

FISH POPULATIONS OF THE SNAKE RIVER,
TENMILE CREEK AND WEST TENMILE CREEK
UPSTREAM OF DILLON RESERVOIR

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Keystone and Copper Mountain Ski Areas

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INTRODUCTION

The purpose of this study was to determine the biological quality of the Snake River, Tenmile Creek, West Tenmile Creek, and selected tributaries in terms of their fish populations. The biological communities of many streams in Summit County have been stressed both chemically and physically as a result of current and historical metal mining activity in the Dillon Reservoir area (Bingham 1966, 1967, Britton 1979, Chadwick & Associates 1985a,b, Goettl 1970, McKnight and Feder 1984, Sealing 1981, Wentz 1974, Woodward 1969, 1970). In addition, portions of Tenmile Creek (Babcock 1982, Babcock and Seaman 1977) and West Tenmile Creek have been subjected to extensive channelization activities. The present study consisted of collection and analysis of fish population data.

STUDY AREA DESCRIPTION

Sampling Locations

A total of twenty sampling sites were located on Summit County streams, with 9 sites on Tenmile and West Tenmile Creeks and 11 sites in the Snake River basin (Fig. 1). Station locations and sampling dates are summarized in Tables 1 and 2. Six sites were sampled on the Snake River mainstem. Five additional sites were sampled on tributaries of the Snake River, including 2 sites on the North Fork of the Snake River and one site each on Deer Creek, Peru Creek and Keystone Gulch. In addition, information collected by the Colorado Division of Wildlife (CDOW) at four sites on the lower Snake River is also included in the report. Nine sites were sampled in the Tenmile Creek basin, five sites located on Tenmile Creek and four sites on West Tenmile Creek. Three sites on West Tenmile Creek were concentrated in a small stretch of the stream in the vicinity of the Copper Mountain Resort in order to evaluate the habitat improvement project, while one site was located upstream in a relatively undisturbed area.

Site Descriptions

Snake River

Snake River Site 1 was located 18.4 km (11.4 mi.) upstream from Dillon Reservoir and 0.4 km (0.2 mi.) upstream from the confluence with Deer Creek. There was relatively good pool development as well as overhanging rock ledges and undercut banks providing potential fish cover at this site. Pools were located near debris dams, with several pools up to 0.6 m (2 ft.) deep. The substrate was predominantly cobble with gravel and boulders common. The riparian vegetation was primarily spruce, with willows and grasses along the stream banks. There was a heavy coating of orange precipitate on the stream bed, a result of metal mine drainage pollution upstream of the site (McKnight and Feder 1984). Station 2 was located upstream of the town of Montezuma, 15.8 km (9.8 mi.) upstream from Dillon Reservoir and 2.2 km (1.4 mi.) downstream from the mouth of Deer Creek. Remnants of old beaver dams and two active beaver ponds were in the vicinity of the sampling site. Riparian vegetation

