THE YIELD OF WILD AND HATCHERY TROUT FROM BIG SPRING CREEK, MONTANA

by

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of

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VITA

The author, Norman Walter Peterson, was born in Browning, Montana, December 8, 1936 to Frank and Mary Peterson. He graduated from Browning High School, Browning, Montana, in 1955. He entered Western Montana College, Dillon, Montana, in the spring of 1957 but only attended for half a quarter, dropping out to marry Elaine Elizabeth Nunez of Browning. He entered Northern Montana College, Havre, Montana, in the fall of 1964 and transferred to Montana State University in the fall of 1966 and received a Bachelor of Science degree in Fish and Wildlife Management there in June, 1968. He began graduate studies at Montana State University in the fall of 1968 as a Graduate Research Assistant with the Montana Cooperative Fishery Unit. He and Elaine have three children, Geraldine Marie, 12, Conrad Lynn, 11, and Craig Matthew, 7.

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ABSTRACT

Estimates on the yield of wild and hatchery trout were made on a portion of Big Spring Creek, Montana, during the fishing seasons of 1968 and 1969. The stream was divided into two study sections (A and B) based on habitat quality, trout populations and fishing intensity. Rainbow trout represented about 80 percent of the wild trout populations within each sampling subsection (A_1 and B_1) during both years. An estimated 49 percent in 1968 and 55 percent in 1969 of all fishermen were interviewed. Total fishermen-hours were estimated by using "fishing intensity curves". The total fishermen-days per stream mile was 635 for 1968 and 534 for 1969. The total fishermen-days per acre for the respective years was 128 and 104. In 1968, 11,986 game-fish (hatchery trout included) were caught during 5,077 fishermen-days for an average of 2.36 game-fish per fishermen-day. In 1969, 7,774 game-fish were caught during 4,109 fishermen-days for an average of 1.89 game-fish per fishermen-day. The yield of wild game-fish increased 14.3 percent from 1968 to 1969 while the catch-rate of wild trout increased from 0.27 per hour to 0.36. The correlation coefficient for the relationship between late summer wild trout populations and yield was 0.97. Wild rainbow trout were not caught and kept in proportion to their relative abundance with respect to size and age. Age groups II and III contributed proportionally more to the yield than did age group I. The effects of a 50 percent reduction in stocked hatchery trout on yield, fishing pressure, percent returned, and catch-rate are discussed.

INTRODUCTION

Estimates of total fishing effort, catch-rate and the game-fish population were made for the upper 9 miles of Big Spring Creek in Central Montana during the fishing seasons of 1968 and 1969. The data were evaluated to determine the yield of wild trout, the relationship of yield to certain characteristics of the wild fish populations, and the efficiency and effect of stocking rainbow trout.

Big Spring Creek has a history of flooding during spring runoff and five flood control dams, which will also serve as settling basins, are planned for tributaries upstream from the city of Lewistown (Marcoux, 1969). The yield may also provide a basis for evaluating the future effects of these dams.

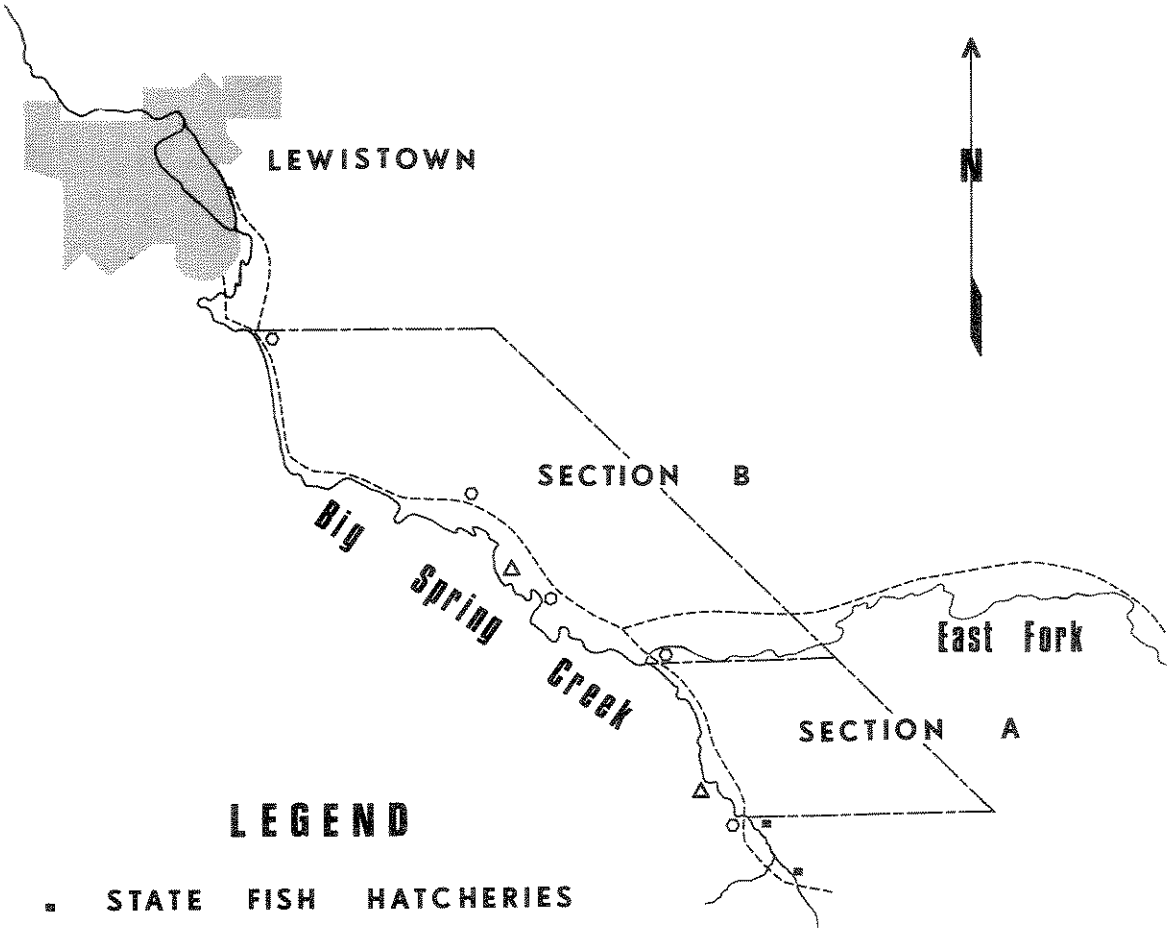

Figure 1. Study area, showing location of study sections A and B on Big Spring Creek.

