

MONTANA FISH AND GAME DEPARTMENT
FISHERIES DIVISION

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

State Montana Title Reservoir Investigations
Project No. F-34-R-4 Title Life Cycle Studies of Westslope Cutthroat
Job No. III-a Trout and Mountain Whitefish
Period Covered July 1, 1969 through June 30, 1970

ABSTRACT

An upstream-downstream fish trap was operated on Hungry Horse Creek from May 15 through August 18, 1969. It was estimated that 1,034 adult westslope cutthroat trout, (Salmo clarki subsp.) passed upstream through the trap of which 219 were repeat spawners marked in the 1968 run. The sex ratio was 1: 3.9 males to females in the total upstream run. Total spent adults returning downstream numbered 523 cutthroat trout and had a sex ratio of 1: 5.2 males to females. The repeat spawners surviving their second year through the trap numbered 107 trout with a sex ratio of 1: 8.7 on their downstream run.

Total mortality accounted for 511 of the 1,034 fish entering the creek for spawning. An estimated 95 of the 511 fish were caught by anglers above the trap. Prior to the start of the 1970 spawning run, anglers caught 45 of the 523 cutthroat trout.

Adult cutthroat were tagged with anchor tags as they passed through the upstream trap. Tag loss in spent spawners recaptured in the downstream trap was 23 percent. Tagging also appeared to have caused high drop-back of fish downstream through the velocity barrier resulting in many fish having to re-enter the upstream trap two or three times.

The downstream trap caught 2,680 juvenile cutthroat trout as they moved downstream toward the reservoir. An estimated 41 percent were one-year-old, 55 percent two-year-old, and 4 percent three-year-old fish.

Mountain whitefish (Prosopium williamsoni) were enumerated passing through the trap to spawn in the fall of 1969. Total catch was 146 males averaging 11.9 inches and 40 females averaging 12.6 inches total length (sex ratio 3.6: 1). The major portion of the whitefish run spawn below the trap.

BACKGROUND

This research project segment has evolved after several years of development of a workable combination upstream-downstream fish trap in Hungry Horse Creek.

Annual flow fluctuations range from 5 cfs to about 600 cfs. The upstream trap, consisting of a velocity barrier with a bypass channel, evolved from the inadequacies of both a trash-rack trap and a barrier falls bypass channel structure. The upstream trap now in use and a downstream Wolf trap were installed and tested during spring and summer 1968.

The upstream trap can be fished at almost all flows in Hungry Horse Creek. It is calculated to withstand maximum flows of about 900 cfs, the exception being when whole trees or large stumps move downstream into the structure. The downstream trap can be fished at flows up to about 200 cfs unless large amounts of debris are in the water.

OBJECTIVES

Data on cutthroat trout spawning in Hungry Horse Creek have been collected yearly since 1963. Numbers, age structure of the spawning run and growth rates have been calculated. Little information is available on other aspects of the life cycle of westslope cutthroat trout. The long-term objective of this project segment is to delineate characteristics of the spawning and rearing phases of the species in Hungry Horse Creek and collect some information on movement patterns while in Hungry Horse Reservoir.

Operations of the upstream and downstream trap were designed to collect information on the following points in 1969:

- 1) Number of adult spawners, their age, growth, sex, fecundity
- 2) Mortality rates of adult spawners and causes of mortality
- 3) Number of emigrant juvenile fish leaving the drainage
- 4) Age, size, growth of juvenile fish
- 5) Relation between movement, stream temperature and time periods for both adult and juvenile fish.
- 6) Mortality rates and movement patterns of marked fish moving out of the drainage.

PROCEDURES

The upstream trap was operated continuously from May 15 through June 26, 1969. Adult fish entering the trap were sexed, measured and examined for an adipose fin-clip denoting those that had spawned in Hungry Horse Creek in 1968. All fish caught were sexed and tagged with numbered anchor tags inserted into the body immediately posterior to and below the dorsal fin. Scale samples for age and growth determinations were taken from all fish handled. Fifteen female cutthroat trout were killed and ovarian eggs counted.

The upstream trap was operated again from October 20 through November 22, 1969 to sample mountain whitefish spawning above the trap. Fish caught were sexed, measured and released above the trap.

