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MONTANA

FISH AND GAME DEPARTMENT

FEDERAL AID IN SPORT FISH RESTORATION

JOB FINAL REPORT

ROCK CREEK CREEL CENSUS

JOB I: SUMMER CENSUS

Period Covered: May 25, 1958 through November 30, 1967

By

LITER SPENCE
November 24, 1971

ACKNOWLEDGEMENTS

The following Fisheries biologists worked on this 10-year project and prepared job completion reports for the various segments as follows:

1958	Robert Averett and Art Whitney
1959	Tommy Smith
1960-1961	Ralph Boland
1962-1963	Robert Domrose
1964	Keith Seaburg
1965-1967	Liter Spence

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MONTANA FISH AND GAME DEPARTMENT
FISHERIES DIVISION

JOB FINAL REPORT

State Montana

Project No. F-27-R Title Rock Creek Creel Census

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ABSTRACT

This is the final report for Project F-27-R, a 10-year creel census on Rock Creek near Missoula, Montana. The census was designed to yield information on the survival of stocked, catchable-sized rainbow trout to the creel and their effect on fishing in a stream containing a wild trout population. Catchables were planted during the first three years of the study. No fish were planted during the following four years; but were again planted, in increasing numbers, during the last three years.

An intensive creel census was conducted during the 10-year period. Estimates were made each year of total fishermen, total hours fished, and total harvest. During the last eight years of the study linear regression techniques using car counter data were used to estimate number of fishermen, hours fished, and fish harvested for noncensus days.

The first-year return of catchables ranged from 25.6 percent to 39.3 percent and averaged 34.6 percent through Labor Day. During years of stocking the first plant of fish was made between June 16 and July 2; 78 percent to 94 percent of the stocked fish caught were harvested by the end of August; one percent to five percent of fish stocked were harvested the second year. The average catch per hour for all fishermen combined was 26 percent higher for the six years with stocking than it was for the four years without stocking (0.77 compared to 0.61), and the average number of fish caught per angler was 40 percent higher during the stocked years than during nonstocked years (2.8 compared to 2.0). These differences were significant at the 95 percent probability level. However, the analyses showed that the more skillful fishermen benefited more than the less skillful fishermen when catchable-sized trout were stocked. There was not a significant difference in the number of hours fished per fisherman or the number of fishing trips made to Rock Creek between stocked and nonstocked years. On the average 47 percent of the fishermen caught zero fish during the nonstocked years, and 41 percent during the stocked years. This difference was significant at the 90 percent probability level. Even in stocked years the lower 50 percent of the fishermen, in terms of success, averaged only 4 percent of the game fish caught.

Fishermen used bait more than any other lure. About one-quarter to one-third used flies only. Based on number of limits caught and kept, bait and fly fishermen were about equal in fishing success. Hardware fishermen were least successful.

The complete statistical methodology, including formulas, is contained in the report.

BACKGROUND

The stocking of catchable-sized hatchery trout has been used as a major fish management tool in Montana. Public sentiment has encouraged this management practice to the point where most of the larger, assessible streams and rivers receive plants of hatchery fish. The economic feasibility of stocking large numbers of these catchable-sized fish has been questioned by fish managers, though it is generally agreed that stocking catchables will increase fishing success. Many anglers like to fish for wild fish only, and they object to stocking catchable hatchery fish in waters having an adequate wild fish population. Many biologists and anglers feel that a disproportionately large share of the cost of this type of planting is borne by anglers who do not benefit from it. Stocking catchables is the singularly most expensive management tool used to improve stream fishing.

The Rock Creek creel census was established in an attempt to answer some of the questions surrounding the stocking of catchable hatchery fish in streams which have a resident wild trout population. The return of hatchery trout to the angler and their harvest in relation to the wild trout harvest have never been evaluated with respect to the numbers of fish planted. There is a need for information on survival of catchables to the creel and their effect on fishing, including their distribution among anglers. Such an evaluation is essential to good management, particularly since up until now the stocking rates of catchable-sized fish in Montana streams have been based principally on public pressure, past stocking rates, and availability of the hatchery product.

OBJECTIVES

The overall objective of the 10-year Rock Creek study has been to obtain the necessary fishing pressure and harvest information for an evaluation of the stocking program of catchable-sized rainbow trout in Rock Creek.

PROCEDURES

General procedures followed during the study are explained in this report. Specific procedures followed during each of the study years are contained in job completion reports for the respective years (F-12-R-5, Job II and F-27-R-1 through F-27-R-9, Job I).

Study Area

Rock Creek, which joins the Clark Fork River about 20 miles east of Missoula, Montana, is one of the most popular and perhaps the most productive trout stream in western Montana. It is one of Montana's "Blue Ribbon" trout streams. Approximately 40 miles of the main stream are served by a single access road,

limiting principal access to either the headwaters or the mouth of the stream. This 40-mile section was chosen for the study.

The study area was divided into a 26-mile lower section and a 14-mile upper section. The division point was Little Hogback Creek, a tributary stream. This division point was chosen because various "spot" checks had indicated that it was somewhat of a natural boundary for anglers entering the section at either the upper or lower end; i.e., most anglers entering at the mouth of the stream did not fish above Little Hogback Creek, and most anglers entering at the headwaters did not fish below the creek. The lower section was designated Section 1, and the upper section was designated Section 2. The division point was marked by a sign to show anglers they were changing sections.

Missoula (pop. 27,000) is the largest and closest population center to Rock Creek. Consequently, most Rock Creek fishermen enter at the mouth of the stream. Only small communities are located near the headwaters and fewer numbers of anglers enter this section. Approximately 50 percent of the access to Rock Creek is over National Forest land and the other 50 percent is private. There are two Fish and Game Department fishermen access sites and seven National Forest campgrounds within the study area. Public access has also been acquired over some private lands. The road along the stream is narrow and rough in many places, although it is passable to campers and small travel trailers during all of the summer fishing season.

Most of the traffic entering Section 1 (near the mouth of the stream) during the fishing season is recreational, although there are several private ranch holdings and acreages which are occupied year around. Much of the private land is presently being sold and subdivided by real estate developers for homesites. Most of the traffic entering Section 2 (near the headwaters) is due to logging and ranching operations.

Design of Study and Collection of Data

The 10-year creel census study began in 1958 and continued through 1967. The first years study was a pilot study to determine if it was feasible, by a census of this type, to obtain good estimates of (1) total pressure, total catch by species, and total number of hatchery fish caught during the general summer season; and (2) total pressure, total whitefish catch, and total number of trout hooked and released during the winter "whitefish only" season.[1/] Daily information obtained from summer fishermen in 1958 included: Number in fishing party; total catch (recorded separately by species, and by marked hatchery trout); total hours fished; section fished; and bait or lure used. In addition to these items, winter fishermen were asked to remember how many trout they had hooked and released while fishing for whitefish.

Following the 1958 study, it was determined that such a census was feasible and plans were made to continue. Summer and winter censuses were conducted again in 1959 in a manner similar to the 1958 census. However, only summer censuses

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[1/] Averett, R. C. and A. N. Whitney. 1959. Rock Creek Creel Census. D-J Completion Report for Montana Project F-12-R-5, Job II, for period May 1, 1958 through April 30, 1959.

were conducted from 1960 through 1967. The basic design for data collection was established during the early years and continued through the entire study with only minor modifications.

Checking Stations

After the 1958 pilot study, permanent checking stations were constructed at the upper and lower ends of the study area. The lower checking station was designated station 1 and the upper one, station 2. Portable signs requesting fishermen to stop and be interviewed were placed at each station. (In Montana anglers are not required to stop at creel checking stations.) A boundary sign was installed near each station to designate to fishermen the study section being entered. One of the interview questions asked, "Where did you fish?" and the signs helped the angler establish that area. All angler interviews were held at the checking stations.

Census Schedules

Creel census schedules were drawn up prior to the opening of the fishing season each year. Schedules were made for the entire fishing season, and days to be censused were selected randomly. During 1958 and 1959 census days were stratified into "a.m." and "p.m." days. An a.m. day ran from 9:00 a.m. to 5:00 p.m. and a p.m. day ran from 2:00 p.m. to 10:00 p.m. From 1960 through 1967 census days covered the period from 9:00 a.m. to 9:00 p.m. or until it appeared most anglers had left the area in the evening. Each nine-to-nine census days coverage was considered complete. Spot checks indicated that only a very small percentage of the total number of anglers left the study area prior to station openings in the morning.

The length of the general fishing season ranged from 190 to 194 days each year (mid-May through November 30).

During the 1958 pilot study, 51 percent of the summer season received census coverage. Coverage in 1959 was 72 percent. From 1960 through 1967, census coverage was as follows at station 1:

1960	50 percent through Sept. 25; 25 percent thereafter to Nov. 30
1961	43 percent through Sept. 3; 25 percent thereafter to Nov. 30
1962	36 percent through entire season
1963	53 percent through Sept. 9; 25 percent thereafter to Nov. 30
1964	53 percent through Sept. 7; 27 percent thereafter to Nov. 30
1965	52 percent through Sept. 30; 21 percent thereafter to Nov. 30

1966 52 percent through Sept. 30; 23 percent thereafter to Nov. 30

1967* 52 percent through Sept. 30; 23 percent thereafter to Nov. 30

*Original schedule. However, 10 census days were eliminated during an 18-day fire closure extending from August 24 through September 10.

Fewer fishermen were checked at station 2 than at station 1. From 1958-63 census coverage at station 2 varied from a full season to termination after Labor Day weekend, depending on the fishing activity. When station 2 was operating the intensity of the census was approximately the same as at station 1. Station 2 was closed after Labor Day during the last four years of the study due to a lack of fishing activity.

Days censused were the same for both stations in 1959, 1960-62, 1966 and 1967 as long as the upper station was open. Days censused at the two stations differed in 1958 and 1963-65.

Interviews

Creel census information was obtained from anglers who voluntarily stopped at the checking station. Most anglers cooperated in this respect; even though each year some vehicles, which obviously contained fishermen, failed to stop. Census data were collected on contact forms. In 1958 and 1959 data from all parties (vehicles) contacted were recorded on one continuous form. The following information was recorded by fishing party in 1958 and 1959 (a party was usually confined to a single vehicle):

(1) Time of contact
(2) Number of anglers in each party
(3) Number of hours fished
(4) Catch (by species and by marked hatchery trout)
(5) Section fished
(6) Type of lure used

Since data was recorded by party, some information was not available for comparative analysis as it was from 1960-67. This will be seen later in the report.

The interview format was changed in 1960 so that a separate contact form was used for each party (vehicle), and the following information was obtained on each fisherman from 1960-67:

(1) Number of fishermen in his party
(2) Fishing license number
(3) Number of hours fished
(4) Number of fish caught by species
(5) Number of marked hatchery fish caught
(6) Residency
(7) Section fished
(8) Type of lure used

With the exception of 1958, the contact forms were sent to the State Data Processing Center in Helena and the data recorded on punch cards. From these cards, data were summarized and retrieved in whatever categories were needed for analysis.

