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JOB COMPLETION REPORT

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FEDERAL AID IN FISHERIES RESTORATION ACT

TEXAS

Federal Aid Project No. F-6-R-14

FISHERY INVESTIGATIONS - REGION 5-B

Job No. B-26 (Seg. 3) The K Factor Index, KI:
A Qualitative Measure of Fish Populations

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ABSTRACT

Monthly netting samples were made at Lake Corpus Christi ending three years of length-weight data collection from lakes of the region. The information was pooled with similar data from Lakes Medina and Falcon, and K factor means were computed.

In order to obtain a productivity measure using K factors, a transformation to additive units was required. Probability was chosen for this purpose. Correction terms consisting of independent K means for month, sexual development, and length were obtained by smoothing empirical K factor data. These were assumed regional means and the probability of deviation of sample K means was measured by Student's distribution. The mean probability was defined as the K factor index, KI.

Tables of the partially completed regional K factor means are included along with recommendations for extending the job another segment to prepare a manuscript to publish the results.

JOB COMPLETION REPORT

State of Texas

Project No. F-6-R-14 Name: Fishery Investigations - Region 5-B

Job No. B-26 (3rd seg.) Title: The K Factor Index, KI: A Qualitative Measure of Fish Populations

Period Covered: January 1, 1966 to December 31, 1966

Objectives:

1. To determine the influence of seasons and gonadal development on the K factors of fishes.

2. To continue to develop a method to approximate water productivity through the use of K factors.

Procedures:

Monthly gill net collections were conducted at Lake Corpus Christi, in order to provide additional and current information on the K factor trends and averages of fishes. Similar work had been done at Lakes Medina and Falcon in the two preceding segments. These three lakes form a triangle about the region and K factor data from them were pooled to produce regional means.

The principle collecting method was the standardized sampling gill net. The nets were 150 feet long and eight feet deep with mesh sizes ranging from 1- to 3½-inch square. Eight nets were used once each month and were set on afternoons and run the following mornings. Angler catches were occasionally used to secure additional data. Rotenone killed fish were not used because of the characteristic gorging induced by the chemical.

Data were recorded on Keysort punch cards in the field. Each fish had a separate card containing all necessary information. Cards were completed and punched at headquarters. The following variables were used to obtain K factor parameters:

1. Date of collection.

2. Collection site.

3. Species.

4. Total and standard length (the latter used for K computations).

5. Weight.

6. Sex and stage of sexual development (see D-J Project F-9-R-12, Job B-25, for definitions of stages).

7. Gonadal weight of selected individuals.

8. Collection method.

Results and Discussion:

The above procedures as outlined in the job description were completed ending the planned field collecting for the job. Considerable progress was made toward computing the regional K means; however, an additional segment will be necessary to complete this phase.

The objective of the K factor index, KI, is to measure water productivity by the use of K factors. Since K factors of different species are non-additive terms due to diverse body relationships and K of the same species is subject to variation from several sources other than nutrition, correction terms are needed to transform K into additive units. Any resulting variation after applying the correction terms can be attributed mainly to water productivity.

