AN ANALYSIS OF BROWN TROUT (SALMO TRUTTA) ANGLING ON AUGUSTA CREEK IN SOUTHWEST MICHIGAN

Thesis for the Degree of M. S.

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James Edward Shideler

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This is to certify that the

thesis entitled

"An Analysis of Brown Trout (Salmo Trutta) Angling on Augusta Creek in Southwest Michigan"

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Peter T. Tack
Major professor

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AN ANALYSIS OF BROWN TROUT (*SALMO TRUTTA*) ANGLING ON AUGUSTA CREEK IN SOUTHWEST MICHIGAN

By

James Edward Shideler

A THESIS

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INTRODUCTION

The extent to which angling for trout involves skill and chance is a much-debated question of importance to fisheries management. It is the aim of this study to determine whether there is any relationship between frequency of angling on a stream and angler success at this same stream. The data for studying this question are creel census records taken during 1951 on Augusta Creek within the area of the Kellogg Forest.

Location and Description of the Area

The stream under consideration is that section of Augusta Creek lying in the Kellogg Forest tract situated in the Ross Township, Kalamazoo County $T^{1}S$ - $R^{9}W$, Section 21, 22, and 27.

The Kellogg Forest consists of 485 acres of land donated to Michigan State College by the late Mr. W. K. Kellogg of Battle Creek, Michigan. The section of Augusta Creek under consideration is near the lower end of the stream and is approximately 2.4 miles in length. The stream is approximately 25 miles long and has many tributaries.

Development of the Stream

A previous study provides information on the history of this stream (Morofsky, Tack, and Lemmien, 1949). Prior to 1934, Augusta Creek had a gravel bottom covered with sand and muck varying from two inches to two feet. This condition was caused primarily by spring floods, erosion, and sluggishness of the stream. A large portion of the stream ran through open meadows with little protection against meandering. During the summer of 1934, a stream alteration project was conducted with the idea of improving conditions for both insects and trout. Ninety-four structures such as deflectors, covers, and wing dams have been built to speed up the flow of water and remove silt from the bottom. Many seedlings and cuttings have been planted along the banks to provide shade in the hope of lowering the water temperatures.

Stocking the Stream

From 1934 until 1945, Augusta Creek was regarded as a brook trout stream and was stocked consistently with brook trout. These plantings were not considered successful, for whereas good early fishing was provided, it did not last more than a few weeks.

During 1946, the management policy was changed and brown trout were planted; and they have furnished better fishing for the entire season. The number of fish stocked are listed in Table 1. Fish thought to be brown trout were observed on spawning beds in the fall of 1947.

The fish planted in the section of the stream under study are free to move beyond the Kellogg Forest area, since it has proven impracticable to place barriers at the boundaries.

MATERIALS AND METHODS

Creel Census History

Information on fishing success, and on other queries, was obtained by a mandatory creel census. A permit, which was issued free of charge, had to be obtained by anglers before fishing. The fish caught had to be submitted for inspection and the removal of stomachs for food studies. The creel census data are believed to represent most of the fishing done on Augusta Creek. Absence of reports from the small number of fishermen who did not report their catch could affect the data in only a minor way. The Augusta Creek creel census results for the past several years are found in Table 1.

TABLE 1

Summary of Stocking and Angling Records

Year	Number of Trout Planted	Number of Trout Caught	No. of Anglers	No. of Hrs. Angling	Fish Hr.
1946	1600	373	133	725	.51
1947	800	484	260	1,350	.36
1948	2200	651	397	1,975	.33
1949	2300	860	587	2,935	.29
1950	1500	903	709	3,545	.25
1951	500	623	542 +	2,670	.23

The exact number of anglers could not be ascertained for 1951. Occasionally individuals were listed by the last name only, and when this same name occurred in records of another day, it might represent the same or a different fisherman. In a few instances, names were not recorded, although other data were. Records on the fishing success of this group of doubtful identity are included later in this study under the heading "combined and deleted."

Collecting the Data

When his fishing was completed, an angler returned to headquarters, gave his name, and stated the number of hours spent fishing, the number of fish caught, and how the fish were marked, if at all. Further information was furnished as to whether natural or artificial bait had been used, the type of bait if artificial, and whether a spinning rod was used.

Treatment of the Data

Visit Classes and Categories

Records for all individuals making the same total number of fishing visits were grouped into a visit category. Some of the visit categories were combined so that a greater

number of individuals would be represented in each visit grouping. There were three such instances where data from two or more visit categories were combined. These comprised (a) those individuals making nine or more fishing visits, (b) those making seven and eight visits, and (c) those making five and six visits. Since large numbers of individuals were represented in one-, two-, three-, and four - visit categories, no combinations of these were made. A visit category refers to the anglers making the same total number of fishing visits; and a visit class represents visit categories which have been combined.

Gross and Adjusted Monthly Averages

A summation was made of the number of fishermen, visits, hours spent fishing, and fish caught monthly for each visit category. The gross monthly average number of fish caught per hour was then calculated from the monthly totals by dividing the number of fish caught by the number of hours fished. For the category "deleted and combined," the information on hours of fishing and number of fish caught was valid, even though the identity of the fishermen in this group was doubtful. The gross monthly averages are misleading since a relatively large number of individuals made few fishing visits. Records of these individuals may,

for example, tend to depress the monthly averages early in the season due to their poor success; therefore the average has been adjusted by giving any visit class the same weight in each monthly computation. This point is discussed later in greater detail.

To determine whether success increases with the numerical value of the visit categories and classes, the average monthly and seasonal catch per hour was computed for each category and class.

The Chi Square test was applied to discover whether there was any statistical significance in differences between the seasonal catches per hour for the different visit classes.

A monthly expected catch was computed for each visit class by multiplying the number of hours fished for each class by the average catch of fish per hour for all the classes combined. These monthly values were summed to obtain the seasonal expected catch. The deviation from the expected catch was then determined for those in each visit class.

To ascertain whether the minority of fishermen who catch the most fish apiece also remove a large proportion of the total catch, the distribution of fish per angler was recorded.

Anglers Utilizing Artificial Lures and Spinning Rods

Those who utilized artificial bait or spinning rods were extracted from the entire sample and listed in visit classes. The monthly catch per hour and the success per hour for each visit class was computed; then the Chi Square test was applied to show if the differences between the seasonal catches per hour were significant. The deviation from the average expected catch of the entire sample was found for each visit class.

The sample of fishermen who utilized artificial lures and spinning rods was reduced to its following components, anglers utilizing a natural bait - artificial fly combination, anglers utilizing a spinning rod, and anglers utilizing artificial flies exclusively. For the above listings, the monthly averages, the catch of fish per hour for the various visit classes, and the deviation of each class from the expected catch were determined. The expected catch was computed, again, from the average catch for all fishermen.

