

Final Report

Arizona Game & Fish Department

Heritage Project

I95017

West Fork of the Black River
and Mineral Creek
Stream Surveys

1997

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Introduction

In 1995, the Springerville Ranger District of the Apache-Sitgreaves National Forests, was granted a Heritage Grant (I95017) by the Arizona Game and Fish Department. The purpose of this grant was to survey the West Fork of the Black River and Mineral Creek to monitor fish populations, in conjunction with General Aquatic Wildlife System (GAWS, USFS 1985) surveys to evaluate and monitor stream and riparian habitat condition. Mineral Creek and the upper watershed of the West Fork of the Black River are Apache trout (*Oncorhynchus apache*) streams.

The Apache trout is a threatened native Arizona species. In 1973 it was brought under the protection of the Endangered Species Act (P.L. 93-205). At that time it was listed as endangered. It was down listed to threatened in 1975 when a recovery team was formed (USFWS 1983). The Apache trout is managed also as a sport fish by the Arizona Game and Fish Department.

The West Fork of the Black River and Mineral Creek have been surveyed previously. The West Fork of the Black River was surveyed in 1989-90. Mineral Creek was surveyed in 1986 and 1991. All reaches and stations were delineated on both streams during the previous survey. There are eight reaches and 44 stations on the West Fork of the Black River. There are three reaches and six stations on Mineral Creek. Each station has been permanently located using a rebar stake placed on the right bank, with a metal tag with the reach and station number engraved on it.

A standardized GAWS sampling station consists of five clustered perpendicular to flow transects spaced upstream at regular intervals from the station identification point (rebar stake). At each station data was collected (as required on the Stream Habitat Inventory Transect form) for five transects, beginning ten (or twenty) meters above the station markers. Stations on the West Fork of the Black River were 50 meters long. Stations on Mineral Creek were 100 meters long.

In addition to the physical habitat data collected, fish population data was also recorded. Blocking nets were placed at either end of each station, and three depletion passes with an AC backpack electroshocker were used to collect fish. The species, length and weight of each fish collected were recorded on the fish data form. Only 25 fish of each species were measured and weighed at each station, any additional fish were only counted. All fish were released after it was measured and weighed.

The following is a summary of the conditions at the West Fork of the Black River and Mineral Creek. Data from previous surveys is provided for comparison purposes.

Survey Information

West Fork of the Black River

The West Fork of the Black River is located on the Apache-Sitgreaves National Forest and Fort Apache Indian Reservation. It is a 31.2 kilometer (19.4 miles) south easterly flowing tributary of the Black River. The drainage area of this system is approximately 156.9 square kilometers (60.6 sq. miles), ranging in elevation from 2281 meters (7484 feet) at its Black River confluence to a maximum of 3048 meters (10000 feet) near its origin on the top of Mount Baldy. The West fork of the Black River descends 24.6 meters/kilometer (129.7 feet/mile) over its stream course (Novy and Lopez 1991).

The West Fork of the Black River is a third order stream that flows through a series of meadows and canyons en route to its Black River confluence, located in SE1/4, SE1/4, Section 11, Township 4N, Range 28E, GSR&M . At this point, the East Fork and the West Fork of the Black River join together to form the mainstream of the Black River. The stream's watershed ranges from open rangeland and ponderosa pine forest to spruce-fir forest and high mountain meadows.

In 1991, Trout Unlimited approached the Springerville Ranger District and the Arizona Game and Fish Department with a proposal for managing a stream on the Forest as a quality, blue ribbon type, coldwater fisheries. The West Fork of the Black River was chosen for this project. The project objectives were to: improve habitat conditions for trout; provide a blue ribbon fisheries within the biological capabilities of the West Fork of the Black River, manage for an Apache trout fisheries in the headwaters and tributaries of the West Fork of the Black River; manage for a brown trout fisheries below the headwaters and tributaries; provide a unique and enjoyable recreational experience; and to provide access for a variety of uses.

Almost all of the project has been implemented to date. In January of 1993, the Arizona Game and Fish Commission implemented Acatch and release@fishing regulations for the majority of the project area. Approximately 150 instream improvement structures were constructed in the

West Fork of the Black River and tributaries between 1992 and 1996. Willow were planted along stream banks to help stabilize banks, reduce sedimentation and provide overhanging vegetation. All of the stream improvements were constructed upstream of stations F6-46 (see Appendix A, Figure A-2). Range management improvements have been implemented. Roads have been closed or obliterated. A trail and parking area providing access to the area was constructed in 1994. In 1994, a secondary fish barrier was built on the upper reach of the stream. This barrier was then raised in 1996. Construction was finished on the primary barrier in 1995. These barriers were constructed to prevent exotic fish species from migrating upstream. A large portion of this project was implemented with the Arizona Game and Fish Department Heritage Funds. In 1995, an experimental stocking of 11,730 Apache trout took place, and in 1996 another 6045 Apache trout were released. These stockings took place below the fish barriers.

The stream was renovated in the fall of 1996, after the present survey was completed. The brown trout that were salvaged were restocked approximately 8 miles downstream from the fish barriers. Gila mountain suckers, Gila suckers and speckled dace were restocked in the upper West Fork of the Black River in the fall of 1996. In the July of 1997 the stream was restocked above the barriers with native Apache trout.

Water Chemistry

A water analysis was conducted at the same time as the GAWS survey was conducted. The water samples were analyzed at the last station of each reach (Table 1). Reach 4 was not sampled. This was conducted to obtain an average reading of each reach. These samples were analyzed for alkalinity, sulphate levels, specific conductivity, and pH levels (using the Exttec Oyster pH/conductivity meter).

Table 1. Water chemistry measurements taken at West Fork of the Black River in 1996.

