MONTANA FISH AND GAME DEPARTMENT
FISHERIES DIVISION
HELENA, MONTANA

JOB COMPLETION REPORT
INVESTIGATIONS PROJECTS

State of Montana

Project No. F-27-R-2 Name Rock Creek Creel Census

Job No. I Title Summer Census

Period Covered May 1, 1960 - April 30, 1961

Abstract:

A creel census study to determine the return of planted rainbow trout to the angler's creel was conducted on a 40-mile section of Rock Creek near Missoula, Montana. Creel census techniques are discussed. Cumulative per cent returns of fish planted the last three years are presented. It was estimated that 40.1 per cent of 28,872 fish planted in 1960 were harvested by anglers in 1960. The estimate of total angler use of the area was 15,872 fishermen days and the estimate of total harvest was 48,475 game fish. The distribution of the catch among individual anglers and the total weight of that catch is presented. An analysis of traffic counter data is presented, which indicates that harvest and pressure estimates may be obtained more economically in the future.

Objectives:

The long-range objective of the Rock Creek creel census study is to obtain the necessary harvest and pressure information for an evaluation of the catchable-sized trout stocking program on Rock Creek.

The primary objective of this year's study was to obtain estimates of total catch, total effort, species composition of the catch, and the return of marked hatchery fish from the 40-mile study section of Rock Creek during the trout fishing season.

Secondary objectives of this study were to obtain (1), number of fish caught per individual angler during the fishing season, for a determination of the degree to which catch limits provide for equitable distribution of fish among anglers, and (2), information to determine the accuracy of estimates of total angler use by statistical analysis of traffic counter data.

Techniques Used:

Study area boundaries and sub-section definitions remained the same as in previous years of the study. Creel check-stations were maintained and operated at both ends of the 40-mile study section. Signs indicating area definitions were located on all points where the single access road crossed section boundaries. Signs requesting anglers to stop were erected during periods when stations were in operation.

Creel census operation:

The schedule for operation of the creel check-station was formulated under the direction of the Department statistician. The eighty-one days of the 193-day season censused in their entirety are shown in Appendix A. This schedule was designed to permit 50 per cent census coverage from May 22 through September 25, and 25 per cent coverage from September 26 through November 30. Data obtained in previous years of this study indicate that during the latter two months of the fishing season relatively little fishing pressure is exerted.

The period from May 22 through September 25 was stratified into week-end days and holidays, weekdays, and opening day. The week-end and holidays strata was sampled by an initial random selection of a week-end day and followed by systematic sampling of the remainder of the strata. In this manner, the first week-end day to be included in the sample was a Saturday. The following Sunday and Saturday were not included in the sample, then the next Sunday and Saturday were included in the sample, and so on. Two of three holidays (Memorial Day and Labor Day) were randomly selected to be included in the sample.

The weekdays strata was further stratified into ten-day periods. Five days from each strata were randomly selected for inclusion into the census schedule. These days were chosen with the restriction that any specific weekday was not included twice in one ten-day strata. In this manner each day of the week was censused once and omitted once during each ten-day period.

Opening day was censused in its entirety.

During the period from September 26 to November 30, one day from each consecutive four days was randomly selected to be included in the sample. These days were chosen with the restriction that from each 28 days during this period, each day of the week would be included for census only once.

Check-stations were in operation from 9:00 a.m. until it appeared that all anglers had departed from the study area. Census records from previous years indicate that only an occasional angler departs from the study area before or after the hours which census check-stations were in operation. Creel census data was therefore considered complete for scheduled census days.

Completed trip contact data were obtained from the angler and were recorded on an individual basis. The creel census contact form used is reproduced in Appendix B.

Information requested by census personnel was as follows:

(1) Fishing license number.
(2) Section fished.
(3) Flies or other type of bait used.
(4) Hours fished.
(5) Total catch (recorded by species and/or marked hatchery trout).
(6) Time angler entered and departed from study area.

