MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS
FISHERIES DIVISION

JOB PROGRESS REPORT

State: Montana Title: Southwest Montana Fisheries investigations

Project No.: F-9-R-35

Title: Inventory and Survey of Waters of the Project Area

Job No.: 1-c

Period Covered: July 1, 1986 through June 30, 1987

Report Period: July 1, 1986 through June 30, 1987

ABSTRACT

Brown trout longer than 16" in the Yellowstone River continue to decline in number, possibly as a result of poor recruitment. Yellowstone cutthroat also declined, except on the catch and release sections. Growth of brown and cutthroat trout is poorest near Livingston, where overall populations of trout are highest, and at Corwin Springs where water temperature is lowest. The 1985 year class of cutthroat trout is expected to be weak as a result of low streamflows in spawning tributaries.

Mountain whitefish populations are about half as high in 1986 as in 1973. The populations of mountain whitefish and brown trout in the Shields River appear to be stable.

Many streams in the area were sampled and are discussed. Mill Creek and Sixmile Creek were studied in detail and future data needs are discussed. Eastern brook trout have been gaining dominance over Yellowstone cutthroat in low gradient tributaries of the Shields River.

Yellow perch in Dailey Lake have increased in average size since rehabilitation in 1984. Walleye have disappeared from the lake, but appear to have preyed heavily on stocked rainbow trout during 1982 and 1983. Summerkills of rainbow trout during 1985 and 1986 have occurred.

Stream protection efforts are discussed.

OBJECTIVES AND DEGREE OF ATTAINMENT

1. To determine fish populations on at least two established study sections on the Yellowstone River and one established study section of the Shields River. Data included in this report.

2. To monitor water temperature at three established sites on the Yellowstone River. Data for one site included in this report.

3. To assess walleye planting success in Dailey Lake. Data included in this report.

4. To mitigate or enhance habitat alterations due to agricultural, residential, mining or industrial development. Data included in this report.

BACKGROUND

The Yellowstone River basin received instream flow protection through the Order of the Board of Natural Resources on December 15, 1978. With this reservation of water, the Department of Fish, Wildlife and Parks was instructed to update and enhance its justification for receiving the allocation. Continued monitoring of the Yellowstone River fish populations is required to learn more about the relationship between streamflows and fish populations.

Recent information suggests that fishing pressure may be altering the population structure of trout in the upper Yellowstone. During 1984, fishing regulations were changed on the upper 50 miles of the Yellowstone River to protect the Yellowstone cutthroat trout (Salmo clarki bouvieri) population from overexploitation by fishermen. In a shorter reach of the river, rainbow trout (Salmo gairdneri) and brown trout (Salmo trutta) also received additional protection. To document the effects and to understand the reasons for change annual monitoring should be continued.

When the Yellowstone Reservation was enacted, the tributary streams also received instream flow protection. The Shields River suffers from annual dewatering which appears to be limiting the fish population. Continued monitoring of the fish populations in this stream should be maintained to try and understand the relationship dewatering and unstable streambeds have on this population.

Tributary streams which support a spawning run of Yellowstone River fish have been monitored to try to understand their role in maintaining high quality fish populations in the river. This relationship should be explored further. Resident populations in these and other tributaries are being monitored on a regular basis to watch for changes in these populations over time.

The Dailey Lake fishery is composed of yellow perch (Perca flavescens), rainbow trout, walleye (Stizostedion vitreum), longnose sucker (Catostomus catostomus), and white sucker (Catostomus commersoni). Management efforts of this water have been complicated recently by poorly understood summer fishkills.

The Yellowstone cutthroat appears to inhabit only a small portion of its historic range (Hadley, 1984). The best way to test a population for genetic purity is by electrophoretic analysis. A sample from various streams in the Upper Yellowstone drainage was collected during 1986 to compare the results with the expected conditions as described by Hadley (1984).

The Department of Fish, Wildlife and Parks is responsible for protecting and enhancing the fishery resource in Montana. The Stream Protection Act of 1963 and the Natural Streambed and Land Preservation Act of 1975 were passed by the Montana legislature in order to give the Department the ability to protect the physical integrity of streams. These laws have been a valuable aid in protecting the fishery resources in Montana.

PROCEDURES

Fish populations in the Yellowstone River were sampled with an 18-foot aluminum boat powered by a 90 horsepower outboard motor with a jet unit. The boat was equipped with a double boom system similar to those described in Novotny and Priegel (1971) and Peterman (1978).

Spring population estimates were calculated using the Chapman modification of the Peterson formula (Ricker, 1975). The method is further described by Vincent (1971). Between three and five sampling runs are required to obtain each estimate. Also, electrofishing was conducted on other areas of the river to characterize spawning concentrations and to tag fish for movement studies. All movement was documented using individually numbered Floy FD-68B anchor tags. The calculations of weekly mean sizes in the text is for all fish during that sampling period, while the calculation of total mean size for the season is for only new fish.

Sampling of spawning migrations and resident populations in tributary streams was usually done with a generator powered backpack unit. Larger streams were sampled either with a bank shocking system or a mobile, boat mounted unit.

Aging of fish was done using scales and comparing them to the scales of "known age" fish from the same population. Brown trout aging was considered to be valid using this method, however Yellowstone cutthroat aging has many inherent difficulties (Lentsch and Griffith, 1986, Jensen and Johnsen,1982). Rainbow trout aging is also difficult.

Water temperature in the Yellowstone River was measured with a Taylor 30 day recording thermograph, everywhere else temperature was recorded with max-min thermometers. Streamflows were measured with a hand held current meter .

Fish samples in Dailey Lake were collected with 125-foot experimental gillnets.

Genetic analysis of Yellowstone cutthroat was done at the University of Montana Genetics lab. Generally, a minimum of 25 fish is optimum for each sample. However, in many cases a smaller number of fish were sampled.

FINDINGS

Yellowstone River

The four population sections which are sampled annually on the Yellowstone River are marked in Figure 1. A fifth population section was sampled for mountain whitefish (Prosopium williamsoni) during 1986. Other areas where electrofishing is done on a regular basis is also indicated in Figure 1.

Brown trout

Populations. The number of 16 inch and longer brown trout per mile of the four study sections during each year of sampling is illustrated in Figure 2. In general, the populations of these large brown have been declining since 1982. This may be the result of weak year classes of two year olds during 1982, 1983, and partially during 1984. Sando (1981) studied brown trout fry in the Yellowstone River and found that they did not associate with cover. This may result in brown trout being succeptible to predation. White and Hunt (1969) found that I year old brook trout competed with young of the year, causing regular fluctuations in the population. Data collection in the future should attempt to identify the causes of fluctuating numbers of small brown trout in the Yellowstone River. Figure 3 illustrates the number of two year old brown trout per mile in the Springdale, 9th Street and Mill Creek Bridge study sections. The weak year classes of the early 1980's may be reflected in the declining

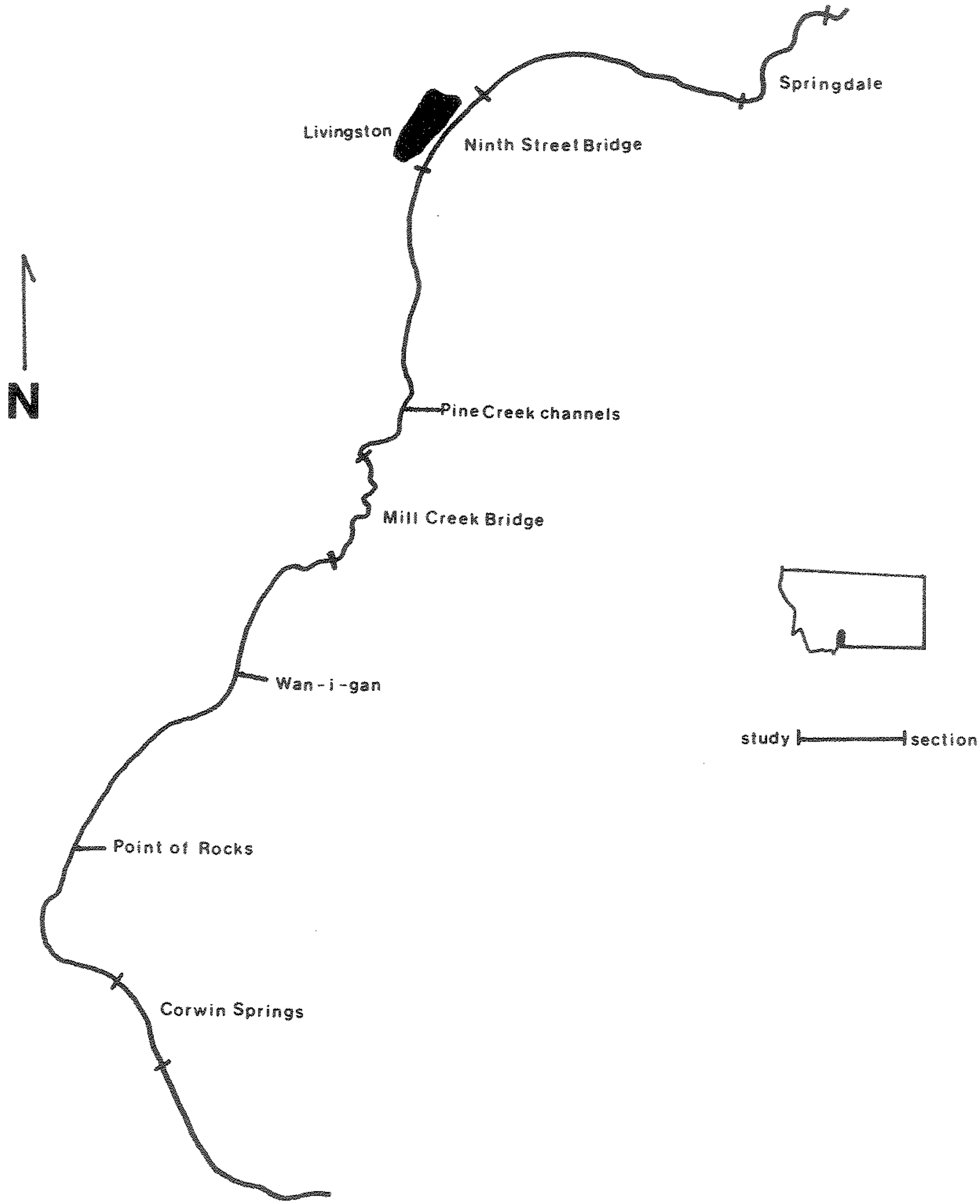


Figure 1. Map of the Upper Yellowstone River.

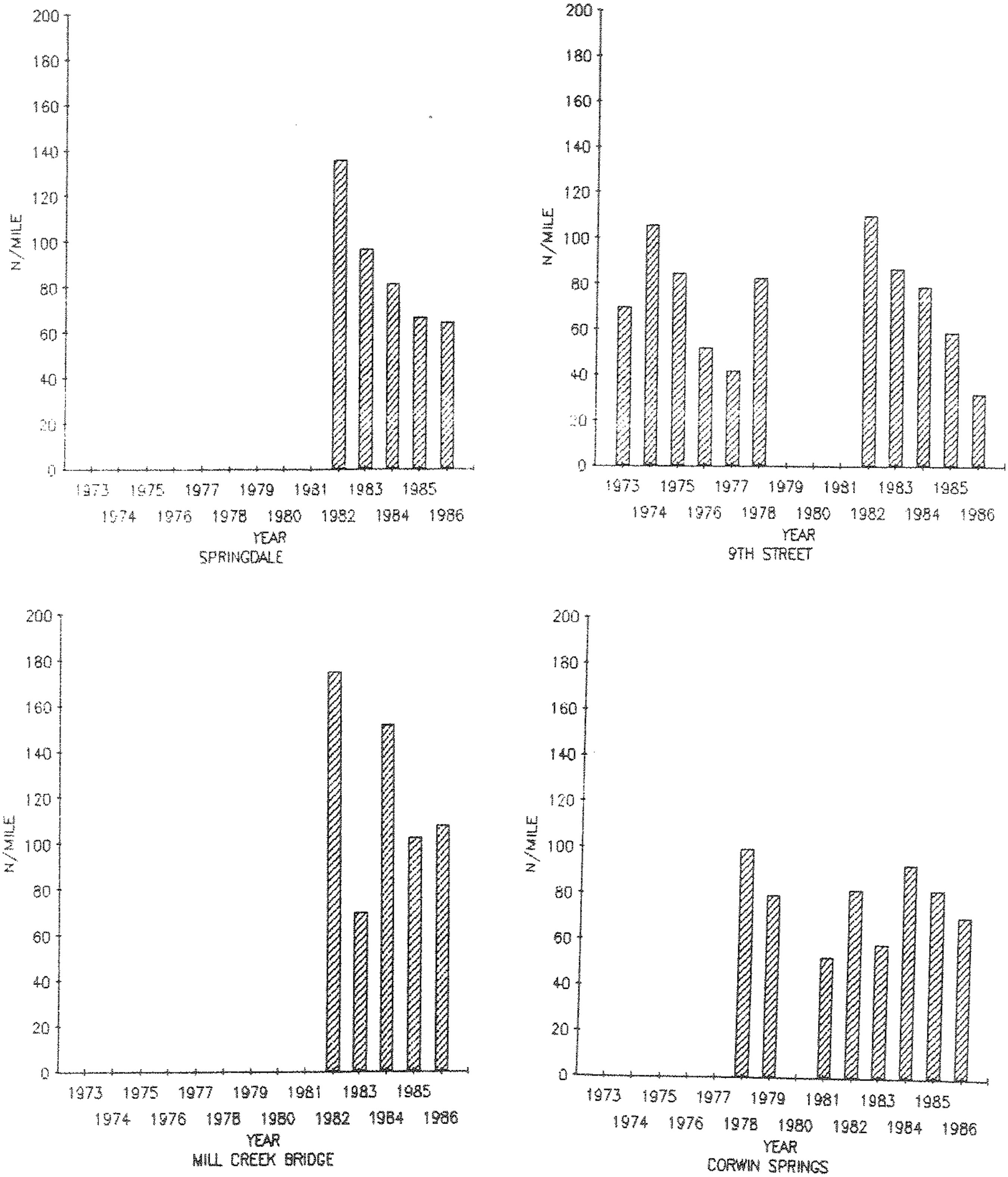


Figure 2. Brown trout longer than 16 inches per mile in the four study sections.