DESCRIPTION OF STUDY AREA

Big Spring Creek arises from several springs 9 miles southeast of Lewistown. Located near the stream's origin are two Montana Fish and Game Department trout hatcheries. Numerous bridges (2.3 per stream mile), Montana State Fish and Game Department access areas, private access areas, and areas where the stream borders the highway provide considerable fishermen access. Seventy-two percent of the permanent homes on the floodplain are located within the lower 3.3 stream miles of the study area.

The study area was divided into two study sections. Study section A began at the highway bridge 600 feet downstream from the lower trout hatchery and continued downstream 1.9 stream miles to the confluence of the East Fork tributary (Figure 1). Section B began at the mouth of the East Fork tributary and continued 6.1 stream miles to the city limits of Lewistown. The upper 3,568 feet (subsection A_1) of section A had an average width of 36.5 feet and an average discharge of 126.6 cfs (Marcoux, 1969). A sampling section beginning about 2 miles below the mouth of the East Fork and extending 5,843 feet (subsection B_1) had an average width of 43.4 feet and an average discharge of 134.1 cfs. An area 3,704 feet long near the lower end of section B where the stream channel was altered had an average width and average discharge of 34.2 feet and 143.9 cfs, respectively.

The gradient from the upstream boundary of section A to the downstream boundary of section B was 27.5 feet per stream mile.

Turbidity measurements (in Jackson units) were made in each subsection and near the lower end of section B during 1968 and 1969 and on the East Fork tributary near its mouth in 1969 on most days when creel census was taken. Data were divided into three categories based on water clarity: clear (0-3 ppm), murky (3+-7 ppm), and muddy (7+-500+ ppm). Section A had the greatest number of clear water days and the station at the lower end of section B had the greatest number of murky and/or muddy days (Appendix, Table 1). The East Fork tributary had the highest percent of muddy water days in 1969. Turbidity increased more in the East Fork and section B than in section A following showers.

Rainbow trout *(Salmo gairdneri)* and brown trout *(Salmo trutta)* were the predominant wild game-fish species occurring in both stream sections. Marcoux found that these two species represented about 99 percent of the wild game-fish in 1967 and 1968 population estimates. A few brook trout *(Salvelinus fontinalis)*, mountain whitefish *(Prosopium williamsoni)* and arctic grayling *(Thymallus arcticus)* were present. The latter probably resulted from an inadvertent hatchery release in 1966. Only 4 suckers per acre, including longnose sucker *(Catostomus catostomus)* and white sucker *(Catostomus commersoni)*, were taken in subsection A_1, but 186 were taken in subsection B_1 and 247 in

the altered area (Marcoux, 1969). Marcoux (1969) found that the fish population in the altered portion of section B was similar to sub-section B_1. This altered area was not sampled in 1969. Hatchery rainbow trout were planted in both sections prior to and during the study.

METHODS

Beginning on opening day (May 19, 1968 and May 18, 1969) of each study year and continuing to September 15, 1968 and September 14, 1969, fishermen were censused a minimum of five days per week with the restriction that all weekends and holidays be included. The selection of the three weekdays censused was made from a table of random numbers. If a holiday fell on a weekday not normally censused, that day was also checked making a total of six census days for that week. Fishing pressure estimates for non-census weekdays were obtained from averaged data of the censused weekdays for that week. A similar partial census method was the most accurate of four studied by Best and Boles (1956).

The daily distribution of fishing intensity was determined by counting fishermen at 7, 8, and 11 a.m. and 1, 4, 6, and 8 p.m. (Mountain Daylight Time). A highway paralleled the stream at no greater distance than 0.26 mile and fishermen were readily visible from the highway on at least 90 percent of the stream. All counts were made as rapidly as possible from a vehicle. Only individuals who were actually fishing or walking to the stream with fishing rod in hand were counted.

As many fishermen as practicable were interviewed from 7 a.m. to dark to obtain length of time fished, total number in the fishing party,

the gender and residence of each individual, and the species, number, weight, and total length of fish caught.

Census cards were given to fishermen (or parties) that indicated they would continue fishing after the interview was made. Numbers on the cards corresponded to numbers on the interview forms. A high rate of card return was encouraged by requesting only party finishing time, number of trout caught and number released. Pencils and self-addressed stamped cards were provided. Cards could be returned in any one of five boxes conveniently placed along the stream or road (Figure 1).

During the study period of 1968 it seemed that a proportionately higher percent of interviews were made around certain access points as compared to the rest of the stream. Several access points also corresponded to trout planting sites so that catch data may have been biased toward hatchery fish. Other studies show that most hatchery recoveries occur within a short distance of the planting sites during the summer months (Butler and Borgeson, 1965; and Cooper, 1952). Electro-fishing data from my study showed that the majority of hatchery rainbow trout were located within 1,000 feet downstream from the planting sites. The 1,000 feet immediately downstream from planting sites were designated as access areas. If a pool and/or run was present immediately above a planting site, it was included as part of the access area. In 1969, the number of fishermen observed and the number contacted in 10 access areas were each compared to corresponding numbers for the rest of the stream.

Population estimates of wild rainbow and brown trout were made in subsections A_1 and B_1 (Figure 1). These were made during the late summers of 1968 and 1969, during March, 1968 in subsection B_1 and during March, 1969 in subsection A_1. The 1968 summer estimates for both subsections were obtained from Marcoux (1969). Estimates of wild trout were made at 2-inch size intervals, excluding fish less than 6.0 inches total length, to compensate for differential efficiency of capture. Computations were made using the Bailey Modification of the Petersen estimator (formula 3.7 of Ricker, 1958). Confidence intervals at the 95 percent level were computed using formula 6 of the Michigan Institute for Fisheries Research (1960).