Traffic Counts

A traffic counter was installed in 1958 to establish the feasibility of using car counts to estimate fishing pressure on days with no census coverage. The counter, however, was not dependable in its operation, and the counts it recorded could not be used for this purpose.

In 1959 a more dependable, hourly recording, battery operated, traffic counter was put in operation at station 1 to record cars entering the study area. This, again, was for the purpose of establishing the feasibility of using car counts for pressure and harvest estimates. Traffic counts were obtained for the entire summer fishing season. Traffic counts were used in the 1959 data analysis to determine the ratio of fishermen to nonfishermen cars for data expansion. It was also determined that they would be useful in estimating census data for noncensus days. Consequently, beginning in 1960 traffic counters were installed at station 1 and station 2, and the counts were used for the remainder of the study to estimate pressure and harvest for noncensus periods.

The traffic counters, Model RCH, were manufactured by the Streeter-Amet Company, Grayslake, Illinois. They operate on a six-volt automobile battery and have eight-day mechanical clocks. Car counts are accumulated hourly and are printed on a paper tape at the end of each hour (on a 24-hour basis). The time of day is printed with the hourly total. Although there were some mechanical problems, these counters served the purpose satisfactorily.

Stocking

Marked hatchery fish were planted during the years 1958 through 1960, and 1965 through 1967. No fish were stocked from 1961 through 1964. From 1965-67, the level of stocking was increased each year to ascertain the effect on the fishing pressure, harvest and catch rate. A summary of the numbers and sizes of hatchery rainbow stocked in Rock Creek during the study is given in Table 1.

From 1958-60 marked hatchery rainbow were stocked in both section 1 and section 2. However, beginning in 1965 stocking was limited to section 1 because most fishing pressure occurred there, and it was felt a better return would be obtained from the hatchery product.

Marking of hatchery fish was done either by fin clipping, or removal of the premaxillary bone. Fins clipped singly or in combination were as follows:

1958	adipose
1959	adipose, left pelvic
1960 (Sec. 1)	right premaxillary
1960 (Sec. 2)	left premaxillary
1961-64	none
1965	adipose
1966	adipose, left pelvic
1967	adipose, right pelvic

TABLE 1. Number, weight and size of marked hatchery rainbow stocked by section in Rock Creek from 1958 through 1967

Year	Number stocked Sec. 1	Sec. 2	Total	Total weight (lbs)	Avg. No/lb	Approx. avg. length (in)
1958	21,795	16,400	38,195	7,979	4.79	8.00
1959	14,330	12,435	26,765	5,775	4.63	8.25
1960	19,917	8,955	28,872	6,590	4.38	8.25
1961	None	None				
1962	None	None				
1963	None	None				
1964	None	None				
1965	5,000	None	5,000	1,960	2.55	10.00
1966	10,087	None	10,087	2,950	3.42	9.00
1967	30,089	None	30,089	8,350	3.60	9.00

All hatchery rainbow were obtained from the Washoe Park Trout Hatchery at Anaconda. The fish were clipped and held at the hatchery a sufficient length of time to allow clipping mortalities, if any, to take place prior to planting. Clipping mortalities were negligible.

Pressure and Harvest Estimates

Fishing pressure and harvest estimates were derived from data collected on census days and by estimating this information for days with no census coverage. For the purpose of these analyses an individual is considered a new fisherman each time he is contacted. Variations in methods used are briefly described below.

1958 and 1959

Data expansion formulas for these years are contained in completion reports F-27-R-5, Job II and F-27-R-1, Job I respectively. Briefly, the method is as follows: "Total pressure and catch estimates were derived from the contact data by (1) expanding partial day (a.m. or p.m.) contact figures to full-day estimates; and, (2) computing total-period estimates from total census-day estimates. Data were treated separately for each census period and for each census station. Week-day and weekend-day estimates were computed separately throughout these expansion procedures, until the final step of making total estimates for the period concerned."[1/]

[1/] Averett and Whitney, op. cit.

This method is further explained in Appendix I, page 2. Confidence intervals were not placed around 1958 and 1959 estimates since no variances were calculated from the data. However, as is explained in Appendix I, these seasons were quite heavily censused and the estimates are believed accurate.

1960-64

From 1960 through 1964, estimation techniques differed from the first two years. Hourly-recording traffic counters installed at both checking stations operated from the beginning of the fishing season through mid-September. Then, using traffic counts and fishermen contact data, it was possible to establish a functional relationship between car counts and (1) number of fishermen; (2) hours fished; and, (3) fish caught for each census day.

These relationships were used in a linear regression analysis which allowed total pressure and harvest estimates to be made for noncensus days. Data for census days were considered complete. Thus estimates of total pressure and harvest from opening day through mid-September were the sum of (1) data from census days and (2) the estimates for noncensus days. From mid-September through November 30, estimates were based on expansion of census data as was done in 1958 and 1959. Thus, total pressure and harvest for the entire fishing season was the sum of (1) data from census days (known total); (2) estimates for noncensus days (regression estimates); and, (3) estimates derived from ratio expansion (ratio estimate). Confidence intervals at the 95 percent level were estimated for each category and for their total. A revision of the 1960-62 estimates (as given in completion reports for those years) was made because of a change in analytical procedures. The estimates were refined and are presented in the F-27-R-4 report. They are also used in this report.

1965-67

Techniques during the final three years of the census remained nearly the same as the previous five years. However, rather than using the ratio estimate method for estimating pressure and harvest after mid-September, the linear regression technique was used to estimate these factors for the entire season. Confidence intervals at the 95 percent level were also determined for estimates for each of these years.

1958-67 (final)

Methods used in data analysis differed somewhat during the study period. Some statistical errors were made. In order to obtain a uniform final analysis for all 10 years of the study, a statistician at the University of Montana was engaged. Mr. Kenneth P. Johnson, Research Associate, Bureau of Business and Economic Research at the University made all statistical analyses for this final report. Appendix I is his statistical report. He reviewed all years data, made necessary corrections, and put each years data (except 1958 and 1959) on the same format for analysis. (The 1958 and 1959 data were found to have been analyzed appropriately and no changes were made from the original estimates.) Daily creel summary data from 1960-67 were repunched on cards at the University. A computer program was written to provide final pressure and harvest estimates, confidence limits for the estimates, and analysis of variance.

Linear regression equations were used in the 1960-67 data analysis. The question arose as to whether a higher order polynomial equation (such as a quadratic)

would better fit the data and improve the estimates. This question was investigated by the statistician and resolved to his satisfaction. He decided a linear regression analysis would best fit the data. His explanation of this is described on pages 8 and 9 of Appendix I.

The consulting statistician compiled his report by station. The station 1 report contains the methodology used to analyze the data from both stations. Methods are not contained in the station 2 report. Both reports are included in their entirety in Appendix I.

Two appendicies were attached to the statistician's report, but are excluded in this report. They are: (1) Appendix A - 24 scatter diagram graphs plotting number of cars against number of fishermen, hours fished, and fish caught from 1960-67 at station 1; and, (2) Appendix B - 24 handwritten analysis of variance tables used to determine if the use of the quadratic equation yielded significant increases in accuracy over the linear regression equation to justify its more complicated use. These appendicies are not considered a necessary addition to this report. They are on file in the Missoula office of the Montana Fish and Game Department.

Since complete census coverage was not obtained at station 2 for all years, the final estimates for this station include only the period from opening day of the fishing season through Labor Day. This puts the total estimates on the same basis for comparison from year to year. The fishing pressure and, in turn, harvest in section 2 between Labor Day and November 30 each year was very light and their omission from the overall estimates is considered inconsequential. Station 1 estimates were made for the entire season each year.

Final estimates of fishing pressure and harvest, catch rates and fishing effort will not be the same as found in individual reports for each year, or as summarized in the F-27-R-9 completion report. Various errors in compilation and analysis of data account for the discrepancies. Confidence intervals applied to the estimates will likewise not be the same as in previous reports (in some instances the confidence intervals were actually made narrower by this final analysis). The official estimates for purposes of this study are contained in this report, and no reference will be made to those contained in previous reports.

Estimating Return of Hatchery Fish

The method used to estimate the number of hatchery trout harvested each year was as follows: (1) Percent composition of hatchery fish was obtained from the creel data obtained on census days; (2) This percent composition was multiplied by the total estimated harvest of all species that year to give the estimated number of hatchery fish caught; and, (3) The estimated number of hatchery fish caught was divided by the number of fish stocked to obtain the percent return of stocked fish. This method was also used to determine percent return in years following initial stocking. The method was used in all years except 1958 and 1959 in which expanded, rather than contact, data was used to determine species composition. However, the data are comparable.

Cumulative percent return was the percent return from succeeding years added to the percent return from the first year the fish were planted.

TABLE 4. Observed average catch per hour and per angler, and the average length of trip for both stations of Rock Creek, 1958-67 (numbers in parentheses were calculated from estimated totals).

Year	Catch per angler	Catch per hour	Combined catch per hour	Average length of trip (hours)
1958	3.3 (3.4)	0.89 (0.90)		3.8 (3.8)
1959	3.0 (3.0)	0.91 (0.92)	0.90	3.3 (3.3)
1960	3.1 (3.1)	0.89 (0.91)		3.4 (3.4)
1961	2.1 (2.2)	0.69 (0.75)		3.0 (3.0)
1962	2.0 (2.1)	0.65 (0.72)	0.64	3.0 (2.9)
1963	2.0 (2.0)	0.61 (0.64)		3.2 (3.2)
1964	2.2 (2.3)	0.60 (0.61)		3.7 (3.7)
1965	2.4 (2.4)	0.67 (0.67)		3.6 (3.5)
1966	2.4 (2.4)	0.63 (0.62)		3.8 (3.7)
1967	2.8 (2.9)	0.72 (0.77)	0.67	3.9 (3.8)

varied only slightly during the study, as did other game fish combined (with the exception of brown trout). The total catch rate was influenced primarily by the hatchery rainbow catch rate.

Return of Stocked Fish

The cumulative percent return of hatchery rainbow stocked in 1958, 1959, 1960, 1965, 1966 and 1967 is shown in Table 5. The first-year return of hatchery fish ranged from 25.6 percent to 39.3 percent. (Over the 10-year period, 139,008 hatchery rainbow were planted and an estimated 49,123 were creeled by fishermen. This is an overall return of 35.3 percent.) The greatest return occurred in 1959 when 26,765 fish were planted in both sections. The least return occurred in 1967 when 30,089 fish were planted only in section 1.

The first-year return of hatchery fish in 1958 and 1959 is based on data collected through the entire season at both checking stations, and is therefore considered complete. During 1960 station 2 was closed after September 30. Thirty hatchery fish were recorded at station 1 between September 30 and November 30. Applying this to the station 2 percentage, an estimated nine fish would have been tallied had station 2 remained open. This would have increased the total return of stocked fish by 0.03 percent, an insignificant increase to the figure shown in Table 5.