Limitations of the Problem

The fishermen who angle in Augusta Creek are assumed to be typical anglers in absence of any information to the contrary. Persons in the visit categories and visit classes probably fished more frequently elsewhere than it might

appear from these data. It is emphasized that these data pertain only to Augusta Creek, and to the relationship between frequency of visits to this stream and fishing success in the same stream.

RESULTS

Average Monthly Catches

Table 2 is a summary of trout fishing in Augusta Creek. The column headed "Visit Category" lists the total number of visits made by individual fishermen over the entire season, and the numbers of such individuals are given in the column headed "Number of Fishermen." The remainder of the table states for each month, the number of visits made, hours fished, and fish caught for each visit category. The row entitled "Deleted and Combined" represents those fishermen whose names are not known or who cannot be differentiated. These data were included in the grand total so an average monthly catch of fish per hour could be computed. These averages, listed across the bottom of Table 2, are based upon all fishing effort and the total catch for the month.

Table 2

The Monthly Catch of Fish per Hour, Number of Anglers, Visits Made, Hours Spent Fishing, and Fish Caught in Each Visit Category

Visit Category	Number of Fishermen	April			May			June			July			August			September		
		Visits	Hours	Fish	Visits	Hours	Fish	Visits	Hours	Fish	Visits	Hours	Fish	Visits	Hours	Fish	Visits	Hours	Fish
22	1	3	7	0	9	17.0	2	6	7.5	4	3	3.5	2	1	2.0	0			
18	2	1	2	0	12	25.5	10	10	16.0	8	8	16.0	5	4	13.0	7	1	3.0	1
14	2	3	13	7	13	35.0	8	3	6.0	3	5	6.0	7	2	3.5	0	2	3.5	2
11	1							4	8.0	1	4	9.0	4	3	6.0	3			
10	2	4	15	4	8	27.5	6	3	11.0	3	2	2.5	3	2	4.5	0			
9	2	2	7	4	14	35.0	13	1	2.0	0				1	2.0	0			
8	6	7	31.5	8	23	69.5	20	10	25.0	2	1	3.0	0	4	8.0	5	3	8.0	2
7	10	7	23	15	46	111.5	43	7	16.5	1	7	13.5	3	2	4.5	0	1	1.0	0
6	2	2	5	1	9	24.0	8	1	4.0	0									
5	12	7	26.5	13	26	68.0	18	13	39.0	12	5	14.0	0	7	10.0	2	2	4.0	4
4	17	16	50	14	40	101.0	9	5	10.5	2	3	7.5	1	3	6.0	1	1	1.0	0
3	48	27	92	31	85	215.0	18	20	50.5	3	3	3.0	0	4	9.0	2	4	10.0	0
2	89	33	100.5	32	97	238.0	52	23	47.0	3	10	22.0	3	14	35.5	5	2	5.0	0
1	339	56	192.5	56	191	488.5	67	47	98.5	8	16	25.0	1	14	30.5	4	15	13.0	3
Total	533	168	565	185	573	1455.5	274	153	341.5	50	67	125.0	29	61	134.5	29	31	48.5	12
Deleted and Combined			85.5	19		147.5	19		20.0	3		13.5	1		4	0		8.5	2
Total			650.5	204		1603.0	293		361.5	53		138.5	30		138.5	29		57.0	14
Fish per Hour			.314			.183			.147			.217			.209			.246	

The highest monthly average catch of the season, 0.314 fish per hour, occurred in April. This is easily understood since Augusta Creek was stocked with trout before the opening day, with no further stocking during this season. Fishing success dropped to 0.183 fish per hour during May, and then to a low of 0.147 fish per hour during June. During July, August, and September, 0.217, 0.209, and 0.246 fish per hour respectively were caught, although there were fewer fish present. These results are expressed graphically on Chart 1. The second curve on this chart is the adjusted average catch which will be explained on Page 12.

Visit Categories and Classes

Average Monthly and Seasonal Catches

The relative success of the fishermen in each visit category is expressed on a monthly basis in Table 3. Since there are few individuals who fished a total of five or more times, their monthly averages vary greatly from each other. It may be noted that averages for those who fished one through four times fluctuated less widely, probably deriving their stability from the greater number of individuals involved.

