File Box C. #17

A Brief Study of the Trout Population in Benton Creek (17-0560)

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Purpose

In this study I attempted to get a brief understanding of the trout population in Benton Creek which is a tributary of the Smith River and located a few miles west of White Sulfur Springs Montana. As far as I know there has not been any research done on this particular creek.

A study area indicative of a natural population was picked and electrofished to give data for a population estimate. From data obtained from lengths, weights, and scale samples of the collected fish; an age structure relationship was constructed. The population estimate was then put into a 95% confidence level. An estimate of the standing crop (biomass) was then made.

Materials and Methods

The method of capture of fish in this study was a fish shocker. The shocker used was a Roberts Pied Piper which consisted of a series of rectifiers and relayers which convert AC power to DC power at approximatly 200 - 300 volts. The generator used was a Homelite AC generator which produced 150 watts of power at 115 volts. I selected to use direct continuous power (DC) for the study because with the use of this type of current the fish show strong galvanotaxis, the fish show little galvanocosis, the least tissue damage is done to the fish, and it is the least dangerous to the people doing the shocking, (Vincent 1969). The only chemical used was MS-222, which was used as a tranquillizer so as to allow easier handling of the fish.

The first trip to Benton Creek was on September 6, 1970. I first picked out a study area which was a section of the creek as it passes through the Buckingham ranch. This area was selected because they allow very little fishing in the creek as it winds through their ranch. This area should then be indicative of a natural population. A section of the creek 218 meters long was set off with stakes and designated as the shocking area or run.

Shocking was started at the upper end of the designated run. The fish were captured with dip nets as they swam toward the positive electrode of the shocking apparatus. After the fish were netted they were stored in a steel tub. When a considerable number of fish were thus captured (20 - 30) we shut the shocker off and worked the fish. This

Drawing the fish out from under obstacles with the shocker's positive pole

consisted of drugging them with MS-222 whereupon they were measured, weighed, scale samples were taken, and they were marked with a lower caudal fin clip. After this operation was accomplished the fish were taken back upstream and released at various points so as to allow for a random dispersment. This operation was then carried on for the rest of the study section of the creek.

The recapture part of the study was done on September 15, 1970. The purpose of the rerun being to get an idea of the ratio of marked fish to unmarked fish. There were four changes in the proceedure during the recapture run. The first of these changes was that we started 20 meters above the start of the original run. We also continued 20 meters past the end of the old run. This change was suggested by

Working the fish - consists of recording lengths and weights, taking scale samples, and marking the fish with a caudal fin clip

George Holton, biologist Montana Fish and Game Dept. The second change was that we shocked the creek a second time to pick up fish that were missed the first time. The second shocking run was done approximatly every 40 meters of stream; or in other words after shocking about 40 meters of stream we would go back over the same section of creek and work the fish together. The third change was that when we worked the fish we did not clip any fins. The last change was that the marked fish were only measured.

During both shocking trips we netted the shocked sculpins which were the only nontrout species found. When it came time to work the fish only the lengths were recorded for the sculpins. At the completion of both shocking trips the water temperature was recorded. At the end of the second trip the width of Benton Creek was measured at 10 meter intervals.

Typical brushy area of the shocking run

Approximately two weeks after the last shocking trip the scale samples were analysed. This was done by mounting the scale samples between two glass slides and "reading" the scales under a compound microscope using 100x power. The number of annuli on the scales were recorded and used for the aging of the fish.

Typical pasture type area of the shocking run

Results

In the consideration of the compilation of results for this study I considered several statistical measures. I finally decided on the following measures; mean and range of lengths, mean and range of the weights, variance of the total population and of the different age groups, and the standard deviation of the population. With the populations standard deviation, I was able to put the population into a 95% confidence interval as far as the final estimation was concerned.