The downstream trap was finished from June 11 through August 18, 1969 except for July 1, 2 and 3. Flows in excess of 200 cfs damaged the trap requiring it be removed for repairs. When spent adult fish appeared in the downstream trap, it was apparent that the anchor tags were being lost by many fish. Fish that had lost their tags were retagged and the adipose fin was removed. Spent adults captured for the first time were sexed, measured and marked by removal of the adipose fin and insertion of the numbered anchor tag. Scale samples were taken from adults captured for the first time. In summary every fish released from the downstream trap was marked two ways, by an adipose fin-clip and by a numbered anchor tag.

Scale samples were taken from 1,100 fish from the downstream trap. All fish were measured and assigned by their length to an age-class or an overlap zone between age-classes. Fish calculated to belong to age classes I, II and III and the overlap between ages I and II and III were marked with separate fin-clips or insertion of colored anchor tags. The lengths assigned to each age-class or overlap class were derived from data on juvenile fish measured and aged from the 1968 downstream trap operation.

Operation of the trap in June and most of July required at least daily screen cleaning and release of fish downstream. Operation in the latter part of July and August required screen cleaning and release of fish once every second or third day.

A staff gauge to measure flows in Hungry Horse Creek was installed in April, 1969. Limited accuracy was obtainable in reading this gauge during high flows due to bounce on the gauge face. A stilling well was built by project personnel in October 1969 to house a U.S. Geological Survey's continuous recorder planned for installation in April 1970.

A 30-day thermograph borrowed from the Washington Water Power Company was used to measure water temperatures during May 1969 and replaced when a new Foxoforo 30-day thermograph was obtained. Unfortunately the new instrument was not in working order and measurements were not obtainable.

FINDINGS

Cutthroat Trout - Adults

The first spawning westslope cutthroat trout were captured May 17, 1969. The upstream trap was operated until June 26, 1969 but the last adult capture was June 20, 1969. A total of 139 male and 730 female cutthroat (sex ratio 1: 5.2) were captured. A total of 854 fish were released above the trap. Spent adults were first taken in the downstream trap June 11 and the last fish was captured July 25, 1969. During this time 72 males and 426 females (1: 5.9) were captured of which 47 and 378 (1: 8.0) were recaptures, respectively.

Estimated number of cutthroat trout entering Hungry Horse Creek for spawning totalled 1,034 fish of which 212 were males and 822 were females (1: 3.9). The females averaged 14.5 inches total length and ranged from 12.4 to 16.2 inches. Males averaged 14.5 inches total length and ranged from 9.5 to 17.3 inches. The fifteen females sacrificed for egg counts averaged 14.6 inches total length and contained an average of 1,086 eggs. Total egg potential of the spawning run was calculated to be 892,500 eggs.

Downstream trap was thought to be 100 percent efficient for spent adult fish except for the three days, July 1-3, when high water damaged the incline screens requiring the trap to be removed for repairs. It was estimated that not more than 25 fish moved downstream during these three days. The estimated total downstream return of spent adult fish was 523 of which 84 were males and 439 were females (1: 5.2). Repeat spawners in 1969 numbered 11 males and 96 females (1: 8.7) which had survived from the 219 marked in 1968 spawning run.

Survival rates for fish spawning in Hungry Horse Creek in 1968 and in 1969 are presented in Table 1. Since the downstream trap was not operated all the time fish were moving downstream in 1968, survival rates from the 1969 data are applied to the 1968 run to obtain 1968 escapement estimates. Total survival for the 1969 run was 39.6 percent for males and 53.4 percent for females.

Table 1. Survival rates of westslope cutthroat trout spawning in Hungry Horse Creek, 1968 and 1969

	1968 Spawning Run		1969 Spawning Run	
	Female	Male	Female	Male
Number of fish in run	913	247	634*	181*
Downstream escapement	487	98	343*	73*
Percent survival	(53.4%)	(39.6%)	(54.1%)	(40.3%)
Number of 1968 fish				
returning to spawn in 1969	-	-	188	31
Percent survival	-	-	(38.6%)	(31.6%)
Downstream escapement	-	-	96	11
Percent survival	-	-	(51.1%)	(35.5%)

* Does not include the 1968 repeat spawners.

