Panchuela Watershed

Stream Inventory Report

Santa Fe National Forest

Surveyed: June – September 2004

Forest Fisheries Crew

Report By

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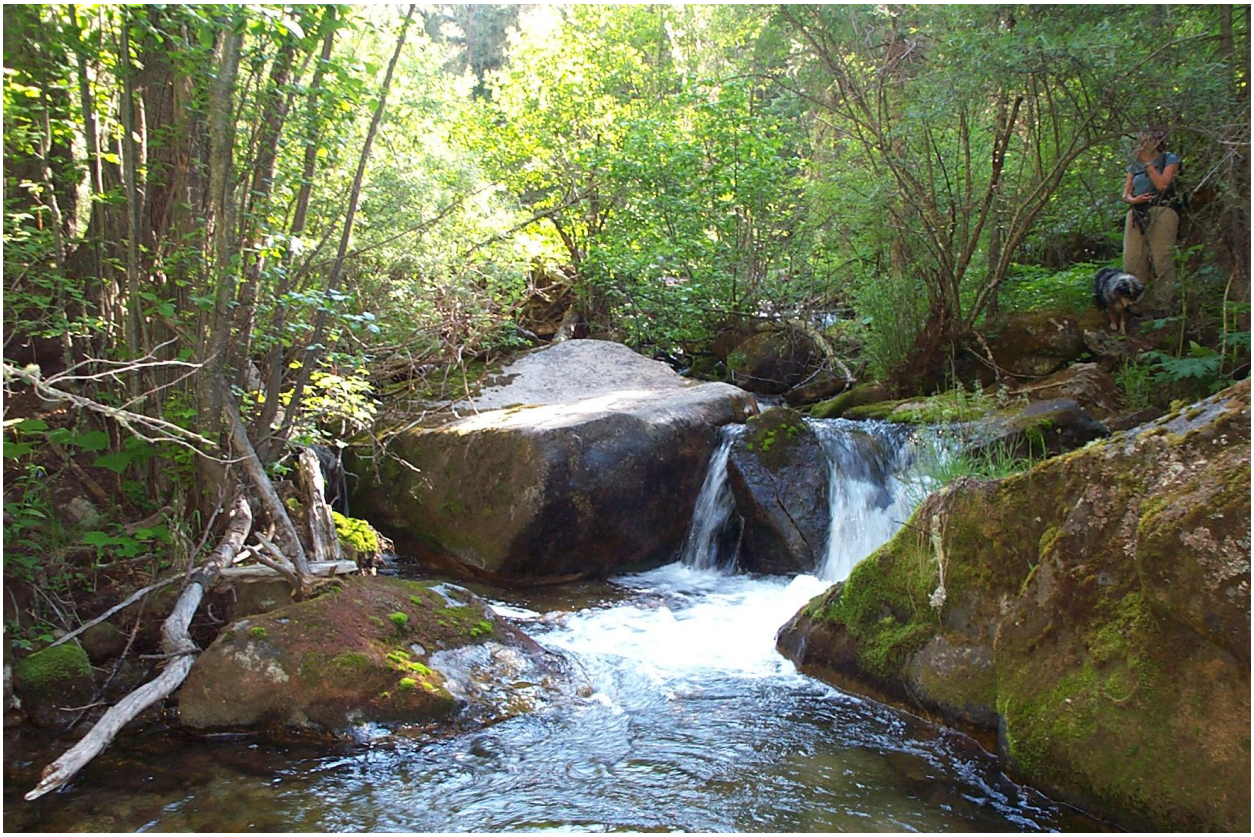

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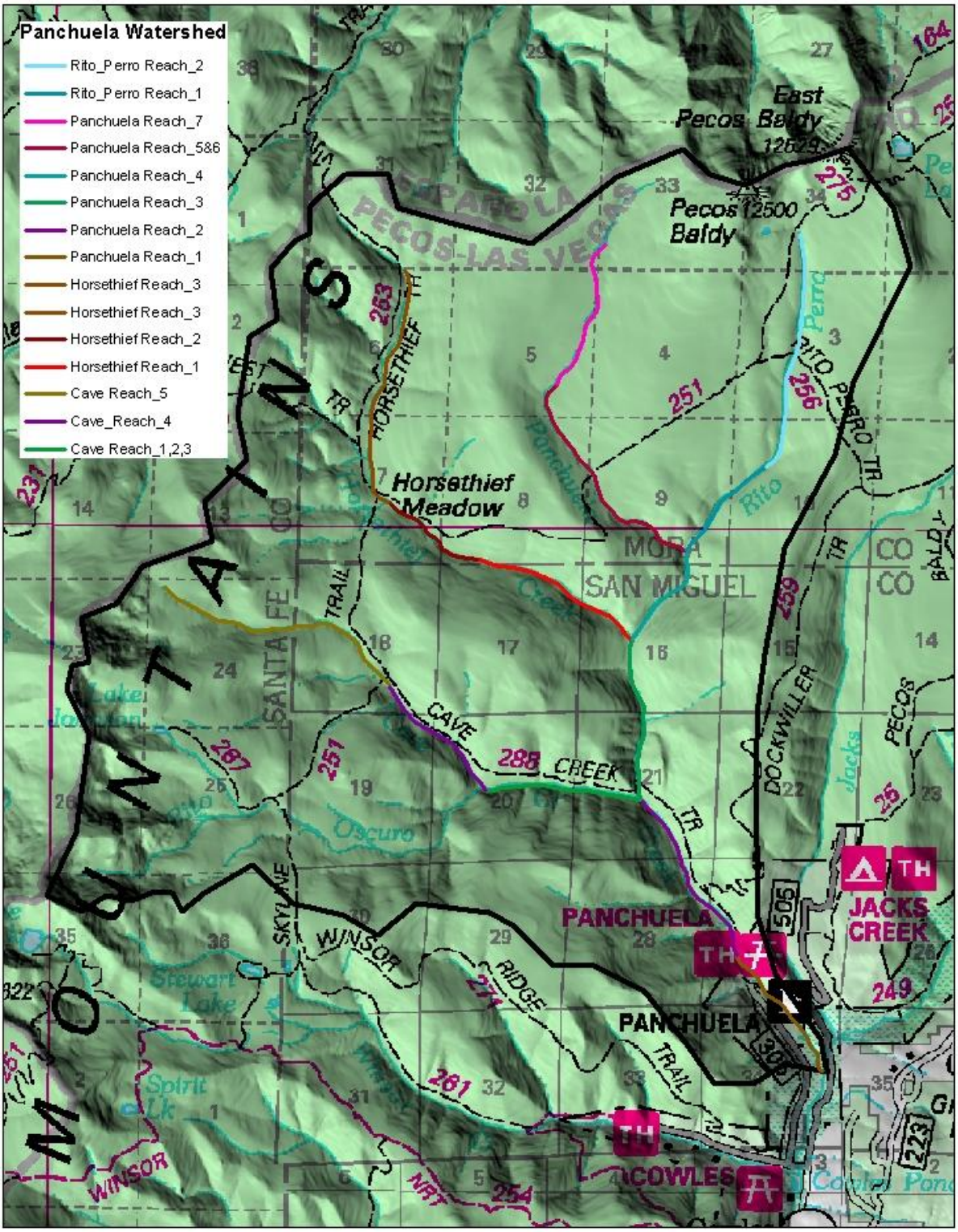
Panchuela Watershed Survey - 2004



This document is a specialist report. It is meant to assist managers in understanding current conditions of a stream corridor and possibly how those conditions have developed over a period of time. Recommendations are drawn up emphasizing the aquatic resource, although the accomplishment of multiple use is considered within those recommendations.

Readers should note that there is some amount of repetition in this document. The author assumes that readers may only read certain sections; therefore, points or observations may be repeated. A glossary is provided at the end of document to help the reader think like a fish biologist. In addition, appendices provide greater detail on certain data points.

INTRODUCTION
Panchuela Watershed 2004 Stream Survey

The Panchuela Watershed is a moderate-sized watershed contributing flow to the Pecos Headwaters and originates in the Pecos Wilderness rimmed by the flanks of Santa Fe Baldy, Redondo Peak and Pecos Baldy (elev. 12,500'). The drainage generally drains south and east with major tributaries that include Panchuela Creek, Rito Perro, Horsethief Creek, Cave Creek, and Rito Oscuro. The streams originate as a series of seeps and springs draining off the eastern slopes of the Sangre de Cristo Mountains. The streams combine to form Panchuela Creek which joins the Panchuela Watershed near the community of Cowles where the Pecos is a Wild and Scenic River. Santa Fe National Forest Fisheries Program conducted a stream survey on all named tributaries in the watershed (minus Rito Oscuro) during the summer of 2004. A total of 18.6 miles of stream was surveyed, from the mouth of all streams up to the headwaters.

The USDA Forest Service Region 3 stream survey protocol is a modified version of the Hankins/Reeves survey used in the Pacific Northwest Region. Under this protocol, streams are surveyed from the mouth upstream and the river is separated into riffle, pool, side channel, dry channel, culvert, and falls habitat types by specific attributes (USFS 2004). Different habitat types require specific measurements relevant to evaluating the habitat (Appendix A, Table 1). In addition to the habitats located in the primary stream, tributary mouths are also surveyed and classified as a seep, spring, or stream (Appendix C). All habitat types are assigned a Natural Sequence Order number (NSO) in the order that they are surveyed. The stream, as a collection of NSOs, is further organized by homogeneous sections and grouped into a sequence of reaches. Each reach is assigned a number in the order that it is surveyed and analyzed separately, as well as together for a holistic overview of the system.

A matrix of factors and indicators was developed to relate stream habitat information into an easily understood habitat condition classification of properly functioning, at risk, or not properly functioning. The matrix originally was developed in the Pacific Northwest by US Fish & Wildlife Service and NOAA Fisheries, but was modified for mountain streams in the intermountain west and relates to regulations determined by New Mexico Environment Department (NMED). The matrix was further refined to incorporate geology of streams historically occupied by Rio Grande cutthroat trout (see Table 1).

Snorkel surveys are another aspect of the stream inventory incorporated for understanding fish populations. Snorkel surveys evaluate fish species presence/absence, distribution within the system, relative composition, and size class analysis in selected areas of the stream. Snorkel protocol involves surveying upstream in one hundred meter transects and classifying fish that pass downstream. Fish species are identified, placed into size categories and counted by the

surveyor. Ideally, a snorkel survey includes 10-100 meter transects (totaling 1 kilometer), but are occasionally composed of less (USFS 2004).

Table 1. Matrix of factors and indicators of habitat condition for historic and currently occupied Rio Grande cutthroat trout (RGCT) streams as related to R3 Stream Habitat Inventory.

FACTORS	INDICATORS	Properly Functioning	At Risk	Not Properly Functioning
Water Quality	***Temperature – State of New Mexico Standards***	**Fully Supporting** <73.4°F at one time; or ≤ 68°F for 4 consecutive hours over 4 consecutive days		**Non Supporting** ≥ 73.4°F at one time; or > 68°F for 4 consecutive hours over 4 consecutive days
	Temperature – Salmonid Development	≤17.8°C (64°F) (7 day avg. max)	>17.8º (64ºF) < 21.1º (70ºF) (7 day avg. max)	≥21.1ºC (70ºF) (7 day avg. max)
Habitat Characteristics	**Sediment**	<20% fines (sand, silt, clay) in riffle habitat. Fine sediment within range of expected natural streambed conditions		≥20% fines (sand, silt, clay) in riffle habitat. Fine sediment outside of expected natural streambed conditions.
	Large Woody Debris[1]	>30 pieces per mile, >12" diameter, > 35 feet (or twice bankfull width) in length	20-30 pieces per mile, >12" diameter, > 35 feet (or twice bankfull width) in length	<20 pieces per mile, >12" diameter, > 35 feet (or twice bankfull width) in length
	Pool Development[2]	≥30% pool habitat by area[3]		<30% pool habitat by area[3]
	Pool Quality	Average residual pool depth ≥1 foot		Average residual pool depth <1 foot
Channel Condition and Dynamics	**Width/Depth Ratios by Channel Type** *(utilize Rosgen type[4] and range given if applicable)*	Width/depth ratios and channel types within natural ranges and site potential		Width/depth ratios and channel types are well outside of historic ranges and/or site potential
		Expected range of bankfull width/depth ratios and channel type	**Rosgen Type[4]** A, E, G B, C, F D	**W/D Ratio** <12 12-30 >40
	Stream Bank Condition[5]	<10% unstable banks (lineal stream bank distance)	10-20% unstable banks (lineal stream bank distance)	>20% unstable banks (lineal stream bank distance)

[1] Large Woody Debris numeric are not applicable in meadow reaches. For this survey a meadow reach can be defined as an area where there is no natural local recruitment of LWD.
[2] Pool Development numeric are applicable to 3rd order or larger streams.
[3] Area is defined by habitat length.
[4] Rosgen stream typing is used throughout this document to determine stream channel type, condition, and dynamics (Rosgen and Silvey 1998).
[5] Stream Bank Condition numeric are not applicable in reaches with > 4% gradient.

Global positioning system (GPS) units are utilized for survey data collection. Trimble GeoExplorer 3 units are used to identify specific features throughout the survey (Appendix A, Table 2). The GPS feature locations are then transferred into a geographical information system (GIS) layer and used to provide graphical representations and spatial analysis of river attributes.

The primary objectives of the Region 3 Hankins/Reeves survey include the compilation of historical information and in-stream habitat data to assist in proper management decisions of the surveyed stream and its watershed. The historical information provides a background of land use and management techniques collected from the Forest Service and a variety of other sources. Previous land use and management practices reflect on the current condition of environmental systems. Historical information helps explain the current condition of the river and is incorporated into the survey. Understanding events that formed the habitat condition enhances

decision-maker options. In-stream survey data is collected to provide an overview of the current condition of a stream. Survey data produces a "snapshot" in time of the stream's habitat condition and the factors affecting it. Survey information can be used to identify both degraded sections as well as ideal areas to be used as a reference or model for other similar sections of stream. By combining the historical and current information pertaining to a stream, management options can be more clearly identified, which is the goal of this document.