Fish populations were sampled with a variable voltage, pulsed D. C. generator. Captured fish were anesthesized, measured, weighed, temporarily marked with a caudal punch or a partial caudal clip, and released near the capture site.

Hatchery rainbow trout planted in the study area totaled about 10,000 in 1968 and 5,000 in 1969. At the time of planting, the fish ranged from an average weight of 2.6 per pound early in the 1968 season to one per pound late in the 1969 season. Between five and seven plantings occurred each summer from May 14 to the last week in July. On each planting day, fish were distributed at an average of seven access points in the study area. Planting sites and dates were similar between years but the number in individual plants was reduced by 50

percent in 1969. Fish stocked in 1968 were marked by removing the adipose fin. In 1969, colored dyes of various combinations were injected intracutaneously into the left and/or right mandibles. Dyes used were chromium oxide and National Fast Blue 8GXM. Kelly (1967) reported that these dyes were externally visible in 100 perent of the fish for at least one year after marking.

An additional 1,625 rainbow trout in 1968 and 1,150 in 1969 were planted near or between the hatcheries. Those stocked in 1969 were marked to determine if they drifted into the study area.

RESULTS

Fishing intensity data were divided into weekdays and weekends-holidays. Data were further grouped into one of five strata to compare seasonal distribution patterns and to facilitate estimates. Stratum one includes opening day and the following three weeks; strata 2, 3, and 4 include consecutive four-week periods following stratum one; and stratum 5 contains the final two weeks.

Angling intensity in hours was estimated by summing the daily distributions of fishermen in each stratum and constructing "fishing intensity curves" (e.g., Figures 2, 3, and 4). Total fishing pressure for any stratum thus became the total fishermen-hours under that period's curve. Total fishermen-hours was computed as the sum of the number of fishermen under the curve at each hour. The left side of each curve was closed through extrapolation from early morning starting times recorded on interview forms. The right side was closed by extrapolation from the finishing times recorded on census cards using only data from fishermen finishing after 8 p.m.

An estimated 49 percent of all fishermen were interviewed in 1968 and 55 percent in 1969. The return on the census cards given to interviewed fishermen, in 1968, was 72 percent (21 percent by mail) and, in 1969, was 71 percent (12 percent by mail). There was little difference in the percent return between strata or between weekdays and weekends-holidays.

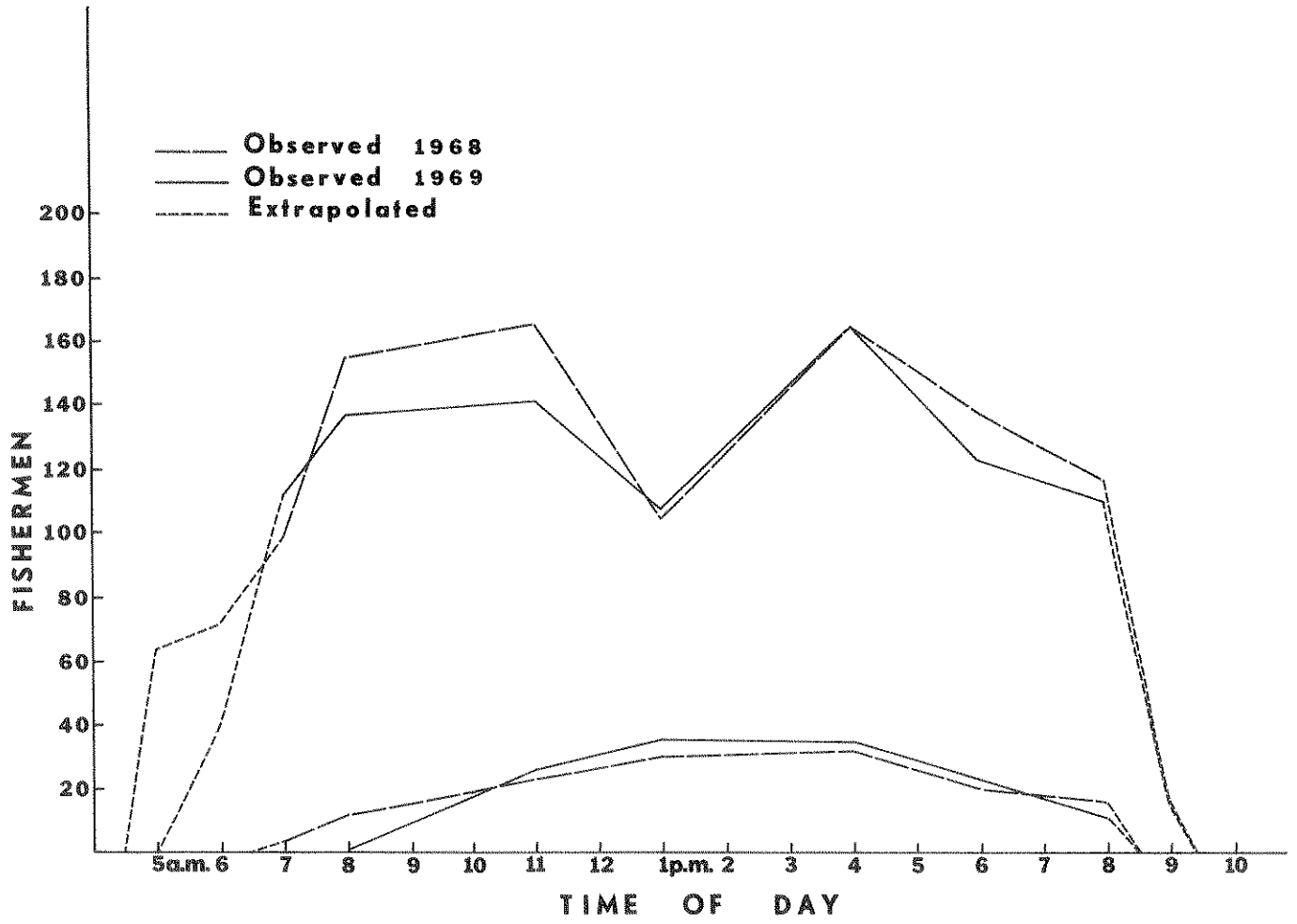

Figure 2. Fishing intensity curves for the weekends-holidays of stratum one (two larger curves) and stratum 5 (two smaller curves) for Big Spring Creek.