Chart 1

Gross and Adjusted Monthly Catch
of Fish per Hour

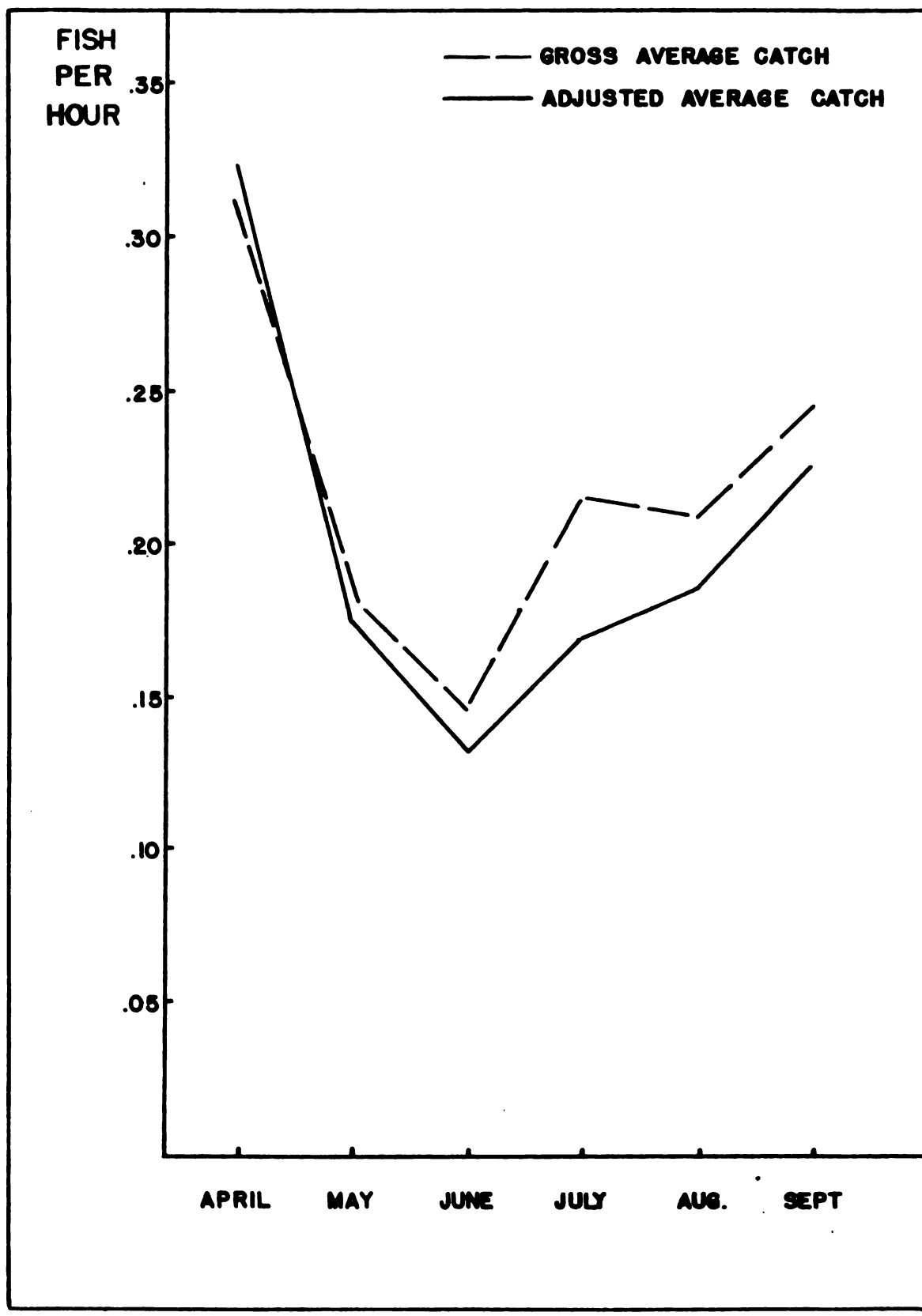

FISH
PER
HOUR
.35
.30
.25
.20
.15
.10
.05
GROSS AVERAGE CATCH
ADJUSTED AVERAGE CATCH
APRIL
MAY
JUNE
JULY
AUG.
SEPT

Table 4 illustrates the seasonal catch of fish per hour and fish per visit for each visit category. There appears to be a tendency for those individuals visiting more times to be the most successful. These results are shown graphically on Chart 2.

Since there is such pronounced fluctuation among certain values for the categories, it was desirable to combine certain of these categories into visit classes to present a more stable picture. Tables 5 and 6 give the basic data combined in this form.

Table 5 lists, for each month, the catch of fish per hour for those in each visit class. It was found that for each month, a general increase in the catch per hour was shown as the numerical value of the visit classes increases.

In Table 6, the seasonal catch of fish per hour and fish per visit is illustrated. With the exception of those individuals in visit classes three and four, the fishing success increases with the numerical values of the visit classes. Those in visit classes three and four had the least success of all the classes. These results are shown graphically on Chart 3.

Table 3

Monthly Average Catch of Fish per Hour
by Visit Categories

Total Visits	Number of Fishermen	April	May	June	July	August	September
22	1	.00	.12	.53	.57	.00	-
18	2	.00	.39	.50	.31	.54	.33
14	2	.54	.23	.50	1.17	.00	.57
11	1	-	-	.13	.44	.50	-
10	2	.27	.22	.27	1.20	.00	-
9	2	.57	.37	.00	-	.00	-
8	6	.25	.29	.08	.00	.63	.25
7	10	.65	.39	.06	.22	.00	.00
6	2	.20	.33	.00	-	-	-
5	12	.49	.26	.31	.00	.20	1.00
4	17	.28	.09	.19	.13	.17	.00
3	48	.34	.08	.06	.00	.22	.00
2	89	.32	.22	.06	.14	.14	.00
1	339	.29	.14	.08	.04	.13	.23
Total	543	4.20	3.13	2.77	4.22	2.53	2.38
Average		.32	.24	.20	.35	.19	.26

Table 4

Average Catch of Fish per Unit of Effort
by Visit Categories

Visit Category	Number of Fishermen	Total Visits	Total Hours	Total Fish	Fish per Visit	Fish per Hour
22	1	22	37.0	8	.364	.216
18	2	36	75.5	31	.861	.411
14	2	28	67.0	27	.964	.403
11	1	11	23.0	8	.727	.348
10	2	19	60.5	16	.842	.264
9	2	18	46.0	17	.944	.370
8	6	48	145.0	37	.771	.255
7	10	70	170.0	62	.886	.265
6	2	12	33.0	9	.750	.273
5	12	60	161.5	49	.817	.303
4	17	68	176.0	27	.397	.153
3	48	143	379.5	54	.378	.142
2	89	179	448.0	95	.531	.212
1	339	339	848.0	139	.410	.164