Reliability of the survival rate between the 1968 and 1969 spawning is questionable. It is possible that westslope cutthroat trout may have a tendency to spawn every other year or may not demonstrate strong homing to the natal stream. Operation of the trap in 1970 disclosed that 6 males and 51 females from the 1968 run returned to spawn in 1970 but not in 1969. Survival rates between spawning in 1968 and 1969 are likely nearer 50 percent for females and 40 percent for males than the values given in Table 1. The data in Table 1 show that females survive from period to period at a greater rate than males.

Estimated angler harvest of trout in Hungry Horse Creek before recapture in the downstream trap was 95 fish with a sex ratio 1: 3.0, male to females. Anglers returned tags from 45 trout that had been caught below the trap or from the reservoir prior to the start of the 1970 spawning run. Sex ratio of these fish was 1: 2.2. Sex ratio of the spawning run was 1: 3.9. It would appear that the male cutthroat trout are somewhat more susceptible to hook and line capture than female trout. It is doubtful that this is the prime reason why the male cutthroat trout death rate is greater for the female.

Age structure and growth rates of the 1968 spawning run were determined from interpretation of scales taken from 592 fish. The data are presented in Table 2 and divided into X_1 , X_2 , X_3 and X_4 migration classes. These classes are for fish that were one, two, three and four years old before they left the rearing stream and moved downstream into the reservoir as juveniles.

Table 2. Age composition by percent, of cutthroat trout spawning in Hungry Horse Creek, 1969

Migration Class	Percent of Total Run	Age-Class Composition						
X_1	5.1	Age/Yrs. in Trib.	3 ₁	4 ₁	5 ₁	6 ₁	7 ₁	
			10.0%	63.3%	26.7%	0.0%	0.0%	
X_2	77.9	Age/Yrs. in Trib.	3 ₂	4 ₂	5 ₂	6 ₂	7 ₂	
			3.3%	34.9%	54.9%	6.9%	0.0%	
X_3	16.9	Age/Yrs. in Trib.		4 ₃	5 ₃	6 ₃	7 ₃	
				2.0%	67.0%	30.0%	1.0%	
X_4	0.1	Age/Yrs. in Trib.			5 ₄	6 ₄	7 ₄	
					100%	0.0%	0.0%	
Total	100%							

Data given in Table 2 show several changes when compared to data for the years 1964-68, by Huston ^{1/}. The strength of the X_1 migration class has increased each year since 1967. This class contributed less than one percent of the run in 1967, two percent in 1968 and five percent in 1969.

^{1/} Huston, Joe E. 1970. Reservoir Investigations. Job Progress Report, Federal Aid to Fish Restoration Project, F-34-R-3, Job 2. Montana Fish and Game Department. 11pp mimeo.

The run of X_2 migration class has shown little change since 1964, averaging about 75 percent of the total run. Major shifts have occurred however; in age-class strengths of the X_2 class. Prior to 1968 age-class 4_2 was the most numerous, but in both 1968 and 1969 fish of age-class 5_2 have been the most numerous. In 1969 age-class 5_2 was weaker than in 1968 being 55 percent and 70 percent, respectively. The 1969 age-class 4_2 was stronger than in 1968 with 35 percent and 19 percent, respectively.

The percentage the X_3 migration class made in the 1969 run was smaller than any past year. These fish comprised 17 percent of the 1969 run compared to an average of about 25 percent in previous years. Age distribution within this migration class has been similar in all years.

An age structure comparison of the spawning run shows some differences between the sexes as presented in Table 3. Very few females mature and spawn at three years of age while three-year-old mature males are numerous.

Table 3. Percent of total run for cutthroat trout spawning in Hungry Horse Creek by age and sex, 1969

	Age	3	4	5	6	7
Males		19.2	23.1	43.6	12.8	1.3
Females		0.6	32.0	57.3	10.1	0.0

Five year old males and females were most abundant but distribution around this age was more diverse for male fish than for female fish.

Growth rates of cutthroat spawning in Hungry Horse Creek in 1969 are presented in Table 4 by migration class and sex.

