FISH POPULATIONS OF A TROUT STREAM IN RELATION TO MAJOR HABITAT ZONES AND CHANNEL ALTERATIONS

by

ALLEN AUGUST ELSER

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Head, Major Department

Chairman, Examining Committee

Graduate Dean

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VITA

The author, Allen August Elser, was born in Denver, Colorado, December 6, 1938, to William and Dorothy Elser. He graduated from South Denver High School in 1957 and entered Otero Junior College, La Junta, Colorado the same fall. In the fall of 1961, he entered Colorado State University, Ft. Collins, Colorado and in June 1964 received a Bachelor of Science degree in Fisheries Science. He began graduate studies at Montana State University in the fall of 1964 as a Graduate Research Assistant with the Montana Cooperative Fisheries Unit. He is married to the former Ardyth Bennett and they have a daughter, Holly Kay.

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ABSTRACT

The relationship of fish populations to major habitat zones and channel alterations was studied in Little Prickley Pear Creek, Montana during the summers of 1965 and 1966. Five major zones were defined as follows: headwater, meadow, mountain, lower meadow, and Wolf Creek Canyon, with at least one representative study section in each. Approximately 23 percent (6 of 30 miles) of the stream has been altered. Field measurements showed no pool-riffle periodicity in the altered mountain sections, while successive riffles were spaced at intervals of 5.7 widths in the unaltered areas. By area, the altered sections of the mountain zone consisted of 87 percent shallow-fast water with no deep-slow, compared to 49 and 14 percent, respectively, for the unaltered sections. The amount of cover per acre of stream was about 80 percent greater in the unaltered mountain sections than in the altered. Rock deflectors in the altered section of Wolf Creek Canyon rendered the physical characters of the stream nearly comparable to the unaltered sections. Fish populations were estimated by means of a simple mark-and-recapture census. Non-trout species were absent from the altered sections, but made up 30 and 58 percent of the total number and weight, respectively, in the unaltered mountain sections. Trout were 78 percent more abundant in the unaltered mountain sections than in the altered, and a statistical test showed a significant difference between the two trout populations. Standing crops of trout ranged from 40 to 226 pounds per acre, and the total stream supported an estimated 20,400 trout greater than 4.0 inches long weighing 9,500 pounds. Channel alterations resulted in a total loss of 4,700 trout with a total weight of 2,200 pounds.

INTRODUCTION

Many streams display gradual changes in physical, chemical, and biological conditions from source to mouth. Allen (1951) divided the Horokiwi Stream into six distinct zones based on differences in physical features and their trout population. The Portage River was classified by Langlois (1965) into three zones, each characterized by a distinct group of fish. Shelford (1911), Ricker (1934), and Hallam (1959) demonstrated linear differences in the distribution of fish in streams with graded series of conditions from source to mouth on the basis of habitat preferences and associated fauna.

Habitat alterations create additional variations within the lotic environment. Gunderson (1966) found major differences in the stream morphology and fish populations between two adjacent segments, one of which had been disturbed through overgrazing of the floodplain vegetation. Following habitat alteration of a small stream for highway construction, Whitney and Bailey (1959) showed a 94 percent reduction in number and weight of trout greater than 6.0 inches in length. Johnson (1964) found that channel alterations of the Shields River resulted in reductions of 90 percent in the number and weight of game fish.

The objectives of the present study were to define and describe the major habitat zones of a trout stream and the associated fish populations, and to compare certain physical and biological conditions of unaltered and altered portions of this stream. Field studies were carried out during July, August, and September of 1965 and 1966.

DESCRIPTION OF AREA

Little Prickley Pear Creek rises on the east slope of the Continental Divide in Lewis and Clark County, Montana, approximately 30 miles northwest of Helena. It flows northeasterly for about 35 miles to its confluence with the Missouri River about 6 miles upstream from Craig. The upper nine miles (headwater zone), with an average summer discharge of three to five cfs flows through a floodplain about 4,000 yards wide. Stream-side vegetation consists primarily of willow (Salix spp.) interspersed with cultivated grasses. The stream triples in size with the convergence of Canyon Creek, a torrential type stream with an approximate summer flow of 10-15 cfs (Figure 1).

Below the confluence of Canyon Creek, the stream meanders 5 miles through a meadow zone. The average floodplain width is 8,150 yards and the gradient is 11 feet per stream mile. Summer discharge increases from 18 cfs at section 2 to 27 cfs at section 3. The stream is somewhat modified by dewatering since the major floodplain use is agricultural. Willow remains the dominant bank vegetation (Figure 2), being interspersed with alder (Alnus spp.), red dogwood (Cornus stolonifera), and chokecherry (Prunus virginiana).