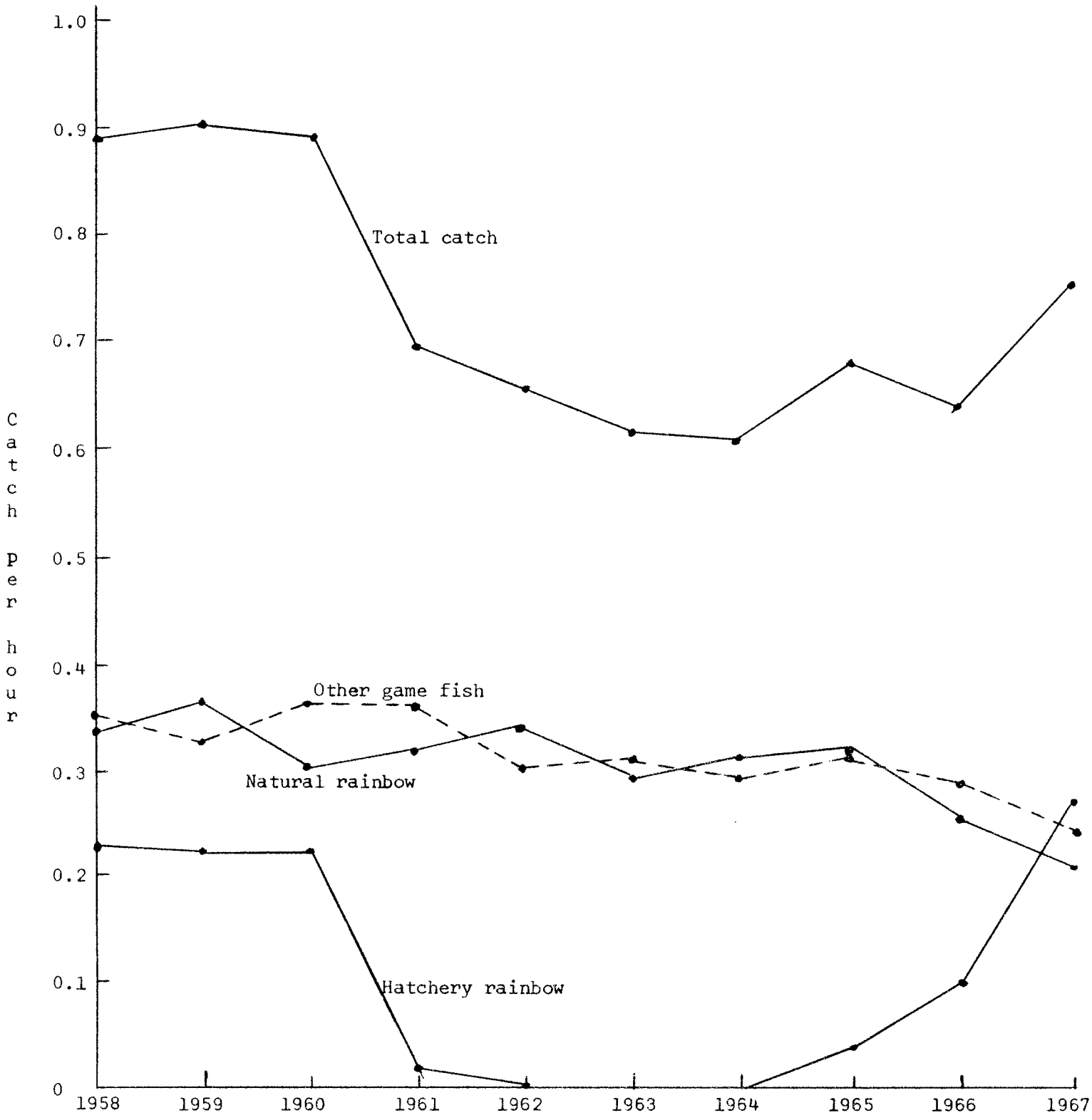

Figure 1. Rate of catch in numbers of fish per man-hour for both sections of Rock Creek during the years 1968 through 1967

TABLE 5. Cumulative percent return of hatchery rainbow trout stocked in Rock Creek, 1958-60 and 1965-67 (First-year return is underlined)

Year of plant	Cumulative percent in									
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1958	34.8	35.9	36.1	36.1 [1/]	36.1	36.1	-	-	-	-
1959		39.3	44.0	44.3	-	-	-	-	-	-
1960			37.3	39.6	40.8	41.7	42.4	-	-	-
1965								26.7	31.8	31.8
1966									35.6	37.5
1967										25.6 [2/]

[1/] Unchanged number indicates only trace return which did not change percentage. Dash indicates no additional return.

[2/] Includes an estimate for the 18-day fire closure

Station 2 was open through Labor Day in 1965 and 1966. In 1967 it was closed starting August 30 due to fire danger and was not reopened. No hatchery fish were checked at station 2 in 1965, so the first-year return shown in Table 5 is complete. In 1966, 4.4 percent of the hatchery fish recorded through August 31 at both stations were checked at station 2. If this same percentage is appled to the number recorded at station 1 after August 31, an additional 0.05 percent return is estimated for station 2. This will not significantly alter the return shown in Table 5. By the same process, the additional return estimated for station 2 in 1967 is 0.03 percent, which also will not alter the return shown in Table 5. The figures shown are therefore considered complete for the entire season each year.

Table 5 illustrates the importance of "catching out" most catchables during the first year of stocking, since there is little return in succeeding years. The return of fish in the second year ranged from 1.1 percent to 5.1 percent and averaged 3.2 percent (excluding the 1967 plant).

It is of interest to note the cumulative harvest of the hatchery trout recorded for each month of the fishing season. These figures are given in Table 6 as derived from unexpanded contact data.

Although dates of stocking differed each year, it is interesting to note that by the end of August in any year over 75 percent of the recorded stocked fish had been caught. In all but two years (1959 and 1960) 50 percent or more of the hatchery fish had been caught by the end of July.

TABLE 6. Cumulative harvest (in percent) of recorded hatchery fish at the end of each month of the fishing season, 1958-67

Year	Date of first plant	Percent harvested by the end of: May	June	July	Aug.	Sept.	Oct.	Nov.	Percent harvested after Labor Day
1958	June 16	0	28.1	63.1	89.3	99.3	99.9	100	7.6
1959	June 30	0	0.2	30.2	78.3	93.3	99.3	100	15.8
1960	June 22	0	4.6	42.6	87.8	99.4	99.9	100	7.5
1961	None								
1962	None								
1963	None								
1964	None								
1965	July 2	0	0	55.8	88.1	95.6	99.4	100	8.8
1966	June 29	0	5.0	65.7	94.3	99.8	100	100	2.4
1967	June 26	0	2.8	51.7	87.7	96.6	99.8	100	6.7

Correlation between Car Counts and the Variables Estimated

Correlation coefficients (r) showing the degree of linear relationship between cars counted by traffic counter and each of the other variables (fishermen, hours, fish) are shown in Appendix I (page 9 of lower station section and page 2 of upper station section). Correlations were highest between car count and fishermen followed usually by hours fished, and fish caught, respectively. Correlations were generally higher at station 1 than at station 2, due to the difference in type of vehicle traffic.

Pressure and Harvest Estimates

The estimates of pressure and harvest for both stations combined are shown in Table 7. Confidence limits at the 95 percent probability level have been applied to the estimates for the years 1960-67. The point estimate for each year includes data only through Labor Day at station 2.

The most obvious change seen in Table 7 is the general reduction of fishing pressure since 1960. There was a 56 percent decrease in resident fishing pressure from 1960 to 1967, while nonresident pressure increased only 25 percent. The net effect was a 49 percent decrease in fishermen. Some of this decrease may have been the result of pollution abatement by the Anaconda Company on the Clark Fork River which gradually improved this stream as a trout fishery. The

TABLE 7. Final estimates of pressure, hours, and harvest and their 95 percent confidence limits for both stations of Rock Creek, 1958-67

Year		Point estimate	95% confidence limits Lower	Upper
1958	Fishermen	14,359		
	Hours fished	53,962		
	Fish caught	48,684		
1959	Fishermen	14,590		
	Hours fished	47,876		
	Fish caught	44,044		
1960	Fishermen	14,205	13,727	14,683
	Hours fished	48,159	46,318	50,000
	Fish caught	43,786	41,992	45,580
1961	Fishermen	11,158	10,643	11,673
	Hours fished	33,100	31,318	34,882
	Fish caught	24,891	23,393	26,389
1962	Fishermen	12,709	12,192	13,226
	Hours fished	37,456	35,362	39,550
	Fish caught	26,942	25,296	28,588
1963	Fishermen	10,001	9,486	10,516
	Hours fished	32,054	30,645	33,463
	Fish caught	20,555	19,319	21,791
1964	Fishermen	9,457	9,047	9,867
	Hours fished	35,416	33,682	37,150
	Fish caught	21,622	19,834	23,410
1965	Fishermen	9,936	9,526	10,346
	Hours fished	35,166	33,456	36,876
	Fish caught	23,455	21,185	25,725
1966	Fishermen	10,107	9,595	10,619
	Hours fished	37,615	35,346	39,884
	Fish caught	23,162	21,252	25,072
1967*	Fishermen	7,291	6,794	7,788
	Hours fished	27,486	25,507	29,465
	Fish caught	21,205	19,803	22,607

*Includes adjustment for the 18-day fire danger closure. See Appendix I for data without this adjustment.

popularity of the Clark Fork may have drawn some fishermen who previously put much of their effort on Rock Creek. Another reason for the decline might be the increased use of travel trailers and campers which would allow local fishermen to travel comfortably to other fishing areas rather than to Rock Creek.

Effect of Stocking on Fishing Success and Effort

A variance analysis was computed to determine if stocking hatchery fish resulted in changes in fishing success and effort. Fish per hour and fish per angler were used to measure fishing success, and hours fished per fishermen were used to measure fishing effort. The complete method used for the analysis of variance is described in Appendix I beginning on page 22.

Briefly, the analysis of variance was designed to test the following null hyptheses:

(1) The catch per hour was not significantly different in stocked years as compared to nonstocked years.

(2) The catch per angler was not significantly different in stocked years as compared to nonstocked years.

(3) The hours fished per angler were not significantly different in stocked years as compared to nonstocked years.

Most of the fishing effort occurred at station 1. An analysis of variance on data only from this station, computed at the 95 percent probability level, showed that:

(1) There was a significant difference in the catch per hour between stocked and nonstocked years. That is, the catch per hour improved significantly during years of stocking.

(2) There was a significant difference in the catch per angler between stocked and nonstocked years. That is, the catch per angler improved significantly during years of stocking.

(3) There was not a significant difference in the hours fished per fisherman between stocked and nonstocked years. That is, the number of hours fished per fisherman did not increase or decrease significantly during years of stocking.

It was found that the average catch per hour was 26 percent higher for the six years with stocking than it was for the four years without stocking (0.77 as compared to 0.61), and that the average catch per angler was 40 percent higher during stocked years than during nonstocked years (2.8 compared to 2.0). However, the hours fished per fisherman was only 12 percent higher during stocked years - a statistically insignificant difference.