Census data were compiled monthly and results were reported in the monthly narrative summaries. Following this compilation, completed contact forms were sent to the Department's IBM service and information was recorded on standard IBM punch cards for final summarization.

Hatchery Fish:

Planting of hatchery-reared rainbow trout was initiated on June 22 and was continued periodically until August 4, 1960. During this period, 28,872 rainbow trout were liberated in the study area. Of these fish, 19,917 were planted in Section I (lower section) and 8,955 were planted in Section II (upper section). Fish planted in Section I were marked for identification with a right premaxillary bone clip, and fish planted in Section II were marked with a left premaxillary bone clip.

Plants were made at over thirty specific sites within the study area. Areas designated as planting sites were easily accessible from the road and had relatively fast, deep water. Project personnel accompanied the hatchery truck on each planting trip and directed the actual stocking.

In addition to the scheduled fish plant, 250, 10 to 15-inch rainbow trout were planted in Rock Creek during tests of various electro-fishing

gear on November 10, 1960. These fish were graded from the brood stock at the Arlee State Fish Hatchery. Each fish was marked with a right pectoral fin clip.

These fish were planted near the end of the season when fishing pressure was very light. As a consequence none of them were checked through the census stations in 1960. These fish will be recorded as a special plant and treated separately in the 1961 completion report.

Catch Distribution Among Anglers:

In the two previous years of the study, contact data were recorded by angler parties. During 1960, contact data were recorded on an individual angler basis. These data were used to determine the portion of the total catch taken by various portions of the most successful anglers, and to determine the per cent of total anglers who caught no fish during the entire season.

If the individual interviewed was a license holder, his fishing license number was recorded in the appropriate column. If the angler's age was less than 15 or over 70 (no license required), this was indicated on the form.

Weight of Total Catch:

Samples of fish from the angler's catch were weighed to obtain an estimate of the total pounds of game fish harvested from Rock Creek during the 1960 fishing season. No specific sampling plan for this procedure was followed. To facilitate creel census operation during busy periods, census personnel were instructed to obtain weights at the convenience of the angler.

Lure Used:

Three categories for "lure used" data were established to determine

the per cent of total fishermen who use only artificial flies or a combination of artificial flies and some other type of lure on Rock Creek. These categories were, (1) artificial flies only, (2) artificial flies and some other type of lure, and (3) some other type of lure. The "other" type category includes all lures other than artificial flies, i.e., hardware, natural bait, commercial bait, etc. The number of individuals, based on fishing license numbers, using each type of lure was tabulated only from known contact data. No estimates were made on a seasonal basis.

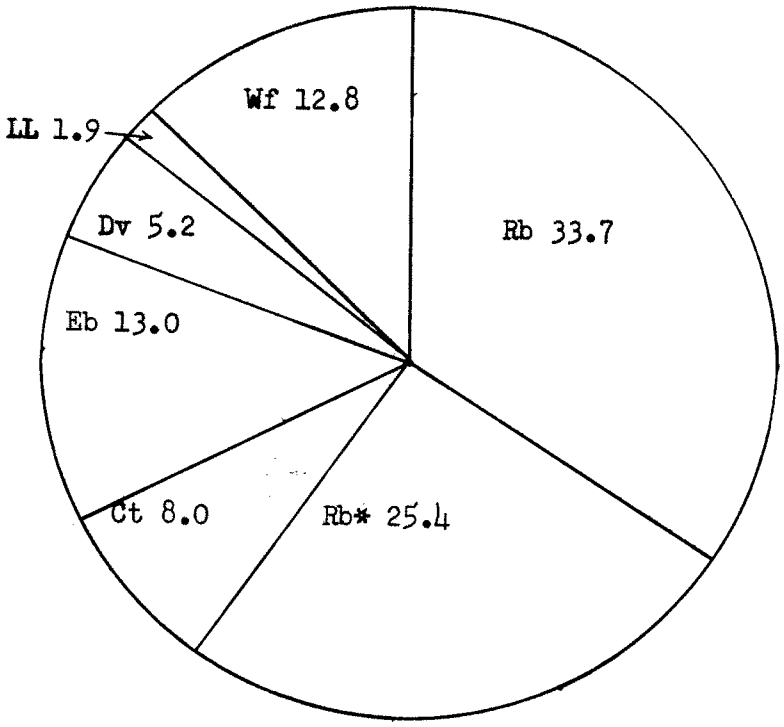
Traffic Counters:

At each check-station a battery-operated, hourly-recording, Streeter-Amet traffic counter was installed to obtain counts of the total amount of automobile traffic utilizing the Rock Creek access road. Data obtained from these counters have not been used as the primary source from which to compute estimates of total fishing pressure, but were gathered to evaluate the feasibility of the future use of traffic counters in computing estimates of total fishing pressure and harvest. These data were analyzed statistically by Dr. C. P. Quesenberry of Montana State College to determine the reliability of regression estimates based on traffic counter data.

Findings:

The following species of game fish contribute to the sport fishing in Rock Creek: rainbow trout, (Rb), Salmo gairdneri; cutthroat trout, (Ct), Salmo clarki; brown trout, (LL), Salmo trutta; Dolly Varden trout, (Dv), Salvelinus malma; brook trout, (Eb), Salvelinus fontinalis; and the Rocky Mountain whitefish, (Wf), Prosopium williamsoni. Figure 1. is a graphic illustration of the species composition, in per cent, of the 23,735 fish

checked through both census stations. Included with the 33.7 per cent of natural rainbow trout are 0.1 per cent of fish on which no species designation was recorded for various reasons, and which, for this purpose, were assumed to be rainbows.



*Hatchery planted rainbow trout.

Figure 1. SPECIES COMPOSITION, BY PER CENT, OF FISH CHECKED THROUGH BOTH STATIONS, ROCK CREEK, 1960.

The 1960 general fishing season opened on May 22 and continued through November 30. The season was sampled by stratification into five strata as previously explained. For purposes of statistical analysis the strata were modified as follows:

Strata

1 Saturdays, Sundays, and holidays from May 22 to September 1.

2 Weekdays from May 22 to September 1.

3 Saturdays, Sundays and holidays from September 1 to November 30.

4 Weekdays from September 1 to November 30.

5 Opening day.

Estimates were obtained by ratio expansion of fishing pressure and success data from each strata. The final estimates at the .95 level of

Table 1. POINT ESTIMATES AND FIDUCIAL LIMITS OF TOTAL HARVEST AND PRESSURE, ROCK CREEK, 1960.

	Lower	Point	Upper
Total Harvest	44,673	48,475 (45,809)*	52,276
Total Hours Fished	49,177	53,939 (48,894)	58,700
Total Fishermen	14,551	15,872 (14,920)	17,193

*Figures in parenthesis are estimates of fishing pressure and success from 1959.

confidence are presented in Table 1. Increased fishing pressure and greater harvest in 1960 are indicated by increases in each category.

Creel check-station personnel contacted 7,718 anglers who fished in Rock Creek during the 81 days censused. These anglers fished for 26,567 hours and caught 23,735 fish. Table 2 shows a comparison of fishing success figures for the three years the study has been in operation.

Table 2. AVERAGE NUMBER OF FISH PER ANGLER AND CPMH, ROCK CREEK, 1958-60.

		Fish Per Angler	Fish Per Angler-Hour
Both Stations:	1958	3.39	.91
	1959	3.07	.94
	1960	3.07	.89
Station 1:	1958	3.12	.85
	1959	2.93	.90
	1960	3.02	.85
Station 2:	1958	4.33	1.08
	1959	3.71	1.10
	1960	3.30	1.10

The average number of fish per angler remained the same in 1960 as in 1959. The CPMH decreased from .94 fish in 1959 to .89 fish in 1960. This decrease occurred in the lower study section. The CPMH at the upper

check-station remained at 1.10 fish per hour.