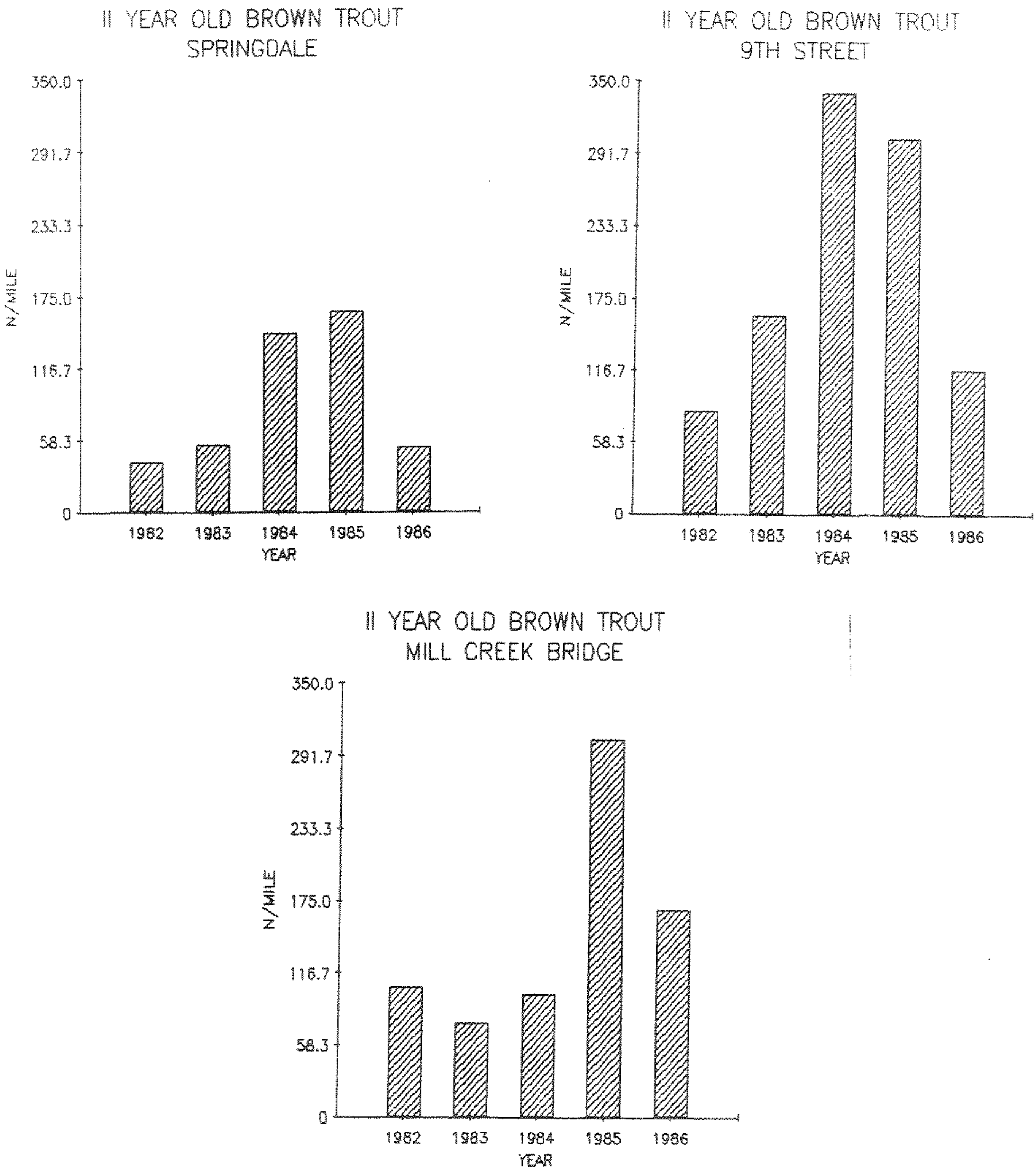


Figure 3. Two year old brown trout per mile in the four study sections.

populations of larger brown trout in the mid 1980's. A strong correlation exists between the number of 2 year old brown trout and 3 year old brown trout one year later ($r=.91, p<.01$). Nelson (1987) found this same relationship in the Beaverhead River, Montana. This seemingly obvious relationship indicates that a weak year class of two year olds will subsequently result in lower numbers of older fish years later.
Engstrom-Heg (1986) found that the number of yearling brown trout controlled the number of large brown trout available to fishermen in future years. Jensen (1971) found that minor increases in the mortality of young of the year trout was reflected in decreased availability of adults years later. If the relationship is consistent with older fish in the Yellowstone River, the recruitment of small fish into the population may be one factor controlling the number of large fish. Also if this is true, the number of large fish should begin to increase in the near future as a result of the strong year classes of 2 year olds in 1984 and 1985. Brown trout reach 16 inches in length at four to six years of age (Figure 4). The two year old year classes of 1984 and 1985 should be reflected as 16 inch and larger fish in the next few years. The Corwin Springs population was not included in this analysis because of uncertainty in aging of these fish.

Table 1 indicates the annual mortality rates of brown trout in the Springdale, 9th Street, and Mill Creek Bridge study sections.

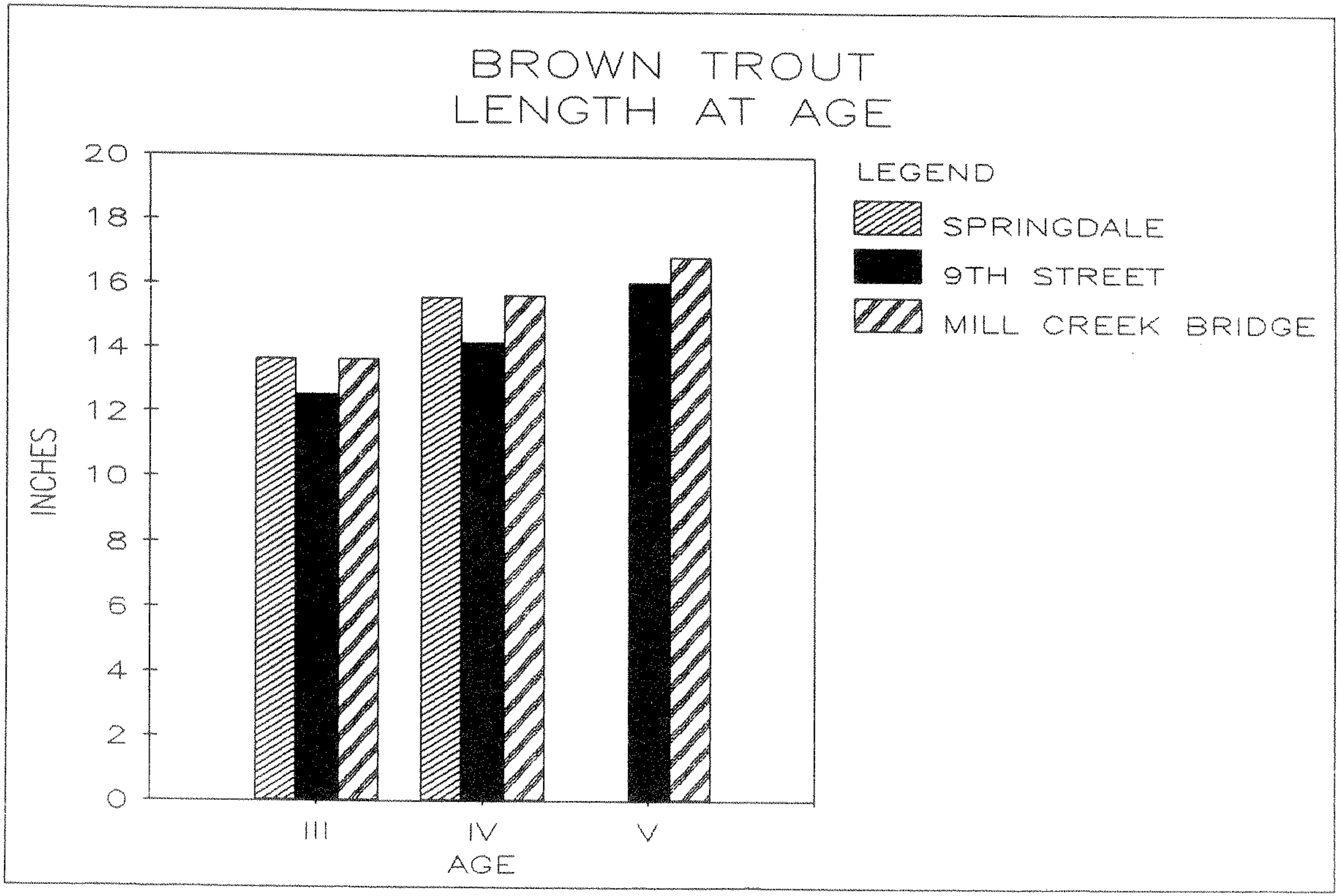
Table 1. Annual mortality rates of II and III+ brown trout in the Springdale, 9th Street, and Mill Creek Bridge study sections during 1982-1985.

	Springdale		9th Street		Mill Creek Bridge	
	II	III+	II	III+	II	III+*
1982	-	49	13	64	34	69
1983	21	46	27	19	22	4
1984	45	45	66	55	52	56
1985	23	34	43	57	55	27
x	30	44	37	49	41	39

* The 1983 population estimate of III+ brown trout may have been an underestimate.

Mortalities of brown trout vary considerably between years. This fluctuation is not well understood and may be identified by further sampling. The mean mortality rates of the III+ brown trout in the three sections is not exccessive. However, if recruitment is poor, these moderate mortality rates could be significant. Also, these low mortality rates undoubtedly are not uniform for each individual age group over three years of age. Aging can only be applied to three year old and younger fish with confidence. This leaves the mortality rates of the oldest fish in question.

Figure 4. Length at age of brown trout in the Springdale, 9th Street Bridge and Mill Creek Bridge study sections.



The decrease in the brown trout population has occurred under a situation of moderate mortality. This points again to the importance of strong recruitment to the adult population, however, it also indicates that when recruitment is poor, moderate fishing harvest may be detrimental to the adult population. Engstrom-Heg (1986) found that when recruitment is poor and harvest is expected to be high, stocking of fingerling brown trout was required to supplement the natural production in New York streams. Another solution to maintaining the adult population would be to limit harvest of adults.

During 1984, the regulations on the Mill Creek Bridge section of the Yellowstone River were changed. The general 5 fish bag limit was changed to a more restrictive slot limit of 4 under 13" and 1 over 22". Also, only artificial flies and lures may be used on this section. Since that change, while overall numbers of large brown have decreased during 1985 and 1986 on the other three sections, the 1986 population of brown trout on the Mill Creek Bridge section increased slightly. The increase is minor and should be assessed in 1987 to document whether the regulations are having a positive effect on the population.

Migration and Spawning. Brown trout spawn in the mainstem of the Yellowstone River during November and December (Clancy, 1985). Some movement also takes place into spring creeks for spawning purposes. Sampling of major spawning areas upstream of Livingston has been undertaken in recent years and the data collected in 1985 and 1986 is presented here.

Clancy (1985) discussed spawning in three major side channel areas by brown trout. The following information is supplemental to that discussion.

Pine Creek channels. This area is used extensively by brown trout and to date has been identified as the heaviest concentration of spawning brown trout encountered. Table 2 illustrates the number and size of fish captured in this concentration during 1985 and 1986.

Table 2. Vital statistics of brown trout longer than 14" captured in the Pine Creek Island area during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	Female condition
		1985	
10/14	34 (16.2)	25 (18.0)	not emitting eggs
11/4	40 (17.9	46 (16.4)	all conditions
Total	74 (17.2)	71 (17.0)	

1986

10/6	21 (16.2)	26 (15.8)	not emitting eggs
10/21	63 (16.9)	56 (17.3)	emmitting eggs
11/3	82 (16.4)	51 (16.3)	all conditions
11/20	57 (17.1)	36 (16.1)	all conditions
Total	223 (16.7)	169 (16.5)	

The mean size of brown trout in the spawning concentration was the smallest since sampling began in 1983. The spawning appears to begin in late October or early November each year.

Table 3 summarizes the tagging locations of brown trout that moved over a mile and were caught in the Pine Creek side channels.

Table 3. Tagging locations of brown trout captured in the Pine Creek side channels.

Number of returns	Location
5	9th Street Bridge study section
4	Springdale study section
1	Grey Owl FAS
1	Downstream of Springdale

Considering the large number of brown trout handled, few tag returns have been collected. The tag returns indicate that brown trout move upstream to spawn in the Pine Creek side channels.

Wan-i-gan side channels. Table 4 depicts the fish captured during sampling of the spawning concentration of brown trout in the Wan-i-gan side channels during 1985 and 1986.

Table 4. Vital statistics of the spawning concentration of brown trout > 14" in the Wan-i-gan side channnels during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	Female condition
		1985	
10/30	22 (17.5)	17 (16.9)	all conditions
		1986	
10/6	7 (15.7)	11 (16.3)	not emitting eggs
10/21	34 (17.6)	18 (16.9)	emmitting eggs
11/3	30 (17.4)	22 (16.3)	all conditions
11/20	23 (16.3)	21 (16.0)	all conditions
Total	94 (17.1)	72 (16.4)	

Table 5 summarizes the tagging location of brown trout that were recaptured in the Wan-i-gan side channels.

Table 5. Tagging location of brown recaptured in the Wan-i-gan side channels.

Number of Tags	Location
2	Pine Creek side channels
2	Mill Creek Bridge study section
1	Emigrant Spring Creek
1	Point of Rocks

Once again, the tag returns are few but the indication is that the brown trout move upstream to spawn.

Grey owl. Table 6 characterizes the concentration of brown trout at the Grey owl fishing access site during 1985 and 1986.

Table 6. Vital statistics of the concentration of brown trout at the Grey Owl fishing access site during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	Female condition
		1985	
10/30	22 (17.5)	17 (16.9)	all conditions
		1986	
10/6	2 (17.3)	4 (15.3)	not emitting eggs
10/21	5 (17.5)	4 (17.6)	emitting eggs
Total	7 (17.4)	8 (16.5)	

This is a small concentration with scattered redds, which causes sampling to be inefficient.

Point of Rocks. Several side channels in the Point of Rocks area are used by brown trout for spawning. Tables 7 and 8 summarize the data collected during 1985 and 1986 in this area.

Table 7. Vital statistics of the concentration of brown in the Point of Rocks area during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	Female condition
		1985	
11/5	34 (17.4)	29 (16.6)	all conditions
		1986	
10/7	18 (17.3)	12 (16.1)	not emitting eggs
10/28	98 (17.6)	45 (17.1)	all conditions
Total	116 (17.5)	57 (16.9)	

Table 8 summarizes the tagging location of brown trout that were recaptured near Point of Rocks.

Table 8. Tagging location of brown trout recaptured in the Point of Rocks area.

Number of Tags	Location
3	Mill Creek Bridge study area
1	Emigrant Spring Creek

Emigrant Spring Creek. Table 9 summarizes the brown trout spawning run into Emigrant Spring Creek during 1985 and 1986.

Table 9. Vital statistics of the spawning run into Emigrant Spring Creek during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	Female condition
		1985	
10/16	0 -	0 -	
10/30	10 (16.4)	10 (16.1)	few emmitting eggs
11/13	1 (14.0)	2 (14.9)	all emmitting eggs
Total	11 (16.2)	12 (15.9)	
		1986	
11/03	4 (17.0)	2 (17.8)	emmitting eggs
11/13	3 (16.7)	3 (16.4)	50-38 emmitting eggs
11/20	5 (16.6)	7 (17.0)	46-42 emmitting eggs
12/5	4 (16.4)	1 (16.4)	46-40 spent
Total	16 (16.7)	13(16.9)	

The time of peak spawning appears to vary between years more than in the mainstem spawners.

Table 10 summarizes the tagging locations of brown trout recaptured in Emigrant Spring Creek.

Table 10. Tagging locations of brown trout captured in Emigrant Spring Creek.

Number of Tags	Location
2	Mill Creek Bridge study section
1	Pine Creek channels
1	Wan-i-gan channels

Gardner River. The Gardner River was electrofished during October,1985 to ascertain the size of the brown trout spawning run and to capture tagged fish. Table 11 summarizes sampling on 10/31/85.

from the Yellowstone River nearby. However, a significant number of fish from downstream as far as the Mill Creek Bridge study section migrate upstream to spawn in Tom Miner Creek. This indicates a lack of spawning and recruitment in Paradise Valley near Mill Creek (Clancy,1984).

Mol Heron Creek. This stream also supports a significant run of Yellowstone cutthroat trout. Table 28 summarizes the spawning runs during 1985 and 1986 into Mol Heron Creek.

Table 28. Vital statistics of the spawning run of Yellowstone cutthroat trout into Mol Heron Creek during 1985-1986.

Date	Males(xlength)	Females(xlength)	°max-min	Female condition
		1985		
6/11	1 (13.3)	0 -		
6/18	10 (12.3)	6 (14.4)	55-42	not emitting eggs
6/24	11 (14.1)	10 (14.1)	57-44	emitting eggs
7/3	10 (13.4)	6 (13.4)	53-42	emitting eggs
7/8	8 (12.5)	3 (13.7)	55-49	spent
7/17	1 (14.9)	2 (13.0)	57-48	spent
Total	41 (13.2)	27 (13.9)		
		1986		
6/26	4 (13.7)	5 (14.0)		not emitting eggs
7/1	13 (13.3)	6 (13.4)	59-44	emitting eggs
7/9	13 (13.1)	14 (12.9)	61-41	emitting eggs
7/15	8 (13.5)	8 (13.8)	61-46	emitting eggs
Total	38 (13.4)	33 (13.3)		

The run appears to have been slightly larger in 1986 than in 1985. This may relate to the larger number of cutthroat in the River during 1986 (Figure 5). As in Tom Miner Creek, the run appeared to peak later in 1986 than 1985.

During sampling of the spawning runs in 1983, 1985 and 1986, 23 tagged fish from the Yellowstone River were captured in Mol Heron Creek. Table 29 summarizes the tagging location of those fish.

Table 29. Tagging location of Yellowstone cutthroat trout captured in Mol Heron Creek during 1983, 1985 and 1986.

Number of returns	Location
14	Corwin Springs study section
4	Mill Creek Bridge study section
4	Carbella-Yankee Jim Canyon area
1	Point of Rocks area

Most of the fish spawning in Mol Heron Creek come from the Yellowstone River in the same vicinity. However, a significant number of fish from the Mill Creek Bridge area spawn in Mol Heron Creek, similar to the situation in Tom Miner Creek. This illustrates the importance of these upper basin tributaries to the cutthroat population in Paradise Valley, a long distance downstream.

