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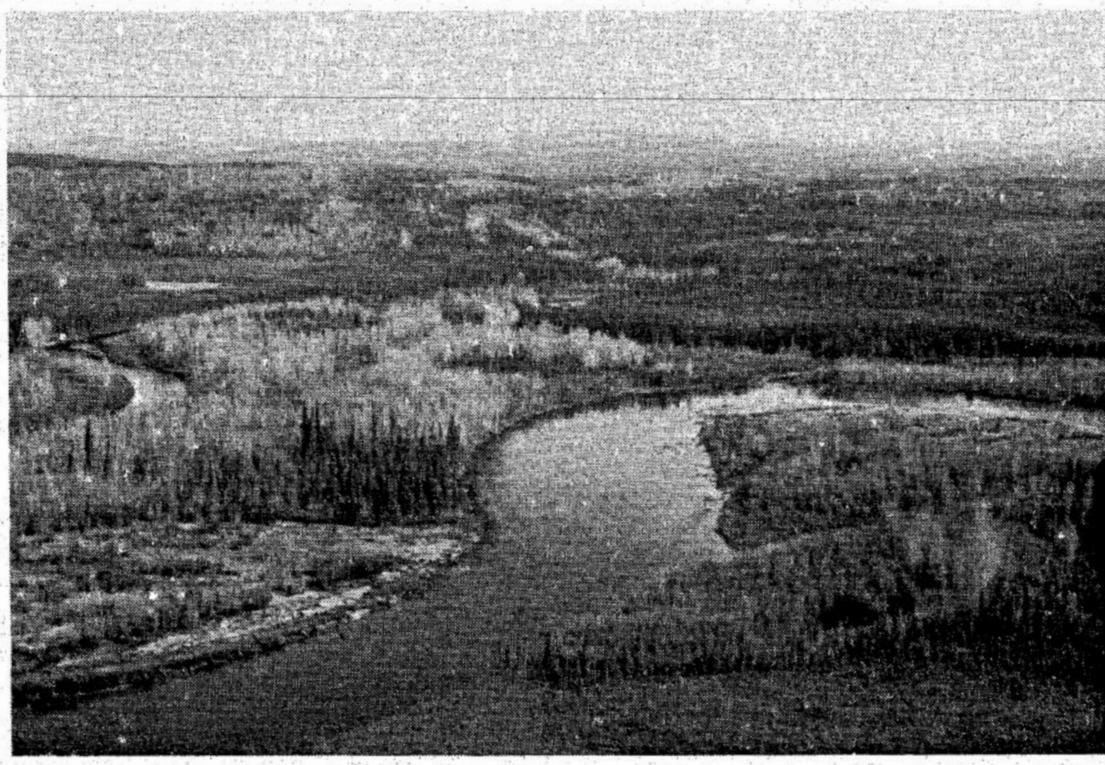
Aquatic Resources of the Salmon Fork Black River, Alaska

A Preliminary Survey, 1991

Jon Kostohrys, Brian Lubinski, and Nathan Collin



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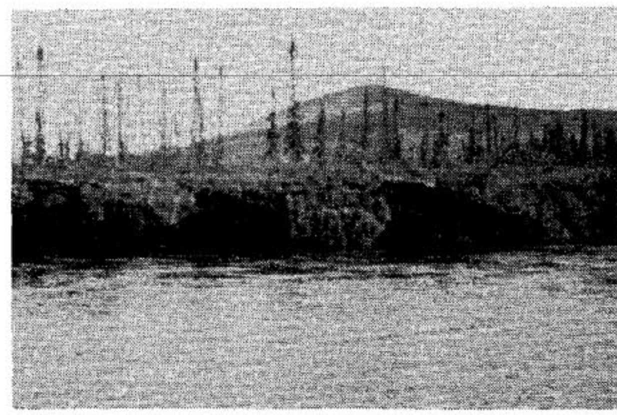
Introduction

The Salmon Fork, a tributary to the Black, Porcupine, and Yukon Rivers in Alaska, is managed by the Bureau of Land Management (BLM) east of 142° west Longitude upstream to the International Boundary. It originates in the mountains of Canada's Yukon Territory, flowing southwesterly and crossing the International Boundary just south of the Arctic Circle. It terminates at the confluence with the Black River near abandoned Salmon Village (Figure 1). In June 1991, the BLM initiated a multidisciplinary resources investigation of the Salmon Fork Black River drainage as part of a reconnaissance resources inventory of the upper Black River watershed. This component of the inventory addresses the aquatic portion of the Salmon Fork ecosystem and includes preliminary fisheries surveys, hydrological quantification, and water quality results from the International Boundary to Kevinjik Creek.

Study Site

Physiography

The Salmon Fork Black River drainage basin, located in the eastern interior of Alaska, is part of the Yukon-Porcupine River physiographic province (Wahrhaftig 1965). This roughly triangular area is bounded by the Yukon River to the south, the Porcupine River to the north and the Alaska-Canada International Boundary to the east. The headwaters, which originate in the western end of the Keele River Range of the Canadian Ogilvie Mountains, lie well to the north of the Arctic Circle. West of the border, the Salmon Fork Black River flows through the Porcupine Plateau, a forested upland of gentle relief, though some ridges are topped by 2,500- to 3,500-feet tundra-covered mountains (Churkin and Brabb 1967). The Salmon Fork, like its tributaries, is narrow and steep in the headwaters, but downstream of the International Boundary, it widens and slows to a moderate gradient stream. The relatively flat floodplain ranges from one to three miles wide. Downstream of the Pink Bluffs, the Salmon Fork widens greatly as the gradient decreases, increasing its meandering to form numerous sloughs and extensive marshy lowlands, often underlain by discontinuous permafrost. The river in the upper drainage is often bounded by steep bluffs, composed of sedimentary and metamorphic rocks (Brabb 1970). In the lower drainage, the banks, composed of alluvial silt and peat, are seldom more than twenty feet above the low water channel and are covered with spruce, cottonwood, and birch (Fitzgerald 1944). Numerous springs occur in the basin, especially in the Tetthajik Creek area and contribute significantly to winter stream flow (Hobgood 1991).



Alluvial silt and peat banks of the lower drainage of the Salmon Fork Black River.

