JOB COMPLETION REPORT

As required by

FEDERAL AID IN FISHERIES RESTORATION ACT

TEXAS

Federal Aid Project No. F-6-15

FISHERIES INVESTIGATIONS - REGION 5-B

Job No. D-3 (3rd of 4 segments) Appraisal of Various Mesh Sizes in Taking Fishes at Lake Corpus Christi, Texas

Project Leader: John C. Barron

J. R. Singleton
Executive Director
Parks and Wildlife Department
Austin, Texas

Marion Toole
D-J Coordinator

Eugene A. Walker
Director, Wildlife Services

October 17, 1968

ABSTRACT

Uniform mesh gill nets varying from 1 to 4 inches square mesh were set monthly at three locations in Lake Corpus Christi. These data were collected and transposed to punched cards for computer analyses.

Tentative analysis utilizing the negative binomial distribution provided information on the net mesh sizes to which various fish species were vulnerable. A detailed example analysis with freshwater drum showed that mesh size introduced the greatest variability into the catch distribution, followed closely by location. Except for blue catfish, few game fish were taken in 3-inch and larger mesh.

JOB COMPLETION REPORT

State of Texas

Project No. F-6-15 Name: Fisheries Investigations - Region 5-B

Job No. D-3 Title: Appraisal of Various Mesh Sizes in Taking Fishes

Period Covered: January 1, 1967 to December 31, 1967

Objective:

To determine the relation between mesh size of gill nets and species composition of the catch.

Procedures:

Monthly netting was conducted at Lake Corpus Christi. The nets used were uniform mesh gill nets 100 feet long and of the following bar measures: 1-, 1½-, 2-, 2½-, 3-, 3½-, and 4-inches. The nets were set parallel to each other approximately fifty yards apart. A random design was used to determine set and run order so that fishing time variation would be minimized. Three stations were established and each mesh size set at each location every month. A total of 252 settings were made. Station No. 1 was immediately above the dam; Station No. 2 was at Miller's Island, about five miles above the dam; and Station No. 3 in Ramirena Creek, about 11 miles above the dam.

For each fish taken, the following data were recorded:

1. Species
2. Net mesh size
3. Date collected
4. Station location
5. Body depth (not measured over curvature)
6. Total length
7. Standard length
8. Weight
9. Fishing time (number of minutes net remained in water)
10. Mean water temperature (average of set and run values)
11. Water turbidity (Secchi disc)
12. Mean station depth (average of inner, mid, and outer depth readings)

All data were recorded in the field; and upon return to headquarters were typed, checked for accuracy, and mailed to the Data Processing Section at the Austin Headquarters to be transferred to punched cards. This procedure was in preparation for future analysis by electronic data processing equipment.

Results:

There is substantial literature on the subject of fishing gear and gear selectivity, and the mathematics are sometimes formidable. Beverton and Holt (1957) have covered the subject extensively in their book, although most of their examples deal with marine species and their equations usually presuppose a knowledge of age of the specimen.

Since the purpose of this study was not to determine the fishing power or efficiency of gill nets, but instead to determine the composition of their catches (with particular emphasis on game fishes), a simple approach seemed justifiable. Moyle and Lound (1960), Lambou (1963), and numerous other investigators have demonstrated that the negative binomial distribution will yield an appropriate unit for comparing catches of the number of fishes of specific species.

The negative binomial is a contagious distribution; contagion being used in the sense that if an individual of a species is found in a given area then the probability that a similar individual will be in the same area is increased and implies that fishes are not distributed at random.

The negative binomial distribution concerns the number of times a specific number of individuals of a species is taken in a series of samples. The shape of the curve is usually positively skewed indicating that more individual observations occur below the mean than do above it. Generally the zero class (no fish of the species in question taken in a sample) has the greatest frequency. The distribution is described by three parameters: the mean, m; the variance, v; and the coefficient of contagion, K. Computation of the first two is common knowledge, and the latter can be approximated by:

$$K = \frac{m^2}{v - m}$$

Obviously, $m = v$ since division by zero is undefined; therefore, if $v = m$ then the distribution in question cannot be fitted to the negative binomial. The mean, too, is never larger than the variance in the negative binomial. This distribution has the advantage in that transformations are available which tend toward the normal distribution. Moyle and Lound demonstrated that the transformation $y_i = \log (x_i + \frac{1}{2}K)$ is more applicable than the easier to use $y_i = \sqrt{x_i + \frac{1}{2}}$. These transformations are of primary importance if analysis of variance is contemplated.