Hatchery Fish:

In 1960, 28,872 marked hatchery rainbow trout were planted in Rock Creek. The estimate of the number of these fish returned to the creel was 11,587, or 40.1 per cent, of the total number planted. In Table 3, the total number of fish planted, numerical and per cent return, and the contribution in per cent to the total catch, by station and year, are listed.

This table represents the return and contribution to the total harvest of fish only for the year in which each plant occurred. The per cent return of hatchery planted fish was slightly higher in 1960 than in 1959. Hatchery fish contribution to the sport fishery remained quite similar, from 23.0 per cent in 1959, to 23.7 per cent in 1960.

Table 3. RETURN OF HATCHERY FISH IN YEAR OF PLANT AND OCCURRENCE IN TOTAL CATCH, ROCK CREEK, 1958-60.

	Number planted	Numerical return	Per cent return	Total harvest	Per cent of total by hatchery
1958 Lower station	21,795	9,641	44.2	35,844	26.9
1958 Upper station	16,400	3,664	22.3	14,476	25.3
1958 Both stations	38,195	13,305	34.3	50,320	26.4
1959 Lower station	14,330	7,584	52.9	35,969	21.1
1959 Upper station	12,435	2,950	23.7	9,840	30.0
1959 Both stations	26,765	10,534	39.3	45,809	23.0
1960 Lower station	19,917	8,511	42.7	38,886	21.9
1960 Upper station	8,955	3,076	34.3	10,064	30.6
1960 Both stations	28,872	11,587	40.1	48,950	23.7

Table 4 shows the cumulative per cent return of fish planted for each successive year following the 1958 plant.

Table 4. CUMULATIVE PER CENT RETURN OF HATCHERY RAINBOW, ROCK CREEK, 1958-60.

Year of plant	Per cent return in 1958	1959	1960
1958	34.3	36.0 (436)*	36.2 (72)
1959		39.3	44.0 (1277)
1960			40.1

*Figures in parenthesis are numbers of planted fish caught each year following year of plant.

In summary of the return to the angler of planted fish for the three years of census operation, it is evident that an approximate 40 per cent return of planted fish during the year of planting is all that can be expected under Rock Creek's present angling pressure and stocking rate. Following the year of plant a return of an additional 5 per cent of hatchery fish might be expected.

Contribution to the sport fishing by hatchery-reared trout has ranged from an approximate 23 to 26 per cent of the total number of fish caught.

Catch Distribution Among Anglers:

Contact data included each angler's fishing license number in addition to standard creel census data. Census station personnel contacted 4,066 individual license holders and recorded trip data for 1,026 juvenile and over-70 anglers.

To determine the seasonal distribution of the catch among anglers, each individual's contact data for the entire season was tabulated according to license number. Data were tabulated for the juvenile and over-70 angler categories separately.

A frequency distribution of the number of anglers who caught 1 fish, 2 fish, 3 fish, etc. during the entire season was constructed. In this manner it was determined that the most successful 4.99 per cent of all license holders contacted made 18.01 per cent of the total trips and caught 33.80 per cent of the total number of fish caught by license holders. By cumulative addition of catch data, the per cent of this catch taken by the 10 and 25 per cent levels of the most successful anglers was determined (Table 5).

Table 5. DISTRIBUTION OF THE TOTAL CATCH AMONG LICENSE HOLDERS, AND PORTION OF TOTAL EFFORT EXPENDED BY VARIOUS PER CENT LEVELS OF THE MOST SUCCESSFUL ANGLERS, ROCK CREEK, 1960.