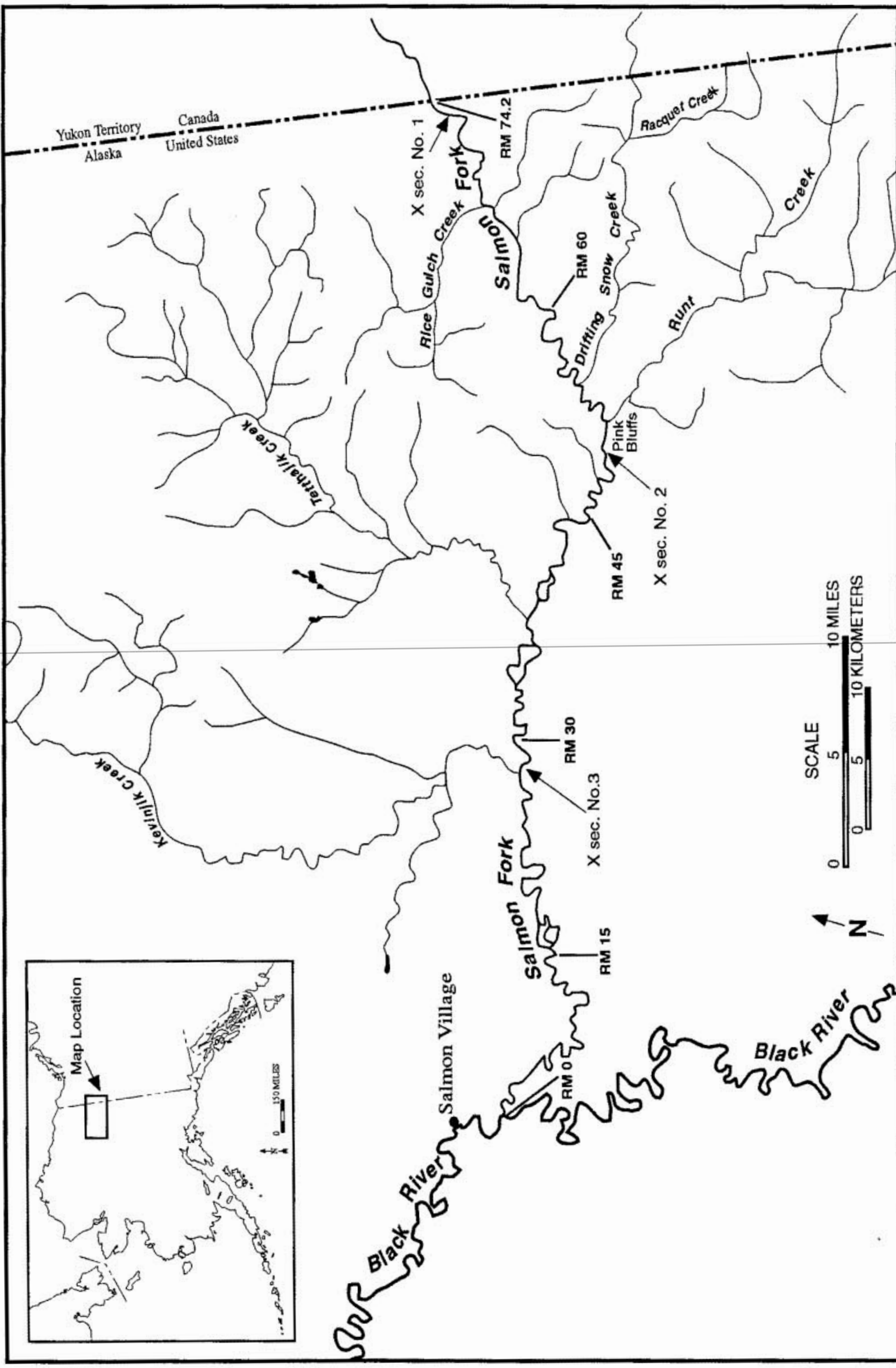


Figure 1
Study area and cross section locations on the Salmon Fork Black River, Alaska, 1991.

Climate

The basin lies largely in the subpolar continental climatic zone characterized by long, cold winters and short, hot summers. Temperature extremes range from -74 °F (-59 °C) in winter to 98 °F (37 °C) in summer. Precipitation ranges from 6 to 10 inches (15 to 25 cm) per year at nearby recording stations, though variations are large due to surrounding topography. Precipitation is generally greater at higher elevations and during the summer, with most coming as rainfall from late June to early September (U.S. Department of Commerce 1963). Snowfall averages about 40 inches (1.0 m) per year, with about 20 inches (0.5 m) remaining on the ground prior to spring break-up, which usually begins in May. Freeze-up often begins at higher elevations in mid September, though some streams lower in the basin remain open until November. Ice cover is usually continuous for the winter, except in the vicinity of springs, and streamflow may not persist throughout the basin during some winters. Additional information of the area can be found in U.S. Department of the Interior (1987).

Fisheries

Caulfield (1983) describes the fishery resources of the Black River and associated tributaries as a major source for subsistence fishing for residents of the area. They catch salmon (*Oncorhynchus spp.*), whitefish spp., sheefish (*Stenodus leucichthys*), burbot (*Lota lota*), and northern pike (*Esox lucius*) with gillnets in the main river and Arctic grayling (*Thymallus arcticus*), both in nets and with hook and line, throughout the system. Shore (1954) reported harvesting large numbers of northern pike with hook and line and nets from the Salmon Fork for dog food. A number of large lakes, including Ohtig and Tiinkdhul, are situated near the Black River, where pike and whitefish are taken. Barton (1984) and Rost (In preparation) found fall chum (*Oncorhynchus keta*) to be the most abundant salmon species within the drainage, followed by summer chum, king (*Oncorhynchus tshawytscha*), and coho salmon (*Oncorhynchus kisutch*). Barton also documented spawning areas in Kevinjik and Tetthajik creeks for both chum and king salmon, and Alt (1987) noted sheefish.

Methods

Fisheries

Fish species occurrence, and Arctic grayling population structure and general habitat data were collected from a point just downstream of the International Boundary, to the mouth of Kevinjik Creek. Sample sites were randomly selected and defined by river mile as measured upstream from the mainstem of the Black River. Species occurrence was determined using a small 2.6 sq. cm (0.4 in^2) mesh fyke net, experimental gill net with bar mesh sizes of 32 mm (1.3 in), 38 mm (1.5 in), 50 mm (2.0 in), and 76 mm (3.0 in), backpack electrofisher (Smith-Root Model 15A), and hook and line. Arctic grayling were collected by hook and line using double aught and single aught Mepps spinners. For all fish, excluding sculpin (*Cottus spp.*), lengths to the nearest millimeter (mm) and weights to the nearest gram (g) were recorded. Scales were collected from grayling, and ages estimated according to Halberg (Alaska Department of Fish & Game, Fairbanks, personal communication). Aging was completed by the Alaska Department of Fish & Game, Division of Sport Fish. General habitat descriptions were recorded where fish use was documented by direct observation or sampling.

Hydrology

Channel cross sections were surveyed by BLM at three sites on the Salmon Fork River, as well as three of the principal tributaries within the basin. Sites were selected to be consistent with the assumptions of the hydraulic model as well as to adequately assess aquatic habitat. At each site, a discharge measurement was made using a Price AA current meter to measure water velocity and a top setting wading rod and tag line for depth and width (USDI 1967). The stream banks, high-water marks, and water surface profiles were surveyed using a level and stadia rod (Benson and Dalrymple 1967).

A water level versus discharge rating was developed from this direct discharge (streamflow) measurement (Rantz et al 1982) and computer-simulated flows using XSAREA, a modification of the BLM slope-conveyance hydraulic model (Parsons and Hudson, 1982). These rating curves (actually log-log regression plots) were then used to relate discharge to the other channel parameters and resource values, identified at the site, and to compute the bankful discharge.

Water quality samples were taken at each cross section using a Hach digital titrator and dry chemical water sampling kit. Parameters collected included pH, temperature, turbidity, conductance, and principal ions.

Results

Fisheries

Fish Captured

Eight species of fish were sampled (Table 1). Gill nets were set overnight on June 7 at mile 71.7 in a slough north of the river. Four northern pike were captured. These fish, similar in size, averaged 371 mm fl (14.6 in) and 452 g (1.0 lbs). Stomach analysis revealed both sculpin and dragon fly (*Odonata* spp.) nymphs were present. Overnight fyke nets were set on June 9 and 12 at the mouths of sloughs at mile 67.2 and 54.7. No fish were captured, however, a beaver was caught at the latter site. Electrofishing was used for a total of 11.5 minutes in a backwater area along the north bank at mile 54.7. Fish captured included one northern pike, one juvenile salmon identified as either a king or coho, one Lamprey spp. believed to be the Arctic lamprey (*Lampetra japonica*), and numerous Slimy sculpin (*Cottus cognatus*). The backpack shocker failed to operate after this sample. However, there was

Table 1
Fish species sampled within the Salmon Fork Black River during June 7-14, 1991.