Station	1-5	2-15	3-25	5-40	6-50	7-60	8-70	Stream Avg.
Date	6/18	6/20	6/26	7/16	7/22	7/23	7/25	---

Station	1-5	2-15	3-25	5-40	6-50	7-60	8-70	Stream Avg.
Time	1040	1010	1245	1325	1025	1410	1215	---
Water Temp (EC)	18	18	19	20	17	26	20	19.7
pH	8.05	8.51	8.41	8.69	8.2	8.01	7.77	8.23
Alkalinity (mg/l)	0	18	0	30	0	0	0	6.9
Sulphate (mg/l)	>400	400	400	>400	400	>400	>400	400
Specific Conductance (Fmhos/cm at 25EC)	40	30	30	60	40	40	40	40

Habitat

The first reach (1) is a low gradient canyon reach. Approximately 46% of stream habitat occurred as riffle area. Pool measure (quantity) increased from the last survey, while pool structure (quality) decreased from 33.3% in 1990 to zero in 1996 (Table 2 and 3). Bank soil and vegetation stability ratings increased to excellent conditions (above 80%, see Table 2 and Figure 1). The Habitat Condition Index (HCI) for reach 1 increased from 50.6% in 1990 to 58.5% in 1996. The Forests=minimum standard for trout streams is 60%. This reach supported a 3.2 hectare (8.1 acre) riparian area that was in fair condition (Table 2). Reach 1 is located below Forest Road 25, which contributes sediment to the West Fork.

Reach 2 is a low gradient meadow reach. Pool measure and pool structure decreased between the survey years, while all other habitat parameters increased (Figure 2). The HCI increased from 50.2% in 1990 to 59.2% in 1996. The 25 hectares (63 acres) of riparian habitat in this reach was found to be in fair condition. Reach 2 is located primarily on the AGFD PS Ranch. This area is known to have a high elk and deer concentration. Several beaver dams were also noted in this reach. Home Creek enters the West Fork of the Black River in this reach.

Reach 3 had the greatest HCI (72.1%) on the West Fork of the Black River during this survey (Table 2). This canyon reach had fair pool measure and structure ratings. Several pools were noted in this reach that were not part of a station. The riparian condition of the 12.4 hectares (31 acres) of riparian habitat was rated as satisfactory. The West Fork Campground is located in this reach. The campground road crosses the West Fork three times. There is a foot trail on the east side (right bank) of the stream facilitating recreational fishing and nature viewing.

Reach 4 is a low gradient canyon reach. All habitat parameters averaged above 80%, except for pool measure and structure (Table 2 and Figure 4). The lack of pool quality and quantity occurred in stations 4-26 and 4-30. The HCI for Reach 4 was 65.8% in 1996, up from 57.5% in 1990. Ungulate damage and embeddedness ratings for this reach improved. Hayground Creek enters the West Fork of the Black River in this reach near station F4-28.

Reach 5 is a moderate gradient canyon reach, with a preponderance of the stream habitat occurring as riffle area. The average pool measure for this reach was 13.7% in 1996, compared to 51.2% in 1990 (Figure 5). Bank soil stability and vegetation stability ratings were excellent. The riparian condition for the 12.6 hectare (31.5 acre) riparian area was excellent. The HCI for this reach in 1996 was 60.5%, down from 65.7% in 1990. This is due to the extremely low ratings for pool measure and pool structure (Table 2). There were however, pools noted that were outside of the stations measured. One beaver dam was noted in this reach.

Reach 6 is also a moderate gradient reach. Stinky Creek enters the West Fork of the Black River in this reach upstream of station F6-41. There were pools in all stations sampled, but the pool quality and quantity was poor. There are several pools in the areas between sampled stations. The HCI for this reach decreased slightly from 69.2% in 1990 to 68.2% in 1996. This reduction is due to the low pool measure and structure ratings. The two fish barriers are located in this reach upstream of station F6-50. An old railroad grade and the Thompson Trail are on the west side (left bank) of the stream.

Reach 7 is a low gradient meadow reach. Burro Creek and Thompson Creek enter the

West Fork of the Black River in this reach. The Burro Creek confluence is just upstream of station F7-53, and the Thompson Creek confluence is located just downstream of Station F7-58. The channel is split many times in this reach. Most of the instream improvement structures are located in this reach and in reach 6. In this reach, all habitat parameters increased from the last survey, except pool structure. Bank soil stability ratings were excellent (Table 2 and Figure 7). The HCI for this reach was 63.7% in 1996. The riparian area was 26 hectares (65.3 acres), and was in satisfactory condition. Heavy elk and beaver activity was noted in this reach.

Reach 8 is a moderate gradient canyon reach which is located just below the Fort Apache Reservation Boundary. Most of the habitat in this reach was recorded as riffle area (Table 2). Here bank cover, soil stability, and vegetation stability ratings were in satisfactory condition and improved from the 1990 survey (Table 2,3 and Figure 8). The HCI for this reach was 57.5% in **Table 2. Summary of Habitat Conditions on West Fork of the Black River, 1996.**

Stream Reach	1	2	3	4	5	6	7	8	Total/ Stream Ave.
Reach Length (m)	1640	4835	2725	1410	7080	4300	2810	1830	25830 total
Reach Area (m ²)	1037	955	1854	726	1335	1032	615.5	694.5	8249 total
Number of Stations	3	4	6	3	6	6	5	6	39 total
Elevation (m)	2316	2362	2377	2415	2560	2633	2730	2735	2516
Gradient (%)	1.2	1.1	1.4	1.8	2.3	2.2	0.80	2.7	1.7
Riffle (%)	46.4	44.7	61.3	84.0	85.2	71.6	66.2	81.9	67.6
Potential Spawning Area (PSA%)	42.0	22.6	19.5	13.3	9.7	9.3	57.3	45.7	27.5
Potential Rearing Area (PRA%)	45.9	59.7	34.6	12.3	6.6	17.8	41.0	10.9	28.6
Channel Width (m)	11.2	11.6	14.7	14.9	9.4	8.3	8.3	6.5	10.6
Water Width (m)	8.8	6.0	7.5	5.9	5.6	4.4	3.1	2.9	5.5
Water Depth (m)	.16	.19	.15	.12	.16	.13	.12	.09	.14
Water Width/Depth Ratio ¹	48.8	31.6	50.0	49.2	35.0	33.8	25.8	32.2	38.3
Pool Measure (%) ²	54.8	49.1	56.3	24.8	13.7	35.1	33.0	23.4	36.3
Pool Structure (%) ²	0	10.3	56.8	24.7	0	45.9	28.1	0	20.7
Gravel Bottom (%) ²	68.0	85.4	83.2	85.4	70.0	52.6	77.5	69.0	73.9