Resident			Non-Resident			Combined		
% Tot Anglers	% Tot Trips	% Tot Catch	% Tot Anglers	% Tot Trips	% Tot Fish	% Tot Anglers	% Tot Trips	% Tot Catch
4.88	17.91	32.86	4.64	10.09	25.26	4.99	18.01	33.80
10.36	28.75	50.31	9.98	15.90	43.02	10.03	27.64	49.79
24.19	44.42	74.95	23.58	81.52	71.63	25.53	44.84	76.84

Little difference was noted in the catch distribution between the license holder category and the juvenile and over-70 category. While it was impossible to identify individual anglers in the latter category, it was found that the most successful 5.16 per cent of these fishermen caught 25.41 per cent of the fish caught by this category. Cumulatively, the most successful 9.26 per cent of fishermen in this group caught 40.13 per cent of their catch, and 23.29 per cent caught 71.97 per cent of the catch.

In addition to the above, it was determined that 31.33 per cent of the total resident license holders contacted caught no fish on the days censused. Of the non-residents, 38.72 per cent caught nothing. Combined,

32.39 per cent of all license holders checked caught nothing. These anglers accounted for 21.38 per cent of the total trips made by license holders.

Weight of Total Catch:

To obtain an estimate of the total number of pounds of game fish harvested from Rock Creek during the 1960 fishing season, average weights, by species, were calculated by station and by two-week periods. No specific trend in increased average weights as the season progressed was noted, probably due to variation in number of fish weighed from different age groups and the range in size of fish weighed. For this reason, no attempt was made to calculate total weights by periods. All fish weights obtained at both stations during the season were added and an average round weight of fish, by species, was calculated. Weights of dressed fish were first converted to round weights using weight-loss-from-dressing factors reported in the F-27-R-1 completion report. Average weights of fish, by species, are presented in Table 6.

Table 6. NUMBER OF FISH WEIGHED AND AVERAGE WEIGHT, BY SPECIES, ROCK CREEK, 1960.

Species	Number weighed	Weight	Average round weight
Natural rainbow	988	621.82	.63
1958 rainbow	6	7.68	1.28
1959 rainbow	24	16.13	.67
1960 rainbow	912	299.39	.33
Whitefish	303	111.51	.37
Cutthroat Trout	605	172.51	.28
Brook Trout	484	135.03	.28
Dolly Varden	158	112.60	.71
Brown Trout	67	105.43	1.57
Total	3,547	1,582.10	.45

The estimated number of fish by species and year of plant was multiplied by the average round weight for each individual species. An estimated

23,408 pounds of fish were taken from Rock Creek by anglers in 1960. The estimated harvest of wild fish only from Rock Creek was 18,638 pounds.

Lure Used:

The lure used and angler success data are presented in Table 7 for 3,462 of the 4,066 individual licenses holders contacted. These anglers consistently fished with one type, or types, of lure listed on days the census was in operation. The remaining 604 individuals were not consistent. They fished with one type of lure one day and changed lures on subsequent fishing trips.

Table 7. LURE USED AND TRIP DATA FOR LICENSE HOLDERS, ROCK CREEK, 1960.

Lure used	No. of fishermen	% of license holders contacted	Hours fished	Fish caught	Fish per angler	CPMH
Flies	802	19.72	2929	2409	3.00	.82
Flies & other	694	17.07	2647	2155	3.10	.81
Other	1966	48.35	9740	8711	4.43	.89

This information was collected primarily to determine the per cent of anglers who are "fly only" enthusiasts. While it is not positive that each "fly only" fisherman did not return to Rock Creek on a day the census was not in operation and fish with bait, an approximate level of 20 per cent of Rock Creek anglers as "fly only" fishermen does not seem unrealistic.

As mentioned previously, it was impossible to record individual data for juvenile and over-70 anglers in such a manner that tabulations of the effort and success of an individual angler throughout the season could be made. In Tables 8 and 9 effort and success data are presented for juvenile and over-70 anglers by fisherman trip. The majority of anglers in these categories fished with some other type of lure than artificial flies. Success was greatest in the "other" category and least for anglers who fished with flies.