		Reach Number (River Miles)					
Species	Gear type	1 (72-67)	2 (67-55)	3 (55-48)	4 (48-36)	5 (36-27)	Total
Arctic grayling	*Hook/line*	55	32	30	38	26	181
Northern pike	*Hook/line*	1					1
	Gill net	4					4
	Electroshock	1					1
Salmon Sp.	*Electroshock*	1					1
	Hook/line					3	3
Round Whitefish	*Dipnet*	1					1
Sheefish	*Hook/line*					19	19
Burbot	*Dipnet*	2					2
Lamprey Sp.	*Electroshock*	1					1
Sculpin Sp.	*Dipnet*	1					1
	Electroshock	20 (est.)					
Total		67	32	30	38	48	215

an abundance of fry and juvenile fish observed in backwater areas, in shallow slack-water along banks, and behind point bars and other obstructions. Only one sheefish was measured and weighed at 598 mm fl (23.5 in), 1950 g (4.30 lbs). All other sheefish captured, however, were of comparable size.

Hook and line sampling resulted in the collection of 181 Arctic grayling, which ranged from 145 to 398 mm fl (5.7 to 15.7 in) and 27 to 700 g (0.06 to 1.54 lbs). Figures 2 and 3 depict the corresponding length-frequency histogram and length-weight regression. Average length was 299 mm (11.8 in) and average weight reached 284 g (0.62 lbs). A subsample of forty-eight randomly selected Arctic grayling were aged using scales (Table 2). Due to the small sample size and gear bias towards larger fish, this sample is only qualitative.

Habitat Descriptions

Juveniles—Although juvenile round whitefish (*Prosopium cylindraceum*), northern pike, burbot, Arctic grayling, salmon, and sculpin were documented on this survey, they will all be considered collectively for the purpose of this section. Juvenile fish were found to be abundant within several discrete habitat types. These included backwater areas formed by point bars, instream obstructions, and fringe areas along stream banks. The majority of these fish were between 25 and 100 mm (1.0 and 3.9 in) in length and could frequently be observed within these areas. Numerous observations of juvenile Arctic grayling, round whitefish, burbot, lamprey, and sculpin were made in isolated pools off the mainstem. They were apparently stranded there by the rapidly changing water levels, characteristic of the Salmon Fork during breakup.

Figure 2
Length frequency of Arctic grayling captured in the Salmon Fork Black River, June 7-14, 1991.

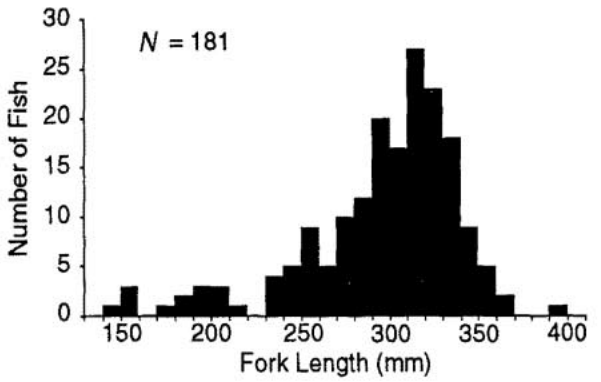


Figure 3
Length-weight regression of Arctic grayling captured in the Salmon Fork Black River, June 7-14, 1991.

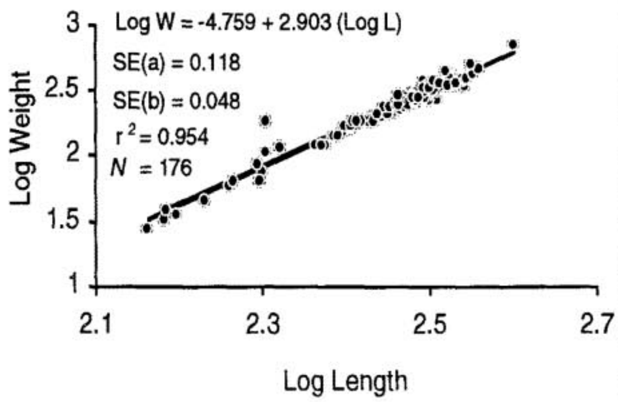


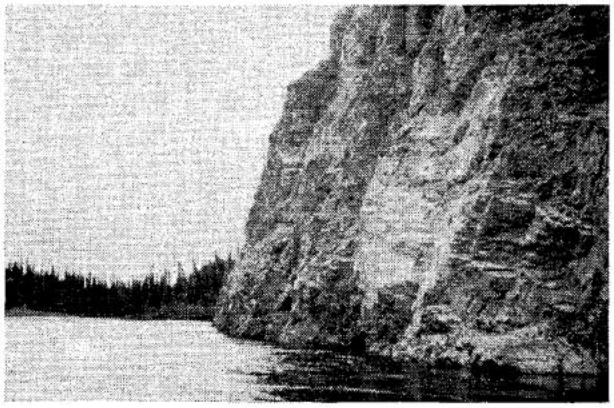
Table 2
Fork lengths by age class for 48 Arctic grayling captured in the Salmon Fork Black River by hook and line, June 7-14, 1991.

Age (*N*)	2 (4)	3 (4)	4 (4)	5 (6)	6 (4)	7 (14)	8 (7)	9 (2)	10 (2)	12 (1)
Mean	152	193	239	254	278	304	307	335	324	362
Minimum	145	170	210	235	272	279	286	331	315	—
Maximum	157	237	259	271	283	330	330	339	332	—

Adults—Although all female grayling examined were spent, several flowing males were observed, indicating spawning had recently taken place. Based on these observations, habitat was probably more indicative of that used for spawning rather than summer feeding. The most common habitats utilized were the sloughs and remnant channels receiving light to moderate stream or groundwater flow from their closed off, upstream ends. The water temperature in these habitats ranged from 39 to 40 °F (4 to 4.5 °C), colder than the mainstem, which ranged from 42 to 52 °F (5.5 to 11.0 °C). Depths reached a maximum 1.5 m (5 ft), with substrates ranging from sand/silt to course gravel 25 to 76 mm (1.0 to 3.0 in) in diameter.

Adult grayling were also observed along cut bank habitats which often exhibited complex hydraulics caused by overhanging trees, exposed root wads, and trees washed downstream from the frequent new channel formations. Deep glide habitats, 1 to 3m (3 to 10 ft) in depth, which ran against steep rock bluffs or silt cut banks, seemed to produce the largest Arctic grayling.

Virtually all sheefish observed were in 1 to 3 m (3 to 10 ft) deep glides, running against rock bluffs, or large, strong eddies formed in the vicinity of 2 to 3 m-high (6 to 10 ft) permafrost-rich, rapidly eroding banks. These latter habitats usually had melting ice lenses visible and an extensive, overhanging root mat.



Steep cliffs like this flank portions of the upper part of the Salmon Fork in Alaska. Deep glide habitats under these cliffs produce some of the river's larger Arctic grayling.

Four adult northern pike were taken by gill net at mile 71.7. The habitat type was a remnant oxbow slough, separated from the mainstem by an old beaver dam. This slough contained an active beaver lodge and was measured to be over 2 m (6 ft) deep. These fish were apparently land-locked during an extremely high water event.

Hydrology

Stream discharge measurements, channel characteristics, and limnological parameters are listed in Tables 3 through 5. Appendix A contains channel geometry, discharge rating curves, and rating tables. Since no historical stream flow data is available for this basin, average and peak flow statistics were computed from regional flood-frequency relationships (Parks and Madison 1985) listed in Table 6.

Table 3
Salmon Fork Black River 1991 discharge measurements.