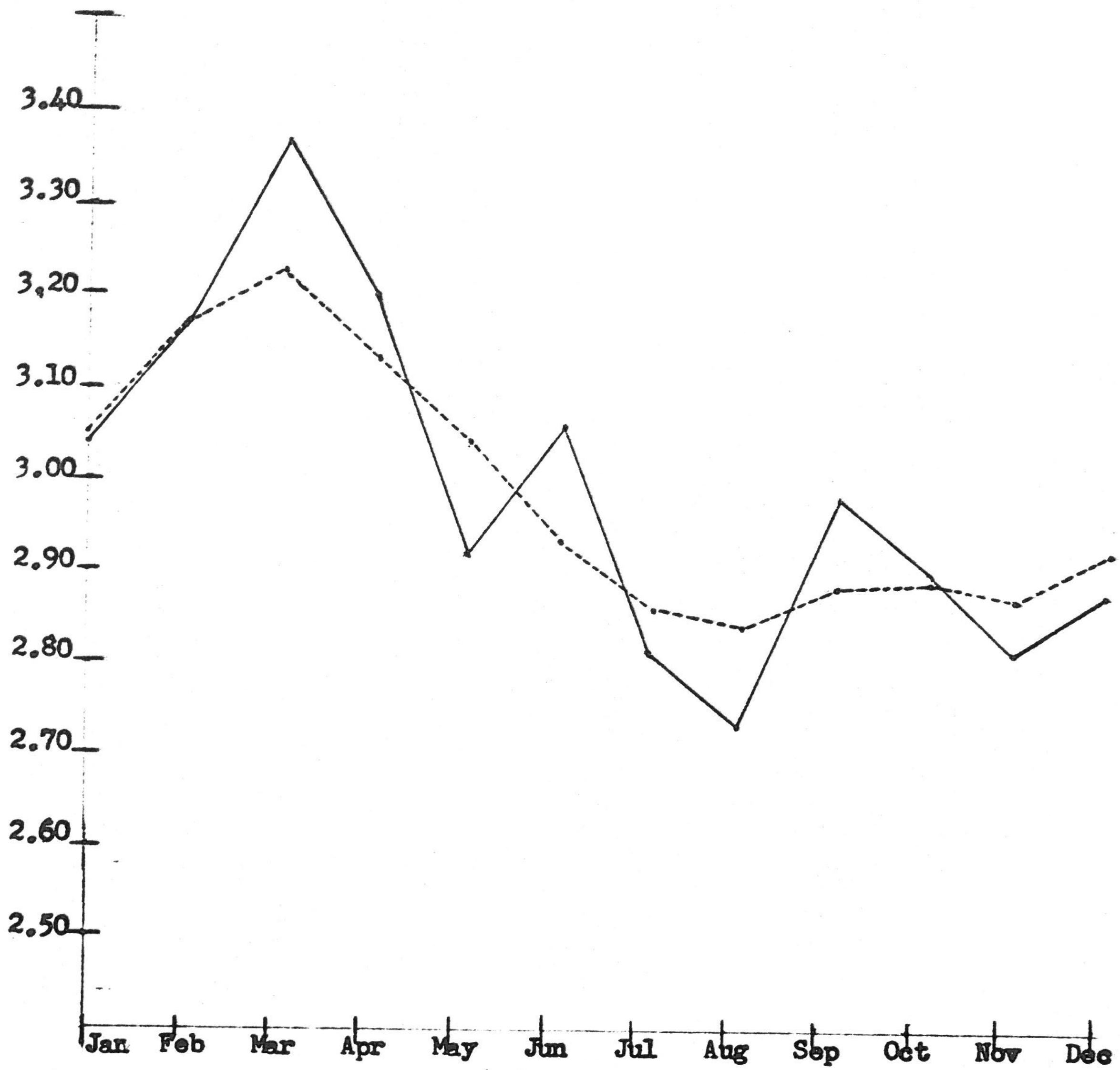
Correction terms, consisting of independent K means, were developed for three measurable sources of variation: time of year, sexual development (dimorphism), and length (age). This was effected by keeping the monthly collections separate and compiling K distributions and moments for the eight stages of sexual development and for centimeter standard length groups.

Extreme variability was encountered with the empirical K means and was complicated by the absense of some values. This made it necessary to apply a smoothing procedure. Figure 1 illustrates the empirical and smoothed K factor trend for white crappie.

A modified, binomially weighted moving average of five was used to smooth the K means. Similar methods are used extensively in other fields to depict seasonal economic trends. In the case of missing means, the other values of the range of five months were weighted with the binomial coefficients and the coefficients of the missing K mean subtracted from the denominator. The main source of error in this method is the necessity of combining K means with unequal frequencies.

The smoothed K means were assumed as regional means since they were obtained from pooled data from the three lakes. The additivity necessary to combine various species was obtained through the use of probability. Since most K factor distributions approximate the normal curve, the significance (in terms of probability) which a sample K mean varies from a regional mean can be measured by Student's distribution. This is obtained by:

Figure 1. Monthly empirical and smoothed K factor means of the white crappie.



$$t = (\text{sample } \bar{K} - \text{regional } \bar{K}) / \text{standard error of sample.}$$

The probabilities of the t values can be approximated from tables found in any standard statistics text. They are weighted by sample frequencies and mean probability equals KI.

Table 1 shows the regional monthly K means for the common species of Region 5. Tables 2 and 3 give the complete K data for gizzard shad and white bass, respectively. It is beyond the scope of this report to give the complete data for all species; however, these will be computed during the coming segment and presented in the final, published report.

