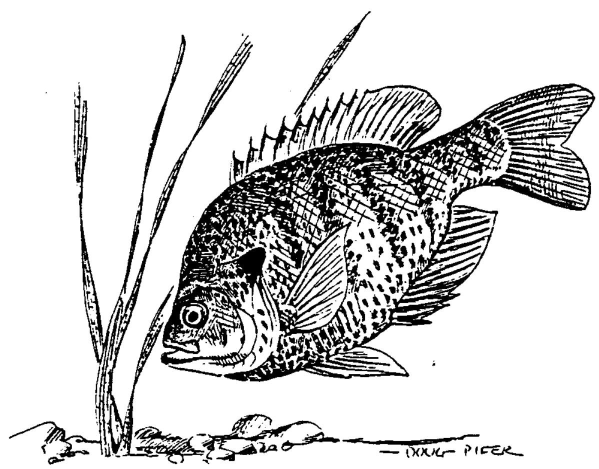
THE DEVELOPMENT OF AN OBJECTIVE RATING SYSTEM TO ASSESS BLUEGILL FISHING IN LAKES AND PONDS

Research Report

Robert L.Ball
and
Joe N. Tousignant
Fisheries Biologists



FISHERIES SECTION
INDIANA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
I.G.C. South, Room W273
402 W. Washington Street
Indianapolis, Indiana 46204

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ABSTRACT

A bluegill fishing potential (BGFP) index was devised to compare bluegill fishing quality among Indiana's lakes and reservoirs. Four bluegill population parameters were scored for each of 110 fisheries surveys on lakes . The four parameters were length-at-age for ages 3 and 4, electrofishing catch-per-unit-effort, proportional stock density, and relative stock density (fish ≥8 inches total length). A BGFP index score was then assigned to each lake survey. It is believed that the scoring system is a fairly accurate, objective assessment of bluegill fishing potential. It assigns a quality rating to lakes that results in a normal distribution of ratings.

Bluegill anglers were interviewed in 18 creel surveys to obtain opinions of their bluegill catches. Using a bluegill harvest quality (HQ) index, the authors compared these ratings to their actual catches. Correlations were poor, suggesting some problems with the approach and wide variability in bluegill angler opinion. However, the bluegill HQ index still presents an objective way to measure the quality of the anglers' harvest from individual bodies of water.

INTRODUCTION

Quality bluegill fishing has long been an important objective in the management of Indiana's lakes and ponds. However, just what constitutes "quality bluegill fishing" has been relatively imprecise and subjective. An accurate, objective assessment of the bluegill fishing potential of a lake is necessary to evaluate the success of different management techniques aimed at improving bluegill fishing.

A quality fishing trip is known to be affected by three factors: fish, environment, and people. The fisheries manager has little control over the last two factors, and can only readily manipulate the fish populations. In a phone survey of 200 anglers in Missouri, Weithman and Anderson (1978a) found that 81% of anglers mentioned fish, 76% mentioned environment, and 41% mentioned people in their descriptions of memorable fishing trips. There is potential for the fisheries manager to improve the quality of fish populations, and therefore increase angler trip satisfaction. The fisheries manager needs two additional tools to be better able to accomplish this goal. The first is angler involvement in exactly what constitutes good bluegill fishing. The second is a system that will give an accurate, objective assessment of the fishing potential of a particular lake that is reflective of these angler attitudes.

In light of this problem, a project was started in June of 1989 to provide an objective rating system that reflects both the angler's and the biologist's criteria for bluegill fishing quality. The objectives of this study are as follows.

1. Develop a database of various bluegill population parameters obtained from lake survey records.
2. Develop a scoring system of specified bluegill population parameters from lake survey data to provide an objective measure of bluegill fishing quality.
3. Assess angler opinions on the quality of their bluegill catches and the general quality of bluegill fishing in the lake they are fishing. Compare angler opinion of bluegill fishing quality to the objective bluegill quality scoring system and adjust scoring to reflect angler opinion.

METHODS

BLUEGILL FISHING POTENTIAL INDEX

Lake Fisheries Survey Database

A computer database was developed containing bluegill population parameters in lakes surveyed in May and June of 1985 to 1991. It was decided only to include surveys conducted in May and June, as this is the best period of time to collect a representative sample of the bluegill population. When available, information on growth, relative abundance by weight and number, catch per unit effort for electrofishing and trap nets, average weights, and size structure of the bluegill population was collected. The biologists supplying the information were also asked to give their opinion of the bluegill fishing potential at each lake.

Survey Rating System

From the information contained in the database, a rating system was developed that assigns a score for each of four population parameters: PSD (proportional stock density, the proportion of stock size fish $\geq$3.0 in. T.L. which are $\geq$6.0 in. T.L.); RSD_8 (relative stock density of 8 inch and larger bluegill); growth and CPUE (catch per unit effort of DC electrofishing) (Appendix 1). The different parameters are interdependent in the scoring process. For example, growth and density scores are dependent on each other, because good growth is most valuable when densities are adequate, and vice versa. Each parameter was given a score on a scale of 1 to 10. This scoring system is similar to the one designed by Colvin and Vasey (1986) to assess crappie populations in large Missouri reservoirs. Ranges of values were assigned based on the actual survey data.