Table 1
Catch Distribution of the Freshwater Drum Fitted
to the Negative Binomial Distribution

Number of Fish per Net	Calculated Frequency (F)		Observed Frequency (f)		$\frac{(f - F)^2}{F}$
0	161.06		146		1.41
1	21.22		32		5.48
2	11.16		17		3.06
3	7.65		12		2.47
4	5.77		4		0.54
5	4.59		6		0.43
6	3.78	6.97	5	8	0.15
7	3.19		3		
8	2.74	5.12	3	4	0.24
9	2.38		1		
10	2.09		1		
11	1.85	5.60	1	6	0.03
12	1.66		4		
13	1.49		0		
14	1.34	5.16	0	1	3.35
15	1.22		1		
16	1.11		0		
17	1.01		1		
18	0.92	3.56	0	4	0.05
19	0.85		3		
20	0.78		0		
20	14.14		12		0.32

Sum $(f - F)^2$ = Chi square = 17.53. P = 4%.

Table 2
Analysis of Variance of the Catch Distribution of Freshwater Drum

Source of Variation	df	SS	MS	F
Mesh sizes	6	194.149016	32.358169	39.23*
Months	11	18.475807	1.679618	2.04
Locations	2	41.160780	20.580390	24.95*
Months x location	22	39.362863	1.789221	2.17
Months x mesh sizes	66	32.162521	0.487310	0.59
Locations x mesh sizes	12	52.819736	4.401644	5.34*
Second order interaction	132	108.883419	0.824874	
Total	151	487.014142	—	

* Significant at the 0.5% level.

Table 3
Catch Distribution Per Mesh Size for Several Species

Species	Mesh (in.)	Number of fish per net 0	1	2	3	4	5+	1/K
Alligator gar	1	36	0	0	0	0	0	*
	1½	35	1	0	0	0	0	*
	2	36	0	0	0	0	0	*
	2½	36	0	0	0	0	0	*
	3	36	0	0	0	0	0	*
	3½	36	0	0	0	0	0	*
	4	36	0	0	0	0	0	*
Longnose gar	1	17	6	12	1	0	0	44.12
	1½	10	5	6	3	4	8	0.70
	2	23	9	3	0	0	1	1.43
	2½	33	2	1	0	0	0	1.08
	3	32	4	0	0	0	0	*
	3½	35	1	0	0	0	0	*
	4	34	2	0	0	0	0	*
Spotted gar	1	9	8	4	5	5	5	2.17
	1½	26	7	1	2	0	0	1.34
	2	33	2	1	0	0	0	1.08
	2½	35	1	0	0	0	0	*
	3	33	3	0	0	0	0	*
	3½	34	1	1	0	0	0	7.54
	4	35	1	0	0	0	0	*
Gizzard shad	1	8	5	3	2	1	17	1.59
	1½	4	6	6	0	2	18	0.99
	2	16	8	6	3	1	2	1.24
	2½	34	2	0	0	0	0	*
	3	36	0	0	0	0	0	*
	3½	36	0	0	0	0	0	*
	4	36	0	0	0	0	0	*
Smallmouth buffalo	1	34	2	0	0	0	0	*
	1½	15	2	4	4	4	7	1.24
	2	7	6	9	8	3	3	0.80
	2½	8	7	3	4	6	8	0.64
	3	10	8	6	6	5	1	0.83
	3½	21	6	4	3	0	2	1.25
	4	24	7	4	0	1	0	1.08

*Denotes an infinite or negative reciprocal.

Table 4
Catch Distribution Per Mesh Size for Several Species

Species	Mesh (in.)	Number of fish per net 0	1	2	3	4	5+	1/K
Carp	1	36	0	0	0	0	0	*
	1½	35	0	1	0	0	0	18.00
	2	31	4	1	0	0	0	1.20
	2½	29	4	3	0	0	0	4.54
	3	26	6	4	0	0	0	0.56
	3½	23	9	2	2	0	0	0.67
	4	30	4	1	1	0	0	2.06
Channel catfish	1	7	3	5	4	5	12	0.97
	1½	16	7	5	4	3	1	0.67
	2	29	4	2	1	0	0	2.12
	2½	34	2	0	0	0	0	*
	3	32	4	0	0	0	0	*
	3½	35	1	0	0	0	0	*
	4	36	0	0	0	0	0	*
Blue catfish	1	2	4	3	4	3	20	0.83
	1½	3	6	3	3	3	18	0.69
	2	11	13	8	2	2	0	0.04
	2½	20	12	2	0	1	1	1.15
	3	31	4	1	0	0	0	1.20
	3½	32	4	0	0	0	0	*
	4	36	0	0	0	0	0	*
Flathead catfish	1	35	1	0	0	0	0	*
	1½	36	0	0	0	0	0	*
	2	34	2	0	0	0	0	*
	2½	35	1	0	0	0	0	*
	3	35	1	0	0	0	0	*
	3½	33	3	0	0	0	0	*
	4	36	0	0	0	0	0	*
White bass	1	28	6	1	0	0	1	3.87
	1½	10	4	5	2	1	14	1.21
	2	31	3	0	0	0	2	10.23
	2½	36	0	0	0	0	0	*
	3	36	0	0	0	0	0	*
	3½	36	0	0	0	0	0	*
	4	36	0	0	0	0	0	*

*Denotes an infinite or negative reciprocal.