Site	Date	Stage (ft)	Discharge (cfs)	Area (sq ft)	Width (ft)	Mean Depth (ft)
Salmon Fork						
above Rice Gulch	Jun 7	3.4	1,389	508	265	2.1
below Runt Creek	Jun 11	3.1	1,226	618	318	2.0
above Kevinjik Creek	Jun 13	6.7	1,414	889	291	3.3
Tributaries						
Rice Gulch Creek	Jun 9	1.1	19	20	31	0.7
Drifting Snow Creek	Jun 11	4.2	361	227	111	2.4
Tetthajik Creek	Jun 12	1.5	94	56	67	0.9

Table 4
Surveyed stream channel site characteristics.

Site	Drainage Area (sq mi)	Gradient (%)	Maximum Width (ft)	Maximum Depth (ft)	Width/ Depth (ft)	Sinuosity
Salmon Fork						
above Rice Gulch	800	0.08	285	8.3	34	1.4
below Runt Creek	1,260	0.10	376	7.6	49	1.4
above Kevinjik Creek	1,670	0.02	335	13.2	25	1.4
Tributaries						
Rice Gulch Creek	70	0.10	49	4.6	11	1.4
Drifting Snow Creek	333	0.22	185	8.0	23	1.3
Tetthajik Creek	260	0.25	83	7.3	11	2.2

Table 5
Chemical and physical characteristics of the Salmon Fork Black River water samples, 1991.

Site	Water Temp. (°C)	Conductance (us/cm)	Turbidity (NTU)	pH	Hardness (mg/L as $CaCO_3$)	Total Akalinity (mg/L as $CaCO_3$)
Salmon Fork						
above Rice Gulch	9	194	4.0	7.7	ND	ND
below Runt Creek	9	214	0.8	7.7	116	90
above Kevinjik Creek	11	189	1.3	8.0	120	96
Tributaries						
Rice Gulch Creek	6	207	0.5	7.7	125	94
Drifting Snow Creek	6	147	3.0	7.5	177	58
Runt Creek	10	84	1.3	7.5	68	49
Tatthajik Creek	10	311	1.3	8.0	160	160
Kevinjik Creek	9	288	1.1	8.0	165	164

Table 6
Flow frequency calculations for the Salmon Fork Black River.

	Discharge (cfs)					
Site	avg.	2 yr	5 yr	10 yr	25 yr	50 yr
Salmon Fork						
above Rice Gulch	250	2,896	5,101	7,088	10,337	13,688
below Runt Creek	403	4,379	7,504	10,287	14,733	19,332
above Kevinjik Creek	543	5,670	9,554	12,986	18,388	23,991
Tributaries						
Rice Gulch Creek	19	316	645	964	1,549	2,154
Drifting Snow Creek	100	1,304	2,421	3,455	5,218	7,032
Tetthajik Creek	77	1,043	1,965	2,825	4,308	5,835

Source: Parks and Madison 1985.

The computer-generated rating based upon the field-identified bankful flood, differed by -5 to 61 percent (Table 7) from the two-year recurrence interval discharge, often used to approximate the bankful stream flow (Williams 1979). Differences are probably due to uncertainty in using regional data, lack of any precipitation data in the basin, and the small data set of measured field sites used for the comparison.

As most of the direct discharge measurements were made at medium flows, the theoretical average annual discharge (Parks and Madison 1985) was used as an indicator of the optimum summer low-flow conditions (Estes and Osborn 1986). Site specific rating tables can then be used to compute the channel parameters that would exist at these average flows (Table 8). The sites appear to have excellent habitat availability at the theoretical low-water level.

Limnological parameters indicate a low turbidity, highly buffered calcium bicarbonate dominated water chemistry. Such a system would be pH stable over a wide variety of flows and provide excellent habitat for aquatic organisms.

Table 7
Bankful Discharge of the Salmon Fork Black River.

Site	Discharge (from field survey)	% difference from Parks and Madison 2 yr recurrence
Salmon Fork		
above Rice Gulch	2,988	3
below Runt Ck	10,400	58
above Kevinjik Ck	11,560	51
Tributaries		
Rice Gulch Creek	301	-5
Drifting Snow Ck	3,350	61
Tetthajik Ck	1,876	44

Recommendations

The Salmon Fork Black River is a clear running, free flowing, moderate gradient river system with undisturbed aquatic, riparian, and upland habitat. Fisheries data, streamflow surveys, and limnological parameters indicate a pristine watershed capable of supporting a wide variety of aquatic and riparian organisms. Bedrock bluffs upstream of Tetthajik Creek provide raptor and upland game habitat as well as contribute to the scenic environment. Further aquatic studies should focus on anadromous and resident spawning habitat, especially during summer low-flow conditions when it would be possible to more completely assess the habitat limitations. Late winter streamflows should be measured to determine overwintering aquatic habitat, as well as to survey the availability of the water resources for this region.

Given the high quality and diversity of this ecosystem, the areas of critical spawning and rearing habitat for anadromous and resident fish populations, and the high potential for future recreational and subsistence use, we should consider giving parts or all of the area a special land designation, such as naming it an Area of Critical Environmental Concern, if the area is continued under federal management.

Table 8
Channel characteristics of the Salmon Fork Black River at average discharge.

Site	Avg. Discharge (cfs)	Area (sq ft)	Width (ft)	Depth (ft)	Velocity (ft/s)
Salmon Fork					
above Rice Gulch	250	173	230	0.7	1.3
below Runt Creek	403	350	298	1.2	1.1
above Kevinjik Creek	543	479	178	2.7	1.1
Tributaries					
Rice Gulch Creek	19	21	30	0.7	0.8
Drifting Snow Creek	100	102	66	1.5	1.0
Tetthajik Creek	77	50	59	0.8	1.4

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Appendix

Table A1
Salmon Fork Black River above Rice Gulch Creek rating table.

Stage (ft)	Discharge (cfs)	Area (sq ft)	Width (ft)	Depth (ft)	Velocity (ft/s)
0.6	4.6	8.1	20	0.4	0.57
1.3	26	36	86	0.4	0.73
2.0	138	130	222	0.6	1.06
2.7	587	304	255	1.2	1.93
3.4	1,390	484	260	1.9	2.87
4.1	2,547	667	264	2.5	3.82
4.8	4,090	853	267	3.2	4.79
5.5	6,020	1,042	271	3.8	5.78
6.2	8,370	1,233	275	4.5	6.79
6.9	11,100	1,430	278	5.1	7.76
7.6	14,400	1,620	282	5.7	8.89
8.3	18,100	1,820	285	6.4	9.95

Table A2
Salmon Fork Black River below Runt Creek rating table.

Stage (ft)	Discharge (cfs)	Area (sq ft)	Width (ft)	Depth (ft)	Velocity (ft/s)
0.6	4.3	29	71	0.4	0.1
1.1	32	73	103	0.7	0.4
1.6	104	171	245	0.7	0.6
2.1	305	310	294	1.1	1.0
2.6	671	461	310	1.5	1.5
3.1	1,230	618	318	1.9	2.0
3.6	2,015	778	322	2.4	2.6
4.1	3,046	941	326	2.9	3.2
4.6	4,360	1,100	331	3.3	4.0
5.1	5,980	1,270	335	3.8	4.7
5.6	7,970	1,440	339	4.2	5.5
6.1	10,400	1,610	343	4.7	6.5
6.6	13,100	1,780	351	5.1	7.4
7.1	16,300	1,960	363	5.4	8.3
7.6	20,000	2,150	376	5.7	9.3

Table A3
Salmon Fork Black River above Kevinjik Creek rating table.

Stage (ft)	Discharge (cfs)	Area (sq ft)	Width (ft)	Depth (ft)	Velocity (ft/s)
0.7	3.0	21	48	0.5	0.1
1.7	28	84	84	1.0	0.3
2.7	105	183	109	1.7	0.6
3.7	255	304	134	2.3	0.8
4.7	495	458	175	2.6	1.1
5.7	917	647	204	3.2	1.4
6.7	1,420	895	291	3.1	1.6
7.7	2,560	1,190	296	4.0	2.2
8.7	4,170	1,490	301	4.9	2.8
9.7	6,360	1,790	306	5.8	3.6
10.7	9,250	2,100	315	6.7	4.4
11.7	13,100	2,420	324	7.5	5.4
12.7	18,200	2,750	332	8.3	6.6
13.2	21,400	2,910	335	8.7	7.4

Table A4
Rice Gulch Creek rating table.