Density

The density is estimated by catch per unit effort with electrofishing gear. Although AC electrofishing data was included in the database, all district and research fisheries biologists in the Fisheries Section now use pulsed DC electrofishing equipment exclusively for lake surveys. DC is more effective than AC in collecting small fishes, and it is used exclusively in the analysis for determining the BGFP index. For 110 lake surveys, catch rates of bluegill from surveys using one person dipping or two persons dipping were tested for normal distributions of catch rates. Neither distribution was normally distributed, as determined by Kolmogorov-Smirnov "d" statistics, due to disproportionate numbers of catch rates under about 400/hr. Therefore, a percentage was assigned to each of the five categories:

	POOR	MARGINAL	FAIR	GOOD	EXCELLENT
Percent of surveys	10	20	40	20	10

These percentages were used to obtain the actual catch rate ranges for each of the five categories (Appendix 1).

Good density for a lake is defined as having a catch rate of 336+ bluegill/hour for a single dipper and 502+ bluegill/hour for two dippers. However, for each category, marginal to excellent, the density score drops if growth is not rated as "good" for that body of water (Appendix 1). It is assumed that higher densities are better for anglers until densities become so high that growth declines.

Growth

The back-calculated lengths at ages of 3 and 4 were picked as indicative of growth rates for two main reasons. It is at these critical ages that the individual fish are usually recruited into the harvestable population, and fish of these ages are almost always represented in fisheries surveys. Distributions of growth for each age group in the complete set of 181 lakes, were approximately normally distributed (p>.20 for age 3 and p<.20 for age 4 for the K-S "d" statistic). The length-at-age data for individual surveys was sorted into five categories based on standard deviations of growth data from the combined database of 181 lake surveys as follows.

	POOR	MARGINAL	FAIR	GOOD	EXCELLENT
Std. Dev.	<-1.49	-1.5 to -0.49	-0.5 to 0.49	0.5 to 1.49	>1.5
Percent of Surveys	11.8	16.7	41.1	13.5	17.0

Because density and growth are closely interrelated, a measure of "good" growth was needed to score the density of bluegill in the lake. Good growth for a lake is defined for this purpose as being above 0.5 standard deviation from the mean of the lake surveys, or the sum of the lengths-at-age of bluegill ages 3 and 4 exceeding 12.1 inches. If both ages 3 and 4 bluegill are not present in the survey sample, a length-at-age of 5.4 inches or more at age 3 or 6.8 inches or more at age 4 is used as a criterion of good growth. When densities are good, growth rates are scored higher, due to the importance of density to quality fishing.

Size Structure

PSD and RSD_8 are used independently of each other in the scoring system. Better scores for PSD and RSD_8 values are given when densities are good. The score is reduced for very high PSD values, indicative of populations skewed towards larger fish and where recruitment is a problem.

Both PSD and RSD_8 distributions were highly skewed from normal distributions, and consequently it was not possible to assign quality ratings based on the standard deviations. For PSD, the divisions approximated the 10, 20, 40, 20, and 10% breakdown of scores used for densities. However, for RSD_8, approximately 40% of the surveys had values of 0.0. Therefore, an arbitrary assignment of score ranges was necessary (Appendix 1).

Relative Weights

Relative weight (W_r) provides a condition index for fish that is consistent throughout the mature size range. Originally, a score was given for the average W_r of 5, 6, and 7 inch bluegill. These sizes were selected as being the largest harvestable size groups that would be present in most of the lakes surveyed. A relative weight of 1.0 would indicate that the fish's weight is in the top 25 percentile for its length based on nationwide statistics. A high relative weight indicates a "chunky" fish--one that is heavy for its length. The relative weight equation used is as follows:

$$W_r = \frac{\text{Weight(g)}}{W_s} \times 100$$

where $Log_{10}W_s = -5.374 + 3.316$ (Log_{10} Length in mm) (Murphy, et al. 1991). This criterion

was dropped, however. In part, the same information is available from the values for growth and size structure, since W_r (and other condition indices) is closely related to these parameters. Another reason is that in many lakes W_r dropped sharply beyond 6 or 7 inches, and the range of 5 to 7 inches was not adequate to show this decline. Finally, the authors felt that it is not as sensitive as the other parameters, and might tend to mask environmental effects.

ANGLER OPINIONS

Creel Survey Questions

From 1989 to 1991, angler opinion regarding bluegill fishing quality was obtained from 18 creel surveys. In each of these surveys, clerks asked bluegill anglers two questions regarding bluegill fishing.

1. How do you rate the quality of your bluegill catch (excellent, good, fair, marginal, or poor)?
2. Using other factors besides just your catch today, how do you rate general bluegill fishing quality at this lake (excellent, good, fair, marginal, or poor)?