Another analysis of variance test showed that stocking catchables did not significantly (95 percent level) increase the number of fishing trips made to Rock Creek. That is, the fishing pressure (Table 7) was not increased by stocking catchables.

Beneficiaries of Hatchery Fish

An effort was made to determine who benefits most from the stocking of catchables. Does the poorer (unsuccessful) fisherman, the better (consistently successful) fisherman, or both benefit from stocking? Some indications of this are presented below.

Over the eight year period 1960-67 the percent of fishermen catching zero fish ranged from 37-51 percent, with an average of 44 percent. The average for stocked years was 41 percent and for nonstocked years 47 percent (Table 8). Thus six percent fewer fishermen caught zero fish in stocked years than in nonstocked years.

TABLE 8. Percent of fishermen who caught zero fish from Rock Creek from 1960-67, by year, and for stocked and nonstocked years

Year	Percent catching zero fish	
1960	37	
1961	48	
1962	48	Nonstocked years
1963	51	
1964	44	
1965	44	
1966	45	
1967	42	
Average for all eight years	44	
Average for stocked years	41	
Average for nonstocked years	47	

An analysis of variance test showed no significant improvement, at the 95 percent level, in the percent of the fishermen who caught zero fish during stocked years. However, there was a significant improvement at the 90 percent level of confidence. Therefore, it is concluded that significantly fewer fishermen caught zero fish during stocked than during nonstocked years. This would indicate the poorer fishermen caught more fish when they were stocked than when they were not stocked.

An analysis was made of how much benefit accrues to each of various groups of fishermen from stocking fish in Rock Creek. All fishermen contacted in any one year (1960-67) were arranged from least successful to most successful in terms of fish caught per day. Then each fisherman's position was expressed in terms of percentage rank. This ranking was arbitrarily divided into five groups: 0 - 40 percent, 41 - 50 percent, 51 - 70 percent, 71 - 90 percent and 91 - 100

percent. The upper four categories were analyzed. The figure of 41 percent was chosen for the starting point for the analysis since in stocked years this percentage, on the average, caught no fish (Table 8). The average catch per angler was determined for each of these groups for both stocked and nonstocked years. Then an analysis of variance test was made on the degree of improvement in catch per angler between stocked and nonstocked years. These data are shown in Table 9. (These tests were conducted on relationships made after gathering the data, i.e., the null hypothesis was formed after gathering the data rather than before.)

TABLE 9. Catch per angler of four success categories in stocked versus nonstocked years, Rock Creek, 1960-67

Success categories in percent of total fishermen	Catch per angler		Improvement* (Catch/angler)	Improvement (Percent)
	Stocked years	Nonstocked years		
41 - 50	0.71	0.26	0.45	173
51 - 70	2.01	1.40	0.61	44
71 - 90	4.85	3.62	1.23	34
91 -100	8.98	7.88	1.10	14

*All improvements are statistically significant at the 97.5 percent probability level

Pursuing these observations further, the catch rate of the 41-70 percent group was compared with that of the 71-100 percent group to determine if any difference in catch rate occurred. It was found that the degree of improvement was significantly greater, at the 95 percent level of confidence, for the 71-100 percent group than for the 41-70 percent group. In other words, the better fishermen caught more fish during stocked years than did the poorer fishermen. However, as can be seen from Table 9, the percentage improvement was greatest for the 41-50 percent group than for all other groups. This is because most of the improvements in this group are based on catching zero fish during nonstocked years. Thus a poor fisherman who caught nothing during nonstocked years, but caught one fish during stocked years, realized a great improvement in his catch rate. The least percentage improvement was in the 91-100 percent group (14 percent). This group included those good fishermen who regularly caught limits and thus could not catch more than 10 fish whether stocking was done or not. Also, some of the better fishermen will not keep hatchery fish. For those fishermen in this group who did not regularly catch limits, their catch rates were still close to a limit so their percent improvement was not so great. It is believed that the realistic approach to determining who benefits most by stocking must be done on a fish per angler basis rather than on a percentage improvement basis.

The average improvement of the six percent of the fishermen who caught fish during the stocked years but not during the nonstocked years (Table 8) was less than one-half fish per angler per trip. This improvement occurred in the 41-50 percent group of fishermen (Table 9). This is equivalent to saying that this group of fishermen improved their catch rate from zero fish per trip to one fish every two trips when fish were stocked.

It is also interesting to note the percentage of hatchery and wild trout caught by fishermen who caught only one trout, only two trout, etc., up to a limit of 10 trout during years of stocking. These data are given in Table 10.

TABLE 10. A comparison of the percentage of hatchery and wild trout caught by fishermen who caught only one trout, only two trout, etc., up to a limit of 10 trout from Rock Creek during stocked years

Year		Number of trout caught daily									
		1	2	3	4	5	6	7	8	9	10
		Percent hatchery (H) & wild (W) trout[1/]									
1960	H	25	27	29	26	26	26	28	29	31	32
	W	75	73	71	74	74	74	72	71	69	68
1965	H	8	6	8	7	3	6	8	5	12	6
	W	92	94	92	93	97	94	92	95	88	94
1966	H	9	12	16	15	19	20	23	22	23	38
	W	91	88	84	85	81	80	77	78	77	62
1967	H	18	25	32	31	37	40	46	38	44	53
	W	82	75	68	69	63	60	54	62	56	47

[1/] Example: In 1960 when all the trout caught by all the fishermen who caught only one trout were totaled, 25 percent were hatchery trout and 75 percent were wild trout.

Table 10 shows that the percentage of hatchery trout in the catch tended to increase as the catch of trout increased. In other words, the more successful fishermen caught more hatchery fish. This trend was most distinct in 1966 when 10,087 catchables (one catchable per angler-day) were stocked, and in 1967 when 30,089 catchables (four catchables per angler-day) were stocked. In 1960 when 28,872 catchables (two catchables per angler-day) were stocked, the upward trend was not as distinct but was still detectable. In 1965 there was quite a fluctuation in percentages and no trend was evident. This was a year when only 5,000 catchables (one-half catchable per angler-day) were stocked. During stocked years, the most successful 10 percent of the fishermen caught an average of 30 percent (26-39) of the hatchery fish (including only those fishermen who caught one or more fish, either hatchery or wild).

These data generally substantiate analyses presented earlier in this section which indicate that in Rock Creek stocking of catchables did not greatly benefit the poorer fishermen. The poorer fishermen were helped only slightly while most of the hatchery fish were caught by the better fishermen who did not need the help.

During the four stocked years an average of 81 percent (72-94) of the fishermen caught no hatchery fish. A maximum of only 2 percent caught 10 hatchery fish, and this was in 1967 when 30,089 fish were stocked. The most frequent catch was one hatchery fish and this was achieved by eight percent (3-12) of the fishermen.

During the four nonstocked years, a few hatchery fish were caught from preceding plants. However, an average of 97 percent (95-98) of the fishermen caught none. Again, the most frequent catch was one hatchery fish and this was accomplished by an average of only three percent of the fishermen, again showing the small carry-over of hatchery fish after initial stocking.

Eighty-three percent (75-87) of the anglers caught less than 5 trout (hatchery plus wild) during all years. Five percent (4-6) caught 5 trout, and 14 percent (10-19) caught from 6 to 10 trout. Eleven percent (10-11) caught over 5 trout during nonstocked years, while 16 percent (14-19) caught over 5 trout during stocked years.

Table 11 shows the average catch per angler of hatchery fish only, for all anglers during each year of the study. Only in 1967 did the total catch of hatchery fish exceed the total number of anglers fishing Rock Creek. This was the year that 30,089 hatchery fish were stocked only in section 1 of Rock Creek rather than in both sections, as was done in 1958 through 1960. This heavy stocking in a more limited area is probably responsible for the improved catch rate. During this year, hatchery fish also were a larger portion of the species composition than in any other year (see Table 2), but this year was not the year of greatest percent return of stocked fish (see Table 5).

TABLE 11. Average catch of hatchery fish per angler (actual observations) from Rock Creek, 1958-67, both stations combined

Year	Total anglers	Total hatchery fish caught	Average catch of hatchery fish per angler
1958	8,803*	7,502*	0.85
1959	12,507*	9,129*	0.73
1960	7,720	5,761	0.75
1961	5,348	313	0.06
1962	4,415	122	0.03
1963	5,107	138	0.03
1964	4,949	115	0.02
1965	5,036	706	0.14
1966	5,492	2,194	0.40
1967	3,783	3,922	1.04

*Based on a.m./p.m. census data expanded to full day estimates (see Techniques section on Pressure and Harvest Estimates for 1958 and 1959)

Another measure of fishing success is the percent of the fishermen who catch the largest percentage of the fish. This was determined at the 50 percent, 25 percent, and 10 percent level for both stocked and nonstocked years and is shown in Table 12.

TABLE 12. Percent of fish caught by the most successful 10, 25, and 50 percent of the fishermen during stocked and nonstocked years from both stations of Rock Creek, 1960-67 (all years combined)

Category of fishermen	Percent of fish they caught: Stocked years	Nonstocked years	All years
Most successful 10 percent	38	43	40
Most successful 25 percent	74	76	75
Most successful 50 percent	96	98	97

Data in this table shows that even in years when catchables were stocked, the least successful 50 percent of the fishermen caught, on the average, only four percent of the fish.

General Information

Types of Lures Used

Data on the types of lures used was collected each year except 1962 (however, 1959 data was tabulated in a manner which could not be used for this analysis). During three years of the study (1958, 1966 and 1967) fishermen had the choice of answering whether they used bait, flies, hardware, or a combination of any of these types. During these years, 43 percent of the fishermen used bait, 28 percent flies, 8 percent hardware, and 20 percent combinations thereof. Table 13 shows the range and average for each type of lure used.

TABLE 13. Percent of fishermen using bait, flies, hardware, or a combination thereof during 1958, 1966 and 1967 on Rock Creek, both stations combined

Type of lure	Percent of use Average	(Range)
Bait	43	(40-49)
Flies	28	(22-36)
Hardware	8	(06-10)
Combination	20	(15-30)

During five years of the study (1960, 1961, 1963, 1964 and 1965) fishermen had a choice of answering whether they fished with flies only, flies and other bait (including bait and hardware), or other bait only. Twenty-nine percent used flies only, 14 percent used flies and other, and 57 percent used other bait only. Table 14 shows the range and average for each type of lure used during these years.

TABLE 14. Percent of fishermen using flies only, flies and other bait and other bait only during 1960, 1961, 1963, 1964 and 1965 on Rock Creek, both stations combined

Type of lure	Percent of use	
	Average	(Range)
Flies only	29	(21-34)
Flies and other bait	14	(08-23)
Other bait only	57	(56-60)

It is apparent from Tables 13 and 14, that bait users comprised the largest single group of fishermen during all years of the study. The percent of fishermen using "flies only" remained about the same during all years, averaging from 28-29 percent of the total. Fishermen using only hardware were in a minority.