Rainbow Trout

Populations. Population estimates for rainbow trout longer than 16" in the four study sections are illustrated in Figure 8. These estimates are collected in April and May each year so the effect of spawning movement of fish is unknown. In the 9th Street Bridge section the population appears to be rebounding after a severe decline in 1983. The other sections, which have considerably smaller populations than the 9th Street Bridge section, have shown a decline recently.

Table 30 compares the number of small and large rainbow trout captured in marking runs in the four study sections.

Table 30. The mean number of rainbow trout per mile captured in marking runs in the four study sections of the Yellowstone River during 1982-1986.

Section	<10"	>10"
Springdale	26	269
9th Street Bridge	270	1085
Mill Creek Bridge	15	259
Corwin Springs	40	195

The Springdale and Mill Creek Bridge study sections support very few rainbow trout under 10" in length. Mill Creek Bridge in particular appears to have very little recruitment of rainbow trout. This may be the result of being located upstream of the primary spawning areas of rainbow trout. The 9th Street Bridge study section is a short distance downstream from the spawning areas and may be receiving the bulk of the recruitment from these areas.

Corwin Springs is well upstream of these areas, yet has better recruitment than the Mill Creek Bridge area. This indicates that if habitat is not the factor limiting recruitment in the Mill Creek Bridge area, the Corwin Springs recruitment is originating from another source. Future efforts should be aimed at identifying this source.

Special regulations were implemented on the Mill Creek Bridge section in 1984. The population on that section does not appear to be responding to these regulations. To have a better

Table 11. Vital statistics of spawning brown trout captured in the Gardner River on 10/31/85.

Date	Males(x-length)	Females(x-length)
10/31	94 (16.2)	106 (15.6)

Five tag returns from the Yellowstone River were recaptured in the Gardner River. Three of the fish were tagged in the Corwin Springs study section and two were from the Mill Creek Bridge study section. Several other fish with adipose and pelvic fin clips were captured which indicates that they were from the Yellowstone River study sections.

Summary of movement. Brown trout tend to move upstream into spawning areas as tag returns indicate that downstream movement is rare except after spawning is complete. Schuck (1943) and Shetter (1967) found that adult brown trout tended to move upstream for spawning purposes.

Aerial counts of brown trout redds in the mainstem of the Yellowstone River should be started to identify the spawning patterns throughout the system.

Yellowstone cutthroat trout

Populations. Figure 5 illustrates the number of 12 inch and longer Yellowstone cutthroat per mile of the four study sections. During 1984, restrictive regulations were enacted on the upper 50 miles of the River. Cutthroat trout could not be kept on this section of the River and in addition, on the section of river between Emigrant and Pine Creek Bridge, only artificial flies and lures could be used. The Mill Creek Bridge study section represents the area where artificial flies and lures only could be used and Corwin Springs represents the area where bait may be used.

After two years of special regulations,the results are encouraging. The two sections with the 5 fish limit, Springdale and 9th Street Bridge, have decreased by 42% and 63%, respectively. The Mill Creek Bridge section where only artificial flies and lures may be used and all cutthroats must be released has been stable, decreasing slightly in 1985 and increasing slightly in 1986. The Corwin Springs section, where bait may be used, decreased in 1985, but then increased in 1986.

Since 1984, all four sections have shown a net decrease in the number of 12" and larger cutthroat trout. Clancy (1985) discussed the strong year class that had increased the population of cutthroat trout above normal levels throughout the river. By 1986, that group of fish appears to have lost prominence in the population. Clancy (1984) discussed the rationale for regulations to limit cutthroat harvest.

The growth patterns of tagged cutthroat trout in the four study sections is illustrated in Figure 6. Carline and

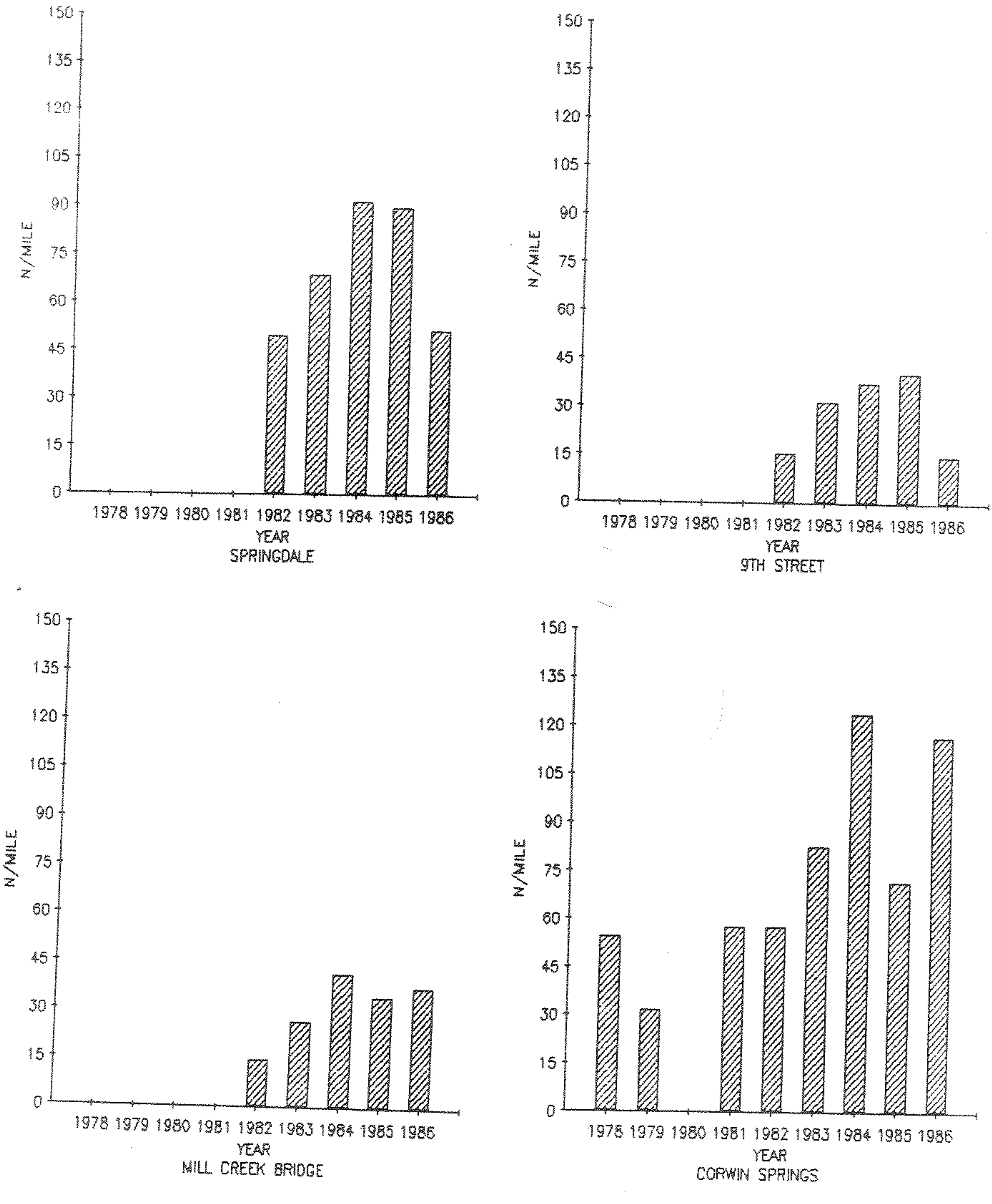


Figure 5. Yellowstone cutthroat longer than 12 inches per mile in the four study sections.

Brynildson (1972) found that Floy anchor tags cause impaired growth the first year after tagging, and subsequent growth is normal. The growth patterns in Figure 6 are probably not the actual growth rates but may be used for comparative purposes. Growth is greatest in the Springdale and Mill Creek Bridge sections. The 9th Street Bridge and Corwin Springs sections exhibit slower growth. This slower growth at the 9th Street Bridge section may be due to the high number of trout in the river in this area. Figure 8 illustrates the number of large rainbow trout in this section of river. The 9th Street Bridge section supports considerably higher numbers of rainbow trout than the other sections. Clancy (1984) found that the growth of brown trout in the Corwin Springs section was slower than at the 9th Street Bridge section. The slow growth of trout in the Corwin Springs area may be due to temperature differences.

The slowest growth of all cutthroat trout was exhibited by fish that were captured in spawning runs in consecutive years (Fig. 6.). This indicates that frequent spawners grow poorly and also indicates that many fish do not spawn every year because the average growth of all Yellowstone cutthroat is better than that of spawners. Ball and Cope (1961) found that most cutthroat in Yellowstone Lake do not spawn every year.

Migration and spawning. Clancy (1985) gives a general overview of the Yellowstone cutthroat migration patterns in the Upper Yellowstone River. The following discussion relates to the tributaries and the movement patterns of fish into them. Table 12 lists the streams that were sampled and the sections that were surveyed by electrofishing.

Table 12. Electrofishing sections for Yellowstone cutthroat spawning surveys, 1983-1986.

Creek	length(ft.)	location(downstream boundary)
Armstrong Sp.	1100	River side channels near corrals
Big	1000	400 feet below U.S. 89 bridge
Cedar	830*	Mouth to 230 ft. above culverts
Locke	1030	Mouth to I-90 culvert
McDonald Sp.	1000	Mouth
Mol Heron	480	Mouth
Nelson Sp.	300	High water mouth to bridge
Peterson	670**	Railroad culvert upstream
Rock	140	Mouth to railroad culvert
Stutches Sp.	1000	Mouth to fork
Tom Miner	500	300 ft. downstream of county bridge to 200 ft. above bridge

*this measurement does not include the 170 ft. through the culverts.
**this measurement includes the length of the culvert.

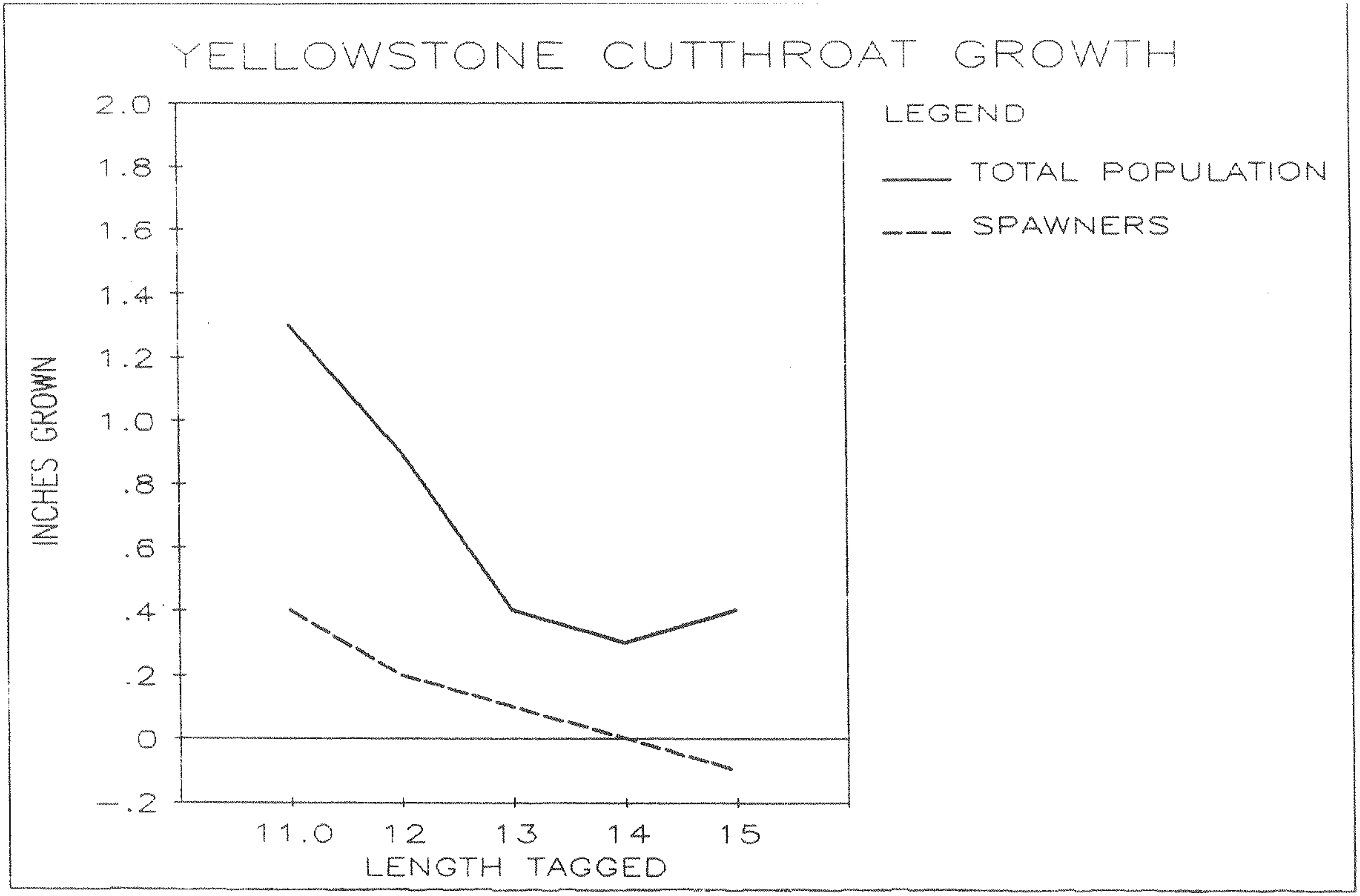


Figure 6. Annual growth of tagged Yellowstone cutthroat trout in the Upper Yellowstone River.

Peterson Creek. Yellowstone cutthroat migrate into Peterson Creek during late May and spawn until early July. Tables 13 and 14 summarize the spawning migration into Peterson Creek during 1985 and 1986.

Table 13. Vital statistics of the spawning concentration of Yellowstone cutthroat trout in Peterson Creek during 1985 and 1986.

Date	Males(xlength)		Females(xlength)		°max-min	female cond.
			1985			
5/31	6	(13.8)	2	(14.1)		not emitting eggs
6/7	19	(13.7)	18	(14.0)	63-45	emitting eggs
6/13	22	(13.4)	21	(14.4)	62-46	emitting eggs
6/20	42	(13.7)	37	(14.1)	63-44	emitting eggs
6/28	20	(13.7)	36	(14.2)	61-44	emitting eggs
7/5	30	(13.4)	37	(14.1)	65-44	spent
Total	139	(13.6)	151	(14.1)		
			1986			
5/25	1	(10.8)	0	-		
6/3	4	(12.3)	1	(12.3)		not emitting eggs
6/10	5	(12.9)	4	(13.5)		emitting eggs
6/17	6	(14.1)	3	(14.3)		emitting eggs
6/25	3	(13.8)	5	(13.6)	64-58	not emitting eggs
6/30	2	(15.8)	4	(14.3)		emitting eggs
7/8	1	(14.5)	0	-	64-50	
Total	21	(13.5)	17	(13.8)		

The 1985 migration was biased from all other years due to low water during the spawning run creating a barrier to movement of fish, therefore, they congregated in a large pool within the shocking section. This caused more fish than normal to be caught in sampling. The 1986 data was collected during a time when several drop structures had been installed in the creek that appeared to be restricting movement of some fish. However, the 1986 data appears to be more in line with past collections.

The average size of the fish in the spawning run appears to be smaller than the fish in the 1984 spawning run. This could indicate that fishing pressure is selecting the larger fish and that some protection of the larger cutthroat trout in the river should be considered.

Between 1983 and 1986, 49 tag returns from the Yellowstone River were captured while moving into Peterson Creek. Table 14 lists the tagging location of these fish.

Table 14. Tagging locations of Yellowstone Cutthroat captured during spawning runs into Peterson Creek during 1983-1986.

Number of returns	Location
45	Springdale study section
2	Big Timber study section
2	Shields R.-Locke Cr.

