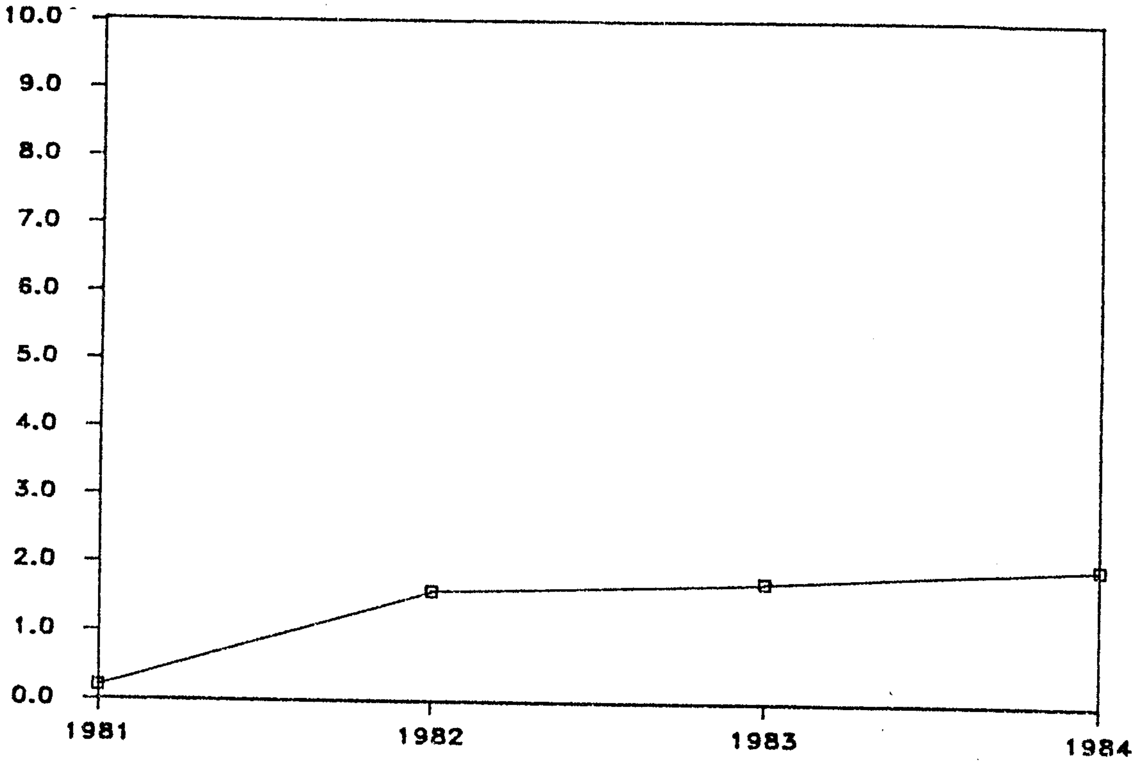

Figure 2. Forage/carnivore ratios for Oak Middle Creek 58--B from 1982 through 1984.

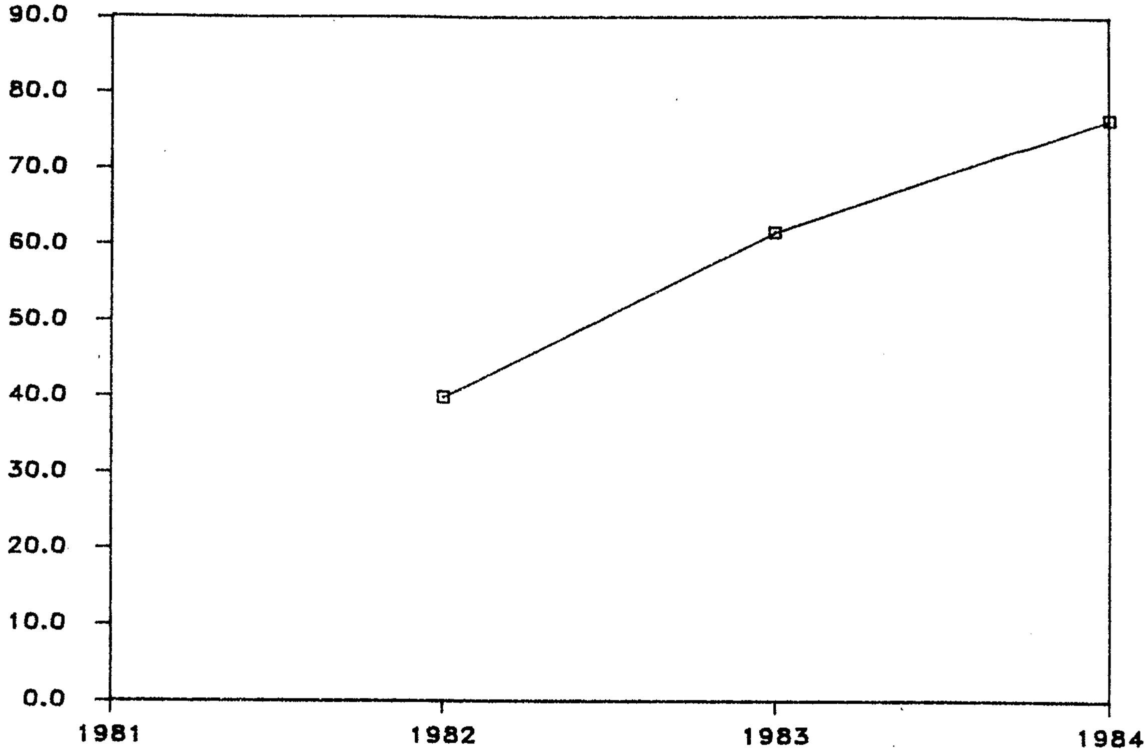

Figure 3. Total biomass of all species available for harvest (A(t)) from Oak Middle Creek 58-B from 1982 through 1984.

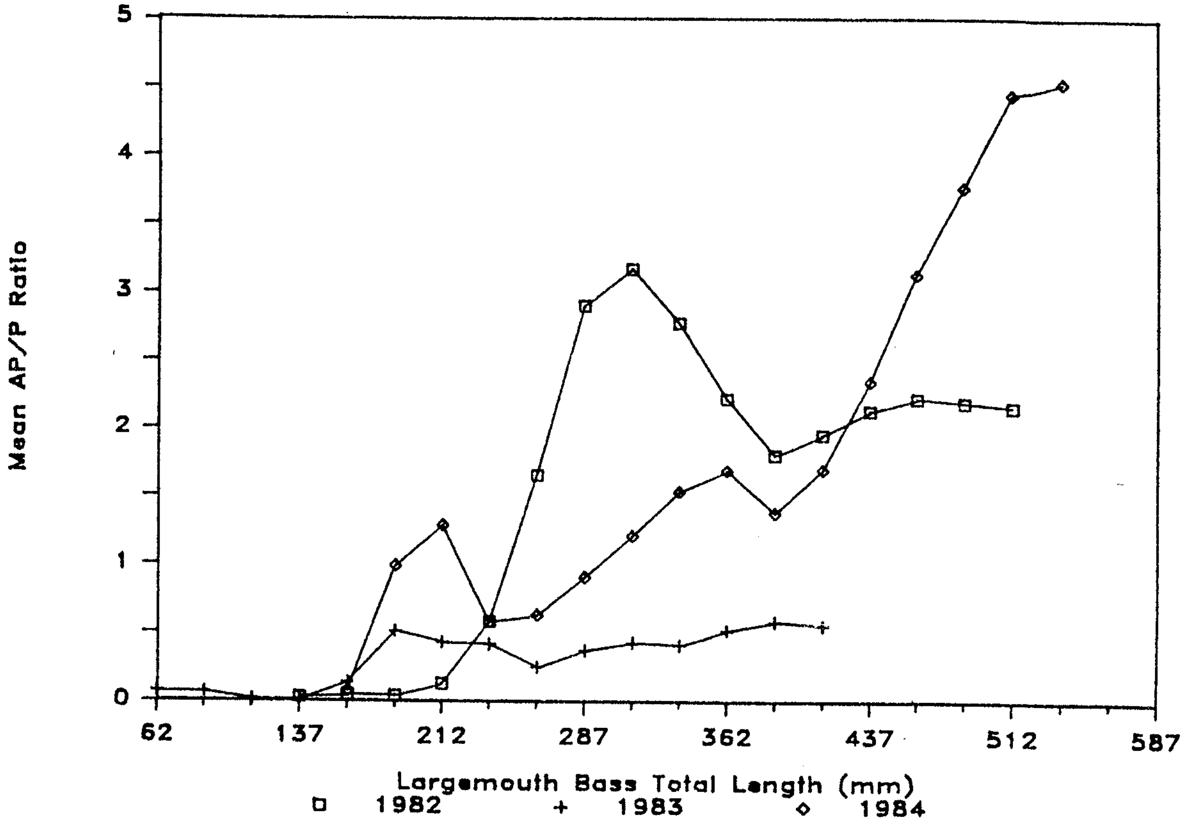

Figure 4. Mean available prey to predator ratio for Oak Middle Creek 58-B from 1982 through 1984.

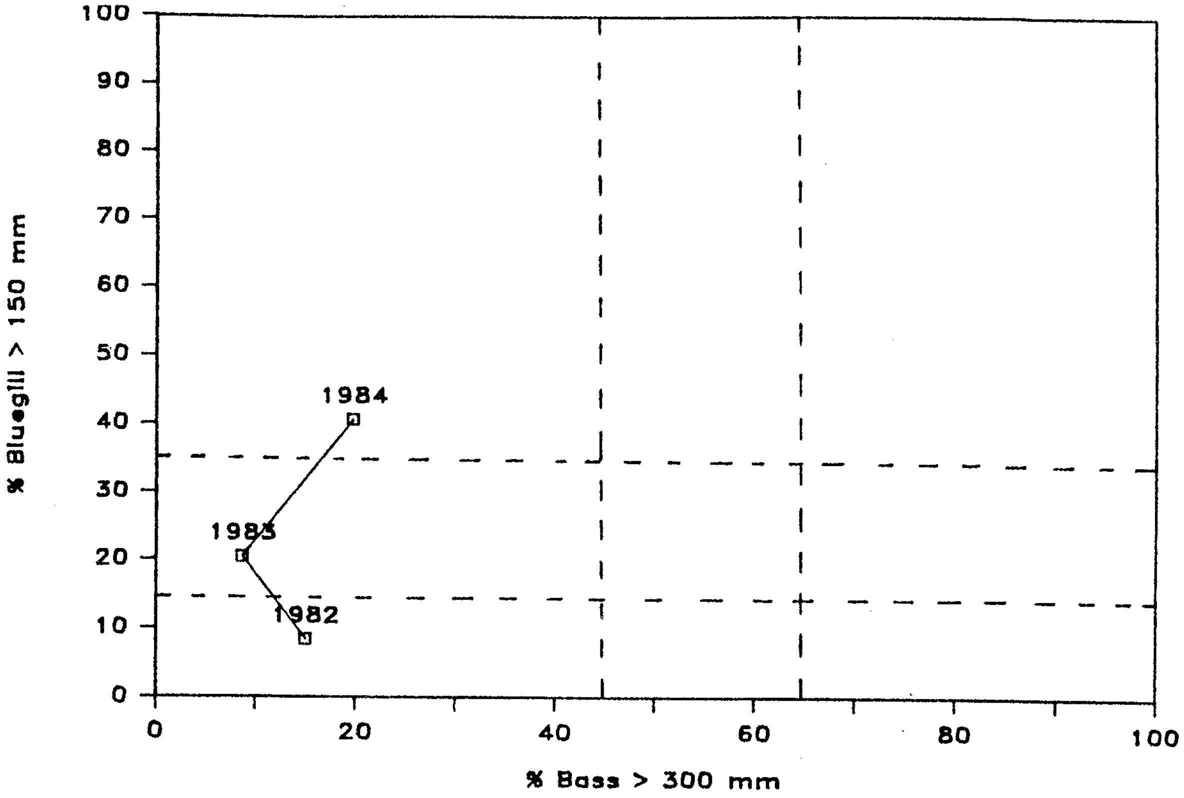

Figure 5. Proportional stock densities of largemouth bass versus bluegill for Oak Middle Creek 58-B from 1982 through 1984.