BASIN SUMMARY

Table 2. Stream Summary Table for the Panchuela Watershed.

LOCATION:	
County:	Santa Fe, San Miguel and Mora Counties
Forest:	Santa Fe National Forest
District:	Pecos
Drainage:	Panchuela Creek
Tributary to:	Pecos River
Survey Began at:	T19N, R12E, Sec. 34, elev. 8,210' (Panchuela Creek mouth)
WATERSHED:	
HUC Code[1]:	1306000102
Watershed Area:	14,387 acres 22.5 square miles
Stream Order:	4
Stream Length:	98,157 18.6 miles[2]
AQUATIC BIOTA:	
Fish Species:	Rio Grande cutthroat trout[3] *(Oncorhynchus clarki virginalis),* rainbow trout (*Oncorhynchus mykiss)*, brown trout (*Salmo trutta),* and eastern brook trout (*Salvelinus fontinalis)*

[1] Hydrologic Unit Code used to identify watersheds.
[2] Stream length includes surveyed.
[3] Listed as a Sensitive Species by the USDA Forest Service, Southwestern Region (1999)

EXECUTIVE SUMMARY

Panchuela Creek is a 4th order stream originating from four named tributaries (Rito Perro, Horsethief Creek, Cave Creek and Rito Oscuro) which are sourced by seeps and springs. The watershed drains from the east side of Sangre de Cristo Mountains on the Pecos Ranger District of the Santa Fe National Forest (Forest). The stream inventory covered four streams, totaling 18.6 miles, from the mouth of Panchuela Creek (T19N, R12E, Sec. 34, elev. 8,210') to the source of Panchuela, Cave, Perro and Horsethief. Fisheries populations are present most of the surveyed length until flow and gradient eliminated fish presence. The Panchuela Watershed drains a rugged area of the Pecos Wilderness with tributaries originating from mountains well over 12,000 feet such as Pecos and East Pecos Baldy, Redondo Peak and Santa Fe Baldy. The watershed encompasses 14,387 acres (22.5 square miles) managed by the Forest.

Panchuela Watershed survey is divided into four streams of which each stream is divided into reaches, each containing relatively homogeneous habitat characteristics. Reach divisions are based on stream and valley morphology, dramatic changes in stream flow, impoundments, or land ownership boundaries. Reaches are numbered sequentially as the survey progresses upstream (see Table 3).

The average gradient of streams surveyed within the Panchuela Watershed is 6.74% or 354.1 feet per mile. When evaluated by reach divisions, the gradient ranges from 3.1% in Panchuela Creek Reach 1 and 2 and Horsethief Creek Reach 2 to 13.3% in Panchuela Creek Reach 5.

The Panchuela Watershed originates in the Pecos Wilderness of the Sangre de Cristo Mountains, the southern most section of the Rocky Mountains. The Rocky Mountains were formed approximately 70 million years ago during the Mesozoic Era. Their formation occurred during the *Cordillerian Orogeny* when the continental crust was folded and uplifted throughout the Americas from Alaska to the southern tip of South America. Streams of the Panchuela Watershed flow through broad valleys and deep bedrock canyons. Rock formations in the watershed include red shale, sandstone, limestone, granite, amphibolite, quartzite and schist. The rock formations originated between 3000 + million years ago (Precambrian Era) and 50 million years ago (Tertiary Period). The mountains that form the rim of the watershed, including Pecos and East Pecos Baldy, Redondo Peak and Santa Fe Baldy, were shaped by glaciers that covered most of North America. The glaciers receded approximately 12,000 years ago, leaving behind the landscape seen today in the watershed (Sutherland & Montgomery 1975).

Stream flow in the Panchuela Watershed fluctuates between the high flow events in the spring and lesser events in the late summer to low flow in mid summer. Spring high flow events originate from snow runoff and vary with the previous winter's snow pack. The late summer high flow events are related to monsoon weather patterns, which typically develop in July and August. The flow related to monsoon events is not as severe as the spring runoff. Low flow in the Panchuela Watershed usually occurs in June, fall and winter seasons, when flow is dependent on spring sources.

Table 3. Description and length of reaches in the Panchuela Watershed.

Stream	Reach	River Miles	Landmark at Beginning and End
Panchuela	1	0.0 to 0.8	Mouth to Panchuela Campground
	2	0.8 to 2.6	Panchuela Campground to Cave Creek Confluence
	3	2.6 to 3.9	Cave Creek to Horsethief Creek Confluence
	4	3.9 to 4.8	Horsethief Creek to Rito Perro Confluence
	5	4.8 to 5.4	Rito Perro to End of canyon
	6	5.4 to 6.1	End of canyon to Trail 251
	7	6.1 to 8.3	Trail 251 to headwaters
Cave	1	8.3 to 8.9	Mouth of Cave Creek to Caves
	2	8.9 to 9.0	Caves
	3	9.0 to 9.6	Caves to Rito Oscuro Conflunece
	4	9.6 to 10.9	Rito Oscuro to Significant LB Trib
	5	10.9 to 12.5	LB Trib to Headwaters
Horsethief	1	12.5 to 14.4	Mouth to Horsethief Meadow
	2	14.4 to 15.5	Horsethief Meadow
	3	15.5 to 17.1	Horsethief Meadow to Headwaters
Perro	1	17.1 to 18.1	Mouth of Rito Perro to Tributary
	2	18.1 to 18.6	Tributary to Headwaters

One water diversion is in the surveyed portion of Panchuela Creek: An irrigation ditch located near the Panchuela Campground in Reach 1. The ditch diverts approximately 15% of the flow on the west bank of the river (see Photo 1) to water horse pastures at the Forest Service Panchuela Cabin Admin Site.

Photo 1. Reach 2, NSO 42, R21. The only flow diversion in the Panchuela Watershed. The headgate delivers flow into a pipe that waters a pasture at the FS Admin Site (28 June 04).

The survey was accompanied by temperature analysis at 6 thermograph or temperature recording sites. The thermograph sites were distributed throughout the watershed from the mouth of Panchuela Creek to the surveyed tributaries' mouths. Two additional stations were placed in the middle reaches of Panchuela Creek to measure influence from the major tributaries. The stream temperatures were analyzed and classified by both Forest and New Mexico Environment Department (NMED) Standards. The Forest and NMED temperature standards classify coldwater fisheries habitat as properly functioning, at risk, or not properly functioning. Water temperatures at the temperature stations are classified as **properly functioning** at all sites by Forest and NMED standards (see Water Temperature section for in-depth description).

Habitat Characteristics

The 18.6 surveyed miles (98,157) of the Panchuela Watershed is divided into 760 Natural Sequence Order Habitat Units (NSOs). The 182 pool habitats comprise 3.9% of the stream habitat length. There are 288 NSOs that are riffle habitat, which comprises the majority of habitat in the Panchuela Watershed (see Table). Other habitat types in the Panchuela Watershed are tributaries, falls, dry channels, and side channels. Tributaries to the Panchuela Watershed are not considered stream habitat and are excluded from length and habitat analyses except for the major tributaries (Cave Creek, Horsethief Creek, and Rito Perro) which were also surveyed and included in this analysis.

Table 4. Stream summary information for the Panchuela Creek Watershed survey in 2004.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	182	4,124	4.2	3.9	>30%
Riffle	288	92,207	94.0	86.2	-
Culvert	0	-	-	-	-
Tributary	137	-	-	-	-
Falls	8	229	0.2	0.2	-
Dry Channel	1	1,597	1.6	1.5	-
Side Channel	145	8,845	-	8.3	-
Total	760	107,002	100.0	100.0	-

*Percent Stream Length calculated with only riffle, pool, culvert, dry channel, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied Rio Grande cutthroat trout streams, the Panchuela Watershed contains not properly functioning, at risk and properly functioning characteristics (see Table). The parameters that are **not properly functioning** include the density of large woody debris (LWD), and pool development. Temperature is **at risk** at two of the four stations by NMED standards and 3 stations by Forest standards. **Properly functioning** characteristics include riffle sediment content, pool quality and stream bank condition.

Table 5. Stream habitat conditions as evaluated by the matrix of factors and indicators of habitat condition for historic and currently occupied Rio Grande cutthroat trout streams.

Factors	Indicators	Panchuela Watershed Conditions
Water Quality	Temperature 3-Day Average	**Site 1) Just above Holy Ghost**
		Site 2) Just above Rio Mora
		Site 3) Below Jacks Creek
		Site 4) Near Beatty's Cabin
Salmonid Development	Temperature 7-Day Average	**Sites 1-3) At Risk**
Habitat Characteristics	Riffle Sediment	**Properly Functioning**
	Large Woody Debris	**Properly Functioning**
	Pool Development	**Not Properly Functioning**
	Pool Quality	**Properly Functioning**
Channel Condition and Dynamics	Stream Bank Condition	**Properly Functioning**
	Width-to-Depth Ratio	**Properly Functioning**

Red= Not Properly Functioning Yellow = At Risk

The riffle habitat in the Panchuela Watershed is the dominant habitat, comprising 86.2% of all stream habitat types. The high relative quantity of riffle habitat reflects the lack of pool habitat. Sediment content in riffle habitat (11.4%) was determined to be **properly functioning** (see Table 5). The dominant substrate type is cobble followed by boulder.

Table 6. Summary of riffle habitat and substrate composition in streams surveyed in the Panchuela Watershed.

Riffle Habitat Summary (ft)					
Stream	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth
Panchuela Watershed	288	320	8.8	0.8	1.6
Panchuela Creek	135	300	11	1.0	1.7
Cave	60	341	7.8	0.8	1.5
Horsethief	63	376	6.2	0.7	1.5
Perro	31	244	7.0	0.8	1.5

Substrate Summary (%)						
Stream	Sand	Gravel	Cobble	Boulder	Bedrock	Total
Panchuela Watershed	11.4	33.2	33.8	20.1	1.5	100.0
Panchuela Creek	12.1	28.6	35.1	22.4	1.8	100.0
Cave	10.3	36.8	29.3	20.7	2.9	100.0
Horsethief	15.7	39.2	33.2	11.9	0	100.0
Perro	2.3	33.5	37.7	25.5	1.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Pool habitat is important over wintering, resting, and feeding habitat for fish. Pool habitat is evaluated by both quality or residual depth and area of pool habitat (by length). Pool quality is **properly functioning** in the Panchuela Watershed with 99% of the pool habitats with at least 1-foot residual depth. Residual depth is calculated by subtracting the maximum depth from the pool tail crest depth to determine the depth of water that would remain in the habitat if flow ceased. The average residual pool depth is over twice the properly functioning indicator (see Table). The relative quantity of pool habitat (3.9%) is **not properly functioning** (see Table 7). Increasing pool habitat in the Panchuela Watershed should be a priority in the river's management.

Large woody debris (LWD) is related to habitat complexity and the health of fish populations in stream habitats (Fausch and Northcote 1992). LWD density is **properly functioning** in the Panchuela Watershed. The LWD density is 37.6 piece per mile, above the standard (see Table 8). The Panchuela Watershed had 699 pieces of wood classified as medium and large sizes. Wood classified as medium LWD must be greater than 12 inches in diameter at a length of 35 feet from the large end. Large pieces of LWD have a diameter of greater than 20 inches at a length of 35 feet from the large end. Increasing the LWD density should be a focus in the management of the Panchuela Watershed. Increasing LWD may also improve other degraded factors in the stream habitat including pool development.

Table 7. Summary of pool habitat and substrate composition in streams surveyed in the Panchuela Watershed.

Pool Habitat Summary											
Stream	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
Panchuela Watershed	182	22.7	10.4	2.1	0.6	1.5	9.8	167	9.0	10	0.5
Panchuela Creek	81	27.4	12.1	2.3	0.7	1.6	10	74	9.1	9	1.1
Cave	43	19.6	9.7	1.9	0.5	1.4	10.8	36	9.0	2	0.5
Horsethief	42	19.6	8.8	2.1	0.5	1.6	9.1	39	8.5	0	0
Perro	15	13.4	7.1	1.9	0.6	1.3	8.3	12	6.7	0	0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Stream	Sand	Gravel	Cobble	Boulder	Bedrock	Total
Panchuela Watershed	21.9	33.2	25.4	18.0	1.5	100.0
Panchuela Creek	23.1	29.9	27.8	16.8	2.4	100.0
Cave	14.7	40.2	22.0	20.3	2.8	100.0
Horsethief	24.8	33.5	23.8	17.4	0.5	100.00
Perro	8.7	30.6	32.0	28.7	0	100.0

Red – Not Properly Functioning
Orange – Dominant Substrate

Bank stability (0.8%) is **properly functioning** when analyzed by the length of the entire surveyed section of stream. When the length of the river is divided into reaches and then analyzed, every reach is **properly functioning** for bank stability. Although the length of bank instability is **properly functioning**, several areas could use mitigation. Areas of instability in need of management are primarily near the dispersed and developed camgrounds throughout the watershed and the numerous user created and developed trail systems.

Table 8. Habitat characteristics for streams surveyed in the Panchuela Watershed.

Stream	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
Panchuela Watershed	1:1.6	12.4:1	37.6	793	0.8
Panchuela Creek	1:1.7	13.1:1	43.1	657	1.3
Cave	1:1.4	14.4:1	16.8	62	0.3
Horsethief	1:1.5	3.6:1	45.4	74	0.3
Perro	1:2.1	17:1	41.1	0	0
Properly Functioning Indicators	-	X<Y	>30	-	<10

Red – Not Properly Functioning
Yellow – At Risk

Reach by Reach Comparison

The 17 reaches of the Panchuela Creek Watershed contain different combinations of properly functioning, at risk, and not properly functioning characteristics. Pool habitat, LWD density, bankfull width:depth ratio and unstable banks are parameters that are outside of properly functioning classification in at least one reach. None of the surveyed reaches are properly functioning in all categories.

Table 9. Reach characteristic summaries for streams surveyed in Panchuela Watershed 2004.