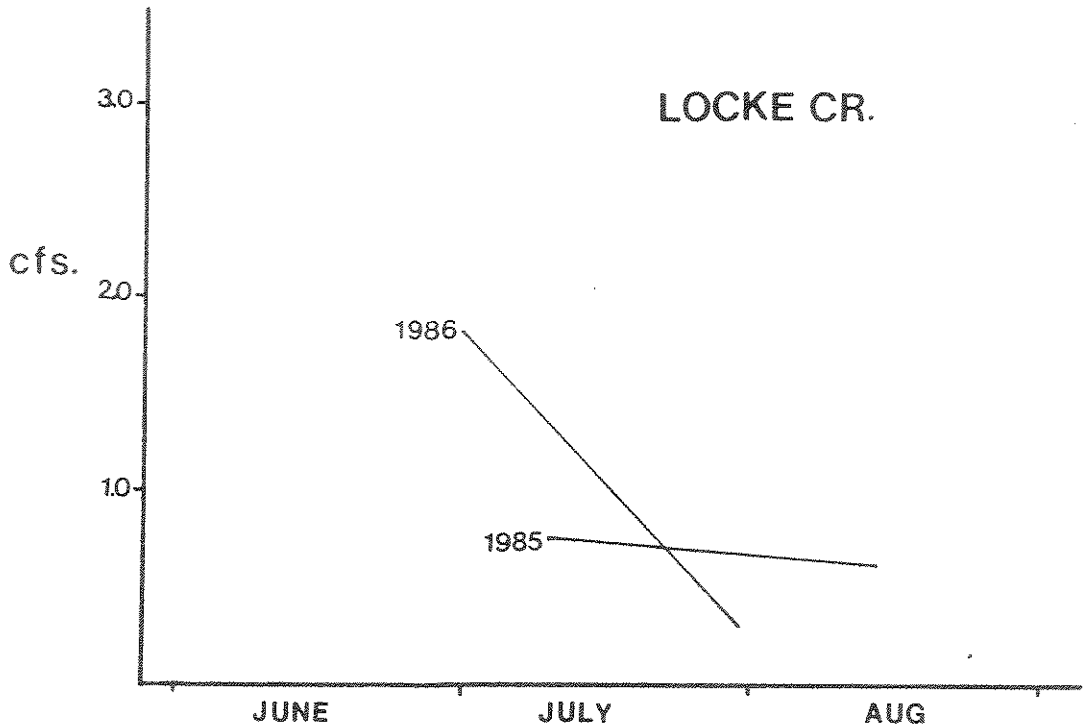
A large majority of the fish had been tagged in the Springdale study section, which begins at the mouth of Peterson Creek and ends at the Springdale bridge. The number of returns is biased toward this section because this sections of river has had more fish tagged in it than most other areas, however, the data does show that fish living between the Shields River and Big Timber use Peterson Creek for spawning.

Figure 7 shows the flow patterns of Peterson Creek during 1985 and 1986. 1985 was a low water year when compared to 1986. Flow data should continue to be collected on Peterson Creek to relate this information to the spawning runs as this stream was not included in the Yellowstone Reservation.

Locke Creek. Yellowstone cutthroat move into Locke Creek at about the same time as Peterson Creek. Table 15 summarizes the spawning run into Locke Creek during 1985 and 1986.

Table 15. Vital statistics of the spawning concentration of Yellowstone cutthroat in Locke Creek during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	°max-min	Female condition
		1985		
5/31	8 (13.2)	2 (13.3)		not emitting eggs
6/7	3 (12.4)	1 (9.3)	72-45	emitting eggs
6/13	1 (12.1)	1 (14.6)		emitting eggs
6/20	2 (12.3)	1 (13.3)		emitting eggs
6/28	1 (10.7)	0 -		
7/5	0 -	0 -		
Total	15 (12.7)	5 (12.8)		



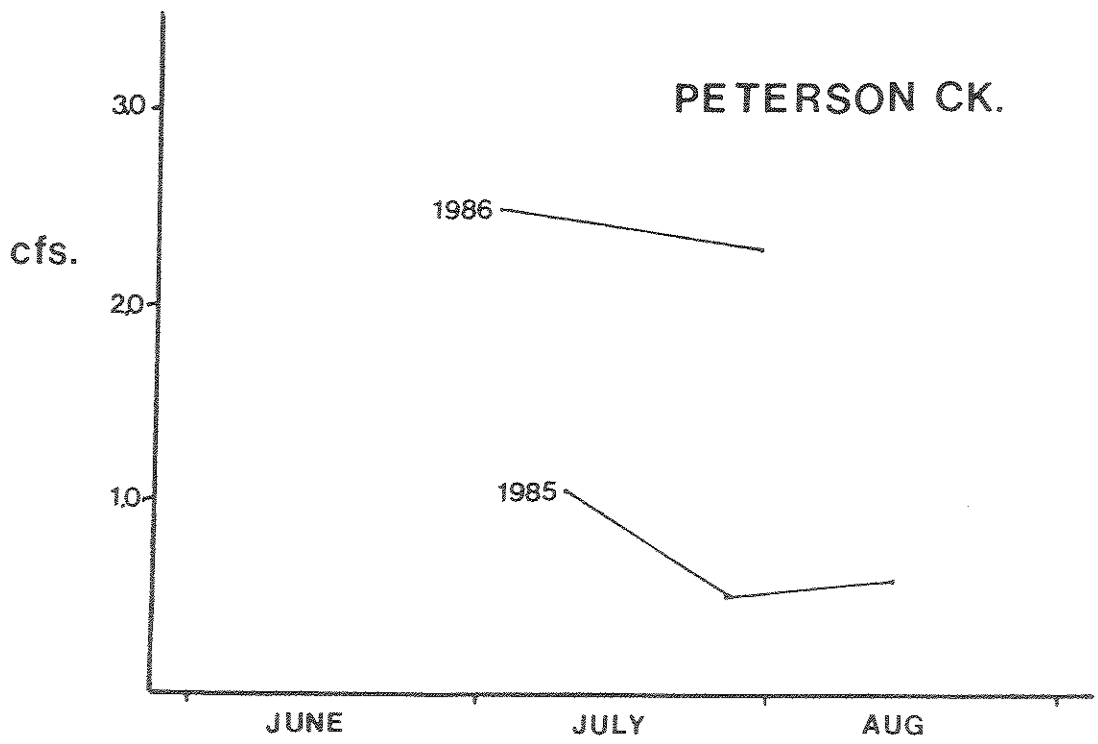


Figure 7. Flow in Locke and Peterson Creeks during 1985 and 1986.

1986

5/29	9 (12.4)	7 (12.5)		not emitting eggs
6/3	3 (12.9)	4 (12.8)		not emitting eggs
6/10	3 (12.7)	2 (12.1)		not emitting eggs
6/17	5 (12.9)	1 (13.7)		not emitting eggs
6/25	2 (14.0)	3 (13.1)		emitting eggs
6/30	4 (13.6)	3 (13.5)	66-46	all conditions
7/8	1 (15.2)	0 -	67-48	
Total	27 (12.8)	20 (13.1)		

During 1985 the run appeared to be cut short by low water in the creek. Several adult and many young cutthroat were found dead in the creek during 1985. This probably was the result of extremely high temperatures in the Creek. The 1986 run was stronger but flows in the creek were not much higher (figure 7). It appears that flows much below 2.0 cfs.are not conducive to spawning in Locke Creek. Incubation may be compatible with lower flows but movement and spawning in the creek appear to require more flow.

The mean length of spawners in Locke Creek is smaller in 1985 and 1986 than it was in 1984. Peterson Creek is following the same trend.

Twelve tagged fish from the Yellowstone River have been recaptured in Locke Creek between 1984 and 1986. Table 16 summarizes the movement patterns of fish into Locke Creek from the river.

Table 16. Tagging locations of Yellowstone cutthroat captured during spawning runs into Locke Creek during 1984-1986.

Number of returns	location
11	Springdale study section
1	Shields River-Locke Cr.

The movement patterns of Yellowstone cutthroat into Locke Creek appear to be similar to the movement into Peterson Creek.

Nelson Spring Creek. Yellowstone cutthroat move into Nelson Spring Creek during early June and spawn through mid-July. Table 17 summarizes the spawning runs into the creek during 1985 and 1986. This data was collected by bank shocking.

Table 17. Vital statistics of the Yellowstone cutthroat trout spawning run into Nelson Spring Creek during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	°max-min	Female condition
		1985		
6/3	1 (11.0)	1 (14.1)		
6/12	2 (15.1)	2 (14.0)	62-48	emitting eggs
6/19	0 -	1 (15.5)	63-49	
6/27	9 (14.0)	6 (13.8)	63-45	emitting eggs
7/5	9 (13.3)	5 (14.5)	65-44	emitting eggs
7/9	5 (13.2)	3 (14.5)	65-50	spent
7/17	3 (14.5)	2 (13.3)	64-50	spent
Total	29 (13.7)	20 (14.2)		
		1986		
6/17	1 (14.6)	0 -	58-51	
6/25	1 (14.4)	4 (14.2)	61-53	not emitting eggs
6/30	4 (14.8)	1 (13.7)	63-49	emitting eggs
7/7	1 (19.0)	4 (12.8)		emitting eggs
7/14	1 (19.0)	1 (12.8)		emitting eggs
Total	8 (15.3)	10 (13.5)		

The spawning run was sampled more often during 1985 than it was in 1986 because high water in the River caused Nelson Spring Creek water to backup during early June of 1986. Spawning appeared to begin later in 1986 than in 1985, possibly because of this. The run in 1986 appeared to be smaller than in 1985, possibly because of lower populations in the River in 1986 (Figure 5). Roberts and White (1986) found that wading on the cutthroat redds could potentially cause high mortalities of the eggs in the redds. Wading in the creek on known spawning areas was prohibited to avoid high egg mortalities.

Tag returns from the Yellowstone River that were subsequently captured in Nelson Spring Creek during 1984-1986 are summarized in Table 18.

Table 18. Tagging locations of Yellowstone cutthroat trout captured in Nelson Spring Creek during 1984-1986.

Number of tags	Location
4	9th Street Bridge study section
4	Springdale study section

Nelson Spring Creek appears to be one of few spawning streams for Yellowstone cutthroat trout from the Livingston area.

It supports spawning from fish as far away as Springdale.

Depuy side channel. During 1985, a Yellowstone River side channel which receives spring water from the Depuy Spring Creek was sampled for possible spawning by Yellowstone cutthroat trout. This is the same channel that supports substantial rainbow trout spawning during the Spring. Table 19 summarizes the sampling during 1985.

Table 19. Vital statistics of the spawning concentration of Yellowstone cutthroat trout in the Depuy side channel in 1985.

Date	Males(xlength)	Females(xlength)	°max-min	Female condition
6/20	2 (14.5)	0 -		
6/27	4 (14.2)	1 (16.3)		
7/5	7 (14.5)	4 (13.8)		emitting eggs
7/9	2 (15.3)	2 (13.8)		emitting eggs
Total	15 (14.5)	7 (14.2)		

The number of fish in this area was not substantial and the substrate is not ideal for spawning. Two of the fish had been previously tagged in the Yellowstone River, one at the 9th Street Bridge study section and one at the Springdale study section. These are the same areas that fish that spawn in Nelson Spring Creek were tagged. More sampling should be done in the Depuy system to identify the cutthroat spawning areas and movement patterns into the creek.

McDonald Spring Creek. The spawning run into McDonald Spring Creek is another small run that could be potentially improved. Table 20 summarizes the spawning runs during 1985 and 1986.

Table 20. Vital statistics of the spawning run of Yellowstone cutthroat trout into McDonald Spring Creek during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	°max-min	Female condition
		1985		
6/19	1 (17.3)	1 (14.2)	58-46	
6/27	4 (13.8)	0 -	59-46	emitting eggs
7/5	1 (11.9)	1 (14.5)	59-47	emitting eggs
7/9	0 -	0 -	61-49	emitting eggs
Total	6 (14.1)	2 (14.4)		

1986

6/10	1 (11.3)	0 -		
6/17	0 -	0 -		
6/25	0 -	2 (14.2)	62-48	emitting eggs
6/30	2 (13.2)	1 (14.1)	59-50	emitting eggs
7/7	1 (16.5)	2 (14.1)	61-47	emitting eggs
7/14	1 (14.9)	3 (14.4)	61-50	emitting eggs
Total	5 (13.8)	8 (14.4)		

Since the run into McDonald Spring Creek is so small, it is difficult to identify the peak. Only one tag return from the Yellowstone River has been recaptured in the creek. That fish had been tagged in the 9th Street Bridge study section. Clancy (1985) identified Nelson Spring Creek as the only spawning creek for cutthroat trout in the Livingston area. This more recent data suggests that McDonald Spring Creek and Depuy Spring Creek also support spawning from that population. This relationship should be further defined in order to learn the significance of each of these streams.

Stutches Spring Creek. During 1985, a small spawning run of Yellowstone cutthroat trout was sampled in Stutches Spring Creek. Table 21 summarizes this sampling.

Table 21. Vital statistics of the Yellowstone cutthroat trout spawning into Stutches Spring Creek during 1985.

Date	Males(xlength)	Females(xlength)	°max-min	Female condition
6/11	1 (12.2)	0 -	61-43	
6/24	1 (15.2)	3 (14.5)	63-43	emitting eggs
7/3	0 -	0 -	64-42	
Total	2 (13.7)	3 (14.5)		

This would be considered a small run, yet when considering the lack of spawning tributaries in Paradise Valley, it is probably significant. No tag returns from the Yellowstone River were captured during sampling.

Big Creek. This stream is dewatered in the lower reaches during August of most years. Nonetheless, a spawning run of Yellowstone cutthroat ascends the stream. Table 22 summarizes the cutthroat runs into Big Creek during 1985 and 1986.

Table 22. Vital statistics of the spawning run of Yellowstone cutthroat trout into Big Creek during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	°max-min	Female condition
		1985		
6/12	1 (12.9)	1 (14.2)		not emitting eggs
6/19	3 (13.7)	0 -		
6/27	4 (13.5)	2 (13.3)		emitting eggs
7/3	0 -	0 -		
Total	8 (13.5)	3 (13.6)		
		1986		
6/26	2 (13.9)	2 (13.2)	59-42	not emitting eggs
7/9	0 -	4 (14.1)		emitting eggs
7/15	4 (14.4)	4 (13.0)	62-47	emitting eggs
Total	6 (14.3)	10 (13.3)		

The spawning run into Big Creek is never very extensive, as dewatering during the spawning and incubation period severely limits reproduction. During 1985 the run was cut short when the streambed became completely dry the first week of July. It appears that this stream has potential to support a substantial run.

Only three fish that were tagged in the Yellowstone River have been recaptured in Big Creek. Table 23 summarizes these returns.

Table 23. Locations of tagged fish from the Yellowstone River subsequently captured in spawning runs in Big Creek during 1983, 1985 and 1986.

Number of returns	Location
1	Point of Rocks
1	Emigrant area
1	Mill Creek Bridge study section

The tag returns indicate that fish from the River many miles downstream and a few miles upstream move into the creek to spawn.

Rock Creek. During 1985 the spawning migration into Rock Creek was monitored. Table 24 summarizes the data collected during that sampling.

Table 24. Vital statistics of the spawning run of Yellowstone cutthroat trout in Rock Creek during 1985.

Date	Males(xlength)	Females(xlength)	°max-min	Female condition
6/18	1 (12.4)	1 (16.4)	57-42	emitting eggs
6/24	5 (13.7)	1 (16.0)	59-46	emitting eggs
7/3	2 (16.0)	1 (13.6)	61-41	emitting eggs
7/8	1 (11.0)	3 (13.1)	65-52	emitting eggs
7/17	1 (13.1)	0 -	64-50	
Total	10 (13.7)	6 (14.2)		

Only 140 feet of Rock Creek is capable of supporting spawning by cutthroat trout. A culvert at this point creates such high velocity that fish are unable to pass further upstream to spawn. The culvert should be modified or removed to allow passage of these fish.

During the sampling in 1985, three tag returns from the Yellowstone River were collected in Rock Creek. Table 25 summarizes these returns.

Table 25. Tagging locations of Yellowstone cutthroat trout in Rock Creek during 1985.

Number of returns	Location
1	Yankee Jim Canyon
1	Mill Creek Bridge study section
1	Big Timber study section

Rock Creek supports spawning movement from many miles downstream, much the same as Tom Miner Creek (Clancy, 1984). One individual travelled from Big Timber to Rock Creek, a distance of 82 river miles, in about 10 months.