From the meadow, the stream flows 8 miles through a mountain zone with a floodplain width of 125 yards. The gradient increases to 23 feet per mile. Summer flow at section 7 averages 35 cfs, increasing to 43 cfs at the Sieben Gage Station (Figure 1). Willow, dogwood and alder remain the dominant stream-side vegetation, with narrowleaf cottonwood (Populus

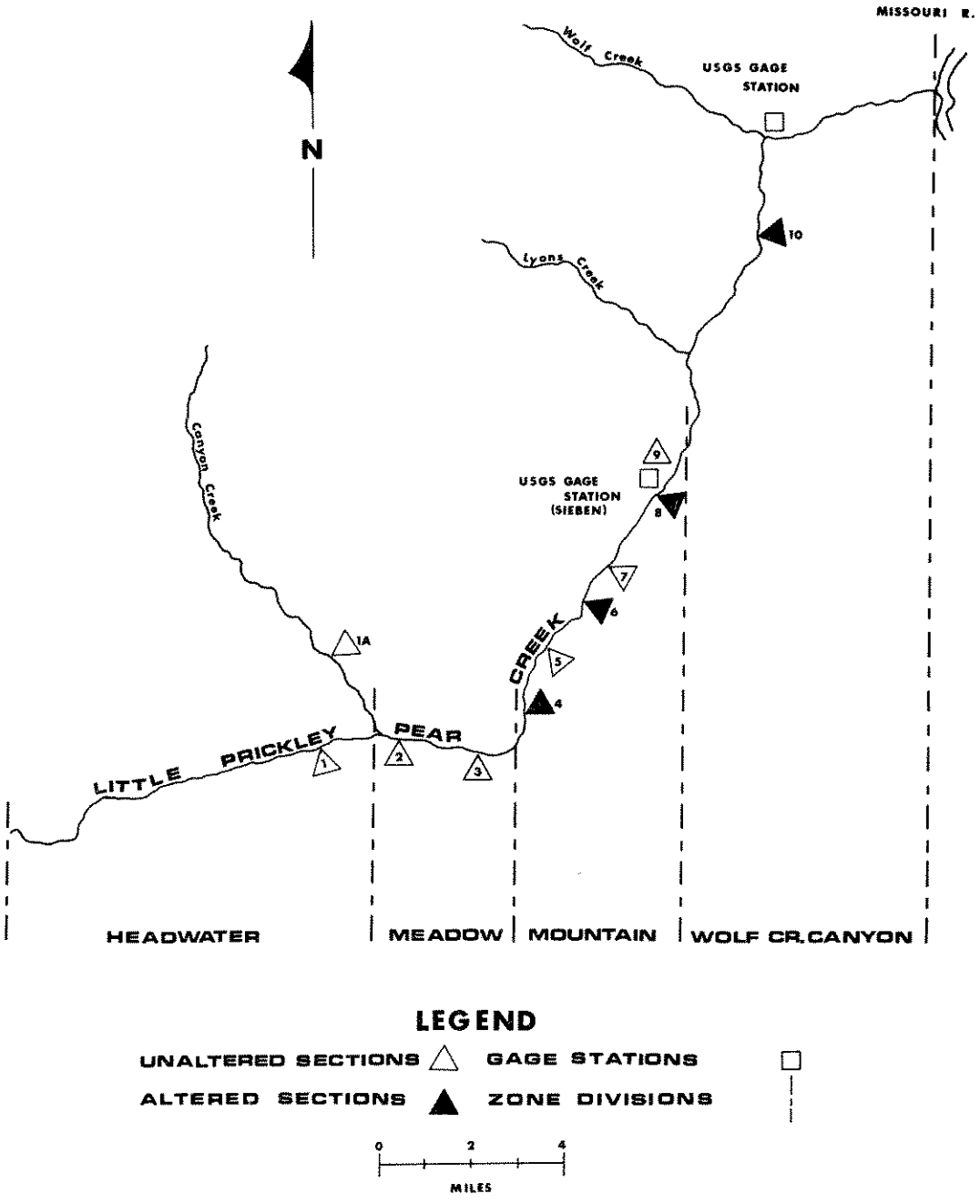

Figure 1. Map of study area, showing location of study sections. (Lower meadow zone, includes sections 8 and 9, not indicated because of the small scale).

Figure 2: Meadow zone showing willows and interspersion of cultivated grasses.

Figure 3: Mountain zone exemplifying local dominance of cottonwoods.

angustifolia) locally important in certain areas (Figure 3). In 1887, the Montana Central Railway Company laid 96 miles of track from Helena to Great Falls, straightening much of the channel in this zone. Differences in the vegetative compositon on these altered sites were noted, with gooseberry (Ribes spp.), raspberry (Rubes spp.), miners candle (Crypthanthe bradburiana), and Russian thistle (Salsola kali) being dominant (Figure 4).

Below the mountain area, the stream proceeds through a small meadow (sections 8 and 9) before flowing through the Wolf Creek Canyon zone to the Missouri. Within the canyon the floodplain is 80 yards wide and the gradient is 33 feet per mile. Summer discharge at the town of Wolf Creek averages 63 cfs. Construction of Interstate Highway 15 greatly altered the stream channel and left only sparse patches of willow, cottonwood, and alder. Following construction, rock deflectors were installed to improve habitat quality (Figure 5).

Peak discharge at the Sieben Gage Station occurs in May and June, coincident with runoff from rains and snow melt. Low flows occurred in August. A slight increase in September resulted from reduced irrigational use. The mean monthly discharges for July, August, and September 1965 were 92, 52, and 86 cfs, respectively. Discharge during 1966 was considerably less, with mean monthly flows of 33, 14, and 20 cfs for July, August, and September, respectively.

Summer water temperatures were measured at the Sieben Gage station. In 1965, the ranges for July, August, and September were: 52.5-63.6 F, 52.9-62.2 F, and 41.0-46.2 F, respectively. The highest recorded temperature was 64.7 F in June 1963 (Swedberg, 1965).