DISCUSSION

Objectives of this study were to compare fish growth (in terms of total length) in Oak Middle Creek 58-B with fish growth prior to stocking; compare fish weight gain in Oak Middle Creek 58-B with published values for plumpness and length/weight relationships in proximal lakes; and, determine if the population is balanced. Each sample year will be analyzed by comparing post-stocking growth, condition factors, and relative weights with pre-stocking growth, condition factors, and relative weights. Results from various balance calculations are also presented.

1981

Age and Growth Statistical Analysis

Largemouth bass: Examination of Table 4 shows that in 1981 the first two year classes had excellent growth. This was to be expected where there was little or no intraspecific competition. Forage from fathead minnows and young-of-the-year (YOY) bluegill was readily available. Depressed growth of the age 4 and 5 fish was also expected. A bass in the 367 to 463 mm range can swallow a bluegill up to 167 mm although smaller forage is preferred (Lawrence 1957). Because only adult bluegills were stocked, there was little or no forage for this size of bass, i.e., less than 200 bluegill for the 34 largemouth bass greater than 367 mm had been stocked (5.8 forage fish for each predator). Therefore, forage opportunities were limited. Calculated weights become significantly less than the pre-stocking weights beginning at this size (367 mm) (Table 7).

All of the condition factor (K(TL) values fall into the average condition category as defined by the state of Illinois (Carlander 1977). Relative weights for largemouth bass in 1981 were good, averaging 0.976 with three values falling outside the 95% confidence interval about the mean (alpha = 0.05, $p < 0.01$). A relative weight between the values of 0.95 and 1.00 is considered stable (Wege and Anderson 1978).

Significantly longer total lengths for age 7 fish (Table 4) coincides with a high ponderal index but a low relative weight and a weight that is significantly less than would be expected from the pre-stocking length/weight ratio. Ponderal indices increase with increasing age for largemouth bass while relative weight values are more sensitive to changes in condition than the ponderal index (Carlander 1977, Wege and Anderson 1978). A significantly longer total length and lower relative weight value appear to be in conflict. A possible scenario is that large largemouth bass were stocked in a pond with only a few bluegill that were acceptable prey, which were rapidly consumed. In the process, the largemouth bass grew quite well over the summer. However, when these fish were sampled in the fall, there was a void of available forage (none were sampled) and large bass were beginning to lose good condition. The 1982 bluegill estimate (Table 9) shows the bulk of that species is clustered about the 105 mm size class (two year old fish, spawned in 1980). In 1981 these fish were approximately 35 mm long, and would not have been large enough to be efficiently ingested by 450+ mm largemouth bass (Niimi 1981). This results in an inefficient predation pattern which can yield poor largemouth bass recruitment the following year (Hackney 1979, Davies *et al.* 1982).

The results of the 1981 sample raises an interesting question. In May and June of 1981, only largemouth bass greater than 300 mm (age three or older) were stocked. Yet in the fall of that year, sampling collected fish that were aged as 1 and 2 years old. The question arises: If only adult fish (at least 300 mm or longer) were stocked in the spring, where did the first two age groups come from? The initial stock spawned in the spring of 1981 but this does not account for the age 1 and 2 bass. There are three possible explanations: (1) the fish were improperly aged;

(2) the fish kill that was presumed to have been total was, in fact, partial; and, (3) immigration from other sources.

(1) Misreading scales and thus improperly aging the fish is not likely. Three largemouth bass were sampled that were less than 155 mm, all aged as one year old. Six fish were collected that were between 223 and 296 mm long and all but one were aged as two years old (one was aged as three). For midwestern states, largemouth bass average 114 mm at age 1, 208 mm at age 2, and 283 mm at age 3 (Carlander 1977). If the fish sampled in 1981 had approximately the same growth as the model growth (Table 2), than a 155 mm bass would be less than two years old (i.e., the second annulus had not formed and the fish had grown since the formation of the first annulus). A 296 mm bass would be less than three years old. The midwestern average and model lengths indicate that the fish were aged correctly.

(2) Investigations immediately after the fish kill using electrofishing equipment did not sample any largemouth bass. Electrofishing has been shown to be very effective (> 95%) for detecting the presence of largemouth bass in ponds (Reynolds and Babb 1978). Some fish were collected in the 1981 sample that could have survived the fish kill, namely, carp, black bullhead, redear sunfish, and channel catfish. All of these fish were large individuals for

their species which may indicate that they were present in the pond before the kill and survived. If this were the case, then it is possible that some largemouth bass and bluegill had survived the fish kill and avoided sampling in the fish kill investigation.

(3) Possible sources of immigration are flushing from upstream ponds and unauthorized stocking. Flushing from upstream ponds is highly unlikely because the only upstream pond that had any fishery had been completely renovated. During this study, fishermen were interviewed and indicated that they had fished in the outflow from Oak Middle Creek 58-B and then carried fish over the dam and stocked them into the pond because "that is where they probably came from." Species that they had stocked included carp, black bullhead, "sunfish", bass, and various "minnows" (which is any fish less than two inches long). It is doubtful if fisherman could stock the number of young bass that were estimated to be present, however.

Considering the three possible explanations, the presence of the first two year classes of largemouth bass are probably a result of an incomplete fish kill and unauthorized stocking. The 1981 population estimate bears supports this conclusion. Annual mortality rates for largemouth bass range between 30% to 40% (Carlander 1977, Ming 1974). If an annual mortality rate of 35% were assumed over seven months since stocking, there should have been 160 of the original stock remaining at the time of the 1981 estimate. This value is less than the lower limit of the 90% confidence interval (Table 8) which means that the estimated largemouth bass population of 314 fish is significantly greater than expected.

Bluegill and Black Crappie: In 1981, seven bluegill and no black crappie were sampled. The low sample numbers do not allow for a precise estimation of back calculated lengths at any annulus (Carlander 1977, Nielson and Schoch 1980). Thus, wide variation of results were expected, as noted by the calculated length of the 1979 year class bluegill at age 2 being longer than the age 3 fish of the 1978 year class. Bearing this in mind, age 1 bluegill are significantly shorter than expected (Table 5). Only one fish of this age was sampled.

Bennet (1943) demonstrated that bluegill transferred from a stunted population to one that is less crowded showed phenomenal growth during the first year after being stocked. Regardless of how far behind normal growth for their age, all had grown to reach normal length at the end of the first year. The age 4 growth comparison indicates that "catch up" growth happened with bluegills from this experiment as well. Growth rates for bluegill have been shown to increase after a winterkill while largemouth bass growth rates decrease during the same period (Beckman 1948).

According to Illinois and Minnesota standards (Carlander 1977), bluegill condition from Oak Middle Creek 58-B would be good for ages 3 and 4 and average for age 1. These data are similar to that found in Salt Valley lakes (Blazer 1982, Tunink 1982a 1982b, Winter 1981a 1981b). Wide confidence intervals for this sample year result from small sample sizes.

Reynolds and Simpson (1978) demonstrated species and size selectivity when using night electrofishing with AC current. They proposed a correction factor based on species and size but cautioned that the corrections should only be applied when the same capture technique is used. Corrections were not used in this study because different means of sampling were used (DC current during the day). However, it is acknowledged that the true abundance of small bluegill is underestimated by the sampling method used.

Population Balance Analysis

No balance criteria using forage fish estimates or biomass were calculated for 1981. Using the balance criteria considering only largemouth bass (Redmond 1974), the pond would be considered balanced. There were 49.1 adults/ha, 55.7 kg/ha of largemouth bass, no missing year classes, the growth rate was sufficient to grow from 200 mm to 310 mm in one year, and the PSD was 50.1%.

1982

In 1982 all three primary species were sampled in large enough numbers and with sufficient recaptures of marked fish to estimate the population and biomass. Population and biomass estimates were typical of expanding populations (Swingle 1956).

Age and Growth Statistical Analysis

Largemouth bass: Largemouth bass growth comparisons were mostly negative (Tables 4 and 5) Predator populations tend to overshoot food resources when the equilibrium is disturbed. Predator reproduction is higher than normal when food sources are abundant. However, after a year of high reproduction, predator biomass is greater than can be supported by prey biomass and thus cycles downward. Largemouth bass growth equilibrium is usually restored after a year while forage equilibrium is restored after about four years (Beckman 1948, Jenkins 1979). The significantly shorter lengths occur in ages 1 through 5 while age 6 fish were not significantly different and age 7 fish were significantly longer.

Condition factors for 1982 were not significantly different from 1981. Relative weight values had a slightly higher overall mean but not all ages improved. Age 2 and 7 fish had lower relative weight values in 1982 than in 1981. The 1982 sample was significantly lighter than the pre-stocking fish 375 mm and larger (Table 7). Close examination also shows that fish less than 275 mm are significantly heavier than the pre-stocking fish.

Age 1 and 2 fish are shorter than expected but plump while the age 6 and 7 fish are longer than expected but slender. This is not an expected result nor is it easily explained. There are at least three possibilities:

-- The younger aged fish were preying upon a large forage base of YOY bluegill and black crappie that was produced shortly after restocking. The older ages had decimated the forage available to them in 1981 and were now lacking in available forage.

-- The degree of error of the weights measured in the field is quite large on small fish and large fish that approach the 2 kg limit of the scale. This source of error could alter the slope and intercept of the length/weight relationship curve resulting in apparent significant differences at each end of the length range. However, the same equipment was used on the pre-stocking sample of fish and on all of the following years. Therefore, if the error was systematic, it would be consistent from year to year, which it was not.

-- A third possible explanation is purely conjecture since I have no hard data upon which to base this idea. The data could be showing a seasonal difference in available prey for different sizes of bass. During the summer and early fall, large bass are efficient ambush predators on swarms of YOY black bullhead, mid-sized bluegills, crappie, and smaller bass (Shelly and Modde 1982). Age 1 and 2 bass cruise the edge of vegetation areas and feed on insects and YOY bluegill and crappie (Carline *et al.* 1984, Savino and Stein 1982) and may not forage as efficiently as older fish because heavy vegetation gives advantage to the prey (Davies *et al.* 1979, Cooper and Crowder 1979, Wiley *et al.* 1984, Durocher *et al.* 1984). In the mid- to late fall, vegetation begins to recede exposing YOY bluegill to active predation. Aquatic insect populations increase during this time of year as well (Ball and Hayne 1952). The advantage shifts to the age 1 and 2 bass which then show improved condition but shorter lengths than expected (Wiley *et al.* 1984). This scenario is not unique to Oak Middle Creek 58-B, but could occur in a body of water that has extensive areas of heavy vegetation. Some of the Salt Valley lakes have areas of heavy vegetation while others do not. If more of the original stock were taken from lakes with lower macrophytic concentrations than Oak Middle Creek 58-B, then model length/weight patterns could be different.

Bluegill: Growth comparisons (Table 5) agree with patterns suggested by Beckman (1948): bluegill respond positively to ecological disturbance. There were no total length comparisons that were less than model values and two sample means were significantly longer than model values. Condition factors for all ages would be classified as good. Relative weight values are very consistent about the mean of 1.07. A relative weight greater than 1.00 may indicate an unstable population (Wege and Anderson 1978). There is no significant difference between the 1982 length/weight relationship and the pre-stocking relationship.