Stream	Reach	Total Length (mi)	Gradient (%)	Rosgen Channel Type	Pool Habitat (%)	Riffle Habitat (%)	Side Channel Habitat (%)	Dominant Substrate in Pools	Dominant Substrate in Riffles	LWD Per Mile	Bankfull Width to Depth	Unstable Banks (%)
Panchuela	1	0.8	3.1	B3	3.9	58.3	38.8	Sand	Cobble	17.9	13:1	3.6
	2	1.8	3.1	B3	7.7	72.4	19.9	Sand	Cobble	24.8	16:1	1.8
	3	1.3	6.2	A3	4.7	84.0	10.7	Cobble	Cobble	16.7	25:1	0.06[1]
	4	0.9	7.7	A4	2.7	85.6	11.7	Gravel	Gravel	87.0	16:1	0.0[1]
	5	0.6	13.3	Aa+2	4.6[3]	82.9	7.5	Boulder	Cobble/Boulder	137.1	N/A	0.0[1]
	6	0.7	6.8	B3c	6.8[3]	92.2	0.9	Gravel	Cobble	71.5	18:1	0.0[1]
	7	2.2	3.9	C3	1.4[3]	97.3	1.3	Gravel	Cobble	30.0	28:1	0.1[1]
Cave	1	0.6	6.8	B4c	8.2	82.7	9.1	Gravel	Gravel	5.1	16:1	0.7[1]
	2[5]	0.1	5.8	A3	NA	NA	NA	NA	NA	NA	NA	NA
	3	0.6	4.4	A3	6.9	84.7	8.4	Gravel	Cobble	28.6	24:1	0.0[1]
	4	1.3	9.6	A3	1.7	91.2	7.1	Gravel	Cobble	20.5	24:1	0.1[1]
	5	1.6	9.9	A4	2.9[3]	95.2	1.9	Gravel	Gravel	13.4	11:1	0.03[1]
Horsethief	1	1.9	6.4	A3	6.2	90.2	3.5	Gravel	Cobble	45.7	19:1	0.0[1]
	2	1.1	3.1	B3	1.4	98.6	0	Gravel	Gravel	14.5	3.6:1	0.9
	3	1.6	6.4		2.1	97.9	0	Gravel	Gravel	26.9	NA	0.2
Perro	1	1.1	7.0		2.9	92.7	4.4	Gravel	Cobble	45.5	14:1	0
	2	0.7	10.5		0.8	57.4	2.1	Cobble	Cobble	34.3	24.3:1	0
Total		18.6	6.74	-	3.9	86.2	8.3	Gravel	Cobble	37.6	-	0.8
Properly Functioning Indicators		-	-	-	≥30	-	-	-	-	>30	A,E,G: <12 B,C,F: 12-30 D: >40	<10

Red – Not Properly Functioning
Yellow – At Risk
[1] Stream bank condition analysis is excluded in reaches with >4% gradient.
[2] Large Woody Debris analysis is excluded in meadow reaches, defined as reaches with no natural local recruitment of LWD.
[3] Pool volume analysis is excluded in reaches that are 2nd order or less in size
[4] No bankfull measurements were taken
[5] Stream flows through a cave in this reach.

The length of pool habitat is of concern in every reach of the Panchuela Watershed. Even the reach with the longest quantity of pool habitat is only less than 1/3 of the greater than 30% properly functioning indicator. The relative quantity of pool habitat in reaches that are **not properly functioning** in the Panchuela Watershed range from 0.8 % in Rito Perro Reach 1 and 8.2% in Cave Creek Reach 1.

LWD density in the Panchuela Watershed is **properly functioning** in 5 of the 17 Reaches. Panchuela Creek Reaches 4-7, Horsethief Creek Reach 1, and Rito Perro Reach 1 are the only reaches that are properly functioning for LWD density. The **properly functioning** reaches are in areas with minimal human disturbance. Panchuela Reaches 1-3, Cave Creek 3 and 4, and Horsethief Creek Reach 3, are **at risk** for LWD density and are between the 20 to 30 pieces per mile classification. The rest of the reaches are **not properly functioning**. The reaches that are **not properly functioning** range from 5.1 pieces per mile in Cave Creek Reach 1 to 17.9 pieces per mile in Panchuela Creek Reach 1. Increasing the low densities of LWD should be a focus in the management of the Panchuela Watershed.

Bankfull width-to-depth ratio is **not properly functioning** in 7 of the 17 reaches. Bankfull width-to-depth ratio in each reach is compared to the expected range for its related Rosgen stream type. Panchuela Creek Reaches 3 and 4, Cave Creek reaches 3 and 4, Horsethief Creek Reach 1 and Rito Perro Reaches 1 and 2 exceed the expected range (see Table 9).

All of the seventeen reaches have **properly functioning** bank condition. The **properly functioning** reaches range from no bank instability in Panchuela Creek Reaches 4-6, Cave Creek Reach 3, Horsethief Creek Reach 1, and Rito Perro Reaches 1 and 2 to 3.6 % in Panchuela Creek Reach 1.

Tributaries

One hundred thirty seven (137) tributaries in the form of seep, spring, and stream habitats contributed surface flow to the Panchuela Watershed during the survey. Of the 127 tributary habitats, 36 are considered significant, contributing 10% or more to the main channel flow. The flow contribution can be deceptive because of its relative and not discrete measurement. A majority of tributaries are found in the upper reaches.

Photo 2. Reach 3 NSO 150 R 67/T14 Panchuela Creek at confluence with Horsethief Creek(12 July 2004).

Several significant tributaries altered the habitat enough to create a reach break. Tributaries that contributed to reach breaks are Cave Creek (at the top of Reach 2), Panchuela Creek, Horsethief Creek, Rito Perro, and Rito Oscuro.

Table 10. Summary of tributaries contributing significant (10%+) surface flow to surveyed Panchuela Watershed streams during the 2004 stream inventory.

Location			Bank	Habitat Type	Name	% Flow*	Time	Tributary Temp (°F)	Stream Temp Below (°F)	Stream Temp Above (°F)
Stream	Reach	Tributary Number								
Panchuela Creek	2	T10	Left	Riffle	Cave Creek	30	1505	54	56	56
Panchuela Creek	3	T14	Left	Riffle	Horsethief		1339	52	52	48
Panchuela Creek	5	T18	Right	Riffle		15	1429	42		
Panchuela Creek	6	T24	Right	Riffle		15	1156	46		
Panchuela Creek	6	T28	Left	Riffle		15	1603	41		
Panchuela Creek	6	T37	Right	Riffle		10	1342	49		
Panchuela Creek	6	T39	Left	Riffle		15	1403	54		
Panchuela Creek	6	T40	Right	Riffle		15	1417	52		
Panchuela Creek	6	T42	Left	Riffle		10	1452	52		
Panchuela Creek	6	T43	Right	Riffle		30	1508	44		
Panchuela Creek	6	T44	Left	Riffle		35	1531	62		
Panchuela Creek	6	T45	Left	Riffle		45	1557	49		
Cave Creek	1	T1	Left	Riffle		50	1336	50		
Cave Creek	4	T6	Left	Riffle		10	1416	48		
Cave Creek	4	T7	Right	Riffle		10	1458	48		
Cave Creek	4	T11	Left	Riffle		10	1554	50		
Cave Creek	4	T12	Left	Riffle		40	1636	51		
Cave Creek	5	T22	Left	Riffle		10	1158	44		
Cave Creek	5	T24	Right	Riffle		30	1301	44		
Cave Creek	5	T26	Left	Riffle		10	1321	46		
Cave Creek	5	T33	Left	Riffle		40	1454	47		
Cave Creek	5	T34	Left	Riffle		40	1541	50		
Cave Creek	5	T35	Right	Riffle		40	1609	44		
Horsethief Creek	1	T3	Right	Riffle		10	1552	54		
Horsethief Creek	1	T6	Right	Riffle		25	1038	42		
Horsethief Creek	2	T8	Right	Riffle		30	1149	48		
Horsethief Creek	2	T11	Left	Riffle		10	1605	49	48	
Horsethief Creek	2	T15	Left	Riffle		40	1751	46	46	41
Horsethief Creek	3	T17	Right	Riffle		10	1128	42		
Horsethief Creek	3	T19	Left	Riffle		40	1308	46		
Horsethief Creek	3	T22	Right	Riffle		15	1445	47		
Horsethief Creek	3	T29	Right	Riffle		15	1657	48		
Rito Perro	1	T16	Right	Riffle		60	1548	42	43	44
Rito Perro	2	T25	Right	Riffle		50	1452	46		
Rito Perro	2	T27	Right	Riffle		100	1531	41		

*-Percent flow is a visual estimate by the surveyors and therefore should not be considered an exact measurement

Stream Flow

From the headwaters to the Pecos River, the Panchuela Watershed is joined by several considerable watersheds including the Cave Creek, Horsethief Creek, Rito Perro and Rito Oscurro. All of the smaller watersheds that comprise the Upper Panchuela Watershed originate in the Sangre de Cristo Mountains. The snow pack of the mountain basins governs the flow of Panchuela Creek and its tributaries. Peak stream flow of the Panchuela Watershed occurs between late May and early June. Smaller high flow events take place after late summer monsoon events.

Flow was measured utilizing Swoffer brand flow meter on September 11, 2004 in Reach 1 of Panchuela Creek, River Mile 0 and in Reach 1 of Cave Creek at River Mile 0. Flow was measured on September 10, 2004 in Rito Perro at River Mile 0, and Horsethief Creek at River Mile 0. The flow measurement location is at the beginning of the survey just above the mouth of each creek. The flow measurement location was in a straight section of riffle with as few flow restricting obstacles (boulders, logs, etc.) as possible. A transect was created and divided into equally spaced sections. At each section, flow was taken at 60% of the depth in twenty-second intervals. The average flow is recorded from each section and related to area to calculate the stream flow. The Panchuela Creek flow on September 11th was 4.17 cubic feet per second (cfs), Cave Creek was 2.37 cfs. The Rito Perro flow on September 10th was 1.6 cfs and the flow in Horsethief Creek was 1.44 cfs.

Water diversions in the surveyed length of the Panchuela Watershed include one irrigation ditch located in Reach 1 near the Panchuela Campground. The headgate diverts an estimated 15% of the total flow of the Panchuela Watershed.

Water Temperature

Water temperature is a key component of water quality in a stream environment. Combinations of multiple factors determine water temperature regimes in stream habitats. Solar radiation, air temperature, riparian vegetation cover, ground water, stream discharge, channel shape, stream orientation, and climate are some of the environmental factors that influence water temperature. Many chemical and biological processes depend on specific temperatures. Temperature can help determine the suitability of waters for aquatic species such as Rio Grande cutthroat trout (RGCT).

Fish growth, health, and reproduction are affected by water temperature. Fish are very sensitive to water temperature due to temperature specific enzymes. As water temperature increases, so does fish performance. Although fish have increased performance with temperature, they also approach a lethal limit. No lethal temperature information is currently available for RGCT. Another high elevation, arid cutthroat subspecies, Lahontan cutthroat trout (*Oncorhynchus clarki henshawi)*, indicated an upper limit for growth and long-term survival is somewhere between 71.6 and 73.4°F. These temperature limits were based on optimal conditions with high food availability and good water quality, not taking into account the other stressors that may exist in stream environments. It is possible that the actual lethal limits are lower due to water chemistry and other environmental factors (Dunham 1999).

Cutthroat trout reproduction is affected by temperature. Smith *et al.* (1983) compared egg quality of cutthroat trout in a variety of water temperatures. Eggs in cold water were expelled

easily and were in good condition. In warm water the eggs were expelled with difficulty, were cloudy or opaque and often broken. Eggs spawned from two-year-old adults exhibited 74% viability in cold water while in warm water only 6.9%.

Forest standards (noted as SFNF in Table 1) are based on seven-day average maximum temperatures and are stricter than the NMED standards. While it is stricter, the Forest standard is more in line with approaches taken by U.S. Fish and Wildlife Service and NOAA Fisheries across the western United States. It also allows the SFNF to be more pro-active in improving watershed conditions for native fish as well as ameliorating impairments to water quality before a stream is listed as impaired on the 303(d) list.

NMED standards are based on temperatures occurring over four consecutive days (see Table 11). These standards are based on the Clean Water Act and Total Maximum Daily Loads mandate for water quality standards but are defined by needs for a successful coldwater fishery. Forest temperature standards are derived from research done on inland cutthroat trout and salmonid development, whereas NMED standards are based on research for non-native salmonids (i.e. brown trout, rainbow trout, and brook trout). Data between June 1st and September 30th is used for maximum water temperature standards analysis to identify high temperatures that occur in summer months.