Figure 4: Altered section of mountain zone, showing the differences in vegetation and straightened channel.

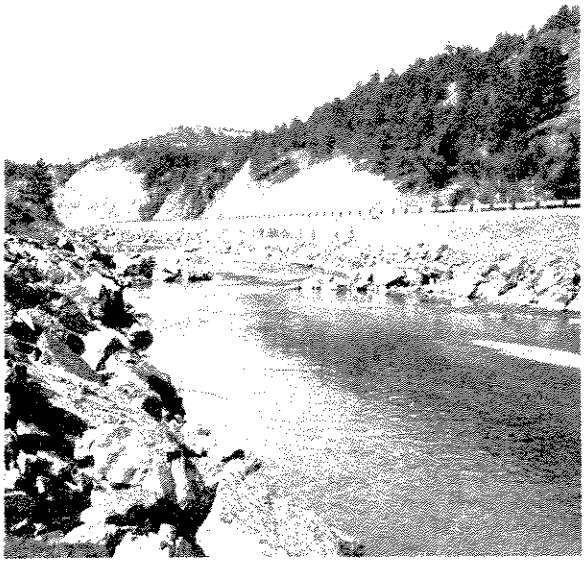

Figure 5: Altered segment of Wolf Creek Canyon zone, illustrating the denuded channel and rock deflectors.

The majority of soils along the floodplain is loamy in texture and weakly calcareous. Soils of the drainage are primarily derived from weathered argillite rock with smaller contributions from weathered quartzite, limestone, and igneous rocks (correspondence with Soil Conservation Service).

Chemical analyses were made at various sites along the stream (Table 1). In general, values increased with progression downstream.

Table 1: Chemical analyses (ranges) for Little Prickley Pear Creek during the summers, 1965-66.

Zone	Total Alkalinity (M.O.) ppm	Total Hardness ($CaCO_3$) ppm	pH	Conductivity in reciprocal megohms (25° C.)
Canyon Creek	125	80-125	8.1-8.3	225
Meadow	180-215	180-215	7.9-8.5	350-440
Mountain	225-245	215-235	8.0-8.7	410-445

Trout were the most abundant fish collected in the stream. Brown trout (Salmo trutta) predominated, followed by rainbow trout (Salmo gairdneri) and eastern brook trout (Salvelinus fontinalis). Longnose suckers (Catostomus catostomus), white suckers (Catostomus commersoni) and and mountain whitefish (Prosopium williamsoni) were present in most sections. The mottled sculpin (Cottus bairdi), while abundant, could not be collected efficiently. No hatchery fish have been stocked in the stream since 1954.

METHODS

General stream morphology was delineated from Montana Highway Department aerial photos (scale 1:3000) taken in the spring of 1965. Stream length and the extent of vegetative bank cover (including shrubs and small trees) and channel alterations were measured in each zone. Photos taken prior to and following construction in the Wolf Creek Canyon zone were used to evaluate changed conditions resulting from alteration. No photos were available for Canyon Creek. Meanders, defined as S-shaped channels patterned in alluvial materials (Matthes, 1941), were counted. The sinuosity, or ratio of channel length to down valley distance (Leopold, Wolman, and Miller, 1964), was determined for each zone. A stream segment was considered meandering if the sinuosity was 1.5 or greater.

Physical conditions and fish populations were measured in 11 study sections which were selected with the aid of aerial photos. At least one representative section was established in each zone (Figure 1). Each of 10 sections was 1,000 to 1,200 feet in length, and one (section 9) was 700 feet long. No measurements were made below the confluence of Wolf Creek.

Each section was mapped and classified using a modified water-type key (Burkhard, 1964) based on depth and surface velocity (Table 2). All physical measurements were made during the period August 10 through September 2, 1966. Transects were placed at 10 foot intervals along the channel perpendicular to the main current. Depths were taken to the nearest 0.1 foot at 1 foot intervals on each transect and velocities estimated

Table 2: Water-type criteria used in mapping.

Water-type	Depth (ft)	Surface Velocity (ft/sec)
Shallow-slow	-1.5	-1.0
Deep-slow	+1.5	-1.0
Shallow-fast	-1.5	+1.0
Deep-fast	+1.5	+1.0

by timing floats over known distances. Cover provided by overhanging brush, undercut banks, stumps, rocks, and log jams was recorded. The area of each water-type and cover was determined with a planimeter.

Most natural channels have a bed consisting of alternating deeps and shallows (Leopold and Langbein, 1966), commonly refered to as pools and riffles. The extent and frequency of these were determined by measuring the thalweg, or line connecting the deepest points of the channel. A pool was arbitrarily defined as a vertical drop in the stream bed greater than the average thalweg depth.

The fish population of each section was sampled with a 300-volt, 850-watt direct current shocker. Captured fish were anesthetized with MS-222 (Tricane Methanesulfonate), measured to the nearest 0.1 inch in total length, weighed to the nearest 0.02 pound, and released near the capture site. Fish were marked in 1965 by clipping the right pelvic fin and in 1966 by an opercular punch. A period of at least 4 hours was allowed to elapse before the section was resampled. On the second pass, lengths and markings were recorded on all fish handled, but weights were taken only on those fish not captured on the first pass.