Chart 2

Catch of Fish per Unit of Effort
for Those in the Visit Categories

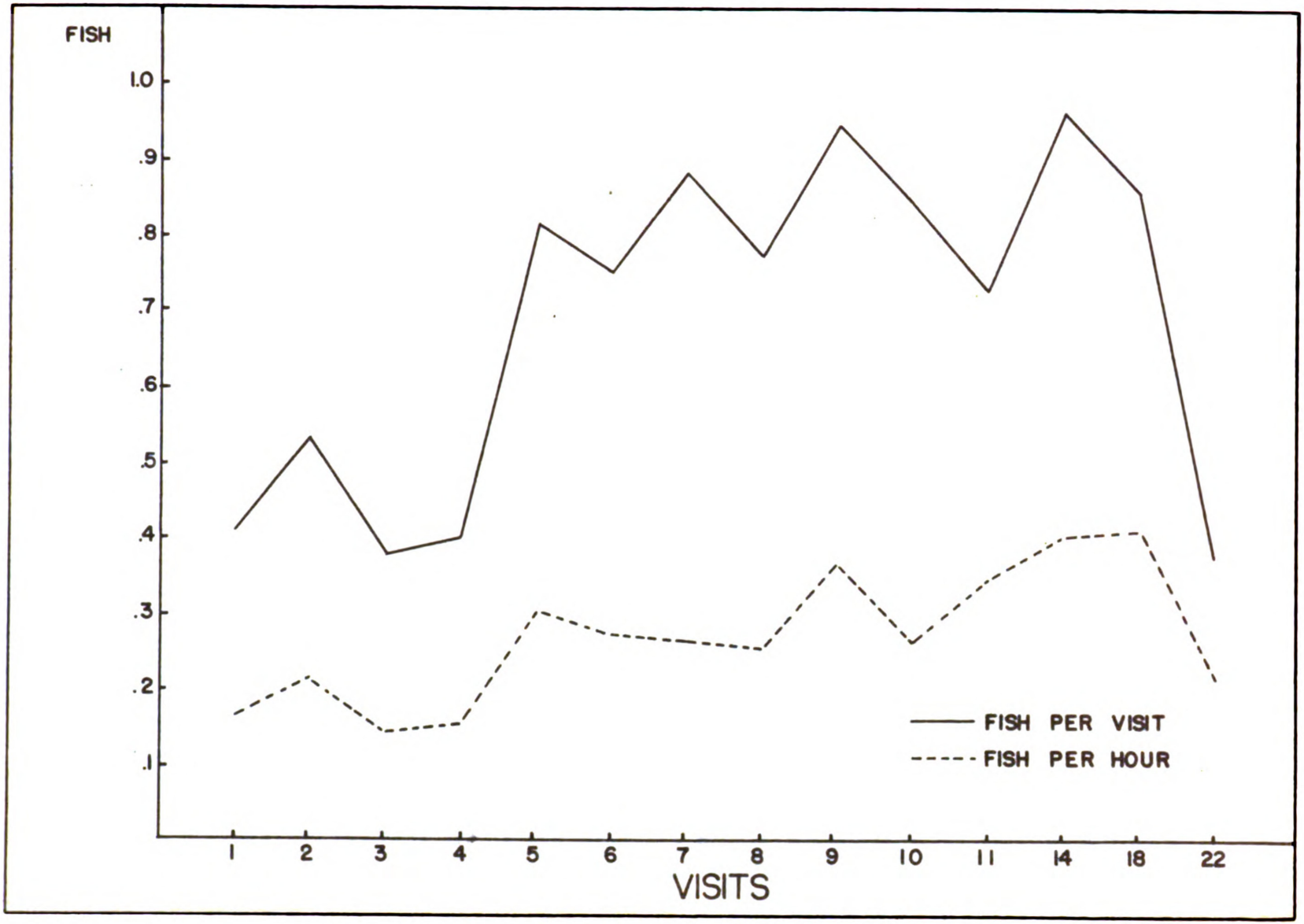

FISH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
FISH PER VISIT
FISH PER HOUR
1
2
3
4
5
6
7
8
9
10
11
14
18
22
VISITS

Table 5

Monthly Average Catch of Fish per Hour
by Visit Classes

Class	April	May	June	July	August	September
9+	.34	.28	.38	.57	.32	.46
7-8	.42	.35	.07	.18	.40	.22
5-6	.44	.28	.28	.00	.20	1.00
4	.28	.09	.19	.13	.17	.00
3	.34	.08	.06	.00	.22	.00
2	.32	.22	.06	.14	.14	.00
1	.29	.14	.08	.04	.13	.23

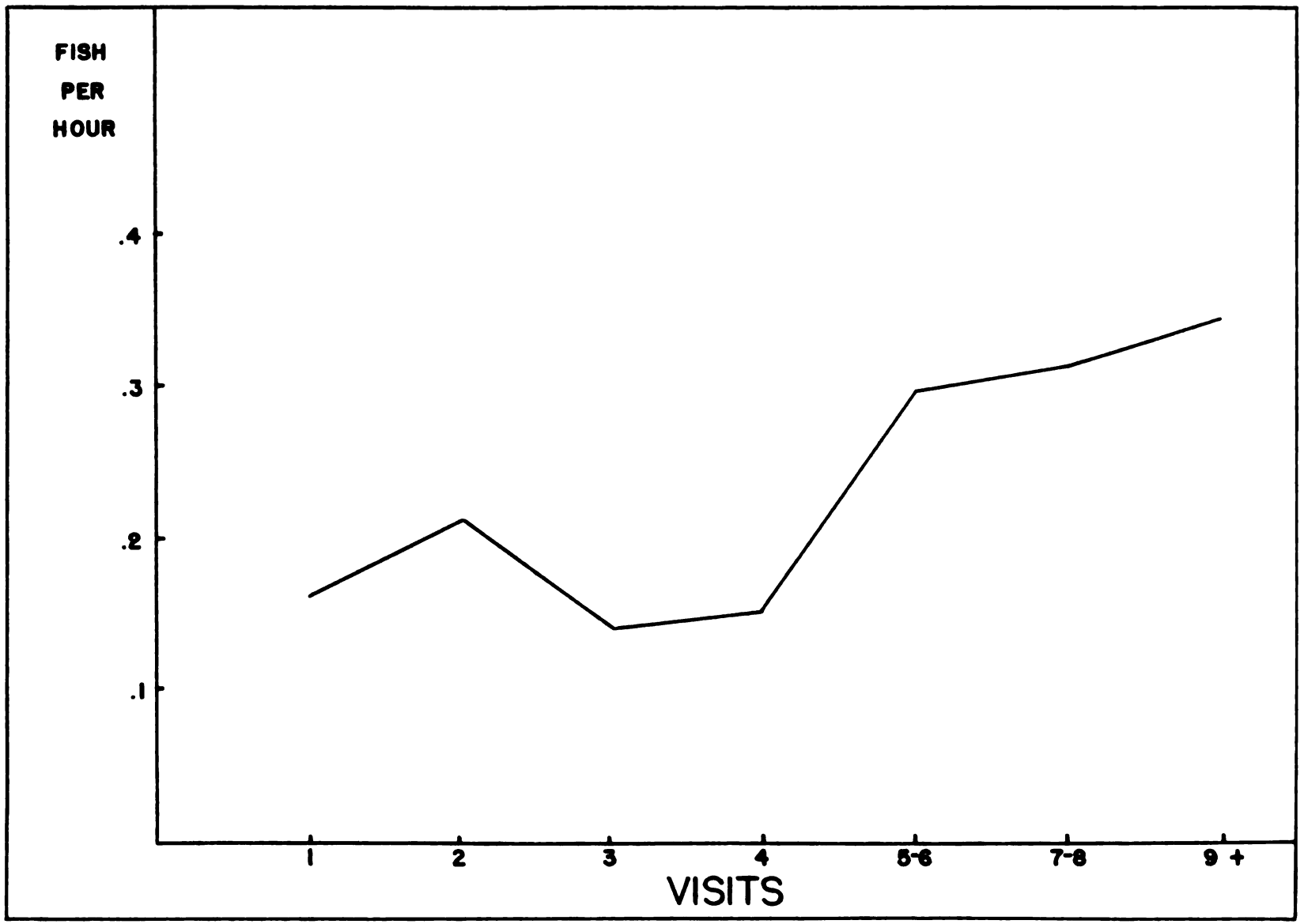
Table 6

Catch of Fish per Unit of Effort
by the Visit Classes

Class	Hours	Fish	Visits	Fish per Hour	Fish per Visit
9+	309	107	134	.346	.799
7-8	315	99	118	.314	.839
5-6	194.5	58	72	.298	.806
4	176	27	68	.153	.397
3	379.5	54	143	.142	.378
2	448	95	179	.212	.531
1	848	139	339	.164	.410
Total	2670	579	1053	.216	.550