I grouped the fish according to several catagories and then computed the statistical measures mentioned above. They were first computed according to specie. I then grouped all the trout species together which was the group used for the overall trout estimations. I also grouped the data according to the different shocking trips to see if there was any significant differences between them. The fish from the second trip were even farthur analysed by comparing the mean lengths of the unmarked fish to that of the marked fish.

Throughout the rest of this paper I use the common names of the fish which I worked with. The scientific names are as follows; Brook Trout - Salvelius fontinalis , Rainbow Trout - Salmo gairdneri , and Mottled Sculpin - Cottus bairdi .

The statistical analysis of the data from both shocking trips is given on the table on the following page.

Table of Statistical Data from the September 6 and September 15, 1970 Shocking Trips on Benton Creek

	Total Brook Trout	Total Rainbow Trout	Total Sculpin	Total Trout	Total Trout first trip	Total Trout second trip	Total unmarked 2nd trip Trout	Total marked 2nd trip Trout
Number of fish	182	2	75	184	82	139	102	37
Mean length	156	222	70	156	160	156	154	165
Range of length	53 - 279	198 - 240	33 - 114	53 - 279	81 - 274	53 - 279	53 - 279	91 - 274
Mean weight	52	104	--	52	54	--	45	--
Range of weight	5 - 195	82 - 127	--	5 - 195	9 - 191	--	5 - 195	--

lengths are in millimeters weights are in grams

The population estimation of trout in the creek was made by analysing the ratio of marked fish to unmarked fish. The mark and recapture formula used was the Chapman modification of the Petersen formula which is $N = \frac{(M+1)(C+1)}{R+1}$; where N is equal to the population estimate, M is equal to the number of fish marked, C is equal to the number of fish in the recapture sample, and R is equal to the number of fish in the recapture sample (C), Ricker, 1958. The data for my estimation is as follows.

R = 37

M = 82 $\qquad N = \frac{(83)(140)}{38} = 305.8$

C = 139

This estimation of 305.8 fish is for a length of creek 218 meters long. The estimation for 1000 meters is 1403 trout.

My next objective was to construct an age structure relationship in the Benton Creek trout population. This was accomplished through the use of the collected scale samples with their recorded fish lengths. The scales were "read" and the number of annuli on the scales were considered to be indicative of the age of the fish. I then set up a table as Vincent suggests in his 1969 paper "River Electrofishing and Fish Population Estimates." This data is given on the following page in the form of a table.

This was done by finding four size groups according to length in which the first group consisted of only 0 year olds (less than 1), the second consists of fish of both 0 and 1 years of age, the third of just 1 year olds, and the fourth a mixture of 1 and 2 year old fish.

Age Length Relationships in Trout from Benton Creek

	Class limits	M	C	R	$\frac{(M+1)(C+1)}{R+1}$	N	Relative percent	Age composition
Class 1	53 - 169	61	64	18	$\frac{62 \times 65}{19}$	212.11	100% - 0yr.	212.11
Class 2	169 - 184	14	14	6	$\frac{15 \times 15}{7}$	32.14	30% - 0yr.	9.64
							70% - 1yr.	22.50
Class 3	184 - 245	29	24	10	$\frac{30 \times 25}{11}$	68.18	100% - 1yr.	68.18
Class 4	245 - 279	8	7	3	$\frac{9 \times 8}{4}$	18.00	50% - 1yr.	9.00
							50% - 2yr.	9.00

class limits lengths are in millimeters

The percentages of age groups within a class were then computed and used in the final analysis of the age structure. For example; the class in which both 0 year old fish and 1 year old fish was found to have the following percentages, 30% 0 year old fish and 70% 1 year old fish. In the final computation then, 30% of this class was added to the class in which only 0 year old fish were found and this sum was the estimation of 0 year old fish in the population.

From the data presented on the previous page, the different groups representing the same age groups can be added and a ratio of these age group sums to the total sums calculated When this is done the following ratios are obtained.