Estimates of the fish population (excluding fish less than 4.0 inches total length) were based on the mark-and-recapture technique of

Petersen, using formula 3.5 of Ricker (1958). Due to differential catchability related to size (Cooper and Lagler, 1956), trout were grouped by 4-inch size groups. Whitefish and suckers were separated into two size groups, i.e. under or over 12.0 inches. Confidence intervals at the 95% level were calculated for each estimate by formula 6 of the Michigan Institute for Fisheries Research (1960).

A stratified subsample of 500 brown trout and 400 rainbow trout scales was selected from the meadow and mountain zones for analysis of age and growth. Annuli were identified with the aid of a scale projection machine. Total lengths at all annuli were determined with a nomograph, assuming a linear relationship between scale and body growth.

RESULTS

Stream Morphology

Physical parameters obtained from the aerial photos of Little Prickley Pear Creek are shown in Table 3. The extent of stream bank protected by vegetative cover was greatest in the meadow (87 percent) and lowest in the heavily altered Wolf Creek Canyon zone (6 percent). The meadow zone, with a sinuosity of 1.76 and 7.7 meanders per mile, was the only meandering segment. An average sinuosity of 1.09 for the lower three zones indicates an almost non-sinuous channel which was the result of alterations.

The upper 14 miles of stream are relatively undisturbed. Channel relocations for railroad construction in the mountain zone left more than one-third of the stream in a disturbed condition. This resulted in a loss of 0.3 mile (4 percent) of natural channel and a 40 percent reduction in meanders. Approximately 50 percent of the altered stream bank was without vegetative cover, while only 20 percent of the natural stream bank was bare. As a result of Interstate construction in Wolf Creek Canyon, 87 percent of the channel from Lyons Creek to Wolf Creek was altered. The channel length was reduced by 1.1 miles (16 percent) and the bank vegetation by 89 percent. Sinuosity decreased from 1.28 to 1.10 with a 73 percent loss of meanders.

Average stream width and depth increased with progression downstream, except near the lower meadow zone (Table 4). Altered sections of the mountain zone were wider and shallower than the unaltered segments of the same zone. The average thalweg depths were about 35 percent less for the

Table 3: Channel measurements obtained from aerial photos.

Zone	Length (miles)	Area (acres)	Bank Cover (%)	Sinuosity	No. Meanders Per Mile	Altered (%)
Headwater	9.0	9.8	82.4	1.25	5.1	0.0
Meadow	5.2	13.2	86.8	1.76	7.7	0.0
Mountain	5.8	18.3	75.4	1.14	3.3	27.5
Lower Meadow	1.7	5.2	64.4	1.03	2.9	49.0
Wolf Creek Canyon (to Wolf Creek)	8.8	46.9	5.5	1.10	0.5	57.2
Total Stream (to Wolf Creek)	30.5	93.4	58.6	1.26	3.8	22.2

Table 4: Channel measurements from 11 sections obtained from Little Prickley Pear Creek, 1966.

Parameter	1A	1	2	3	4[1]	5	6[1]	7	8[1]	9	10[1]
Area (acres)	0.59	0.27	0.46	0.56	0.74	0.65	0.78	0.53	0.43	0.31	0.80
Average width (ft)	18.0	9.0	18.0	24.0	25.0	27.0	29.0	24.0	21.0	25.0	44.0
Average depth (ft)	0.7	0.6	0.9	1.0	0.7	1.1	0.7	1.1	0.8	1.0	1.1
Gradient (%)	1.00	0.75	0.50	0.50	1.25	0.50	1.25	0.50	1.00	0.75	0.50
Avg thalweg depth (ft)	1.2	0.9	1.4	1.7	1.1	1.7	1.1	1.8	1.2	1.8	2.0
Thalweg / Down valley distance	1.27	1.43	1.61	1.39	1.08	1.66	1.10	1.54	1.08	1.18	1.12
Pool-riffle periodicity[2]	7.8	6.3	5.4	4.1	-	5.8	-	5.7	9.3	5.2	4.4
Water-types (%)											
Shallow-slow	27.4	25.8	54.5	36.5	14.3	23.5	13.2	26.1	33.0	26.4	40.4
Deep-slow	2.6	2.8	16.2	19.3	0.0	16.9	0.0	13.2	1.8	7.8	8.8
Shallow-fast	62.6	64.2	26.1	31.5	84.2	45.3	86.7	49.7	61.7	56.3	42.4
Deep-fast	7.4	7.2	3.2	12.7	1.5	14.3	0.1	12.8	3.5	9.5	8.4
Cover (ft^2/acre)	3218	10792	11467	6674	438	6169	1648	4068	3133	1090	143

1/ Altered sections.
2/ Average distance between successive riffles divided by average width, expressed in widths.

altered sections of the mountain and lower meadow zones than for the unaltered portions of the same zones. Gradients were greater for the altered than the unaltered sections.

Increased stream flow and alteration in Wolf Creek Canyon resulted in a greater channel width. The rock deflectors in the altered segments of this zone were installed at intervals of 180-200 feet along the channel. Paired structures were established opposite, but somewhat offset from each other, to constrict the current and produce a meander. Large pools (4.2 feet deep) were scoured immediately below the deflectors, with an area of deposition beyond. As a result, the average depth and average thalweg depth were greater in this altered section than in the altered sections of the mountain and lower meadow zones.