Black Crappie: There were only three comparisons with the pre-stocking calculated lengths at annulus. No pattern can be discerned, growth was normal in two of the three comparisons. Condition factors averaged 1.75 which would be considered good according to standards set by the State of Minnesota (Carlander 1977). Relative weights were greater than the 1.00 value and could be considered unstable. The length/weight relationship is based on a small number of fish in a narrow size range and is therefore not considered accurate.

Statistical analyses indicate largemouth bass growth is slower than expected for larger fish ($\geq$ 375 mm). The probable cause is lack of forage. The forage species are growing faster than expected in a density dependent manner: as their populations are thinned by predators, competition is lessened for existing food supplies; therefore, bluegill and black crappie grow more rapidly and are in good condition.

Population Balance Analysis

Recruitment of age 2 largemouth bass was good (Table 8). Age 1 fish were not well sampled. Sampling efficiency for the age 1 largemouth bass is about 22% as efficient as for age 2 and older when using AC electrofishing at night (Reynolds and Simpson 1978). Even though we used DC current during the day, the fact is the density of age 1 fish is underestimated. The 1982 estimate implies that the unknown quantity of bass in the pond may have included some adults as well as numerous members of the 1980 year class. Over 400 fish were estimated to be greater than 312 mm long. Only 200 of this size were stocked and were subject to one-and-one-half years of mortality which would leave about 108 fish, assuming 35% mortality. The 1982 estimate had the lowest coefficient of variation (9.32%) for any of the estimates, i.e., it is more precise than the other estimates. Therefore, it is quite probable that some bass were present in the lake that did not originate from our stocking.

The bluegill population increased from a known stocking of 416 adults to approximately 27,000 individuals. The bulk of the numbers and biomass estimated fell between 95 and 165 mm (Table 9), age 2 and 3 fish. Age 2 fish could have been progeny of some of the original stocking in the fall of 1980 if those fish spawned immediately after stocking. Age 3 fish would have been 105 mm long in 1981 which would have made about 100 of them the size that were stocked. Estimated numbers greatly exceed the expected value, indicating that more bluegill are present than were stocked. The age class distribution is not complete, some age 5 or age 6 fish should have been sampled.

Black crappie also had rapid numerical expansion. It is possible for the 50 black crappie that were stocked originally to produce close to 20,000 offspring. Only two ages (1 and 2) were collected in 1982 indicating poor age distribution. However, most crappie sampled were found in the north arm of the lake close to the inlet from a flood control structure 0.8 km upstream. This pond had a population of black crappie that could have been flushed downstream during several overflow events in 1982.

Sufficient data were available for calculation of the F/C ratio, A_t ratio, AP/P, and the PSD. The F/C ratio was quite low, 1.60, classifying the pond as unbalanced. a low F/C ratio indicates an inadequate supply of forage to meet the needs of the carnivore (bass crowded). The A_t for largemouth bass was 64.5%, bluegill 44.7%, and black crappie 0.0%, with an overall rating of 39.9%. All A_t values, except for the black crappie, would be classified as balanced (Swingle 1950b). The AP/P ratio (Figure 4) for 1982 was widely variable as bass length increased. There was lack of forage up to the 237 mm length (age 2) after which there is an overabundance of forage. From this information the relative weights of the age 1 and 2 fish should be low and relative weights for ages 3 through 7 should be greater than 1.00. The peak forage availability at the 287 to 337 range coincides with the peak biomass of the age 2 bluegill and age 1 black crappie. Figure 5 shows that the PSD for 1982 is the worst for any of the three years of sampling. The reasons for the low PSD rating is the strong year classes of young largemouth bass and bluegill that were estimated in 1982.

Balance criteria using only the bass population indicate a balanced population except for the PSD value. There were 144 adults/ha, 155 kg/ha of largemouth bass, no missing year classes up to age 5, and the growth rate was sufficient to have growth from 200 mm to 310 mm in one year. The PSD value was 18%. Another criterion for measuring balance is instantaneous growth rate. Instantaneous growth rate for age 3 bluegills is higher in balanced ponds than in unbalanced ponds (Anderson 1973). In 1982, instantaneous growth for age 3 bluegills is 1.19 which is greater than the 1981 value of the original stock. The original stock was taken from lakes that are considered to be balanced, therefore Oak Creek 58-B would be considered balanced by this criterion as well.

In general, population and biomass estimates and relationships lend support to the age and growth statistcal analysis. The AP/P ratio does not support the age and growth analysis. Young of the year fish were not sampled during population estimates therefore forage available to bass less than 237 mm was not estimated. The AP/P ratio does level off around 2.0 for bass lengths of greater than

362 mm indicating smaller bass sizes would have better forage opportunities than larger bass.

1983

Inclement weather limited data collection in 1983. Growth at annulus and condition factor information is considered accurate enough to use. Body-scale relationships are considered to be accurate to within 1% if greater than 63 sampled are taken over the full range of sizes sampled (Carlander 1949). All three primary species meet this criteria. There were too few recaptures to make population or biomass estimates with any degree of accuracy or precision.

Age and Growth Statistical Analysis

Largemouth Bass: Comparisons of length at each annulus for largemouth bass (Table 4) show that the growth rate appears to be recovering to the pre-stocking rate from age 3 onward. Ages 1 and 2 are still not equal to the pre-stocking model. Only four age classes were sampled this year, possibly relating to the shortened sampling season. Condition factors of the 1983 sample were significantly less than the 1982 sample (alpha = 0.05, $p \leq 0.01$) for ages 1 and 2. The age 5 condition factor was significantly greater than the 1982 condition factor. The relative weight value for age 1 is significantly less than the 1982 sample, with the rest of the ages not showing any significant difference. The length/weight relationship (Table 7) supports this conclusion about the relative weight and condition factor values.

Bluegill: Positive growth effects of perturbation become less evident in 1983. Bluegill growth was better than the pre-stocking growth in two of three comparisons (Table 5); however, the condition factors for bluegill sampled in 1983 are significantly less than the 1982 sample. Relative weight values drop to less than 1.00 indicating that the fish are less plump and are experiencing more competition for forage than in 1982. The length/weight relationship is not significantly different from the pre-stocking relationship. There were no age 3 fish sampled, therefore no instantaneous growth value could be calculated on this age.

Black Crappie: Growth comparisons show that growth is less than expected when compared to a pre-stocking model (Table 6). Condition factors and relative weight values are significantly less than condition factors and relative weight values for the same age classes in 1982. Condition factors are near the lower limit considered to be good in Minnesota (1.22). Relative weights for two year classes are quite low indicating that black crappie are not doing well. Calculated weights are very near the lower limit of the 95% confidence interval of the pre-stocking length/weight relationship (Table 7).

Statistical analyses indicate the forage species are recovering numerically, thus increasing inter- and intra-specific competition which produces slower growth rates. Largemouth bass are taking advantage of the improved forage base and are growing as rapidly as the pre-stocking model.

Population Balance Analysis

No balance criteria were calculated that required the use of population or biomass estimates from forage species because of low accuracy and precision. However, the largemouth bass criteria of Redmond (1974) indicate a balanced population with the exception of the PSD value which was 10%.

1984

Age and Growth Statistical Analysis

Largemouth Bass: Comparative lengths for largemouth bass showed considerable improvement from 1983. All ages had at least one value that was significantly better than the pre-stocking model except age 6, which was not significantly different. Sixty-six percent of the 1983 comparisons were significantly shorter than model values while in 1984 33% of the comparisons were significantly shorter than model values. The 1980 year class was significantly shorter than the pre-stocking standard for all ages. This year class has unknown origins but it is assumed the year class was produced within Oak Creek 58-B prior to the fish kill of 1980. The 1978 year class (one that had been originally stocked) had consistently better growth in 1984.

Condition factors improved slightly in 1984 from the 1983 estimate. A slight increase in the ponderal index from fall to spring is to be expected because of gonadal swelling (Colle and Shireman 1980). All ages would be classified as having average condition factors. Age 1 fish were bordering on poor condition. Relative weights for 1984 have a high peak at age 2 and then hit a low in age 5. Relative weights parallel condition factors until age 5. Condition factors for largemouth bass increase with increasing length; therefore, relative weight is more sensitive to a drop in condition than the ponderal index. Comparison of length/weight ratios show that the 1984 growth rate was not as good as 1983 but that the 1984 rate was better than 1981 and 1982. It is still significantly less than the pre-stocking growth rate.

Bluegill: Comparisons with the pre-stocking model (Table 5) show that growth is essentially normal. The same is true for the length/weight ratio for 1984 (Table 7), condition factors and relative weights. Age 1 values for both condition factor and relative weight were higher than the rest of the ages, probably attributable to the problem of weighing small fish in the field.

Black crappie: Total length comparisons to the pre-stocking model are mixed. One year class (1981) was always shorter than the pre-stocking model. The length/weight ratio is identical to the pre-stocking model. Condition factors are consistent from age to age and are classified as average. Relative weight values are quite low (mean of 0.872) but are significantly greater than the 1983 relative weights.

Generally speaking, largemouth bass and bluegill growth criteria are rebounding to the pre-stocking model, following a pattern described by Beckman (1948) and Jenkins (1979). To compare weights, Regier (1963) selected 256 mm largemouth bass to use as a standard. In the four years of his study, the calculated weights were 236 g, 250 g, 245 g, and 218 g. The calculated weights using the length/weight relationships for each year in Oak Creek 58-B were 289 g, 233 g, 227 g, and 226 g. With the exception of the 1981 weight of 289 g, weights estimated in this study are similar to those found by Regier (1963). Black crappie are not doing well in this pond.

Population Balance Analysis

None of the three primary species were fully represented with all year classes in the 1984 sample. Age 3 and age 7 largemouth bass were not sampled. One age 6 bass was sampled but was not weighed because it exceeded the 2 kg capacity of the scale. In the spring of the fourth year, fish that had been stocked at 300 mm (age 3), would be six and seven years old. Assuming a 30% mortality rate and no fishing mortality, there should be about 55 of the original stock left in the pond. In 1984, age 2 fish would be the first spawn in from the original stock. Thirty nine of these fish were aged from the 1984 sample. No age 5 or older bluegill were sampled in 1984 nor were any age 3 or 4 sampled in 1983. Only one age 4 bluegill was sampled in 1984. Older age classes of bluegill and black crappie appear to have been cropped off either by predation or by fishermen.

Largemouth bass population and biomass estimates declined in 1984. The biomass decline is similar to that seen when a population is opened for harvest (Anderson 1976). The 1982 biomass estimate shows three distinct groupings: large trophy sized fish (> 450 mm), mid-sized fish (300 to 412 mm) and sub-stock sized fish (< 200 mm). The sub-stock sized fish are of unknown origin. The 1983 sample (based on two recaptures with wide confidence intervals and a poor coefficient of variation) shows the growth of each size group. Sub-stock fish appear nearly ready to become harvestable fish. In 1984, distinct size classes are still present but the total biomass is greatly reduced.

Why the decline? One possibility is fisherman harvest. As stated earlier, fishermen were interviewed who indicated they had been fishing this pond and harvesting all of the primary species since 1982. This would not explain the sharp decline in 1984 unless there was considerable ice fishing harvest. No icefishing evidence was seen during monthly observations of the pond during winter. During the 1984 sample fishing pressure was present but thought not heavy enough to reduce the biomass to the extent seen. Another possibility is that there was a winterkill; however, no evidence of any dead fish were noted. A more plausible explanation of the drop in biomass is seasonal sampling differences between fall and spring.

The bluegill population improved since 1982. Age classes became clearly defined by 1984. Although numbers were reduced, biomass shifted from a small forage fish population to a harvestable population.