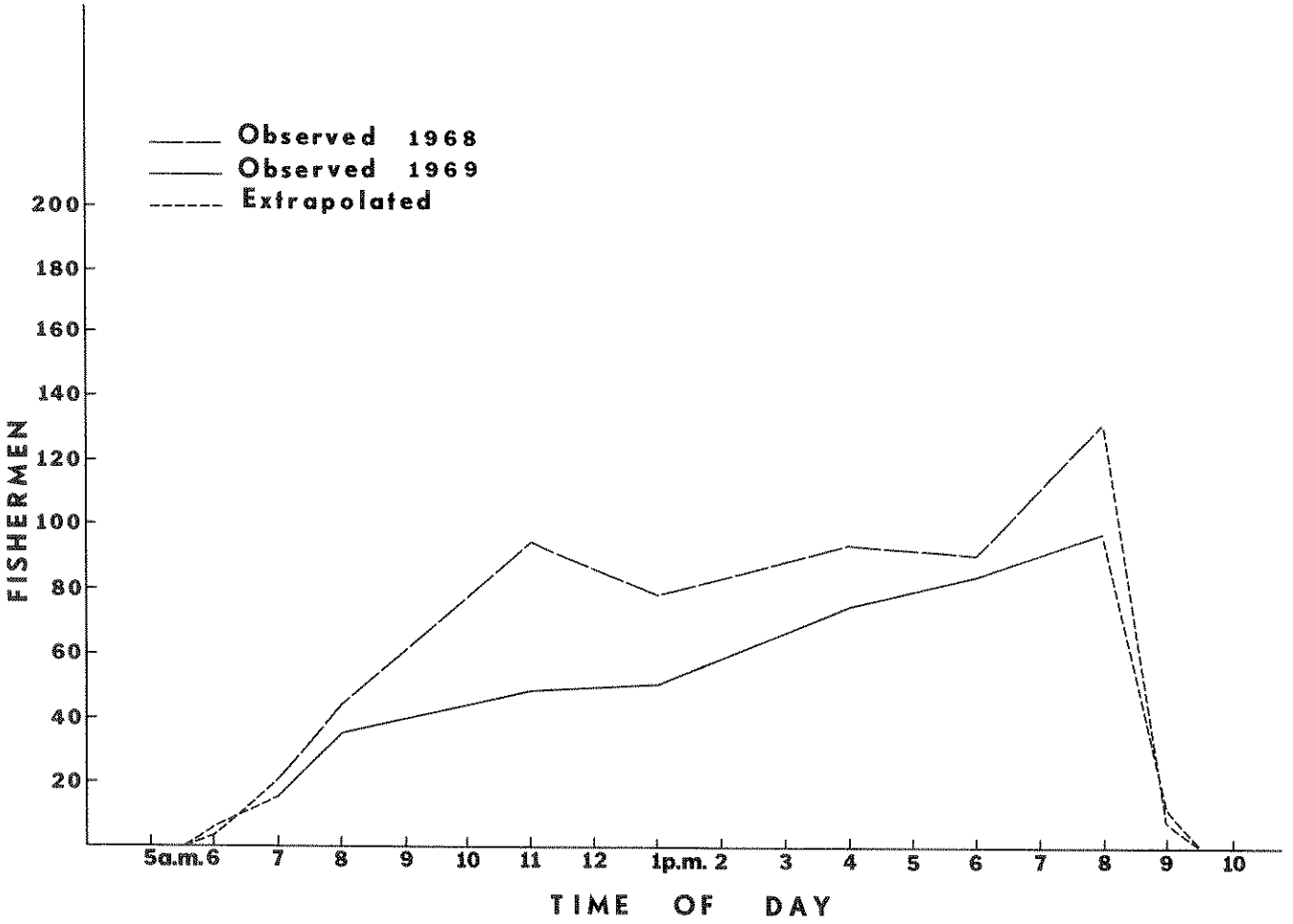

Figure 3. Fishing intensity curves for the weekends-holidays of stratum 4 for Big Spring Creek.