Gonadal data from the three lakes will also be presented in the published report. After initiating its collection, it became apparent that gonad weight could not easily be used as a source of K factor variation, but it will make valuable supplemental information of particular interest to life history studies.

Computations of KI are illustrated by Tables 4-6 which consist of a randomly chosen month from each of the three lakes. Since gizzard shad and white bass are the only species with complete regional K means, KI of the other species will consist only of their total mean for the month.

Weighting of species KI by individual frequency is controversial. In doing so, I realize that KI is being biased by gear selectivity of the species involved; some species are nevertheless more numerous than others and tie up proportional amounts of nutrition. This problem can be overcome only by the development of selectivity coefficients for the various collecting methods.

The KI tables show that Falcon Lake leads the others in productivity by a considerable margin. This was anticipated, but the magnitude of the difference should be qualified. When the Falcon collections were made from December 1964 to November 1965, the lake was in prime condition. Fall rains had filled it the previous year and had produced a virtual plankton explosion. Fishes collected were in optimum condition and generally had ample stores of body fat even when sexually ripe.

At the other extreme, Medina Lake, which was sampled in 1964, was in a period of low productivity. The fish populations were very crowded and in poor condition, as seen by KI. Low productivity, however, should be expected here since this lake is deep and near the beginning of its water source, allowing little chance for nutrients to enter.

Continued sampling and updating of the regional K means should eliminate the denoted inequities. This additional sampling should include all bodies of water within the region. Other regions of the state may wish to adapt this measurement tool. This task can best be accomplished by electronic data processing equipment. The information can be stored on computer tape making periodic updating easy.

Table 1

Smoothed Monthly K Factor Means for the Common Fishes of the Region

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Alligator gar			1.54	1.42	1.22	0.98	0.81	0.84	1.01	1.11	1.12	1.12
Longnose gar	0.48	0.47	0.44	0.42	0.41	0.40	0.40	0.40	0.40	0.40	0.41	0.45
Spotted gar	0.73	0.75	0.74	0.73	0.71	0.70	0.69	0.68	0.66	0.64	0.64	0.68
Threadfin shad	2.25	2.23	2.21	2.14	2.07	2.08	2.15	2.22	2.22	2.13	2.12	2.20
Gizzard shad	1.91	1.91	1.87	1.82	1.78	1.79	1.83	1.88	1.89	1.90	1.91	1.93
Smallmouth buffalo	3.90	4.05	4.10	3.96	3.77	3.67	3.64	3.62	3.58	3.56	3.63	3.76
River carpsucker	2.91	2.90	2.95	3.00	3.03	3.05	3.05	3.04	3.03	3.01	3.00	2.97
Carp	2.95	3.02	3.02	2.96	2.86	2.80	2.75	2.67	2.57	2.59	2.71	2.84
Channel catfish	1.57	1.60	1.63	1.64	1.62	1.59	1.58	1.57	1.56	1.56	1.55	1.55
Blue catfish	1.57	1.65	1.71	1.73	1.71	1.65	1.60	1.57	1.56	1.54	1.52	1.53
Flathead catfish	1.94	1.96	2.00	2.04	2.02	1.95	1.87	1.83	1.84	1.84	1.83	1.88
White bass	2.78	2.79	2.75	2.71	2.69	2.70	2.72	2.71	2.68	2.66	2.67	2.73
Largemouth bass	2.38	2.48	2.51	2.48	2.43	2.40	2.38	2.34	2.30	2.26	2.24	2.28
Warmouth	4.10	4.06	4.00	3.92	3.88	3.94	4.01	4.02	4.03	4.10	4.20	
Green sunfish	3.90	3.81	3.68	3.63	3.72	3.92	4.13	4.28	4.02	3.66	3.66	3.74
Redear sunfish	3.28	3.92	4.09	4.02	3.80	3.52	3.41	3.56	3.65	3.47	3.24	3.14
Bluegill	4.13	4.29	4.43	4.54	4.54	4.46	4.33	4.19	4.11	4.05	3.95	3.96
Redbreast sunfish	5.46	5.26	4.76	4.26	4.06	3.54	3.02	3.02	3.02	3.02	3.02	4.24
White crappie	3.04	3.17	3.22	3.16	3.05	2.96	2.88	2.86	2.90	2.91	2.90	2.94
Black crappie	3.53	3.61	3.76	3.82	3.76	3.70	3.67	3.62	3.58	3.58	3.58	3.54
Freshwater drum	2.94	3.12	3.23	3.20	3.04	2.87	2.78	2.77	2.75	2.67	2.63	2.74
Rio Grande perch	5.43	5.49	5.40	5.27	5.30	5.45	5.44	5.27	5.18	5.18	5.13	5.14