Table 5
Catch Distribution Per Mesh Size for Several Species

Species	Mesh (in.)	Number of fish per net 0	1	2	3	4	5+	1/K
Largemouth bass	1	29	3	1	0	1	2	6.47
	1½	31	5	0	0	0	0	*
	2	36	0	0	0	0	0	*
	2½	36	0	0	0	0	0	*
	3	36	0	0	0	0	0	*
	3½	36	0	0	0	0	0	*
	4	36	0	0	0	0	0	*
Warmouth	1	35	1	0	0	0	0	*
	1½	36	0	0	0	0	0	*
	2	36	0	0	0	0	0	*
	2½	36	0	0	0	0	0	*
	3	36	0	0	0	0	0	*
	3½	36	0	0	0	0	0	*
	4	36	0	0	0	0	0	*
Bluegill	1	28	5	2	0	1	0	2.56
	1½	35	1	0	0	0	0	*
	2	36	0	0	0	0	0	*
	2½	36	0	0	0	0	0	*
	3	36	0	0	0	0	0	*
	3½	36	0	0	0	0	0	*
	4	36	0	0	0	0	0	*
Redear sunfish	1	32	2	1	0	1	0	7.20
	1½	36	0	0	0	0	0	*
	2	36	0	0	0	0	0	*
	2½	36	0	0	0	0	0	*
	3	36	0	0	0	0	0	*
	3½	36	0	0	0	0	0	*
	4	36	0	0	0	0	0	*
White crappie	1	5	5	3	1	2	20	1.10
	1½	3	7	5	4	2	15	0.67
	2	15	8	2	6	2	3	0.83
	2½	25	5	4	1	1	0	1.43
	3	20	13	3	0	0	0	*
	3½	30	5	1	0	0	0	*
	4	34	0	1	1	0	0	11.00

*Denotes an infinite or negative reciprocal.

Table 6
Catch Distribution Per Mesh Size for Several Species

Species	Mesh (in.)	Number of fish per net 0	1	2	3	4	5+	1/K
Black crappie	1	23	8	2	0	2	1	1.86
	1½	10	4	4	6	2	10	1.34
	2	29	6	0	1	0	0	1.83
	2½	36	0	0	0	0	0	*
	3	35	1	0	0	0	0	*
	3½	36	0	0	0	0	0	*
	4	36	0	0	0	0	0	*
Freshwater drum	1	20	5	4	1	2	4	0.57
	1½	5	2	3	5	0	21	1.76
	2	8	8	4	2	1	13	2.30
	2½	22	4	4	3	1	2	1.51
	3	26	6	2	1	0	1	3.83
	3½	31	5	0	0	0	0	*
	4	34	2	0	0	0	0	*

*Denotes an infinite or negative reciprocal.

In order to demonstrate the use of the negative binomial a catch distribution of freshwater drum was used (Table 1). Some precision was lost due to the combination of all mesh sizes, but the difference measured by Chi square is still not highly significant. Since the process is tedious, time did not permit the fitting of any more of the distributions; but a computer program will be prepared during the next segment for this procedure, and all of the species will be tested.

An analysis of variance was also conducted with the drum data making use of the logarithmic transformation shown above. This test was intended to show the source of the variation in the catch distribution. Table 2 shows that the greatest variation in catch was attributed to the different mesh sizes with the different locations following closely. The interaction between location and mesh size is also highly significant. The variation attributable to months and monthly interaction was not significant and can be considered sampling deviations.

In Tables 3 to 6 the catch distributions of each species taken are stratified by mesh size. Using 36 net sets, a negative binomial distribution was computed for each mesh size. The quantity 1/K was defined by Moyle and Lound as the dispersion index. The greater the value of this reciprocal, the greater the spread of the data. This appears to be true if the distribution fits the negative binomial. In the above mentioned tables, those meshes which show an infinite or negative reciprocal are of little value for capturing a species. Those meshes which show the smallest frequency for the zero-class should be considered the optimum mesh size for the species.

Observation of the maximum mesh size for capture shows that nets of 3-inch mesh produce a negligible catch of all game species except blue catfish. It would appear that gill nets of 3-inch mesh or larger will not harm game fish populations which reaffirms present regulations to this effect.

During the 16th segment of this project additional analyses will be conducted using the ADP methods.

Prepared by John C. Barron
Project Leader

Approved by Marion Toole
Coordinator

Date October 17, 1968

Elgin M. C. Dietz
Inland Supervisor

References Cites

Beverton, R. J. H. and S. J. Holt. 1957. On the dynamics of exploited fish populations. Her Majesty's Stationery Office, London. 533.

Lambou, Victor W. 1963. Application of distribution pattern of fishes in Lake Bistineau to design of sampling programs. Prog. Fish-Culturist 25(2):79-87.

Moyle, John B. and Richard Lound. 1960. Confidence limits associated with means and medians of series of net catches. Trans. Am. Fish Soc. 89(1):53-58.