Chart 3

Catch of Fish per Unit of Effort
by Visit Classes


FISH
PER
HOUR
.4
.3
.2
.1
1
2
3
4
5-6
7-8
9 +
VISITS

Test of Significance

To determine whether there is any statistical significance in differences between the catches per hour for the different visit classes for the entire season, the Chi Square formula was applied:

$$x^2 = \frac{\text{Sum (observed catch - expected catch)}^2}{\text{Expected Catch}}$$

For purposes of computing Chi square, the monthly expected catch was determined by multiplying the number of hours fished by each visit class by the monthly average number of fish caught per hour for all the classes. These values were then summed to determine the seasonal expected catch adjusted for differences in quality of fishing from month to month. The Chi Square test shows differences in fishing success among the visit classes to be highly significant (Table 7).

Deviation from the Expected Catch

To determine how much the catch for each of the visit classes departs from the average catch, an "expected catch" has been computed for each visit class for each month (Table 7). The overall seasonal departures are expressed on an hourly basis, such that, difference per hour

$$= \frac{\text{(observed catch - expected catch)}}{\text{Total hours fished}}$$

Table 7

The Deviation of the Observed Catch per Hour from the Expected Catch

Class		April	May	June	July	August	September	Sums	Difference	x^2	Hours	Difference Per Hour*
9+	Expected	13.82	25.62	7.42	8.03	6.48	1.60	62.97	+44.03	30.79	309	+.142
	Observed	15	39	19	21	10	3	107				
7-8	Expected	17.11	33.12	6.10	3.58	2.61	2.21	64.73	+34.27	18.14	315	+.109
	Observed	23	63	3	3	5	2	99				
5-6	Expected	9.89	16.84	6.32	3.04	2.09	.98	39.16	+18.84	9.06	194.5	+.097
	Observed	14	26	12	0	2	4	58				
4	Expected	15.70	18.48	1.54	1.63	1.25	.25	38.85	-11.85	3.61	176	-.067
	Observed	14	9	2	1	1	0	27				
3	Expected	28.89	39.34	7.42	.65	1.88	2.46	80.64	-26.64	8.80	379.5	-.070
	Observed	31	18	3	0	2	0	54				
2	Expected	31.56	43.55	6.91	4.77	7.42	1.23	95.44	+ .44	0.00	448	+.001
	Observed	32	52	3	3	5	0	95				
1	Expected	60.45	89.40	14.48	5.43	6.37	3.20	179.33	-40.33	9.07	848	-.048
	Observed	56	67	8	1	4	3	139				
Total										97.47		

* Formula used:

$$\frac{\text{(Observed - expected)}}{\text{Hours}} = \text{Difference per hour}$$

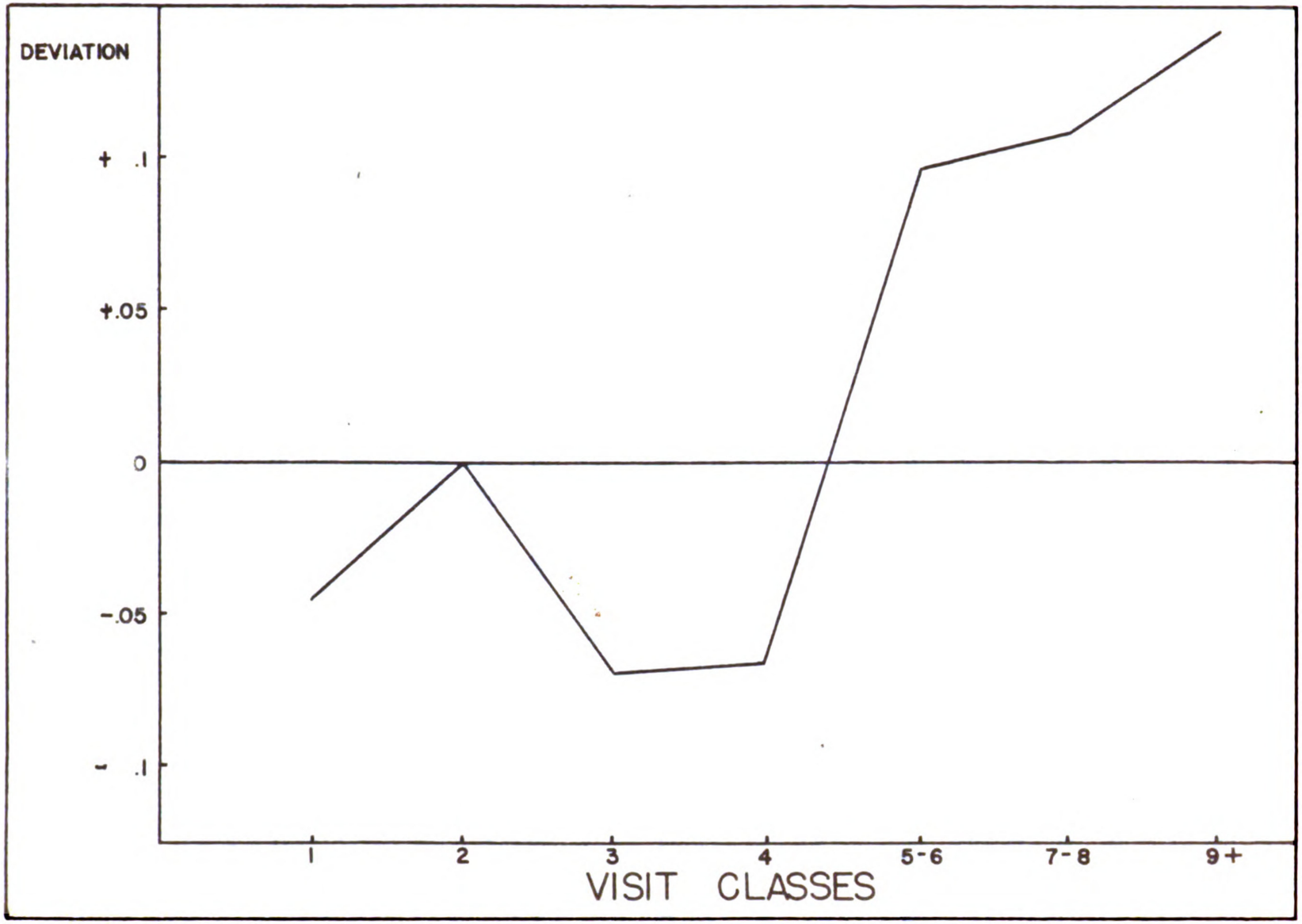
It may be seen that those individuals who fished five or more times caught a considerably greater number of fish than might be expected according to the average success, whereas those who fished one, three, and four times fell far below the expected averages; and those who fished twice experienced the average success. These results are expressed graphically on Chart 4. Shown in this manner, the data reveal the same general pattern as do the averages for the corresponding classes in Table 6.