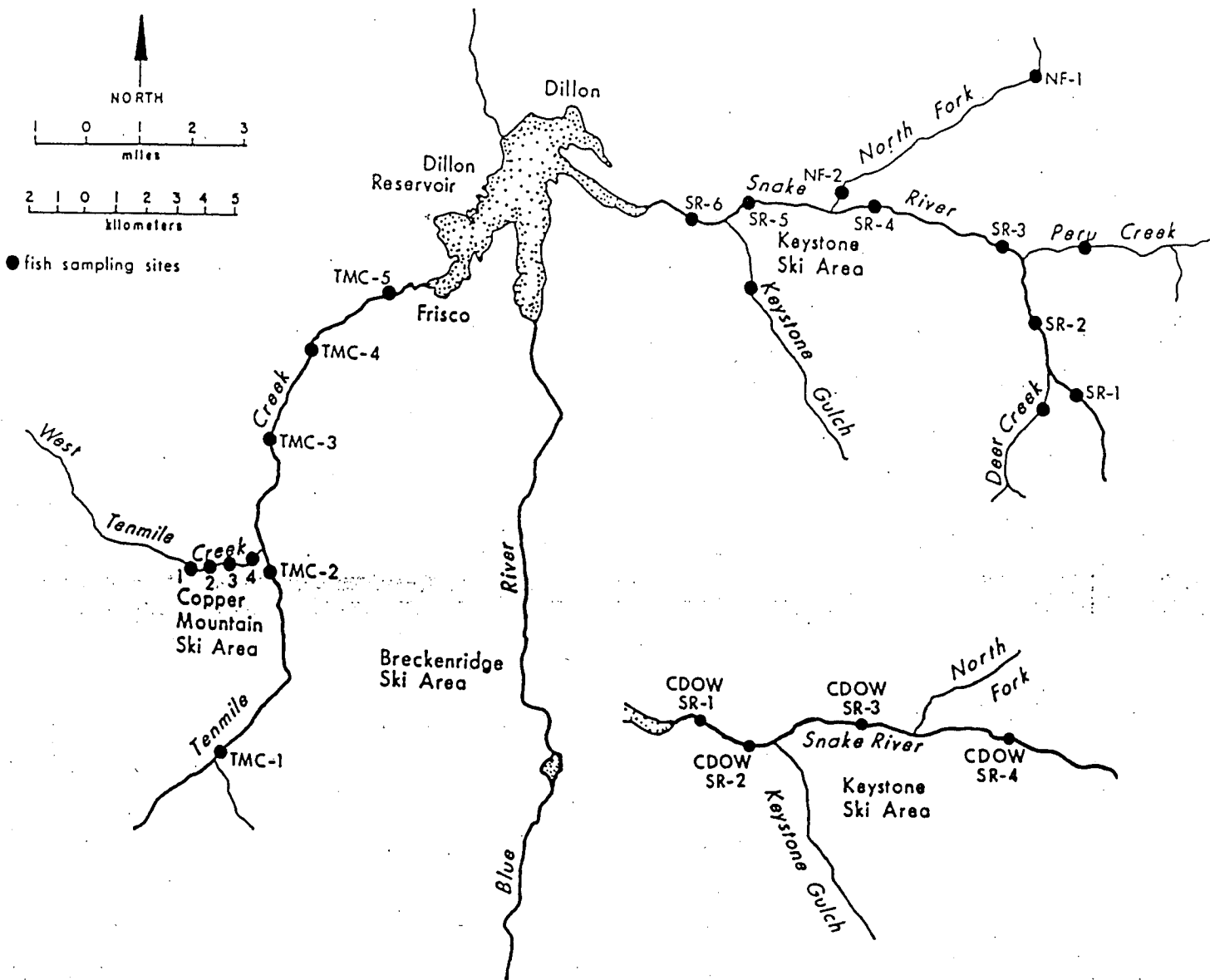


Figure 1: Fish sampling sites on streams in Summit County, Fall 1985.

Table 1: Date of sampling, location of stations, and presence (+) or absence (-) of fish in the Snake River Basin, Summit County, Fall 1985.

Station	Fish Present	Date Sampled (1985)	Location
Snake River 1	-	9 September	(NW1/4, NE1/4, Sec. 2, T6S, R76W)
2	+	9 September	(NW1/4, NE1/4, Sec. 35, T5S, R76W)
3	-	9 September	(SW1/4, SE1/4, Sec. 22, T5S, R76W)
4	+	9 September	(NW1/4, NW1/4, Sec. 20, T5S, R76W)
5	+	27 September	(SW1/4, NE1/4, Sec. 23, T5S, R77W)
6	+	27 September	(NE1/4, SE1/4, Sec. 22, T5S, R77W)
Deer Creek	+	9 September	(SW1/4, NW1/4, Sec. 2, T6S, R76W)
Peru Creek	-	9 September	(NE1/4, SE1/4, Sec. 23, T5S, R76W)
NF Snake River 1	-	9 September	(NE1/4, SE1/4, Sec. 3, T5S, R76W)
2	+	10 September	(NW1/4, NE1/4, Sec. 19, T5S, R76W)
Keystone Gulch	+	10 September	(NE1/4, SE1/4, Sec. 26, T5S, R77W)
<u>CDOW Sampling Stations</u>			
Snake River 4	-	3 October	(NW1/4, NE1/4, Sec. 20, T5S, R76W)
3	+	3 October	(NE1/4, NW1/4, Sec. 24, T5S, R77W)
2	+	3 October	(NW1/4, SW1/4, Sec. 23, T5S, R77W)
1	+	3 October	(SE1/4, NE1/4, Sec. 21, T5S, R77W)

Table 2: Date of sampling, location of stations, and presence (+) or absence (-) of fish in the Tenmile Creek Basin, Summit County, September 1985.

Station	Fish Present	Date Sampled (1985)	Location
Tenmile Creek 1	+	11 September	(NW1/4, NW1/4, Sec. 18, T7S, R78W)
2	+	11 September	(SE1/4, SW1/4, Sec. 29, T6S, R78W)
3	+	12 September	(SW1/4, SW1/4, Sec. 8, T6S, R78W)
4	+	23 October	(SW1/4, SE1/4, Sec. 5, T6S, R78W)
5	+	23 October	(NE1/4, SW1/4, Sec. 34, T5S, R78W)
West Tenmile Cr 1	+	11 September	(SW1/4, NE1/4, Sec. 25, T6S, R79W)
2	+	12 September	(SW1/4, NW1/4, Sec. 30, T6S, R78W)
3	+	12 September	(SW1/4, NE1/4, Sec. 30, T6S, R78W)
4	+	12 September	(NW1/4, NW1/4, Sec. 29, T6S, R78W)

was comprised of willows, with a few spruces on the steeper west bank of the stream. The substrate was dominated by boulders and cobble. Riffles were common, with pools up to 0.6 m deep and undercut banks present on the meanders. Orange flocculant was present on the substrate but not as prevalent as Station 1. Site 3 on the Snake River was located 12.7 km (7.9 mi.) upstream from Dillon Reservoir and 0.7 km (0.5 mi.) downstream of the confluence of the Snake River with Peru Creek. The substrate was cobble-boulder with small amounts of gravel, which was coated with orange precipitate and some siltation. Although riffles were predominant, several pools up to 1 m (3 ft.) deep, runs, undercut banks and overhanging riparian willows were present. Site 4 was located 8.2 km (5.1 mi.) upstream of Dillon Reservoir, 1.2 km (0.7 mi.) upstream of the confluence of the Snake River with the North Fork. Pools, deep runs, and undercut banks were common with overhanging willows also present. One pool in the site was 6.7 m (22 ft.) wide and 1 m (3 ft.) deep. The substrate was cobble-boulder with small amounts of gravel. A slight orange stain was on the substrate. Site 5 was 3.4 km (2.1 mi.) upstream from Keystone Gulch. The substrate was cobble-gravel with silt covering rocks in the slower current areas. Riparian vegetation consisted of willow and grasses, with a few lodgepole pines on the south bank of the stream. Shallow pools and runs with areas of overhanging banks were present. Site 6 on the Snake River corresponded to the Bio/West IFG-2 Site, 2.1 km (1.3 mi.) upstream from Dillon Reservoir and 0.7 km (0.4 mi.) downstream of Keystone Gulch. The habitat differed from Site 5 with a steeper gradient, larger substrate, and pools present throughout the site, with a slight orange stain evident. Riparian vegetation consisted of a narrow band of willows, alders and conifers.