Stage (ft)	Discharge (cfs)	Area (sq ft)	Width (ft)	Depth (ft)	Velocity (ft/s)
0.4	1.4	3.6	13	0.3	0.4
1.0	12	17	29	0.6	0.7
1.6	44	36	32	1.1	1.2
2.2	98	55	33	1.7	1.8
2.8	174	75	35	2.2	2.3
3.4	279	97	37	2.6	2.9
4.0	412	121	41	2.9	3.4
4.6	564	147	49	3.0	3.8

Table A5
Drifting Snow Creek rating table.

Stage (ft)	Discharge (cfs)	Area (sq ft)	Width (ft)	Depth (ft)	Velocity (ft/s)
1.0	7.1	21	32	0.7	0.3
1.8	34	53	47	1.1	0.6
2.6	90	96	64	1.5	0.9
3.4	192	156	85	1.8	1.2
4.2	362	234	112	2.1	1.5
5.0	802	432	179	2.4	1.9
5.8	1,408	576	180	3.2	2.4
6.6	2,242	720	181	4.0	3.1
7.4	3,350	865	182	4.8	3.9
8.0	4,365	975	185	5.3	4.5

Table A6
Tetthajik Creek rating table.

Stage (ft)	Discharge (cfs)	Area (sq ft)	Width (ft)	Depth (ft)	Velocity (ft/s)
0.5	4.6	6.5	22	0.3	0.7
1.5	94	60	67	0.9	1.5
2.5	336	128	69	1.9	2.6
3.5	711	198	71	2.8	3.6
4.5	1,222	270	73	3.7	4.5
5.5	1,876	344	75	4.6	5.5
6.5	2,649	421	80	5.3	6.3
7.3	3,408	486	83	5.8	7.0

Figure A1
Channel cross section for the Salmon Fork Black River above Rice Gulch Creek.

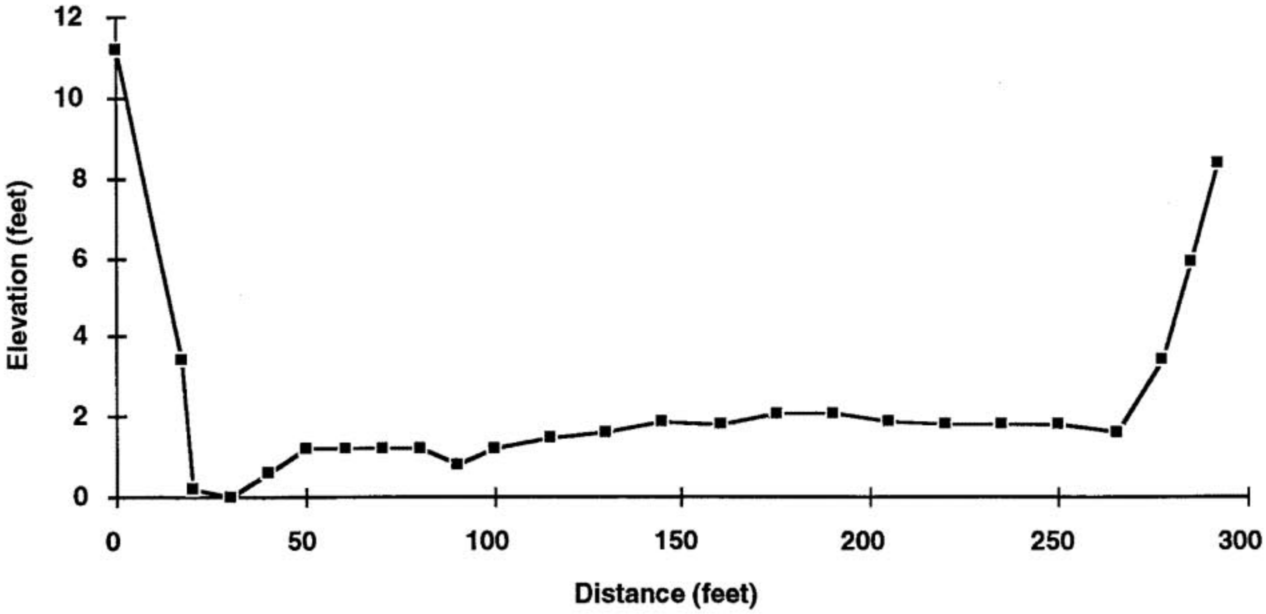

Figure A2
Discharge rating curve for the Salmon Fork Black River above Rice Gulch Creek.

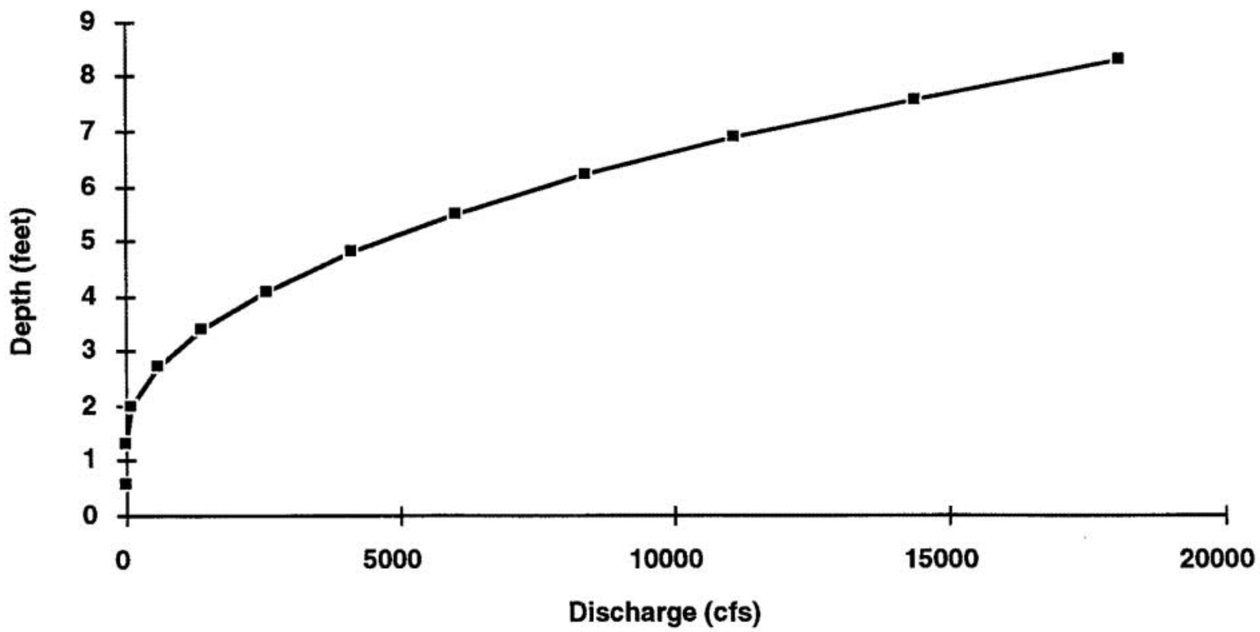

Figure A3
Channel cross section for the Salmon Fork Black River below Runt Creek.