Tom Miner Creek. The spawning run into Tom Miner Creek is consistently strong and appears to be one of the most significant runs of the Upper Yellowstone River. Most years the creek is too high to sample when the run begins, but it appears that cutthroats move into Tom Miner Creek in early June during most years. Table 26 summarizes the spawning run into Tom Miner Creek during 1985 and 1986.

Table 26. Vital statistics of the spawning run of Yellowstone cutthroat trout into Tom Miner Creek during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	°max-min	Female condition
		1985		
6/4	3 (10.9)	1 (10.1)		not emitting eggs
6/11	6 (14.7)	1 (15.2)	61-42	emitting eggs
6/18	19 (13.6)	12 (14.1)	62-42	emitting eggs
6/24	15 (13.7)	9 (14.5)	62-45	emitting eggs
7/3	14 (13.7)	12 (14.4)	59-	emitting eggs
7/8	9 (13.3)	9 (13.8)		emitting eggs
7/17	2 (11.5)	1 (11.8)		spent
Total	68 (13.5)	45 (14.0)		
		1986		
6/26	22 (13.5)	10 (14.3)		emitting eggs
7/1	18 (13.4)	20 (13.8)	57-46	emitting eggs
7/9	16 (13.6)	23 (13.5)		emitting eggs
7/15	21 (13.7)	14 (13.5)		emitting eggs
Total	77 (13.5)	67 (13.7)		

It appears that movement times into the creek and the peak of spawning vary between years. The fish appear to have moved into the creek earlier and left earlier during 1985 than 1986. This may relate to flow conditions of the creek, but will have to be analyzed in more detail. A relationship appears to occur between the flows during the summer and the number of 2 year old cutthroat trout, 2 years later. This relationship should be further explored with continuous sampling in the future.

During sampling of Tom Miner Creek between 1983 and 1986, 28 cutthroat trout that were previously tagged in the Yellowstone River have been recaptured. Table 27 summarizes the tagging locations of those fish.

Table 27. Tagging locations of Yellowstone Cutthroat Trout captured in Tom Miner Creek between 1983-1986.

Number of returns	Location
12	Yankee Jim Canyon area
5	Mill Creek Bridge study section
5	Point of Rocks area
4	Corwin Springs study section
2	Emigrant area

Most of the fish that spawn in Tom Miner Creek have moved in

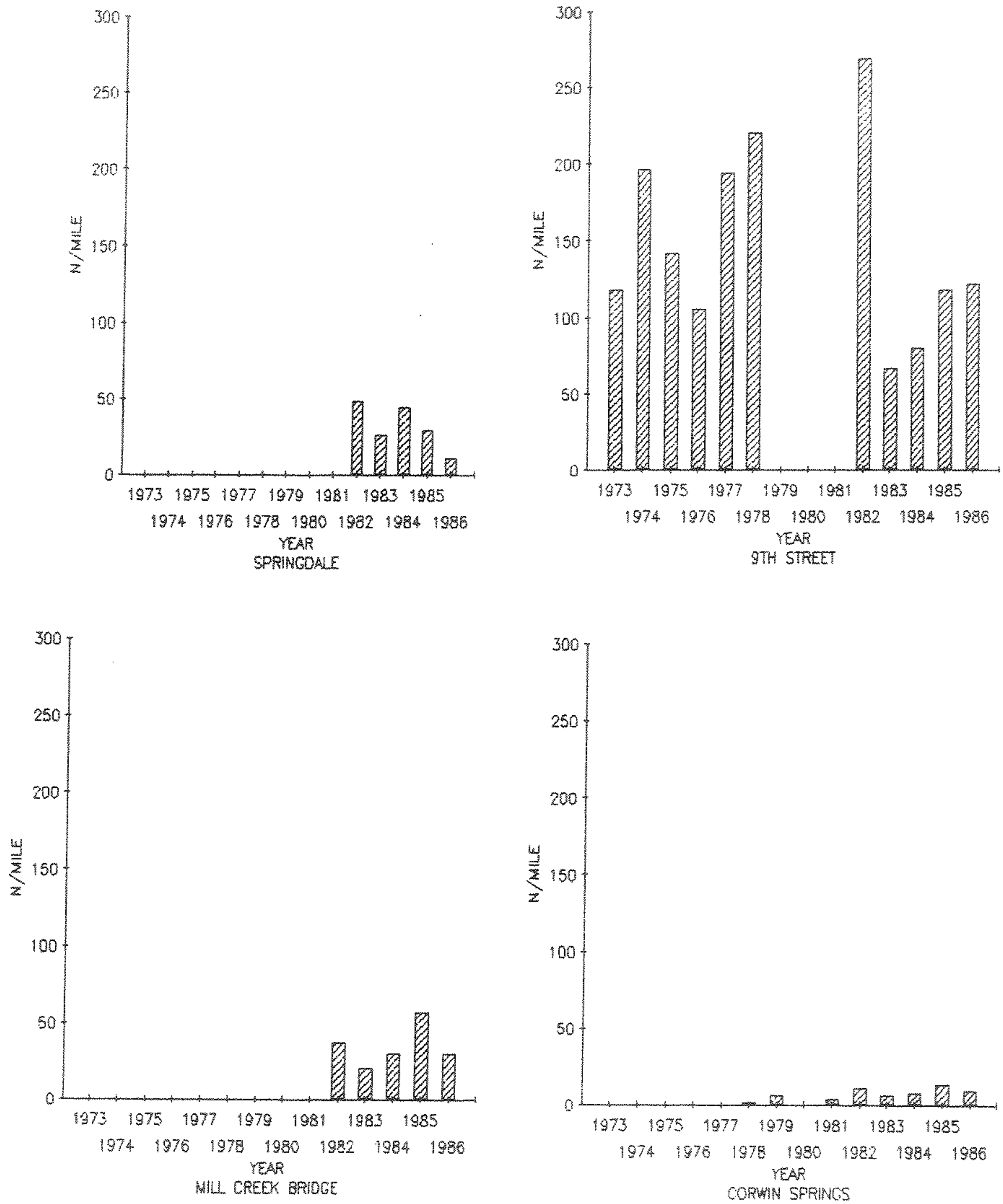


Figure 8. Rainbow trout longer than 16 inches per mile in the four study sections.

idea of the effects of the regulations on the rainbow trout population, a Fall population estimate should be collected and compared to Fall estimates from the early 1980's.

Migration and Spawning. Nelson Spring Creek and Armstrong Springs are key spawning areas for rainbow trout. Both creeks support spawning for rainbow trout throughout the system. Tables 31 and 32 illustrate the vital statistics of the rainbow migration into these creeks during the years indicated.

Table 31. Vital statistics of the rainbow trout migration into Armstrong Springs during 1985 and 1986.

Date	Males(xlength)	Females(xlength)	°max-min	Spawning condition
		1985		
1/18	2(13.3)	0 -		
2/7	1(18.4)	0 -	51-41	
2/19	0 -	0 -	52-41	
2/28	3(17.9)	1(18.4)	52-44	emitting eggs
3/11	111(16.1)	31(17.1)	54-45	emitting eggs
3/19	103(15.9)	43(16.4)	55-45	emitting eggs
3/28	105(16.1)	48(16.4)	55-45	emitting eggs
Total	325(16.0)	123(16.6)		
		1986		
1/30	5(16.3)	1(13.2)		
2/17	25(16.6)	8(16.6)	50-44	emitting eggs
3/4	81(16.2)	36(16.7)	54-42	emitting eggs
3/18	50(16.1)	23(16.0)		emitting eggs
Total	161(16.2)	68(16.4)		

Table 32. Vital statistics of the rainbow trout migration into Nelson Spring Creek during 1986.

Date	Males(xlength)	Females(xlength)	°max-min
1/29-1/31	18 (17.1)	4 (16.7)	49-42
2/1-2/15	13 (16.8)	7 (16.5)	51-42
2/16-2/28	17 (16.9)	15 (16.3)	53-40
3/1-3/15	37 (16.1)	23 (16.6)	55-46
3/16-3/30	1 (15.7)	9 (16.1)	
Total	86 (16.6)	58 (16.4)	

Yellowstone River rainbow trout spawn early in the year in the spring creeks. Kaya (1977) found that rainbow trout in the geothermally heated Firehole River spawn in the Fall, which appeared to be an adaptation that aided survival. This early spawning in the spring creeks may also aid in survival.

Table 33 lists the locations of previously tagged rainbow trout that were captured in spawning areas.

Table 33. Tag returns of rainbow trout captured while spawning.

Location recaptured	Location tagged	number
Armstrong Spring	Pine Cr. channels	10
	9th St. study sec.	4
	Mill Ck. Br. study sec.	4
	Nelson Spring Cr.	2
Nelson Spring Cr.	Pine Cr. channels	7
	Armstrong Spring	1
	Mill Ck. Br. study sec.	1
Pine Creek channels	Nelson Spring Cr.	1
	Mill Cr. Br. study sec.	1

Numerous tag returns from fish captured in the Armstrong Spring Creek while spawning have been recaptured in the Springdale, 9th Street and Mill Creek Bridge study sections. However, the spawning areas of the rainbow trout in the Corwin Springs area remain unknown. Sampling in the Gardner River during early and late March of 1986 did not result in identifying a spawning run. There appears to be a disjoint population of rainbow trout in the upper river. Rainbow trout are considered rare in the section of river from Carbella to Emigrant and no tag returns of Corwin Springs rainbow trout have been found outside of the study section.

Mountain whitefish.

Populations. The population of mountain whitefish in the Yellowstone has been documented (Berg, 1975). The Mallards Rest study section was electrofished during 1986 to assess the population size. Table 34 summarizes the population of mountain whitefish per mile during 1973 and 1986, and compares the structure of the biomass for the two years.

Table 34. Mountain whitefish over 9" per mile in the Mallards Rest study section and the biomass structure during 1973 and 1986.

YEAR	N	% biomass between 10.0" and 14.0"
1973	12210(+2471)	86
1986	6569(+ 874)	87

The population in 1986 was slightly over half as large as the population in 1973. The biomass during both years is largely concentrated in the 10"-14" size classes. This sampling should be done each year to follow trends in mountain whitefish numbers in the river.

Yellowstone River Water Temperature. Figure 9 depicts the 5 day mean water temperature at Greybear during 1985 and 1986. The thermograph has been erratic and the data is incomplete, however it indicates that temperatures during these two years were close to the values of the past.

Shields River

Convict Grade. Population estimates of rainbow trout, brown trout and mountain whitefish longer than 10 inches in the Convict Grade section of the Shields River are illustrated in Figure 10.

The populations of all three species have been stable since 1979. Brown trout and mountain whitefish have increased since 1972. This may relate to the recovery of the River from prior abuses (Clancy, 1985).

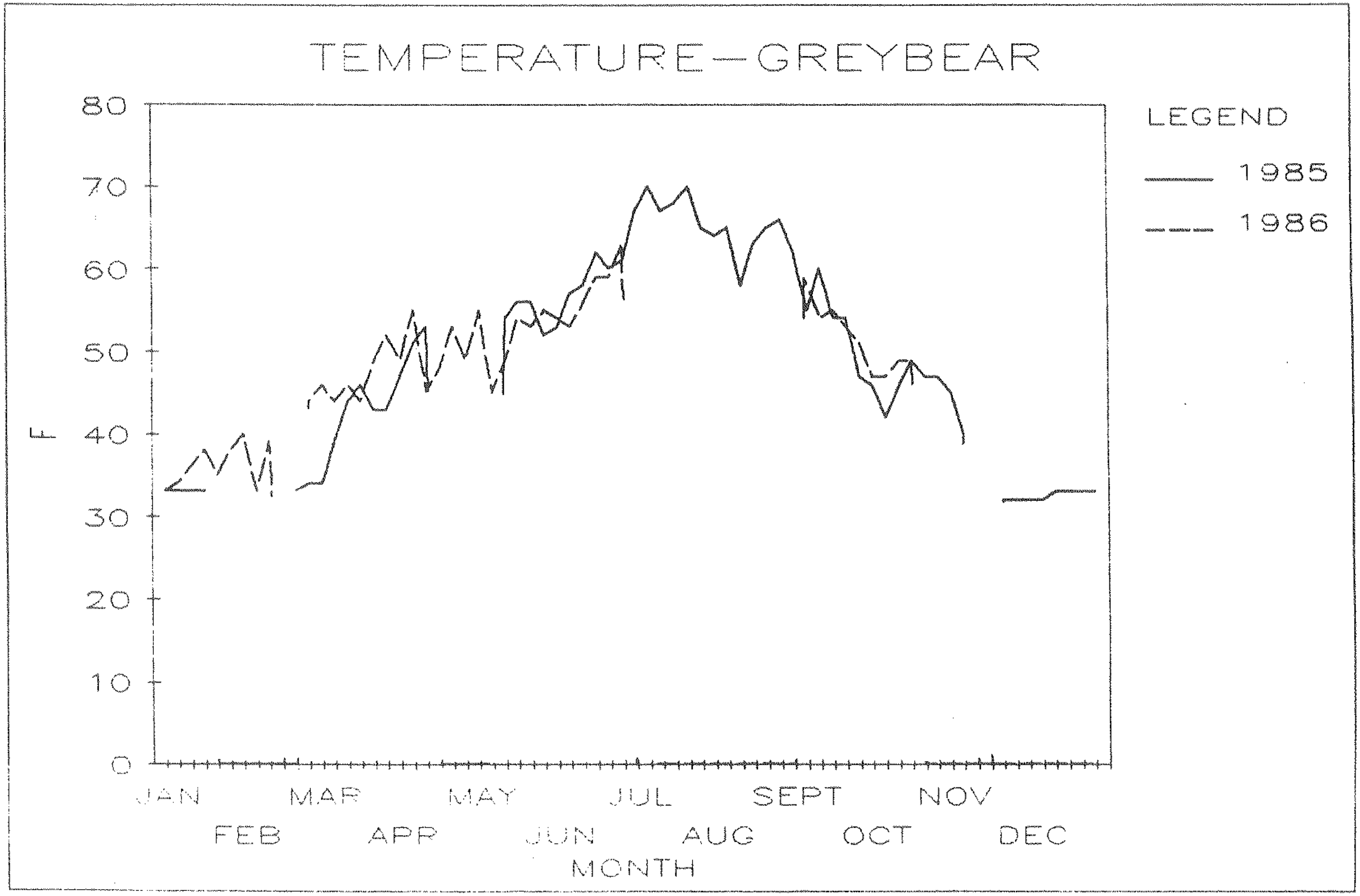
Zimmerman. Figure 11 depicts the number of brown trout and mountain whitefish larger than 10" in this section during recent years. The number of brown trout has remained consistent through the 1980's, even though summer flows appear to be limiting the population (Clancy,1985). Mountain whitefish have decreased in number since the early 1980's. There is no obvious relationship between the population of brown trout and mountain whitefish.

Streamflow data for this section of stream is presented in Figure 12. 1985 was a low flow year through mid-August, and then flows increased with high rainfall. 1986 was a more typical flow year and flows did not reach quite as low levels as 1985. This is reflected in the water temperature data. During 1985 the water temperature reached a peak of 70°F, while it only reached 68°F during 1986 (Figure 13).

Small Streams

Some long term study sections have been set up on the following

Figure 9. Five day mean maximum water temperatures at Greybear during 1985 and 1986.