Lures Used vs Limits of Fish Caught

Based on the number of trout limits (10 fish) caught and kept, fly and bait fishermen were about equal in fishing success (fly fishermen were only slightly more successful). A small percentage of the hardware fishermen caught limits. Table 15 shows the percent of limits caught by each group of fishermen.

TABLE 15. Percent of fishermen using various lures who caught limits from Rock Creek, both stations combined, 1960-67

Period	Percent of limits caught by fishermen using:			Percent of all fishermen who caught limits
	Flies	Flies & other bait	Other bait only	
1960-65	4.0	2.3	3.7	3.6

Period	Percent of limits caught by fishermen using:				Percent of all fishermen who caught limits
	Flies	Hardware	Bait	Combination	
1966-67	5.5	4.0	5.1	4.9	4.5

Whitefish Catch

The mountain whitefish comprised a small part of the catch during the general trout fishing season. This is probably because the whitefish is not actively sought by the average trout fisherman, and he either returns those he catches to the stream or does not utilize fishing methods which will catch them in larger numbers.

Throughout the 1960 period, seven percent (range 5-9) of the fishermen checked at station 1 had whitefish in their creels. At station 2, 17 percent (range 8-23) of the fishermen checked had kept whitefish, indicating that more whitefish are kept in upper Rock Creek than in lower Rock Creek. Limits of 20 whitefish were taken by 0.2 percent of the fishermen at station 1 and 0.4 percent of fishermen at station 2 during the same period.

Residency of Anglers

The residency of anglers contacted is shown in Tables 16 and 17.

TABLE 16. Residency of anglers contacted at each station on Rock Creek from 1960-67, all years combined

	Percent residents		Percent nonresidents	
	Average	(Range)	Average	(Range)
Station 1	82	(73-90)	18	(10-27)
Station 2	89	(77-97)	11	(03-23)
Both stations	83	(74-91)	17	(09-26)

TABLE 17. Residency of anglers contacted each year at both stations of Rock Creek, 1960-67

Year	Percent Montana residents	Percent nonresidents
1960	91	9
1961	90	10
1962	87	13
1963	82	18
1964	80	20
1965	74	26
1966	79	21
1967	78	22

There was a decrease in resident fishermen and an increase in nonresident fishermen on Rock Creek between 1960 and 1967. Resident fishing pressure decreased 56 percent while nonresident pressure increased 25 percent. The overall change was a 49 percent decrease in total fishing pressure. The most nonresidents were observed in 1965.

Number of Licensed and Unlicensed Anglers

During the period 1963-67 [1/] licensed anglers made up 89 percent (range 82-98) of all fishermen contacted. Juveniles, who needed no license, comprised the next highest number with a 9 percent average (range 2-14). Fishermen over 70 years of age made up 2 percent of the total (range 0.3-4.0).

Angler Contacts at Each Checking Station

The percentage of total anglers contacted yearly at each checking station is shown in Table 18.

TABLE 18. Percent of total anglers contacted at each checking station on Rock Creek, 1959-67

Year	Percent of total anglers	
	Station 1	Station 2
1959	84	16
1960	81	19
1961	84	16
1962	89	11
1963	90	10
1964	91	9
1965	89	11
1966	88	12
1967	88	12
9-year average	87	13

During the early years of the study (1959-61), a greater percentage of fishermen were checked at the upper station. After 1961, the average changed very little, ranging from 88-91 percent at station 1 and 9-12 percent at station 2.

Stream Sections Fished

Of all fishermen checked at station 1 from 1960-67, 93 percent reported fishing only in study section 1; 4 percent fished in section 2; and 3 percent fished in both sections.

Eleven percent of the fishermen contacted at station 2 reported fishing only in section 1; 80 percent fished only in section 2; and 9 percent fished in both sections.

[1/] Comparable data not obtained from 1958-1962.

Of all the fishermen contacted at both stations combined, 82 percent fished in section 1; 14 percent in section 2; and 4 percent in both sections. Few fishermen drove all the way through the 40-mile study area on their fishing trips. Most of them fished in the section nearest their point of entry to the stream.

Size of Fish Caught

Length and weight data from the catch was obtained each year of the census for all species. Inasmuch as this information was never summarized in annual reports, it is uncertain whether the information was obtained so as not to be biased toward larger or smaller fish. In view of this, it was decided to use information only from the last three years of the census (1965-67) where there was assurance that the data was gathered so as to be as unbiased as possible. The basic data in the files was also more certain to be complete for these years.

Average lengths given are from all wild fish measured during the year as scale samples were collected, whereas the weights are from undressed fish only. This resulted in a smaller sample size. (A large percentage of the fish checked at the checking stations had already been cleaned.) Length-weight data was obtained at the convenience of the fishermen. These data are given in Tables 19 and 20.

TABLE 19. Average length of wild fish from Rock Creek, 1965-67[1/]

Year	Species and length (inches)					
	Rb	Ct	Eb	DV	LL	Wf
1965	11.4 (195)[2/]	9.0 (38)	9.5 (26)	13.4 (30)	13.7 (44)	11.3 (12)
1966	12.4 (473)	10.8 (34)	10.1 (39)	13.0 (67)	12.8 (122)	12.6 (65)
1967	12.2 (105)	9.5 (07)	8.7 (14)	14.8 (14)	13.9 (64)	12.0 (28)

[1/] Calculated from all fish sampled, whether dressed or undressed
[2/] Sample size in parentheses

TABLE 20. Average weight of wild fish from Rock Creek, 1965-67[1/]

Year	Species and weight (pounds)					
	Rb	Ct	Eb	DV	LL	Wf
1965	.72 (91)[2/]	.36(21)	.30(22)	.63(17)	1.06 (20)	1.24(02)
1966	.82(229)	.62(11)	.42(21)	.85(30)	.97 (54)	.84(46)
1967	.67 (83)	.29(06)	.25(12)	1.18(10)	1.10 (54)	.59(28)

[1/] Calculated from weights of undressed fish only
[2/] Sample size in parentheses

Variability in sample size may account for some differences in length and weight of a species between years. The largest samples were of rainbow trout, the predominate species, and the figures are probably quite reliable. Even with the variation shown, however, the relative size of each species is evident. Brown trout and Dolly Varden were the largest fish caught, followed by rainbow trout and whitefish. Cutthroat and brook trout were the smallest fish caught.

Factors Influencing the Conduct and Results of the Census

Some of the factors involved in the creel study which may have influenced the accuracy of the data collected and the general conduct of the study are listed below:

(1) Traffic counter breakdown required that traffic estimates be made for the hours or days not recorded. This was usually not a major problem as long as the counter was checked frequently.

(2) Failure of some fishermen to stop at checking stations on census days. Some creel data was lost because certain fishermen believed if they caught no fish they need not stop for an interview. Also, apparently some fishermen knowingly disregarded the check stations.

(3) An inaccurate estimate by each fisherman of how many hours he fished. The assumption which must be made is that the degree of inaccuracy is constant from year to year.

(4) Reduction in total numbers of fishermen fishing Rock Creek because of the influence of pollution abatement in the Clark Fork River. Fishing in the Clark Fork gradually improved during the study, attracting some fishermen who previously put much of their fishing effort on Rock Creek.

(5) Return to the water of marked hatchery fish by fishermen who do not wish to keep them. This would reduce the percent return to the creel from each yearly plant. Conversely, some people who normally throw back a hatchery trout may keep one they know is marked for the sake of curiosity. Again, it must be assumed that this is a problem which remained fairly constant, although it may be open to debate.

Items 2 through 5 above may partially have been the result of one additional factor -- fishermen acceptance of the study was good during the early years of the census. However, during the last few years it became apparent that many fishermen were getting tired of having to stop and be interviewed at the checking stations. Some wondered when we were going to terminate the study, while some

"wild fish" fishermen asked when we were going to stop planting hatchery fish. How much influence this had on the study cannot be determined accurately.

COMMENTS AND RECOMMENDATIONS

Traffic counters are a useful and accurate tool under the circumstances found on Rock Creek to estimate fishing pressure and harvest. They can be used whenever access points to a fishing water are limited, or can be so controlled, and are recommended for such use.

An intensive census over a long period of time, such as this, requires coordination and attention from year to year to make sure the procedures are correct or modified as needed. A statistician who can devote adequate time to this is invaluable. Although the study design was good and satisfactory results were obtained, greater attention could have been paid to this aspect of the study, particularly since six project personnel changes were made during the ten years. With better statistical supervision it probably would have been unnecessary to reanalyze the ten years data following completion of the study. Also, it is believed checking station 2 could possibly have been eliminated at some point during the study, thus reducing cost and amount of data to be analyzed.

The census design did not allow the determination of optimum stocking rates, if any, for Rock Creek and none are recommended.

Prepared by Liter Spence

Date November 24, 1971

Waters referred to:

06-5263

06-5282

APPENDIX I

ROCK CREEK CREEL CENSUS

ANALYSIS OF DATA OBTAINED

AT LOWER STATION

PREPARED BY KENNETH JOHNSON

OCTOBER 1969

TABLE OF CONTENTS

Rock Creek Creel Census

Data Analysis

Introduction

Data were collected at two stations (at the upper entrance and at the lower entrance) on Rock Creek during the summer fishing seasons in 1958 through 1967 with the intention of providing yearly estimates of total fish take, total fishermen, total hours spent fishing, and average fish caught per hour and man.

During six of these ten seasons, various numbers of catchable size trout were stocked in the stream. Analysis of variance tables have been calculated to determine whether or not these stocked years are charactarized by a significant improvement in fishing success.

Separate analyses were conducted for the lower station and the upper station as they have decidedly different charactaristics. The lower station was analyzed more carefully as most of the pressure occurred there and the data from the upper station were not complete.

It is the purpose of this report to describe the methods used in the study and to summarize the final results for each of the ten years. As such, the following relates specifically to the methodology used at the lower station although the data were analyzed in the same fashion at the upper station unless data restrictions made modifications necessary.

Methodology

Since several people became responsible for the Rock Creek project while it was in progress, there was some variation in the methods used to collect data and consequently in the methods required to provide the final estimates.

During the summer seasons of 1958 and 1959 the days were randomly sampled and censused with data being collected on total fish catch, total fishermen, and total hours fished for each of the census days. These were the only seasons during which car count data were not also collected and,since the purpose of this final examination was to review the statistical analysis used in those years requiring regression estimates from car count data, I have not added to the original analysis done during these years. The computations were checked and found to be accurate which was not a charactaristic shared by the other years in the study. A brief description of the estimating technique follows in order to make this report comprehensive and not in an attempt to claim credit for the work.

Formally, the seasons were stratified into periods and each period was further stratified into weekend days (including all holidays) and weekdays (except for holidays).

Using total fish take as an example, the estimates were derived as follows during these years: For each period,

(Total weekday catch)=(total weekdays)x(average catch on weekdays censused)

(Total weekend catch)=(total weekend days)x(ave.catch on weekend days censused)

These two estimates were then added to provide an estimate of the total for the period. Having derived separate estimates for each period in the season, the grand total was estimated as their sum. The seasons were very heavily censused during both these years and hence the estimates are probably quite accurate (especially in view of the careful stratification which was incorporated). However, no variances were calculated during these seasons so it is impossible to precisely state how accurate the estimates are.