Adjusted Average

The adjusted averages were computed on the basis of the following line of reasoning. The fishermen who made few visits, for the most part, did their fishing early in the season, thus depressing the apparent quality of early seasonal fishing by their poor success. Since the visit classes varied in respect to the relative amount of fishing done each month, an adjusted average was computed by weighting the fishing success of each class the same for each month. This is done in order to more closely estimate the general fishing success on a standard basis. The weights used in computing the adjusted average were proportional to the total number of hours fished for the entire season.

Chart 4

The Deviation of the Observed Catch per Hour
from the Expected Catch


DEVIATION
+ .1
+.05
0
-.05
- .1
1
2
3
4
5-6
7-8
9+
VISIT CLASSES

The proportion of the total number of hours spent fishing was determined by dividing the total number of hours spent fishing, by those in each visit class, by the total number of hours fished by all fishermen for the entire season. The proportion thus determined for each visit class was then multiplied by the catch of fish per hour, for each month, for those in the corresponding visit class. The monthly contribution from each class was summed to obtain an adjusted average of the monthly catch of fish per hour. Thus the following formula was developed.

$$\text{Sum} \quad \frac{(t_i \; s_i)}{T}$$

t_i = Total hours spent fishing during the season by a visit class.

s_i = Monthly average fishing success for that class.

T = Total hours fished by all classes for the entire season.

The adjusted monthly average catches are .325, .175, .131, .127, .186, and .227 for April through September respectively. These averages may be compared with the gross monthly averages of fish caught per hour on Chart 1. It was found that the adjusted average catch exceeded the gross average catch only during April. This is apparently due to the poor angling success of those in the visit classes characterized by fewer visits.

This adjusted average reflects more truly the inherent quality of the angling from month to month, since it is not influenced by the changing representation of visit classes.

Distribution of Fish per Angler

Table 8 illustrates for the fishermen catching zero through sixteen fish, the number of individuals catching a prescribed number of fish and the total number of fish they caught. It is evident that the majority of fish are removed by the minority of individuals catching the most fish each. Seven percent of the 533 anglers removed fifty-two percent of the total season's catch. On the other hand, sixty-six percent of the anglers caught no fish.

Other workers have found similar results. Studies conducted on Hunt Creek experimental waters indicate that a minority of expert anglers, from about two percent to seventeen percent, removed from thirty-eight to seventy-three percent of the total season's catch of trout. In general, less than ten percent of the individuals are removing fifty or more percent of the total catch (Shetter and Proshek, 1951).

Table 8

Number of Individuals, Number of Hours Expended, Total Number of Fish Caught, and Percent of Fish Caught for Those Catching a Specific Number of Fish

Number of Adult Browns Caught Per Angler	Number of Individuals Catching Browns	Number of Hours Expended	Total Number of Fish Caught	Percent of Fish Caught
0	352	1148	0	0
1	84	469	90	16
2	33	205	70	12
3	26	209	72	12
4	6	77.5	28	5
5	4	62	20	3
6	3	23	18	3
7	4	36.5	28	5
8	4	81.5	32	6
9	2	25.5	18	3
10	3	45	30	5
11	1	25	11	2
12	3	61	36	6
14	2	36	42	7
15	3	99	30	5
16	1	28.5	16	3
17	1	17	17	3
21	1	21.5	21	4
Total	533	2670	579	100

Fishermen Utilizing Artificial Lures and Spinning Rods

Average Monthly Catches

Table 9 was constructed in the same manner as was Table 2 in order to demonstrate the average monthly catch of fish per hour. It was found that a high of 0.400 fish per hour were caught during April, while May, June, and July had 0.225, 0.212, and 0.221 fish per hour respectively. August had the lowest average of 0.153 fish per hour. September was the second most successful fishing month with a catch of 0.343 fish per hour. Except for August, the monthly average catches were larger than those of the corresponding months for the entire sample.

Visit Classes

Average Seasonal Catches

From the information contained in Table 9, the hours spent fishing and the number of fish caught were recorded for each visit class in Table 10. The number of fish caught per hour for each visit class for the entire season was then calculated. As the numerical value of the visit classes increase, the corresponding catches per hour increase, with the exception of those making five-six visits. The individuals in this class caught more fish per hour than those in the next greater class.

Table 9

The Monthly Catch of Fish Per Hour, and the Number of Anglers Visits Made, Hours Spent Fishing, and Fish Caught in Each Visit Category for Those Using Artificial Bait

Total Times Each Fished	Total Number of Individuals	April			May			June			July			August			September		
		Visits	Hours	Fish	Visits	Hours	Fish	Visits	Hours	Fish	Visits	Hours	Fish	Visits	Hours	Fish	Visits	Hours	
18	1				6	8.5	5	7	8.5	3	5	7.0	2						
16	2				11	21.0	5	8	12.5	8	6	12.5	5	6	19.0	7	1	3.0	1
14	1				4	6.0	1	2	4.0	3	5	6.0	7	2	3.5	0	1	1.5	1
8	0																		
7	0																		
6	1							2	3.0	0	2	3.0	0	2	3.0	0			
5	2	1	5	9	8	17.0	10	1	1.5	1									
4	4	1	3	2	11	25.0	14				3	5.0	1				1	3.0	4
3	7				9	23.0	5	4	9.5	1	4	12.5	4	3	6.0	1	1	1.0	0
2	18	1	2	0	12	21.5	1	11	21.0	3	10	24.5	3	4	9.5	0			
1	90	8	30	8	44	120.5	17	19	44.0	3	10	24.5	1	6	16.0	0	3	9.0	0
Total		11	40	19	105	242.5	58	54	104.0	22	45	95.0	23	23	57.0	8	7	17.5	6
Combined and Deleted			10	1		33.0	4		0	0		13.5	1		8.5	2		0	0
Total			50	20		275.5	62		104.0	22		108.5	24		65.5	10		17.5	6
Fish per Hour		.400			.225			.212			.221			.153			.343		

Table 10

The Average Catch of Fish Per Hour as Experienced by the Visit Classes for Those Utilizing Artificial Bait

Visit Class	April		May		June		July		August		September		Total	Total	Fish
	Hours	Fish	Hours	Fish	Hours	Fish	Hours	Fish	Hours	Fish	Hours	Fish	Hours	Fish	Per Hour
9+			35.5	11	25.0	14	25.5	14	22.5	7	4.5	2	113.0	48	.424
7-8															
5-6	5	9	17.0	10	4.5	1	3.0	0	3.0	0			32.5	20	.615
4	3	2	25.0	14			5.0	1			3.0	4	36.0	21	.583
3			23.0	5	9.5	1	12.5	4	6.0	1	1.0	0	52.0	11	.211
2	2	0	21.5	1	21.0	3	24.5	3	9.5	0			78.5	7	.089
1	30	8	120.5	17	44.0	3	24.5	1	16.0	0	9.0	0	244.0	29	.118

With the exception of those making one and two visits, it was found that those using artificial lures caught more fish per hour than those in the corresponding classes for the entire sample.