Table 4. Growth rates of spawning cutthroat trout by sex and migration class, Hungry Horse Creek, 1969

Migration Class	Sex	Total length in inches at annulus						
		I	II	III	IV	V	VI	VII
X_1	Male	3.3(4)*	7.8(4)	11.2(4)	14.3(3)	15.7(1)		
	Female	3.3(26)	8.7(26)	12.2(26)	14.2(24)	15.2(7)		
X_2	Male	2.8(67)	5.1(67)	10.4(67)	13.1(53)	15.0(39)	15.9(8)	
	Female	2.7(394)	4.9(394)	10.8(394)	13.1(393)	14.5(246)	15.5(24)	
X_3	Male	2.5(7)	4.7(7)	7.3(7)	11.4(6)	13.8(4)	15.2(2)	16.5(1)
	Female	2.2(93)	4.0(93)	6.2(93)	11.6(93)	13.9(93)	14.8(28)	
X_4	Male	2.0(1)	3.8(1)	6.0(1)	8.2(1)	14.1(1)		

* Number in parentheses is size of sample

Fecundity counts were made on the ovaries of 15 female cutthroat trout captured as they passed through the upstream trap. A length-frequency distribution study was made of the total catch during the first five days of the 1969 fish trapping. Data were seriated by one-half inch intervals and the percentage that each length group contributed determined. The sample of females was distributed around the expected size of the average female in the run. Fifteen fish were randomly selected by half-inch groups, killed, ovaries removed and eggs from each ovary were counted manually. The results of these counts are given in Table 5.

Table 5. Size of female cutthroat trout and number of eggs contained in ovaries

Size of Fish	Number of Eggs	Size of Fish	Number of Eggs
13.7 inches	902	14.7 inches	897
13.9 "	1,001	14.8 "	1,076
14.1 "	1,172	14.8 "	1,440
14.2 "	1,033	14.9 "	1,484
14.5 "	810	15.0 "	841
14.5 "	1,428	15.2 "	1,109
14.5 "	1,185	15.4 "	1,051
14.6 "	858	Average 14.6 "	Average 1,086

It was determined that an average length trout contained an average of 1,086 eggs. In 1968 the average female contained 983 eggs. The estimated total egg capacity of the 1969 run was 892,500 eggs compared to 897,000 eggs in 1968 ^{2/}.

Effect of Tagging

Each adult cutthroat trout was tagged by insertion of an anchor tag posterior to and immediately below the dorsal fin. Tags were numbered for individual identification and were International Orange color coded for easy visual observation. The fish were anesthetized with tricaine methanosulfonate (MS-222) before the tag was inserted. The fish were held in a live box for at least thirty minutes or until fully recovered from the effects of the anesthesia before they were released above the trap. Release point was about 100 feet upstream in a quiet pool.

In previous years the fish had been anesthetized with MS-222 or urethane to facilitate data collection and marked by fin-removal. Fish dropping back downstream and re-entering the upstream trap had never been a problem previously, although a few did. The drop-back of fish tagged with the anchor tag was a serious problem in 1969. A total of 306 fish dropped back and re-entered the upstream trap one, two or three times. Table 6 shows the number of fish re-entering the trap and the time lapsed between initial entry and final entry.

^{2/} Op. sit.

Table 6. Drop-back through the trap, re-entry and time lapse,
Hungry Horse Creek, 1969

	Number of re-entries into upstream trap		
	One time	Two times	Three times
Number of fish	224	68	14
Average time before final re-entry	11 days	16 days	16 days
Range of time	1-22 days	9-26 days	3-24 days

Male cutthroat trout entering Hungry Horse Creek were ripe enough to start spawning immediately. Female cutthroat trout were green when first caught and appeared to require several days before being able to spawn. The ratio of males to females dropping back and re-entering the trap was 1: 4.5 compared to the ratio of 1: 5.2 in the total trap catch. The ratios indicate that the males suffered as much or more drop-back than the females suggesting that drop-back was not related to the ripeness of the individual female fish. It is probable that insertion of the anchor tag caused enough traumatic injury to the fish causing drop-back downstream. One tagged fish dropped back downstream and into the reservoir where it was caught by an angler. Two fish were observed near the mouth of another stream entering Hungry Horse Reservoir several miles away from Hungry Horse Creek.