The first question is aimed at determining the anglers' opinion of their harvest. This emphasizes what the fisheries manager can manipulate, namely the sizes and abundance of bluegill in the lake. The second question is a rating of the general quality of bluegill fishing at the lake. This may include factors other than harvest that might affect the overall quality of the fishing experience. Such factors may include previous experience, proximity to other anglers, weed problems, lake reputation and the like. The answers to these two questions, and the lengths and numbers of bluegill caught were recorded on the creel survey forms.

There may be an inherent bias in a creel-based interviewing system. Where people fish is likely to be a critique of the fishing quality of a lake. Anglers who don't like the quality of fishing at a particular lake will not fish there. This may result in a higher than expected angler opinion of a marginal bluegill fishing lake. However, an alternative to interviewing anglers at lakes, the mail questionnaire, was not felt to be sensitive enough for this project, as it required recall of a prior year's fishing experiences in detail.

In some instances, it was necessary to throw out some individual responses when anglers rated their harvest better than poor but didn't keep any fish. Question 1 was directed at getting an angler's opinion of what he caught and kept. It seems that in some instances, the angler misunderstood the question and a marginal or better rating was given to their harvest when they didn't keep any fish. Since the question is concerned only with harvest, such answers are anomalous. The authors did their best to insure that all creel clerks were informed that question 1 refers only to bluegill harvest, not to what was caught and released.

Harvest Quality Index

A spreadsheet to contain angler responses and harvest data was created for each applicable lake creel survey from 1989 to 1991. In this spreadsheet, a harvest quality (HQ) index was calculated for each angler's harvest, based on the number, weight, and size of the fish caught and kept. A fish quality (FQ) index was calculated using Weithman and Anderson's (1978b) technique. This FQ index is used to estimate the quality of each bluegill an angler caught. The index is calculated as

$$FQ = (X)(W)$$

where X is a standard point value from 1.00 to 3.00 (Table 1). This point value is determined from the bluegill's length expressed as a percentage of the world record length (15 in., Gabelhouse 1984). The weight of the bluegill in kilograms is represented by W. This estimated weight is based on the actual bluegill length-weight regression calculated from data collected during recent fisheries surveys at the particular lake. The HQ index is the sum of the fish quality indices calculated for bluegill in the angler's creel.

This FQ index gives increasingly higher points for fish between 40% and 60% of the world record length for the species (Table 1 and Figure 1). This system gives a

Table 1. Standard point values (X) determined by expressing the length of a fish as a percentage of the world-record length for the species taken on hook and line (Weithman and Anderson 1978b).

LENGTH (%)	X	LENGTH (%)	X	LENGTH (%)	X
<10	1.00	42	1.33	59	2.72
10 - 15	1.01	43	1.38	60	2.75
16 - 20	1.02	44	1.44	61	2.78
21 - 24	1.03	45	1.50	62	2.81
25 - 27	1.04	46	1.57	63	2.84
28 - 29	1.05	47	1.66	64	2.86
30 - 31	1.06	48	1.76	65	2.88
32	1.07	49	1.87	66	2.90
33	1.08	50	2.00	67	2.92
34	1.10	51	2.13	68	2.93
35	1.12	52	2.24	69 - 70	2.94
36	1.14	53	2.34	71 - 72	2.95
37	1.16	54	2.43	73 - 75	2.96
38	1.19	55	2.50	76 - 79	2.97
39	1.22	56	2.56	80 - 84	2.98
40	1.25	57	2.62	85 - 90	2.99
41	1.28	58	2.67	91 - 100+	3.00

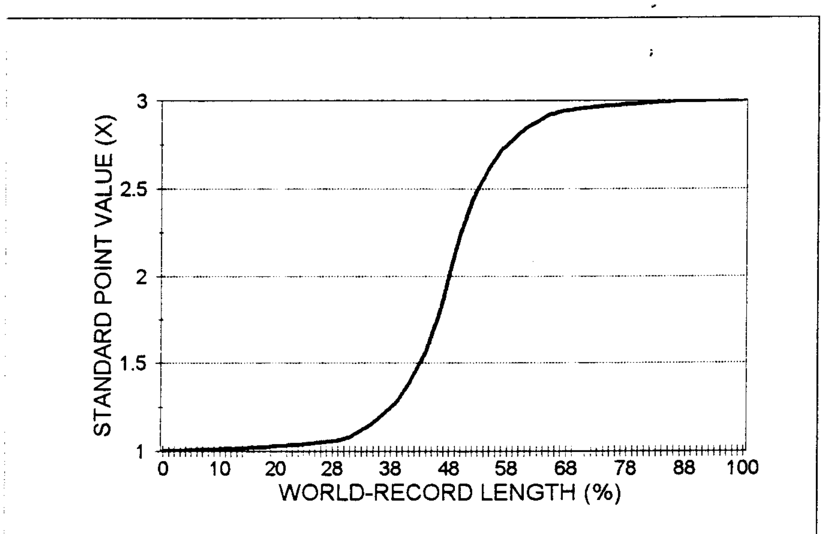

Figure 1. Standard point value (X) determined by expressing the length of any fish as a percentage of the world-record length for the species (Samson 1997, cited from Weithman and Anderson 1978b).

high score for big fish, which are usually scarce and harder to catch. The more plentiful, smaller fish will receive a lower score. Due to this flexibility, the HQ index awards points for a few large fish or for many smaller ones. It is therefore believed that the system is fair to both perceived "types" of bluegill anglers: those fishing for large numbers of smaller fish, and those seeking a few "jumbos".