During the 1960 through 1964 seasons, additional information was gained through the use of car counters. These machines recorded the number of cars entering and leaving the Rock Creek area continuously from the start of the season until mid-September.

The days of the season were again randomly sampled for each of these seasons but,in addition to fish take, fishermen, and hours, the number of cars was also counted on each census day. Using these data, it was possible to establish a functional relationship between (1) daily fish catch and daily car count, (2) daily fisherman count and daily car count, and (3) number of hours fished daily and daily car count. These three relationships were established using linear regression techniques with daily totals from the census days serving as observations in the model.

Again using total fish take as an example to illustrate the precise procedure, the equation hypothesized was of the form: $F = \theta_1 C + \theta_2$ where F indicates daily fish take, C indicates daily car count, and θ_1 and θ_2 are parameters to be estimated using the observations. Least squares techniques yield that the best estimates of these are:

$$(1)\quad \hat{\theta}_1 = \frac{n\sum_{i=1}^{n}(f_i c_i) - \sum_{i=1}^{n}(f_i)\sum_{i=1}^{n}(c_i)}{n\sum_{i=1}^{n}(c_i^2) - [\sum_{i=1}^{n}(c_i)]^2}$$

and

$$(2)\quad \hat{\theta}_2 = \bar{f} - \hat{\theta}_1 \bar{c}$$

In these equations, n is the number of days censused, f_i is the number of fish caught on the ith census day, c_i is the car count on the ith census day, and $\bar{f}$ and $\bar{c}$ denote their respective averages over all census days.

Using these estimates of the parameters in the original equation, an estimate of fish take on any non-census day can be obtained from the car count on that day as:

$$(3)\quad \hat{f}_j^* = \hat{\theta}_1 c_j^* + \hat{\theta}_2$$ where c_j^* and $\hat{f}_j^*$ denote the car count and the estimated fish take respectively on the jth non-census day.

This is an estimate, and as such is subject to statistical variability. The degree of this variability depends on how closely the regression equation represents the actual relationship between the two variables, and on how variable the number of cars observed daily is. The exact formula for the variance of this estimate is given by:

$$(4)\quad \mathrm{Var}(\hat{f}_j^*) = S_{f.c}^2\left(1 + \frac{1}{n} + \frac{(c_j^* - \bar{c})^2}{(n-1)S_c^2}\right)$$ where

$$(5)\quad S^2_{f.c} = \frac{\sum_{i=1}^{n}[f_i - (\hat{\theta}_1 c_i + \hat{\theta}_2)]^2}{(n - 2)}$$

(which is an estimate of how closely the regression equation desribes the relationship)

and

$$(6)\quad S^2_c = \frac{\sum_{i=1}^{n}[c_i - \bar{c}]^2}{(n - 1)}$$

(which is an estimate of the variance of daily car counts)

The square root of $S^2_{f.c}$ is known as the standard error of f on c or simply as the "standard error of estimate". The smaller it is, the more accurate the equation is as an estimating device.

If there are m days for which car counts are available but fish harvests are not, then the total fish take for these m days can be estimated as:

$$(7)\quad [\text{Total}] = \sum_{j=1}^{m}(\hat{f}^*_j) = \sum_{j=1}^{m}(\hat{\theta}_1 c^*_j + \hat{\theta}_2)$$

Since each day can be considered independently, we also have that the variance of this sum is the sum of the variances of the individual estimates. Thus:

$$(8)\quad \text{Var(Total)} = \sum_{j=1}^{m}(\text{Var}(\hat{f}^*_j) = \sum_{j=1}^{m}[S^2_{f.c}(1 + \frac{1}{n} + \frac{(c^*_j - \bar{c})^2}{(n-1)S^2_c})]$$

With the values from equations (7) and (8) it is possible to estimate a 95% confidence interval for this total via the formula:***

$$(9) \quad \begin{matrix}\text{95\% Confidence} \\ \text{Limits}\end{matrix} = \begin{matrix}\text{Regression Estimate} \\ \text{of Total}\end{matrix} \pm 2\sqrt{\text{Var(Regression Total)}}$$

This approach yields estimates of fish take, fishermen, and hours for the part of these seasons during which car counts were made. The estimates for the periods from mid-September to the end of the seasons were calculated by expanding the census data as was done in 1958 and 1959. The periods were stratified into weekdays and weekends with the stratum totals being estimated precisely as in those years. The two stratum estimates were then added to give the estimate of the total for the period in each year.

In each of these years, variances were calculated for these estimates as follows: (in each stratum)

$$(10) \quad \text{Var(Stratum Total)} = \frac{N(N-n).\sum_{i=1}^{n}(f_i - \bar{f})^2}{n\,.(n-1)}$$

where N is the total number of days in the stratum, n is the number of days which were censused, f_i is the number of fish counted on the ith census day, and $\bar{f}$ is the average number of fish on a census day.

***Note: The precise formula uses a multiplier taken from a table of values for a random variable with Student's t distribution on the appropriate degrees of freedom at the .975 probability level. However, these values range from 1.96 to about 2.06 so it is felt that the ease with which the analysis can be completed by using a standard multiplier of 2 more than compensates for the insignificant error introduced by this convention.

Since the estimates were derived independently in each stratum, the variance of their sum is again the sum of their variances and we can thus estimate the variance of the total for the period. The 95% confidence limits are given by:

$$(11) \qquad \begin{matrix}\text{95\% Confidence} \\ \text{Limits}\end{matrix} = \begin{matrix}\text{Ratio Estimate} \\ \text{of Total}\end{matrix} \pm 2\sqrt{\text{Var(Ratio Total)}}$$

For each of these five years we now have (i) total fish take for all census days prior to mid-September, (ii) a regression estimate of total fish take for all non-census days prior to mid-September with 95% confidence limits, and (iii) a ratio estimate of total fish take for the remainder of the season with 95% confidence limits. The grand total for the season is the obvious sum of (i), (ii), and (iii). Also, since there is no variance associated with the quantity (i) and the estimates (ii) and (iii) are independent,it is possible to estimate the variance of this grand total as the sum of the variances of its components. The 95% confidence intervals for the grand total are then estimated using a formula of the precise form given by (9) and (11). These new confidence limits are not the sums of the component confidence limits since the standard deviation of a sum is not the sum of the standard deviations of its components.

This completes the analysis for the years 1960 through 64. In the remaining 3 years of the season, car count data were collected throughout the fishing season so the expansion of census data for the latter part of the season was not necessary. Estimates were derived using the regression methods described for 1960 through 64.

PRELIMINARY ANALYSIS AND RESULTS

This section in included in order that questions may be avoided regarding the validity of the linear regression analysis used. The results are of little value as far as information regarding the ten year study is concerned. They are, however, important from a technical standpoint.

Consideration was given as to whether the functional form of the estimating equations should be linear or a higher order polynomial. Scatter diagrams representing each of the 24 relationships to be determined were constructed as a preliminary step. i.e., the fish count, man count, and hour count was plotted against the car count for every census day in each of the eight years requiring regression analysis. These 24 diagrams are presented in appendix A.[1] Such diagrams are frequently sufficient for a researcher to determine the form of the regression equation. In this case, my inclination after viewing the scatter diagrams was to immediately hypothesize a linear formula and proceed.

However, in order to quiet the doubts frequently arising when a linear equation does not give an excellent fit, further investigation regarding the adequacy of a linear estimating form was carried out.

Analysis of variance tables were calculated for each of the relationships to determine if a significant improvement in accuracy could be achieved through the use of a quadratic equation (one of degree 2). These tables are presented in appendix B.[1]

(1) The scatter diagrams and analysis of variance tables are not considered to be an integral part of this report and have not been formalized. The diagrams are penciled plots on standard graph paper and the tables contain the handwritten computations involved in these analyses of variance. They will be presented to the biologist in charge and will be available in his files. A complete explanation accompanies each appendix.

In seven cases the quadratic form was found to be significant. It was felt that the same functional form should be hypothesized for every equation so this minority was not enough to imply a general quadratic formula.

As a conclusion to this phase, correlation coefficients were calculated since they indicate the degree of linear relationship between two variables. They are presented below in table 1.

Table 1: Correlation Coefficients between car count and-

	Man Count	Hour Count	Fish Count
1960	.93076	.91812	.91745
1961	.90090	.87912	.89163
1962	.94600	.84778	.85177
1963	.92629	.89515	.86068
1964	.87893	.87316	.81133
1965	.87471	.82421	.79919
1966	.87746	.85057	.79716
1967	.87734	.89490	.85657

The general functional form used was $Y = \theta_1 C + \theta_2$; where Y is the dependent variable (fish, men, or hours as the case might be), C is the car count, and θ_1 and θ_2 are the regression parameters.

The regression statistics are given in table 2 for each of the eight years analyzed.

TABLE 2: Regression Statistics from fishermen, fishermen hours, and fish take regressed on car counts.

$$Y = \theta_1 C + \theta_2$$

	When Y denotes fishermen				When Y denotes fishermen hours				When Y denotes fish take			
	$\hat{\theta}_1$	$\hat{\theta}_2$	$S_{fm.c}$	R^2	$\hat{\theta}_1$	$\hat{\theta}_2$	$S_{fh.c}$	R^2	$\hat{\theta}_1$	$\hat{\theta}_2$	$S_{f.c}$	R^2
1960	1.27993	-40.40781	25.37546	.86632	4.71799	-167.68794	102.77831	.84295	3.73518	-122.13009	81.74793	.84171
1961	.85282	-23.85289	26.64420	.81163	2.67421	-93.69692	94.01940	.77285	1.67155	-43.73482	55.04542	.79500
1962	1.27845	-49.94720	18.38347	.89492	3.53749	-128.23510	92.86667	.71873	2.33815	-89.58947	60.35158	.72552
1963	.89941	-34.49010	15.65474	.85802	3.07270	-131.02082	65.47190	.80129	1.72526	-70.84549	43.66981	.74077
1964	.70954	-16.75040	21.63196	.77253	2.62743	-58.00433	82.40854	.76240	1.39196	-30.98020	56.34872	.65827
1965	.84330	-22.98727	18.54533	.76513	2.78499	-70.93148	75.94910	.67932	1.79233	-45.96291	53.50588	.63870
1966	.69815	-25.54541	23.72429	.76994	2.72197	-108.75629	104.61302	.72347	1.87216	-86.31597	88.14661	.63547
1967	.61671	-36.75374	22.33482	.76974	2.68613	-177.34559	88.69330	.80086	1.58640	-80.81374	63.28291	.73371

$S_{y.c}$ is the standard error of estimate for each equation. R^2 is a statistic which measures the proportion of the total variance of the dependent variable which is accounted for by the regression equation. Thus, the closer R^2 is to 1, the better the equation fits the data.

FINAL ESTIMATES OF TOTALS FOR STATION ONE

The following ten pages give the estimates derived following the methodology described in the second chapter of this report. Confidence limits at the 95% level have been calculated and are presented with the totals.