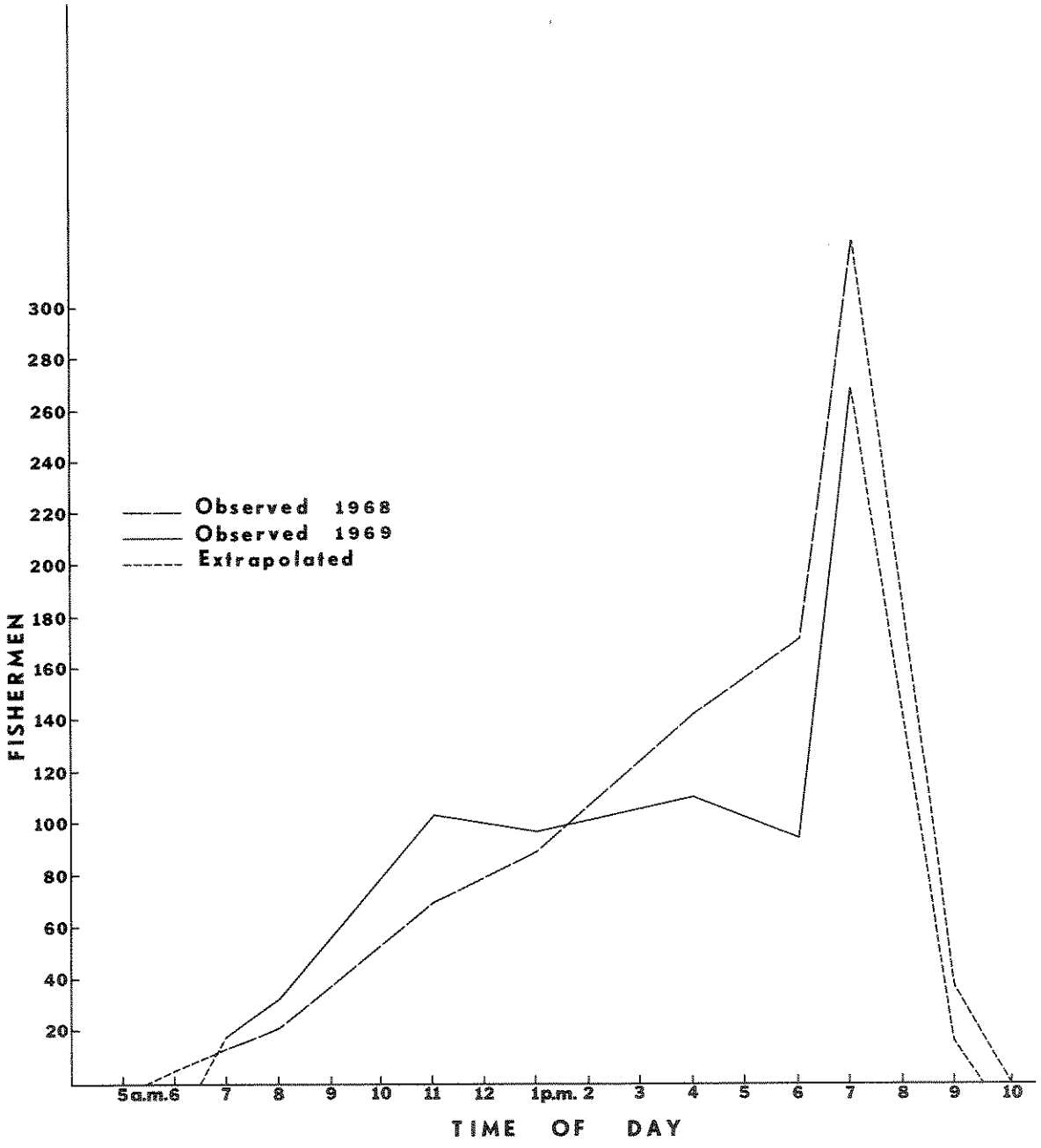

Figure 4. Fishing intensity curves for the weekdays of stratum 4 for Big Spring Creek.

Characteristic patterns in the distribution of fishing effort have been demonstrated for various types of fisheries. Cope (1955) described a situation on Yellowstone Lake similar to the weekends-holidays pattern in stratum one (Figure 2) as a "resort" situation. Eschmeyer (1935) reported a similar bimodal distribution that had a morning peak from 8 to 10 a.m. and an evening peak from 6 to 7 p.m. with over 10 percent of all fishing effort in the latter period.

The distributions of angling intensity on weekends-holidays for both study years on Big Spring Creek were, in general, bimodal (e.g., stratum one, Figure 2); but, a few strata were trimodal with another peak at 4 p.m. (e.g., 1968, Figure 3). The morning mode decreased more than the evening mode as the season progressed through August (Figure 3). Stratum 5 was a period of low fishing intensity characterized by a bell-shaped distribution. Churchill and Snow (1964) found, during the summer period on two lakes, a bell-shaped distribution similar to the weekends-holidays pattern in stratum 5 (Figure 2). Vincent (1969) described a bell-shaped distribution on the Madison River, Montana.

The distribution of intensity on weekdays, during both years, was generally bimodal for each of the first four strata; however, the 8 p.m. mode was, in each case, much higher than the 11 a.m. mode (Figure 4). This suggests that the weekday intensity was primarily local. Weekdays in stratum 5 were characterized by a bell-shaped distribution and

low angling intensity. Similar distribution patterns, with only minor fluctuations, existed for the same strata between years (e.g., Figures 2, 3, and 4).

Total fishermen-hours were estimated to be 13,185 in 1968 compared to 11,244 in 1969. The estimated percent of total fishermen-hours at 6 a.m. and earlier was 1.3 in 1968 and 0.5 in 1969. The majority of early morning intensity was on weekends-holidays. The percent of total fishermen-hours at 9 p.m. and later was 3.1 for both years. Hunt (1966) found that early morning and late evening fishing represented only a small percent of the overall fishing intensity.

The decrease in total fishermen-hours in 1969 was due to a decrease in local fishermen (residing in Lewistown and vicinity). The percent of local fishermen decreased from 62 in 1968 to 52 in 1969. In 1968, construction personnel and their families, totaling approximately 1,100 people, moved into Lewistown and remained until just before the opening of the 1969 fishing season. They probably contributed to greater fishing intensity and tended to concentrate more in access areas than other local fishermen. In 1969, 45 percent of fishermen observed and 44 percent contacted were in access areas. This indicates that fishermen were contacted in proportion to their observed distribution on the stream.

During 1968, the length of the average fishermen-day, as determined by interview and census card data, on weekdays was 2.36 hours

and on weekends-holidays 2.90 hours. During 1969, it was 2.67 and 2.81 hours, respectively.

The total number of fishermen-days for each stratum was determined by dividing the total number of fishermen-hours by the average fishermen-day for that stratum. On weekdays, the number of fishermen-days remained fairly constant for strata one through 4 (Table 2), but was greater in 1968 (average 672) than in 1969 (average 522). In stratum 5, the number of fishermen-days dropped 78 and 88 percent

Table 2. Total number of fishermen-days and average number of fishermen per day (in parenthesis) for each of five strata for Big Spring Creek, 1968 and 1969.

	1968		1969	
Stratum	Weekdays	Weekends-Holidays	Weekdays	Weekends-Holidays
	1/			
1	381 (27.2)	723 (90.4)	500 (35.7)	681 (85.1)
2	754 (39.7)	461 (51.2)	500 (26.3)	513 (57.0)
3	845 (42.3)	543 (67.8)	533 (26.6)	351 (43.9)
4	709 (35.4)	402 (50.2)	554 (27.7)	301 (37.6)
5	153 (17.0)	106 (21.2)	65 (7.2)	111 (22.2)
Total	2,842	2,235	2,152	1,957

1/ Due to adverse weather, the normal number of fishermen-days probably was decreased.

from the previous stratum during 1968 and 1969, respectively. The number of fishermen-days on weekends-holidays showed a general decrease from stratum one through 5 for both years.