Table 8. LURE USED AND TRIP DATA FOR OVER-70 ANGLERS, ROCK CREEK, 1960.

Lure used	No. fishermen	% of Tot. fishermen	Hours fished	Fish caught	Fish per angler	CPMH
Flies	16	15.84	56.0	26	1.62	.46
Flies & other	19	18.81	75.0	46	2.42	.61
Other	66	65.35	251.0	275	4.16	1.10

Table 9. LURE USED AND TRIP DATA FOR JUVENILE ANGLERS, ROCK CREEK, 1960.

Lure used	No. fishermen	% of Tot. fishermen	Hours fished	Fish caught	Fish per angler	CPMH
Flies	160	17.30	422	239	1.49	.57
Flies & other	172	18.59	532	340	1.98	.64
Other	593	64.11	1836	1220	2.06	.66

Traffic Counters:

This section is based on information obtained from Dr. C. P. Quesenberry of Montana State College in cooperation with Mr. T. H. Leik, Montana Fish and Game Department Biometrician. A procedure for obtaining total estimates by regression analysis of traffic counter data and subsequent comparison with ratio estimates was established. This procedure was (1), the correlation coefficients (r) between fish caught, hours fished, and the number of fishermen were computed; (2) the total traffic count on days checked was correlated with the harvest for those days, and (3), a regression estimate was made of total harvest and this estimate compared the ratio estimate of harvest.

Step (1) was concerned with the relationships that exist among the variates sampled. Correlation coefficients were computed for all pairs of the variates sampled. The correlation matrix obtained for fishermen (x_1), hours fished (x_2), and harvest (x_3) was:

	x_1	x_2	x_3
x_1	1	.98801	.96490
x_2	.98801	1	.97852
x_3	.96490	.97852	1

From the significance of those correlations, it appeared that a very good estimate of any two could be obtained from the other.

Step (2) consisted of computing the r value for car count data on days censused with the harvest for those days. The r value obtained was .94393.

The magnitude of these correlations suggest that very good relationships exist between all variates.

In view of the foregoing consideration, step (3) consisted of establishing a linear model, which was fitted for harvest, y, in terms of car count data, x. The actual model is

$$y_i = b_o + b_1 \ (x_i - \bar{x}) + e_i \qquad (1)$$

for $b_o = \bar{y}$, $b_1 = \dfrac{\sum x_i y_i - \left(\sum x_i\right)\left(\sum y_i\right)/n}{\sum x_i^2 - \left(\sum x_i\right)^2/n}$.

Where n is the number of sampled days and y_i' and x_i' are the values obtained on the ith day sampled.

If we denote y_i' and x_i' the values for unsampled days the y_i' 's can be estimated from the x_i' 's in hand using equation (1). Then

$$\text{Var}\ (y_i') = \left(1 + 1/n + \frac{(x_i' - \bar{x})^2}{\sum x_i^2 - (1/n)\left(\sum x_i\right)^2} \right)\sigma^2$$

and for $y_\cdot' = \sum_{i=1}^{k} y_i'$

$$\text{Var}\ (y_\cdot') = \left\{ k + \frac{k^2}{n} + \frac{\left(\sum_1^k x_i' - \bar{x}\right)^2}{\sum x_i^2 - (1/n)\left(\sum x_i\right)^2} \right\} \sigma^2 \qquad (2)$$

This variance is estimated by replacing σ^2 by the mean square for error, s^2.

Confidence intervals are then obtained by using the usual formula

$$y_{\cdot}' \pm t_{\alpha \cdot}'(v)\, s_{y_{\cdot}'} \cdot \qquad (3)$$

The use of (3) to obtain confidence intervals for harvest on the unsampled days implies an assumption that the deviations e_i from the model in (1) are normally and independently distributed. An investigation of these assumptions for the deviations from the fitted model was performed. All of the deviations were computed and were investigated. They were plotted in histogram form and appear to the eye to follow an approximate normal distribution very well. They show no marked trends in time for the season. It is thought from this investigation that the use of normal theory in constructing confidence intervals for estimates is justified.