A Chi Square test on Table 11 shows the difference in fishing success among the visit classes to be highly significant.

Deviation from the Expected Catch

Table 11 illustrates for those using artificial lures how much each visit class deviates from the expected average catch of the entire sample. The same procedure was used as was in Table 7. It was found that all the classes, except those making one and two visits, caught above the expected average. Also, with the exception of those making one and two visits, the average of each class was higher than for the corresponding classes of the entire sample in Table 7.

Determining the Success of Various Artificial Fishing Gear

The types of artificial fishing gear were recorded for those in each visit class. To determine the type of fishing gear which was most successful, Table 12 was constructed for those individuals using a natural bait - artificial fly combination, Table 13 for those using a spinning rod, and Table 14 was constructed for those using only artificial flies.

Table 11

The Deviation of the Observed Catch Per Hour from the Expected Catch and Chi Square Results for Those Using Artificial Bait

Class		April	May	June	July	August	September	Sums	Difference	x^2	Hours	Difference Per Hours
9+	Expected		6.50	3.68	5.53	4.70	1.11	21.52	+26.48	32.58	113.0	+.234
	Observed		11.00	14.00	14.00	7.00	2.00	48.00				
7-8	Expected											
	Observed											
5-6	Expected	1.57	3.11	.66	.65	.63		6.62	+13.38	27.04	32.5	+.412
	Observed	9.00	10.00	1.00	0.00	0.00		20.00				
4	Expected	.94	4.58		1.09		.74	7.35	+13.65	25.35	36.0	+.379
	Observed	2.00	14.00		1.00		4.00	21.00				
3	Expected		4.21	1.40	2.71	1.25	.25	9.82	+ 1.18	.05	52.0	+.023
	Observed		5.00	1.00	4.00	1.00	0.00	11.00				
2	Expected	.63	3.93	3.09	5.32	1.99		14.96	- 7.96	4.24	78.5	-.101
	Observed	0.00	1.00	3.00	3.00	0.00		7.00				
1	Expected	9.42	22.10	6.47	5.32	3.34	2.21	48.86	-19.86	8.07	244.0	-.081
	Observed	8.00	17.00	3.00	1.00	0.00	0.00	29.00				
	Total								97.33			

Table 13

The Average Catch of Fish Per Hour for Those Fishermen Utilizing Spinning Rods

Class	April Hours	April Fish	May Hours	May Fish	June Hours	June Fish	July Hours	July Fish	August Hours	August Fish	September Hours	September Fish	Total Hours	Total Fish	Fish Per Hour
9+															
7-8															
5-6	5	9	7.0	3	1.5	1							13.5	13	.963
4	3	2	5.5	2							3	4	11.5	8	.696
3			3.0	4									3.0	4	1.333
2															
1	1	0	1.0	0									2.0	0	0.000
Total													30.0	25	.833

Table 14

The Average Catch of Fish Per Hour for Those Fishermen Utilizing Artificial Flies Alone

Class	April Hours	April Fish	May Hours	May Fish	June Hours	June Fish	July Hours	July Fish	August Hours	August Fish	September Hours	September Fish	Total Hours	Total Fish	Average Fish Per Hour
9+			26.5	11	25	14	25.5	14	5.5	0	4.5	2	87.0	41	.471
7-8															
5-6			10.0	7	3	0	3.0	0	3.0	0			19.0	7	.368
4			5.5	2			5.0	1					10.5	3	.286
3			3.0	4	4	0	8.0	0	2.0	0	1.0	0	18.0	4	.222
2	2	0			17	2	8.5	2	9.5	0			37.0	4	.108
1			35.5	10	32	3	15.5	1	9.5	0			92.5	14	.151
Total													264.0	73	.277

For each table, the fish caught per hour were then calculated for each of the visit classes. Then the average number of fish caught per hour for the entire season was calculated for each table.

Limitations

For those using a natural bait - artificial fly combination, only three individuals fished over three times, and for those utilizing a spinning rod, only three individuals are represented; therefore no comparisons can accurately be drawn from the success of the various visit classes. A more even distribution of anglers in different classes was found for those using only artificial flies. It was found that for these individuals, the catch per hour increased as the numerical value of the visit classes increased, except that those who fished one time were more successful than those making two visits.

Comparisons of these gross seasonal averages may be misleading and probably there is need for an adjusted value. For instance, the anglers using artificial flies fished only two hours during April when fishing was the best, and 65.5 hours in July when fishing was poorer, thus depressing the apparent success as compared to all fishermen.

Average Seasonal Catch

For the seasonal catch, it was found that those who used a spinning rod caught 0.833 fish per hour; those who used

only artificial flies caught 0.277 fish per hour; those who used a natural bait - artificial fly combination caught 0.163 fish per hour; and those who used only natural bait (Table 15) caught 0.206 fish per hour.

Deviation from the Expected Catch

It was determined for those using artificial bait how much the catch of each visit class deviated from that expected according to the average experience of the entire sample.

Tables 16, 17, and 18 illustrate the deviation from the expected catch for those fishermen using natural bait - artificial fly combinations, spinning rods, and artificial flies alone respectively. Except for the instance of those anglers using artificial flies exclusively, the results, as summarized for the remaining tables, show considerable variation. For those utilizing artificial flies exclusively, all the classes, except for those making one and two visits, caught above the expected average. As the numerical value of the classes increase, the corresponding catch of fish per hour increases, except for those making one visit; these individuals were more successful than those making two vists. The catch per hour of each visit class using artificial bait appears to be more successful than the corresponding catches of the entire sample, except for those making two visits.