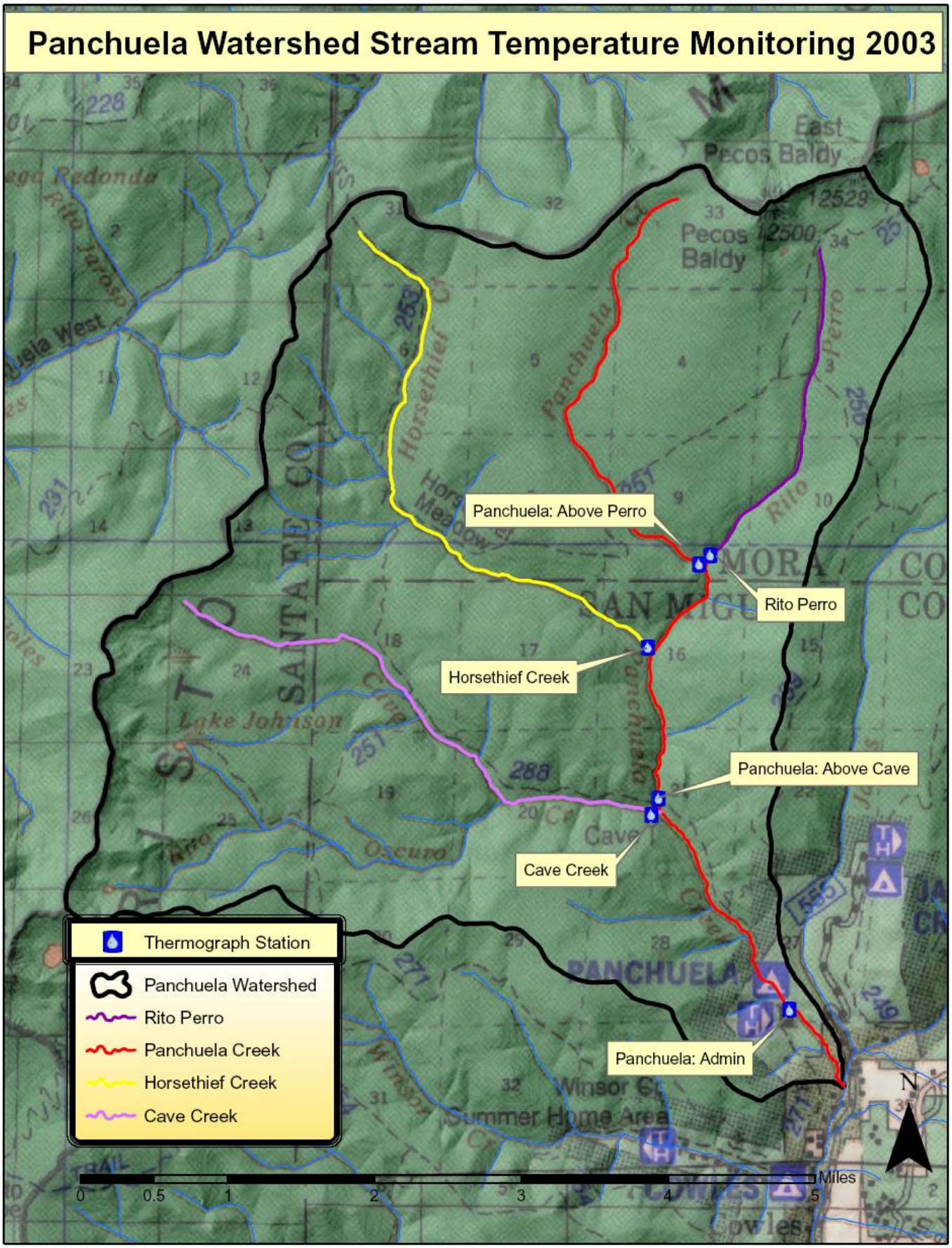


Figure 1. Map of 2003 Panchuela Watershed Stream Temperature Monitoring Stations

Table 11. Forest and NMED water quality temperature standards (NMED revised Dec 2003).

Water Temperature Standards	Properly Functioning	At Risk	Not Properly Functioning
Forest 7-day Average Maximum	≤ 64°F	64 to 70°F	> 70°F
	Fully Support		**Not Fully Support**
NMED High Quality Coldwater Fishery	<73.4°F at one time; or ≤ 68°F for 4 consecutive hours over 4 consecutive days		≥ 73.4°F at one time; or > 68°F for 4 consecutive hours over 4 consecutive days

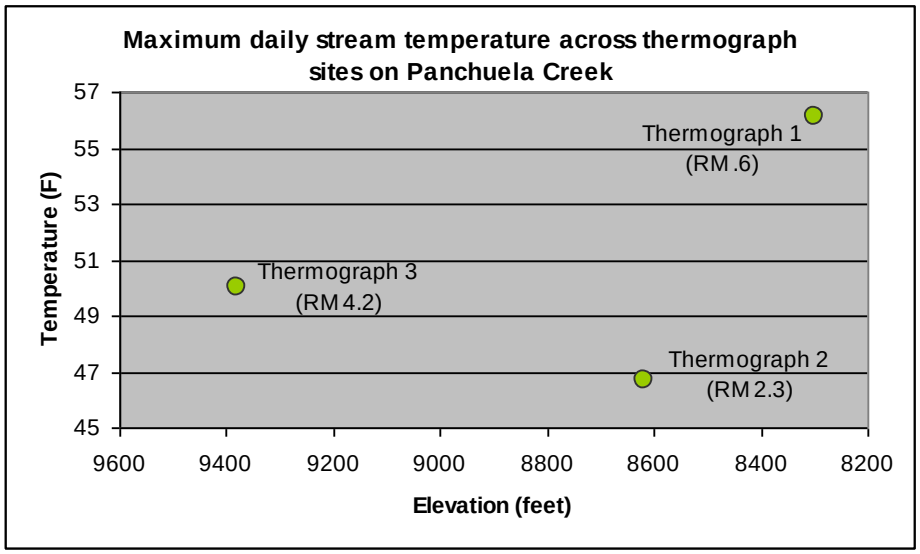
Panchuela Creek

Three temperature monitoring stations were established on Panchuela Creek. The stations were not moved for the duration of the survey. Water temperatures were recorded from June 20th to October 9th, 2003. Thermographs recorded temperature every 4 hours.

The first thermograph station was placed in Panchuela Creek across from the Forest Service-owned Panchuela Cabins below the wilderness boundary (RM 0.6). The second location was upstream of the confluence with Cave Creek (RM 2.3). The final station was located above the confluence with Rito Perro (RM 4.2).

Thermograph data collected between June 20th and September 30th was used to determine water quality in Pancheula Creek. When SFNF standards were applied all three sites were **properly functioning.** According to NMED standards, Panchuela Creek **fully supports** a high quality coldwater fishery in all locations.

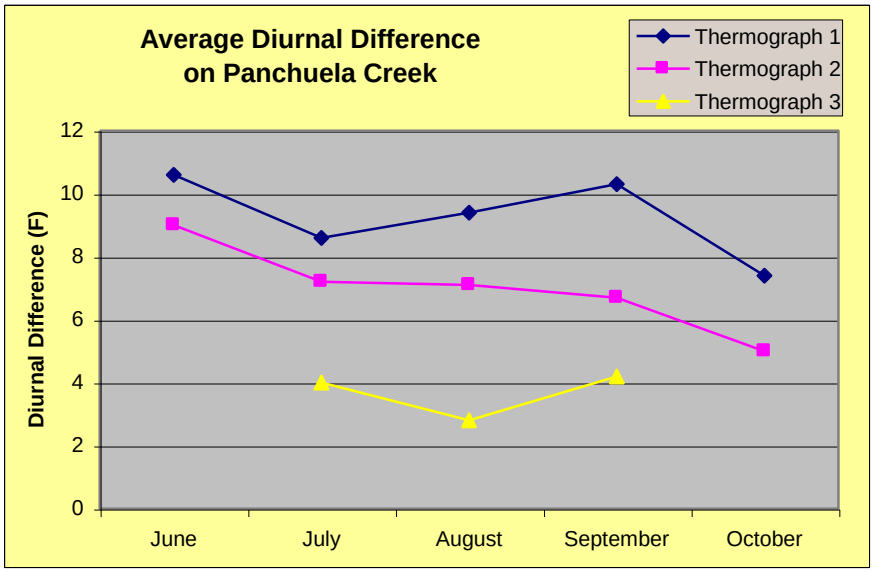
Figure 2. Maximum stream temperatures on July 31st, 2003 across three thermograph stations on Panchuela Creek.



Looking at stream temperatures across elevation can also distinguish areas of influence. On July 31st, the lowest daily maximum temperature (46.7°F) was recorded at Station 2 (elevation 8620'). Station 3 had the next lowest temperature of 50°F. Station 1 had the highest maximum daily temperature of 62.8°F. This is likely due to natural conditions (upwellings, coldwater springs, differing valley formations and aspect, etc.).

A station by station comparison of maximum temperatures on July 31st, 2003, revealed a 6.1°F increase in temperature from the most upstream station (above Rito Perro) to the station furthest downstream, Panchuela Administration Site (see Figure 2).

Figure 3. Diurnal difference averaged by month for the three thermograph stations on Panchuela Creek.



Diurnal difference is a measure of daily stream temperature fluctuation. It is determined by subtracting the minimum daily temperature from the maximum. On July 31st, 2003, diurnal fluctuations ranged from 4.7°F above Rito Perro to 7.6°F at the administration site. Diurnal difference data averaged by month showed a similar pattern. The station above Rito Perro consistently had the lowest diurnal difference and the administration site had the highest (see Figure 3).

The properly functioning classification of multiple sites by both standards shows that Panchuela Creek can support a healthy cold-water fishery. This stream should be maintained in its current condition.

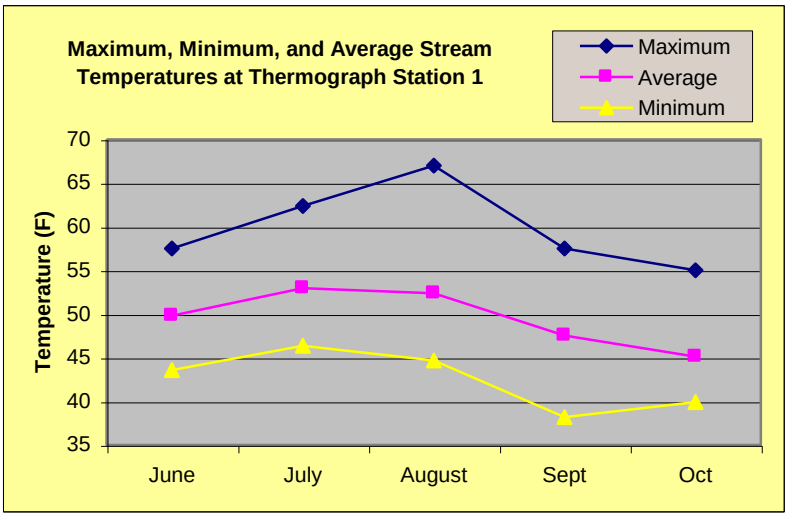
Photo 3. G. Sausen points to Thermograph 1 deployment site below the administration site (20 Jun 03).

Thermograph Station 1: Administration Site
Elevation: 8300'
Stream Mile: 0.6

Thermograph Station 1 monitored 1.8 miles of stream. This section of creek begins below the wilderness boundary and passes through a fairly open canyon and some wide meadow sections. It ends just above the entrance of Cave Creek. Thermograph data collected in 2003 determined Panchuela Creek at the Administration Site (Panchuela Cabins) was **properly functioning** by Forest standards and **fully supporting** by NMED standards.

Maximum stream temperatures were recorded in August (see Figure 4). Temperature in Panchuela Creek peaked at 67.0°F on August 4th. Temperatures then decreased steadily until the thermograph was pulled in October.

Figure 4. Maximum, minimum, and average temperatures for each month at the Administration Site.



Diurnal difference was calculated for June through October. Average monthly diurnal difference peaked in June at 10.6°F and again in September at 10.3°F. Daily diurnal difference reached a maximum of 18.3°F on August 18th. The minimum recorded diurnal difference of 1.7°F occurred on August 29th.

Thermograph Station 2: Above Cave Creek
Elevation: 8620'
Stream Mile: 2.3

Thermograph Station 2 monitored 1.9 miles of stream. This section of stream flows through an open canyon for its entire length. Horsethief Creek confluence is approximately half way through this section. Thermograph data collected in 2003 determined Pancheula Creek above the confluence with Cave Creek was **properly functioning** by Forest standards and **fully supporting** by NMED standards.

Maximum stream temperatures were recorded in August, although August and July temperatures were very similar (see Figure 5). Temperature peaked at 58.4°F on August 8th. Temperatures decreased steadily until the thermograph was pulled in early October.

Diurnal difference was calculated for June through October. Average monthly diurnal difference peaked in June at 9°F. The maximum daily diurnal difference of 11.4°F occurred on July 2nd. The minimum daily temperature fluctuation occurred of 1.7°F was recorded on August 20th.

Figure 5. Maximum, minimum and average temperatures for each month above the confluence with Cave Creek.

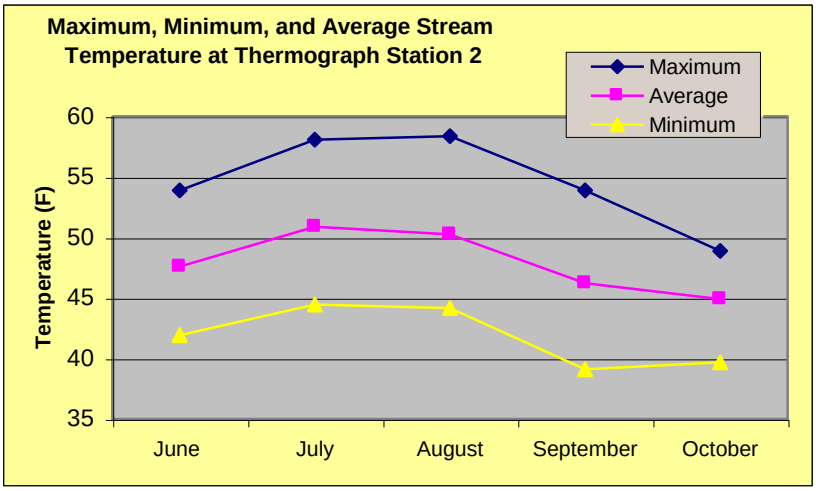


Photo 4. S. Eddy deploying Thermograph 2 (20 Jun 03).

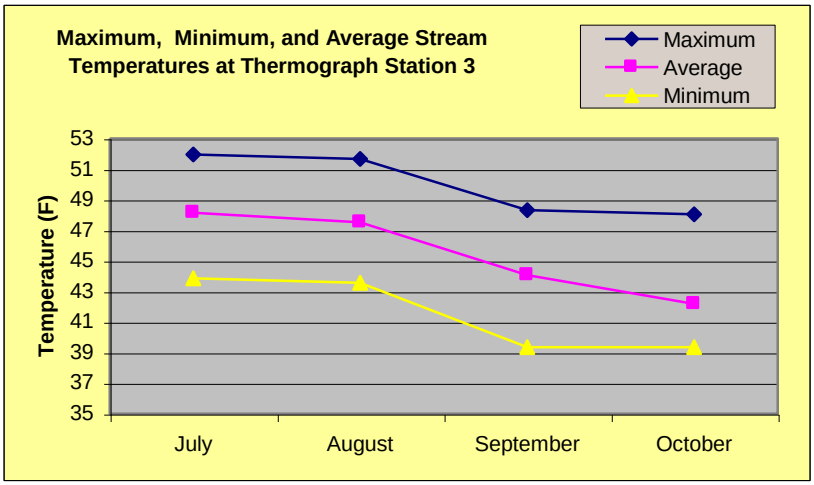
<u>*Thermograph Station 3*</u>: Above Rito Perro
Elevation: 9380'
Stream Mile: 4.2

Thermograph Station 3 monitored 2.7 miles of stream. This section of creek flows through a tight canyon above which it opens into a periodic meadow system with low rolling canyon walls. Thermograph data collected in 2003 determined Panchuela Creek above the confluence with Rito Perro was **properly functioning** by Forest standards and **fully supporting** for NMED standards.