Weekends-holidays showed a higher fishing intensity per day than weekdays (Table 2). During both years, 49 percent of the total

fishermen-hours was on weekends-holidays. A higher weekend intensity was observed by various other authors (Brown, 1969; Cope, 1955; and Churchill and Snow, 1964). Total fishermen-days per stream mile was 635 for 1968 and 534 for 1969. Vincent (1969) found 490 and 590 fishermen-days per mile on the Madison River (a much wider stream) during 1966 and 1967, respectively, for seasons of comparable length. Total fishermen-days per acre on Big Spring Creek was 128 for 1968 and 104 for 1969. McFadden (1961) found that for three years on Lawrence Creek, a stream considered to have high fishing intensity for Wisconsin, the annual fishermen-days per acre ranged between 170 and 218. Based on Montana Fish and Game Department postal survey estimates of fishing pressure, the Big Spring Creek study area was considered to have a high fishing intensity relative to other streams in Montana.

Section A represented 24 percent of the study area, but contained 36 percent of the fishing intensity in 1968 and 28 percent in 1969. The disproportionate intensity between sections decreased as the season progressed. This difference in intensity may have resulted from early season turbidity which was greater in section B (Appendix, Table 1). On days of high turbidity during both years, over 50 percent of the intensity was in section A.

Of fishermen interviewed in 1968, 69 percent were males, 10 percent were females, and 21 percent unlicensed juveniles. In 1969, these percentages were 72, 9, and 19, respectively.

In 1968, the number of rainbow exceeding 5.9 inches in length represented 85 percent of the wild trout population in subsection A_1 and 81 percent in subsection B_1. In 1969 this species represented 80 percent of the trout in both subsections. The greatest number and pounds per acre of all trout were in section A during both study years (Table 3). The size distribution (Table 8) shows there was a greater percentage of larger rainbow trout in subsection B_1 than in subsection A_1. Trout population dynamics for Big Spring Creek were described by Marcoux (1969). The only pre-season estimates that could be made were in subsection B_1 in 1968 and subsection A_1 in 1969. Comparing the 1968 late summer populations of wild trout with the 1969 spring populations indicates an increase in populations during the winter. Normally this is a period of decline because of mortality and slow growth. The increase may be due to immigration and/or sampling error. McFadden (1961) found that changes in number and weight of brook trout within a single stream section are influenced considerably by movement of fish.

During both years, the yield was estimated as the product of the total fishing pressure (fishermen-hours) and the catch-rate (fish per hour as taken from interview information only). The yields were calculated for weekdays, weekends-holidays, and for each stratum to compensate for possible differences. The total yield for each study year then became the sum of the strata yields. The harvest in pounds

Table 3. Population and yield estimates of wild rainbow and brown trout in two sections of Big Spring Creek, 1968 and 1969. (Total pounds in parenthesis and confidence intervals underlined).

Section		Spring Populations Per Acre	Late Summer Populations Per Acre	Estimated Yield Per Acre
		RAINBOW TROUT		
A	1968		312 (97) 276-348	198 (81)
	1969	460 (164) 410-510	282 (118) 238-326	128 (48)
B	1968	232 (145) 189-276	131 (67) 103-158	43 (22)
	1969		166 (114) 141-191	80 (49)
		BROWN TROUT		
A	1968		55 (65) 42-67	19 (23)
	1969	78 (64) 61-94	70 (63) 56-84	12 (10)
B	1968	35 (32) 24-46	31 (30) 22-40	8 (7)
	1969		41 (40) 34-48	12 (9)

was estimated as the product of the yields (total numbers) and the average weight of the trout caught for the various divisions.

In 1968, an estimated 11,986 game-fish (hatchery trout included) were caught during 5,077 fishermen-days for an average of 2.36 fish per fishermen-day (Table 4). In 1969, an estimated 7,774 game-fish were caught during 4,109 fishermen-days for an average 1.89 fish per fishermen-day (Table 4).

Wild and hatchery rainbow trout contributed 96.3 percent of game-fish taken during 1968 and 93.9 in 1969 (Table 4). The brown trout catch contributed most to the remaining percentage during both years, while arctic grayling and brook trout were rarely taken. Hatchery rainbow trout, marked and unmarked, contributed 71.0 percent of all game-fish taken in 1968 and 47.9 percent in 1969. From 1968 to 1969 there was about a 14.3 percent increase in the yield of wild game-fish and a 56.3 percent decrease in the yield of all hatchery fish.

The yields of wild rainbow and brown trout in 1968, were 1,382 and 402 pounds; and in 1969, 1,937 and 360 pounds, respectively. During both years the number of rainbow trout was 91 percent of the wild trout caught in section A. In section B, rainbow trout contributed about 86 percent for both years. The contribution of rainbow trout by weight in section A was 79 percent in 1968 and 83 percent in 1969. In section B, it was 76 and 85 percent, respectively. A definite relationship existed between the yield in numbers per acre and

Table 4. Estimated game-fish yield and catch-rate for Big Spring Creek, 1968 and 1969.

Game-fish	1968 Number	1968 Percent of Total	1968 Catch Per Hour	1969 Number	1969 Percent of Total	1969 Catch Per Hour
Wild rainbow trout	3,033	25.3	0.24	3,576	46.0	0.32
Brown trout	407	3.4	0.03	462	5.9	0.04
Marked hatchery rainbow trout (caught same season as plant)	8,305	69.3	0.65[3/]	3,212	41.3	0.33[3/]
Marked hatchery rainbow trout (caught season after plant)	61	0.5[2/]	--	36	0.5	--
Unmarked hatchery rainbow trout[1/]	147	1.2	--	453	5.8	--
Marked hatchery rainbow trout planted above and "drifting" into study section	--	--	--	22	0.3	--
Arctic grayling	28	0.2	--	5	0.1	--
Brook trout	5	0.1	--	8	0.1	--
Total	11,986		0.92	7,774		0.69

1/ Identification based on eroded fins and to a lesser degree, coloration.