Correlation and Regression Analysis of Creel Versus Fishery Survey Data

Anglers' responses to the two questions were coded in the lake spreadsheet on a scale of 1 to 5, with 5 being excellent. After the data was transformed to logarithms to approximate normal distributions, various correlations and regressions were made to compare responses to angler questions to the fish harvest and fishery survey data. Both NWA Statpak for the Macintosh computer and Statistica/W for Windows were used in analyses.

RESULTS AND DISCUSSION

LAKE FISHERIES SURVEY DATABASE

Fisheries survey information was collected from a total of 214 lakes. Out of this number, 33 could not be scored for bluegill fishing potential because of missing data. Of the 181 remaining lake surveys, 46 were from the AC electrofishing, and 135 were from DC electrofishing (Appendix 2). Surveys using AC electrofishing were primarily pre-1990 surveys, but many of the DC electrofishing surveys also predate 1990. The high average DC survey PSD for barrow pits is suspect because all five surveys were from Boone's Pond, which had very high bluegill PSDs in four years. In some ways, this data set is not representative of Indiana's public bluegill fisheries because the fisheries surveys were not selected to be representative of the State's public lakes. The average bluegill PSD for natural lakes varies sharply from a mean of 16.4 for the AC survey set to 24.1 for the DC survey set. Neither compares favorably with the values for impoundments (29.9 AC and 27.1 DC). Strip pits had by far the poorest growth scores of any group in DC electrofishing (3.6), and were second poorest in AC electrofishing (3.2) behind municipal ponds (2.3).

Relationships of four variables, CPUE versus PSD, RSD_8, and length at age 3, were evaluated with regression analysis. The DC electrofishing data set from 135 surveys was used, with each record normalized (square root transformations for PSD and RSD_8, log transformations for remainder). The result was a highly significant relationship for the multiple regression (Table 2). The F value for 132 degrees of freedom was 9.78, having a probability value of less than 0.00001. PSD, RSD_8, and length at age 3 were negatively correlated to CPUE. Of these three independent variables, however, only PSD was significantly correlated with CPUE (t = -4.537, df = 132). A similar result was obtained when only impoundments were included, using a sample size of 84.

Table 2. Multiple regression summary of CPUE versus three independent variables, PSD, RSD_8, and Length at Age 3, for 135 electrofishing lake surveys, all resource types and all combinations of dippers. R=0.426, R^2=0.182, and adjusted R^2=0.163. Standard error of estimate = 0.494. Data has been transformed to normalize it.

Part A. Regression Results

Variable	t Value	p-Level (significance)
Intercept	6.176	0.000000
PSD	-4.537	0.000013
RSD_8	-1.025	0.307414
Length: Age 3	0.230	0.818165

Part B. Correlation Results

Variable	PSD	RSD_8	Length: Age 3	CPUE
PSD	1.00			
RSD_8	0.38	1.00		
Length: Age 3	0.22	0.33	1.00	
CPUE	-0.42	-0.23	-0.10	1.00

To group the BGFP index scores into the five categories, the breakdown was based on the s.d. (standard deviation): within $\pm$1/2 s.d. from the mean was fair, $\pm$1.5 s.d. from the mean was marginal or good, and $\pm$2.5 s.d. from the mean was poor or excellent (Table 3). One hundred ten lake surveys using DC electrofishing and one or two dippers were included in this sample, having a s.d. of 6.17. With a database of 110 DC lake surveys, one and two dippers combined, a distribution of scores was plotted and found to approximate a normal distribution (p>.20 for the K-S "d" statistic). Although this appears to show a bias toward more surveys in the excellent compared to poor categories, there may be a bias toward the number of surveys done on the better lakes due to more intensive management on them (lakes may be larger, have predator stockings, or other factors which may require more frequent surveying). Also, the total percent of poor and marginal (32.8%) is close to that for good and excellent (30.9%).

Table 3. Bluegill fishing potential index ranges and percentage of scores falling within each BGFP index category.

	BGFP INDEX Survey Categories				
	Poor	Marginal	Fair	Good	Excellent
Ranges of total scores based on S.D.	0-7.0	7.1-12.9	13.0-18.9	19.0-25.9	26.0-40
No. of surveys in each group	7	29	40	21	13
% of surveys in each group	6.4	26.4	36.4	19.1	11.8

The scoring system was found to be flexible. For example, if a lake has a poor RSD_8 but good densities of bluegill, it can still be rated as good, if all other parameters are good. If the RSD_8 is good but densities are low, the lake could still be considered good by the index.

For a lake to be truly excellent, it must have high values for all of the parameters. It is therefore expected that there would be fewer excellent lakes than good lakes, as is the case with the scoring system. Only a small number of lakes are judged poor by this scoring system. This is because there are few bluegill populations that have no redeeming qualities. A population with poor densities or size structure may have good growth, for example. Also, a lake that is surveyed, typically is important enough to have received management efforts in the past, and its fish population usually reflects that.