The delay of the fish reaching the spawning areas in the Hungry Horse Creek drainage may have more serious ramifications than drop-back out of Hungry Horse Creek. Observations in past years indicated that little spawning took place immediately upstream from the trap for a distance of about 3/4 mile. Evidence of spawning, redds and fish observed, were abundant in this area in 1969 indicating that many fish did not reach their "normal" spawning area further upstream.

The anchor tags were inserted to provide identification of individual fish. It was readily apparent that the spawning cutthroat trout did not retain the anchor tag. Twenty-three percent of the spent spawners captured in the downstream trap had lost their tags. Many of the fish still retaining tags showed evidence of severe ulceration around the point of entry. Operation of experimental trap in 1970 showed that very few of the downstream adults escaping in 1969 retained their tags. Trout that had been tagged could easily be identified by tagging scars. Tagged fish caught in 1970 numbered 172 but only 17 fish still retained the tags, the remainder were identified by tag scars.

Cutthroat trout, Juveniles

Juvenile cutthroat trout were first captured June 13, 1969, two days after the downstream trap was installed. About 3 fish per day were being captured when the trap was dismantled August 18, 1969.

Operation of the trap resulted in the capture of 2,680 juvenile cutthroat trout as they moved downstream toward the reservoir. Scale samples from 1,100 of these fish were taken for age and growth analysis. All fish were measured and assigned to an age-class or age-class overlap by length and marked. The anticipated age-length relationships and the actual age-length relationships are presented in Table 7.

Table 7. Anticipated and actual age-length relationship for juvenile cutthroat trout moving down Hungry Horse Creek, 1969

Time period	Length of fish in inches for age-class or overlap				
	I	I-II	II	II-III	III
June 13-June 23					
Anticipated	2.0-4.2	4.3-4.7	4.7-5.7	5.8-7.0	7.1
Actual	2.5-4.1	4.2-4.8	4.9-6.5	6.6-7.4	7.5
June 24-July 6					
Anticipated	2.0-4.3	4.4-4.9	5.0-6.2	6.3-7.1	7.2
Actual	2.2-4.3	4.4-4.8	4.9-6.7	6.8-7.1	7.2
July 6-July 21					
Anticipated	2.0-4.7	4.8-5.4	5.5-6.5	6.6-7.2	7.3
Actual	2.3-4.7	4.8-5.4	5.5-6.6	6.7-7.5	7.6
July 22-August 18					
Anticipated	2.0-5.0	5.1-5.5	5.6-6.6	6.7-7.3	7.4
Actual	2.2-5.1	5.2-5.6	5.7-7.3	None	7.6+

Each fish was marked or tagged according to the age-class or age-class overlap to which it was assigned. Marks used included the removal of the right pectoral fin for age-class I, anal fin age-class I-II, a green plastic jaw tag for age-class II, removal of the right pelvic fin for age-class II-III and a blue jaw tag for age-class III. Subsequent return of these marked fish to a spawning stream should give some insight into homing tendencies and age-class mortality rates. Many of these fish should spawn for the first time in the spring of 1971.

It was known that the downstream trap was not 100 percent efficient when operated and that juvenile fish move downstream in months other than those fished. No estimate of total downstream escapement of juvenile cutthroat trout from the Hungry Horse Creek drainage can be obtained from the 1969 catch data. Short term trap operation in April and October, 1970 caught small numbers of fish. It is thought that the peak out-migration does occur in June and July and that some fish move downstream throughout the entire year. The number of juvenile fish caught, measured, marked and released by age-class and time-period are shown in Table 8. The number of fish in each age-class was estimated from catch by time periods and from scale analysis. Age-growth data are presented later in Tables 9 and 10.

Table 8. Number of juvenile cutthroat trout by age captured in the downstream trap, Hungry Horse Creek, June 13 through August 18, 1969

Time period	Number of fish in age-class			Total	Average per day
	I	II	III		
June 13-June 23	129	374	39	542	49.3
June 24-July 6	132	333	33	498	45.3
July 7-July 21	639	666	36	1,341	89.4
July 22-August 18	195	99	5	299	10.7
TOTAL	1,095	1,472	113	2,680	41.2

The data in Table 8 indicate that the peak migration occurs in the middle of July. Daily catch for July 8 through July 13 averaged 131.5 fish and was more than 100 fish each day. Daily catch exceeded 100 fish only one other day, June 19, for the rest of the days fished.