Population and biomass estimates for black crappie declined. A strong black crappie age class in 1982 was not sampled well in 1984, probably because of the pelagic nature of adult crappie. Crappie YOY spend only a short time in shallow water before migrating to deeper water and are not available as forage for YOY largemouth bass or to electrofishing. They are available as forage for age 1 and older bass and northern pike (Swingle and Swingle 1967). Five crappie greater than 200 mm long were sampled in 1984. Occurrences of large individuals of the forage species is an indication of a healthy fish population (Anderson 1973, Pritchard *et al.* 1976, Cooper and Wagner 1971, and Ellison 1984).

Total biomass production followed a similar pattern to that noted by Regier (1963) and Graham (1974) where the peak production was seen in the third year after stocking and then declined. In this case, peak production was apparently in 1983 (two years after stocking) and then declined in 1984.

The F/C ratio for 1984 was 2.00, still an unbalanced relationship. Total percentages of fish available for harvest were 96.1% of the largemouth bass, 84.2% of the bluegill, and 8.6% of the black crappie for an overall A_t of 76.7%. This criterion classifies the pond as balanced. The AP/P plot (Figure 4) shows a more desirable (near 1.00) and steady ratio up to the 412 mm largemouth bass total length. After this point the ratio increases rapidly indicating an abundance of forage. The PSD plot (Figure 5) shows an improved relationship over 1982 and 1983 points although it is not in the most desirable area. Instantaneous growth rate for age 3 bluegill was 1.18, greater than the pre-stocking growth rate, an indication of a balanced population.

The A_t for bluegill showed an increase from 44.7% in 1982 to 84.2% in 1984 indicating steady growth. The A_t looks good to the fisherman but is too high to maintain a good forage base. The most desirable range of the A_t for bluegill is 18% to 35% (Swingle 1950b). The A_t ratio is designed to be used with a fall sample and is strongly influenced by size selectivity of the sampling method. If the A_t is correct, then there may not be sufficient forage available for young predators. However, numerous small bluegill were observed but not collected in 1984.

Largemouth bass balance criteria indicate an unbalanced pond: the number of adults per hectare droped to 40 and the

PSD value 20%. However, the criteria presented by Redmond (1974) apply to a fall sample and thus may not be applicable to the spring sample of 1984.

CONCLUSIONS

Objective 1. For the species of interest, is the growth (in terms of total length) after stocking less than or greater than the growth before stocking?

Bluegill and black crappie growth in terms of total length was about the same as pre-stocking growth. Forage fish that may have survived the kill had improved growth after the kill, probably not attributable to the stocking technique. Largemouth bass growth was slowed during the first two years after stocking. Growth in terms of total length were less than the pre-stocking conditions. However, bass were recovering in the last year of sampling with improved growth, approaching pre-stocking growth.

Objective 2. Are published values for plumpness and for length/weight relationships from lakes proximal to Oak Middle Creek 58-B the same as those found in the study?

There were no significant differences between published length/weight ratios, ratios from lakes proximal to Oak

Middle Creek 58-B and those found in this study for largemouth bass and bluegill. Results of black crappie length/weight analysis were not precise enough to make firm conclusions; however, it appeared as though there were no differences.

Objective 3. Is the pond balanced?

Population and biomass estimates, balance criteria for only the largemouth bass population, and the A_t values were generally in agreement with statistical analyses of age and growth information. Biomass estimates and relationships helped explain increases and decreases in growth indices for a particular species or size group within that species. However, other balance criteria were not in agreement with statistical analyses. The maximum F/C value calculated during this study was 2.0. The minimum most desirable value of 3.0 was never reached. The AP/P ratio was widely variable and not always in agreement with statistical analysis. Wide variation may be attributable to inabilities to collect young of the year fish, which, in turn, can alter calculated ratios. Proportional stock densities did not reach the most desirable relationships during this study. From this information, the pond is probably not balanced.

It is recognized that balance criteria will not always agree with each other, much less other population and growth indices. Balance criteria are dependent upon the efficacy and efficiency of collecting a representative sample. If the sample method is biased, then balance calculations will be skewed. Balance criteria are indicators of present conditions. Growth indices are dependent on the efficacy and efficiency of the fish to exploit its environment. Growth indices can be skewed by ageing and back-calculation errors. Growth indices are indicators of past conditions.

Relative weight and expected lengths at each annulus are good descriptions of population health with minimal data requirements. Population and biomass estimates help clarify trends over time but are expensive to gather.

Other conclusions:

1. Largemouth bass and bluegill populations were successfully re-established by stocking only adult fish. Populations had a good age class distribution and individual fish were in good condition. The bass population suffered from lack of forage in the early years but successfully spawned in all years. Establishment may have been aided by survivors from the assumed total kill.

The surviving bluegill provided a forage base while surviving bass filled in missing age classes. Black crappie did not respond well to stocking only adults. Their population appeared to decline rapidly after establishment in 1982. Apparent declines in biomass could be a result of either predation or inefficient sampling.

2. Sampling time of year must be consistent from year to year. The sharp decline in biomass for 1984 was questionable because sampling was performed inconsistently with the previous samples.

3. Electrofishing is an effective means of sampling largemouth bass and bluegill populations but is not efficient at collecting black crappie. Other sampling techniques (e.g., otter and mid-water trawls, gill netting, and seining) would have been necessary to evaluate the stocking success of all the fish species in the pond. Poor trap netting and seining sites hampered this investigation.

4. Relative weight (W_r) values and comparison to expected length/weight curves are more sensitive to growth changes than comparisons of condition factors (K(TL). Condition factors vary with age and length and are difficult to compare against a standard.

5. The stocking technique may have some merit in providing short term instant fisheries. The instant fishery may need to be protected for two years before harvest of predators is allowed. Stocking adults produces a more complete age structure and the presence of trophy size individuals in a shorter time frame than does normal stocking. However, presence of trophy fish in this pond was obtained at the expense of losing trophy fish in Salt Valley lakes. The benefit/cost ratio would need to be evaluated before this stocking procedure is undertaken for other waters. More controls would be needed to fully evaluate the success of this technique.

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APPENDICES

APPENDICES

Form A-1. Example of field data collection form for Oak Middle Creek 58-B. Length/weight data.

Date: ___________

No.	Sp.	L-W	No.	Sp.	L-W
1			41		
2			42		
3			43		
4			44		
5			45		
6			46		
7			47		
8			48		
9			49		
10			50		
11			51		
12			52		
13			53		
14			54		
15			55		
16			56		
17			57		
18			58		
19			59		
20			60		
21			61		
22			62		
23			63		
24			64		
25			65		
26			66		
27			67		
28			68		
29			69		
30			70		
31			71		
32			72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Form A-2. Largemouth Bass mark and recapture recording forms, noting those fish that were dead and released (D/R).

Length		Recaps	D/R
00-24			
25-49			
50-74			
75-99			
100-124			
125-149			
150-174			
175-179			
200-224			
225-249			
250-274			
275-299			
300-324			
325-349			
350-374			
375-399			
400-424			
425-449			
450-474			
475-499			
500-524			
525-549			

Form A-3. Bluegill and black crappie mark and recapture recording forms, noting those fish that were dead and released (D/R).

Length		Recaps	D/R
00-09			
10-19			
20-29			
30-39			
40-49			
50-59			
60-69			
70-79			
80-89			
90-99			
100-109			
110-119			
120-129			
130-139			
140-149			
150-159			
160-169			
170-179			
180-189			
190-199			
200-209			
210-219			

Table A-1. Sampling dates and number of fish sampled for each year of the study.

		Number of fish captured			Grand
Year	Date	Bass	Bluegill	Crappie	Total
1981	6 - October	47	-	-	
	15 - October	58	-	-	
	Total	105			105
1982	27 - September	220	179	18	
	5 - October	81	52	35	
	12 - October	164	95	105	
	14 - October	25	12	4	
	19 - October	98	315	157	
	25 - October	37	221	97	
	5 - November	69	228	111	
	Total	694	1102	527	2323
1983	20 - October	47	143	50	
	28 - October*	-	271	56	
	1 - November	52	46	13	
	2 - November*	-	79	5	
	4 - November*	-	61	15	
	16 - November	21	194	10	
	17 - November	41	53	3	
	Total	161	847	152	1160
1984	21 - May	82	176	92	
	29 - May	77	104	42	
	1 - June, a.m.	67	119	41	
	2 - June, p.m.	47	78	7	
	Total	273	477	182	932

* Trap nets only, no electrofishing

Table A-2. Efficiency of recapture for largemouth bass from 1982 through 1983.

1982

mean TL	Total Sampled	Recaptures by size, for each day of sampling 1	2	3	4	5	6	7	8	R/S %	R/Tot R %
62.5	18	0	0	0	0	0	0	0	0	0%	0.00
87.5	74	0	0	0	0	1	1	0	0	3%	2.27
113	25	0	0	0	0	2	0	0	0	8%	0.02
138	20	0	0	2	0	0	0	0	0	10%	2.27
163	230	0	0	8	1	12	4	12	0	16%	42.05
188	196	0	0	3	2	6	2	6	0	10%	21.59
213	25	0	0	3	0	1	1	1	0	24%	6.82
288	2	0	0	0	0	0	0	0	0	0%	0.00
313	9	0	0	2	0	0	0	1	0	33%	3.41
338	23	0	0	1	2	1	0	1	0	22%	5.68
363	44	0	1	1	2	1	0	1	0	14%	6.82
388	23	0	0	2	0	3	0	0	0	22%	5.68
413	2	0	0	1	0	0	0	0	0	50%	1.14
488	2	0	0	0	0	0	0	0	0	0%	0.00
513	1	0	0	0	0	0	0	0	0	0%	0.00

Total sampled: 694

Total recaptured: 88

Overall efficiency: 13%

1982

mean TL	Total Sampled	Recaptures by size, for each day of sampling 1	2	3	4	5	6	7	8	R/S %	R/Tot R %
25	3	0	0	0	0	0	0	0	0	0%	0.00
50	28	0	0	0	0	0	0	0	0	0%	0.00
75	46	0	0	0	1	0	0	0	0	2%	0.00
100	19	0	0	0	0	0	0	0	0	0%	0.00
125	1	0	0	0	0	0	0	0	0	0%	0.00
150	6	0	0	0	0	0	0	0	0	0%	0.00
175	9	0	0	0	0	0	0	0	0	0%	0.00
200	17	0	0	0	0	0	0	0	0	0%	0.00
225	16	0	0	0	1	0	0	0	0	6%	0.61
250	2	0	0	0	0	0	0	0	0	0%	0.00
275	2	0	0	0	0	0	0	0	0	0%	0.00
300	2	0	0	0	0	0	0	0	0	0%	0.00
325	1	0	0	0	0	0	0	0	0	0%	0.00
350	4	0	0	0	0	0	0	0	0	0%	0.00
375	5	0	0	0	0	0	0	0	0	0%	0.00

Total sampled: 161

Total recaptured: 2

Overall efficiency: 1.24 %

Table A-2. (con't).

1984

mean TL	Total Sampled	Recaptures by size, for each day of sampling									
		1	2	3	4	5	6	7	8	R/S %	R/Tot R %
25	3	0	0	0	0	0	0	0	0	0%	0.00
50	23	0	0	0	1	0	0	0	0	4%	2.27
75	9	0	0	0	0	0	0	0	0	0%	0.00
100	1	0	0	0	0	0	0	0	0	0%	0.00
125	9	0	1	0	0	0	0	0	0	11%	2.27
150	15	0	2	2	1	0	0	0	0	33%	11.36
175	94	0	4	7	2	0	0	0	0	14%	29.55
200	56	0	4	2	4	0	0	0	0	18%	22.73
225	11	0	1	0	0	0	0	0	0	9%	2.27
250	3	0	0	0	0	0	0	0	0	0%	0.00
275	3	0	1	0	0	0	0	0	0	33%	2.27
300	5	0	1	0	0	0	0	0	0	20%	2.27
325	26	0	1	2	4	0	0	0	0	27%	15.91
350	8	0	0	0	2	0	0	0	0	25%	4.55
375	5	0	0	1	0	0	0	0	0	20%	2.27
400	3	0	1	0	0	0	0	0	0	33%	2.27
425	1	0	0	0	0	0	0	0	0	0%	0.00
450	1	0	0	0	0	0	0	0	0	0%	0.00

Total sampled: 276

Total recaptured: 44

Overall efficiency: 16%

Table A-3. Efficiency of recapture for bluegill for 1982 through 1984.