In natural stream conditions, the thalweg tends to wander back and forth across the channel, even in straight reaches. The relative degree of wandering is indicated by the ratio of thalweg length to mean down valley distance. This ratio for altered sections averaged 1.09 (range 1.08 to 1.12), compared to 1.46 (1.18 to 1.66) for the unaltered sections. Channel alignment and bank stabilization with riprap prevented the thalweg from following a sinuous course in the altered sections. This is further shown by the lack of pool-riffle periodicity (spacing of successive riffles) in the altered sections. The periodicity of riffles in the unaltered sections ranged from 4.1 to 7.8 widths (Figure 6A). According to Leopold and Langbein (1966) the spacing of successive riffles is ordinarily in the magnitude of from 5 to 7 times the average stream width. In the altered mountain sections (all riffle) there was no periodicity (Figure 6B), and in

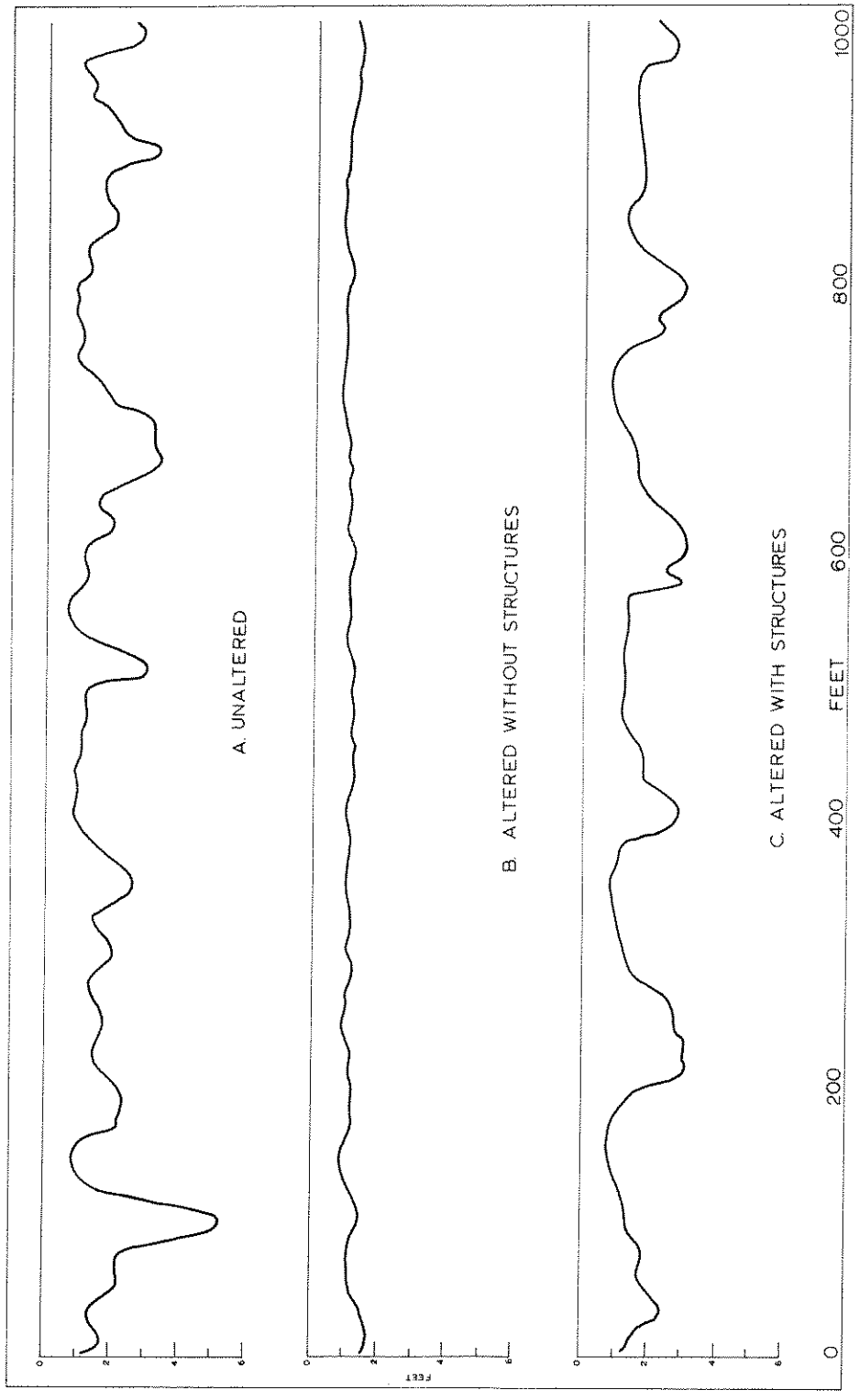

Figure 6: Bottom profiles along the thalweg of three stream sections, showing the pool-riffle periodicity: A. Unaltered, B. Altered without structures, and C. Altered with structures.

the altered lower meadow section, riffles were spaced at an average of 9.3 widths. The Wolf Creek Canyon section, although altered, had a periodicity of riffles near 4.4 times the width, corresponding to the spacing of the deflectors (Figure 6C).