Table 2

Smoothed Monthly K Factor Means for Gizzard Shad

Source of Variation	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Total	1.91	1.91	1.87	1.82	1.78	1.79	1.83	1.88	1.89	1.90	1.91	1.93
Sex. Dev. Stage												
M-1	2.06	2.00	1.89	1.77	1.69	1.72	1.80	1.84	1.84	1.82	2.12	2.10
M-2	1.96	1.90	1.81	1.69	1.61	1.59	1.67	1.91	1.93	1.93	1.97	2.00
M-3	1.84	1.80	1.79	1.82	1.87	1.90	1.86	1.84	1.87	1.90	1.90	1.89
M-4	2.08	1.90	1.87	1.81	1.76	1.78	1.88	2.03	2.12	2.15	2.13	2.10
F-1	1.98	1.94	1.91	1.88	1.82	1.72	1.61	1.50				
F-2	2.07	2.01	1.89	1.75	1.68	1.66	1.66	1.78	1.93	1.99	2.05	2.09
F-3	1.86	1.82	1.82	1.89	1.95	1.95	1.89	1.86	1.88	1.89	1.91	1.91
F-4	1.92	1.87	1.87	1.83	1.79	1.87	1.87	1.90	1.94	2.02	2.08	2.06
St. Length Interval												
110-119	2.34	2.42			1.97	1.97	1.97	1.97	2.00	2.10	2.18	2.26
120-129	1.96	1.81	1.79	1.90	2.21	2.24	2.21	2.17	2.10	2.03	2.02	2.06
130-139	1.87	1.85	1.88	1.94	1.99	2.02	2.03	2.03	2.01	1.96	1.92	1.90
140-149	1.78	1.78	1.81	1.82	1.81	1.80	1.81	1.82	1.83	1.81	1.80	1.79
150-159	1.73	1.70	1.71	1.70	1.67	1.67	1.69	1.70	1.72	1.73	1.76	1.77
160-169	1.73	1.70	1.69	1.66	1.64	1.66	1.71	1.72	1.71	1.72	1.75	1.76
170-179	1.86	1.83	1.77	1.64	1.57	1.62	1.70	1.76	1.82	1.88	1.91	1.89
180-189	2.04	1.98	1.90	1.81	1.79	1.87	1.97	2.04	2.09	2.10	2.09	2.07
190-199	2.00	1.98	1.96	1.95	1.98	2.01	2.03	2.07	2.10	2.10	2.08	2.04
200-209	1.97	1.96	1.94	1.92	1.92	1.93	1.94	1.98	2.02	2.04	2.03	2.00
210-219	1.98	1.96	1.92	1.87	1.85	1.86	1.88	1.91	1.94	1.96	1.98	1.99
220-229	1.94	1.92	1.88	1.84	1.83	1.82	1.82	1.83	1.89	1.97	1.99	1.96
230-239	2.02	1.98	1.89	1.76	1.68	1.71	1.80	1.88	1.93	1.98	2.04	2.05
240-249	2.00	1.98	1.86	1.68	1.64	1.72	1.83	1.96	2.08	2.08	2.02	2.00
250-259	2.16	2.18	2.13	2.00	1.87	1.90	2.09	2.21	2.14	2.03	2.02	2.11
260-269	2.20	2.15	2.06	1.94	1.80	1.72	1.74	1.76	1.82	1.94	2.04	2.12
270-279	1.78	1.92	1.91	1.86	1.88	2.11	2.12	2.06	2.00	1.83	1.72	1.72
280-289	2.50	2.23	1.87	1.71	1.68	1.69	1.69	1.74	1.84	1.96	2.10	2.34
290-299	2.17	2.09	2.00	1.92	1.89	1.90	1.80	1.70	1.77	1.88	1.92	1.92
300-309						1.72	1.72	1.72	1.72	1.72		