Age Structure

0 years of age	$\frac{221.75}{330.43}$
1 year of age	$\frac{99.68}{330.43}$
2 years of age	$\frac{9.00}{330.43}$

These ratios can then be computed into percents and converted to number of age group fish out of a sample of 1000 fish. This data is given below.

Age Relationships per one thousand Fish

0 years of age		671
1 year of age		301
2 years of age		27
	total	1000

The fish per thousand data given on the previous page can also be computed as number per age group per 1000 meters of stream. This data is as follows.

Number and Age of Trout per 1000 meters of Creek

0 years of age		942
1 year of age		423
2 years of age		38
	total	1403

The next topic in this project is the varience of the different age groups and the variance of the total population. The value determined for the variance is used to compute the standard deviation which is in turn used to place the population into a 95% confidence interval. The formula used to compute variance was the formula given by Ricker in 1958. This formula is as follows.

$$\text{Variance} = \frac{(\text{Pop. Est.})^2 \ (C-R)}{(C+1)\ (R+2)}$$

My data for the different age groups is as follows.

Variance class 1 $\quad \frac{(212.11)^2 \times 46}{(65) \times (20)} = 1591.97$

Variance class 2 $\quad \frac{(32.11)^2 \times 8}{(15) \times (8)} = 68.86$

Variance class 3 $\quad \frac{(68.18)^2 \times 14}{(25) \times (12)} = 216.93$

Variance class 4 $\quad \frac{(18.00)^2 \times 4}{(8) \times (5)} = 32.40$

total 1910.16

Variance for the total population was also computed and is given below.

$$V = \frac{(305.8)^2 \times 102}{(140) \times (39)} = 1747$$

It has been shown that the best or more accurate standard deviation is obtained by taking the square root of the sum of the variances corresponding to the different classes. I have computed the standard deviation using both the sum of the variances of the classes and the variance of the total population. I chose to use the standard deviation derived from the sum because it was a bigger number and would thus have a greater probability to be correct and I also chose it because it has been shown to be more correct. Both figures are given below.

Stndard deviation using the sum of the variances of the classes.	$\sqrt{1910.16}$	=	43.71
Standard deviation using the variance of the total population.	$\sqrt{1747}$	=	41.80

The standard deviation was then used to place the population into a 95% confidence level. The method used was that obtained from Vincent, 1969. This is done by multiplying the standard deviation by two and then adding and subtracting this number from the population estimate. The two numbers obtained are the two desired bounds. My data for this is as follows.

$305.8 \pm 2 \times 43.71$

This interval turns out to be 393.2 - 218.4. This interval means that there is a 95% chance that the true population number will fall between these two bounds. This data is for a section of stream 218 meters long. The confidence interval for a stretch of stream 1000 meters long is 1001.8 - 1803.7.

The next step in my study was to estimate the standing crop (biomass) of trout in Benton Creek. This was done by following the method pro-

posed by Vincent in 1969. The first done was to compute the average weight of fish in each of the different size groups set up from the age analysis part of the study. The average or mean weight was then multiplied by the number of fish estimated to be in that particular class. The total weights of trout from the different classes were thus computed. The next step was to determine the total weights contributed by the three different age groups which was accomplished in the same manner as was the age analysis using relative percents of age groups within a class. The three total weights corresponding to the three different age groups were added and this figure was used as the estimation of biomass. My data for these computations is on the following page.

Age Mass Analysis

0 years of age	5268 grams
1 year of age	18489 grams
2 years of age	1396 grams
	15153? total

The age mass relationship given above is for 218 meters of Benton Creek. The total figure obtained for a stretch of stream 1000 meters long is 69,509 grams or 69.509 kilograms.

The water temperature was considered as not being a variable in this project as the readings taken on both September 6 and 15 were the same. The recorded temperature from both days was 3 degrees centigrade.

The width of Benton Creek was determined by recording the width of the stream at 10 meter intervals along the original shocking run. The mean width was determined to be 1.94 meters wide.