Stream Reach	1	2	3	4	5	6	7	8	Total/ Stream Ave.
Bank Cover (%) ²	65.0	59.4	70.4	89.2	97.5	84.6	66.0	82.1	76.8
Bank Soil Stability (%) ³	80.8	71.3	83.3	85.0	90.4	95.4	88.5	86.7	85.2
Bank Vegetation Stability (%) ³	82.5	80.0	82.5	85.8	91.7	95.8	89.0	84.2	86.4
Canopy Density (%) ³	8	6	26	34	47	39	6	48	26.8
Ungulate Damage (%) ⁴	30.0	22.3	9.7	9.3	3.6	3.3	10.8	13.5	12.8
Embeddedness (%) ⁴	60.0	48.2	22.6	21.3	24.1	34.5	50.1	30.1	36.4
Habitat Condition Index (HCI%) ⁵	58.5	59.2	72.1	65.8	60.5	68.2	63.7	57.5	63.2
Habitat Vulnerability Index (HVI%) ⁶	55.3	52.9	44.7	52.1	53.3	44.8	48.1	47.9	49.9
Riparian Condition ⁷	6	7.5	9	10	11	10	9	11	9
Riparian Area (ha)	3.2	25	12.4	2.9	12.6	7.2	26	3.1	92.4

¹ = <15 Good; 16-25 Fair; >26 Poor

² = >70% Good; 40-69% Fair; <39% Poor

³ = >80% Good; 40-79% Fair; <39% Poor

⁴ = <25% Good; 26-50% Fair; >51% Poor

⁵ = >60% Good; 40-59% Fair; <39% Poor

⁶ = <45% Good; 46-59% Fair; >60% Poor

⁷ = 9-12 Mod. High - High; 6-8 Moderate; 0-5 Low - Mod. Low

1996, down from 61.1% in 1990. The decrease is due to poor pool measure and structure ratings (Figure 8). Again, several pools were noted in this reach that were outside of the sampling stations.

Fish Population

Prior to the introduction of exotic species and habitat disruption associated with man-related activity, the West Fork of the Black River's native fish population probably consisted of Apache trout (*Oncorhynchus apache*), Speckled Dace (*Rhynchichthys osculus*), Gila mountain-sucker (*Pantosteus clarki*) and Gila sucker (*Catostomus insignis*)(Novy and Lopez 1991). The 1990 survey documented the presence of rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), speckled dace, Gila-Mountain sucker, and Gila sucker. This survey documented the presence of rainbow trout, brown trout, speckled dace, Apache trout, Gila mountain-sucker

and Gila sucker.

Historical stocking records of the Arizona Game and Fish Department indicate that rainbow trout and brown trout have been released since the 1930's (Novy and Lopez 1991). In 1995 no rainbows were stocked, then in 1996, 1000 catchables were released. The last brown trout stocking, of fingerlings, took place in 1981. These stockings, in conjunction with fish migrating from the Black River system, have eliminated the native trout fishery that was once present and produced the present mix of native and exotic species that now inhabit the West Fork of the Black River.

Six species of fish were captured in the West Fork of the Black River in 1996. Gila Mountain sucker, Gila sucker, speckled dace, rainbow trout and Apache trout (Table 4). Apache trout were found in reaches 2, 3 and 6. A total of 89 Apache trout were captured in the West Fork of the Black River in 1996. The Apache trout measured had a size

Table 3. Summary of Habitat Conditions on West Fork of the Black River, 1990.

Stream Reach	1	2	3	4	5	6	7	8	Stream Avg. Or Total
Reach Length (m)	1640	4835	2725	1410	7080	4300	2810	1830	26600 total
Reach Area (m ²)	1042.5	1570	1995.5	1357.5	1101.1	1572	1990	105	10733.6 total
Number of Stations	3	4	6	3	6	6	6	6	40 total
Elevation (m)	2289	2326	2360	2399	2501	2630	2694	2738	2494
Gradient (%)	1.20	1.10	1.40	1.80	2.30	2.20	0.80	2.70	1.70
Riffle (%)	92.0	57.5	73.7	72.9	72.2	52.8	66.2	81.9	66.8
Potential Spawning Area (PSA%)	21.6	52.7	18.0	16.6	14.7	13.7	20.3	51.8	27.2
Potential Rearing Area (PRA%)	18.1	40.7	29.1	31.2	27.8	48.4	61.8	18.7	37.4
Channel Width (m)	9.6	21.1	18.1	13.2	9.2	11.9	11.8	5.9	13.0
Water Width (m)	8.4	10.3	8.4	8.3	5.4	6.7	7.9	3.5	7.3
Water Depth (m)	0.19	0.15	0.13	0.13	0.15	0.16	0.16	0.11	0.15
Water Width/Depth Ratio ¹	44.0	69.0	65.0	64.0	36.0	42.0	49.0	32.0	49.0

Stream Reach	1	2	3	4	5	6	7	8	Stream Avg. Or Total
Pool Measure (%) ²	16.0	55.0	52.9	48.0	51.2	66.2	30.7	36.9	49.1
Pool Structure (%) ²	33.3	33.6	95.2	31.5	40.1	83.6	81.5	42.0	55.2
Gravel Bottom (%) ²	46.2	53.7	72.5	64.7	55.6	44.2	53.3	69.2	55.5
Bank Cover (%) ²	77.5	58.1	80.4	70.0	92.9	82.9	54.6	79.2	76.5
Bank Soil Stability (%) ³	64.2	43.8	63.3	65.0	79.2	69.6	49.2	68.3	64.0
Bank Vegetation Stability (%) ³	66.7	56.9	65.0	65.8	75.4	68.8	54.6	70.8	66.4
Canopy Density (%) ³	26	15	42	44	54	36	6	57	32
Ungulate Damage (%) ⁴	26.7	62.8	26.3	35.0	9.2	43.4	38.0	17.8	32.3
Embeddedness (%) ⁴	49.7	41.9	32.8	32.6	27.3	47.7	63.6	40.5	41.2
Habitat Condition Index (HCI%) ⁵	50.6	50.2	71.6	57.5	65.7	69.2	54.0	61.1	59.9
Habitat Vulnerability Index (HVI%) ⁶	59.1	56.0	58.2	53.5	65.9	59.9	58.4	54.5	59.1
Riparian Condition ⁷	7.4	5.4	7.6	9.2	9.4	8.8	3.5	7.7	6.8
Riparian Area (ha)	3.61	24.66	6.27	4.65	9.91	12.47	10.96	3.11	75.64 total