1982

mean TL	Total Sampled	Recaptures by size, for each day of sampling									
		1	2	3	4	5	6	7	8	R/S %	R/Tot R %
10	3	0	0	0	0	0	0	0	0	0%	0.00
20	9	0	0	0	0	0	0	0	0	0%	0.00
30	8	0	0	0	0	0	0	0	0	0%	0.00
40	58	0	1	0	0	0	0	0	0	2%	3.03
50	162	0	0	0	0	0	1	2	0	2%	9.09
60	298	0	0	0	0	3	2	8	0	4%	39.39
70	193	0	0	0	0	0	2	2	0	2%	12.12
80	116	0	0	0	0	1	0	2	0	3%	9.09
90	100	0	0	0	0	2	0	3	0	5%	15.15
100	59	0	0	0	0	0	0	2	0	3%	6.06
110	50	0	0	0	0	1	0	0	0	2%	3.03
120	25	0	0	0	0	0	0	0	0	0%	0.00
130	9	0	0	0	0	0	0	0	0	0%	0.00
140	2	0	0	0	0	0	0	0	0	0%	0.00
150	2	0	0	0	0	1	0	0	0	50%	3.03
160	0	0	0	0	0	0	0	0	0	0%	0.00
170	3	0	0	0	0	0	0	0	0	0%	0.00
180	2	0	0	0	0	0	0	0	0	0%	0.00

Total Bluegill Sampled: 1099
Total Recaptured: 33
Overall efficiency: 3.0%

Table A-3 (con't)

1983

mean TL	Total Sampled	Recaptures by size, for each day of sampling 1	2	3	4	5	6	7	8	R/S %	R/Tot R %
10	5	0	0	0	0	0	0	0	0	0%	0.00
20	50	0	0	0	0	0	0	0	0	0%	0.00
30	4	0	0	0	0	0	0	0	0	0%	0.00
40	6	0	0	0	0	0	0	0	0	0%	0.00
50	24	0	0	0	0	0	0	0	0	0%	0.00
60	88	0	0	0	0	0	0	0	0	0%	0.00
70	146	0	1	1	0	0	0	0	0	1%	33.33
80	132	0	0	0	0	0	0	0	0	0%	0.00
90	108	0	2	1	0	0	0	0	0	3%	50.00
100	52	0	0	0	0	0	0	0	0	0%	0.00
110	16	0	0	0	0	0	0	0	0	0%	0.00
120	10	0	0	0	0	0	0	0	0	0%	0.00
130	21	0	0	0	0	0	0	0	0	0%	0.00
140	49	0	1	0	0	0	0	0	0	2%	16.67
150	39	0	0	0	0	0	0	0	0	0%	0.00
160	40	0	0	0	0	0	0	0	0	0%	0.00
170	26	0	0	0	0	0	0	0	0	0%	0.00
180	13	0	0	0	0	0	0	0	0	0%	0.00
190	4	0	0	0	0	0	0	0	0	0%	0.00

Total sampled: 833
Total recaptured: 6
Overall efficiency: 0.72%

1984

mean TL	Total Sampled	Recaptures by size, for each day of sampling 1	2	3	4	5	6	7	8	R/S %	R/Tot R %
10	1	0	0	0	0	0	0	0	0	0%	0.00
20	2	0	0	0	0	0	0	0	0	0%	0.00
30	20	0	0	0	0	0	0	0	0	0%	0.00
40	45	0	0	0	0	0	0	0	0	0%	0.00
50	59	0	0	0	0	0	0	0	0	0%	0.00
60	59	0	0	1	0	1	0	0	0	3%	7.69
70	41	0	0	1	1	0	0	0	0	5%	7.69
80	40	0	0	1	0	1	0	0	0	5%	7.69
90	7	0	0	2	1	1	0	0	0	57%	15.38
100	9	0	0	1	1	0	0	0	0	22%	7.69
110	16	0	0	1	1	0	0	0	0	13%	7.69
120	46	0	0	3	2	1	0	0	0	13%	23.08
130	64	0	0	1	0	1	0	0	0	3%	7.69
140	53	0	2	0	0	0	0	0	0	4%	7.69
150	14	0	0	1	1	0	0	0	0	14%	7.69
160	1	0	0	0	0	0	0	0	0	0%	0.00

Total Sampled: 477
Total recaptured: 26
Overall efficiency: 5.5%

Table A-4. Efficiency of recapture for black crappie from 1982 through 1984.

1982

mean	Total	Recaptures by size, for each day of sampling									
TL	Sampled	1	2	3	4	5	6	7	8	R/S %	R/Tot R %
10	1	0	0	0	0	0	0	0	0	0%	0.00
20	37	0	0	0	0	1	0	0	0	3%	10.00
30	126	0	0	0	0	0	0	2	0	2%	0.20
40	228	0	0	0	0	0	1	4	0	2%	50.00
50	68	0	0	0	0	0	0	0	0	0%	0.00
60	5	0	0	0	0	0	0	0	0	0%	0.00
70	3	0	0	0	0	1	0	0	0	33%	10.00
80	10	0	0	0	0	0	0	0	0	0%	0.00
90	24	0	0	0	0	1	0	0	0	4%	10.00
100	18	0	0	0	0	0	0	0	0	0%	0.00
110	6	0	0	0	0	0	0	0	0	0%	0.00

Total sampled: 526
Total recaptured: 10
Overall efficiency: 2%

1983

mean	Total	Recaptures by size, for each day of sampling									
TL	Sampled	1	2	3	4	5	6	7	8	R/S %	R/Tot R %
65	8	0	0	0	0	0	0	0	0	0%	0.00
75	8	0	0	0	0	0	0	0	0	0%	0.00
85	8	0	0	0	0	0	0	0	0	0%	0.00
95	1	0	0	0	0	0	0	0	0	0%	0.00
105	1	0	0	0	0	0	0	0	0	0%	0.00
115	1	0	0	0	0	0	0	0	0	0%	0.00
125	7	0	0	0	0	0	0	0	0	0%	0.00
135	24	0	0	0	0	0	0	0	0	0%	0.00
145	25	0	0	1	0	0	0	0	0	4%	100.00
155	12	0	0	0	0	0	0	0	0	0%	0.00
165	4	0	0	0	0	0	0	0	0	0%	0.00
175	2	0	0	0	0	0	0	0	0	0%	0.00
185	2	0	0	0	0	0	0	0	0	0%	0.00
195	2	0	0	0	0	0	0	0	0	0%	0.00

Total sampled: 105
Total recaptured: 1
Overall efficiency: 1%

Table A-4. (con't)

1984

mean TL	Total Sampled	Recaptures by size, for each day of sampling									
		1	2	3	4	5	6	7	8	R/S %	R/Tot R %
10	4	0	0	0	0	0	0	0	0	0%	0.00
20	6	0	0	0	0	0	0	0	0	0%	0.00
30	1	0	0	0	0	0	0	0	0	0%	0.00
40	4	0	0	0	0	0	0	0	0	0%	0.00
50	14	0	0	0	0	0	0	0	0	0%	0.00
60	41	0	0	0	0	0	0	0	0	0%	0.00
70	35	0	0	0	1	0	0	0	0	3%	0.52
80	36	0	0	1	0	0	0	0	0	3%	0.52
90	14	0	0	1	1	0	0	0	0	14%	1.04
100	7	0	0	1	0	0	0	0	0	14%	0.52
110	8	0	0	0	0	0	0	0	0	0%	0.00
120	7	0	0	0	0	0	0	0	0	0%	0.00
130	5	0	0	0	0	0	0	0	0	0%	0.00

Total sampled: 182

Total recaptured: 5

Overall efficiency: 3%

Table A-5. Chi-square contingency table for largemouth bass recapture efficiency in 1982

mean	Total				Chi-Squared calculations					
TL	Cap.	E(r1)	Sum R	E(r2)	Not R	E(r3)	T(r)	(C-pC)2	(R-pr)2	(N-pn)2
62.5	18	18	0	2.28	18	15.72	36	0	2.28	0.33
87.5	74	74	2	9.38	72	64.62	148	0	5.81	0.84
113	25	25	2	3.17	23	21.83	50	0	0.43	0.06
138	20	20	2	2.54	18	17.46	40	0	0.11	0.02
163	230	230	37	29.16	193	200.84	460	0	2.11	0.31
188	196	196	19	24.85	177	171.15	392	0	1.38	0.20
213	25	25	6	3.17	19	21.83	50	0	2.53	0.37
288	2	2	0	0.25	2	1.75	4	0	0.25	0.04
313	9	9	3	1.14	6	7.86	18	0	3.03	0.44
338	23	23	5	2.92	18	20.08	46	0	1.49	0.22
363	44	44	6	5.58	38	38.42	88	0	0.03	0.00
388	23	23	5	2.92	18	20.08	46	0	1.49	0.22
413	2	2	1	0.25	1	1.75	4	0	2.20	0.32
488	2	2	0	0.25	2	1.75	4	0	0.25	0.04
513	1	1	0	0.13	1	0.87	2	0	0.13	0.02
Totals	694		88		606					

df = 28

X2 = 26.93

H0: sigma = sigma(0); there is no gear selectivity by size class

H1: sigma > sigma(0); gear is selective for larger fish

alpha = .10

Rejection region: X2 > X2(alpha)

At alpha = .10, the critical value for X2 = 18.9392

26.93 > 18.9392

Therefore, then null hypothesis that there is no gear selectivity by size class is rejected.

Table A-6. Chi-squared contingency table for largemouth bass recapture efficiency for 1983.

mean TL		Total Cap.			Chi-Squared calculations						
			E(r1)	Sum R	E(r2)	Not R	E(r3)	T(r)	(C-pC)2	(R-pr)2	(N-on)2
62.5	¦	3	3	0	0.04	3	2.96	6	0	0.04	0.00
87.5	¦	28	28	0	0.35	28	27.65	56	0	0.35	0.00
113	¦	46	46	1	0.57	45	45.43	92	0	0.32	0.00
138	¦	19	19	0	0.24	19	18.76	38	0	0.24	0.00
163	¦	1	1	0	0.01	1	0.99	2	0	0.01	0.00
188	¦	6	6	0	0.07	6	5.93	12	0	0.07	0.00
213	¦	9	9	0	0.11	9	8.89	18	0	0.11	0.00
238	¦	17	17	0	0.21	17	16.79	34	0	0.21	0.00
263	¦	16	16	1	0.20	15	15.80	32	0	3.23	0.04
288	¦	2	2	0	0.02	2	1.98	4	0	0.02	0.00
313	¦	2	2	0	0.02	2	1.98	4	0	0.02	0.00
378	¦	2	2	0	0.02	2	1.98	4	0	0.02	0.00
363	¦	1	1	0	0.01	1	0.99	2	0	0.01	0.00
488	¦	4	4	0	0.05	4	3.95	8	0	0.05	0.00
513	¦	5	5	0	0.06	5	4.94	10	0	0.06	0.00
Totals			161		2		159				
df =			28								
X2 =			4.84								

H0: sigma = sigma(0); there is no gear selectivity by size class

H1: sigma > sigma(0); gear is selective for larger fish

alpha = .10

Rejection region: X2 > X2(alpha)

At alpha = .10, the critical value for X2 = 18.9392

4.84 < 18.9392

Therefore, fail to reject H0, gear selectivity cannot be proven with this information.