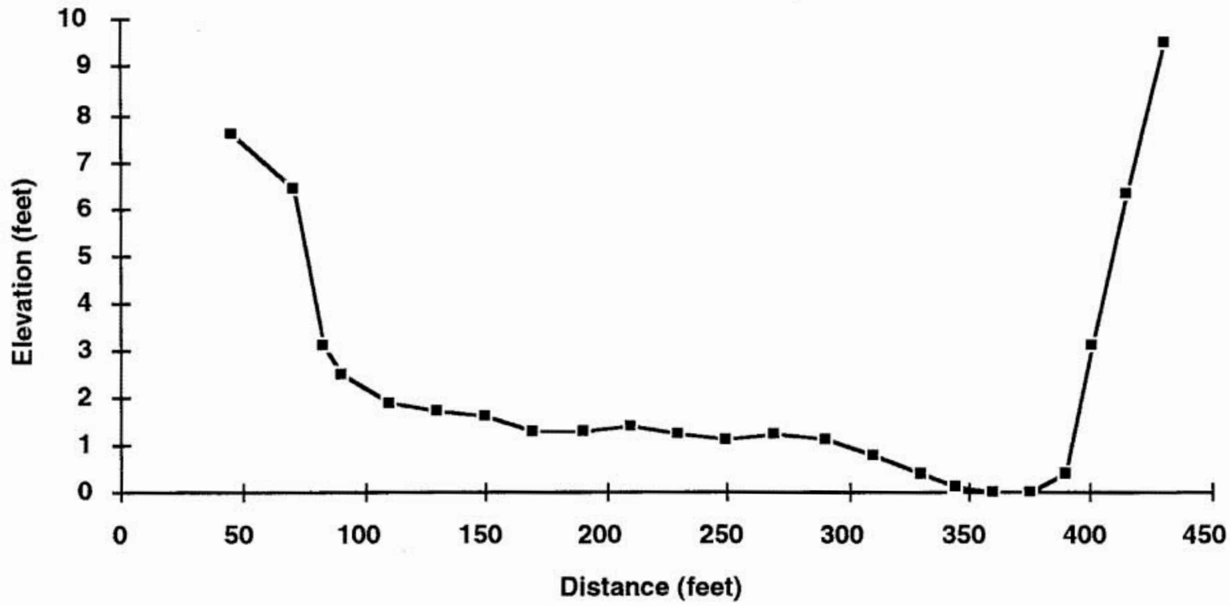

Figure A4
Discharge rating curve for the Salmon Fork Black River below Runt Creek.

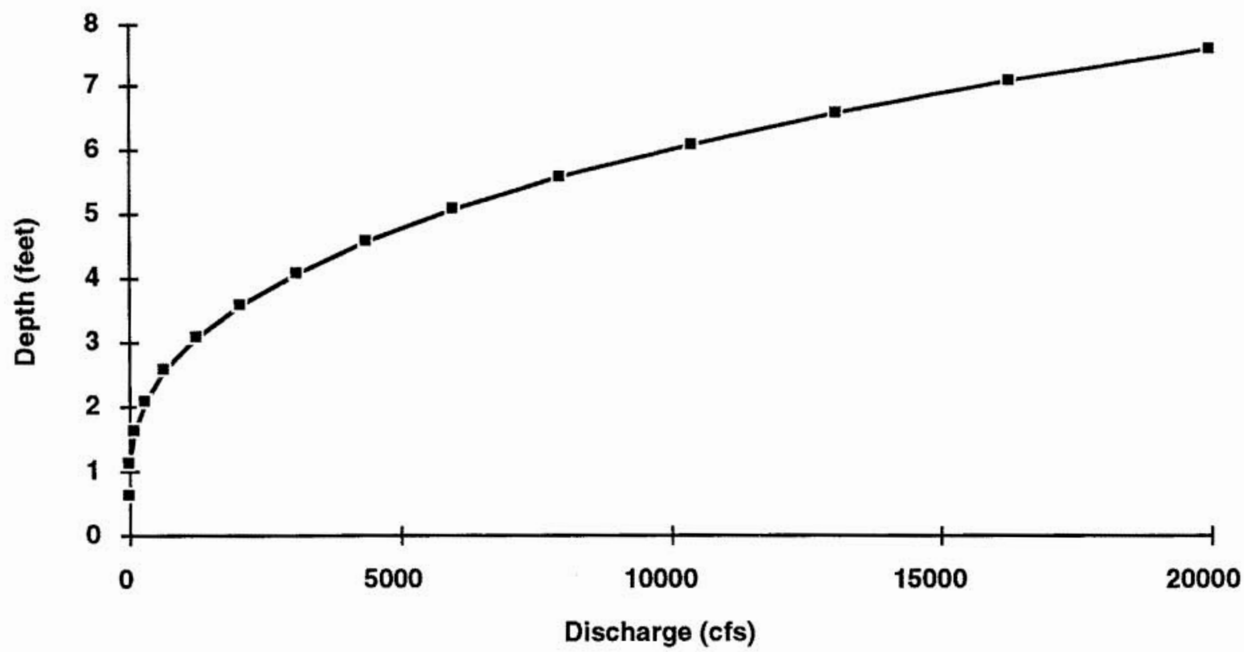

Figure A5
Channel cross section for the Salmon Fork Black River above Kevinjik Creek.

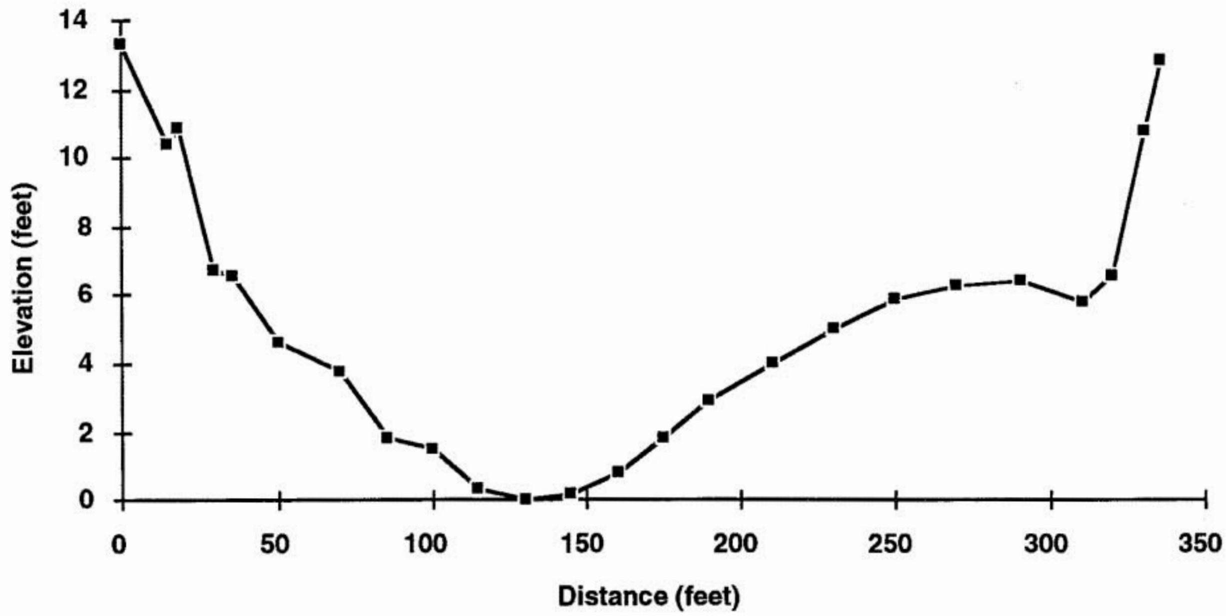

Figure A6
Discharge rating curve for the Salmon Fork Black River above Kevinjik Creek.