¹ = <15 Good; 16-25 Fair; >26 Poor

² = >70% Good; 40-69% Fair; <39% Poor

³ = >80% Good; 40-79% Fair; <39% Poor

⁴ = <25% Good; 26-50% Fair; >51% Poor

⁵ = >60% Good; 40-59% Fair; <39% Poor

⁶ = <45% Good; 46-59% Fair; >60% Poor

⁷ = 9-12 Mod. High - High; 6-8 Moderate; 0-5 Low - Mod. Low

range of 190 to 279mm in length. The 1336 speckled dace captured during electroshocking efforts, ranged in length from 20 to 129mm. There were 90 Gila Mountain suckers captured on the West Fork in 1996. They ranged in length from 40 to 390mm. A total of 69 Gila suckers were captured during this survey, ranging in length from 40 to 369mm. There were 1033 brown trout and 5 rainbow trout captured during this survey of the West Fork of the Black River (Appendix B, Figures B-1 to B-25). Occurrence records have been filed with the Arizona Game and Fish Department Heritage Data Management System Coordinator.

Mineral Creek

Mineral Creek has been surveyed twice prior to the 1996 survey using GAWS methodology. The 1986 survey of Mineral Creek was the first time GAWS methodology was used on the Forests. The 1986 survey used 167 meter station lengths. The survey was conducted by Arizona Game & Fish Department (Pinetop) and Forest Service personnel. In 1991, the survey was repeated, using 100 meter station lengths. The 1996 survey used the same station locations and station lengths, and the same methodology applied in the 1991 survey.

Approximately 35 instream habitat improvement structures were placed in Mineral Creek between 1989 and 1992 (USFS 1990). The objectives of the improvement project was to: stabilize banks, reduce stream width-to-depth ratios and braiding, increase pool to riffle ratios, and increase stream cover. The majority of these structures were constructed in reach 1. Mineral Creek was divided into three reaches. There are six sampling stations on the Creek, each 100 meters in length. Reach 1 had four sampling stations, and reaches 2 and 3 had one sampling station each (Appendix A, Figures A-3 and A-4).

Table 4. Number, relative abundance, relative biomass, and catch per unit effort, of fish sampled by electrofishing at West Fork of the Black River in 1996.

Reach Number	Species Sampled	No. Sampled	Percent of Total	Catch Per Effort	Weight Sampled (g)	Percent of Total	Size Range (mm)
1	PACL	35	9.5	23.3	112	46.9	40-339
	CAIN	5	1.4	3.3	9	3.8	50-309
	RHOS	123	33.5	82.0	118	49.3	30-109
	SATR	204	55.6	136.0	NOT	WEIGHED	0-9
	TOTAL	367	100.0	244.6	239	100.0	---
2	PACL	16	5.0	8	1569	26.6	40-119
	CAIN	12	3.7	6	1075	18.2	40-369
	RHOS	282	87.9	141	2749	46.6	30-99
	SATR	10	3.1	5	405	6.9	40-339
	ONAP	1	0.3	0.5	97	1.7	220
	TOTAL	321	100.0	160.5	5895	100.0	---
3	PACL	1	0.2	0.33	61	1.0	160
	CAIN	10	1.7	3.33	1352	23.4	100-369
	RHOS	524	87.9	174.7	699	12.1	20-109
	SATR	37	6.2	12.3	1715	29.7	50-269
	ONAP	19	3.2	6.3	1732	29.9	190-269
	ONMY	5	0.8	1.7	225	3.9	140-179

Reach Number	Species Sampled	No. Sampled	Percent of Total	Catch Per Effort	Weight Sampled (g)	Percent of Total	Size Range (mm)
	TOTAL	596	100.0	198.7	5784	100.0	---
4	CAIN	1	0.7	0.7	80	3.9	189
	RHOS	126	85.1	84.0	302	14.7	30-109
	SATR	21	14.2	14.0	1671	81.4	50-289
	TOTAL	148	100.0	98.7	2053	100.0	---
5	PACL	30	12.05	10.0	8139	44.4	149-390
	CAIN	21	8.43	7.0	4812	26.3	130-349
	RHOS	49	19.68	16.3	166	0.9	30-99
	SATR	149	59.84	49.7	5206	28.4	30-279
	TOTAL	249	100.0	83	18323	100	---
6	PACL	7	1.4	2.8	NOT WEIGHED	SCALE BROKEN	90-309
	CAIN	20	4.1	8.0	---	---	90-309
	RHOS	135	27.6	54.0	---	---	30-129
	SATR	258	52.8	103.2	---	---	50-279
	ONAP	69	14.1	27.6	---	---	210-279
	TOTAL	489	100.0	195.6	---	---	---
7	PACL	1	0.45	0.4	NOT WEIGHED	SCALE BROKEN	119
	RHOS	97	43.89	38.8	---	---	40-99
	SATR	123	55.66	49.2	---	---	60-239
	TOTAL	221	100.0	88.4	---	---	---
8	SATR	231	100	77	NOT WEIGHED	WEIGHED	30-249

PACL = *Pantosteus clarki*
CAIN = *Catostomus insignis*
RHOS = *Rhynchithys osculus*
SATR = *Salmo trutta*
ONAP = *Oncorhynchus apache*
ONMY = *Oncorhynchus mykiss*

Water Chemistry

A water analysis was conducted at the same time GAWS surveys were completed. The water samples were analyzed in the field at the last station of every reach (Table 5). The samples were analyzed for total alkalinity, sulphate, specific conductivity, and pH levels.

Table 5. Water Chemistry Results from Mineral Creek, 1996.