Table A-7. Chi-squared contingency table for largemouth bass recapture efficiency in 1984.

					Chi-Squared calculations					
mean TL	Total Cap.	E(r1)	Sum R	E(r2)	Not R	E(r3)	T(r)	(C-pC)2	(R-pr)2	(N-pn)2
87.5	3	3.00	0	0.48	3	2.52	6	0	0.48	0.09
113	23	23.00	1	3.67	22	19.33	46	0	1.94	0.37
138	9	9.00	0	1.43	9	7.57	18	0	1.43	0.27
163	1	1.00	0	0.16	1	0.84	2	0	0.16	0.03
188	9	9.00	1	1.43	8	7.57	18	0	0.13	0.02
213	15	15.00	5	2.39	10	12.61	30	0	2.85	0.54
238	94	94.00	13	14.99	81	79.01	188	0	0.26	0.05
263	56	56.00	10	8.93	46	47.07	112	0	0.13	0.02
288	11	11.00	1	1.75	10	9.25	22	0	0.32	0.06
313	3	3.00	0	0.48	3	2.52	6	0	0.48	0.09
338	3	3.00	1	0.48	2	2.52	6	0	0.57	0.11
363	5	5.00	1	0.80	4	4.20	10	0	0.05	0.00
388	26	26.00	7	4.14	19	21.86	52	0	1.97	0.37
413	8	8.00	2	1.28	6	6.72	16	0	0.41	0.08
438	5	5.00	1	0.80	4	4.20	10	0	0.05	0.00
463	3	3.00	1	0.48	2	2.52	6	0	0.57	0.11
488	1	1.00	0	0.16	1	0.84	2	0	0.16	0.03
513	1	1.00	0	0.16	1	0.84	2	0	0.16	0.03
TOTAL	276		44		232		552			
df =	28									
X2 =	14.42									

H0: sigma = sigma(0); there is no gear selectivity by size class

H1: sigma > sigma(0); gear is selective for larger fish

alpha = .10

Rejection region: X2 > X2(alpha)

At alpha=.10, X2 = 18.9392

18.94 >14.42136

Therefore, (fail to reject) H0, gear selectivity cannot be shown with this data

Table A-8. Chi-squared contingency table for bluegill recapture efficiency for 1982.

mean	Total				Chi-Squared calculations					
TL	Cap.	E(r1)	Sum R	E(r2)	Not R	E(r3)	T(r)	(C-pC)2	(R-pr)2	(N-pn)2
55 ¦	3	3	0	0.09	3	2.89	6	0	0.09	0.00
65 ¦	9	9	0	0.27	9	8.68	18	0	0.27	0.01
75 ¦	8	8	0	0.24	8	7.71	16	0	0.24	0.01
85 ¦	58	58	1	1.74	57	55.92	116	0	0.32	0.02
95 ¦	162	162	3	4.86	159	156.18	324	0	0.71	0.05
105 ¦	298	298	13	8.95	285	287.29	596	0	1.83	0.02
115 ¦	193	193	4	5.80	189	186.07	386	0	0.56	0.05
125 ¦	116	116	3	3.48	113	111.83	232	0	0.07	0.01
135 ¦	100	100	5	3.00	95	96.41	200	0	1.33	0.02
145 ¦	59	59	2	1.77	57	56.88	118	0	0.03	0.00
155 ¦	50	50	1	1.50	49	48.20	100	0	0.17	0.01
165 ¦	25	25	0	0.75	25	24.10	50	0	0.75	0.03
175 ¦	9	9	0	0.27	9	8.68	18	0	0.27	0.01
185 ¦	2	2	0	0.06	2	1.93	4	0	0.06	0.00
195	2	2	1	0.06	1	1.93	4	0	14.71	0.45
215	3	3	0	0.09	3	2.89	6	0	0.09	0.00
225	2	2	0	0.06	2	1.93	4	0	0.06	0.00
Total	1099		33		1066					
df =	32									
X2 =	6.95									

H0: sigma = sigma(0); there is no gear selectivity by size class
H1: sigma > sigma(0); gear is selective for larger fish
alpha = .10
Rejection region: X2 > X2(alpha)
At alpha = .10, the critical value for X2 = 20.5992
6.95 < 20.5992
Therefore, fail to reject H0

Table A-9. Chi-squared contingency table for bluegill for recapture efficiency in 1984.

mean	Total				Chi-Squared calculations					
TL	Cap.	E(r1)	Sum R	E(r2)	Not R	E(r3)	T(r)	(C-pC)2	(R-pr)2	(N-pn)2
55	1	1.00	0	0.05	1	0.95	2	0	0.05	0.00
65	2	2.00	0	0.10	2	1.90	4	0	0.10	0.00
75	20	20.00	0	1.05	20	18.95	40	0	1.05	0.06
85	45	45.00	0	2.36	45	42.64	90	0	2.36	0.13
95	59	59.00	0	3.09	59	55.91	118	0	3.09	0.17
105	59	59.00	2	3.09	57	55.91	118	0	0.39	0.02
115	41	41.00	2	2.15	39	38.85	82	0	0.01	0.00
125	40	40.00	2	2.10	38	37.90	80	0	0.00	0.00
135	7	7.00	3	0.37	4	6.63	14	0	18.90	1.05
145	9	9.00	2	0.47	7	8.53	18	0	4.95	0.27
155	16	16.00	2	0.84	14	15.16	32	0	1.61	0.09
165	46	46.00	6	2.41	40	43.59	92	0	5.34	0.30
175	64	64.00	2	3.35	62	60.65	128	0	0.55	0.03
185	53	53.00	2	2.78	51	50.22	106	0	0.22	0.01
195	14	14.00	2	0.73	12	13.27	28	0	2.19	0.12
205	1	1.00	0	0.05	1	0.95	2	0	0.05	0.00
Totals	477		25		452					
df =	30									
X2 =	43.12									

H0: sigma = sigma(0); there is no gear selectivity by size class

H1: sigma > sigma(0); gear is selective for larger fish

alpha = .10

Rejection region: X2 > X2(alpha)

At alpha = .10, X2 = 20.60

43.1 > 20.6

Therefore, reject H0, there was selectivity by size.

Table A-10. Chi-squared contingency table for black crappie recapture efficiency for 1982.

mean	Total				Chi-Squared calculations					
TL	Cap.	E(r1)	Sum R	E(r2)	Not R	E(r3)	T(r)	(C-pC)2	(R-pr)2	(N-pn)2
65	1	1	0	0.02	1	0.98	2	0	0.02	0.00
75	37	37	1	0.70	36	36.30	74	0	0.13	0.00
85	126	126	2	2.40	124	123.60	252	0	0.07	0.00
95	228	228	5	4.33	223	223.67	456	0	0.10	0.00
105	68	68	0	1.29	68	66.71	136	0	1.29	0.03
115	5	5	0	0.10	5	4.90	10	0	0.10	0.00
125	3	3	1	0.06	2	2.94	6	0	15.59	0.30
135	10	10	0	0.19	10	9.81	20	0	0.19	0.00
145	24	24	1	0.46	23	23.54	48	0	0.65	0.01
155	18	18	0	0.34	18	17.66	36	0	0.34	0.00
165	6	6	0	0.11	6	5.89	12	0	0.11	0.00
Totals	526		10		516					
df =	20									
X2 = 18.94										

H0: sigma = sigma(0); there is no gear selectivity by size class

H1: sigma > sigma(0); gear is selective for larger fish

alpha = .10

Rejection region: X2 > X2(alpha)

At alpha = .10, the critical value for X2 = 12.4426

18.94 > 12.4426

Therefore, reject H0.

Table A-11. Chi-square contingency table for black crappie recapture efficiency for 1984.

					Chi-Squared calculations					
mean TL	Total Cap.	E(r1)	Sum R	E(r2)	Not R	E(r3)	T(r)	(C-pC)2	(R-pr)2	(N-pn)2
55	4	4	0	0.11	4	3.89	8	0	0.11	0.00
65	6	6	0	0.16	6	5.84	12	0	0.16	0.00
85	1	1	0	0.03	1	0.97	2	0	0.03	0.00
105	4	4	0	0.11	4	3.89	8	0	0.11	0.00
115	14	14	0	0.38	14	13.62	28	0	0.38	0.01
125	41	41	0	1.13	41	39.87	82	0	1.13	0.03
135	35	35	1	0.96	34	34.04	70	0	0.00	0.00
145	36	36	1	0.99	35	35.01	72	0	0.00	0.00
155	14	14	2	0.38	12	13.62	28	0	6.78	0.19
165	7	7	1	0.19	6	6.81	14	0	3.39	0.10
175	8	8	0	0.22	8	7.78	16	0	0.22	0.00
185	7	7	0	0.19	7	6.81	14	0	0.19	0.00
205	5	5	0	0.14	5	4.86	10	0	0.14	0.00
Totals	182		5		177					
df =	24									
X2 =	13.01									

H0: sigma = sigma(0); there is no gear selectivity by size class

H1: sigma > sigma(0); gear is selective for larger fish

alpha = .10

Rejection region: X2 > X2(alpha)

At alpha = .10, X2 15.6587

15.66 > 13.01

Therefore, fail to reject H0

Table A-12. Calculated length at each annulus for largemouth bass grouped by the year sampled.

Number aged	Age	TL (mm)	Weight (g)	Length at Annulus 1	2	3	4	5	6	7
Sampled in 1981										
2	0	145	39							
6	1	248	248	127.3						
4	2	290	336	94.5	224.5					
18	3	341	596	100.9	214.0	312.8				
6	4	393	714	119.2	217.3	304.6	345.2			
1	5	441	1130	58.6	222.3	384.9	443.5	476.4		
1	7	507	1385	53.2	138.6	263.8	315.3	359.1	404.6	434.3
38				105.1	213.8	311.8	353.8	417.7	404.6	434.3
Sampled in 1982										
9	0	85	4							
25	1	170	69	74.5						
4	2	265	232	82.0	180.9					
16	3	353	522	86.1	206.6	316.4				
13	4	382	860	86.4	201.8	317.9	360.6			
2	5	423	1180	61.0	145.0	232.1	349.2	401.0		
1	6	475	--	132.5	185.4	276.4	367.4	417.0	455.1	
2	7	508	1970	115.1	272.7	345.2	391.1	428.7	467.0	492.9
72				82.2	201.9	312.5	363.1	415.3	463.0	492.9
Sampled in 1983										
28	0	106	14							
6	1	165	62	77.0						
27	2	239	186	79.3	193.2					
1	3	335	602	78.9	213.7	284.4				
1	4	421	--	74.7	203.8	360.3	379.9			
3	5	389	590	91.1	177.4	249.3	319.8	359.2		
66				79.7	192.7	278.5	334.8	359.2		
Sampled in 1984										
15	1	115	18	113.2						
38	2	247	225	80.9	182.0					
17	4	385	755	86.2	197.9	298.0	356.9			
4	5	436	764	80.4	235.5	330.3	377.6	422.7		
1	6	480	--	75.5	227.0	341.0	416.0	443.8	466.1	
75				88.5	190.8	305.8	363.4	426.9	466.1	

Table A-13. Calculated length at each annulus for bluegill grouped by the year sampled.