Tributaries to the Snake River

Deer Creek was sampled 0.7 km (0.4 mi.) upstream from its confluence with the Snake River. Riparian vegetation included willows and grasses with small, scattered spruces present. The stream bottom substrate was comprised of cobble with smaller amounts of gravel and boulders. Riffles predominated but several large, deep pools up to 0.6 m (2 ft.) deep were present in association with debris dams and large boulders. A faint orange staining on the substrate was probably related to drainage from iron bogs upstream (McKnight and Feder 1984).

The site on Peru Creek was located 1.3 km (0.8 mi.) upstream of the mouth of the stream. Deep pools (up to 1 m) and runs were common downstream of narrow, swift chutes, constricted between large boulders and downstream of large boulders in the channel. The substrate was predominantly boulders and cobble, with a milky-orange flocculant coating the substrate; probably a result of precipitation of iron and zinc (Chadwick & Associates 1985a).

Site 1 on the North Fork of the Snake River was 7.3 km (4.5 mi.) upstream of the confluence with the mainstem of the Snake River, approximately 300 m (1000 ft.) downstream of the Arapahoe Basin Ski Area. The site is approximately 300 m upstream of a large waterfall that acts as a barrier to upstream fish migration. The substrate in this section of stream is cobble-boulder with small amounts of gravel and sand. Old logs and tree trunks buried in the bank and channel were common, forming small pools. Site 2 on the North Fork was located 0.5 km (0.3 mi.) upstream from its confluence with the Snake River. The substrate was composed of cobble with several large boulders. The

riparian habitat on both banks included spruce, aspen and alders, with much of the stream shaded. Tree trunks and limbs created several debris dams, with pools present upstream and downstream of these dams. Plunge pools were found downstream of boulder constrictions, with small pools also found along bank undercuts. The lower 30 m of the site, was shallow, flat and lined on each side with a narrow row of unconsolidated rock.

Keystone Gulch was sampled 2.1 km (1.3 mi.) upstream of the confluence with the Snake River. This stream was small and shallow (Table 4), with willows lining the bank. The substrate was mostly cobble and gravel with small amounts of boulders and silt. Pools were generally not large or deep, but accounted for much of the surface area of the stream. Bank undercutting, thick, overhanging willows, debris dams, and associated pools were common. Old beaver dams and signs of recent beaver activity were observed throughout the site.

Tenmile Creek

Site 1 on Tenmile Creek was located 19.0 km (11.8 mi.) upstream of Dillon Reservoir and 7.4 km (4.6 mi.) upstream of the confluence with West Tenmile Creek. There was poor pool development and moderately steep gradient, with riffles and swift runs being the predominant habitat features. The substrate was mainly boulders with some cobble and gravel, with orange stain and small amounts of flocculant present on the substrate. Riparian vegetation consisted of willows and grasses and patches of small spruce. Site 2 was located 1.6 km (1.0 mi.) upstream of the confluence with West Tenmile Creek. Although small pools were present, riffle habitat was most common, with one long, deep pool near an undercut bank. Other pools were shallow and small and located downstream of boulders. The substrate was a mixture of cobble and boulder. Riparian vegetation was comprised of willows and small pines. As at Site 1, the substrate was stained orange, although to a lesser extent. Site 3 was sampled just downstream of the confluence with Officer's Gulch. The site was 7.0 km (4.3 mi.) upstream of Dillon Reservoir and 4.5 km (2.8 mi.) downstream of the confluence of Tenmile and West Tenmile Creeks. This section of stream was channelized during construction of I-70 and was dominated by run habitat with few riffles or pools. Small pools were present downstream of boulders and one large deep pool was included in the station. The substrate was boulder-cobble, with riparian vegetation consisting of thin stands of lodgepole pines. The stream banks were steep and rocky and appear to have been rip-rapped. These banks were devoid of woody vegetation. Tenmile Creek Site 4 was located 4.9 km (3.0 mi.) upstream of Dillon Reservoir, in a relatively steep, channelized section of stream adjacent to I-70. The relatively steep gradient of the stream was mitigated by several man-made log dams that created deep, long pools upstream and deep, short plunge pools downstream of the dams. The remainder of the site was deep riffles and runs with small pools downstream of boulders. The substrate was boulder-cobble, with rip-rap lining both banks of the stream along the entire length of the site. Riparian vegetation was mostly grasses with no woody plants growing on the rocky banks. Site 5 was 2.2 km (1.4 mi.) upstream of Dillon Reservoir. The site was in a channelized section of stream near the I-70 Frisco exit. The habitat at this site was dominated by riffles and runs, although several large and deep (up to 1 m deep) pools were present. The substrate was primarily boulders and cobble. Riparian vegetation consisted of a narrow band of willows and alders.

West Tenmile Creek

West Tenmile Creek Site 1 was located upstream of the Copper Mountain Resort, 2.9 km (1.8 mi.) upstream of the confluence of West Tenmile and Tenmile Creeks. The substrate was boulder and cobble with smaller amounts of gravel present. Riparian vegetation was willows with scattered lodgepole pines. This section of stream appeared to be in a relatively natural condition. Potential fish habitat at the site was not well developed. Runs and steep riffles dominated the section and pools were usually small and shallow, although there was one large, deep (1 m) pool in the middle of the section. A small area of bank undercutting was present near the upper end of the site and no staining was evident. Site 2 was sampled immediately upstream of the Copper Circle bridge. This site was located 2.1 km (1.3 mi.) upstream of Tenmile Creek. The gradient at this site was relatively steep, with large, deep (up to 1 m) pools located in the reconstructed lower half of the sampling site. The habitat of the upper half of the site was dominated by riffles, runs and small pools downstream of boulders, with small sections of undercut banks. The substrate was an assortment of boulder, cobble and gravel. Riparian vegetation in the lower section consisted of a thin band of willows adjacent to the stream. Site 3 on West Tenmile Creek was located immediately upstream of the Cooper Road bridge crossing 1.0 km (0.6 mi.) upstream of the mouth of West Tenmile Creek. The section had been reconstructed and habitat improvements had been made. The substrate is mainly cobble, with boulders and gravel. The habitat rehabilitation of this section of stream has created several pools downstream of groups of boulders, while the remainder of the site consisted of shallow riffles and runs. The banks of the stream had been stabilized with boulders; however, no riparian vegetation was present. West Tenmile Creek Site 4 was adjacent to the golf course and the exit ramp leading from Interstate Highway-70 to Highway-91 corresponding to the IFG-2 Site of the EIS (RCI, Bio/West 1985) and 250 meters upstream of Tenmile Creek. The habitat was similar to that at Site 3, with runs and riffles predominating. The unconsolidated substrate was composed of a uniform mixture of small cobble and large gravel, which had become silted, probably a result of recent stream manipulation just upstream. Boulder dams had been constructed in the stream and had created pools upstream and downstream, with steep banks throughout the channelized section of stream. Riparian vegetation was limited to a few willows and patches of grasses with much of the bank rip-rapped.