ROCK CREEK CREEL CENSUS

Final Estimates for 1958 and 1959*

Station one.

1958

Fishermen	11498
Hours Fished	41989
Fish Take	35844

1959

Fishermen	12268
Hours Fished	39961
Fish Take	35969

*These are the same estimates as were originally made as both years were very heavily censused and,although there were no car count data, it does not appear that the estimates made can be improved. (The totals were estimated by simply expanding the census data).

ROCK CREEK CREEL CENSUS

Final Estimates for 1960

Station one

	Point Estimate	95% Confidence Limits
Fishermen:		
Known Total	6065	±0
Regression Estimate	4676	±399
Ratio Estimate	772	±214
Total*	11513	±452
Hours Fished:		
Known Total:	21607	±0
Regression Estimate	16114	±1617
Ratio Estimate	2408	±722
Total*	40129	±1770
Fish Take:		
Known Total:	18021	±0
Regression Estimate	13394	±1287
Ratio Estimate	3581	±1090
Total*	34996	±1685

*The Confidence Limits for the total are not the sums of the confidence limits for the components; instead, they are approximately the square root of the sum of their squares.

ROCK CREEK CREEL CENSUS

Final Estimates for 1961

Station one

	Point Estimate	95% Confidence Limits
Fishermen:		
Known Total	4317	±0
Regression Estimate	4421	±440
Ratio Estimate	751	±240
Total*	9489	±500
Hours Fished:		
Known Total	12994	±0
Regression Estimate	12637	±1550
Ratio Estimate	2198	±778
Total*	27829	±1734
Fish Take:		
Known Total	8218	±0
Regression Estimate	8863	±907
Ratio Estimate	3401	±1100
Total*	20482	±1428

*The confidence limits for the total are not the sums of the confidence limits for the components; instead, they are approximately the square root of the sum of their squares.

ROCK CREEK CREEL CENSUS

Final Estimates for 1962

Station one

	Point Estimate	95% Confidence Limits
Fishermen:		
Known Total	3484	±0
Regression Estimate	6164	±326
Ratio Estimate	1288	±382
Total*	10936	±503
Hours Fished:		
Known Total	10535	±0
Regression Estimate	17775	±1645
Ratio Estimate	3791	±1184
Total*	32101	±2060
Fish Take:		
Known Total	6981	±0
Regression Estimate	11401	±1069
Ratio Estimate	3740	±1328
Total*	22122	±1576

*The confidence limits for the total are not the sums of the confidence limits for the components; instead, they are approximately the square root of the sum of their squares.

ROCK CREEK CREEL CENSUS

Final Estimates for 1963

Staion one

	Point Estimate	95% Confidence Limits
Fishermen:		
Known Total	4285	±0
Regression Estimate	3802	±236
Ratio Estimate	955	±326
Total*	9042	±402
Hours Fished:		
Known Total:	13802	±0
Regression Estimate	12276	±985
Ratio Estimate	2837	±952
Total*	28915	±1370
Fish Take:		
Known Total	7706	±0
Regression Estimate	7040	±658
Ratio Estimate	3464	±986
Total*	18210	±1185

*The confidence limits for the total are not the sums of the confidence limits for the components; instead, they are approximately the square root of the sum of their squares.

ROCK CREEK CREEL CENSUS

Final Estimates for 1964

Station one

	Point Estimate	95% Confidence Limits
Fishermen:		
Known Total	3829	±0
Regression Estimate	3611	±322
Ratio Estimate	1211	±245
Total*	8651	±404
Hours Fished		
Known Total	14644	±0
Regression Estimate	13586	±1226
Ratio Estimate	4511	±1188
Total*	32741	±1709
Fish Take:		
Known Total	7816	±0
Regression Estimate	7184	±839
Ratio Estimate	3946	±1544
Total*	18946	±1757

*The confidence limits for the total are not the sums of the confidence limits for the components; instead, they are approximately the square root of the sum of their squares.

ROCK CREEK CREEL CENSUS

Final Estimates for 1965

Station one

	Point Estimate	95% Confidence Limits
Fishermen:		
Known Total	4482	±0
Regression Estimate	4432	±399
Total	8914	±399
Hours Fished:		
Known total:	15655	±0
Regression Estimate	15195	±1635
Total	30850	±1635
Fish Take:		
Known Total	10218	±0
Regression Estimate	9743	±1152
Total	19961	±1152

ROCK CREEK CREEL CENSUS

Final Estimates for 1966

Station one

	Point Estimate	95% Confidence Limits
Fishermen:		
Known Total	4831	±0
Regression Estimate	4125	±506
Total	8956	±506
Hours Fished:		
Known Total:	18084	±0
Regression Estimate	15066	±2231
Total	33150	±2231
Fish Take:		
Known Total	11494	±0
Regression Estimate	/9084	±1880
Total	20578	±1880

ROCK CREEK CREEL CENSUS

Final Estimates for 1967

Station one

	Point Estimate	95% Confidence Limits
Fishermen:		
Known Total	3333	±0
Regression Estimate	2315	±458
Total**	5648	±458
Hours Fished:		
Known Total	13257	±0
Regression Estimate	8326	±1819
Total**	21583	±1819
Fish Take:		
Known Total	9576	±0
Regression Estimate	7357	±1297
Total**	16933	±1297

**The rock creek area was closed for 18 days (Aug. 24 thru Sept. 10) due to fire danger. In order to compare 1967 totals with previous totals it is necessary to adjust for this. There were 73 days censused of a total 194 day season yielding:

	Mean	S.E.	S.E.(Mean)	Estimate	S.E.(Est.)	2xS.E (Est)
Fishermen	45.7	45.9	4.24	868	80.56	161.
Hours Fished	181.6	196.0	18.10	3450	343.90	688
Fish Take	131.2	120.9	11.17	2493	212.23	424

Where the estimate is made simply by multiplying the mean by 19. S.E. stands for Standard Error (the finite population correction factor has been considered in its computation). These estimates will be added to the totals listed above wherever comparisons of yearly data are made such as in an analysis of variance. New totals:

Fishermen	6516	±485
Hours Fished	25033	±1945
Fish Take	19426	±1375

ROCK CREEK CREEL CENSUS

TABLE 3-Summary of final estimates made for Station 1.

Year	Fishermen	Hours Fished	Fish Take
1958	11498	41989	35844
1959	12268	39961	35969
1960	11513	40129	34996
1961	9489	27829	20482
1962	10936	32101	22122
1963	9042	28915	18210
1964	8651	32741	18946
1965	8914	30850	19961
1966	8956	33150	20578
1967*	6516	25033	19426

*Includes estimated action during 18 days of fire closure. The following are the actual estimates made:

5648	21583	16933

SUCCESS RATES AND ANALYSIS OF VARIANCE

It was decided to use fish per hour and fish per man as rates indicating degree of fishing success for each of the ten seasons. Hours fished per man was taken as the measure of effort. The estimates of these rates were obtained using only data from the actual observations taken on census days, not from the estimated totals in table 3 on page 21. The totals from census days only are given in table 4 for each of the years in the study.

Table 4: Total of actual observations for-

	Fishermen	Hours Fished	Fish harvest
1958	7729	28731	24599
1959	10310	34032	30205
1960	6270	22246	18963
1961	4503	13528	9069
1962	3940	11881	7309
1963	4557	14628	8767
1964	4315	16052	9151
1965	4482	15655	10218
1966	4831	18084	11494
1967	3333	13257	9576

The rates presented in table 5 were calculated from these data.

Table 5: Success Rates and Effort Rate

	Fish per hour	Hours per man	Fish per man
1958#	.85618	3.71730	3.18268
1959#	.88755	3.30087	2.92969
1960#	.85242	3.54801	3.02439
1961	.67039	3.00422	2.01399
1962	.61518	3.01548	1.85506
1963	.59933	3.21001	1.92386
1964	.57008	3.72005	2.12074
1965#	.65270	3.49286	2.27979
1966#	.63559	3.74332	2.37922
1967#	.72233	3.97750	2.87307

# Indicates that hatchery fish were stocked during the season.

It is desired to test the following hypotheses:

(i) Fish take per man was not significantly different in stocked years as compared to non-stocked years,

(ii) Fish take per hour was not significantly different in stocked years as compared to non-stocked years, and

(iii) Hours fished per man was not significantly different in stocked years as compared to non-stocked years.

These hypotheses are to be tested using analysis of variance and a very brief explanation of what this entails is given below.

We have (for example) the rate at which fish were caught per hour for each of the ten seasons. These rates are the observations used in computing the necessary statistics. Six of them are associated with years in which fish were stocked and four are not, so we partition them into these two subgroups. Let r_1, r_2, r_3, r_4, r_5, and r_6 denote the rates associated with the stocked years and let r_7, r_8, r_9, and r_{10} denote the rates for the non-stocked years. Then

$\bar{r}_1 = \dfrac{\sum_{i=1}^{6}(r_i)}{6}$ and $\bar{r}_2 = \dfrac{\sum_{i=7}^{10}(r_i)}{4}$ are the averaged rates for the stocked and non-stocked years respectively, and

$\bar{r} = \dfrac{\sum_{i=1}^{10}(r_i)}{10}$ is the averaged rate for all years of the study.

The differences in these averages measure the effect of stocking and it is desired to test if the differences are significant in a statistical sense. Note that the variance associated with these rates is

$\text{Var}(r) = \dfrac{\sum_{i=1}^{10}(r_i - \bar{r})^2}{9}$. The hypothesis can be tested through a breakdown of this quantitiy. It can be shown that

$$\sum_{i=1}^{10}(r_i - \bar{r})^2 = \left[\sum_{j=1}^{2}(\bar{r}_j - \bar{r})^2 n_j\right] + \left[\sum_{k=1}^{6}(r_k - \bar{r}_1)^2 + \sum_{k=7}^{10}(r_k - \bar{r}_2)^2\right].$$

$n_1 = 6$
$n_2 = 4$

This is known as partitioning the sum of squares. The quantity to the left of the equals sign is known as the total sum of squares and is the sum generally associated with the variance. The first term in square brakets on the right is called the sum of squares between groups and the last term in square brackets is the sum of squares within groups.

There are 9 independent components to the total sum of squares, 1 independent component to the sum of squares between groups, and 8 independent components to the sum of squares within groups. For this reason they are said to have 9, 1, and 8 degrees of freedom respectively.

When each sum of squares is divided by its degrees of freedom, the corresponding mean squares are determined. Under the null hypothesis (i.e. if the hypothesis we are testing is true) the ratio of the mean square between groups and the mean square within groups is a random variable which is statisticaly distributed with the F distribution having one degree of freedom in the numerator and 8 degrees of freedom in the denominator.

There is less than 5% chance that such a random variable will be 5.32 or larger. Thus, if the ratio which we calculate from our data is larger than 5.32, we must assume that either (i) our hypothesis is wrong and must be rejected or (ii) the hypothesis is correct and we have observed a rare occurance (one which would happen less than 5% of the time by probability measure). The procedure is to assume that our hypothesis is wrong and to reject it knowing that we will be making a mistake about 5% of the time. Thus, we say that the hypothesis is rejected at the 95% level of confidence whenever the observed ratio is larger than 5.32.