The extent of water-types is shown for each section in Table 4 and for each zone in Figure 7. The Canyon Creek and headwater sections both possessed large amounts of shallow-fast with limited amounts of deep-slow and deep-fast water. The increase of slower water-types in the meadow illustrates the increased stability and pool development of this zone. Unaltered sections of the mountain and lower meadow zones were combined because of their similarity. Altered sections of the mountain zone consisted of 86 percent shallow-fast water with no deep-slow as compared to 49 and 14 percent, respectively, for the unaltered sections. The altered section of the lower meadow appears to be somewhat transitional, with a greater degree of shallow-slow and a slight increase in deep-slow and deep-fast water. Unaltered sections had a greater degree of interspersion of types as indicated by the pool-riffle periodicity.

Scouring action below each deflector in the Wolf Creek Canyon section resulted in a greater amount of deep water than in the altered sections of the mountain and lower meadow zones (17%, 1%, and 4%, respectively). Measured physical conditions indicated that the structures rendered the stream more like the unaltered sections. Cover was the only factor which remained unimproved (Table 4).

The amount of cover per acre of stream was greatest in the meadow zone (Table 4). Distinct differences occurred between the unaltered and altered

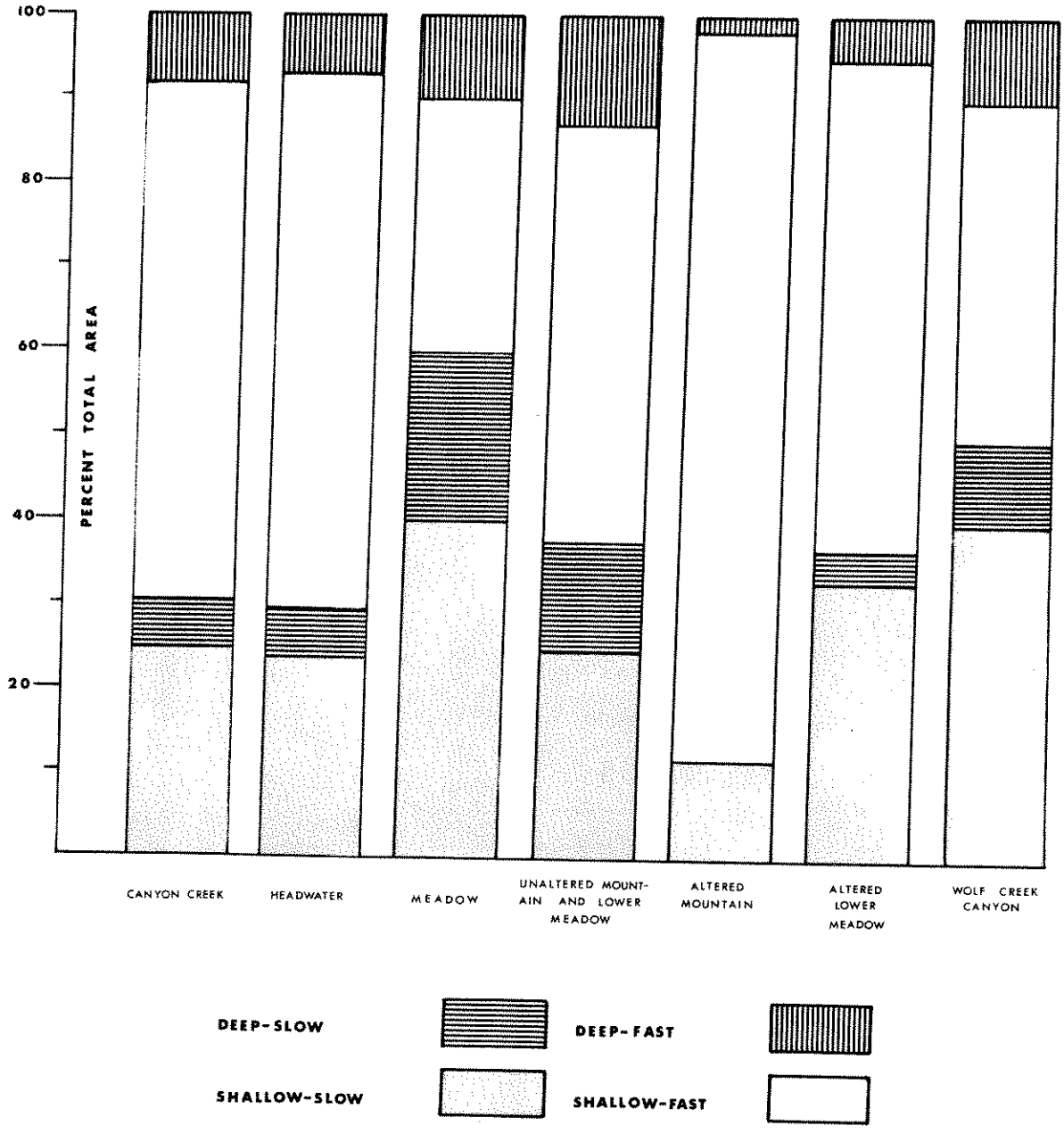

Figure 7: Percent of water-types in each zone.

sections of the mountain and lower meadow zones. Unaltered sections had 81 percent more cover than the altered mountain sections and 44 percent more than the altered lower meadow section. The lower meadow alteration appears to be transitional in cover also, with 67 percent more cover than the altered sections of the mountain zone. The Wolf Creek Canyon section was extremely poor in cover, possessing 67 to 95 percent less than other altered areas.