METHODS

Fish Populations

Fish populations were sampled quantitatively at each stream site using Coffelt backpack and shoreline electrofishing gear. Each sampling station consisted of at least 143 m (470 ft.) measured section of stream and was selected to be representative of the stream in the study area, taking into consideration cover, pool-to-riffle ratio, shading, and other general habitat features. Within each study section two consecutive electrofishing passes were made, with fish captured in each pass kept separate. All salmonids and non-game species captured were identified, counted, measured for length, weighed, and released.

Fish population density estimates were calculated from the results of two consecutive passes using the modified Seber-LeCren method (Everhart and Youngs 1981), which provides estimated density with a 95% confidence interval (95% C.I.). Population estimates for salmonids were calculated three ways to provide results comparable to Colorado Division of Wildlife studies. Estimates were calculated for salmonids < 15 cm in length and > 15 cm in length. This procedure takes into account that smaller fish are often more difficult to capture, which may result in density estimates with wider confidence intervals than those for the larger fish. The third method estimates density on all fish captured in the first and second passes regardless of size. This "pooled total" estimate does not necessarily equal the sum of the first two estimates due to the reduced influence of the higher variability in the smaller fish.

In addition to population estimates, the condition or well-being of the fish was calculated using the formula for the condition factor (K) found in Carlander (1969). The condition factor was determined for each fish and averaged for each site and species to provide a mean condition factor.

Physical Parameters

In addition to fish data, certain physical parameters were also obtained at each station. Width and average depth were measured at 50 ft. intervals throughout the study section and percent slope was determined utilizing a clinometer. Discharge was determined using a General Oceanics digital flow meter, Gurly current meter, or a Montedoro-Whitney electronic flow meter. Physical parameters for all sampling sites where fish were found are given in Tables 3 - 5.

Table 3: Physical parameters for stations with fish in the Snake River Basin, Summit County, September 1985.

Station	Station Length (m)	Mean Width (m)	Mean Depth (cm)	Flow [m ³ /sec (cfs)]	Percent Slope	Elevation (m)	
Snake River	2	144	4.4	12.5	0.23 (8.1)	1.5	3146
	4	168	6.9	21.9	0.71 (25.1)	1.7	2861 ^E
	5	173	8.9	21.0	0.93 (32.9)	0.5	2809 ^D
	6	166	11.4	22.9	1.40 (49.5)	1.2	2784 ^E
Deer Creek	151	3.4	10.7	0.14 (5.0)	4.4	3273	
NF Snake River	2	175	4.8	15.8	0.34 (12.2)	4.4	2859
Keystone Gulch	143	2.4	10.7	0.12 (4.1)	3.4	2893	

Table 4: Physical parameters for Colorado Division of Wildlife stations with fish on the Snake River, Summit County, October 1985.

Station	Station Length (m)	Mean Width (m)	Elevation (m)
Snake River 3	152	13.4	2822 f
2	152	10.5	2792
1	152	13.2	2754

Table 5: Physical parameters for stations with fish in the Tenmile Creek Basin, September 1985.

Station	Station Length (m)	Mean Width (m)	Mean Depth (cm)	Flow [m ³ /sec (cfs)]	Percent Slope	Elevation (m)
Tenmile Creek 1	155	7.2	18.2	0.87 (30.9)	2.8	3141
2	157	7.7	17.3	1.31 (46.1)	1.9	2980
3	155	10.5	24.3	1.78 (62.7)	2.7	2876
4	162	8.0	27.2	0.75 (26.5)	2.8	2832
5	187	11.7	18.1	0.76 (27.0)	1.4	2790
West Tenmile Cr 1	165	7.4	15.4	0.66 (23.4)	2.5	3005
2	157	6.3	16.6	0.45 (16.0)	3.3	2981
3	161	6.9	16.9	0.31 (11.0)	1.5	2962
4	159	6.8	14.0	0.29 (10.1)	2.1	2955

RESULTS AND DISCUSSION

Species Composition

The most common species of fish in the study area was brook trout (Salvelinus fontinalis), which were captured at each station where fish were present except Tenmile Creek Station 2. Brown trout (Salmo trutta) were found at 12 sampling sites, while cutthroat trout (Salmo clarki) and rainbow trout (Salmo gairdneri) were captured at 3 sites. A brook trout-brown trout hybrid called a tiger trout was captured at Tenmile Creek Site 5. Three species of non-game fish were also found during the study. Paiute sculpins (Cottus beldingi) were captured at all four sites on West Tenmile Creek. One mottled sculpin (Cottus bairdi) was found at in Tenmile Creek and a large white sucker (Catostomus commersoni) was captured at CDOW Snake River Site 3.