Station	1-4	2-5	3-6	Average
Date	07/30/96	07/31/96	07/31/96	---
Time	1335	0850	1100	---
Water Temp (EC)	20	17	20	19

Station	1-4	2-5	3-6	Average
pH	7.98	8.06	8.31	8.1
Alkalinity (mg/l)	0	0	0	0
Sulphate (mg/l)	400	400	400	400
Specific Conductance (Fmhos/cm at 25EC)	110	80	80	90

Habitat

Reach 1 is a moderate gradient meadow reach. The average bank cover, soil stability, and vegetation ratings were excellent (Table 6). This reach had an embeddedness rating of 71.2% which is unsatisfactory (Figure 9 and Table 6). There were very few pools noted in this reach. Station F1-1 is the only station where a pool was measured. The pool structure rating for that station was 100%, which means that the pool had excellent characteristics (i.e., cover, depth, etc.). The average HCI for this reach in 1996 was 64.3%, which is above the Forests minimum standard (60%). The average HCI for this reach in 1991 was 61.4% and it was 53.8% in 1986 (Tables 6, 7, and 8). Figure 10 displays a comparison of the habitat parameter ratings for the three survey years. The riparian area for this reach was 3.3 hectares (8.2 acres), and had an average riparian condition rating of 10, which is satisfactory (Table 6). Reach 1 is excluded from livestock grazing. There are three livestock drinkers along this reach for which water is piped out of Mineral Creek. Excess water from the drinkers is piped back to the creek.

Reach 2 is a high gradient canyon reach. This reach also had high embeddedness ratings (68.0%, see Figure 9). There were no pools measured in this reach. Pool structure and pool measure ratings were zero (Figure 11 and Table 6). Bank soil stability and vegetation stability ratings were excellent (Table 65). The mean HCI for this reach in 1996 was 51.7% (Table 6). In 1991 the HCI was 44.2% (Table 7). In 1986, the mean HCI for this reach was 23.9% (Table 8). Figure 11 is a comparison of the habitat parameter ratings for the three survey years. This reach has also been excluded from livestock grazing. Dense aquatic vegetation was noted in this

reach.

Reach 3 is a moderate gradient meadow reach. The canopy density and embeddedness ratings for this reach were unsatisfactory (Table 6). There were no pools measured in this reach. Bank cover, soil stability, and vegetation stability ratings were all satisfactory. The HCI for Reach 3 in 1996 was substandard (51.9%; Table 6). In 1986, the HCI for this reach was only 13.5% (Table 7), and in 1991 the HCI was 56.8% (Table 8). Between the 1991 and 1996 survey years, the habitat parameter ratings that showed decreases were: pool measure, soil stability, and vegetation stability (Figure 12). The riparian area for this reach was 1.2 hectares (2.9 acres) and in satisfactory condition (Table 6). This reach is also excluded from livestock grazing.

Fish Population

During electroshocking efforts at Mineral Creek in 1996, ten Apache trout were captured. The fish were only caught in Reach 1 and 2. Occurrence records are on file with the Arizona Game and Fish Department Heritage Data Management System Coordinator. The fish ranged in length from 88 to 156mm. The fish were not weighed because the portable scale was broken at the time of survey.

Table 6. A summary of habitat conditions at Mineral Creek, 1996.

Stream Reach	1	2	3	Stream Average or Total
Reach Length (m)	3301	925	786	5012 total
Reach Area (m ²)	295.5	141.5	257.5	694.5 total
Number of Stations	4	1	1	6 total
Elevation (m)	2423	2530	2570	2508
Gradient (%)	4.5	8.4	3.7	5.5
Riffle (%)	71.1	56.3	31.7	53.0
Potential Spawning Area (PSA%)	51.2	26.8	36.7	38.2
Potential Rearing Area (PRA%)	4.1	0	0	1.4
Channel Width (m)	5.5	8.7	7.5	7.2
Water Width (m)	1.9	3.7	6.4	4
Water Depth (m)	0.06	0.04	0.04	0.05

Stream Reach	1	2	3	Stream Average or Total
Water Width/Depth Ratio ¹	31.7	92.5	160	94.7
Pool Measure (%) ²	8.8	0	0	2.9
Pool Structure (%) ²	25.0	0	0	8.3
Gravel Bottom (%) ²	62.1	62.8	46.4	57.1
Bank Cover (%) ²	98.8	65.0	82.5	82.1
Bank Soil Stability (%) ³	95.6	92.5	92.5	93.5
Bank Vegetation Stability (%) ³	95.6	90.0	90.0	91.9
Canopy Density (%) ³	45	51	48	48
Ungulate Damage (%) ⁴	0	0	0	0
Embeddedness (%) ⁴	71.2	68.0	72.0	70.4
Habitat Condition Index (HCI%) ⁵	64.3	51.7	51.9	56
Habitat Vulnerability Index (HVI%) ⁶	54.3	55.9	53.6	54.6
Riparian Condition ⁷	10	9	9	9.3
Riparian Area (ha)	3.3	1.4	1.2	5.9

¹ = <15 Good; 16-25 Fair; >26 Poor

² = >70% Good; 40-69% Fair; <39% Poor

³ = >80% Good; 40-79% Fair; <39% Poor

⁴ = <25% Good; 26-50% Fair; >51% Poor

⁵ = >60% Good; 40-59% Fair; <39% Poor

⁶ = <45% Good; 46-59% Fair; >60% Poor

⁷ = 9-12 Mod. High - High; 6-8 Moderate; 0-5 Low - Mod. Low

Table 7. A summary of habitat conditions at Mineral Creek, 1991.