Photo 5. S. Ferrell pointing to Thermograph 3 (01 Jul 03).

Maximum stream temperatures were recorded in July (see Figure 6). Temperature peaked at 52°F on July 18th. Stream temperatures then dropped in September and early October when the thermograph was pulled.

Figure 6. Maximum, minimum and average temperatures for each month for the thermograph station above Rito Perro.



Diurnal difference was calculated for July through September. Average monthly diurnal difference peaked in June at 4.2°F (see Figure 6). The maximum daily diurnal difference of 6.4°F occurred on July 2nd. The minimum daily diurnal difference of 1.1°F was recorded on August 29th.

Cave Creek

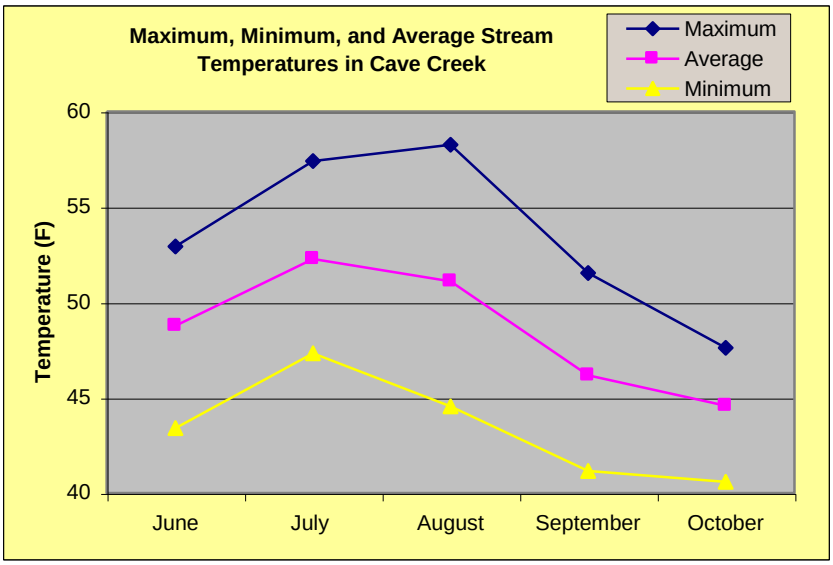
One temperature monitoring station was established at the mouth of Cave Creek (elev. 8620'). The thermograph was not moved for the duration of the survey. This station monitored the 4.2 mile length of the creek. Water temperature was recorded between June 20th and October 8th, 2003. The thermograph recorded temperatures every 4 hours.

Photo 6. S. Eddy pointing to Cave Creek thermograph (20 Jun 03).

Thermograph data collected between June 20th and September 30th was used to determine water quality. When SFNF standards were applied Cave Creek was **properly functioning.** According to NMED standards, Cave Creek **fully supports** a high quality coldwater fishery.

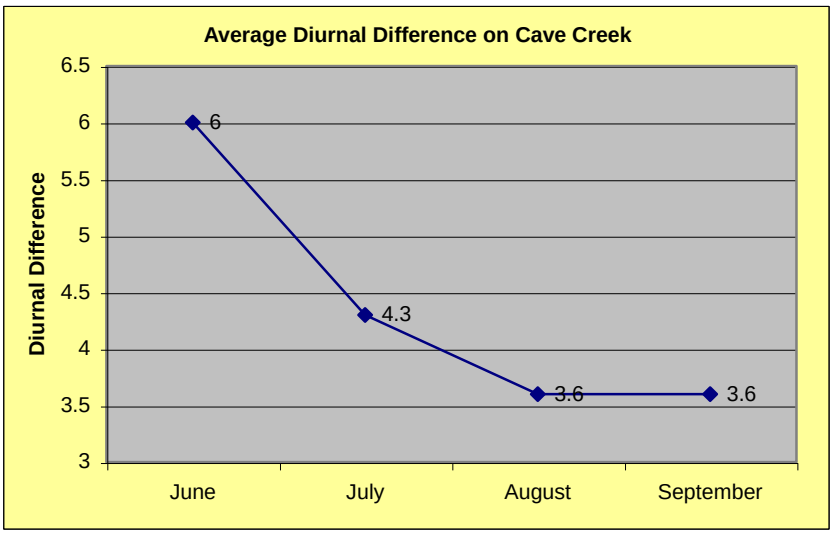
Stream temperatures on Cave Creek increased steadily through August (see Figure 7). Temperatures peaked at 58.3°F on August 4th, 2003. Temperatures then decreased through October when the thermograph was pulled

Figure 7. Maximum, minimum, and average temperatures for each month at the mouth of Cave Creek.



Average monthly diurnal difference peaked in June (see Figure 7). Diurnal difference is a measure of daily stream temperature fluctuation. It is determined by subtracting the minimum daily temperature from the maximum. The maximum daily diurnal difference of 7.3°F was recorded on June 23rd. The minimum daily temperature fluctuation of 0.8°F occurred on August 29th.

Figure 8. Diurnal difference averaged by month at the mouth of Cave Creek.



The properly functioning classification by both standards suggests this stream can support a healthy coldwater fishery. This system should be maintained in its current state.

Horsethief Creek

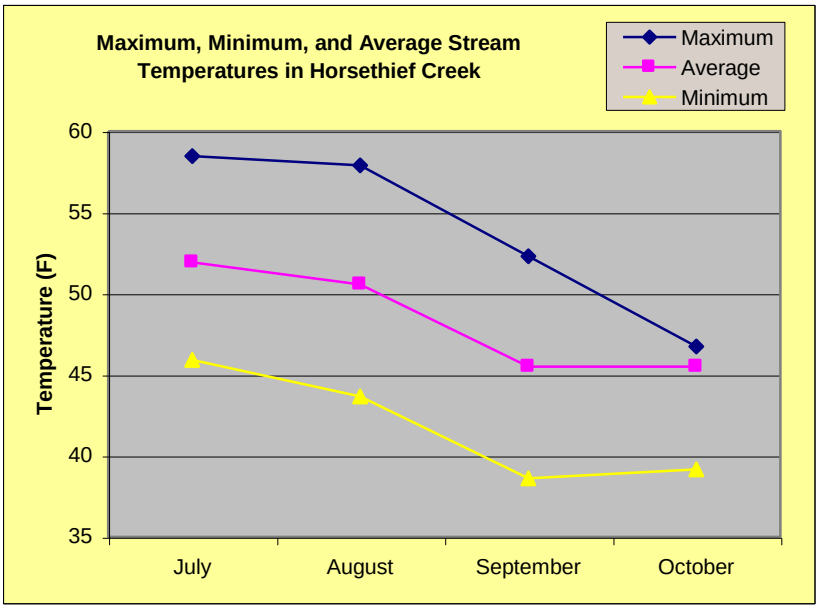
One temperature monitoring station was established at the mouth of Horsethief Creek (elev. 9020'). The station was not moved for the duration of the monitoring period. This station monitored the 4.6 mile length of the creek. Stream temperatures were measured from July 1st through October 9th, 2003. The thermograph recorded temperature every 4 hours.

Photo 7. S. Ferrell pointing to Horsethief Creek thermograph (01 Jul 03).

Thermograph data collected between July 1st and September 30th was used to determine water quality. When SFNF standards were applied Horsethief Creek was **properly functioning.** According to NMED standards, Horsethief Creek **fully supports** a high quality coldwater fishery.

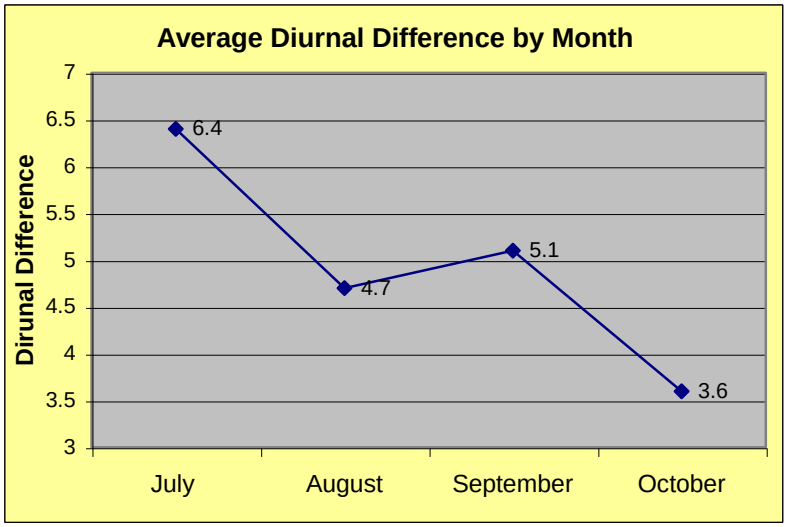
Maximum stream temperatures in Horsethief Creek were recorded in July (see Figure 9). Temperature peaked at 58.5°F on July 18th. After July, maximum temperatures decreased steadily until the thermograph was pulled in October.

Figure 9. Maximum, minimum and average temperatures for each month at the mouth of Horsethief Creek.



Average monthly diurnal difference also peaked in July (see Figure 10). Diurnal difference is a measure of daily stream temperature fluctuation. It is determined by subtracting the minimum daily temperature from the maximum. The maximum daily diurnal difference of 10.6°F occurred on July 2nd. The minimum daily temperature fluctuation of 1.1°F was recorded on August 29th.

Figure 10. Diurnal difference averaged by month at the mouth of Horsethief Creek.



The properly functioning classification by both standards suggests this stream can support a healthy coldwater fishery. This system should be maintained in its current state.

Rito Perro

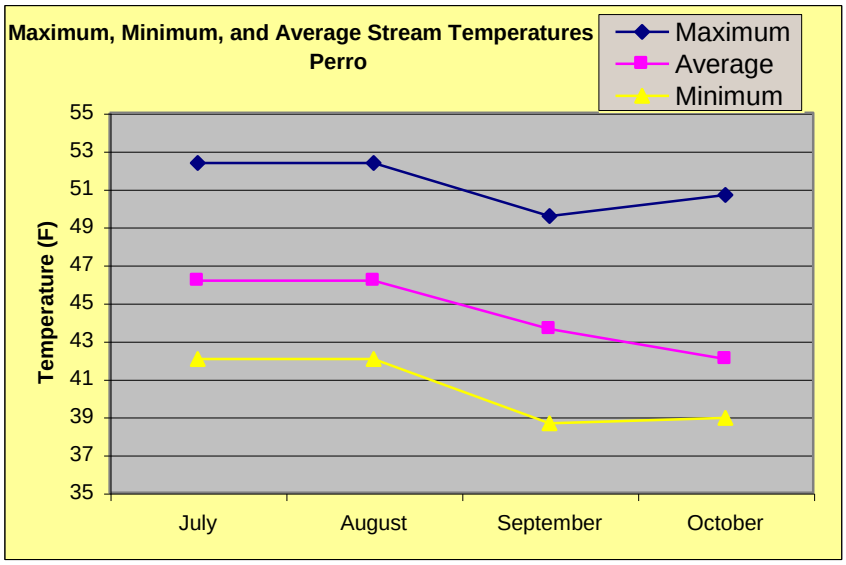
A water temperature monitoring station was established at the mouth of Rito Perro (elev. 9380'). The station was not moved for the duration of the monitoring period. This station monitored the entire 2.4 miles of stream. Stream temperature was monitored from July 1st through October 9th, 2003. The thermograph recorded temperature every four hours.

Photo 8. S. Ferrell pointing to Rito Perro thermograph (01 Jul 04).

Thermograph data collected between July 1st and September 30th was used to determine water quality. When SFNF standards were applied Rito Perro was **properly functioning.** According to NMED standards, Rito Perro **fully supports** a high quality coldwater fishery.

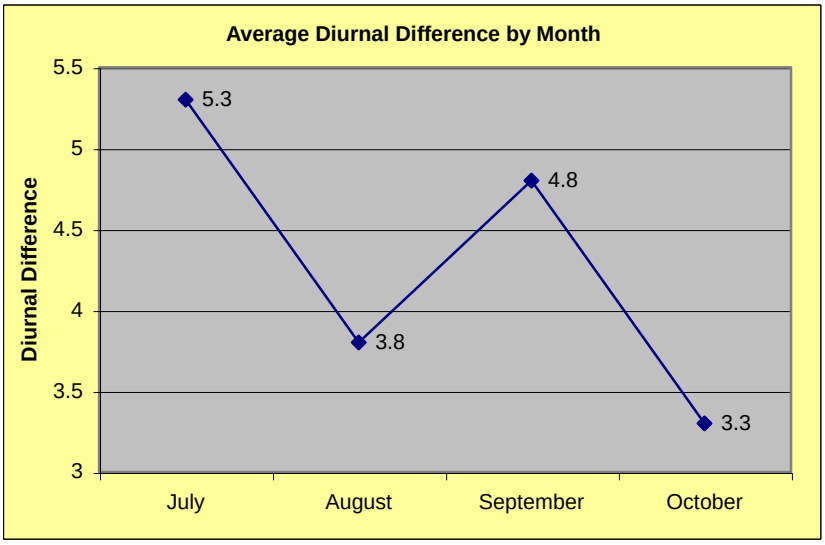
Maximum stream temperatures were recorded in July and August (see Figure 11). Stream temperatures peaked at 52.4°F on July 18th and August 4th. Maximum stream temperatures then decreased in September, but rose again in early October. The thermograph was pulled in early October.