Fish Populations

Population Estimates. Fish populations were censused in 1965 and 1966 but analyses were limited to 1966 data (Table 5), since all physical measurements were made in 1966. Also, the ratio of total marked fish to total marked recaptures (rate of efficiency) was 12 percent better in 1966 than in 1965. Lower average stream flows in 1966 probably accounted for the increased efficiency. Population estimates for each section for 1965 were similar to those of 1966 but with less degree of confidence.

The population of Canyon Creek was predominantly rainbow trout, which comprised 75 and 66 percent of the total number and weight, respectively. Over 65 percent of all trout were less than 8.0 inches long.

Brook trout were predominant in section 1 (headwater zone), making up 49 and 57 percent of the total population by number and weight, respectively. Rainbow trout made up 46 percent by number but only 27 percent by weight.

The meadow population tends toward brown trout predominance. The three trout species were about numerically equal in section 2 (brown

Table 5: Estimated fish populations for 11 sections, 1966, expressed as number per acre with pounds per acre in parentheses. (Confidence intervals at 95% level).

Species	1A	1	2	3	4 1/	5	6 1/	7	8 1/	9	10 1/
Brown trout	22 (14)	37 (28)	247 (115)	514 (149)	76 (30)	355 (157)	74 (39)	289 (153)	333 (93)	387 (99)	64 (14)
Rainbow trout	257 (42)	396 (45)	253 (50)	295 (51)	35 (8)	208 (57)	78 (18)	315 (70)	123 (17)	271 (53)	298 (36)
Brook trout	67 (9)	414 (96)	232 (34)	142 (18)	8 (2)	11 (4)	8 (1)	15 (3)	28 (6)	10 (2)	5 (1)
Whitefish	--	--	--	39 (45)	1 (2)	31 (52)	--	17 (26)	--	10 (8)	--
Longnose sucker	--	--	1 (3)	281 (345)	--	255 (383)	--	145 (150)	--	--	--
White sucker	--	--	--	33 (42)	--	9 (11)	--	42 (31)	--	--	--
Total trout	346	847	732	951	119	574	160	619	484	668	367
Confidence interval (±)	69 (65)	159 (169)	79 (199)	121 (218)	36 (40)	103 (218)	24 (58)	123 (226)	59 (116)	99 (154)	86 (51)
Total non-trout	--	--	1	353	1	295	--	204	--	10	--
Confidence interval (±)			(3)	98 (432)	(2)	86 (446)		42 (207)		5 (8)	
Grand total	346 (65)	847 (169)	733 (201)	1304 (650)	120 (42)	869 (664)	160 (58)	823 (433)	484 (116)	678 (162)	366 (51)

1/ Altered sections

trout 34%, rainbow trout 34%, and brook trout 32%), but brown trout comprised 58 percent of the weight and rainbow trout 35 percent. Only one non-trout speciman, a longnose sucker, was collected. In section 3, trout made up 73 percent of the total number with brown trout predominant (60 percent of the trout and 40 percent of the total population). The non-trout species dominated by weight with longnose suckers contributing 53 percent of the total. Brook trout, whitefish, and white suckers made up approximately 16 percent of the total number and weight.

A difference in fish populations occurred between the unaltered and altered sections of the mountain zone. Non-trout species were almost completely absent from the altered sections, but made up 30 and 58 percent of the total number and weight, respectively, in the unaltered sections. The number and weight of brown trout and rainbow trout were about 78 percent greater in the unaltered sections. Differences in the number of trout occurring between the unaltered and altered sections were not restricted to any one size-group (Table 6). Confidence limits showed a significant difference at the 95% level for trout or total population numbers between the unaltered and altered sections.

Population differences between the unaltered and altered sections of the lower meadow zone were not as pronounced. Brown trout predominated in both sections, being 14 and 6 percent greater by number and weight, respectively, in the unaltered section. A greater difference was obvious in the number and weight of rainbow trout, being 55 and 68 percent greater, respectively, in the unaltered section.

The lower meadow alteration was considered transitional, since brown

Table 6: Average brown and rainbow trout populations for the major zones, expressed as numbers and pounds per acre.

Species	Size Group	Zone					
		Meadow	Unaltered Mountain	Altered Mountain	Altered Lower Meadow	Unaltered Lower Meadow	Wolf Creek Canyon
Brown trout	4.0-7.9	184	107	26	179	226	51
	8.0-11.9	147	120	29	126	129	10
	12.0-15.9	59	92	16	28	29	2
	16.0-plus	8	9	3	-	3	1
Total brown trout		398	328	74	333	387	64
Confidence interval		367-429	277-379	59-89	296-370	339-435	35-93
Total weight		133	155	35	93	99	14
Rainbow trout	4.0-7.9	178	171	39	102	213	273
	8.0-11.9	84	54	15	21	35	25
	12.0-15.9	16	29	4	-	23	-
	16.0-plus	2	2	-	-	-	-
Total rainbow trout		280	256	58	123	271	298
Confidence interval		241-319	203-309	47-69	111-135	229-313	245-351
Total weight		51	64	13	17	53	36
Grand total		678	584	132	456	658	362
Confidence interval		608-748	480-688	106-158	407-505	568-748	280-444
Total weight		184	219	48	110	152	50

trout and rainbow trout were 79 and 53 percent more numerous, respectively, than in the mountain altered sections. Confidence intervals for combined brown trout and rainbow trout population estimates show an over-lap between the meadow, unaltered mountain, and unaltered lower meadow sections. No over-lap was evident between the estimated populations of the unaltered and altered sections of the lower meadow zone (Table 6).