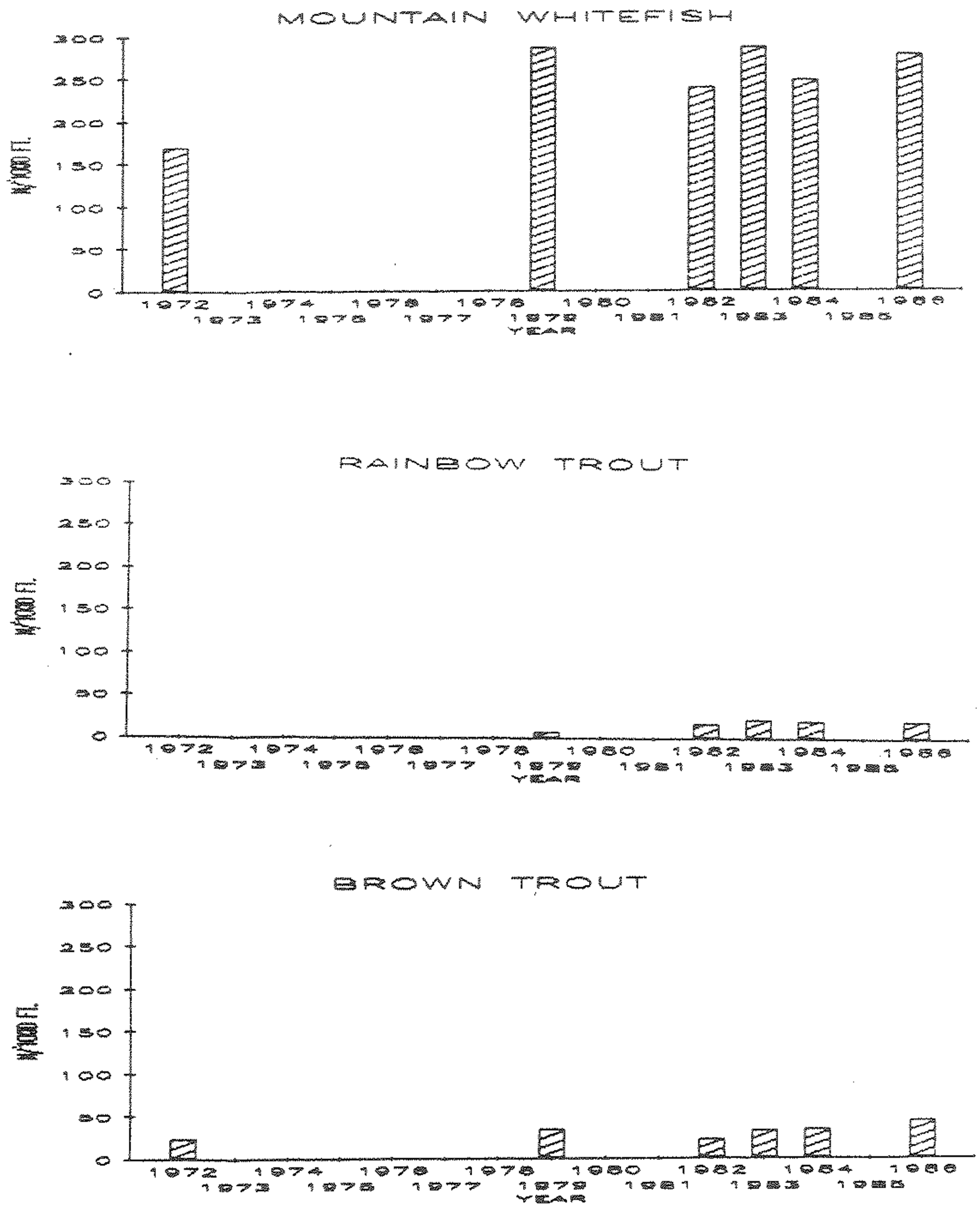


Figure 10. Populations of brown and rainbow trout and mountain whitefish longer than 10 inches per 1000 feet in the Convict Grade section of the Shields River.

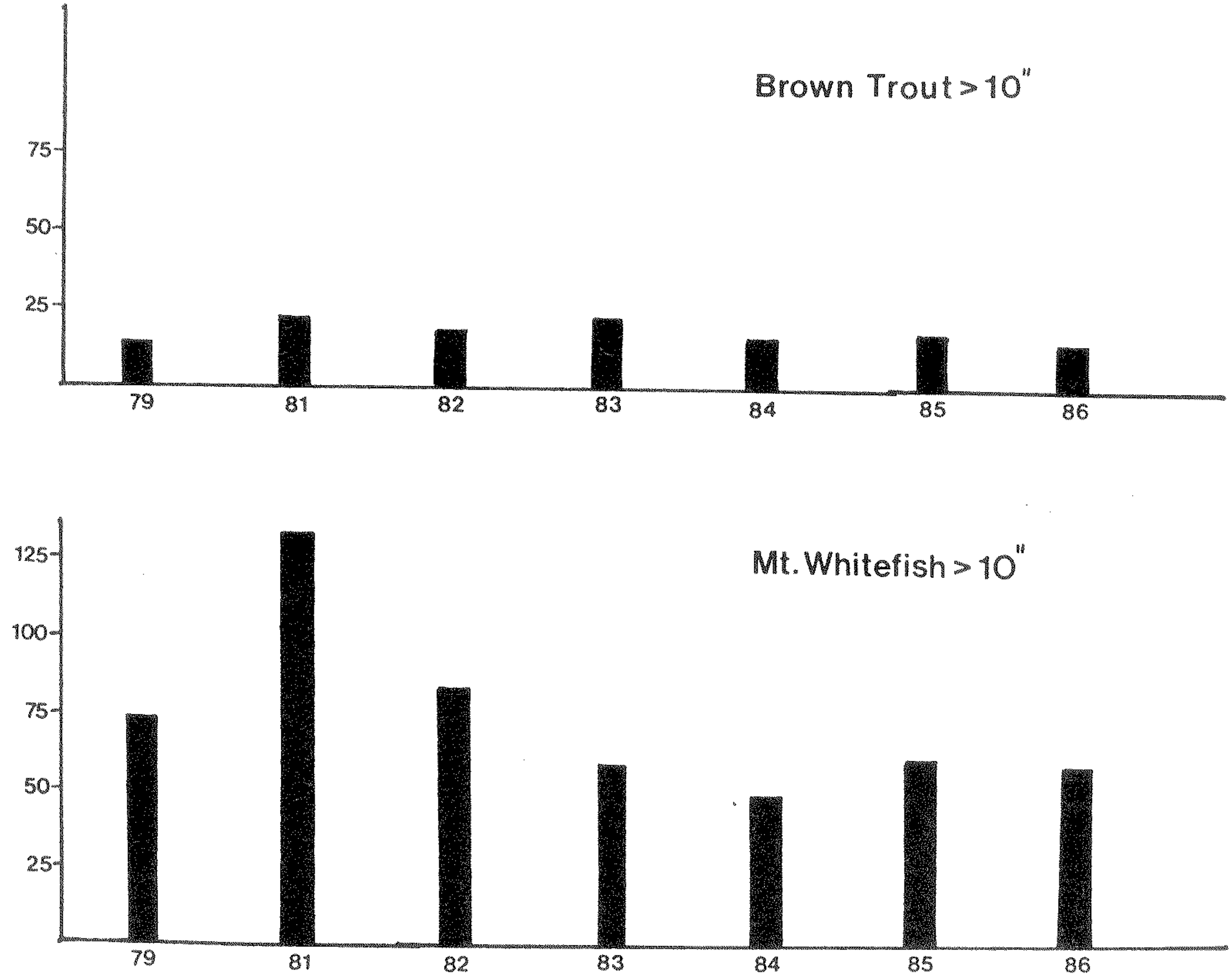


Figure 11. Population estimates of brown trout and mountain whitefish longer than 10 inches in the Zimmerman section of the Shields River.

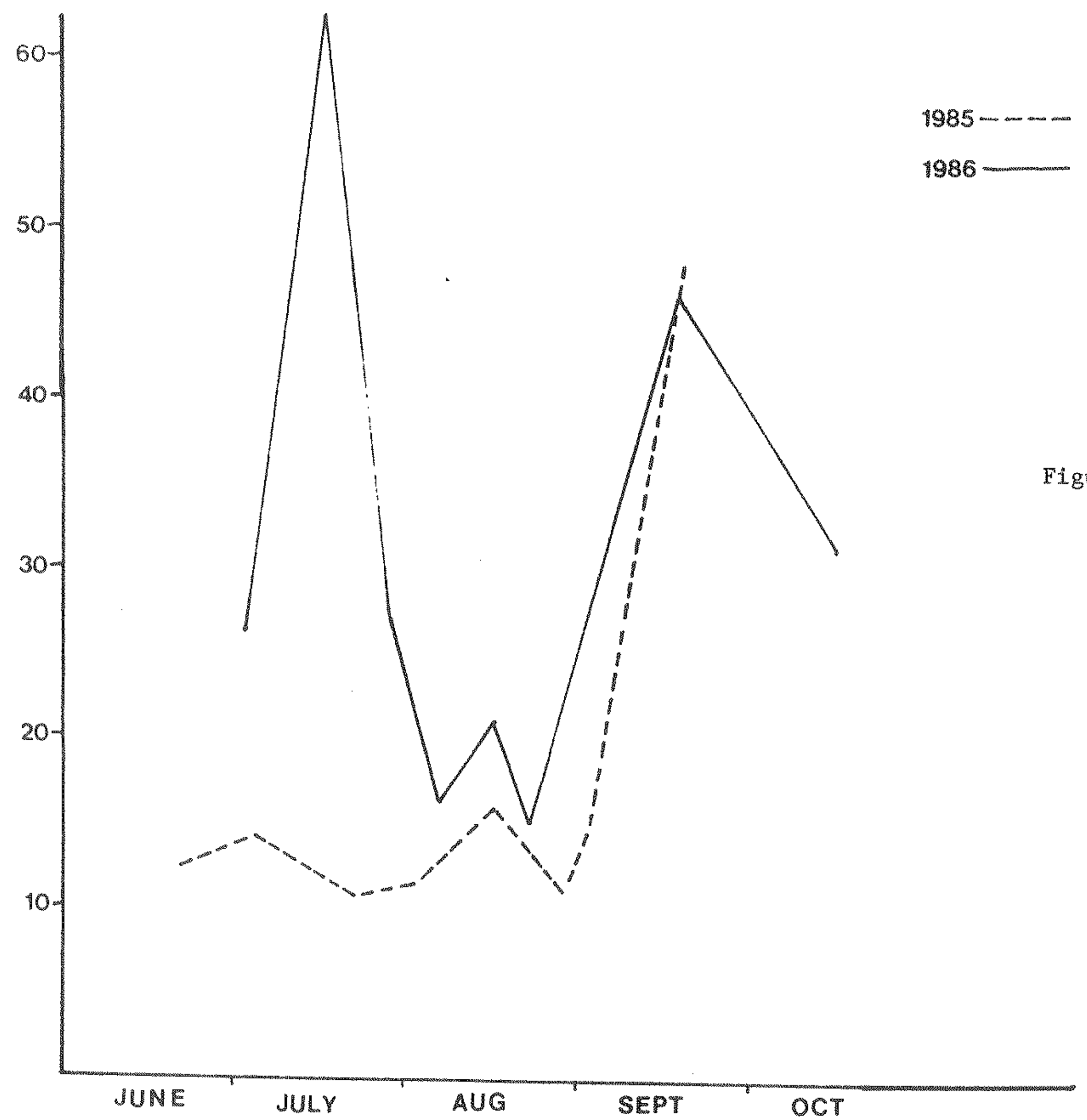
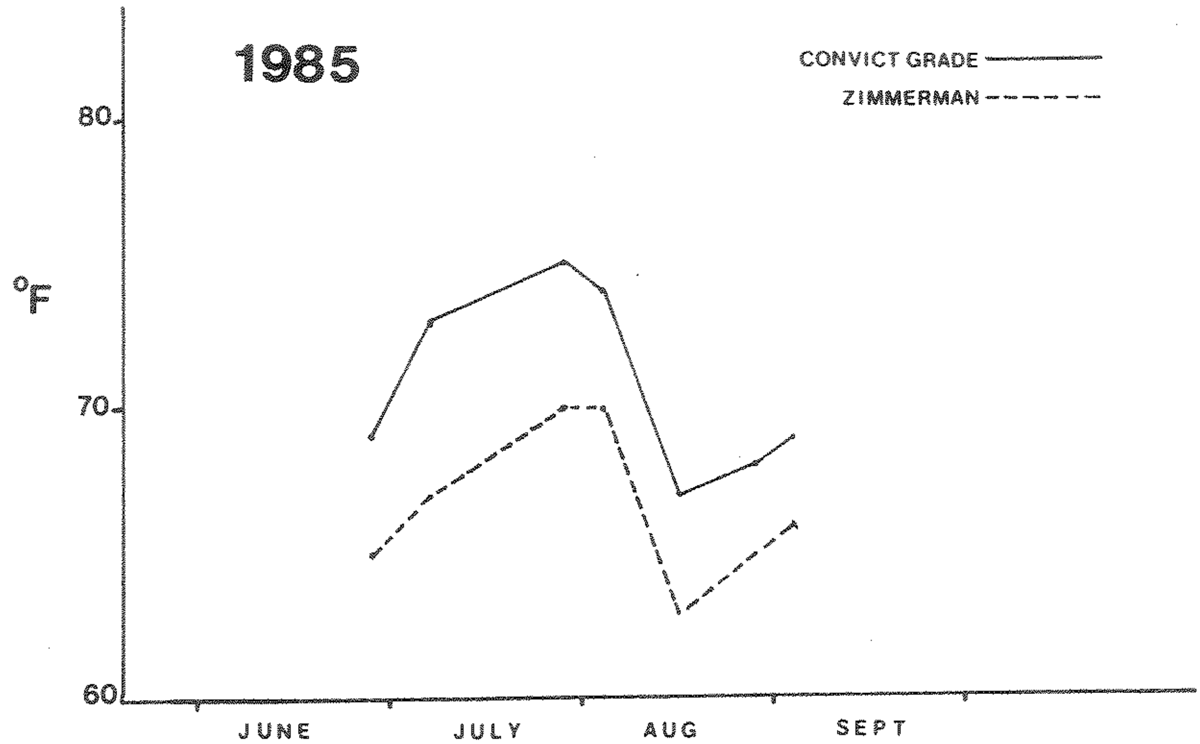


Figure 12. Flows in the Zimmerman section of the Shields River during 1985 and 1986.



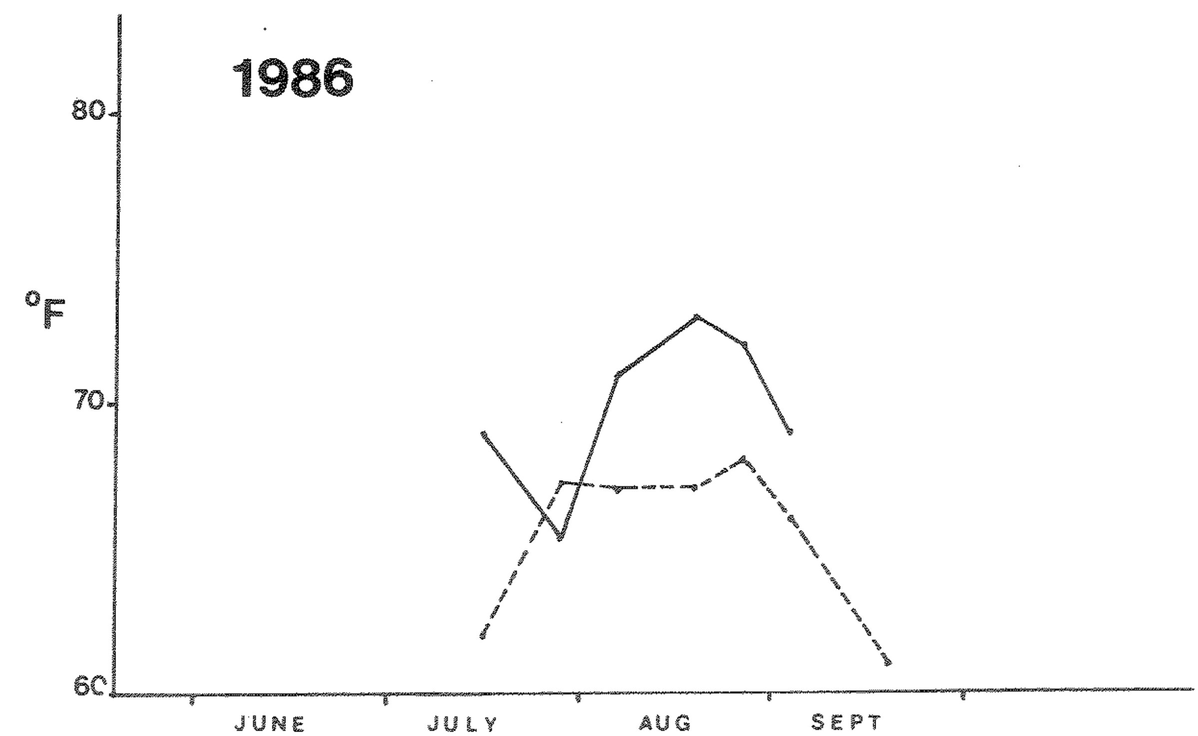


Figure 13. Maximum water temperatures in the Zimmerman and Convict Grade sections of the Shields River during 1985 and 1986.

small streams in order to monitor the populations of fish over the years. Sampling should be done at regular intervals of 3-5 years to try and document population changes over time. More sections should be set up on other streams as time permits. Table 33 lists most of these streams and has directions for finding the study sections.