Stream Reach	1	2	3	Stream Average or Total
Reach Length (m)	3301	925	786	5012 total
Reach Area (m ²)	295.5	141.5	257.5	694.5 total
Number of Stations	4	1	1	6 total
Elevation (m)	2423	2530	2570	2508
Gradient (%)	5	7.4	2.0	4.8
Riffle (%)	78.4	60.0	70.6	69.7
Potential Spawning Area (PSA%)	0	26.9	32.1	19.7
Potential Rearing Area (PRA%)	0	0	17.1	5.7
Channel Width (m)	6.0	12.5	18.2	12.2
Water Width (m)	2.4	5.2	4.4	4
Water Depth (m)	0.09	0.07	0.05	0.07
Water Width/Depth Ratio ¹	27	74	88	63
Pool Measure (%) ²	24.3	0	33.9	19.4
Pool Structure (%) ²	38.4	0	0	12.8
Gravel Bottom (%) ²	67.3	42.7	36.7	48.9
Bank Cover (%) ²	86.3	72.5	70.0	76.3
Bank Soil Stability (%) ³	71.9	75.0	100	82.3
Bank Vegetation Stability (%) ³	80.0	75.0	100	85
Canopy Density (%) ³	67.8	64.0	39	56.9
Ungulate Damage (%) ⁴	28.1	0	0	9.4
Embeddedness (%) ⁴	42.0	40.0	52.0	44.7
Habitat Condition Index (HCI%) ⁵	61.4	44.2	56.8	54.1
Habitat Vulnerability Index (HVI%) ⁶	50.8	51.4	62.7	54.7
Riparian Condition ⁷	7.5	6	10	7.8
Riparian Area (ha)	3.6	1.8	2.3	7.7 total

¹ = <15 Good; 16-25 Fair; >26 Poor

² = >70% Good; 40-69% Fair; <39% Poor

³ = >80% Good; 40-79% Fair; <39% Poor

⁴ = <25% Good; 26-50% Fair; >51% Poor

⁵ = >60% Good; 40-59% Fair; <39% Poor

⁶ = <45% Good; 46-59% Fair; >60% Poor

⁷ = 9-12 Mod. High - High; 6-8 Moderate; 0-5 Low - Mod. Low

Table 8. A summary of habitat conditions at Mineral Creek, 1986.

Stream Reach	1	2	3	Stream Average or Total
Reach Length (m)	3301	925	786	5012 total
Reach Area (m ²)	295	141.5	257.5	694 total
Number of Stations	4	1	1	6 total
Elevation (m)	2423	2530	2570	2508
Gradient (%)	2.9	8.0	3.7	4.9
Riffle (%)	31.1	22.7	31.0	28.3
Potential Spawning Area (PSA%)	54.6	62.5	27.4	48.2
Potential Rearing Area (PRA%)	58.9	8.0	7.1	24.7
Channel Width (m)	4.9	1.3	1.6	2.6
Water Width (m)	3.1	1.3	1.2	1.9
Water Depth (m)	0.11	0.02	0.02	0.05
Water Width/Depth Ratio ¹	28	65	60	51
Pool Measure (%) ²	74.2	15.9	14.3	34.8
Pool Structure (%) ²	0	0	0	0
Gravel Bottom (%) ²	54.4	73.9	27.4	51.9
Bank Cover (%) ²	80.6	14.3	14.3	36.4
Bank Soil Stability (%) ³	55.6	21.4	12.5	29.8
Bank Vegetation Stability (%) ³	58.1	17.9	12.5	29.5
Canopy Density (%) ³	37.5	4	0	13.8
Ungulate Damage (%) ⁴	50.0	80.4	91.1	73.8
Embeddedness (%) ⁴	68.0	85.7	91.4	81.7
Habitat Condition Index (HCI%) ⁵	53.8	23.9	13.5	30.4
Habitat Vulnerability Index (HVI%) ⁶	69.7	53.25	71.8	64.9
Riparian Condition ⁷	DATA	NOT	AVAIL-	ABLE
Riparian Area (ha)	2.6	0.3	0.39	3.29 total

¹ = <15 Good; 16-25 Fair; >26 Poor

² = >70% Good; 40-69% Fair; <39% Poor

³ = >80% Good; 40-79% Fair; <39% Poor

⁴ = <25% Good; 26-50% Fair; >51% Poor

⁵ = >60% Good; 40-59% Fair; <39% Poor

⁶ = <45% Good; 46-59% Fair; >60% Poor

⁷ = 9-12 Mod. High - High; 6-8 Moderate; 0-5 Low - Mod. Low

Only seven Apache trout were captured in the 1985 survey at five, 100 meter stations. Fish sampled in 1985 ranged in length from 75 to 235mm. In 1991, six Apache trout were captured in six, 100 meter stations (same stations as the 1996 survey). These fish ranged in length from 134 - 241mm.

Table 9. Number, relative abundance, relative biomass, and catch per unit effort, of fish sampled by electrofishing at Mineral Creek in 1996.

Reach Number	Species Sampled	Number Sampled	Percent of Total	Catch Per Effort	Weight Sampled (g)	Percent of Total	Size Range (mm)
1	ONAP	4	100	1	NOT	WEIGHED	98-138
2	ONAP	6	100	6	NOT	WEIGHED	88-156

ONAP = *Oncorhynchus apache*

Discussion

The West Fork of the Black River is a wide shallow stream with a mean water width of 5.5 meters (18.04 feet), a mean water depth of 0.14 meters (0.46 feet), and a mean width to depth ratio of 38.3. The average stream gradient was 1.7 percent. The average embeddedness of this stream was 36.4% (Table 2). Ungulate damage ratings averaged 12.8%, which is good. The estimated riparian area of the Forests=portion of the West Fork of the Black River was 92.4 hectares (232 acres). The overall riparian condition rating was 9 which is satisfactory.

As mentioned previously, many management changes have occurred in the West Fork of the Black River watershed since the last survey in 1990. Range management was changed with an objective to increase riparian condition. Roads were closed and obliterated to decrease soil erosion. Over 140 instream habitat improvement structures and several fish migration barriers were constructed in these recently stocked Apache trout waters. Most of the structures are located in reaches 6, 7 and 8 of the West Fork of the Black River. The two fish migration barriers and one barrier on Stinky Creek are located in (or adjacent to) Reach 6. The HCI= for reaches 5, 6 and 8 of the West Fork of the Black River decreased. This was mainly due to decreases in pool measure and structure ratings. There are many pools located throughout this

reach that were not part of the sample and this is not considered a serious problem at this time. Only three of the eight reaches surveyed had HCI's below the Forests minimum standard of 60% - reaches 1, 2 and 8. The HCI's in these reaches were all above 57% and the HCI's in reaches 1 and 2 do reflect an improvement in fish habitat condition from 1990. Reaches 1, 2 and 3 are on the Alpine Ranger District. The grazing allotments that affect these reaches are currently undergoing analysis for new Allotment Management Plans. A large portion of reach 2 is on the AGFD PS Ranch. The riparian condition on this reach and the reach downstream from it (reach 1) shows need for improvement. The large willow populations that have occurred in this area are decreasing, most likely a result of significant beaver activity and large wild ungulate use (cattle do not graze the PS Ranch). Since the PS Ranch area is not under the management jurisdiction of the Forest Service, it is recommended that an Arizona Game & Fish Department Habitat Specialist visit the area to determine Department management activities that would help improve the riparian condition of the PS Ranch area.