2/ Approximately 10,000 marked trout were stocked in the study area in 1967.

3/ All hatchery combined.

the late summer population numbers for both rainbow and brown trout. The simple correlation coefficient was 0.97 which was significant at the 1 percent level. Fewer brown trout were caught in proportion to their abundance in the stream than were wild rainbow trout. This difference in catchability was not sufficient to greatly reduce the correlation coefficient.

Stratum 2 accounted for 31.7 percent of the total yield in 1968 and stratum one and 2 each accounted for 28.6 percent in 1969 (Table 5). The largest yield on weekdays was in stratum 2 and on weekends-holidays in stratum one during both years. Harvest on weekdays accounted for 50.9 percent of the estimated yield during 1968 and 51.4 in 1969 (Table 5). Section B provided 61.8 and 71.4 percent of the total yield during 1968 and 1969, respectively (Table 6). During both years, more game-fish were caught per acre of stream in section A than in section B.

There was an increase in the catch-rate of wild trout, from 0.27 per hour in 1968 to 0.36 in 1969, which was accompanied by a 50 percent decrease in the catch-rate of all hatchery fish (Table 4). The weighted average catch-rate in 1968 was higher than in 1969 (Table 7). Little difference existed in the weighted average catch-rate between weekdays and weekends-holidays within each year. Differences did exist between strata, however, and the highest catch-rate was generally in stratum 2. Catch-rates determined from interview information were

Table 5. Estimated total yield of game-fish for each of five strata on weekdays and weekends-holidays for Big Spring Creek, 1968 and 1969.

	1968		1969	
Stratum	Weekdays	Weekends-holidays	Weekdays	Weekends-holidays
1	892	1,858	864	1,366
2	2,201	1,601	1,097	1,130
3	1,488	1,692	889	632
4	1,275	643	1,032	365
5	242	94	113	286
Total	6,098	5,888	3,995	3,779

Table 6. Estimated total yield of game-fish for each of five strata from section A and B for Big Spring Creek, 1968 and 1969.

	1968		1969	
Stratum	Section A	Section B	Section A	Section B
1	1,291	1,459	600	1,630
2	1,687	2,115	812	1,415
3	963	2,217	466	1,055
4	527	1,391	304	1,093
5	113	223	61	338
Total	4,581	7,405	2,243	5,531
Total per acre	536	238	263	178

Table 7. Catch per hour including all game-fish comparing weekdays with weekends-holidays, 1968 and 1969

Stratum	Weekdays		Weekends-holidays	
	Interview Information			
	1968	1969	1968	1969
1	0.99	0.65	0.89	0.71
2	1.24	0.82	1.20	0.79
3	0.75	0.62	1.07	0.64
4	0.76	0.70	0.55	0.43
5	0.68	0.65	0.31	0.92
Weighted Average	0.92	0.70	0.92	0.69
	Census Card Information			
1	0.81	0.62	0.81	0.49
2	1.00	0.64	1.19	0.73
3	0.84	0.67	1.05	0.67
4	0.71	0.63	0.54	0.65
5	0.77	0.60	0.64	0.42
Weighted Average	0.84	0.64	0.86	0.63

slightly higher than those from census cards.

In 1968, the predominant size of wild rainbow trout in the catch was in the 8.0-11.9 inch range which contained 68.1 percent of the total catch in section A and 67.7 percent in section B (Table 8). Marcoux (1969) determined that wild rainbow trout in section A averaged 7.4 inches at annulus II and 10.8 at III in 1968. In section B, they averaged 8.1 and 11.7 inches, respectively. Based on these growth rates and considering growth throughout the fishing season, it appears that age group II predominated in the 1968 catch for both sections. In 1969, the predominant size in the catch was in the 8.0-11.9 inch range (72.4 percent) in section A. Assuming little change in annual growth rates, it appears that age group II predominated in the 1969 catch for section A. Marcoux also found that the 1967 year class was quite predominant in section A. This may account for the greater percentage of 8.0-11.9 inch fish in the catch in 1969. In section B, the 8.0-11.9 inch range contained 51.8 percent and the 12.0-13.9 inch interval 34.2 percent. Age groups II and III were apparently important in the 1969 catch in this section. The catch of fish in the 6.0-7.9 inch size interval (considered mostly yearlings) exceeded 6.0 percent only in section A, 1969, where they made up 16.1 percent. The latter also reflect the strong 1967 year class. Although it was permissible to keep fish under 6.0 inches, only two were observed during this study. No evaluation of the brown trout

Table 8. Population and yield of wild rainbow trout by size intervals for sections A and B for Big Spring Creek, 1968 and 1969. (Percent in parenthesis).

Stream Section	Size Interval	1968 Population 1/		1968 Yield		1969 Population 1/		1969 Yield	
A	6.0- 7.9	1,357	(50.9)	272	(16.1)	671	(27.9)	62	(5.7)
	8.0- 9.9	538	(20.2)	511	(30.3)	754	(31.3)	386	(35.4)
	10.0-11.9	509	(19.1)	638	(37.8)	662	(27.5)	404	(37.0)
	12.0-13.9	216	(8.1)	221	(13.1)	240	(10.0)	201	(18.3)
	14.0-15.9	29	(1.1)	32	(1.9)	69	(2.8)	26	(2.4)
	16.0-19.9	8	(0.3)	13	(0.8)	11	(0.5)	9	(0.8)
	20+	8	(0.3)	0	(0.0)	0	(0.0)	4	(0.4)
Total		2,665		1,687		2,407		1,092	
B	6.0- 7.9	614	(15.1)	30	(2.2)	485	(9.4)	42	(1.7)
	8.0- 9.9	1,228	(30.2)	390	(29.0)	1,343	(26.0)	472	(19.0)
	10.0-11.9	996	(24.5)	521	(38.7)	1,492	(28.9)	815	(32.8)
	12.0-13.9	809	(19.9)	230	(17.1)	1,311	(25.4)	850	(34.2)
	14.0-15.9	403	(9.9)	160	(11.9)	475	(9.2)	288	(11.6)
	16.0-19.9	16	(0.4)	15	(1.1)	57	(1.1)	17	(0.7)
	20+	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Total		4,066		1,346		5,163		2,484	

1/ Late summer population estimates projected for the entire section.

population and yield by size intervals was made since numbers were small for both years.