Rainbow and cutthroat are spring spawning fish, while brook trout and brown trout are fall spawners (Carlander 1969). In Colorado, brook and brown trout spawn in September and October (higher elevations), and November (lower elevations). In Summit County, large brook and brown trout from Dillon Reservoir move into the Blue River, Tenmile Creek, and to a limited extent, West Tenmile Creek. The sampling period of this study coincided with the brook and brown trout spawning periods resulting in the capture of resident fish populations of the streams and migrating spawning adults from Dillon Reservoir.

The fish species found are typical of those found in streams of the Colorado Rocky Mountain region (Beckman 1974). Although cutthroat trout are the native salmonid species in the area, they have become displaced throughout much of their original range by the introduced brook, brown and rainbow trout (Behnke and Benson 1980). White suckers are not native to the western slope, but have become established in many areas west of the continental divide in Colorado. Paiute and mottled sculpins are native to the Colorado River basin. Although neither species have been reported as being present in Summit county (Woodling 1985), they have been reported in nearby Grand and Eagle counties. The presence of the tiger trout indicates that brook and brown trout are spawning in close proximity to each other and is not indicative of unusual spawning behavior.

Snake River

No fish were collected at Station 1, upstream of Deer Creek, or Station 3, downstream of Peru Creek. The lack of fish at these sites may be a result of the poor water quality associated with past mining activities. Results of spring water quality and benthic invertebrate sampling indicates the Snake River is a metal stressed stream throughout much of its length (Chadwick & Associates 1985a, 1985b).

A population of brook trout was found at Station 2 (Table 6). The size range of captured fish (Fig. 2) indicates a stable, self-sustaining population. However, the condition of the fish was poor ($K = 0.91$). The biomass estimate of 19.5 kg/ha (17.3 lbs/ac) is relatively low for a stream of this size and elevation. The low condition factors and biomass values are probably a result of poor water quality. The dilution provided by Deer Creek apparently improves water quality in the Snake River to the extent that the brook trout can survive, although this population may be sustained by downstream drift from the Deer Creek population.

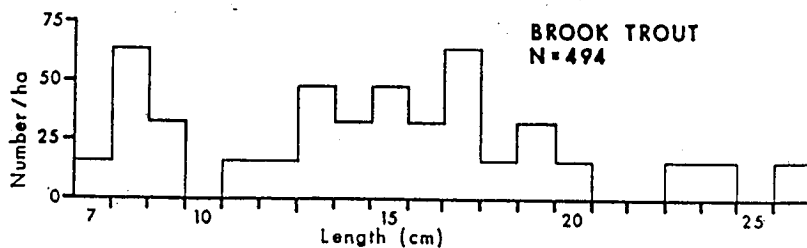


Figure 2: Length-frequency of fish collected from Snake River Site 2, Colorado, 9 September 1985.

Table 6: Fish population parameters for the Snake River, Summit County, September 1985.

Species	Number Captured	Estimated Density (#/ha)	95% Confidence Interval	Biomass (kg/ha)	Mean Length (cm)	Mean Weight (g)
Station 2						
<u>Brook Trout</u> <15 cm	15	266	+ 110	3.4	10.7	12.9
>15 cm	15	239	- 10	15.8	18.4	66.0
pooled total	30	494	- 54	19.5	14.6	39.4
Mean condition factor: K = 0.91						
Station 4						
<u>Brook Trout</u> <15 cm	1	9	+ 0	0.2	12.9	18.0
>15 cm	3	26	- 0	4.1	24.0	158.3
pooled total	4	35	- 0	4.3	21.3	123.3
Mean condition factor: K = 1.04						
Station 5						
<u>Brook Trout</u> <15 cm	24	202	+ 122	0.9	6.8	4.2
>15 cm	7	46	- 8	5.2	21.8	113.3
pooled total	31	238	- 85	6.9	10.1	28.8
Mean condition factor: K = 0.99						
<u>Brown Trout</u> <15 cm	1	7	+ 0	<0.1	8.9	6.6
>15 cm	14	91	- 4	6.3	18.9	69.2
pooled total	15	98	- 4	6.4	18.2	65.0
Mean condition factor: K = 0.96						
<u>Rainbow Trout</u> >15 cm	1	7	+ 0	0.2	15.0	35.6
Condition factor: K = 1.05						
Station 6						
<u>Brook Trout</u> <15 cm	27	159	+ 42	1.4	9.0	9.1
>15 cm	9	47	- 5	3.5	19.3	73.4
pooled total	36	204	- 17	5.1	11.6	25.2
Mean condition factor: K = 0.99						
<u>Brown Trout</u> <15 cm	1	5	*	<0.1	9.3	8.9
>15 cm	5	26	*	4.8	25.3	184.0
pooled total	6	32	*	4.9	22.6	154.8
Mean condition factor: K = 1.01						

* Not calculated due to positive or zero slope.

Only four brook trout were captured at Site 4, just upstream of the North Fork, with an estimated biomass of only 4.3 kg/ha (Table 6). Water quality and benthic invertebrate collections indicate continued problems with metals near this station (Chadwick & Associates 1985a,b), which may result in the low trout biomass observed.

Brook, brown and one rainbow trout were captured at Station 5. The estimated total trout biomass was relatively low at 13.5 kg/ha (Table 6). The two more numerous species were in fair-to-average condition for this time of year ($K = 0.99$ for brook trout, 0.96 for brown trout). Despite the depressed population densities, the size distribution of brook trout (Fig. 3) indicates the presence of 0+ age class. The size distribution of brown trout at Stations 5 and 6 suggests that viable reproduction is not occurring in the Snake River. The continued low biomass is apparently due to poor water quality.