After scoring the lakes in the database, it became clear that the various types of lakes in Indiana have different potentials for quality bluegill fishing. Lakes were classified as natural, impoundments (6 acres or bigger), ponds (<6.0 acres), and pits (barrow or strip) (Table 4). Strip pits, barrow pits and ponds were not included because of the small samples. None of these three groups had more than five surveys in them. Impoundments had a higher percent of surveys in the good and excellent categories (41.8%) compared to natural lakes (20.9%). However, the sample size was limited, and this difference should not be considered important without further samples.

Table 4. Lake ratings based on bluegill fishing potential index, by resource type. Other resource types (barrow pits, strip pits, and ponds) were not included due to small sample sizes.

Lake Type		Natural Lakes	Impoundments
Total No. of Surveys:		43	55
Poor	No.	3	1
	%	7.0	1.8
Marginal	No.	14	12
	%	32.6	21.8
Fair	No.	17	19
	%	39.5	34.5
Good	No.	8	11
	%	18.6	20.0
Excellent	No.	1	12
	%	2.3	21.8

Correlation and Regression Analysis of Creel Survey Versus Fishery Survey Data

For each of 18 creel surveys, the two angler responses, the HQ index, and the harvest (numbers and pounds per hour of angling) were obtained (Table 5a). No lakes from the "poor" group were included in creels, so this category is not included. All of the lake creel surveys were 7 months long except Upper Long 1991, Webster 1990, Big 1990, Crane 1990, and Waveland 1991, which were spot creels. Indian Lake had the highest average HQ index, and had one of the highest angler opinions of harvest (3.6), although this was only 0.6 above the "Fair" score. The lowest HQ index and lowest angler opinion of harvest both occurred at Big Lake.

Means for each of the four angler BGFP index rank categories are given in Table 5b. Due to variation and small sample size, means for some lower ranking categories overlapped with higher categories. For example, a "good" and "marginal" rankings on angler opinion of harvest exceeded the "excellent" means. The number of bluegill harvested per hour in "good" lakes was higher than that for "excellent" lakes. However, angler opinion of bluegill fishing quality showed a progressive upward trend from marginal to excellent, although means were very close together for the last three rankings. There were also nice upward trends for the HQ index and weight of fish caught by anglers.

Table 5. Bluegill fishing potential index, angler opinion of harvest, general bluegill fishing quality, and harvest quality for creeled lakes.

Part A. Individual Creel Survey Statistics

Lake & Year of Creel Survey	Angler SS*	Bluegill Fishing Potential Index Score	Bluegill Fishing Potential Index Code**	Angler Opinion of BG Harvest Index	Angler Opinion of BG Harvest Std.Dev.	Angler Opinion of BGFQ Index	Angler Opinion of BGFQ Std.Dev.	Harvest Quality Index Anglers With Fish Index	Harvest Quality Index Anglers With Fish Std.Dev.	HARVEST MEANS Anglers With Fish SS*	HARVEST MEANS Anglers With Fish No. Caught	HARVEST MEANS Anglers With Fish Lb. Caught
Brookville '89	108	9	M	3.3	0.59	3.2	0.55	1.4	0.70	124	10.8	2.5
Brookville '90	124	9	M	3.0	0.73	2.8	0.81	2.0	1.98	106	12.4	2.2
Brookville '91	64	11	M	3.3	0.63	3.1	0.72	1.3	0.81	64	10.7	2.0
Webster '90	502	11	M	2.4	1.25	3.2	1.05	0.9	1.32	277	13.7	0.7
West Boggs '89	85	13	F	2.5	1.05	2.7	1.17	1.7	1.56	68	13.8	2.6
Tipsaw '90	28	13	F	2.9	1.41	3.0	1.26	4.0	3.03	26	15.6	4.5
Upper Long '90	24	13	F	2.6	1.28	3.4	0.83	1.7	1.78	18	16.8	2.6
Crane '90	61	15	F	1.9	1.29	3.4	1.10	1.3	1.46	26	5.5	1.8
Starve Hollow '90	269	15	F	3.4	1.31	4.1	0.83	1.8	1.54	232	8.4	2.2
Middle Fork '90	338	15	F	3.7	0.58	4.0	0.28	2.2	3.16	338	9.9	2.7
Big Lake '90	44	16	F	1.7	1.17	3.4	1.00	0.7	0.75	20	4.6	1.0
Maxinkuckee '90	208	17	F	3.0	1.25	3.4	0.83	4.6	5.96	179	14.3	4.3
Celina '90	30	21	G	3.4	1.27	3.5	1.11	2.2	2.02	30	8.1	2.1
Indian '90	38	22	G	3.6	1.17	3.7	1.24	4.7	3.22	37	13.9	4.8
Monroe '91	153	24	G	2.8	1.23	3.2	1.15	2.2	1.84	134	15.6	3.1
Patoka ' 89	236	26	E	2.6	1.39	2.8	1.30	2.7	1.65	149	5.6	1.1
Patoka '91	510	27	E	3.5	1.09	4.1	0.68	4.5	3.41	510	12.3	4.4
Waveland '91	26	28	E	2.6	1.54	4.0	0.81	4.5	4.70	18	11.8	4.6

*Sample size.
**P=Poor=0.0-7.0; M=Marginal=7.1-12.9; F=Fair=13.0-18.9; G=Good=19.0-25.9; and E=Excellent=26.0-40.0.