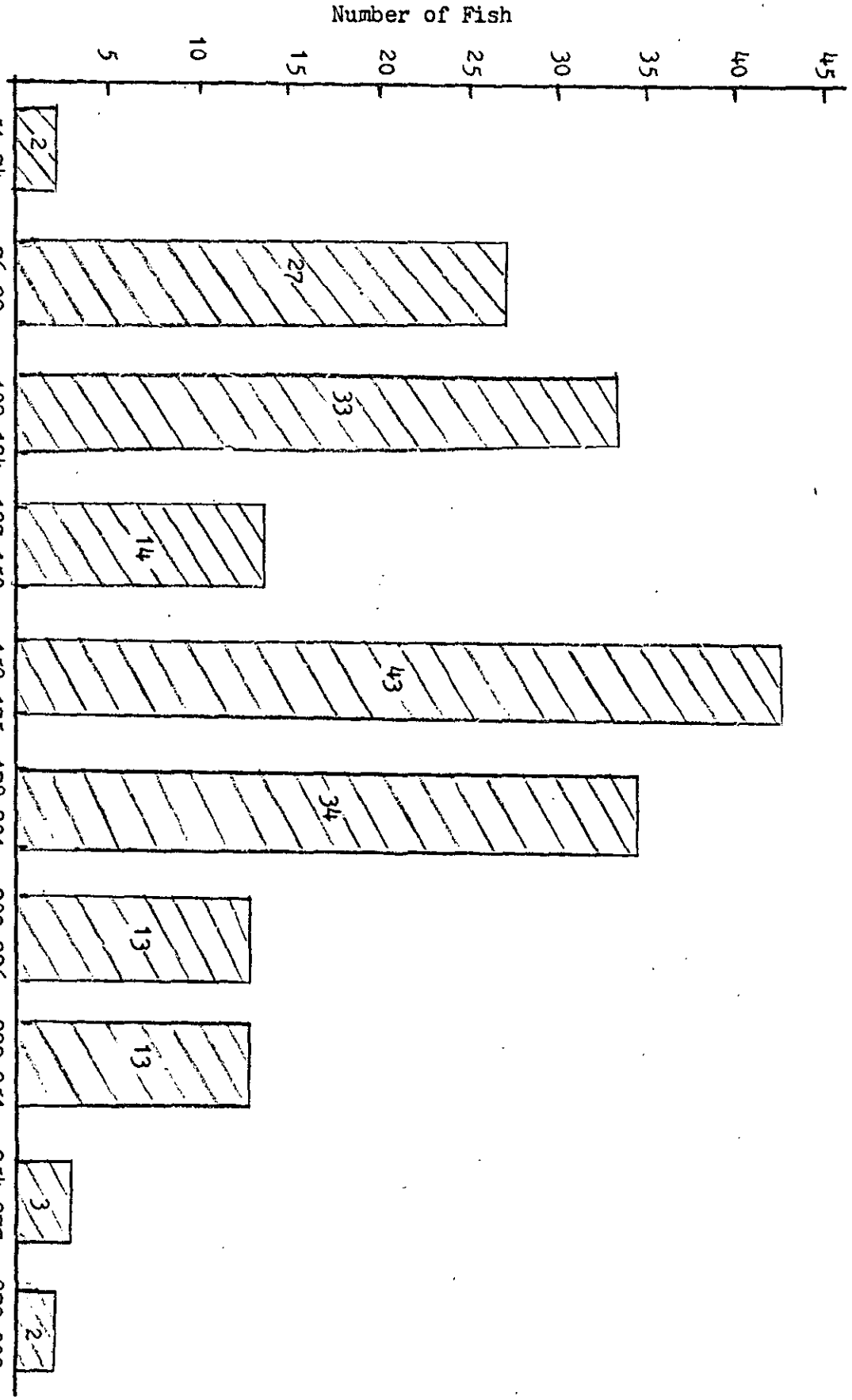
Mass per Age Group Estimation

	Class limits	Total Trout in class	Total mass	Mean mass	Est. Pop. within class	Mean mass times Est. Pop.	Relative Percent	Age composition mass
Class 1	53 - 169	107	2372	23	212.11	4713	100% - 0	4713
Class 2	169 - 184	22	1270	57	32.14	1851	30% - 0	555.3
							70% - 1	1365.7
Class 3	184 - 245	43	3583	84	68.18	~~5737~~	100% - 1	~~5727~~
Class 4	245 - 279	12	1859	155	18.00	2792	50% - 1	1396
							50% - 2	1396