Mineral Creek is a shallow stream with an average width of 4.0 meters (13.1 feet), a mean water depth of 0.05 meters (0.2 feet), and an average width to depth ratio of 94.7. The average stream gradient was 5.5%. Mineral Creek supports a riparian area that was 5.9 hectares (14.5 acres). The overall riparian condition rating was 9.3, which is satisfactory. Mineral Creek is very embedded. The mean embeddedness rating for the creek was 70.4%.

Mineral Creek has undergone several management changes between 1986 and 1996, most being livestock management changes. In 1986 and prior to that, livestock had access to all reaches surveyed. By 1991 some of the reaches had been exclosed from livestock use and some were incorporated into riparian pastures. By the end of 1996 all reaches of Mineral Creek had been excluded from livestock use. Permitted numbers of livestock grazing in this allotment have been reduced.

The major habitat parameters affecting low HCI's on Mineral Creek are pool measure and structure. A serious problem that has been noted in this stream, since it has been surveyed, is embeddedness. The percent embeddedness did go down between 1986 and 1991, but it

increased again by 1996. A large flood event may wash some of the sediment out of the system.

All of the current management activities on the upper West Fork of the Black River watershed and Mineral Creek have been implemented to protect and improve habitat for the Apache trout. It is recommended that these streams be resurveyed in 2001 using GAWS or newer methodology to determine the habitat condition trend in these streams. It is also recommended that the fish populations be monitored periodically to determine the effectiveness of the barriers on both streams. It is also recommended that the Arizona Game and Fish Department actively enforce the catch and release fishing regulations implemented on these streams.

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Glossary

Bank Angle - The average of angles formed between the downward sloping stream banks and the water surface. If the stream bank is undercut, the angle is always less than 90 degrees, otherwise the angle is 90 degrees or greater. Valuable rearing habitat is lost if the bank has been cut away and moved back from the water column. Fish often congregate near undercuts and vertical banks.

Bank Cover - A rating of stream bank vegetation types. Brush is considered optimal and assigned the highest rating of 4. Forested is rated 3, grass and forbes is rated a 2, and exposed (rock or soil) is assigned the lowest rating of 1. The ratings are converted to a percentage of the maximum possible.

$$\text{Bank Cover\%} = \frac{\text{Sum of all bank cover ratings}}{8 \times \text{number of transects}} \times 100$$

Bank Soil Stability - A rating of the stream banks soil characteristics and ability to resist erosion. Plant density, rootmass, particle size composition, rawbanks and extent of erosion are considered in the rating of each bank. The ratings are converted to a percentage of the maximum possible.

$$\text{Bank Soil Stability \%} = \frac{\text{Sum of all soil stability ratings}}{8 \times \text{number of transects}} \times 100$$

Bank Vegetation Stability - A rating of the stream banks vegetation density and ability to resist erosion. Stream bank vegetation provides cover shade and a terrestrial food source for fish, as well as rootmass and soil cover to resist erosion from flowing water. The ratings are converted to a percentage of the maximum possible.

$$\text{Vegetation stability\%} = \frac{\text{Sum of vegetation stability ratings}}{8 \times \text{number of transects}} \times 100$$

Canopy Density - The percentage of sky over the stream channel which is blocked out by vegetation. A canopy provides shading of the stream which helps prevent water temperatures from increasing to critical levels for trout. Leaf drop in the fall can be a major energy source to the streams aquatic food web when a healthy canopy is made up of deciduous trees and shrubs.

Embeddedness - A rating of the amount of surface area of large size particles (gravel, rubble, and boulder) on the stream bottom which is covered by fine sediments. High silt levels inhibit successful spawning of trout, production of stream bottom macroinvertebrates and primary production of attached algae by covering rocky substrate. High embeddedness is also an indicator of unstable conditions upstream. The ratings are converted to a percentage of the maximum possible.

$$\text{Embeddedness \%} = \frac{\text{Sum of all embeddedness rating}}{5 \times \text{number of transects}} \times 100$$

Gravel Bottom - (stream bottom) The percentage of the stream bottom composed of gravel and rubble. These size particles are necessary for spawning and are the most productive in producing food (aquatic macroinvertebrates) for fish.

$$\text{Gravel bottom \%} = \frac{\text{Sum of gravel and rubble measurements}}{\text{Sum of water widths}} \times 100$$

HCI - (Habitat Condition Index) is a multi variate rating of existing trout habitat quality. It is computed using pool measure (PM), pool structure (PS), gravel bottom (GB), bank cover (BC), bank soil stability (BSS), and bank vegetation stability (BVS) ratings. The HCI increases as habitat quality increases.

$$\text{HCI \%} = \frac{\text{PM} + \text{PS} + \text{GB} + \text{BC} + \text{BSS} + \text{BVS}}{6} \times 100$$

HVI - The Habitat Vulnerability Index is a rating that predicts the vulnerability of stream habitat to management activities and natural occurrences. It is computed using valley bottom width (VWC), stream gradient (SGC), side slope gradients (SSC), lower banks type (LBC), bank stability (CSC), and indicators of potential sediment production (SPC) coefficients. The HVI increases as the streams susceptibility to damage increases.

$$\text{HVI \%} = \frac{\text{VWC} + \text{SGC} + \text{SSC} + \text{LBC} + \text{CSC} + \text{SPC}}{3 + 4 + 4 + 3 + 4 + 4}$$

Pool Measure - A rating of the pool - riffle ratio of the sample area. A fifty-fifty pool-riffle ratio is assumed to be the most productive. Pools provide resting and rearing habitat for fish, whereas riffles produce food and support trout spawning. The pool measure rating decreases as the pool-riffle ration deviates either direction from a fifty-fifty ratio.