It appears that the age II and III fish move downstream in greatest numbers in early June and July. The movement of the older fish was further substantiated by the short-term trap operation in April 1970 when almost all the fish caught were two or three year old fish. Short term trap operation in October 1970 caught few two-year old fish. The greatest movement of one-year old fish seems to occur in July, August or later. Trap operation in October 1970 yielded mostly one-year old fish.

Most of the juvenile fish and spent adult spawners were caught between the hours of midnight and 6 A.M. contrasted to afternoon upstream movement of adults moving into the drainage. Spent adult and juvenile fish could be seen congregating above the downstream trap in quiet waters during daylight hours and a rough estimate of downstream catch could be made from the number of fish observed.

A review of the age-growth data collected in 1968 indicated that the age of about 65 percent of the downstream fish could have been correctly predicted from lengths. Scales from 701 juvenile cutthroat trout collected in 1969 were analyzed to determine growth rates, ages and accuracy of assigning fish to age-groups by lengths. Accuracy of assigning fish to age groups by lengths is shown in Table 9. Data show that of 196 fish assigned to age-class I, 194 were one-year old fish; of the 217 assigned to age-class II, 215 were two-year old; and of the 33 assigned to age-class III, 27 were three-year old fish. Fish assigned to overlap age-classes numbered 255 of which 42 were I, 202 were II and 11 were III year old fish. The data show that fish assigned to a specific age-class very likely were that age and that fish assigned to an overlap likely were age-class II fish.

Table 9. Numbers of juvenile cutthroat trout assigned in the field to various age-classes or overlap classes compared with numbers in same classes determined by scale reading for different collection periods, Hungry Horse Creek, 1969

Age by length Age by scale analysis	I		I-II		II		II-III		III	
	I	II	I	II	II	III	II	III	II	III
June 13-June 23	36	1	6	7	60	1	66	3	5	12
June 24-July 6	8	0	2	15	45	0	14	2	0	7
July 7-July 21	84	1	20	43	86	0	38	6	1	8
July 22-August 18	66	0	14	15	24	1	4	0	-	-
Total Numbers	194	2	42	80	215	2	122	11	6	27

Growth rates of 701 juvenile cutthroat trout captured in the downstream trap were calculated from scale analysis. These data are presented in Table 10 by age-class.

Table 10. Growth of juvenile cutthroat trout collected during out-migration, Hungry Horse, 1969

Out-migration age	Total Length in inches at Annulus		
	I	II	III
1+	3.1 (236)		
2+	2.9 (425)	4.9 (425)	
3+	2.6 (40)*	4.6 (40)	6.6 (40)

* Number in parentheses is size of sample.

Mountain Whitefish, adults

The upstream trap was operated from October 20 through November 22, 1969 to enumerate mountain whitefish spawning above the trap-site. During the years of 1962 through 1968 observations indicated that this creek supported a good number of spawning whitefish. Several hundred were estimated to have spawned in the creek above the trap. The major part of the run was thought to spawn in the stream below the trap. The total catch included 146 males and 40 female whitefish (sex ratio 3.6: 1). The males averaged 11.9 inches and the females 12.6 inches total length. The fish were enumerated, measured and released upstream.

Hungry Horse Reservoir was drawn down about 41 feet at this time, forming several hundred yards of creek that is normally inundated at the start of the whitefish spawning run. Observations indicate that many mountain whitefish were spawning in this area. It is assumed that the drawdown resulted in forming more stream channel below the trap and reduced considerably the number of fish that "normally" would have spawned above the trap in 1969.

RECOMMENDATIONS

Recommendations are for the continuation of this job. It is recommended that the upstream and downstream trap be operated in 1970 but only during the time adult fish are in the drainage. Use of the anchor tag to mark either adult or juvenile cutthroat trout should be discontinued.

Investigations should be made to determine whether the downstream trap can be fished during the period of March through December. Methods would have to be found to alleviate ice-formation on the screens during freezing weather and to eliminate flow ice from entering the trap.

Trapping of the mountain whitefish spawning run should not be attempted unless Hungry Horse Reservoir is at or near full pool during the spawning run.

Prepared by Joe E. Huston

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Waters referred to:

1-08358001
1-08886005