Table 3

Smoothed Monthly K Factor Means for White Bass

Source of Variation	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Total	2.73	2.79	2.75	2.71	2.69	2.70	2.72	2.71	2.68	2.66	2.67	2.73
Sex. Dev. Stage												
M-1	2.72	2.72	2.62	2.52	2.45	2.41	2.22	2.30	2.38	2.46	2.53	2.62
M-2	2.79	2.85	2.99	2.88	2.65	2.40	2.82	2.76	2.72	2.72	2.76	2.77
M-3	2.68	2.72	2.66	2.59	2.57	2.60	2.65	2.70	2.72	2.67	2.59	2.61
M-4	2.45	3.22	3.06	2.88	2.71	2.64	2.65	2.62	2.56	2.51	2.47	2.45
F-1	3.16	3.06	2.88	2.75	2.70	2.72					3.12	3.17
F-2	2.73	2.67	2.60	2.55	2.52	2.49	2.54	2.54	2.55	2.57	2.62	2.70
F-3	2.70	2.69	2.68	2.64	2.68	2.74	2.76	2.73	2.66	2.61	2.62	2.67
F-4	2.79	2.81	2.88	2.90	2.85	2.78	2.75	2.73	2.70	2.71	2.75	2.79
St. Length Interval												
120-129					3.62	3.48	3.34	3.16	2.91	2.75	2.72	2.72
130-139	2.37				3.22	3.06	3.08	2.96	2.81	2.65	2.53	2.44
140-149	2.87	2.91	2.90			2.85	2.86	2.86	2.79	2.69	2.67	2.78
150-159	2.64	2.74	2.92	2.97	3.02	3.10	3.00	2.86	2.71	2.57	2.51	2.56
160-169	2.91	3.02	3.07			2.70	2.65	2.62	2.58	2.55	2.59	2.74
170-179	2.75	2.70	2.63	2.62	2.62	2.62		2.94	2.85	2.78	2.75	2.75
180-189	2.87	2.83	2.77	2.72	2.68			2.84	2.87	2.89	2.91	2.91
190-199	2.79	2.76	2.73	2.67	2.66	2.71	2.76	2.83	3.04	3.14	3.03	2.88
200-209	2.69	2.64	2.64	2.65	2.64	2.62	2.61	2.61	2.64	2.75	2.80	2.77
210-219	2.75	2.68	2.53	2.46	2.53	2.63	2.66	2.61	2.54	2.49	2.53	2.67
220-229	2.65	2.60	2.54	2.59	2.69	2.73	2.70	2.63	2.56	2.50	2.50	2.59
230-239	2.52	2.60	2.59	2.49	2.39	2.40	2.49	2.54	2.54	2.50	2.45	2.46
240-249	2.69	2.73	2.73	2.72	2.76	2.83	2.83	2.72	2.60	2.54	2.56	2.63
250-259	2.80	2.84	2.76	2.63	2.58	2.61	2.64	2.64	2.66	2.67	2.67	2.70
260-269	2.82	2.82	2.82	2.83	2.82	2.80	2.78	2.72	2.67	2.76	2.86	2.86
270-279	2.78	2.87	2.82	2.79	2.80	2.79	2.74	2.68	2.65	2.63	2.60	2.62
280-289	3.26	3.22	3.11	2.96	2.76	2.65	2.65	2.65	2.63	2.69	2.86	3.12
290-299	2.96	2.90	2.74	2.63	2.64	2.65	2.56	2.54	2.58	2.63	2.64	2.69
300-309	2.59	2.48	2.34	2.22					2.47	2.50	2.56	2.61
310-319								2.67	2.67	2.67	2.67	2.67
320-329	2.92	3.07	3.07	3.07	3.07				2.77	2.77	2.77	2.77