An estimated 83 percent of the 10,000 marked hatchery rainbow trout stocked in the study area in 1968 were caught by fishermen while 64 percent of 5,000 stocked in 1969 were caught.

Of the marked hatchery fish caught, in 1969, 74 to 89 percent were taken within 2 weeks after stocking. Butler and Borgeson (1965) found that it required an average of 6.5 days to harvest 75 percent of the hatchery fish in California streams.

Unlicensed juveniles fishing without their parents had a larger proportion of marked hatchery trout than was found in the overall catch (Table 4). In 1968 and 1969, hatchery fish represented 87 and 79 percent, respectively in their catch. In 1969, 83 percent were contacted in access areas, where marked hatchery trout were most available.

The catch of "drifting" hatchery rainbow trout planted above the study area in 1969, amounted to only 0.3 percent of the total catch.

Of the total number of fish caught, in 1969, approximately 27 percent were released. The percent released was about the same for weekdays and weekends-holidays and between strata, except stratum 5 where about 50 percent were released.

Fishing party size ranged from one to seven in 1968 and one to 10 in 1969. One was the most predominant size during both years

representing 43.7 and 41.4 percent, respectively, of the total party numbers. Using finished interview and card information, the fishing success of parties was estimated. The percent of parties catching a limit of 10 fish per individual was 3.8 in 1968 and 3.0 in 1969. The percent of parties catching five or more fish was 17.7 and 12.4 for the two years, respectively. If the bag limit had been reduced to five and assuming that the fish "saved" would not have been caught by other fishermen, the total yield of game-fish would have been reduced by 1,988 (16.6 percent) in 1968 and 1,002 (12.9 percent) in 1969. The percent of parties catching no fish was 29.4 in 1968 and 37.4 in 1969.

Relationships between numbers in the fishing party, the total trout caught, the catch-rate, and the total hours fished per party were computed. The information for these relationships was taken from randomly selected census cards combined for both years. The simple correlation coefficient between total hours per party and the number of fishermen in the party was 0.65 (significant at the 1 percent level). The regression coefficient was 2.93 (i.e., as the number in the party increased from one to two, the hours fished increased from 2.5 to 5.4 or 1:2.2). This indicated that the average fishing time per individual increased with an increase in the party size.

The simple correlation coefficient between total hours per party and total trout caught was 0.43 (significant at the 1 percent level). The regression coefficient was 0.44 (i.e., as the hours fished

increased from one to two, the trout caught increased from 1.7 to 2.1 or 1:1.2). This indicated that as the hours in the party increased the rate at which they caught fish decreased.

The simple correlation coefficient between total hours per party and the catch-rate was -0.16 (significant at the 1 percent level). The regression coefficient was -0.59. The partial correlation between total hours per party and a particular party size having adjusted for the catch-rate was not significant. The latter correlation could mean that the catch-rate did not influence the length of time people stayed even though there was a simple correlation between total hours per party and catch-rate. But, the simple correlation was based on fishing party size, which was usually greater than one. Larger parties tended to stay longer and catch fish at a slower rate.

From these three relationships it would appear that the larger fishing parties were not as efficient in catching fish and/or added non-fishing periods to the census cards.

DISCUSSION

There was an increase in the catch of wild trout in 1969 despite a decrease of some 2,000 fishermen-hours (14.7 percent) from the previous season. The increase in yield for both wild rainbow and brown trout was in section B. Assuming that the late summer fish populations were indicative of those for the entire season, the yield of wild trout paralleled changes in abundance more than changes in fishing pressure.

A reduction of 50 percent in the number of marked hatchery rainbow trout stocked in 1969 compared to 1968, resulted in a 71 percent reduction in the catch of marked hatchery fish. The catch-rate decreased by about the expected 50 percent but the in-season return of marked hatchery trout decreased from 83 to 64 percent. The difference between the return (19 percent) of marked hatchery fish was probably due to the 14.7 percent decrease in fishing pressure.

During both years, wild rainbow trout were not caught and kept in proportion to their relative abundance with respect to size, particularly those under 10.0 inches. It is probable that a high percentage of the fish released were under 10.0 inches. In heavily fished Lawrence Creek, Wisconsin, yearling brook trout made up 48 to 89 percent of the numerical yield, exploitation of age group II resulted in a scarcity of older fish and the stability of the population was becoming dependent upon the reproduction of a single age

group (McFadden, 1961). In Big Spring Creek, age group II wild rainbow trout usually predominated in the catch while the estimated percent of age group III and older (longer than 12.0 inches) varied from 15.8 to 46.5 between years and sections. The presence of multiple age group structure imparts a damping effect upon population fluctuations in that reproduction is not dependent upon a single age group (Ricker, 1954).

Marcoux (1969) discussed the effects of habitat quality on the abundance of trout populations in Big Spring Creek, particularly below the East Fork tributary. Since the yield followed population abundance it may be used as an indirect estimator of changes in the quality of habitat following watershed improvements.

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APPENDIX

Table 1. Percent of days with clear, murky, and muddy water at three stations on Big Spring Creek, 1968 and 1969, and at one station on the East Fork tributary, 1969.

STATION	CLEAR (0-3 ppm)		MURKY (3+-7 ppm)		MUDDY (7+-500+ ppm)	
	1968	1969	1968	1969	1968	1969
Subsection A_1	73%	83%	8%	11%	19%	6%
Subsection B_1	56%	48%	20%	37%	24%	15%
Lower end of section B	45%	26%	31%	46%	24%	28%
East Fork Tributary	--	7%	--	34%	--	59%