Number aged	Age	TL (mm)	Weight (g)	Length at Annulus			
				1	2	3	4
Sampled in 1981							
1	1	155	80	34.5			
2	2	155	--	33.0	127.6		
2	3	170	114	48.0	84.1	120.2	
2	4	202	235	53.3	103.4	161.3	186.5
7				43.3	104.9	140.8	186.5
Sampled in 1982							
3	0	90	20				
14	1	109	27	51.3			
19	2	141	59	63.4	111.7		
4	3	168	107	53.7	104.7	144.0	
2	4	204	205	34.4	75.3	148.1	176.0
42				56.6	107.7	145.4	176.0
Sampled in 1983							
1	0	51	--				
78	1	101	23	51.9			
48	2	174	108	59.1	127.9		
127				54.6	127.9		
Sampled in 1984							
1	0	76	10				
11	1	81	12	69.1			
45	2	107	27	46.3	97.5		
44	3	166	104	48.7	102.9	155.2	
1	4	189	150	66.5	109.9	153.2	173.8
102				50.0	100.3	155.2	173.8

Table A-14. Calculated length at each annulus for black crappie grouped by the year sampled.

Number aged	Age	TL (mm)	Weight (g)	Length at Annulus			
				1	2	3	4
Sampled in 1981							
2	2	172	70	88.8	148.5		
5	3	222	162	75.2	141.7	198.4	
1	4	215	140	92.2	141.3	174.0	206.8
8				80.7	143.4	194.3	206.8
Sampled in 1982							
2	0	82	19				
4	1	142	46	71.2			
1	2	147	52	53.6	136.1		
7				67.7	136.1		
Sampled in 1983							
21	0	77	6				
36	2	152	43	76.1	116.4		
5	3	191	94	54.9	113.0	154.3	
62				73.3	116.0	154.3	
Sampled in 1984							
6	1	140	39	82.8			
25	2	148	45	80.0	140.6		
15	3	168	69	64.6	107.7	160.6	
46				75.3	128.3	160.6	

Table A-15. Calculated weight at each annulus for largemouth bass grouped by the year sampled.

Number		TL	Weight at Annulus						
aged	Age	(mm)	1	2	3	4	5	6	7
Sampled in 1981									
6	1	248	34.2						
4	2	290	13.7	193.4					
18	3	341	16.8	167.1	533.1				
6	4	393	27.2	175.1	491.5	719.2			
1	5	441	3.2	187.7	1004.9	1549.7	1928.5		
1	7	507	2.4	44.3	316.7	546.2	812.9	1170.5	1453.5
			19.0	166.6	527.9	776.8	1290.3	1170.5	1453.5
Sampled in 1982									
25	1	170	6.9						
4	2	265	9.1	89.8					
16	3	353	10.5	131.8	451.4				
13	4	382	10.6	123.1	457.1	658.5			
2	5	423	3.9	47.4	184.4	600.1	894.8		
1	6	475	36.5	96.4	305.5	695.0	1001.9	1259.7	
2	7	508	24.3	293.8	580.5	832.5	1085.2	1389.5	1623.9
72			9.2	123.3	435.5	671.7	990.1	1355.4	1623.9
Sampled in 1983									
6	1	165	4.2						
27	2	239	4.6	89.2					
1	3	335	4.5	124.8	323.4				
1	4	421	3.8	106.6	711.4	848.7			
3	5	389	7.3	67.1	208.5	478.1	704.2		
66			4.7	88.4	301.6	557.0	704.2		
Sampled in 1984									
15	1	115	16.8						
38	2	247	5.8	76.5					
17	4	385	7.1	99.9	368.4	654.8			
4	5	436	5.6	173.9	511.5	783.8	1123.3		
1	6	480	4.6	154.7	566.2	1067.5	1312.1	1534.1	
75			7.7	88.9	400.1	893.6	1159.3	1534.1	

Table A-16. Calculated weight at each annulus for bluegill grouped by the year sampled.

Sampled in 1981

Number		TL	Weight at Annulus			
aged	Age	(mm)	1	2	3	4
1	1	155	1.0			
2	2	155	0.9	46.3		
2	3	170	2.6	13.5	38.8	
2	4	202	3.9	24.9	92.5	142.0
7			1.9	26.0	61.9	142.0
Sampled in 1982						
14	1	109	2.6			
19	2	141	5.0	28.6		
4	3	168	3.0	23.4	62.6	
2	4	204	0.8	8.5	68.2	116.1
42			3.5	25.6	64.5	116.1
Sampled in 1983						
78	1	101	2.1			
48	2	174	3.2	38.9		
127			2.5	38.9		
Sampled in 1984						
11	1	81.	7.1			
45	2	107	2.1	19.9		
44	3	166	2.5	23.4	80.4	
1	4	189	6.3	28.6	77.4	112.9
102			2.7	21.7	80.4	112.9

Table A-17. Calculated weight at each annulus for black crappie grouped by the year sampled.

			Weight at Annulus			
Number aged	Age	TL (mm)	1	2	3	4
Sampled in 1981						
2	2	172	8.3	42.9		
5	3	222	4.9	36.9	108.5	
1	4	215	9.3	36.6	71.3	123.9
8			6.1	38.4	101.5	123.9
Sampled in 1982						
4	1	142	14.4			
1	2	147	8.6	46.9		
7			13.2	46.9		
Sampled in 1983						
36	2	152	5.0	18.6		
5	3	191	1.8	17.0	44.5	
62			4.5	18.4	44.5	
Sampled in 1984						
6	1	140	7.3			
25	2	148	6.5	37.5		
15	3	168	3.4	16.5	57.3	
46			5.4	28.5	57.3	

Table A-18. Biomass calculations for largemouth bass for 1982.

Estimated Number of fish: 4101

Size Class	# Sampled	Adjust. Factor	Est. Number	(Kg) Est. Biomass	
12	0	0%	0	0.0	
37	0	0%	0	0.0	
62	18	3%	106	0.4	
87	74	11%	437	4.7	
112	25	4%	148	3.3	
137	20	3%	118	4.8	
162	230	33%	1359	88.7	
187	196	28%	1158	114.5	
212	25	4%	148	21.0	
237	0	0%	0	0.0	
262	0	0%	0	0.0	
287	2	0%	12	4.0	
312	9	1%	53	23.0	
337	23	3%	136	73.6	
362	44	6%	260	173.1	
387	23	3%	136	109.8	
412	2	0%	12	11.4	
437	0	0%	0	0.0	
462	0	0%	0	0.0	
487	2	0%	12	18.5	
512	1	0%	6	10.7	
537	0	0%	0	0.0	
562	0	0%	0	0.0	
587	0	0%	0	0.0	
Total:	694	100%	4101	661.7	kg
TTL/Hectare			962.6	155.3	kg
Adults/HA			144		
PSD			18%		

Table A-19. Biomass calculations for largemouth bass for 1983.

Estimated Number of fish: 6929

Size Class	# Sampled	Adjust. Factor	Est. Number	(Kg) Est. Biomass
12	0	0%	0	0.0
37	0	0%	0	0.0
62	3	2%	129	0.3
87	28	17%	1205	7.5
112	46	29%	1980	28.7
137	19	12%	818	23.2
162	1	0%	43	2.1
187	6	4%	258	20.7
212	9	6%	387	47.1
237	17	11%	732	128.9
262	16	10%	689	169.4
287	2	1%	86	28.7
312	2	1%	86	37.9
337	2	1%	86	49.0
362	1	0%	43	31.1
387	4	2%	172	155.4
412	5	3%	215	239.3
437	0	0%	0	0.0
462	0	0%	0	0.0
487	0	0%	0	0.0
512	0	0%	0	0.0
537	0	0%	0	0.0
562	0	0%	0	0.0
587	0	0%	0	0.0
Total:	161	100%	6929	969.3 kg
TTL/Hectare			1,626.5	227.5 kg
Adults/Ha			141	
PSD			10%	

Table A-20. Biomass calculations for largemouth bass in 1984.

Estimated Number of fish: 865

Size Class	# Sampled	Adjust. Factor	Est. Number	(Kg) Est. Biomass
12	0	0%	0	0.0
37	0	0%	0	0.0
62	0	0%	0	0.0
87	3	1%	9	0.1
112	23	8%	72	1.2
137	9	3%	28	0.9
162	1	0%	3	0.2
187	9	3%	28	2.4
212	15	5%	47	5.8
237	94	34%	295	52.3
262	56	20%	176	42.9
287	11	4%	34	11.3
312	3	1%	9	4.0
337	3	1%	9	5.1
362	5	2%	16	10.7
387	26	9%	81	69.1
412	8	3%	25	26.0
437	5	2%	16	19.6
462	0	0%	0	0.0
487	3	1%	9	16.6
512	1	0%	3	6.5
537	1	0%	3	7.6
562	0	0%	0	0.0
587	0	0%	0	0.0
Total:	276	100%	865	282.0 kg
TTL/Hectare			203.0	66.2 kg
Adults/ha			40	
PSD			20%	

Table A-21. Biomass calculations for bluegill for 1982.

Estimated Number of fish: 27013

Size Class	# Sampled	Adjust. Factor	Est. Number	(Kg) Est. Biomass
5	0	0%	0	0.0
15	0	0%	0	0.0
25	0	0%	0	0.0
35	0	0%	0	0.0
45	0	0%	0	0.0
55	3	0%	74	0.2
65	9	0%	221	1.2
75	8	0%	197	1.6
85	58	5%	1426	17.6
95	162	15%	3982	69.2
105	298	27%	7325	173.2
115	193	18%	4744	148.4
125	116	11%	2851	115.4
135	100	9%	2458	126.1
145	59	5%	1450	92.7
155	50	5%	1229	96.5
165	25	2%	614	58.5
175	9	0%	221	25.2
185	2	0%	49	6.7
195	2	0%	49	7.8
205	0	0%	0	0.0
215	3	0%	74	15.9
225	2	0%	49	12.2
235	0	0%	0	0.0
Total:	1099	100%	27013	968.3 kg
TTL/Hectare			6,341.1	227.3 kg
Adults/ha			4956	
PSD			9%	

Table A-22. Biomass calculations for bluegill for 1983.

Estimated Number of fish: 10973

Size Class	# Sampled	Adjust. Factor	Est. Number	(Kg) Est. Biomass
5	0	0%	0	0.0
15	0	0%	0	0.0
25	5	0%	66	0.0
35	50	6%	659	0.4
45	4	0%	53	0.1
55	6	0%	79	0.2
65	24	3%	316	1.4
75	88	11%	1159	8.0
85	146	18%	1923	20.0
95	132	16%	1739	25.7
105	108	13%	1423	29.2
115	52	6%	685	18.9
125	16	2%	211	7.6
135	10	1%	132	6.1
145	21	3%	277	16.1
155	49	6%	645	46.7
165	39	5%	514	45.4
175	40	5%	527	56.6
185	26	3%	342	43.8
195	13	2%	171	26.0
205	4	0%	53	9.4
215	0	0%	0	0.0
225	0	0%	0	0.0
235	0	0%	0	0.0
Total:	833	100%	10973	361.6 kg
TTL/Hectare			2,575.8	84.9 kg
Adults/ha			1,168.9	
PSD			26%	

Table A-23. Biomass calculations for bluegill in 1984.

Estimated Number of fish: 12715

Size Class	# Sampled	Adjust. Factor	Est. Number	(Kg) Est. Biomass
5	0	0%	0	0.0
15	0	0%	0	0.0
25	0	0%	0	0.0
35	0	0%	0	0.0
45	0	0%	0	0.0
55	1	0%	27	0.1
65	2	0%	53	0.3
75	20	4%	533	4.8
85	45	9%	1200	15.8
95	59	12%	1573	29.0
105	59	12%	1573	39.2
115	41	9%	1093	35.8
125	40	8%	1066	44.8
135	7	1%	187	9.9
145	9	2%	240	15.7
155	16	3%	426	34.2
165	46	10%	1226	118.5
175	64	13%	1706	196.7
185	53	11%	1413	192.4
195	14	3%	373	59.5
205	0	0%	0	0.0
215	0	0%	0	0.0
225	1	0%	27	6.5
235	0	0%	0	0.0
Total:	477	100%	12715	803.3 kg
TTL/Hectare			2,984.7	188.6 kg
Adults/ha			2,190.1	
PSD			69%	

Table A-24. Biomass calculations for black crappie in 1982.