Average Monthly Catch for Those
Using Artificial Bait

		Entire Population	Those Using Artificial Bait	Those Using Natural Bait	Fish Per Hour (Natural Bait)
Apr.	Hours	650.5	50	600.5	.306
	Fish	204	20	184	
May	Hours	1603	275.5	1327.5	.174
	Fish	293	62	231	
June	Hours	361.5	104	257.5	.120
	Fish	53	22	31	
July	Hours	138.5	108.5	30	.200
	Fish	30	24	6	
Aug.	Hours	138.5	65.5	73	.260
	Fish	29	10	19	
Sept.	Hours	57	17.5	39.5	.203
	Fish	14	6	8	

Average Seasonal Catch for Those Using Natural Bait Exclusively	0.206

Table 16

The Chi Square and Deviation of the Observed Catch Per Hour from the Expected Catch for Those Fishermen Utilizing a Natural Bait - Artificial Fly Combination

Class		April	May	June	July	August	September	Sums	Difference	x^2	Hours	Difference Per Hour
9+	Expected		1.65			3.55	.74	5.94	+ 2.06	.41	29.0	+ .071
	Observed		0.00			7.00	1.00	8.00				
7-8	Expected											
	Observed											
5-6	Expected											
	Observed											
4	Expected		2.38					2.38	+ 8.62	31.22	13.0	+ .663
	Observed		11.00					11.00				
3	Expected		3.66	.81	.98	.84		6.29	+ .71	.01	34.0	+ .021
	Observed		1.00	1.00	4.00	1.00		7.00				
2	Expected		1.92	1.32	3.04			6.28	- 4.28	2.28	33.5	- .128
	Observed		0.00	1.00	1.00			2.00				
1	Expected	9.42	14.46	1.18	1.95	1.36	2.21	30.58	-15.58	7.94	141.5	- .110
	Observed	8.00	5.00	2.00	0.00	0.00	0.00	15.00				
Total										46.19		

Table 17

The Chi Square and Deviation of the Observed Catch Per Hour from the Expected Catch for Those Fishermen Utilizing Spinning Rods

Class		April	May	June	July	August	September	Sums	Difference	x^2	Hours	Difference Per Hour
9+	Expected											
	Observed											
7-8	Expected											
	Observed											
5-6	Expected	1.57	1.28	.22				3.07	+ 9.93	32.12	13.5	+ .736
	Observed	9.00	3.00	1.00				13.				
4	Expected	.94	1.01				.74	2.69	+ 5.31	10.48	11.5	+ .462
	Observed	2.00	2.00				4.00	8.				
3	Expected		.55					.55	+ 3.45	15.82	3.0	+1.150
	Observed		4.00					4.				
2	Expected											
	Observed											
1	Expected	.31	.18					.49	- .49	0.00	2.0	- .245
	Observed	0.00	0.00					0.				
Total										58.77		

Table 18

The Chi Square and Deviation of the Observed Catch Per Hour from the Expected Catch for Those Fishermen Utilizing Only Artificial Flies

Class		April	May	June	July	August	September	Sums	Difference	x^2	Hours	Difference Per hour
9+	Expected		4.85	3.68	5.53	1.15	1.11	16.32	+24.68	37.32	87.0	+ .284
	Observed		11.00	14.00	14.00	0.00	2.00	41.00				
7-8	Expected											
	Observed											
5-6	Expected		1.83	.44	.65	.63		3.55	+ 3.45	2.45	19.0	+ .182
	Observed		7.00	0.00	0.00	0.00		7.00				
4	Expected		1.01		1.09			2.10	+ .90	.08	10.5	+ .086
	Observed		2.00		1.00			3.00				
3	Expected		.55	.59	1.74	.42		3.30	+ .70	.12	18.0	+ .039
	Observed		4.00	0.00	0.00	0.00		4.00				
2	Expected	.63		2.50	1.84	1.99		6.96	- 2.96	.87	37.0	- .080
	Observed	0.00		2.00	2.00	0.00		4.00				
1	Expected		6.50	4.70	3.36	1.99	.25	16.80	- 2.80	.03	92.5	- .030
	Observed		10.00	3.00	1.00	0.00	0.00	14.00				
Total										41.36		

SUMMARY

The question of the relationship between frequency of fishing in a stream and fishing success in the same stream has been examined with reference to date from a season-long creel census of a section of Augusta Creek, Kalamazoo County, Michigan. More than 542 anglers fished for 2,949 hours and caught 623 fish.

When the data are arranged in visit categories, that is, according to number of visits made to the stream, there is an apparent general increase in success in fish per hour associated with greater numbers of visits throughout the season. Relatively few individuals were in any single category fishing the stream more than four times, and consequently the success per unit effort in these categories fluctuated considerably.

When the visit categories covering the larger numbers of visits were combined into visit classes, the fluctuation in average values for fish caught per hour was reduced, reflecting the larger numbers contributing to each average. Here again was seen an increase in fish per hour accompanying an increase in the numerical value of the visit class involved. For example, those individuals fishing five or more times caught 0.30 fish per hour or more, while those fishing fewer times caught 0.21 fish per hours or less. A Chi-Square test showed differences in catch among visit classes to be significant.

By computing the catch expected if all had experienced the same success, and comparing with the actual catch, the relation between number of visits and fishing success was shown in a different way. Fishermen making nine or more visits to Augusta Creek caught, on the average, 0.142 fish per hour more than the average, while fishermen in the classes making one, three, and four visits caught fish at below the average rate, with an average deficiency in success as great as -0.070 fish per hour. Those making two visits experienced just about average success. Expressed in another way, the 40 persons who visited the stream five or more times rather consistently caught more trout than the average, and over the season accounted for 97 fish more than should be expected from the average success.

Having found the distribution of fish per angler, it was evident that the greater number of fish are removed by the minority of individuals catching the most fish, for instance, the most successful seven percent of the anglers removed fifty-two percent of the total season's catch. Sixty-six percent of the anglers caught no fish.

For those using artificial lures and spinning rods the average monthly catch, except for August, and the seasonal success per hour for each visit class, except those making one and two visits, was greater than for the corresponding classes of the entire sample.

Upon closer examination of the data for fishermen using artificial lures and spinning rods, it was found that those using spinning rods were the most successful with an average catch of 0.833 fish per hour; those using artificial flies exclusively were the next most successful group with a catch of 0.277 fish per hour; and those using a natural bait - artificial fly combination were the least successful group with an average catch of 0.163 fish per hour. Those who angled with natural bait alone constituted the bulk of the entire sample and had an average seasonal catch of 0.206 fish per hour.

Comparisons made between the seasonal average catches may be misleading; for instance, those using artificial flies fished only two hours during April when fishing was most successful and 65.5 hours during July when the monthly average success was poorer, thus the apparent seasonal success may be depressed for this group. There is need of an adjusted value.

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