mass is given in grams in this table

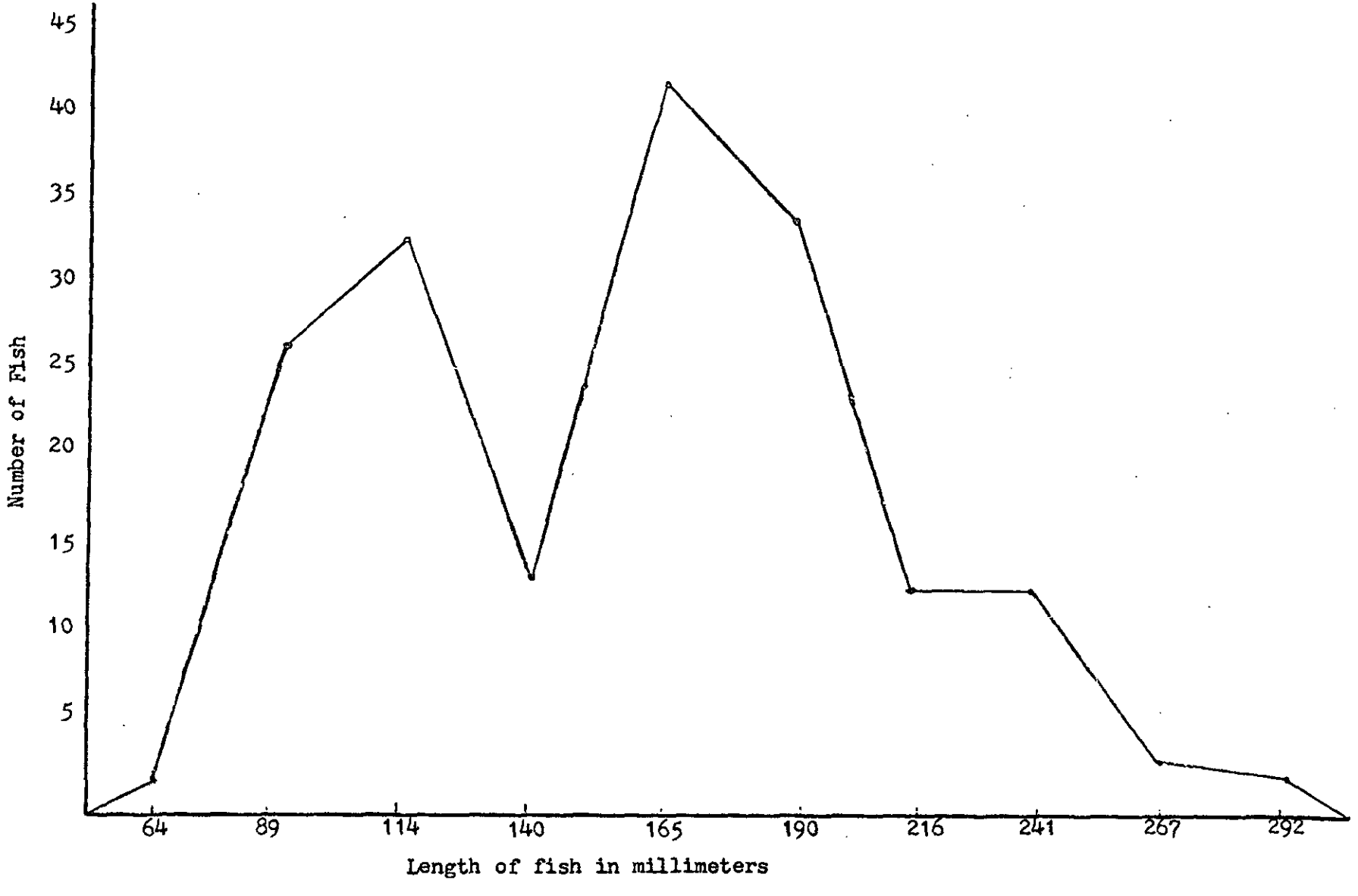
Graph 1

Bar Graph of Length vs Number of Fish per Length Class

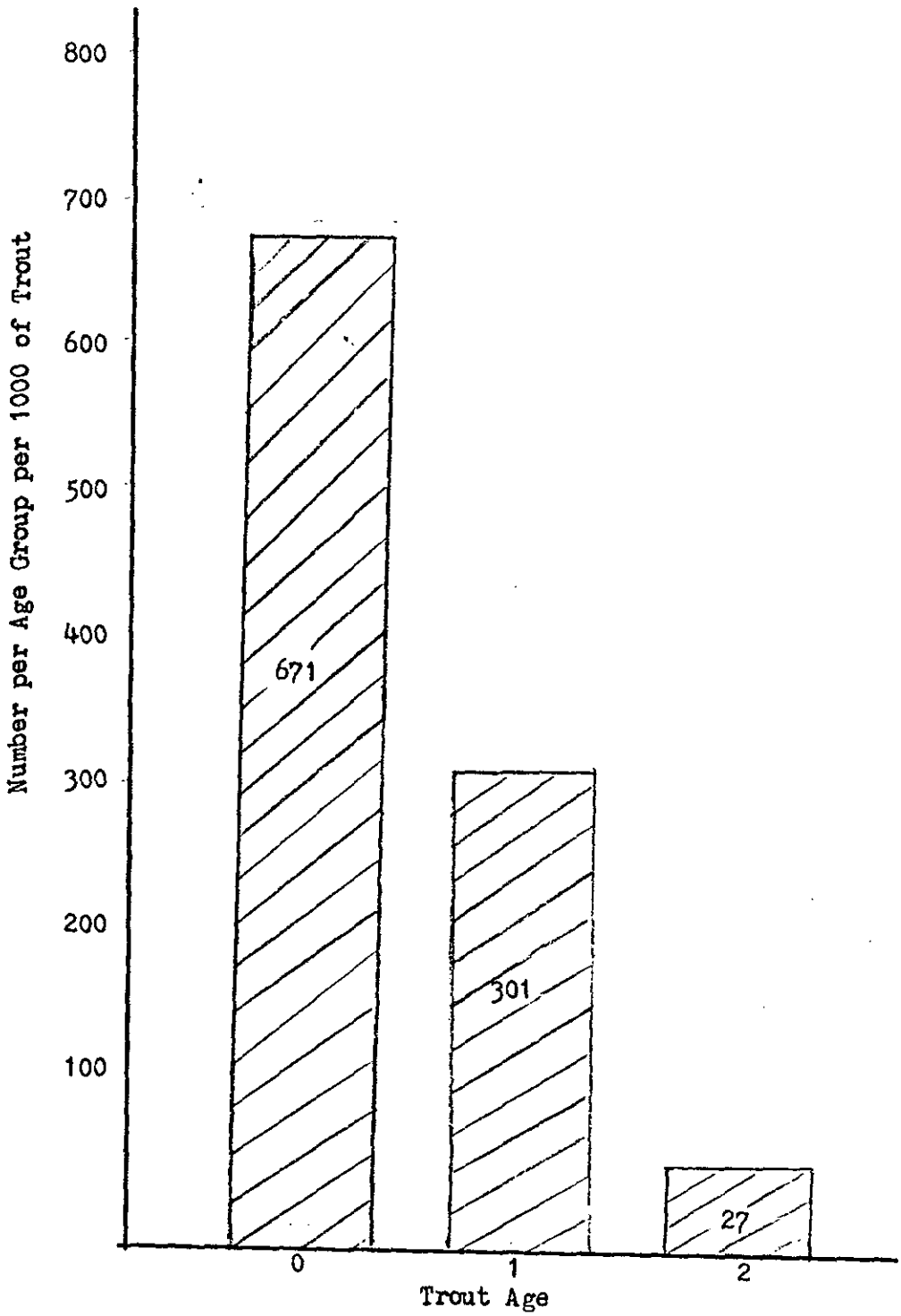


Graph 2

Broken Line Graph of Length vs Number of Fish per Length Class



Bar Graph of Age vs Number per thousand per Age Group of Fish



Discussion

The first thing done in this study was to estimate the population of trout in Benton Creek. The formula used was the Chapman modification of the Petersen formula. This formula is relatively unbiased. In order for it not to be biased there are two conditions of which one the other or both must be met. These conditions are 1. (M+C) must equal or exceed N, 2. MC must be more than 4N. In my study only the second of these conditions was met. Only having met one of these conditions some bias can be expected. However when the estimation is put into a 95% confidence level the bias is negligible, Robson and Regier, 1964.

According to Vincent 1969, two other requirements should be observed in a fish estimation through the use of a shocker. These are that the length of stream shocked should be 1000 feet long and that a sample of more than 150 fish should be taken each time. My