Part B. Means for Each of Four Angler Bluegill Fishing Potential Index Rankings

Bluegill Fishing Potential Index Category	SS	Angler Opinion of BG Harvest Index	Angler Opinion of BG Harvest Std.Dev.	Angler Opinion of BGFQ Index	Angler Opinion of BGFQ Std.Dev.	Harvest Quality Index Anglers With Fish Index	Harvest Quality Index Anglers With Fish Std.Dev.	HARVEST MEANS Anglers With Fish No. Caught	HARVEST MEANS Anglers With Fish Std.Dev.	HARVEST MEANS Anglers With Fish Wt. Caught	HARVEST MEANS Anglers With Fish Std.Dev.
MARGINAL	4	3.0	0.37	3.1	0.16	1.4	0.39	11.9	1.24	1.9	0.69
FAIR	8	2.7	0.64	3.4	0.43	2.3	1.26	11.1	4.37	2.7	1.11
GOOD	3	3.3	0.34	3.5	0.21	3.0	1.18	12.5	3.21	3.3	1.11
EXCELLENT	3	2.9	0.42	3.6	0.59	3.9	0.85	9.9	3.05	3.4	1.60

A multiple regression analysis was performed on the eight variables in Table 6, using the BGFP index as the dependent variable. Lake area was included as the seventh variable to define its relationship in the model. The objective was to measure partial correlations, which are the correlations between the respective variable and the dependent variable, after controlling for all other variables in the equation. The linear model was significant with F=7.4 and p=0.003. Three variables were not significantly correlated to the BGFP index (p>0.10): HQ index, harvest in number, and harvest in weight. This was disappointing because all three relate directly to catch. Partial correlations revealed some significant relationships. Angler's opinion of bluegill fishing conditions was strongly negatively correlated to the BGFP index. Since angler opinion of fishing quality was positively correlated (p=0.064), this suggests that the anglers may have been strongly coloring their expectations of catch with that of the lake's reputation. The HQ index and the lake area were positively and significantly related to the BGFP index at p<0.05 level. The positive correlation with lake area shows that the database of 18 creel surveys may be biased towards the large reservoirs. A bigger sample of lake creels is needed to clarify the relationships.

Table 6. Partial correlation results for statistics from 18 creeled lakes, with BGFP index versus listed variables. Regression summary: R^2=0.84, Adjusted R^2=0.73, F=7.431 (p<0.003). Standard error of estimate = 0.083.

Variables	Partial Correlation	R^2	t	Probability Level
Biologist's Lake Rating	0.67	0.706	2.832	0.016
Angler Opinion of BG Harvest	-0.66	0.486	-2.772	0.018
Angler Opinion of BG Quality	0.55	0.421	2.057	0.064
Harvest Quality Index	0.19	0.882	0.617	0.550
Harvest (No./Hr.)	-0.19	0.479	-0.621	0.547
Harvest (Lb./Hr.)	0.13	0.843	0.416	0.685
Lake Area	0.65	0.455	2.723	0.020

A set of simple correlations were computed to relate a series of variables from the creel surveys on 18 lakes: BGFP index, biologist's lake rating, angler opinion of bluegill harvest, angler opinion of general fishing conditions, HQ index, harvest (no./hr.), harvest (lb./hr.) (Table 7). Two variables were significantly correlated to the BGFP index: biologist's lake rating was highest at 76% and HQ index second at 57%. In most cases, the biologist who collected the field data for the BGFP index was the same one who assigned the subjective biologist's lake rating. As a result, some correlation would be expected. However, the correlation was not strong enough to suggest using the biologist's lake rating in place of the BGFP index, since it accounted for just 58% of the variation in the BGFP index regression. The correlation with the HQ index suggests that the BGFP index is representative, although a stronger correlation might have been anticipated. In fact, the HQ index is more highly correlated with the biologist's lake rating (60%). The HQ index was highly correlated with the harvest (lb./hr.) at 83%, but this is due to the importance of weight in the HQ index (Weithman and Anderson 1978b).

Table 7. Correlations for eight variables from 18 creeled lakes.

	Variable No.: Corresponds to Variable on Left Side							
Variable Name	1	2	3	4	5	6	7	8
1. Biologist's lake rating	1.00							
2. Angler opinion of BG harvest	0.25	1.00						
3. Angler opinion of BG fishing quality	0.45	0.31	1.00					
4. Harvest quality index	0.60*	0.54	0.28	1.00				
5. Harvest in No.	-0.08	0.47	-0.04	0.42	1.00			
6. Harvest in Wt.	0.30	0.53	0.33	0.83**	0.57*	1.00		
7. Lake area	-0.26	0.27	-0.34	0.11	0.18	-0.02	1.00	
8. BGFP index	0.76**	0.05	0.44	0.57*	-0.15	0.30	0.05	1.00

*F test significant at p<0.05 level.
**F test significant at p<0.01 level.