Figure 11. Maximum, minimum, and average temperatures for each month at the mouth of Rito Perro.



Average monthly diurnal difference peaked in July (see Figure 12). Diurnal difference is a measure of daily stream temperature fluctuation. It is determined by subtracting the minimum daily temperature from the maximum. The maximum daily diurnal difference of 8.4°F occurred on July 17th and 18th. The minimum daily diurnal difference of 1.4°F was recorded on August 29th.

Figure 12. Daily diurnal difference averaged by month at the mouth of Rito Perro.



The properly functioning classification by both standards suggests this stream can support a healthy coldwater fishery. This system should be maintained in its current state.

Riparian and Upland Vegetation

Riparian vegetation is located on both banks of streams. Riparian areas serve many important functions including water purification and storage, erosion reduction and more. Riparian vegetation removes toxins from the water column and improves water quality. Riparian vegetation also stores water in the stream banks increasing available water and stream flow duration. Streamside vegetation also improves stream bank stability reducing erosion and its associated fine sediment inputs (Brodie 1996). Riparian vegetation is important in maintaining a healthy fish population in the Panchuela Watershed.

Native riparian vegetation includes alder, willow and cottonwood species (see **Error! Reference source not found.**). In some upper riparian stretches an altered fire regime has allowed an increase in coniferous species in what were historically riparian woodland sites (Sarabia 2002).

The upland vegetation species can be divided into three vegetation types: mixed conifer, ponderosa pine and spruce-fir. The mixed conifer zone ranges from approximately 8,000 to 9,500 feet and primarily contains white fir, Douglas-fir, corkbark fir, limber pine, scattered ponderosa pine and patches of aspen. Ponderosa pine forests range from the beginning of the survey (7,500 ft) to 8,000 feet. The spruce-fir forests range from 8,000 to 12,000 feet and consist of Engelmann spruce, subalpine fir or corkbark fir with patches of aspen or blue spruce (Sarabia 2002).

Photo 9. Horsethief Creek, Reach 2, NSO 97, R42. Riparian vegetation dominated by willow in Horsethief Meadow (4 Sep 04).

Several plant species in the Panchuela Watershed are listed on the Regional Sensitive Species List. The sensitive species include the Arizona Willow (*Salix arizonica)*, Chiricahua (bloomers) dock (*Rumex orthoneurus)* and the hairless (Pecos) fleabane (*Erigeron subglaber)*. These plant species demand attention with any management plan within the watershed.

Beaver Activity

No beaver activity was documented within the Panchuela Watershed. However in a 2002 survey of the Pecos River, beaver activity was documented. Historically beavers may have been found within the Panchuela Watershed.

While the beaver's role in a watershed has been generally misunderstood by the public, land managers and biologists, studies over the last few decades conclude that beavers are a critical component to increasing stream integrity as well as biotic productivity within the stream and floodplain. Beaver dams were methodically removed from streams on public land until recently (FS Files).

Beavers have many influences on stream systems, surrounding riparian vegetation, and fisheries populations. Beaver-caused stream impacts are considered to be generally beneficial to trout habitat and an asset to stream systems.

Beaver activity and its associated ponds have many effects on stream water quality, most of which are considered beneficial to trout habitat. The decreased stream velocity that occurs in pool habitat, such as beaver ponds, decreases the water's ability to carry sediment suspended in the water column. Suspended sediment tends to settle into a pond's substrate, creating a sink for stream sediment and reducing turbidity. Sediment transport has been reduced by as much as 90% in studied streams (Olson and Wayne 1994).

Nitrogen- and phosphorus-containing sediments also settle, making beaver ponds a nutrient sink for a stream system. The storage of nutrient laden soil in sediment reduces eutrophication in nutrient-rich systems. In low-nutrient systems, such as headwater streams, the nutrient storage in pond sediment creates a time-release system increasing productivity. After the beaver leaves an area and the pond drains, the nutrient-rich soil is utilized by riparian vegetation to produce dense riparian areas (Allen 1983).

Decreased water velocity caused by beaver ponds alters the carbon cycle of streams. Reduced water velocity combined with increased water temperatures allows macroinvertebrates and bacteria to break down organic matter (leaves and wood) at a faster rate, creating dense macroinvertebrate populations. The breakdown converts organic matter to sediment and in some cases methane gas. The increased bacterial action reduces dissolved oxygen levels within the ponds and immediately downstream. The decreased velocity combined with increased width and overall surface area of the beaver ponds increases stream temperatures. The reduced concentration of dissolved oxygen and increased temperatures usually does not reach levels of concern for trout in Rocky Mountain streams (Gard 1961).

Beaver activity also has an effect on the riparian vegetation within proximity of the ponds, as well as the water table. Beaver activity increases the surface area of ponds by several hundred times, which is highly influential on the surrounding riparian vegetation (Clements 1991). The

increased surface area allows for storage of water in the banks and floodplain. The storage of water in the soil and floodplain increases the water table and stores water for times of low flow. During late summer low flow conditions, water stored in the banks provides cool water to moderate flow and extreme temperatures (Parker *et al*. 1985).

While storing water, beaver dams also reduce extreme flows and related disturbance. The dams moderate flow during flood periods. This moderation reduces bank erosion related to flood events, improving bank stability in downstream areas (Olson and Wayne1994).
Beavers consume large quantities of riparian vegetation or woody supplies in their diet, as well as for the construction and maintenance of their habitat. Consumption rates for beaver populations are higher than the regeneration rates of riparian vegetation. Beaver tend to occupy an area until the surrounding supplies are consumed and then move on to a new section of river within or outside of the watershed. Once a beaver leaves, high nutrient content in the area allows for fast regeneration of consumed riparian vegetation. Over time, the area will regenerate and be ready for a beaver to return in future years (DeByle 1985).

Beavers generally improve trout habitat. Cutthroat trout in Rocky Mountain streams tend to be most abundant in streams with beaver ponds. Beavers do several things for fisheries habitat: provide a food source, moderate stream temperatures, as well as increase habitat volume and over wintering habitat. Trout biomass and individual size increases with the presence of beaver dams. One possible explanation is high density of macroinvertebrates involved in the decomposition of organic matter and consumption of bacteria. Macroinvertebrates are a key food source for many trout, including RGCT. Increased pool volume, a vital habitat feature for trout, could also contribute to the correlation of healthy fish populations and beaver ponds. Over wintering habitat is also provided by the deep pools created by some ponds. The deeper pools become a refuge for fish when riffle habitat is frozen and can determine the carrying capacity of a stream. Flow and water temperature moderating effects that are caused by increased water tables provide cool water to the stream during low flow conditions. This could further increase the fish population carrying capacity of the stream (Olson and Wayne 1994).

Fisheries

As with most of the rivers in New Mexico, extensive stocking practices with non-native trout species has led to a drastic change in species assemblages. Historically Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*) was the only trout species found in the Panchuela Watershed. Currently, a small population of Rio Grande cutthroat trout (RGCT) exists in the upper reaches of Cave Creek. It is likely that an occasional RGCT is found in other fish-bearing stretches in the watershed. The remaining waters in the Panchuela Watershed host non-native German brown trout *(Salmo trutta)*, eastern brook trout (*Salvelinus fontinalis*) and rainbow trout (*Oncorhynchus mykiss;* see 12 and Figure 12).

Table 11. Fish distribution determined by USFS snorkel surveys and observation (2004).

Fish Species	Native/Non-Native	Distribution by Stream and Reach
Rio Grande cutthroat trout	Native	Cave Creek: Reach 5
German brown trout	Non-Native	
Rainbow trout	Non-Native	
Eastern brook trout	Non-Native	

RGCT have been eliminated from much of the Panchuela Watershed by exotic trout. Exotic trout species have been stocked in the watershed as early as 1896, with Forest Service records dating back to 1914.

Photo 10. Rio Grande cutthroat trout captured in Cave Creek, Reach 5 (6 Sep 04).

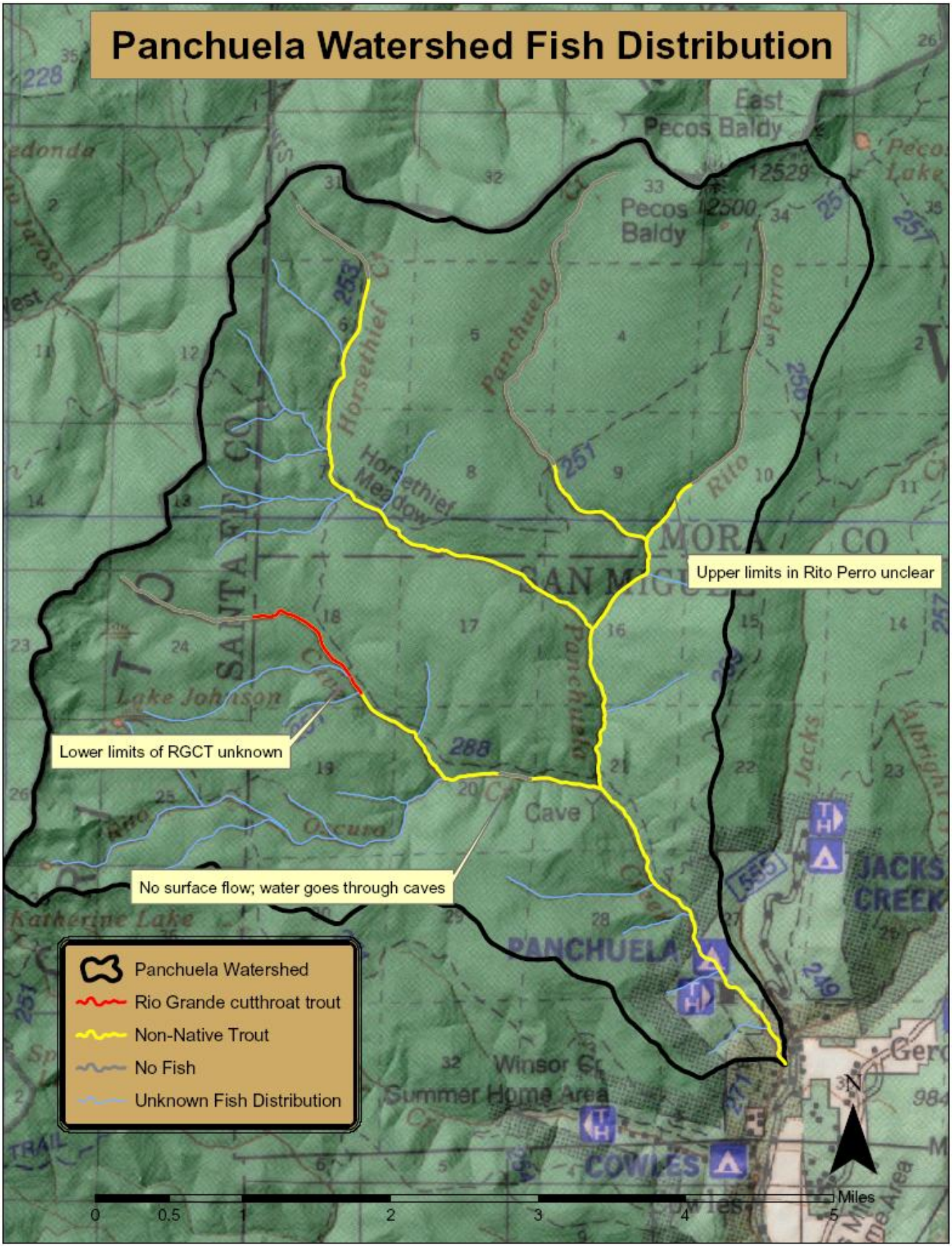


Figure 13. Map of fish distribution within Panchuela Watershed, including Rio Grande cutthroat trout in Cave Creek.

Table 12. Documented stocking records of surveyed streams in Panchuela Watershed.