Estimated Number of fish: 19448

Size Class	# Sampled	Adjust. Factor	Est. Number	(Kg) Est. Biomass
5	0	0%	0	0.0
10	0	0%	0	0.0
15	0	0%	0	0.0
25	0	0%	0	0.0
35	0	0%	0	0.0
45	0	0%	0	0.0
55	0	0%	0	0.0
65	1	0%	37	0.4
75	37	7%	1368	21.7
85	126	24%	4659	92.8
95	228	43%	8430	205.6
105	68	13%	2514	73.5
115	5	0%	185	6.4
125	3	0%	111	4.4
135	10	2%	370	17.1
145	24	5%	887	46.7
155	18	3%	666	39.5
165	6	1%	222	14.8
175	0	0%	0	0.0
185	0	0%	0	0.0
195	0	0%	0	0.0
205	0	0%	0	0.0
215	0	0%	0	0.0
225	0	0%	0	0.0
Total:	526	100%	19448	523.0 kg
TTL/Hectare			4565	122.8 kg
Adult/ha			52	
PSD			5%	

Table A-25. Biomass calculations for black crappie in 1983.

Estimated Number of fish: 11464

Size Class	# Sampled	Adjust. Factor	Est. Number	(Kg) Est. Biomass
5	0	0%	0	0.0
15	0	0%	0	0.0
25	0	0%	0	0.0
35	0	0%	0	0.0
45	0	0%	0	0.0
55	0	0%	0	0.0
65	8	8%	873	2.7
75	8	8%	873	4.2
85	8	8%	873	6.2
95	1	0%	109	1.1
105	0	0%	0	0.0
115	1	0%	109	2.0
125	1	0%	109	2.5
135	7	7%	764	22.5
145	24	23%	2620	96.2
155	25	24%	2730	123.1
165	12	11%	1310	71.7
175	4	4%	437	28.6
185	2	2%	218	17.0
195	0	0%	0	0.0
205	2	2%	218	23.3
215	2	2%	218	27.0
225	0	0%	0	0.0
235	0	0%	0	0.0
Total:	105	100%	11464	428.1 kg
TTL/Hectare			2,691.1	100.5 kg
Adults/ha			256	
PSD			4%	

Table A-26. Biomass calculations for black crappie for 1984.

Estimated Number of fish: 4357

Size Class	# Sampled	Adjust. Factor	Est. Number	(Kg) Est. Biomass
5	0	0%	0	0.0
15	0	0%	0	0.0
25	0	0%	0	0.0
35	0	0%	0	0.0
45	0	0%	0	0.00
55	4	2%	96	0.20
65	6	3%	144	0.49
75	1	0%	24	0.13
85	0	0%	0	0.00
95	0	0%	0	0.00
105	4	2%	96	1.46
115	14	8%	335	6.79
125	41	23%	982	25.77
135	35	19%	838	27.95
145	36	20%	862	35.91
155	14	8%	335	17.19
165	7	4%	168	10.44
175	8	4%	192	14.33
185	7	4%	168	14.91
195	0	0%	0	0.00
205	5	3%	120	14.65
215	0	0%	0	0.00
225	0	0%	0	0.00
235	0	0%	0	0.00
Total:	182	100%	4357	170.20 kg
TTL/Hectare			1,022.77	39.95 kg
Adult/ha			230	
PSD			3%	

Table A-27. Available prey/Predator calculations for 1982 through 1984.

1982

Bass TL	Biomass	Cum. Biomass	Cumulative Total Prey biomass LMB	BG	BLC	TOTAL	AP/P
62	0.4	0.4					--
87	4.7	5.1					--
112	3.4	8.5					--
137	5.0	13.5	0.4			0.4	0.03
162	97.0	110.5	5.0	0.3		5.2	0.04
187	128.2	238.7	8.2	1.2	0.5	9.8	0.04
212	24.0	262.7	8.2	3.4	23.3	34.9	0.13
237	0.0	262.7	12.8	22.5	118.7	154.1	0.59
262	0.0	262.7	12.8	96.6	325.9	435.3	1.66
287	4.8	267.5	99.4	279.8	398.7	777.9	2.91
312	28.1	295.6	99.4	435.0	404.9	939.4	3.18
337	91.0	386.6	112.1	554.4	409.2	1075.6	2.78
362	216.6	603.2	232.1	683.7	425.3	1341.1	2.22
387	138.9	742.1	232.1	683.7	425.3	1341.1	1.81
412	14.6	756.7	232.1	777.8	468.9	1478.9	1.95
437	0.0	756.7	232.1	875.1	505.4	1612.5	2.13
462	0.0	756.7	232.1	933.5	518.8	1684.5	2.23
487	24.4	781.1	236.1	958.6	518.4	1713.0	2.19
512	14.2	795.3	236.1	965.1	518.4	1719.6	2.16

1983

Bass TL	Biomass	Cum. Biomass	Cumulative Total Prey biomass LMB	BG	BLC	TOTAL	AP/P
62	0.3	0.3		0.0		0.0	0.07
87	7.5	7.8		0.5		0.5	0.07
112	28.7	36.5		0.5		0.5	0.02
137	23.2	59.7	0.3	0.6		0.9	0.02
162	2.1	61.8	8.0	0.9		8.9	0.14
187	20.7	82.5	37.3	2.5	2.7	42.5	0.52
212	47.8	129.6	37.3	11.7	6.9	55.9	0.43
237	128.9	258.5	60.7	34.1	13.0	108.0	0.42
262	169.4	427.9	60.9	32.6	14.1	107.6	0.25
287	28.7	456.6	63.0	94.2	14.1	171.4	0.38
312	37.9	494.5	83.8	114.4	16.0	214.2	0.43
337	49.0	543.5	83.8	122.4	18.5	224.7	0.41
362	31.1	574.6	130.9	128.7	40.6	300.2	0.52
387	155.4	730.0	259.6	128.7	40.6	428.8	0.59
412	239.3	969.3	259.6	145.2	134.4	539.2	0.56

Table A-27. (con't).

1984

Bass TL	Biomass	Cum. Biomass	Cumulative Total Prey biomass				AP/P
			LMB	BG	BLC	TOTAL	
87	0.1	0.1					
112	1.2	1.2					
137	0.9	2.1					
162	0.2	2.3	0.1	0.1		0.2	0.08
187	2.4	4.6	1.3	0.4	2.9	4.6	0.99
212	5.8	10.5	1.3	5.3	6.9	13.5	1.29
237	52.3	62.8	2.1	21.3	13.0	36.5	0.58
262	42.9	105.6	2.1	50.6	14.1	66.8	0.63
287	11.3	116.9	2.3	89.9	14.1	106.3	0.91
312	4.0	120.9	4.7	125.7	16.0	146.4	1.21
337	5.1	126.1	4.7	170.5	18.5	193.7	1.54
362	10.7	136.8	10.6	180.3	40.6	231.5	1.69
387	69.1	205.9	63.2	180.3	40.6	284.1	1.38
412	26.0	231.8	63.2	196.0	134.4	393.7	1.70
437	19.6	251.4	106.4	229.9	254.3	590.6	2.35
462	0.0	251.4	117.8	347.4	323.9	789.1	3.14
487	16.6	268.0	117.8	542.2	351.6	1011.6	3.78
512	6.5	274.5	121.8	732.3	368.1	1222.2	4.45
537	7.6	282.0	121.8	791.1	368.1	1281.0	4.54

Table A-28. Instantaneous growth rates (G) calculated from average weight at each annulus for each year of sampling from Oak Middle Creek 58-B.

Largemouth Bass:

			Age			
Year	2	3	4	5	6	7
1981	2.17	1.15	0.39	0.51	-0.10	0.22
1982	2.60	1.26	0.43	0.39	0.31	0.18
1983	2.93	1.23	0.61	0.23	--	--
1984	2.45	1.50	0.80	0.26	0.28	--
Bluegill:						
1981	2.62	0.87	0.83			
1982	1.99	0.92	0.59			
1983	2.74	--	--			
1984	2.08	1.31	0.34			
Black Crappie:						
1981	1.84	0.97	0.20			
1982	1.27	--	--			
1983	1.41	0.88	--			
1984	1.66	0.70	--			

Table A-29. Average calculated lengths and weights of largemouth bass, bluegill, and crappie in five southeastern Nebraska lakes (standard deviations in parenthesis).

	Calculated length at annulus						
Species	1	2	3	4	5	6	7
Largemouth Bass	131.1	224.6	288.9	345.5	411.6	441.5	--
	(20.3)	(21.3)	(23.3)	(19.9)	(37.2)	(33.2)	
Bluegill	48.7	100.2	138.5	160.5	174.0	186.3	191.0
	(5.6)	(11.0)	(12.0)	(7.4)	(5.8)	(6.7)	(4.2)
Crappie	91.2	165.6	203.0	253.3	312.0	361.0	368.0
	(7.0)	(4.8)	(8.3)	(44.2)	(46.1)	(12.7)	--

	Calculated weight at annulus						
Species	1	2	3	4	5	6	7
Largemouth Bass	36.7	173.9	375.0	650.0	1135.0	1305.5	--
	(17.6)	(56.2)	(109.5)	(145.1)	(316.1)	(276.5)	
Bluegill	1.3	16.2	49.3	81.5	104.8	154.0	--
	(1.0)	(8.5)	(18.8)	(17.2)	(18.56)	--	
Crappie	11.0	60.7	99.0	236.5	466.5	571.0	571.0
	(4.36)	(16.5)	(1.4)	(153.4)	(57.3)	(101.8)	--

Table A-30. Length/weight and total length/scale radius ratios of largemouth bass, bluegill, and crappie in five southeastern Nebraska lakes.

Species	Length/Weight ratio
Largemouth Bass	logW=-4.8385+3.0004 logTL
	logW=-5.3398+3.1926 logTL
	logW=-5.3649+3.0277 logTL
	logW=-4.7865+2.9725 logTL
	logW=-5.3912+3.2325 logTL
Bluegill	logW=-5.4251+3.3339 logTL
	logW=-5.3399+3.2820 logTL
	logW=-5.5918+3.3912 logTL
	logW=-6.6269+3.8592 logTL
Crappie	logW=-5.4185+3.2028 logTL
	logW=-4.8186+2.9513 logTL
	logW=-8.4202+4.6200 logTL
	logW=-4.7652+2.9796 logTL

Table A-31. Mean condition factors (K(TL)) for largemouth bass, bluegill, and crappie from Salt Valley lakes.

Largemouth bass:

				Year Class				
	82	81	80	79	78	77	76	75
		2.71	1.39	1.50	1.51			
			1.61	1.64	1.51	1.49	1.58	1.82
		1.28	1.26	1.27	1.37	1.53		1.47
			1.20	1.28	1.32	1.43		
	1.21	1.32	1.35	1.41	1.47	1.53	1.46	
		1.48	1.40	1.38	1.49			
		1.33	1.42	1.47	1.67	1.57	1.70	
Mean	1.21	1.62	1.38	1.42	1.48	1.51	1.58	1.65

Bluegill:

				Year Class				
	82	81	80	79	78	77	76	75
		1.60	1.85	2.00	2.10	2.15	2.15	2.12
		1.61	1.87	1.91	1.89	1.77	1.82	
	1.25	1.74	1.95	1.95	1.88			
			1.09	1.46	1.72	1.85	1.92	
Mean	1.25	1.65	1.66	1.83	1.92	1.91	1.96	2.12

Crappie:

				Year Class				
	82	81	80	79	78	77	76	75
		0.98	1.15	1.13	1.11	1.17		1.47
	1.21	1.20	1.18	1.15	1.17			1.32
			1.56	1.54	1.63			
Mean	1.21	1.09	1.30	1.27	1.30	1.17		1.40