Correlations between the angler's opinion of the harvest and the HQ index were tested after deleting all "zero catch" anglers (Table 8). The data was transformed into logarithms to remove effects of possibly non-normalized raw data. The purpose of calculating a r value in this case would be to test for predictability between an angler's opinion of his harvest and the HQ index. In other words, we want to predict how anglers rate a given harvest. The correlation coefficient (r) values ranged from 33% for Monroe Reservoir to 74% for Tipsaw Lake. The correlations for all lakes were significant at p<0.01 (F-test), with the exceptions of Waveland (p<0.05), and Big and Upper Long Lakes, which were not significant. However, the average correlation was 47.25%, not considered of importance because it accounts for only 22.3% of the variation of the angler question 1 by the regression of the HQ index. One could gather two conclusions from these poor r values. The most likely reason for low correlations is that different people have different likes and expectations. Some people are satisfied with a much smaller harvest than others fishing at the same lake. This becomes obvious when one looks at the large range of HQ indices that are given the same quality rating by different anglers. Another possibility is that anglers rate their harvest based on other qualities besides those that the HQ index is based upon. Probably previous experience has much to do with the rating given. Variables such as the weather, expectations, and effort may also affect the angler's rating of his harvest.

Table 8. Correlation between angler's opinion of bluegill harvest and the HQ index. The data was log-transformed, with linear correlations. All fishing parties with zero catches were removed.

Lake & Survey Date	Fishing Party Sample Size	Correlation to Angler Opinion of BG Harvest	Significance of Correlation (p<value)
Celina '90	30	47	0.01
Indian '90	37	50	0.01
Webster '90	250	36	0.01
Tipsaw '90	26	74	0.01
Brookville '89	124	59	0.01
Brookville '90	106	37	0.01
Brookville '91	65	47	0.01
Starve Hollow '90	230	44	0.01
West Boggs '89	68	39	0.01
Maxinkuckee '90	179	38	0.01
Crane Lake '90	61	49	0.01
Monroe '91	134	33	0.01
Patoka '89	68	39	0.01
Patoka '91	508	58	0.01
Middle Fork '91	337	48	0.01
Waveland '91	18	58	0.05
Big Lake '90	20	35	n.s.
Upper Long '91	20	43	n.s.

Mean r = 47.25 (Big and Upper Long excluded)

CONCLUSIONS

It is apparent that the objective scoring system for bluegill fishing potential gives a different result from the district biologists' methods. It is believed that the scoring system accurately addresses fishing quality for bluegill. It assigns a quality rating to lakes that results in a normal distribution of ratings. As the biologists subjectively rated their lakes, they may have used the word "excellent" a little too freely, as more lakes were judged excellent than good. If it is agreed that excellent implies the "best of the best", less than 25% of the lakes should be judged excellent. On the average, however, Indiana's lakes were scored equally by the scoring system and the biologists' ratings. The mean ratings for Indiana's lakes were the same for both rating systems.

Anglers gave widely different views in the way they rate their harvest. One angler's excellent harvest is another one's poor harvest. This tends to make it more difficult to draw any conclusions on angler opinions. This was particularly apparent in comparing Maxinkuckee anglers to those of the other lakes creeled. Maxinkuckee anglers seem to have much greater expectations of their bluegill catch. This was also the case for Patoka and Indian Lake anglers.

Even though the HQ index did not correlate well with the angler bluegill harvest quality question, it still presents an objective way to measure the quality of the angler's harvests from individual bodies of water. Baccante and Colby (1991) found their walleye quality fishing index to be inversely related to annual angler effort at northern walleye lakes. The HQ index may be useful for comparing fisheries within or among groups of lakes selected for their similarities in eutrophic stage, management method, or other methods of grouping.

One problem observed is that a lack of uniformity in training and emphasis for creel clerks may have reduced the quality of the data collected. In the present study, each district or research biologist was responsible for interpreting the instructions of the project and training his or her clerks accordingly. As a result, instructions were not uniformly carried out, especially the first year of the project. It is hoped that, if such a project is attempted in the future, all clerks can be trained for the work so that each understands the importance of the questions and the best way to ask them. This would not necessarily mean bringing them into a classroom, as has been done in some surveys. But training responsibility could be limited to two or more biologists, who would conduct briefings and follow-up contacts with each clerk.

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LITERATURE CITED

Baccante, D.A. and P.J. Colby. 1991. Quantifying walleye angling success. American Fisheries Society Symposium 12: 397-405.

Colvin, M.A. and F.W. Vasey. 1986. A method of qualitatively assessing white crappie populations in Missouri reservoirs. Pages 79-85 in G.E. Hall and M.J. Van Den Avyle (Ed.), Reservoir Fisheries Management: Strategies for the 80's. Reservoir Committee, S. Division of the American Fisheries Society, Bethesda, Maryland. 1986.