Table 33. Location of population study sections on streams where population work has been done in recent years.

Bangtail Creek: T1N R9E Sec29. The lower boundary of the section is at the county road crossing.

Big Creek: T6S R6E Sec 13. The midpoint of the section is where the road comes next to the creek upstream of USFS cabins.

Brackett Creek: T1N R7E Sec5,8. The upper boundary of the section is where the South Fork enters Brackett Creek (Danfall).
T1N R7E Sec4,9. The middle of the section is at the bridge which crosses to the Harris cabin (Harris).

Coke Creek: T2S R8E Sec26. The upper boundary is about 100 feet below the mouth of Miner Creek.

Cottonwood Creek: T2N R10E Sec2. The upper boundary is where the road crosses the creek.

East Fork Mill Creek: T6S R10E Sec17. The upper boundary is about 200 feet above the powerhouse intake at the Snowy Range Ranch.

Emigrant Creek: T6S R8E Sec13. The lower boundary is just across the section line at the cattleguard.

Fleshman Creek: The Enterprise section lower boundary is at the C Street crossing and the upper boundary is the culvert at the swimming pool. The St. Mary's section lower boundary is at the H Street crossing and the upper boundary is at the F Street crossing.

Little Mission Creek: T3S R11E Sec2. The lower boundary is about 50 feet above the lower fence, about 1/4 mile below the Gordon schoolhouse.

McDonald Creek: T4S R9E Sec11. The lower boundary is 50 feet above the mouth.

Mill Fork Creek: T3S R11E Sec4. The lower boundary is at the cabin by the creek.

Mission Creek: T2S R11E Sec33. The upper boundary is at the culvert under the county road.

Mol Heron Creek: T8S R7E Sec 25. The upper boundary is the mouth of Cinnabar Creek.

North Fork Brackett: T1N R7E Sec5. The lower boundary is about 100 feet above the mouth.

Pine Creek: T4S R10E Sec7. At the Luccock Park.

Rock Creek: T7S R7E Sec19. Lower boundary is immediately above the county road culvert.

Sixmile Creek: T6S R8E Sec32. The middle of the section is where the bridge crosses the creek (Bridge).
T7S R8E Sec9. The upper boundary is about 200 feet below the mouth of the North Fork (Horsethief).

Smith Creek: T5N R9E Sec24. The lower boundary is where the first bridge crosses the creek.

Tom Miner Creek: T8S R6E Sec9. The lower boundary is where the ranch road crosses the creek just downstream of some buildings and a small spring.

Trail Creek: T4S R8E Sec11. The lower boundary is at the culvert just above the mouth of West Pine (West Pine).
T3S R8E Sec20. The upper boundary is at a farmhouse where the creek passes through a culvert (Section 20).

West Fork Mill Creek: T6S R9E Sec25. The middle of the section is where the road crosses the creek.

Yellowstone River Tributaries

Coke Creek. This extremely brushy tributary of Billman Creek was sampled during October, 1985. The population consists of a large number of small Yellowstone cutthroat trout. Electrophoretic analysis during 1986 indicated that a small proportion (12%) of the population are first generation rainbow x cutthroat hybrids.

The population consisted of 2163 (+738) fish longer than 3" per 1000 feet of stream. 780 or 36% of the population was longer than 6". A large population of mottled sculpin (*Cottus bairdi*) was present.

Sampling during 1974 did not result in a population estimate but 158 fish were caught in 150 feet of creek.

Mission Creek. During 1985 and 1986 a 550-foot section of Mission Creek was electrofished to assess the composition and size of the trout population. The section of stream, immediately below the Triangle 7 ranch is composed of a large population of brown trout and a smaller population of Yellowstone cutthroat. Table 34 lists the population estimates during 1985 and 1986.

Table 34. Population estimates of brown and Yellowstone cutthroat trout per 1000 feet in the Triangle 7 section of Mission Creek during 1985 and 1986.

Date	brown trout > 6.0"	Yellowstone cutthroat > 6.0"
7/85	220(+24)	72(+18)
9/86	256	98(+27)

The population of each species was stable or increased slightly between 1985 and 1986.

Little Mission Creek. This stream was sampled during September, 1985 and found to have a population of 436 (+58) Yellowstone cutthroat trout longer than 3" per 1000 feet of stream. 100 or 23% of the population was longer than 6". Berg (1975) captured 148 Yellowstone cutthroat in 250 feet of stream during October, 1974, however 99% of the fish were over 6". The reason for the difference between the years is unknown. During sampling in 1985 several rainbow trout between 6.3 and 7.8 inches were captured. Berg (1975) did not mention rainbow trout suggesting that this their presence may be a recent occurrence.

Mill Fork Creek. The same section as reported in Clancy (1985) was sampled again during July of 1985.

The population during 1985 was similar in overall numbers to the 1984 population but the number of fish longer than 5" was lower, probably reflecting the poor recruitment of small fish identified during 1984. Table 35 lists the population estimates for this section.

Table 35. Population estimates of Yellowstone cutthroat trout per 1000 feet of Mill Fork Creek during the years indicated.

Date	N 3.0-4.9"	N >5.0"	N Total
1982	135	63	198
1984	51	62	113
1985	70	26	96

This is baseline information which should be used for comparison purposes if logging takes place in the Tie Creek drainage which is a tributary a short distance upstream.

Sixmile Creek. Population estimates were collected on two sections of Sixmile Creek during 1985. The lower (Bridge) section is composed primarily of brown trout, with a few

Yellowstone cutthroat present. The population estimate of brown trout during September, 1985 was 167 (+34) over 5.0 inches per 1000 feet. The upper (Horsethief) section is composed primarily of Yellowstone cutthroat and a few brown trout. The population estimate during September, 1985 was 65 (+10) cutthroat trout longer than 6.0" per 1000 feet. This section was used as a comparison with Mill Creek.

Emigrant Creek. During September, 1986 a 1000 foot section of Emigrant Creek was sampled to assess the composition and size of the trout population. The population was composed of Eastern brook trout and a small population of cutthroat trout. The population estimate of brook was 26(+6), while the cutthroat population was too small to estimate.

Fleshman Creek. The populations of rainbow and brown trout in Fleshman Creek have recovered since the creek was dewatered and rehabilitated in 1981. Table 36 illustrates the population changes since 1982 in the Enterprise section, which was rebuilt, and the St. Mary's section, which was a control.

Table 36. Rainbow and brown trout in the Enterprise and St. Mary's sections of Fleshman Creek during the years indicated.

Brown Trout

	Enterprise		St. Mary's	
Year	I	II+	I	II+
1982	48	0	78	2
1983	65	17	116	27
1984	108	19	240	28
1986	37	30	86	70

Rainbow Trout

	Enterprise		St. Mary's	
Year	6.0-9.9"	>10"	6.0-9.9"	>10"
1982	68	5	113	10
1983	92	11	25	19
1984	19	18	12	5
1986	44	17	3	4

The St. Mary's section has consistently supported more brown trout and fewer rainbow trout than the Enterprise section. The number of brown trout one year olds has been about twice as high at the St. Mary's section. The number of two year and older brown trout in both sections has continued to increase, while the number of one year olds decreased significantly in 1986. This may mean that the population in the creek is going to stabilize soon.

The population size of rainbow trout is difficult to assess because of the influence of hatchery fish that escape the Sacajawea lagoon, immediately upstream of the Enterprise section.

The St. Mary's rainbow trout population has decreased significantly since 1982.

These sections should be monitored annually until the adult population stabilizes. It is clear that 5 years after the stream was dewatered, the population of trout is still increasing.

Rock Creek. A 1000 foot section of Rock Creek was electrofished during September, 1986. The population estimate of Yellowstone cutthroat was 197 (+49) larger than 3.5 inches (138 > 6.0 inches) per 1000 feet. The population size structure was normal, containing a healthy population of younger fish. There were also a few rainbow and brown trout present.

Tom Miner Creek. A section of Tom Miner Creek was sampled on the B-Bar ranch during September, 1985. The fish population was composed of Yellowstone cutthroat trout, with 253 (+69) per 1000 feet being the estimate. 201 or 83% of the fish were over 6".

Trail Creek. Two sections of Trail Creek were sampled during 1985 as a comparison to sampling in 1973. Table depicts the populations of rainbow-cutthroat hybrid trout.

Table. Rainbow-cutthroat hybrids per 1000 feet in two sections of Trail Creek during 1973 and 1985.

	West Pine	Section 20
8/16/73	31	63
9/05/85	22(+3)	138(+41)

The population of rainbow-cutthroat hybrid trout in Trail Creek, near West Pine Creek, was similar in 1973 and 1985. A small population of brown trout is also present in this section.

The population of rainbow-cutthroat trout in the upper section has increased between 1973 and 1985.

Mill Creek-Sixmile Creek Study

A study was initiated in 1985 to assess factors that may be limiting the fish populations in Mill Creek within the Gallatin National Forest. Mill Creek is the largest drainage within Paradise Valley that enters the Yellowstone River. Fish populations have been characterized as very sparse, and this study was initiated in an attempt to learn more about the creek.

Sixmile Creek is also included in the study because it drains the same mountains as Mill Creek, looks similar in habitat yet supports a fish population considerably higher than Mill Creek. Table 38 illustrates fish surveys that were done on Mill Creek and Sixmile.

Table 38. Number of Yellowstone cutthroat collected in 1000 feet of electrofishing of Mill Creek (3 sections) and Sixmile Creek (1 section), during September, 1985.

Section	fish < 9.0 inches	fish > 9.0 inches
Mogen (Mill)	0	4
Road (Mill)	0	4
Bridge (Mill)	5	6
Horsethief (Sixmile)	30	11

Mill Creek supports a small number of cutthroat trout that are comparatively large in size, while Sixmile supports a high number of small fish and a higher number of large fish. 73% of Sixmile Creek cutthroat are < 9.0 inches while only 26% of Mill Creek fish are < 9.0 inches. The population structure of the Mill Creek fishery is topheavy.

Tributary streams. The major tributaries of Mill Creek and one tributary of Sixmile Creek were sampled to assess the presence or absence of fish (Figure 14). Clancy (1985) discussed the East and West Forks of Mill Creek which enter Mill Creek downstream of the three study sections.

Table 39 characterizes the fish populations in the tributaries of Mill Creek near the study area.

Table 39. Fish abundance in the tributary streams of Mill Creek near the study sections.

Stream	Section length-mouth-upstream	Fisheries
Wicked	300 ft.	barren
Passage	1000 ft.	minimal
Colley	300 ft.	barren
Lambert	200 ft.*	barren
Anderson	700 ft.	CT common

*section about 1/2 mile above mouth

Most of the tributaries in the vicinity of the study sections have few or no resident fish near the mouth. The exception is Anderson Creek, the only south flowing stream that was sampled. Twenty seven Yellowstone cutthroat between 3.0 and 9.0 inches were captured in a 700 foot section. The temperature and streambottom of Anderson Creek should be studied and compared to the other barren tributaries.

Gold Prize Creek was the only tributary of Sixmile Creek that was sampled. The 300 feet upstream of the road were barren.

Future plans for this study involve transplanting pure fluvial Yellowstone cutthroat into Mill Creek to test whether

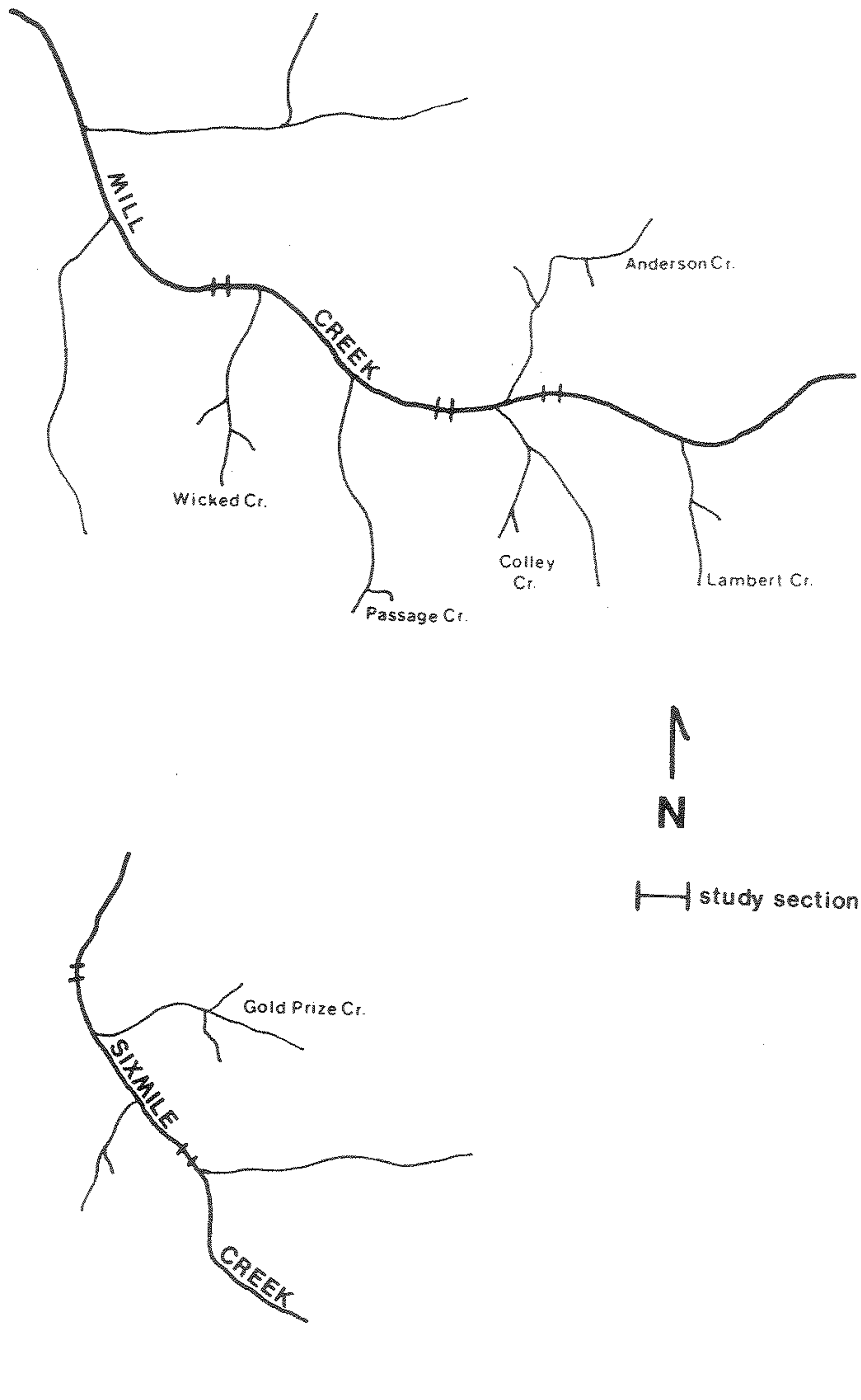


Figure 14. Map of the Mill Creek and Sixmile Creek study sections.

this increases the population in the future.

In an attempt to better understand the habitat factors involved in the two streams, water quality, aquatic insects, physical habitat and streambottom substrate were analyzed.

Streambottom substrate. Embeddedness was measured in two sections of Mill Creek and two sections of Sixmile Creek to compare the embeddedness of the streams. Table 40 lists the embeddedness values using the ringtoss technique (Burns, 1984).

Table 40. Percent embeddedness and percent of free matrix particles in two sections of Mill Creek and two sections of Sixmile Creek during September, 1986.

Section	% embeddedness	% free matrix particles
Bridge (Mill)	27.0	33.0
Road (Mill)	21.0	44.0
Bridge (Sixmile)	22.0	49.0
Horsethief (Sixmile)	16.0	58.0

The Bridge section of Sixmile Creek is downstream of the Horsethief section and supports few cutthroat trout. It is more meaningful to compare the Horsethief section with the two sections of Mill Creek. The Mill Creek sections both have higher embeddedness values and lower % of free matrix particles than the Horsethief section of Sixmile Creek. This indicates that Mill has higher amounts of fine sediments in the streambottom than Sixmile Creek. A thorough substrate analysis should be performed to evaluate the actual differences in substrate composition between the two streams.

Water quality. Water samples were collected from Mill Creek and Sixmile Creek on 10/29/85 and analyzed for basic water quality parameters. Table 41 lists the values of the parameters tested.