Stream	Year	Species	# Stocked
Cave Creek	1936	Native Black Spotted Trout	9000
	1939	New Mexico Cutthroat	2500
	1942	New Mexico Cutthroat	3075
	1946	Rainbow Trout	3000
	1947	Rainbow Trout	4800
	1948	New Mexico Cutthroat	2560
	1949	New Mexico Cutthroat	2640
	1950	New Mexico Cutthroat	6400
	1958	Rainbow Trout	8000
Horsethief Creek	1935	Native Black Spotted Trout	12800
	1936	Native Black Spotted Trout	8000
	1945	New Mexico Cutthroat	2200
	1946	Rainbow Trout	3000
	1947	Rainbow Trout	9600
	1948	New Mexico Cutthroat	5120
Panchuela Creek	1914	Brook Trout	5500
	1917	Native Black Spotted Trout	6500
	1921	Brook Trout	24000
	1927	Brook Trout	30000
	1928	Brook Trout	38000
	1929	Rainbow Trout	15000
	1931	Native Black Spotted Trout	30000
	1931	Rainbow Trout	15000
	1932	Rainbow Trout	4000
	1933	Native Black Spotted Trout	62000
	1934	Native Black Spotted Trout	50000
	1935	New Mexico Cutthroat	30000
	1936	Native Black Spotted Trout	35000
	1937	Native Black Spotted Trout	25000
	1938	Native Black Spotted Trout	18000
	1938	Rainbow Trout	1000
	1939	Rainbow Trout	5000
	1942	New Mexico Cutthroat	3075
	1943	New Mexico Cutthroat	11250
	1944	Rainbow Trout	3113
	1945	New Mexico Cutthroat	2200
	1945	Rainbow Trout	12180
	1946	Rainbow Trout	6405
	1947	Rainbow Trout	13843
	1948	New Mexico Cutthroat	2560
	1948	Rainbow Trout	3710
	1949	New Mexico Cutthroat	7920
	1949	Rainbow Trout	8790
	1950	Rainbow Trout	22048
	1951	Rainbow Trout	2025
	1952	Rainbow Trout	4600
	1953	Rainbow Trout	14670
	1954	Rainbow Trout	825
	1955	Rainbow Trout	2262
	1956	Rainbow Trout	3320
	1957	Rainbow Trout	1712
Panchuela Creek	1958	Rainbow Trout	1535
	1959	Rainbow Trout	1854
	1960	Rainbow Trout	2548
	1961	Rainbow Trout	2822
	1962	Rainbow Trout	2027
	1963	Rainbow Trout	2366
	1964	Rainbow Trout	2528
	1965	Rainbow Trout	2152
	1966	Rainbow Trout	2087
	1967	New Mexico Cutthroat	5000
	1967	Rainbow Trout	10375
	1968	New Mexico Cutthroat	15000
	1968	Rainbow Trout	2207
	1969	Rainbow Trout	1790
	1970	Rainbow Trout	2024
	1971	Cutthroat Trout	10000
	1971	Rainbow Trout	1519
	1972	Cutthroat Trout	15413
	1972	Rainbow Trout	1624
	1973	Rainbow Trout	2684
	1974	Rainbow Trout	2002
	1975	Rainbow Trout	2391
	1976	Rainbow Trout	2761
	1977	Rainbow Trout	3465
	1978	Rainbow Trout	3422
	1979	Rainbow Trout	1824
	1980	Rainbow Trout	3043
	1981	Rainbow Trout	3299
	1982	Rainbow Trout	3301
	1983	Rainbow Trout	1984
	1984	Rainbow Trout	1898
	1985	Rainbow Trout	1618
	1986	Rainbow Trout	2310
	1987	Rainbow Trout	2430
	1988	Rainbow Trout	2350
	1989	Rainbow Trout	2473
	1990	Rainbow Trout	743
	1993	Rainbow Trout	450
	1995	Rainbow Trout	1150
	1996	Rainbow Trout	1900
	1997	Snake River Cutthroat	3120
	1997	Rainbow Trout	2500
	1998	Rainbow Trout	2371
	1999	Rainbow Trout	900
	2000	Rainbow Trout	700
	2001	Rainbow Trout	1321
	2002	Rainbow Trout	596
	2003	Rainbow Trout	1456
	2004	Rainbow Trout	693
	2006	Rainbow Trout	?
Rito Perro	1936	Native Black Spotted Trout	3000
	1947	New Mexico Cutthroat	2220

Panchuela Creek, Cave Creek, Horsethief Creek, and Rito Perro were stocked with various species of trout. Most notably, the first non-native fish (rainbow trout) were introduced into Cave Creek in 1947, Horsethief Creek in 1946, and Panchuela Creek in 1914 (brook trout). No non-native fish were stocked in Rito Perro. Panchuela Creek has been stocked annually with rainbow

trout since 1993. Prior to that rainbow trout were introduced annually from 1944 to 1990. Rainbow were last stocked in Cave Creek in 1958 and Horsethief Creek in 1947 (NMGF 2004). Despite the heavy stocking history with rainbow trout, wild populations of brook trout and brown trout dominate. Non-native German brown trout have never been documented as stocked in the Panchuela Watershed and may have been recruited from stockings in the Panchuela Watershed. Eastern brook trout were last stocked in the watershed in 1928.

The large number of exotic trout stocked in the Panchuela Watershed placed pressure on native trout that led to their extirpation. The exotic trout displaced the native population through competition for resources, hybridization and predation. Brown trout is a piscivore, consuming fish like RGCT. Brown trout also compete with native fish for food and living space in the river. A characteristic such as higher temperature tolerance (80.6°F) (Sublette et al. 1990) increases the brown trout's success over native trout in water where temperature is an issue. Rainbow trout freely hybridize with RGCT and threaten genetic purity of native populations (Sublette et al. 1990). Conflicts with exotic trout species are one factor that has led to the listing of RGCT as a sensitive species for the Forest Service.

It is unclear if the Rio Grande cutthroat trout population found in Reach 5 of Cave Creek has hybridized with rainbow trout. As of 2006, New Mexico Game and Fish has not scheduled the population for a genetics analysis (Patten 2006).

Photo 11. Non-native eastern brook trout from Horsethief Creek, Reach 1 (7 Sep 04).

Three USFS snorkel surveys were conducted during the summer of 2004 to investigate the fish population in Panchuela Creek, Rito Perro, and Horsethief Creek. 86 fish were observed in the 500 meters of stream that was snorkeled in Reach 3 of Panchuela Creek. Although brown trout are not currently stocked in the Panchuela Watershed, their population is dominant (77 fish) and 8 fish were unidentified with one large Rio Grande cutthroat observed. In Panchuela Creek 100 meters above and 100 meters below Rito Perro 16 fish were observed. Brook trout were the dominant species in this section of the creek with 13 individuals of various sizes. One rainbow trout, 1 Rio Grande Cutthroat trout, and one rainbow/cutthroat hybrid were observed. In 200 meters of Rito Perro 10 brook trout, 2 brown trout, 1 rainbow trout and 3 unknown trout were observed of various size classes. In 500 meters of Horsethief Creek 214 fish were observed with Brook trout being the most prolific species with 153 being observed. Fifty unknown trout were observed, 10 brown trout, and one cutthroat trout. All size classes of brown, brook, and unknown trout were observed. The "juvenile" size class is prevalent in all trout species of the Panchuela Watershed.

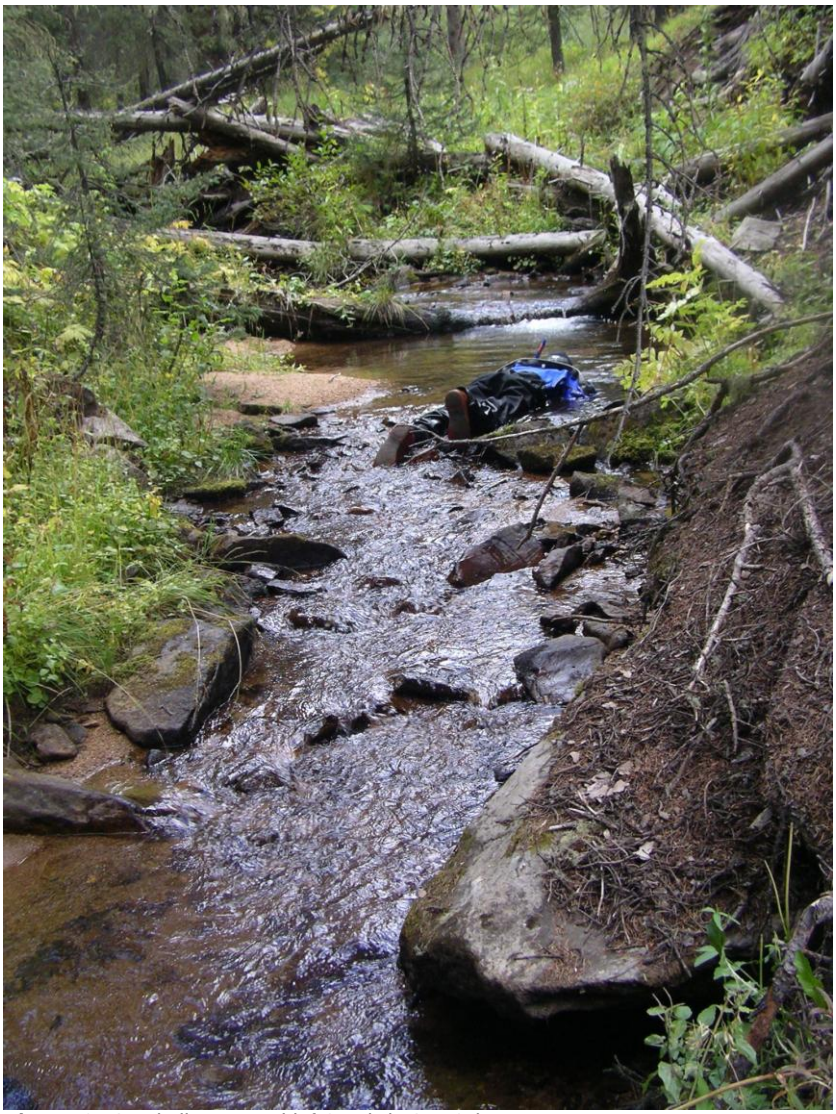


Photo 12. Snorkeling Horsethief Creek (7 Sep 04).

Wildlife Species

The Panchuela Watershed is home to a diverse array of wildlife including two threatened and five sensitive species (see Table 14). The threatened species that is of most concern in the watershed is the Mexican spotted owl. Mexican spotted owl habitat is characterized by cool, steep canyons and mixed conifer forest typical to the Panchuela Watershed. No Mexican spotted owls have been observed in the recent owl surveys of the Panchuela Watershed, but habitat makes their presence possible. Bald eagles, another threatened species in the watershed, are of lesser concern in watershed management because of their transient use of the area. Bald eagles do not over winter in the watershed and utilize the area occasionally for forage (Sarabia 2002).

The sensitive species present in the Panchuela Watershed are of concern in its management. Boreal owls inhabit older spruce and fir forests above 8,000 feet. Potential threats to the owl include removal of tree snags and reduction of prey habitat. Northern goshawks and peregrine falcons reside in ponderosa pine, mixed conifer, and spruce-fir forests. While northern goshawks nest and forage in these forests, the peregrine falcons only forage. The northern goshawk is sensitive to habitat loss from logging, catastrophic wildfire and other disturbances especially during breeding season. White-tailed ptarmigan's habitat is above 10,000 feet and is sensitive to human presence and grazing practices. It is not known if the blue-black butterfly is present within the watershed. The butterfly was not observed during recent surveys, although the necessary wet meadow habitat does exist. The butterfly's lifecycle is linked to the *Viola nephrophylla*, which grows in wet meadows and near seeps (Sarabia 2002).

Table 13. Threatened and sensitive wildlife species of the Panchuela Watershed (2004).

Species Type	Common Name	Scientific Name	Status
Birds	Bald eagle	*Haliaeetus leucocephalus*	Threatened
	Mexican spotted owl	*Strix occidentalis lucida*	Threatened
	Boreal owl	*Aegolius funereus*	Sensitive
	Northern goshawk	*Accipter gentiles*	Sensitive
	Peregrine falcon	*Falco peregrinus anatum*	Sensitive
	White-tailed ptarmigan	*Lagopus leucurus*	Sensitive
Insects	Blue-black silverspot butterfly	*Speyeria nokomis nokomis*	Sensitive

Non-listed wildlife can be used as indicators of habitat condition in the Panchuela Watershed. Management Indicator Species present in the watershed include Rocky Mountain elk (*Cervis elaphus neisoni*), Rock Mountain bighorn sheep (*Ovis canadensis Canadensis*), hairy woodpecker (*Picoides villosus)*, Merriam's turkey (*Meleagris gallopavo*) and mourning dove (*Zenaia macroura*). The elk population in the watershed is stable to increasing and is ranked as common with 100 to 10,000 pairs. Elk inhabit much of the area covered in the stream inventory. The bighorn sheep population is considered to be at capacity for the available habitat. The sheep habitat is in steep and rocky areas common in the tundra and alpine areas near the headwaters. The hairy woodpecker population is ranked as abundant in the Forest and breeding pairs range from 10,000 to 100,000. The woodpecker can be used as an indicator species for the presence of down logs averaging 17 inches diameter at breast height (DBH) and greater than 30 feet long, which are their foraging habitat. The turkey population in the Forest is ranked as common with 1,000 to 10,000 breading pairs. Ponderosa pine forests and surface water are requirements for turkey habitat common to the lower reaches of the survey. The mourning dove population in the forest is ranked as common with between 1,000 to 10,000 breeding females. The dove habitat is abundant and occurs primarily in the lower elevations of the survey (Sarabia 2002).

Stream Improvements

Stream improvement structures have been installed in the Panchuela and other rivers around New Mexico since the 1930's. Most of the structures were installed by the Forest Service, NMGF or as a cooperative effort between the two agencies. Historic stream restoration efforts were focused on improving fishing habitat and not stream habitat (Tatschl 1981). Tatschl's statement emphasizes the entertainment focus that historically dominated fisheries biology and management. One basic type of stream improvement structure exists in the Panchuela Watershed: Log structures used to increase pool habitat.

The Forest Service reports that between 1946 and 1955 four stream imporvement structures were installed in Panchuela Creek. In 1964 HJ McKirdy, working for the Forest Service, reports that 18 log structures were built in the creek above Panchuela Campground (McKirdy 1964).

Photo 13. Panchuela Creek, Reach 1, NSO 31, R15. Typical stream improvement structure found in the watershed (28 June 04).

Log structures were utilized to increase pool habitat in the rivers around New Mexico. In the early 1950's the structures were only used in wilderness areas where material transport was an issue. In wilderness situations stream improvements were built from native materials, with specific emphasis on aesthetic considerations. These structures were much more expensive to construct, averaging $100 per structure (Jester and McKirdy).

The fixed log structures were anchored in place, either straight across or in a "V" shape spanning the river channel. The logs created a drop in the channel and eventually a scour pool. While initially quality habitat was formed, most of the structures are not successful in creating long-term pool habitat. Nearly all of the anchored log structures caused the stream's width to increase or forced the stream to move around the structure. Due to the anchored and unbending nature of the modifications, many ended up breaking due to the flow's extreme force, leaving only evidence and scraps of their existence.

LAND USE

From approximately 5000 BC until the 19th century AD peoples native to the Panchuela Watershed area used the land to fulfill basic livelihood needs. From about 1600 until the 19th century, the local Hispanic population also used the area for grazing. There have been no known settlements in this area besides edifices built by the Forest Service, although archeological findings from 1952-1955 have uncovered some pottery and artifacts dated to about 1500 AD. These were found at about 11,000 feet elevation (near the timberline) on the Horsethief/Panchuela divide. Other artifacts (not dated) were also discovered in Horsethief Meadow. These archeological findings were incidental, and it is thought that other artifacts could be discovered with a targetted inventory.

Henry D. Winsor purchased the Wano Mine in the copper mining district located at the confluence of Panchuela Creek with the Panchuela Watershed from J.T. Cooper. Henry Winsor's son, Martin, received a Land Patent in 1891 and built Winsor's Camp, a boarding house (Mvranch).