Gabelhouse, D.W., Jr. 1984. A length categorization system to assess fish stocks. North American Journal of Fisheries Management. 4: 273-285.

Murphy, B.R., D.W. Willis, and T.A. Springer. 1991. The relative weight index in fisheries management: status and needs. Fisheries: A bulletin of the American Fisheries Society, 16(2): 30-38.

Weithman, A.S. and R.O. Anderson. 1978a. An analysis of memorable fishing trips by Missouri anglers. Fisheries: A Bulletin of the American Fisheries Society, 3(1): 19-20.

Weithman, A.S. and R.O. Anderson. 1978b. A method of evaluating fishing quality. Fisheries: A Bulletin of the American Fisheries Society, 3(3): 6-11.

Submitted by: Robert L. Ball and Joe N. Tousignant
Fisheries Biologists
Date: March 14, 1996

Approved by: Thomas M. Flatt
Thomas M. Flatt, Fisheries Supervisor

Approved by: William D. James
William D. James, Chief of Fisheries
Date: July 16, 1996

Appendix 1. Point values assigned to the four population parameters used to determine the Bluegill Fishing Potential Index.

	Poor	Marginal	Fair	Good	Excellent
Density*					
1 Dipper	0-73	74-155	156-335	336-905	906-∞
2 Dippers	0-75	76-169	170-501	502-1379	1380-∞
Good growth**	0	3	6	8	10
Less than good growth	0	2	4	6	5
Growth†					
Total Length Age 3	2.7-3.5	3.6-4.3	4.4-5.3	5.4-6.3	6.4-7.3
Total Length Age 4	3.5-4.8	4.9-5.7	5.8-6.7	6.8-7.6	7.7-8.4
Total Length Age 3 & 4	0-8.3	8.4-10.0	10.1-12.0	12.1-13.9	14.0-15.7
Good density††	0	3	5	8	10
Less than good density	0	2	4	6	8
PSD	0.0-4.4	4.5-11.9	12.0-24.9	25.0-39.9	40.0-100.0
Good Density	0	4	6	9	10
Less than good density	0	3	5	7	7
RSD_8	0.0	0.1-0.9	1.0-3.9	4.0-13.0	13.1-∞
Good Density	0	4	6	9	10
Less than good density	0	3	5	7	8

*Density as indicated by DC electrofishing CPUE.

**Good growth is a combination of >5.3" at age 3 and >6.7" at age 4 unless only one age group was present.

†Growth is total lengths in inches at ages 3 and 4.

††Good density is >335 for 1 dipper or 501 for 2 dippers.

Appendix 2. Selected means from the bluegill fisheries survey database.

Part A. AC Electrofishing Surveys

Body of Water	Sample Size	PSD	RSD_8	Mean Length-at-Age (inches TL) Age 3	Age 4	Wr for Inch-Group 5.0-7.0	Electrofishing CPUE	Relative Abundance No.	Relative Abundance Wt.	Biologist's BG Fishing Quality
Impoundments	16	29.9	2.5	5.5	6.8	99.0	102	38.3	13.8	3.6
Ponds, Farm	10	26.7	2.4	4.9	6.4	91.5	139	69.1	24.7	2.6
Ponds, Municipal	5	0.7	0.0	4.0	5.0	83.0	512	75.4	24.1	1.0
Ponds, All	15	18.1	1.6	4.6	5.7	89.3	234	71.9	25.4	2.1
Pits, Strip	6	27.8	0.0	4.2	5.6	89.6	44	41.6	23.2	3.2
Lakes, Natural	9	16.4	0.8	4.7	6.0	97.5	272	67.2	42.5	3.3
AC Surveys Avg.	46	23.2	1.5	4.9	6.1	94.3	171	54.3	24.0	3.0

Part B. DC Electrofishing Surveys

Body of Water	Sample Size	PSD	RSD_8	Mean Length-at-Age (inches TL) Age 3	Age 4	Wr for Inch-Group 5.0-7.0	Electrofishing CPUE	Relative Abundance No.	Relative Abundance Wt.	Biologist's BG Fishing Quality
Impoundments	73	27.1	3.8	5.2	6.5	94.8	412	45.2	17.0	3.7
Ponds, Farm	3	33.8	0.0	4.3	6.1	89.7	166	40.4	12.9	2.7
Ponds, Municipal	3	33.1	0.0	4.3	5.2	99.5	270	47.0	17.8	2.0
Ponds, All	6	33.5	0.0	4.3	5.6	94.6	218	43.7	15.4	2.3
Pits, Barrow	5	43.3	3.5	4.4	6.2	103.8	114	40.2	16.9	3.6
Pits, Strip	8	30.6	0.3	4.3	5.2	87.4	50	35.5	16.7	1.6
Pits, All	13	35.4	1.5	4.4	5.6	93.7	74	37.3	16.8	2.4
Lakes, Natural	43	24.1	1.2	4.6	6.0	87.1	450	48.6	19.8	2.9
DC Surveys Avg.	135	27.2	2.6	4.9	6.2	92.3	383	45.2	17.9	3.2