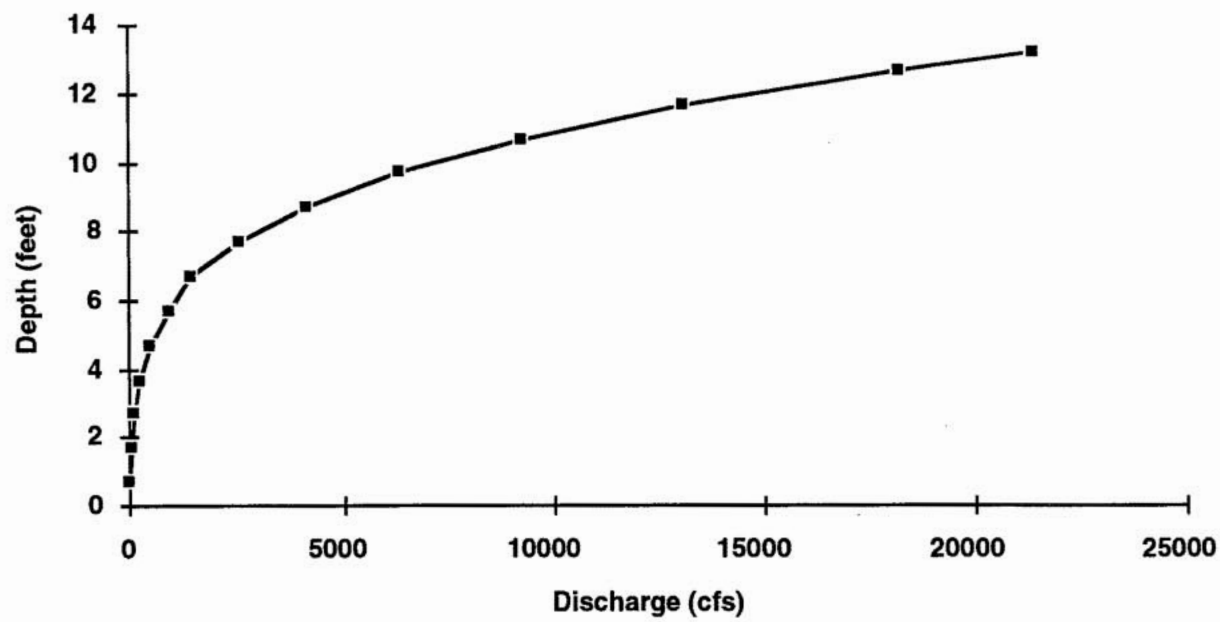

Figure A7
Channel cross section for Rice Gulch Creek.

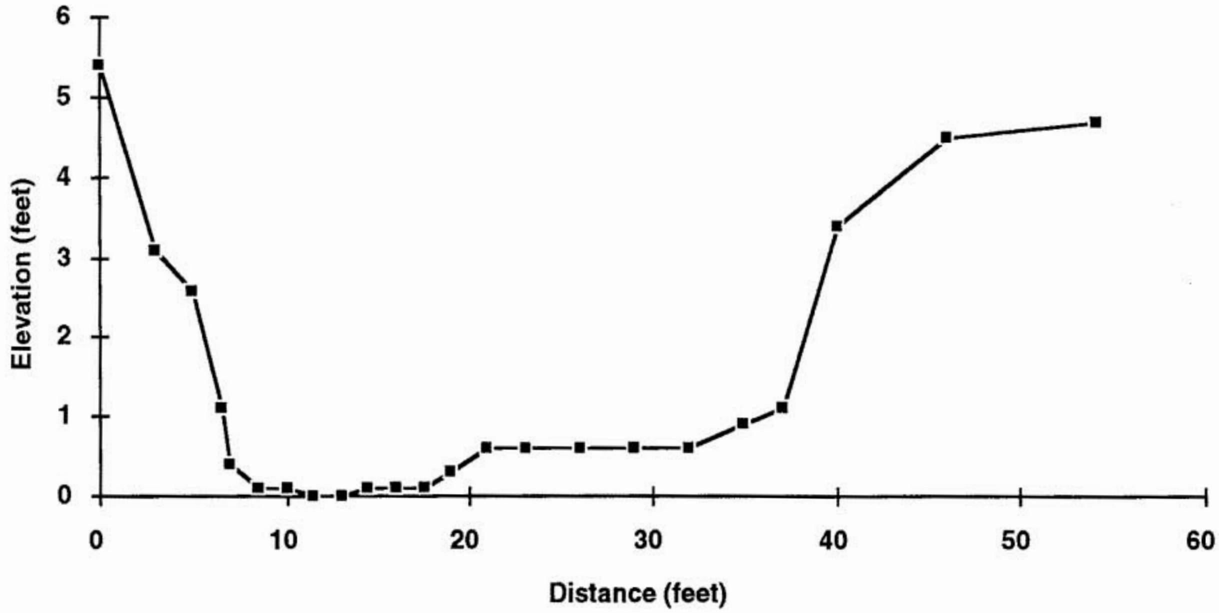

Figure A8
Discharge rating curve for Rice Gulch Creek.

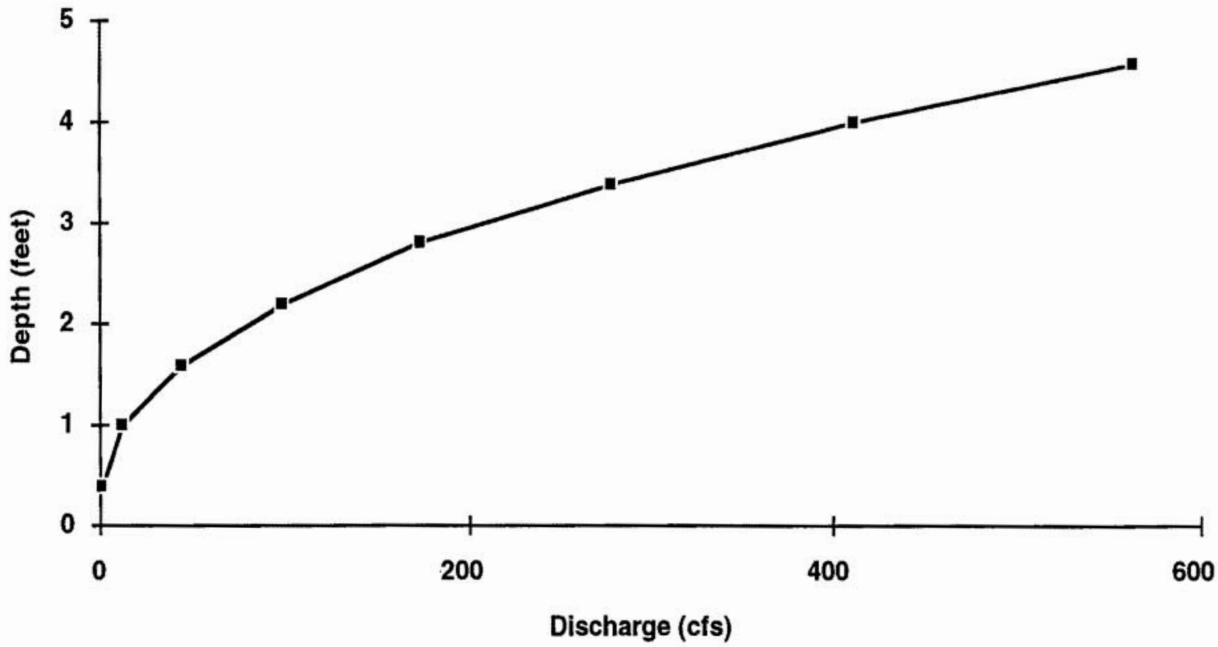

Figure A9
Channel cross section for Drifting Snow Creek.