$$P = \frac{\text{Total pool widths}}{\text{Total water widths}} \times 100$$

where P = 50, the rating is 100%

where P < 50, solve

$$\text{Pool measure \%} = 100 - [(50-P) \times 2]$$

where P > 50, solve

$$\text{Pool measure \%} = 100 - [(P-50) \times 2]$$

Pool Structure - A rating of pool quality which reflects the percentage of high-rated pool widths out of the total pool widths measured. Pools are rated by size, depth, and fish cover available. A good relationship exists between high quality pools and high fish standing crops.

$$\text{Pool structure \%} = \frac{\text{Total 1, 2, and 3 rated pools}}{\text{Total of all pools}} \times 100$$

PRA - Potential Rearing Area is the percentage of stream area with water velocities < 1 foot per second (pools). Small trout require these pools for rearing.

PSA - Potential Spawning Area is the percentage of stream bottom area composed of 1/8" to 3" diameter gravel. Trout require these gravels for spawning and embryo incubation.

Riffles - The percentage of stream area where water velocity is fast, stream depth is shallow and water surface gradient is steep. Riffles are the food (aquatic macroinvertebrate and periphyton) producing areas of a stream.

Riparian Condition - A rating of existing riparian conditions using the USFS Region 3 Riparian scorecard. Overstory, midstory, and understory conditions are all rated. Riparian vegetation is important in stabilizing stream banks, filtering eroded soil, blocking solar radiation, providing cover and a source of terrestrial insects for fish as well as providing organic input to the stream's aquatic food web.

Shore Depth - The average of water depths measured at the shoreline or at the edge of a bank overhanging the shoreline. Shore depth is critical for young-of-the-year fish. Valuable rearing habitat is lost when the banks have been cut away and there is zero shore depth.

Stream Channel Stability - A rating of 15 parameters describing upperbank, lowerbank, and stream bottom characteristics and stability. There has been a good relationship between these ratings and resident trout standing crops.

Undercut banks - The average of all undercut widths (the distance from the furthest point of protrusion of the bank to the furthest undercut of the bank) measured at each station. If no undercut is present at the transect, the undercut measurement is recorded as a zero. Undercut banks provide valuable cover for fish and provide conditions favorable to producing high trout biomass.

Ungulate Damage - A rating of observed bank damage caused by ungulates including trampling, removal of stream bank riparian vegetation, sloughing and bank erosion. The ratings are converted to a percentage of the maximum possible. Excessive ungulate damage destroys riparian vegetation, causes bank sloughing, increases sedimentation and embeddedness, causes the stream to widen and shallow resulting in an increase of water temperature.

APPENDIX A
MAPS
AND
STATION LOCATIONS

Figure A-1. West Fork of the Black River, GAWS Station Locations.

Reach 1	Station 1-1	100	Meters Upstream of Confluence
Reach 1	Station 1-3	790	Meters Upstream of Confluence
Reach 1	Station 1-5	1480	Meters Upstream of Confluence
Reach 2	Station 2-6	1740	Meters Upstream of Confluence
Reach 2	Station 2-11	4315	Meters Upstream of Confluence
Reach 2	Station 2-13	5345	Meters Upstream of Confluence
Reach 2	Station 2-15	6375	Meters Upstream of Confluence
Reach 3	Station 3-16	6575	Meters Upstream of Confluence
Reach 3	Station 3-18	7115	Meters Upstream of Confluence
Reach 3	Station 3-20	7655	Meters Upstream of Confluence
Reach 3	Station 3-21	7925	Meters Upstream of Confluence
Reach 3	Station 3-23	8465	Meters Upstream of Confluence
Reach 3	Station 3-25	9005	Meters Upstream of Confluence
Reach 4	Station 4-26	9300	Meters Upstream of Confluence
Reach 4	Station 4-28	9900	Meters Upstream of Confluence
Reach 4	Station 4-30	10500	Meters Upstream of Confluence
Reach 5	Station 5-31	10710	Meters Upstream of Confluence
Reach 5	Station 5-33	12240	Meters Upstream of Confluence
Reach 5	Station 5-35	13770	Meters Upstream of Confluence
Reach 5	Station 5-36	14535	Meters Upstream of Confluence
Reach 5	Station 5-38	16065	Meters Upstream of Confluence
Reach 5	Station 5-40	17595	Meters Upstream of Confluence
Reach 6	Station 6-41	17790	Meters Upstream of Confluence
Reach 6	Station 6-43	18310	Meters Upstream of Confluence
Reach 6	Station 6-45	18830	Meters Upstream of Confluence
Reach 6	Station 6-46	19260	Meters Upstream of Confluence
Reach 6	Station 6-48	20120	Meters Upstream of Confluence
Reach 6	Station 6-50	20980	Meters Upstream of Confluence
Reach 7	Station 7-53	22670	Meters Upstream of Confluence
Reach 7	Station 7-55	23250	Meters Upstream of Confluence
Reach 7	Station 7-56	23540	Meters Upstream of Confluence
Reach 7	Station 7-58	24120	Meters Upstream of Confluence
Reach 7	Station 7-60	24700	Meters Upstream of Confluence
Reach 8	Station 8-61	24900	Meters Upstream of Confluence
Reach 8	Station 8-63	25620	Meters Upstream of Confluence
Reach 8	Station 8-65	25620	Meters Upstream of Confluence
Reach 8	Station 8-66	25800	Meters Upstream of Confluence
Reach 8	Station 8-68	26160	Meters Upstream of Confluence
Reach 8	Station 8-70	26520	Meters Upstream of Confluence

Figure A-3. Mineral Creek, GAWS station locations.

Reach 1	Station 1-1	61	Meters above fish barrier
Reach 1	Station 1-2	1248	Meters above fish barrier
Reach 1	Station 1-3	2015	Meters above fish barrier
Reach 1	Station 1-4	2751	Meters above fish barrier
Reach 2	Station 2-5	3301	Meters above fish barrier
Reach 3	Station 3-6	4287	Meters above fish barrier

Appendix B:

Charts

Appendix C:
Photographs