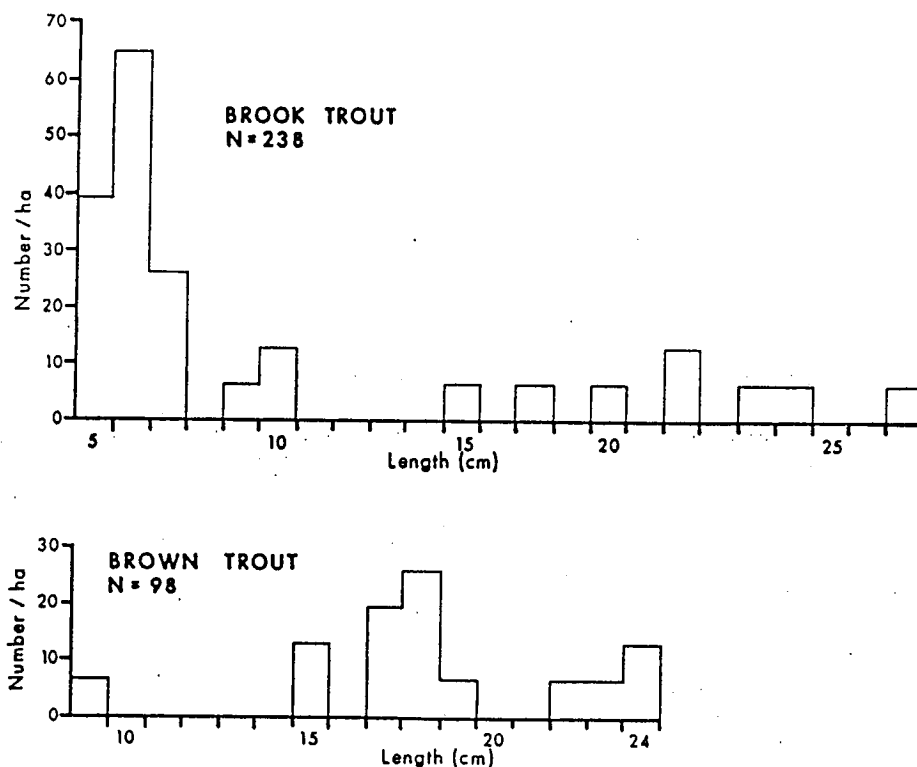


Figure 3: Length-frequency of fish collected from Snake River Site 5, Colorado, 27 September 1985.

Brook trout were the most abundant fish collected in the lower Snake River (Station 6), with six brown trout also captured. The condition of both species was average (Table 6) and the size distribution of brook trout (Fig. 4) indicates either some degree of natural reproduction downstream or movement of young-of-the-year from the North Fork and Keystone Gulch. The total trout biomass at this site was only 10.0 kg/ha (8.9 lbs/ac) downstream of the input of relatively clean water from Keystone Gulch. Continuing water quality problems are probably a major factor in this low biomass as water quality and benthic invertebrate results from this section of the Snake River indicate continued problems with metal contaminants (Chadwick & Associates 1985a,b).

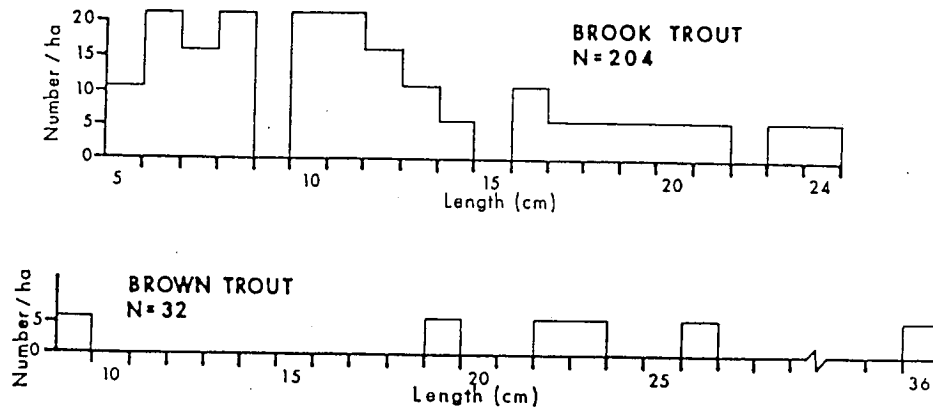


Figure 4: Length-frequency of fish collected from Snake River Site 6, Colorado, 27 September 1985.

Tributaries to the Snake River

Deer Creek exhibits the characteristics of a self-sustaining population of brook trout (Table 7). The size distribution of captured fish (Fig.5), combined with the presence of numerous trout in spawning condition indicates a naturally reproducing population. The estimated biomass was 28.7 kg/ha (25.5 lbs/ac) and the condition of these brook trout was better than that of the brook trout found nearby at Snake River Site 2.

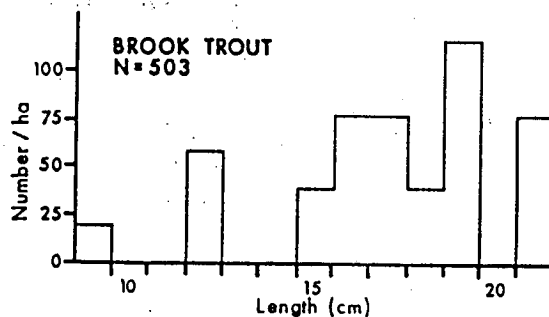


Figure 5: Length-frequency of fish collected from Deer Creek, Colorado, 9 September 1985.

No fish were found at the Peru Creek site, despite relatively good physical habitat. The absence of fish is probably a result of severe water quality problems that exist in this basin.

The North Fork of the Snake River was sampled at two locations. No fish were found at Station 1. The lack of fish is probably due to the waterfall downstream of this site acting as a barrier to upstream migration of fish from downstream populations, and poor overwintering habitat.

Table 7: Fish population parameters for the tributaries to the Snake River, Summit County, 9 September 1985.