run was approximately 675 feet long and my samples were 82 and 139 fish. The reason for the smaller length of stream and smaller sample sizes is that time was a factor in the study. I was not able to take four trips to the study area nor was I able to shock more than 218 meters of stream the first trip. This will allow for more error in my results, however with the 95% confidence limits applying I think the bias caused by this will be compensated for.

I would next like to compare my results with results found in two papers. The first of these is a paper written by James McFadden in 1961 and the second is a paper written by George Holton in 1953.

In "A Population Study of the Brook Trout, Salvelinus fontinalis" by McFadden Ifound several similarities to my study. He divided his study into several sections of stream. The uppermost of these is the section which I would like to expound upon. It was about 16 feet wide whereas my study area had a mean width of about 6 feet. His studies were done in September as were mine. I found only Brook Trout, Rainbow Trout, and Mottled Sculpin whereas McFadden found many species of fish in his study area which included Brook Trout, Rainbow Trout, bass, and several other species. In September 1956 he found that his population of trout was composed of 85% less than 1 year, 12% 1 to 2 year olds, and 3% 2 years or more. In my study I found that 67% of the population was composed of fish less than 1 year of age, 30% were 1 year olds and 3% were 2 year olds. He also gave a table of ranges of his fish as far as age was concerned. The ranges were 0 year olds 1.5 - 6.4 inches, 1 year olds 5.5 - 10.4 inches, and 2 year olds 6.5 - 11.4. My data for this was estimated from the broken line gragh and the bar gragh. The data is as follows 0 year olds 2.1 - 5.5, 1 year olds 5.5 - 9.8, and 2 year olds 9.8 - 11.0.

It appears that McFaddens study and mine were fairly close in most respects. The obvious differences are that his study stream was more than twice the width of Benton Creek where I did my study and that he had a much wider species diversity than did mine. I think the two areas would have compared closer as to range of length of age groups if I had computed actual ranges instead of interpolating from my graphs.

I would next like to compare my data with the data given in "A Trout Population Study On A Small Creek In Gallatin County Montana" written by George Holton, 1953.