Rainbow trout were predominant in the Wolf Creek Canyon section, contributing 81 percent of the total number. Total trout of this altered section were 62 and 4 percent greater by number and weight, respectively, than in the mountain alterations; but 25 and 55 percent less, respectively, than in the lower meadow alteration.

Age and Growth. Brown trout and rainbow trout were 16 percent less abundant numerically but 14 percent greater by weight in the mountain zone than in the meadow zone. Average calculated total lengths of both species from the two zones indicated very similar growth rates (Table 7). Hence, the greater weight in the mountain zone was due to more large fish, rather than a faster growth rate. There was also no indication of differential growth between unaltered and altered sections of the mountain zone for brown trout or rainbow trout.

Grand average calculated lengths for the first three annuli were less than those reported by Bishop (1955). Bishop adjusted the calculated lengths at each annulus by using intercepts of regression lines as the zero points of the nomograph. For the present study, zero was used as the intercept.

Table 7: Average calculated total length at each annulus for brown and rainbow trout from the meadow and mountain zones.

Zone	Age Group	Brown Trout						Rainbow Trout				
			Length at Annulus						Length at Annulus			
		No.	1	2	3	4	5	No.	1	2	3	4
Meadow	I	72	3.5					31	3.1			
	II	83	3.4	7.3				75	2.9	6.8		
	III	37	3.5	7.7	11.1			58	2.8	5.7	8.5	
	IV	18	3.2	6.9	10.6	13.5		7	2.6	5.2	8.4	10.9
	V	7	2.8	5.9	9.7	12.9	15.5					
Average			3.4	7.3	10.8	13.5	15.5		2.9	6.2	8.5	10.9
Mountain	I	72	3.4					75	3.0			
	II	95	3.5	7.8				58	2.9	6.6		
	III	99	3.6	7.7	11.0			73	2.9	6.5	9.5	
	IV	29	3.4	6.8	10.7	13.8		15	2.9	5.6	9.1	12.1
	V	4	2.7	5.9	10.0	13.6	17.3					
Average			3.5	7.6	10.9	13.7	17.3		2.9	6.4	9.4	12.1
Grand Average			3.4	7.4	10.9	13.6	16.5		2.9	6.3	9.0	11.6
Bishop (1955)			3.8	7.7	11.1	13.7	16.5		3.5	6.6	9.4	11.8

DISCUSSION

Estimated standing crops of trout ranging from 40 to 226 pounds per acre in the 11 sections are comparable to those reported by others. McFadden and Cooper (1962) reported standing crops ranging from 60 to 137 pounds per acre for three hard-water streams in Pennsylvania. In Trout Creek, Montana, Wipperman (1963) found an average standing crop of 210 pounds per acre (67 to 340 pounds per acre). Nicholls (1958) reported total standing crops in several Australian streams ranging from 3 to 186 pounds per acre. Trout populations in Rock Creek, Montana were estimated at 121 pounds per acre for a disturbed section and 155 pounds per acre for an undisturbed section (Gunderson, 1966).

The average standing crops of trout in Little Prickley Pear Creek were much higher than the average of 56 pounds per acre reported by Stefanich (1952) for the Wolf Creek Canyon zone. However, his values are total numbers of fish captured in 600 foot sections using a 240-volt alternating current shocker, rather than population estimates. If sampling efficiency for the two studies was similar, Stefanich's standing crops would be approximately 25 percent greater than those reported, based on population estimates. Aerial photos taken prior to Interstate Highway construction and field maps suggest that at least some of his sections were in an altered state.

To evaluate the effects of habitat alterations on the fish population, estimated standing crops of trout were projected to the total stream for each zone from the confluence of Canyon Creek to Wolf Creek.

Trout in the meadow zone numbered 11,100 and weighed 2,750 pounds (210 pounds per acre). The mountain zone supported 8,600 trout and 3,200 pounds (175 pounds per acre). Alterations in this zone probably accounted for a loss of 2,300 fish with a total weight of 900 pounds. A total of 2,900 fish and 700 pounds were present in the lower meadow zone. Probable losses from alterations here amounted to 600 fish weighing 100 pounds. The Wolf Creek Canyon zone maintained a standing crop of 7,800 fish and 2,800 pounds. Based on population estimates modified from Stefanich's total numbers, the alterations probably resulted in an increase of 1,000 trout, but a loss of 700 pounds.

The probable loss for the total stream through channel alteration amounted to 2,900 fish weighing 1,700 pounds. A loss of 1.4 miles of natural channel resulted in an additional loss of 1,800 fish and 500 pounds. Total losses represent a 12 and 19 percent decrease in number and weight, respectively.

The rock deflectors in the Wolf Creek Canyon section resulted in physical characteristics nearly comparable to unaltered sections, except for vegetative cover. Since the alterations are recent, the fish population may not have stabilized to its potential, as indicated by the preponderance of small rainbow trout. In time, with the improvement of vegetative cover, the populations may increase to a level better than other altered sections.

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