Species	Number Captured	Estimated Density (#/ha)	95% Confidence Interval	Biomass (kg/ha)	Mean Length (cm)	Mean Weight (g)
Deer Creek						
<u>Brook Trout</u> <15 cm	5	96	+ 0	1.6	12.0	16.6
>15 cm	21	407	+ 23	27.1	18.1	66.6
pooled total	26	503	+ 19	28.7	17.0	57.0
Mean condition factor: $K = 1.06$						
North Fork Snake River Station 2						
<u>Brook Trout</u> <15 cm	6	71	+ 0	1.1	10.2	16.0
>15 cm	39	476	+ 40	43.5	20.0	91.4
pooled total	45	544	+ 34	45.6	18.7	83.8
Mean condition factor: $K = 1.05$						
Keystone Gulch						
<u>Brook Trout</u> <15 cm	35	1282	+ 545	15.7	10.0	12.3
>15 cm	43	1311	+ 116	95.0	19.3	72.5
pooled total	78	2516	+ 319	114.4	15.1	45.5
Mean condition factor: $K = 0.93$						

North Fork Station 2 had a sizeable brook trout population (Table 7). The size range of the captured trout (Fig. 6) indicates a self-sustaining population. The biomass of the brook trout at Site 2 was 45.6 kg/ha (40.6 lbs/ac). The fish were in average condition and the adult fish were exhibiting spawning characteristics.

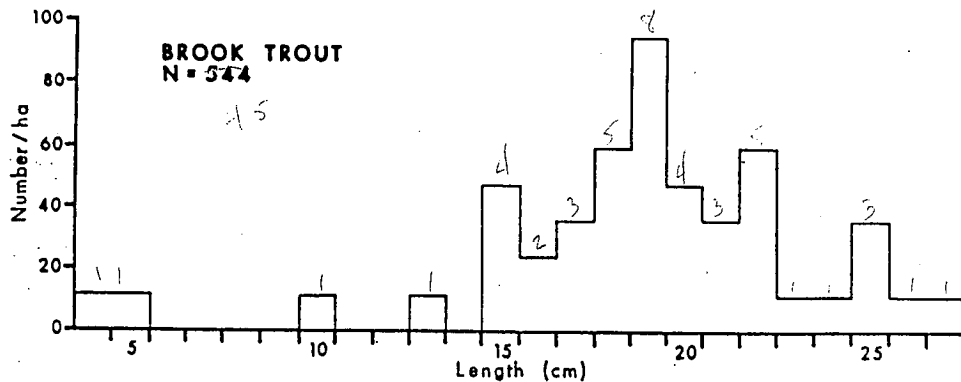


Figure 6: Length-frequency of fish collected from the North Fork of the Snake River, Station 2, Colorado, 10 September 1985.

Keystone Gulch had a very high biomass estimate of 114.4 kg/ha (Table 7). This high biomass of brook trout may relate to the good pool development with extensive willow cover. The size distribution of captured trout includes young of the year fish (Fig. 7), indicating that this population is naturally reproducing. The condition of the fish is below average ($K = 0.93$), which could be attributed to the presence of spent spawning adults and possibly overcrowding.

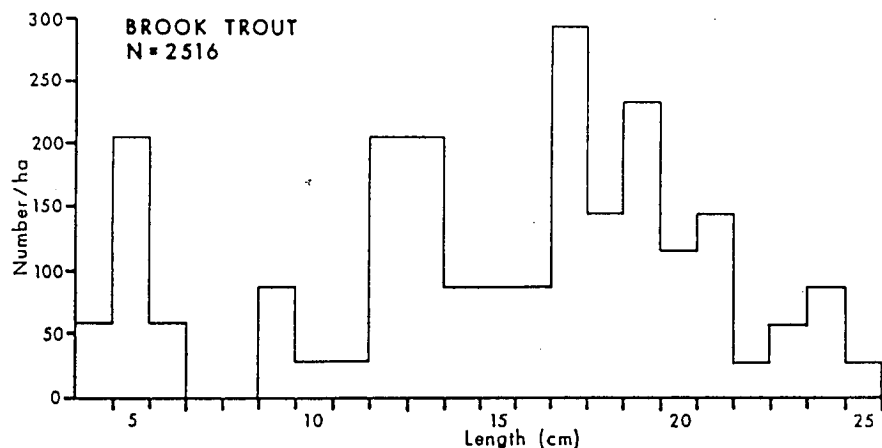


Figure 7: Length-frequency of fish collected from Keystone Gulch, Colorado, 10 September 1985.

CDOW Snake River Stations

No fish were collected at Snake River Site 4. The site was located 0.5 km (0.3 mi.) upstream of Snake River Site 4 in the present study, where only four trout were located (Table 6).

Site 3 sampled by the CDOW was located between the confluences with the North Fork and with Keystone Gulch. A moderate population of brook trout was found at this site (Table 8). The size range of captured fish was wide and included young-of-the-year fish (Fig. 8). The condition of the brook trout was relatively poor ($K = 0.89$) with an estimated biomass of only 6.8 kg/ha. One large white sucker (14.6 in, 1.25 lbs) was also captured.

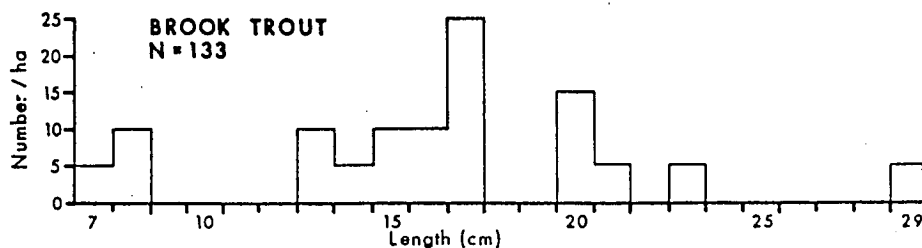


Figure 8: Length-frequency of fish collected from the CDOW Snake River Site 3, Colorado, 9 September 1985.