Table 41. Water quality parameters for Mill Creek and Sixmile Creek within the study areas on 10/29/85.

	Mill Creek (ppm.)	Sixmile Creek (ppm.)
Calcium	16.9	18.3
Magnesium	6.3	10.0
Sodium	3.7	3.6
Potassium	1.7	1.1
Iron	.01	.03
Managanese	--	--
SiO	24.6	12.2
HCO	84.4	107.6
Chlorine	.3	.5
Sulphate	4.8	6.0
Nitrogen	.05	.06
Nitrate	.22	.28
Conductivity(25°C)	150.0	185.1
Lab pH	6.7	6.6

Heavy metals were also tested on both samples and found to be within normal limits. Overall the water quality information indicates that Sixmile Creek tends to be more productive than Mill Creek, but this difference does not explain the large difference in fish populations.

Aquatic Invertebrates. Three-one square foot Surber samples were collected in the study areas on 10/29/85 to identify the aquatic portion of the food supply available to fish. Table 42 lists the results of that sampling.

Table 42. The total number of aquatic invertebrates in three-one square foot Surber samples in Mill and Sixmile Creek.

	Mill Creek	Sixmile Creek
Ephemeroptera		
Ameletus sp.	1	1
Baetis bicaudatus	4	5
Caudatella heterocaudata	0	1
Drunella doddsi	14	26
Drunella spinifera	1	2
Epeorus deceptivus	0	1
Ephemerella infrequens	3	0
Heptagenid (unknown)	8	7
Rithrogena sp.	15	104
Plecoptera		
Chloroperlidae	2	16
Despaxia sp.	1	0
Doroneuria theodoria	2	1

Malenka sp.	0	43
Megarcys sp.	0	1
Skwala sp.	2	5
Zapada sp.	5	15
Trichoptera		
Apatania	4	7
Arctopsyche grandis	1	8
Neothremma sp.	0	1
Rhyacophila sp.	2	14
Diptera		
Chironomidae	0	2
Cricotopus nostocki	399	0
Ephydridae	0	2
Hexatoma sp.	1	3
Pericoma sp.	0	2
Oligochaeta	9	22
Turbellaria	3	19

Mill Creek has considerably less food available to fish (George Roemhild, personal communication). The most common invertebrate in Mill Creek is Cricotopus nostocki, which is not available to fish. Sixmile Creek supports more invertebrates, and a more diverse community than Mill Creek. The fish that were captured in electrofishing surveys in Mill Creek were in good condition. Adelman et al. (1955) found that starvation was probably not the reason for overwinter mortality of brook trout. Ellis and Gowing (1957) found that brown trout living in a stream with a poor aquatic food base adapted to a terrestrial insect diet but were not in good condition. Ware (1971,1972) showed that rainbow trout can learn from experience to feed on what is available and palatable and that prey density did not affect the amount of feeding.

Winter icing conditions. On 11/13/85 both Sixmile and Mill Creek were accumulating anchor ice. Anchor ice can be detrimental to the fish and aquatic invertebrates in a stream (Needham and Jones, 1959). The younger age classes of fish are more vulnerable to the damaging effects of anchor ice (Benson,1955, Stalnaker and Milhous,1983, Cerven,1973). The physical effects are more detrimental to fish than depletion of food supply (Reimers,1957, Maciolek and Needham,1952). During spring breakup of ice, large ice dams and subsequent flooding and scouring by ice is a frequent occurrence in Mill Creek. Hoopes (1975) and Segrist and Gard (1972) found that flooding causes high mortality in young fish. This information suggests that the winter mortality of young fish may be high in a stream with severe anchor ice formation.

The anchor ice in Mill Creek appeared to increase in a downstream direction from the upper Bridge section. The lower sections of Mill Creek supported virtually no young fish.

Sixmile Creek also formed considerable anchor ice, however, it did not appear to be as severe as Mill Creek.

Shields River tributaries

Bangtail Creek. This creek was electrofished during September, 1985 duplicating the area that was sampled in 1974. The creek supports a population of Yellowstone cutthroat trout and brook trout (*Salvelinus fontinalis*). The population estimate per 1000 feet of stream in 1985 was 97 (+21) cutthroat longer than 3", and 136 (+17) brook trout longer than 4.5 inches. During 1974 a population estimate was not made so comparison of the actual number of fish collected is the only comparison that can be made (Table 43).

Table 43. Fish captured during electrofishing in Bangtail Creek during 1974 and 1985.

Date	Yellowstone cutthroat (%)	brook trout (%)
8/74 (150 feet)	19 (68%)	9 (32%)
9/85 (1000 feet)	54 (40%)	80 (60%)

The survey data shows that the population was mostly cutthroat trout in 1974 and by 1985 it was 60% brook trout. Clancy (1985) found the same trend in the North Fork Brackett Creek. Griffith (1986) felt that brook trout were able to dominate cutthroat trout in streams that were not ideal cutthroat habitat. High gradient streams were more likely to support ideal cutthroat habitat. Glova (1984) found that cutthroat trout were found in riffles when living sympatrically with coho salmon. The tribuaries of the Shields River where brook trout appear to be outcompeting cutthroat trout are low gradient streams with silty substrate. Cunjak and Green (1984) found that brook trout dominated rainbow in slow flow habitat, while neither species dominated in fast flowing habitat. This information indicates that brook are very competitive in certain habitats, and not as successful in the high gradient habitats.

Smith Creek. Table 44 depicts the population estimates of brook and Yellowstone cutthroat trout in Smith Creek during 1974 and 1985.

Table 44. Population estimates of brook and Yellowstone cutthroat trout >5.0 inches per 1000 feet of Smith Creek during 1974 and 1985.

Date	Yellowstone cutthroat (%)	brook trout(%)
10/74	176(68)	81(32)
9/85	62(44)	78(56)

The number of brook trout has remained stable since 1974, however, the number of Yellowstone cutthroat has diminished to 35% of it's 1974 value. The reason for this is unclear, however the decline of Yellowstone cutthroat in this stream is consistent with declines in other streams where they live sympatrically with brook trout. This stream does receive more fishing pressure than the other brook trout-cutthroat streams which have been studied in the Shields River drainage, and that may also be contributing to the decline of Yellowstone cutthroat trout.

Cottonwood Creek. This section of stream is very different than the other Shields River tributaries that have been discussed. It is a high gradient section with a very clean, unsilted, gravel streambottom. The population is composed of brook trout, brown trout and Yellowstone cutthroat trout in small numbers. The population estimate during September, 1985 was 55 (+14) trout longer than 7.0 inches per 1000 feet of stream. Population estimates are not available for each individual species.

Genetic analysis of tributary fish. Samples of trout were collected from streams in the Upper Yellowstone and the Shields River drainages to assess the genetic purity of the Yellowstone cutthroat populations. Hybridization between cutthroat and rainbow trout is common. This study should identify which streams support pure populations of Yellowstone cutthroat. Table 46 presents the information collected during 1986.

Table 46. Electrophoretic analysis of trout in tributaries of the Yellowstone and Shields Rivers during 1986.

Yellowstone River

Stream	#individuals	remarks
Anderson Creek	25	pure Yellowstone cutthroat
Area Creek	25	introgressed*
Bear Creek, N.Fk.	10	introgressed**
Bear Creek, E.Fk.	10	introgressed**
Billman Creek	19	pure Yellowstone cutthroat
Coke Creek	25	introgressed**
Cinnabar Creek	15	introgressed*
Eagle Creek	25	introgressed*
Little Trail Creek	4	introgressed*
Mill Creek	8	pure Yellowstone cutthroat
Mill Fork Mission	21	pure Yellowstone cutthroat
Miner Creek	28	pure Yellowstone cutthroat
Mol Heron Creek	29	introgressed**
Rock Creek	25	pure Yellowstone cutthroat
Sixmile Creek	25	pure Yellowstone cutthroat
Tom Miner Creek	25	pure Yellowstone cutthroat

Shields River

Stream	#individuals	remarks
Lodgepole Creek	4	pure Yellowstone cutthroat
Turkey Creek	13	pure Yellowstone cutthroat

*Rainbow trout and Yellowstone cutthroat genetic material is randomly distributed among the individuals, therefore, there are probably no pure Yellowstone cutthroat trout in the population.

**introgressed populations that may contain some individuals that are pure Yellowstone cutthroat trout.

Hadley (1984) attempted to identify populations of Yellowstone cutthroat which are genetically pure using stocking records and survey data. The electrophoretic information collected this year indicates that the assumptions used by Hadley, while seemingly reasonable, are not adequate for indentifying these populations. It appears that a drainage by drainage approach using electrophoresis will be the only effective means of identifying the purity of Yellowstone cutthroat populations. Also, a drainage should be sampled in several areas, if possible, to determine the status of the genetic material. Leary et. al. (1987) discusses the details of the analysis and the specific locations of the samples collected.

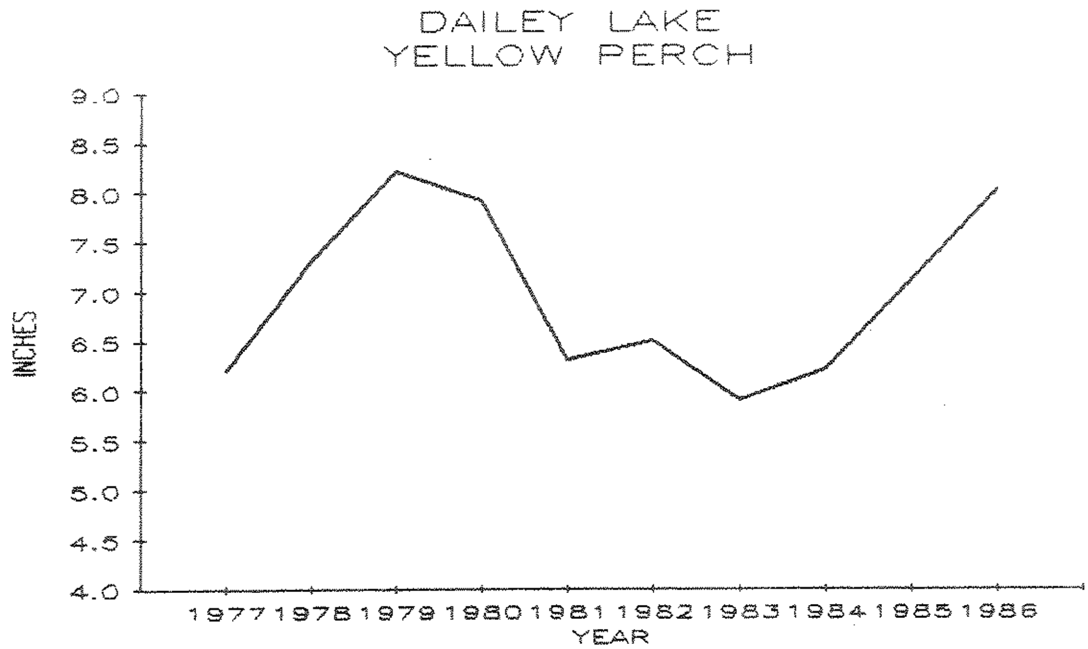
Dailey Lake

During 1984 Dailey Lake was rehabilitated with rotenone in an attempt to remove a portion of the yellow perch population. Clancy,1985 discusses the history of Dailey Lake and the rationale for periodic rehabilitation.

The average size of yellow perch has increased since 1984 in a manner similar to the results of rehabilitation during 1977 (Figure 15). By 1986, the average size of yellow perch captured in gill nets was 8.0 inches.

Walleye have not been captured since rehabilitation. They were introduced in an attempt to find a predator that would control the yellow perch population. While the walleye did feed heavily on yellow perch, they did not appear to keep the yellow perch from stunting. During 1982-1984 the average size of yellow perch remained low, making rehabilitation necessary. Rotenone is more toxic to walleye than to yellow perch (Bradbury, 1986), and it appears that most or all of the walleye in the lake were destroyed. Subsequent stocking of fingerling walleye has not produced results yet.

The average size of rainbow trout increased through 1984 when the lake was rehabilitated. Since then the average size has remained around 10". The increase in average size was due to an absence of small fish in the population. Clancy,1985 found that the 1982-1984 plants of rainbow trout did not contribute



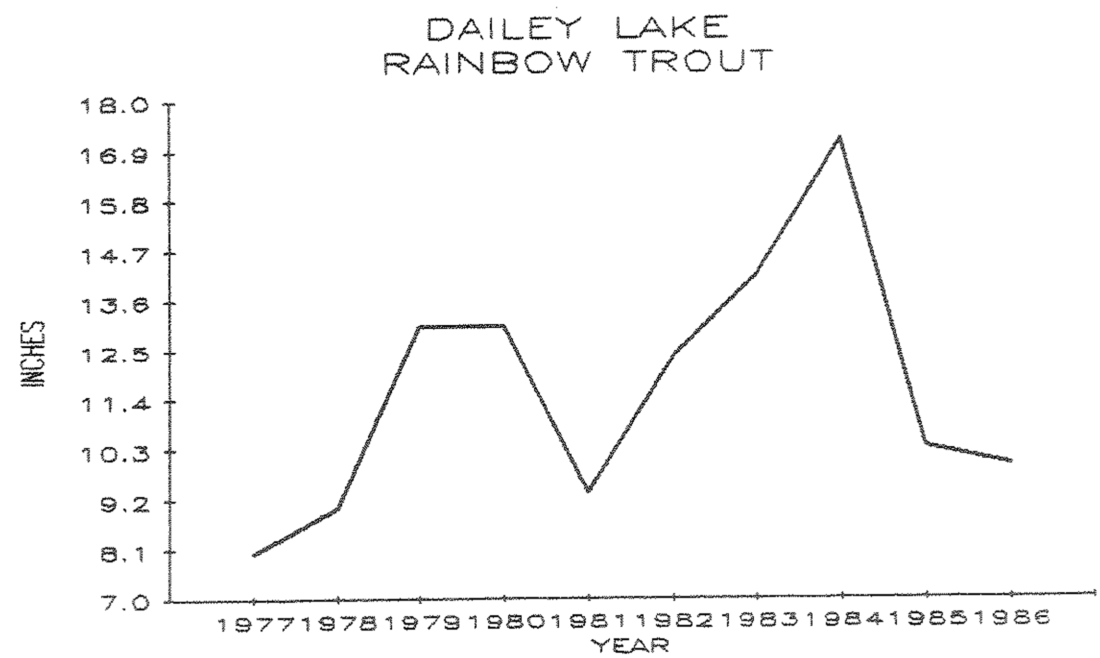


Figure 15. Mean length of rainbow trout and yellow perch captured in gill nets in Dailey Lake.

significantly to the fishery. These were the years when the walleye were averaging over 14" and may have been preying heavily on stocked trout.

During the summer of 1985 and 1986, major rainbow trout summerkills have been encountered in the lake. The cause of the fishkills is unknown, but it appears to be coincident with blooms of the blue-green algae Anabaena flos-aquae (Loren Bahls, WQB). Oxygen concentrations were measured at dawn and appeared to be normal, and no pathogenic bacteria or viruses were found in the fish.

Future management efforts should include public meetings to ascertain the preferences of fishermen as to the type of fishery they prefer in Dailey Lake, and a strong effort should be made to identify the cause of the summer fishkills. The sampling of Dailey Lake should be more standardized between years with a consistent netting pattern that would make the yearly comparisons more meaningful

Stream protection. In Park and Sweetgrass counties during 1985 and 1986, 70 projects were inspected under the provisions of the Natural Streambed and Land Preservation Act and 9 projects under the Stream Protection Act.

These laws have been instrumental in maintaining the physical integrity of streams in Montana. Clancy, 1985 cited some recovery of the Shields River and attributed it to the NSLPA. Continued vigilance by the Department with respect to these laws should be a priority.

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Prepared by:	Christopher G. Clancy	
Date:	February, 1987	
Waters Referred To:	Dailey Lake	3-22-7644-03
	Shields River	3-22-5362-01
	Shields River	3-22-5334-01
	Yellowstone River	3-22-7056-01
	Yellowstone River	3-22-7070-01
	Yellowstone River	3-22-7084-01
	Big Creek	3-22-0476-01
	etc.	
Key Words:	Population Survey	
	Spawning Migration	
	Brown Trout	
	Rainbow Trout	
	Yellowstone Cutthroat Trout	
	Brook Trout	
	Competition	
	Dewatering	
	Fishing Regulations	
	Electrophoresis	
	Fishkill	
	Walleye Predation	