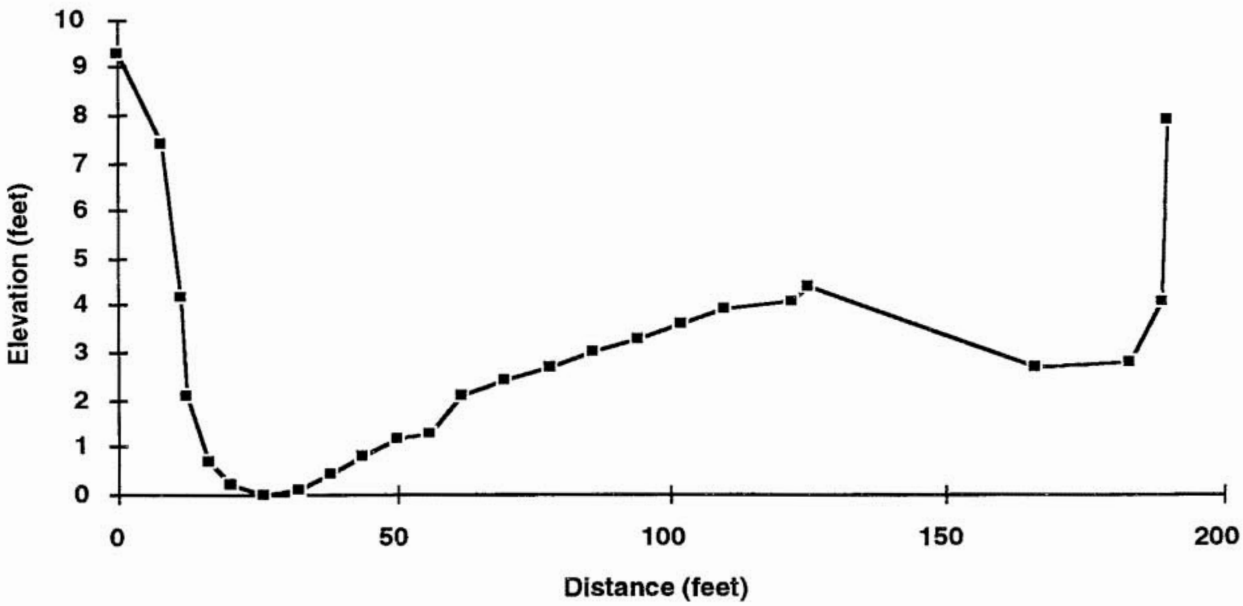

Figure A10
Discharge rating curve for Drifting Snow Creek.

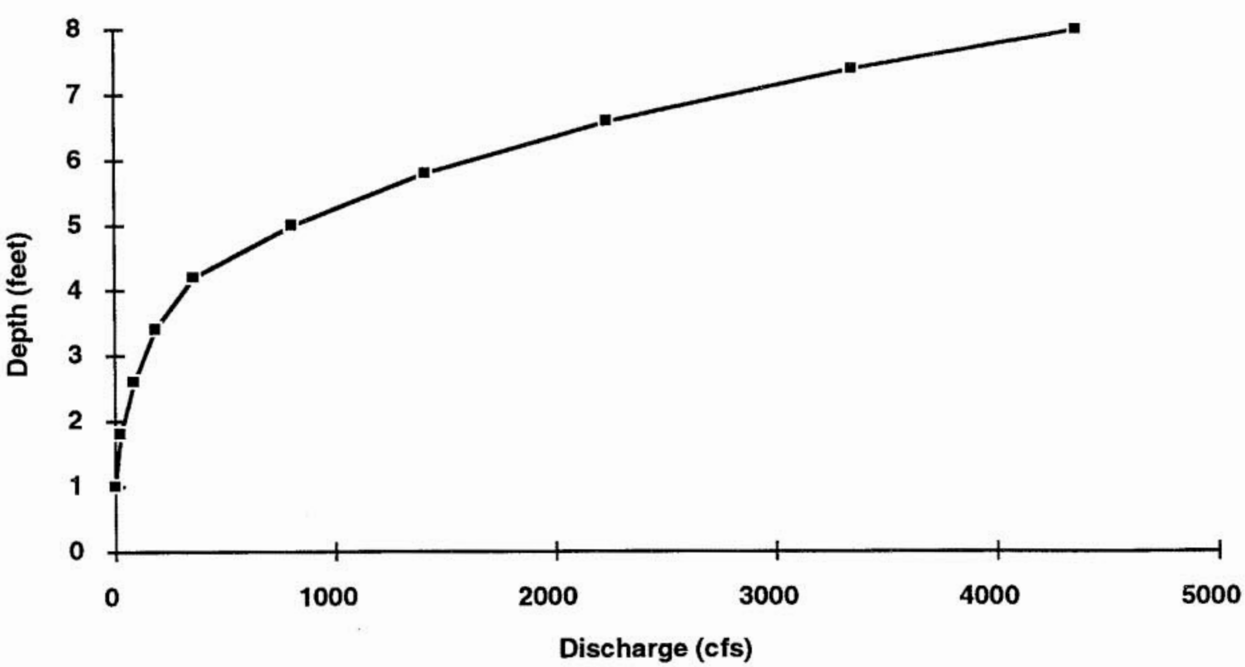

Figure A11
Channel cross section for Tetthajik Creek.

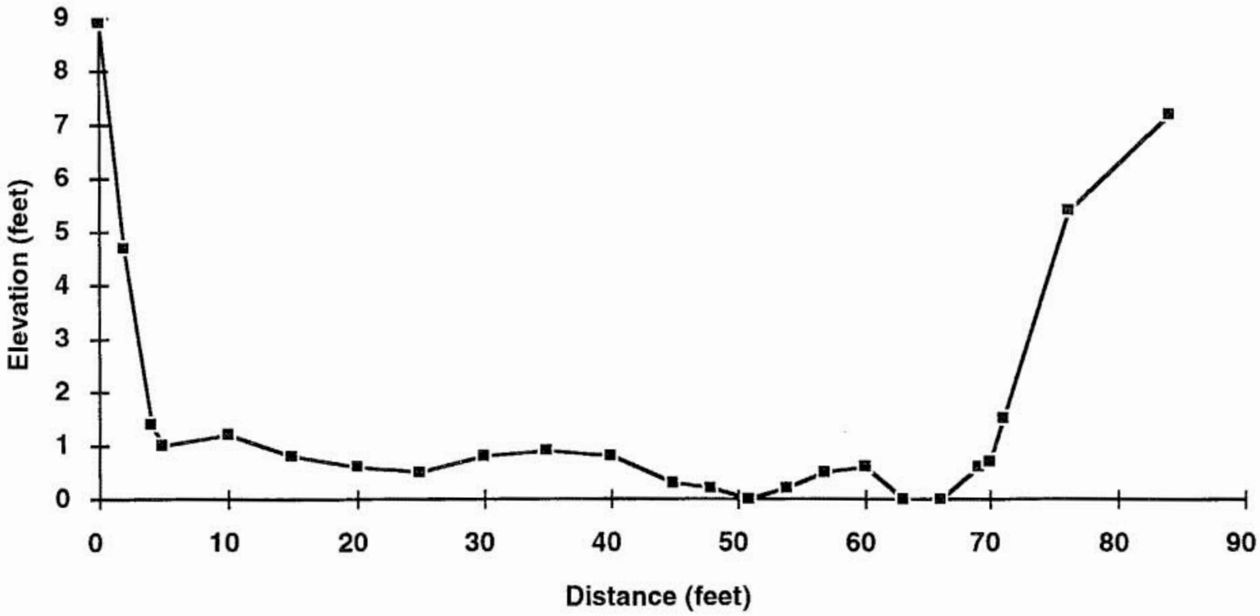

Figure A12
Discharge rating curve for Tetthajik Creek.