Table 8: Fish population parameters for Colorado Division of Wildlife electrofishing stations on the Snake River, Summit County, 3 October 1985.

Species	Number Captured	Estimated Density (#/ha)	95% Confidence Interval	Biomass (kg/ha)	Mean Length (cm)	Mean Weight (g)
Station 3						
<u>Brook Trout</u> <15 cm	6	29	*	0.3	10.7	11.1
>15 cm	15	77	+ 17	5.2	18.7	67.1
pooled total	21	133	+ 90	6.8	16.3	51.1
Mean condition factor: K = 0.89						
<u>White Sucker</u> >15 cm	1	5	+ 0	2.8	37.0	570.0
Station 2						
<u>Brook Trout</u> <15 cm	2	12	*	0.1	9.5	5.7
>15 cm	10	62	*	7.0	21.2	111.7
pooled total	12	75	*	7.0	19.3	94.0
Mean condition factor: K = 0.97						
<u>Brown Trout</u> >15 cm	3	19	+ 0	2.5	23.3	131.3
Mean condition factor: K = 1.03						
Station 1						
<u>Brook Trout</u> <15 cm	21	100	*	0.8	8.9	8.1
>15 cm	13	77	+ 52	5.7	19.5	74.6
pooled total	34	321	+ 452	10.8	12.9	33.5
Mean condition factor: K = 1.00						
<u>Brown Trout</u> <15 cm	3	15	+ 35	0.3	12.0	20.3
>15 cm	16	83	+ 16	10.8	22.2	129.5
pooled total	19	100	+ 22	11.3	20.6	112.3
Mean condition factor: K = 1.01						
<u>Mottled Sculpin</u> <15 cm	1	5	*	<0.1	8.0	6.0

* Not calculated due to positive or zero slope.

At CDOW Site 2 on the Snake River downstream of Keystone Gulch, relatively small populations of both brook and brown trout were captured (Table 8). Only three brown trout were captured. The estimated total trout biomass at the site was 9.5 kg/ha. This may be an underestimate of biomass present in the stream at this site, because more brook trout were captured on the second shocking pass than on the first, precluding the use of the Seber-LeCren model.

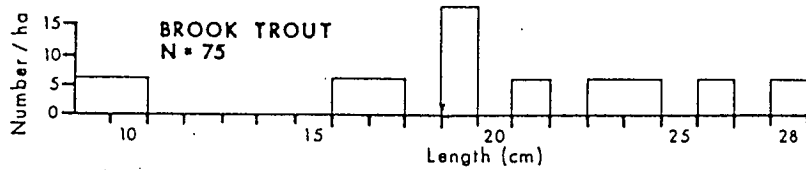


Figure 9: Length-frequency of fish collected from the CDOW Snake River Site 2, Colorado, 9 September 1985.

Site 1 sampled by the CDOW was 0.5 km upstream of Dillon Reservoir. Brook and brown trout were captured at the site (Table 8). The size distribution for both species included a wide range of year classes (Fig. 10). Three brown trout were captured that were 30 cm (12 in.) or greater, representing 5.4 kg/ha in biomass. These fish probably migrated upstream of Dillon Reservoir. The total estimated biomass of trout at this site was 22.0 kg/ha. This estimate is noticeably higher than estimates for other sites on the Snake River, and may be due in part to the presence of the large brown trout moving into the river from the reservoir.

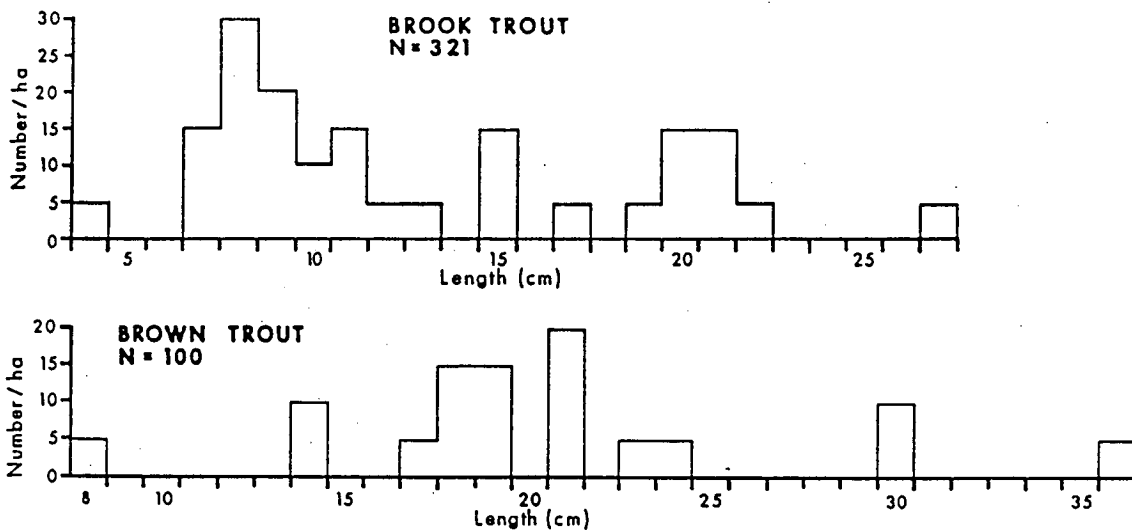


Figure 10: Length-frequency of fish collected from the CDOW Snake River Site 1, Colorado, 9 September 1985.

Tenmile Creek

Five brook trout and five cutthroat trout were captured at Station 1 on Tenmile Creek (Table 9). The size range of captured fish was narrow for both species and included no young-of-the-year fish. This section of Tenmile Creek has poor water quality and extremely low densities of benthic invertebrates (Chadwick & Associates 1985a,b). Fish of this size and condition would probably not survive for an extended period of time in this section, and probably migrated downstream of a tributary stream.