Table 4

KI of Falcon Lake in May 1965

Source of Variation	No.	Sample Mean K	Regional Mean K	Standard Error	t	KI
Spotted gar	5	0.71	0.71	0.0230	0.00	50%
Gizzard shad	103					94
Total	103	1.98	1.78	0.0159	12.58	100
M-4	63	1.98	1.76	0.0182	12.09	100
F-1	3	2.00	1.82	0.0833	2.16	90
F-3	2	2.00	1.95	0.0035	14.28	98
F-4	32	1.99	1.79	0.0362	5.52	100
130-139	3	2.17	1.99	0.1041	1.73	90
140-149	7	2.10	1.81	0.0447	6.49	100
150-159	3	2.06	1.67	0.0600	6.50	99
160-169	4	2.12	1.64	0.1369	3.29	98
180-189	7	2.04	1.79	0.0285	8.77	100
190-199	21	2.02	1.98	0.0279	1.43	90
200-209	36	1.93	1.92	0.0229	0.44	65
210-219	17	1.88	1.85	0.0352	0.85	80
220-229	4	2.03	1.83	0.1463	1.37	85
Carp	24	3.06	2.86	0.0482	4.15	100
Channel catfish	12	1.90	1.62	0.0688	4.07	100
Blue catfish	7	1.57	1.71	0.0463	- 3.02	1
White bass	11					8
Total	11	2.53	2.69	0.0386	- 4.14	0
M-3	3	2.38	2.57	0.0600	- 3.17	5
M-4	5	2.60	2.71	0.0514	- 1.75	10
F-4	3	2.55	2.85	0.0163	-18.40	0
190-199	2	2.52	2.66	0.1000	- 1.40	20
200-209	4	2.60	2.64	0.0662	- 0.60	30
220-229	2	2.52	2.69	0.0500	- 3.40	10
Largemouth bass	5	2.50	2.43	0.0406	1.72	90
Warmouth	2	3.50	3.88	0.1800	- 2.11	15
Green sunfish	7	3.55	3.72	0.0892	- 1.90	5
Redear sunfish	15	3.90	3.80	0.1117	0.90	80
Bluegill	57	4.77	4.54	0.0658	3.50	100
White crappie	33	2.87	3.05	0.0399	- 4.51	0
Freshwater drum	3	2.72	3.04	0.1942	- 1.65	10
Rio Grande perch	8	4.78	5.30	0.1945	- 2.66	1

KI (sample = 5(50) + 103(94) + ··· + 8(1) / 5 + 103 + ··· + 8

= 21,080/292 = 72%.

Table 5

KI of Lake Corpus Christi in January 1966

Source of Variation	No.	Sample Mean K	Regional Mean K	Standard Error	t	KI
Spotted gar	7	0.74	0.73	0.0421	0.24	60%
Gizzard shad	20					6
Total	20	1.74	1.91	0.0602	- 2.82	1
M-2	5	1.68	1.96	0.0579	- 4.84	1
M-3	3	1.59	1.84	0.0441	- 5.67	2
F-2	5	2.03	2.07	0.1756	- 0.23	40
F-3	7	1.63	1.86	0.0472	- 4.87	1
130-139	4	1.63	1.87	0.0688	- 3.49	2
180-189	2	1.54	2.04	0.0250	-20.00	0
190-199	4	1.58	2.00	0.0314	-13.38	0
200-209	2	1.87	1.97	0.0500	- 2.00	15
240-249	2	1.74	2.00	0.1250	- 2.08	15
Smallmouth buffalo	11	3.78	3.90	0.1614	- 0.74	25
Channel catfish	50	1.53	1.57	0.0295	- 1.36	10
Blue catfish	100	1.53	1.57	0.0145	- 2.76	1
Flathead catfish	2	2.28	1.94	0.0050	68.00	99
White bass	5					81
Total	5	3.01	2.78	0.1102	2.09	95
F-2	4	2.98	2.73	0.1372	1.82	90
260-269	2	2.78	2.82	0.0650	- 0.62	30
Largemouth bass	4	2.10	2.38	0.0832	- 3.36	2
White crappie	38	3.18	3.04	0.0654	2.14	98
Black crappie	9	3.46	3.53	0.1330	- 0.53	30
Freshwater drum	26	2.97	2.94	0.0671	0.45	65

KI (sample) = 7,710/272 = 28%

Table 6

KI of Medina Lake in October 1964

Source of Variation	No.	Sample Mean K	Regional Mean K	Standard Error	t	KI
Longnose gar	9	0.44	0.40	0.0184	2.17	97%
Gizzard shad	256	1.77	1.90	0.0107	-12.15	0
Smallmouth buffalo	3	3.55	3.56	0.2869	- 0.03	50
Carp	6	2.21	2.59	0.1328	- 2.86	2
Channel catfish	41	1.53	1.56	0.0200	- 1.50	5
Flathead catfish	8	2.06	1.84	0.0439	5.01	100
White bass	23	2.55	2.66	0.0194	- 5.67	0
White crappie	31	2.75	2.91	0.0360	- 4.44	0

KI (sample) = 2,040/376 = 5%

KI does not contribute more fish to the creel, but it should prove useful in productivity studies, evaluating management projects, locating dominant species or groups within populations, and determining sources of pollution.

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