In this study Trout Creek was split into four study areas by Holton. The uppermost of these sections is the section which I would like to use for comparison purposes. The average width of the stream at this section was 5.5 feet whereas mine is about 6 feet wide. Brook Trout were the predominent specie in this section with Rainbow Trout and sculpin also being present. Three other species were found in the stream, however it was not mentioned as to whether they were found in the upper section. Brown Trout were also found in the study however there were no Brown Trout found in the upper section. It was found that Brook Trout made up 83 - 96% of the trout population in the upper section. In my study Brook Trout were found to compose 99% of the population. In August 1950 the age composition was found to be 53% less than 1 year, 46% 1 year olds and 1 % of the population 2 year olds. In August 1951 the age composition was 74% less than 1 years of age, 26% 1 year olds, and no 2 year olds were found. My data as far as age composition was 67% less than 1 year of age, 30% 1 year olds and 3 % 2 years of age. The average lengths of the different age groups were 2.90 inches for the 0 year olds, 6.08 inches for the 1 year olds, and 8.80 inches for the 2 year olds. This was computed for all four sections in his study. Data for this estimated from the broken line graph for my study is as follows; 4.5 inches for 0 year olds, 6.5 inches for 1 year olds and an estimate for 2 year olds could not be made.

The data given in Holton's 1953 paper corresponds very closely to the data obtained in this study. The predominence of Brook Trout in both sets of data, along with the typical age relations and length relations typify this type of small stream I think. It seems that

in this type of stream there is a predominence of young Brook Trout rather than any other group. This is probably due to the winter kill in a small creek. This type of environment seems to be more suitable to the young Brook Trout. This is emphasised in Holton's paper where he found that some of the young of the year (less than 1 year) were ripe or capable of spawning. He also found that the survival from fall to the following summer was 84% for the age group which was less than 1 year in the fall and the survival for the age group 1 year old in the fall as being only 6 %.

Conclusions

I found that Benton Creek's trout population is composed of predominently Brook Trout. There are also a few Rainbow Trout in the stream. The only other specie found in the creek was Mottled Sculpin of which there were quite a few. The mean length of trout in the creek is 156 mm. The range of length is 53 - 279 mm. The mean weight was found to be 52 grams and the range of weight was found to be 5 - 195 grams. The mean lenght of sculpin in the creek was found to be 70 mm. The range of length of sculpin was found to be 33 - 114 mm. The population estimate was computed to be 1403 trout per 1000 meters. Put into a 95% confidence interval the population was found to be between 1001.8 and 1803.7 trout per 1000 meters of fish. The stream was found to be 1.94 meters wide along the study area.

The age composition of trout was also found. The age composition of trout out of a population of 1000 was found to be 671 trout less than 1 year of age, 301 trout 1 year of age, and 27 trout 2 years of age. The corresponding numbers of fish for a stretch of stream 1000 meters long is as follows; 942 trout less than 1 year of age, 423 trout 1 year of age, and 38 trout 2 years of age.

An estimate of the standing crop of trout in Benton Creek was also made. This estimate for a stretch of stream 1000 meters long is 69.509 kilograms. Breaking this biomass down into contributing age groups gives the following data; 24.165 kilograms from fish less than 1 year of age, 38.941 kilograms contributed by 1 year old fish, and 6.403 kilograms contributed by fish 2 years of age.

References Cited

Holton, George D. 1953. A Trout Population Study On A Small Creek In Gallatin County Montana. The Journal of Wildlife Management. 17 (1) : 62-82.

McFadden, James T. 1951. A Population Study of the Brook Trout, Salvelinus fontinalis. Wildlife Monographs. Dept. of Biology, University of Louisville. 1-73.

Ricker, W.E. 1958. Handbook of Computations for Biological Statistics of Fish Populations. Fisheries Research Board of Canada Bull.,119. 300pp.

Robson, D.S. and H.A. Reiger. 1964. Sample size in Petersen Mark-and-Recapture Experiments. Transactions American Fisheries Society. 93 (3) : 215-226.

Vincent, Richard. 1969. Electrofishing and Fish Population Estimates. D-J Projects F-9-R-15 through 17, Job VII, Evaluation of River Fish Populations, Mont. Fish and Game, Fisheries Division.