ANALYSIS OF VARIANCE ON DATA FROM ROCK CREEK STATION ONE-STOCKED VERSUS NON-STOCKED

Computed from rates in table 5 page 23 using methods described.

The F statistic computed to test each of the hypotheses is with 1 and 8 degrees of freedom in the numerator and denominator respectively. The probability that such a statistic is greater than 11.26 is only .01. greater than 5.32 is only .05 and the probability that it is greater than 11.26 is only .01. (That is, of course, if the hypothesis is true).Thus, 1 & 3 are rejected at the specified levels of confidence.

Table 6

Hypothesis tested: There is no significant difference in fish take per hour between years in which fish were stocked and those in which they were not.

Conclusion: This hypothesis can be rejected at the 95% level of confidence.

SOURCE--	SUM SQUARES	DEGREES FREEDOM	MEAN SQUARE	F(1,8)
BETWEEN	.0569	1	.0569	6.7570
WITHIN	.0674	8	.0084	
TOTAL	.1243	9	.0138	

MEANS ARE- .76779 .61374 .70617 (for stocked, non-stocked, and total)

Table 7

Hypothesis tested: There is no significant difference in hours fished per man between years in which fish were stocked and those in which they were not.

Conclusion: This hypothesis must be accepted. (More appropriately, can not be rejected)

SOURCE--	SUM SQUARES	DEGREES FREEDOM	MEAN SQUARE	F(1,8)
BETWEEN	.3698	1	.3698	4.8308
WITHIN	.6123	8	.0765	
TOTAL	.9822	9	.1091	

MEANS ARE- 3.62997 3.23744 3.47296 (stocked, non-stocked, & total resp.)

Table 8

Hypothesis tested: There is no significant differnce in fish take per man between years in which fish were stocked and those in which they were not.

Conclusion: This hypothesis can be rejected at the 99% level of confidence.

SQURCE--	SUM SQUARES	DEGREES FREEDOM	MEAN SQUARE	F(1,8)
BETWEEN	1.5349	1	1.5349	17.4558
WITHIN	.7034	8	.0879	
TOTAL	2.2384	9	.2487	

MEANS ARE- 2.77814 1.97841 2.45824 (Stocked,non-stocked,& total resp.)

From these computations, it can be said that there is a significant difference in fish per hour and fish per man although there is no significant difference in hours spent per man between stocked and non-stocked years. It should be noted that the averaged rate of fish per hour was 25% higher for the six stocked years than it was for the four non-stocked years (.76779 as compared to .61374) and that the averaged rate of fish per man was 40% higher for the stocked years (2.77814 as compared to 1.97841) whereas the averaged rate for hours per man was only 12% higher resulting in the last difference being found to be insignificant.

This completes the analysis of data obtained at the lower station on Rock Creek during the ten year creel census.

APPENDIX I (Continued)

ROCK CREEK CREEL CENSUS

(Summary of results from:)

ANALYSIS OF DATA OBTAINED

AT UPPER STATION

(Station two)

PREPARED BY KENNETH JOHNSON

OCTOBER 1969

Data were collected at two stations (at the upper entrance and at the lower entrance) on Rock Creek during the summer fishing seasons in 1958 through 1967 with the intention of providing yearly estimates of total fish take, total fishermen, and total fishermen hours, and average fish take per hour and man (success rates) and average hours fished per man (effort rates) for each season.

The upper and lower stations have been analyzed separately and the report on the results for the lower station contains a complete description of the methodology used for the study. This report will not contain this information as the upper station was analyzed in the same way as the lower station but,for this reason, should be read only in conjunction with the other report.

Estimates were made through labor day at this station as data were not collected beyond that date in some years and were incomplete in others.

Regression techniques were used to estimate the totals and 95% confidence intervals in the years 1960 through 1967. Table 1 gives the correlation coefficients calculated between the three independent variables and car counts in each of these eight years.

Table 1:Correlation Coefficients between car count and-

	Fishermen	Hours Fished	Fish Take
1960	.87458	.86152	.82525
1961	.90689	.89401	.79379
1962	.90822	.88857	.82505
1963	.77027	.73777	.56770
1964	.64199	.49449	.52266
1965	.69212	.60420	.59692
1966	.86823	.75828	.56713
1967	.61264	.63368	.49202

The same care was taken here prior to determining the general form of the regression equation as was taken at station one (the lower station). Plot diagrams and analysis of variance tables were constructed from the data for each year. They are presented in Appendices A and B respectively.

At this station, five of the twentyfour relationships might have been quadratic,but, again, this minority was not enough to imply a general quadratic relationship. Thus, the general form of the equation was $Y = \theta_1 C + \theta_2$; where Y is the dependent variable (fish, men, or hours as the case might be), C is the car count, and θ_1 and θ_2 are parameters.

The regression statistics are given in table 2 for each of the years.

TABLE 2: REGRESSION STATISTICS FROM FISHERMEN, FISHERMEN HOURS, AND FISH TAKE REGRESSED ON CAR COUNTS

$$Y = \theta_1 C + \theta_2$$

	When Y denotes fishermen				When Y denotes fishermen hours				When Y denotes fish take			
	θ_1	θ_2	$S_{fm.c}$	R^2	θ_1	θ_2	$S_{fh.c}$	R^2	θ_1	θ_2	$S_{f.c}$	R^2
1960	.84659	-3.24777	10.29094	.76490	2.60518	-12.08049	33.66238	.74223	2.73701	-9.68933	41.06953	.68103
1961	.65985	-4.28740	7.60459	.82245	2.05607	-12.46944	25.55907	.79925	1.47589	-2.44553	28.04827	.63011
1962	.67675	-6.74783	6.00184	.82486	1.91075	-16.06274	18.98615	.78955	1.83098	-18.67795	24.13552	.68070
1963	.41030	-4.94667	6.20178	.59332	1.18980	-11.34997	19.87568	.54431	.80275	-4.90444	21.25279	.32229
1964	.28014	-1.22486	4.73157	.41215	.76389	+1.44426	18.98960	.24452	.92346	-3.88113	21.30305	.27318
1965	.37225	-4.69758	5.56275	.47903	1.54711	-18.89129	29.22887	.36506	1.27794	-17.18295	24.60592	.35631
1966	.47232	-7.76525	5.25854	.75383	1.69115	-24.64261	28.32705	.57499	.81440	-7.84749	23.04256	.32164
1967	.21134	-2.01189	7.29732	.37532	.75945	-10.38047	24.81450	.40155	.39063	-.50144	18.49885	.24209

$S_{y.c}$ is the standard error of estimate for each equation. R^2 is a statistic which measures the proportion of the total variance which is accounted for by the regression equation for the dependent variable. Thus, the closer R^2 is to 1, the better the equation fits the data.

FINAL ESTIMATES OF TOTALS FOR STATION TWO

The following three pages contain the estimates derived following the methodology desribed for regression in the report for station one.

Confidence limits at the 95% level have been calculated and are presented with the totals.

The estimates for Rock Creek Station II have been made only for the period extending through Labor Day of each season (the 1st Monday in September) as little activity was observed after that date and the data available are not sufficient to provide estimates for the entire season in all years. The terminal date in each of the years is as follows:

1958 Sept. 1

1959 Sept. 7

1960 Sept. 5

1961 Sept. 4

1962 Sept. 3

1963 Sept. 2

1964 Sept. 7

1965 Sept. 6

1966 Sept. 5

1967 Sept. 4

The Estimates for 1958 and 1959 are the ones originally made (through the appropriate dates) as no improvement can be made on them. They do not have 95% confidence limits computed for them as I did no analysis of the data other than to adjust it to the appropiate dates.

The final estimates for station 2 follow.

ROCK CREEK CREEL CENSUS

FINAL ESTIMATES OF ACTIVITY AT STATION II WITH 95% CONFIDENCE LIMITS

	FISHERMEN	HOURS FISHED	FISH TAKE
1958: Expanded Data	2861	11973	12840
1959: Expanded Data	2322	7915	8075
1960: Known Total	1376	4093	4491
Regression Estimate	1316 ± 154	3937 ± 506	4299 ± 617
Total	2692 ± 154	8030 ± 506	8790 ± 617
1961: Known Total	820	2570	2066
Regression Estimate	849 ± 122	2701 ± 412	2343 ± 453
Total	1669 ± 122	5271 ± 412	4409 ± 453
1962: Known Total	446	1360	1265
Regression Estimate	1327 ± 118	3995 ± 374	3555 ± 476
Total	1773 ± 118	5355 ± 374	4820 ± 476
1963: Known Total	488	1579	1113
Regression Estimate	471 ± 102	1560 ± 329	1232 ± 351
Total	959 ± 102	3139 ± 329	2345 ± 351
1964: Known Total	373	1261	1239
Regression Estimate	433 ± 73	1459 ± 296	1437 ± 332
Total	806 ± 73	2720 ± 296	2676 ± 332

ROCK CREEK CREEL CENSUS

FINAL ESTIMATES OF ACTIVITY AT STATION II WITH 95% CONFIDENCE LIMITS (Continued)

	FISHERMEN	HOURS FISHED	FISH TAKE
1965: Known Total	442	1863	1572
Regression Estimate	580 ± 95	2453 ± 500	1922 ± 421
Total	1022 ± 95	4316 ± 500	3494 ± 421
1966: Known Total	656	2529	1447
Regression Estimate	495 ± 77	1936 ± 415	1137 ± 337
Total	1151 ± 77	4465 ± 415	2584 ± 337
1967: Known Total	440	1411	987
Regression Estimate	336 ± 108	1042 ± 367	792 ± 273
Total	776 ± 108	2453 ± 367	1779 ± 273

The success and effort rates were calculated from the data actually observed on the census days (up to labor day), not from the estimated totals listed on pages 6 and 7. These totals for census days only are given in table 3 for the ten years of the study.

Table 3: Total of actual observations on-

	Fishermen	Hours Fished	Fish Harvest
1958	984	4041	4444
1959	1946	6586	6583
1960	1376	4093	4491
1961	820	2570	2066
1962	446	1360	1265
1963	488	1579	1113
1964	373	1261	1239
1965	442	1863	1572
1966	656	2529	1447
1967	440	1411	987

The rates given in table 4 were calculated from the above data.

Table 4: Success Rates and Effort Rate

	Fish per Hour	Hours per Man	Fish per Man
1958	1.09973	4.10671	4.51626
1959	.99954	3.38438	3.38284
1960	1.09724	2.97456	3.26381
1961	.80389	3.13415	2.51951
1962	.93015	3.04933	2.83632
1963	.70487	3.23566	2.28074
1964	.98255	3.38070	3.32172
1965	.84380	4.21493	3.55656
1966	.57216	3.85518	2.20579
1967	.69950	3.20682	2.24318

No analysis of variance to differentiate between types of years was planned for this station.

This completes the analysis of data from Rock Creek Station Two.