The actual confidence interval computed for total harvest using the foregoing formulae was (40,173; 46,289). This compares with the interval (42,453; 50,056) obtained by stratification. It is felt that these intervals agree very well. The half-lengths for the regression and stratification methods are 3,058 and 3,801, respectively. The ratio of these half-lengths is 1.24:1, which is very good agreement.

The regression analysis possesses several practical advantages. It requires a considerably smaller number of sampled days to give the same precision for the estimates. A sample of 30 to 40 days would give sufficient degrees of freedom for estimating error. Also, the numerical work involved in the analysis is much more easily performed. Standard regression programs for digital computers can be used and the analysis performed on a computer very efficiently.

Recommendations:

It is recommended that the Rock Creek creel study be continued until an evaluation of the catchable-sized trout stocking program can be achieved. Planting of hatchery-reared rainbow trout should be discontinued for a period of three years to obtain pressure and harvest data for comparison with data gathered during the initial three years of this study. The majority of catchable-sized fish planted previously will be removed in this three year period, and a naturally-reproduced fish population should be present.

Generally, present census methods and techniques should continue as in the past.

Specifically, sampling methods should be designed after a statistically valid sampling plan, and methods refined, when possible, for more economical operation. Traffic counter data gathered in 1961 should be statistically analyzed to verify the validity of estimates made by regression analysis of these data.

For less inconvenience to the angler, it is recommended that the taking of scale samples be discontinued until 1963, which will be the third year without planting catchable-sized fish in Rock Creek. The practice of recording fishing license numbers should also be discontinued until 1963.

Prepared by Ralph Boland

Date November 8, 1961

Approved by George D. Holton

Appendix A

ROCK CREEK CREEL CENSUS SCHEDULE, 1960.

May 22 -- 24 -- 26 -- 28 -- 30 --

June 1 - 3 - 5 - 7 8 9 -- 11 -- 13 -- -- -- 17 -- 19 -- -- 22 23 24 25 -- 27 28 -- --

July - - 3 - - 6 7 - 9 -- 11 12 -- -- 15 -- 17 18 19 20 -- 22 23 -- -- -- -- 28 -- -- 31

August - 2 - 4 5 6 - 8 - 10 -- -- -- 14 -- 16 -- 18 19 20 -- 22 -- 24 -- -- -- 28 -- -- 31

September - - 3 - 5 6 - 8 9 -- 11 12 13 -- 15 16 17 -- -- -- 21 -- -- -- 25 -- -- -- 29 --

October - - 3 - 5 - - - - -- 11 -- -- 14 -- 16 -- -- -- -- -- 22 -- -- -- -- 27 -- 29 -- --

November - - - 4 - - 7 - 9 -- -- -- -- -- 15 -- -- -- -- 20 -- 22 -- -- 25 -- -- -- -- 30

Appendix B

ROCK CREEK INDIVIDUAL CONTACT FORM

Date__________ Day_______ Station No._____ Sheet No._____ Checker__________

Lic. No. R or N	Section fished	Lure	Hours fished	Total fish	Hat. fish	Nat. fish	Hatch. Rb Clip	Hatch. Rb No.	Nat. Rb	Ct	Eb	Dv	LL	Wf
TOTALS														

Time: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Codes: Ad Clip ------ 1 Flies only ----- 1 Lower Sec. -- 1 Resident ------- 1
Ad-Lv clip --- 2 Flies & other -- 2 Upper Sec. -- 2 Non-resident --- 2
Rt Pmx clip -- 3 Other ---------- 3 Both Sec. --- 3
Lf Pmx clip -- 4