In 1892, the Panchuela Watershed Reserve was created by President Harrison. The land was used for sheep grazing until the Second World War, when cattle were first introduced and became the primary grazing animals. Currently the Horsethief Allotment covers most of the watershed area, with additional acreage extending past the watershed's southern border. The geographical location and size of the Horsethief Allotment is important to note (see map), as much of the recorded historical land use in the Panchuela Watershed occurred in connection with this allotment.

In the early 1900's, Amado Chaves leased land from the Forest Service and built the Los Pinos Resort. The cabins he built are still found on the road leading to the former Panchuela Ranger Station. By 1915 H.D. Winsor sold Winsor's camp to H.U. Mudge, except for the northern-most two acres. The land was then turned into Winsor's Ranch, where several cabins, also known as Winsor's Cabins, were subsequently built near the road leading to the old Panchuela Ranger Station. The old Winsor's Camp was later renamed the Mountain View Ranch and, after renovations of the main cabin in 1922, sold to Skipper Viles in 1930. The property extended north, past Los Pinos, to approximately where the Panchuela Cabins are located, and served as a base for a great deal of horseback riding activity (wilford, mtn view ranch).

Photo 14. Panchuela Ranger Station in the early 1900's.

In 1912 the Forest Service built the first Panchuela Ranger Station where the campground are presently located. An acequia, or irrigation diversion, was built soon afterwards in 1915 by the Forest Service.

According to the former Pecos District ranger J. Johnson, the area was overstocked with cattle for a number of years. Between 1920 and 1922, roughly twice the allowed number of sheep were grazing on the Pecos Ranger District. During a similar time frame (exact date not given), the Gross-Kelly Company, which was involved in timber products, owned a sizeable portion of the forest from exchanging lieu-selection script. A tornado hit the area during the late 1920's, taking down numerous trees according to J. Johnson. In 1943 J. Johnson also planted 5000 fingerlings into Johnson Lake, source of Rito Oscuro and tributary to Cave Creek (mtn view ranch).

By 1945, the former Panchuela Ranger Station was abandoned and relocated to Pecos. This area later became the Panchuela Campground, and reportedly mine spoil from Tererro Mine (a

Superfund Site) was used to build some parts of it. Deer mice and brown trout were studied for levels of various inorganic toxins originating from this mine waste (1991 Tim O'Brien water quality study). In 1960, the SFNF imposed a reduction of standard permits, thereby decreasing allowed grazing. Several years later, the Pecos Wilderness was created by the Wilderness Act of 1964. The Forest Service bought the Mountain View Ranch in 1976 (Jeremy interview, Wilford). Numerous cabins were auctioned off and the remainder burned down, including the Viles Cabin (wilford). Starting at around this time, the Forest Service began installing stream structures in the Panchuela Watershed (wilford).

Photo 15. Spraying DDT insecticide over Panchuela Cabins in 1955 to kill spruce budworm.

In a 1967 FS document, Horsethief Meadow was described as receiving increasing use by anglers on foot and horseback and by deer and elk hunters, while the area was already showing signs of deterioration. While the Horsethief /Cave Creek divide was receiving little recreational use, its small size also prevented rotating cattle within the area, placing extra stress on the local flora. Winsor Ridge reportedly received heavy recreational use, especially by horseback riders; elk also used it as winter range (AMP 1967, file 2210).

Photo 16. Trail riders along the watershed and Horsethief Allotment boundary near Pecos Baldy in 1959.

The same document breaks down use of the Horsethief Allotment in terms of animal months as follows: Recreational use (including anglers and hunters on horseback as well as trailriders) totalled 53.5 animal months. Total cattle and elk use was equivalent to 531 animal months (81 and 450 respectively). Combined recreation and wildlife use totaled 584.5 animal months while suitable range was estimated to provide only about 65 animal months (AMP 1967, file 2210). Presently the area is still used primarily for grazing, hunting, horseback riding, and hiking.

Roads

Fish habitat degradation can result from poorly planned, designed, located, constructed, or maintained roads (Furniss et. al 1991). Even in good condition, roads introduce large quantities of sediment to streams (Grayson et al. 1993). The increased fine sediment concentrations that result from high road densities has been associated to decreased fry emergence, decreased juvenile densities, loss of winter carrying capacity, and increased predation of fishes. The introduction of fine sediment has also been related to the reproductive degradation in salmonids. Survival of incubating salmonids from embryos to emergent fry has been inversely related to the proportion of fine sediment in spawning gravels (USDA Forest Service 2000).

Panchuela Watershed is primarily in wilderness with only the Reach 1 of Panchuela Creek accessible by road. A total of 1.04 miles of road are located inside the Panchuela Watershed, equating to a meager 0.05 miles per square mile of road.

Mines

Any info on Wano Mine or any other mines in the watershed.

Fires

Historically, fire has played an important role in the forests of northern New Mexico. The forests adapted to a natural fire regime, which played an important role in the ecology of these systems. The historic fire regime consisted of smaller, more frequent fires that burned at a lower temperature than the current catastrophic, large scale burns. Historic burns reduced the density of trees and shrubs, the amount of dead wood and kept forest fire fuels low. However, human intervention has dramatically altered the historic fire regime. Fire frequency in the Sangre de Cristo Mountains has declined since the 1750's, possibly due to intensive grazing and shrub removal (Touchan et al. 1994). Over a century of fire suppression further reduced the fire regime frequency creating an abundance of fuel and increasing the potential for catastrophic fires similar to the 2000 Viveash Fire. Catastrophic fires create larger and hotter burns, dramatically altering the ecosystem.

Two major fires have burned within the watershed in the last 35 years. The 1989 Horsethief Fire (863 total acres) burned 39.7 acres in the upper portion of Panchuela Creek (Reach 7). In 1974, an unnamed fire burned 40 acres along a ridge between Cave Creek and Horsethief Creek, affecting the lower reaches of those two streams along with Reach 3 of Panchuela Creek. Since 1970, there have been 5 fires reported in the watershed, 3 of which have been an acre or less in size, totaling 81.1 acres in the Panchuela Watershed (0.6% of the watershed area).

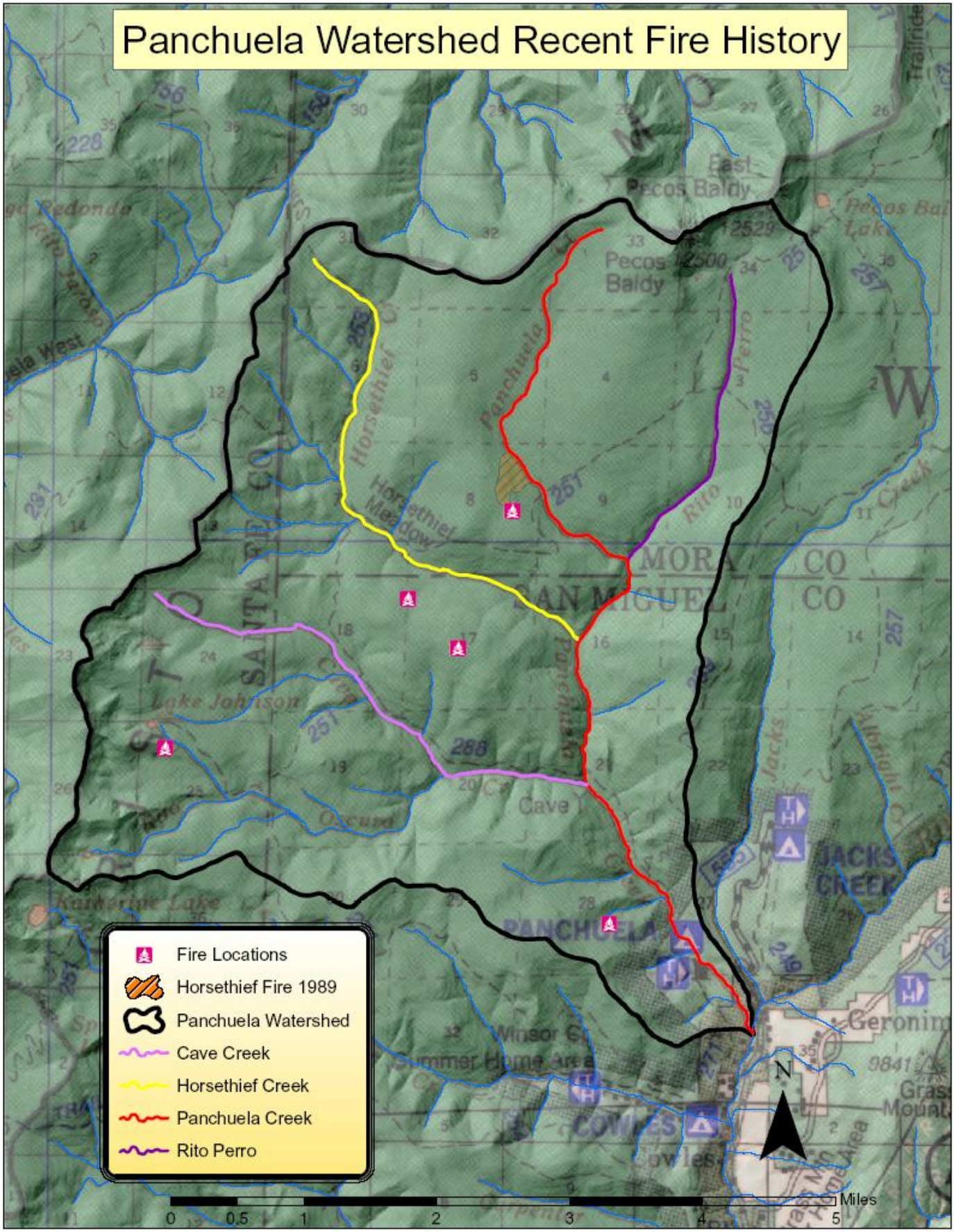


Figure 14. Panchuela Watershed Fire Locations since 1970.

Stock Grazing

Ranching is a tradition and has been a way of life in Northern New Mexico since the Europeans arrival in the 1540's (USDA Forest Service 1996). Grazing on public lands has occurred for nearly a century. Horsethief allotment is only one within the Panchuela Watershed.

A 1966 Horsethief Allotment Re-analysis describes the topography of the area as having temperature range of -35 to 85°F, with most suitable grazing ranges located at approximately 10,000 feet elevation and along several narrow canyon bottoms. Parent material comprising the soils was described as originating from glacial till, including granite, gneiss, and schist. Near the timberline the dominant soil type was said to be stony loam with a high percentage of fine gravel, with moderate overall erosion hazard. Vegetation described in the Horsethief Allotment is of primarily four types, including mixed conifer, aspen, grassland, and meadow. The growing season was described as short and beginning only once the ambient temperatures reached more than 40°F (HT allotment reanalysis 1966).

A 1967 Horsethief Grazing Allotment Action Plan describes the allotment as being 19,964 acres in size, with only 234 acres suitable for grazing. These 234 acres included Horsethief Meadow (105 acres), Cave Creek Divide Park (23 acres), and Winsor Ridge (96 acres).

In 1951 R.M. Jarrot received permission from the Forest Service to graze 800 sheep on the Horsethief Allotment, equivalent to 480 cows for the purpose of grazing impact analysis. He gave up these rights to New Mexico Game and Fish by 1960 (AMP files 2210). According to a 1966 Allotment Re-analysis, the Horsethief Meadow grazed about 1000 sheep between June 1st and September 30th until 1962; however the document also claims that the area was not grazed between 1956 and 1962. Enclosures were installed in several areas in the allotment in 1958 to monitor grazing impact. It appears that this project received little follow up besides some monitoring in 1966. In 1963 the allotment was once again grazed by the Gonzales Brothers, and suffered poor management practices due to the small size of suitable grazing areas. Their small area prevented rotating cattle, so that they grazed the same areas (usually Horsethief Meadow) during the entire grazing season from June 1st until September 30th (AMP file 2210-1).

In 1967, an action plan recommended removing cattle altogether from the Horsethief Allotment and rotating them between Grass Mountain and Dockwiller Allotments. It is not certain to what extent, if at all, these recommendations were followed. In addition, the annual plan described the Horsethief Meadow as being grazed continuously during the forage plants' growing season, thereby impeding their vigor. An allotment analysis performed in 1966 showed this area to be in fair condition. Another recommendation in the 1967 document suggested changing the cattle entry date from June 1 to June 15, thereby allowing foraging species the required growing period, believed to start in mid-May. In addition, it recommended rotating cattle between Horsethief Meadow, Horsethief/Cave Creek Divide, and the Horsethief Meadow in one month intervals during the June to September grazing season. Long range objectives detailed in this document included converting the Horsethief Allotment to recreational grazing only, because it was projected to increase substantially. Here again it is not certain to what extent these recommendations were followed (AMP notes 2210-1).

Recreation

The Pancheula Watershed is utilized for a variety of recreational activities. Fishing, hiking, hunting, camping and horseback riding are some examples of the recreational uses of the watershed. The watershed hosts one developed campsite, trailhead and six FS trails (# 243, 251, 253, 259, 267, and 288) that total 23.0 miles of which 8.3 miles are located within the floodplain and/or near a stream. The trail system has 13 documented stream fords on major streams within the watershed. Other than recreational opportunities provided at Panchuela Campground, the remainder of activities are non-motorized. Majority of the watershed is located in designated wilderness.

Historic dispersed (user-created) campsites can be found throughout the watershed, most often associated with water, unique land features, and established trails. These sites should be improved with an emphasis on protecting stream habitat. Campsite improvements should be augmented and supported by an educational approach. Education should focus on proper camping techniques as well as stewardship of the environment. Recreation should be managed to increase riparian zone vegetation and stream integrity.

Photo 17. Horsethief Creek, Reach 2. Popular camping area in Horsethief Meadow (4 Sep 04).

A watershed restoration and education program, entitled Respect the Rio, has been established in the Jemez Mountains. This program can be used to promote and implement better user stewardship in the watershed.

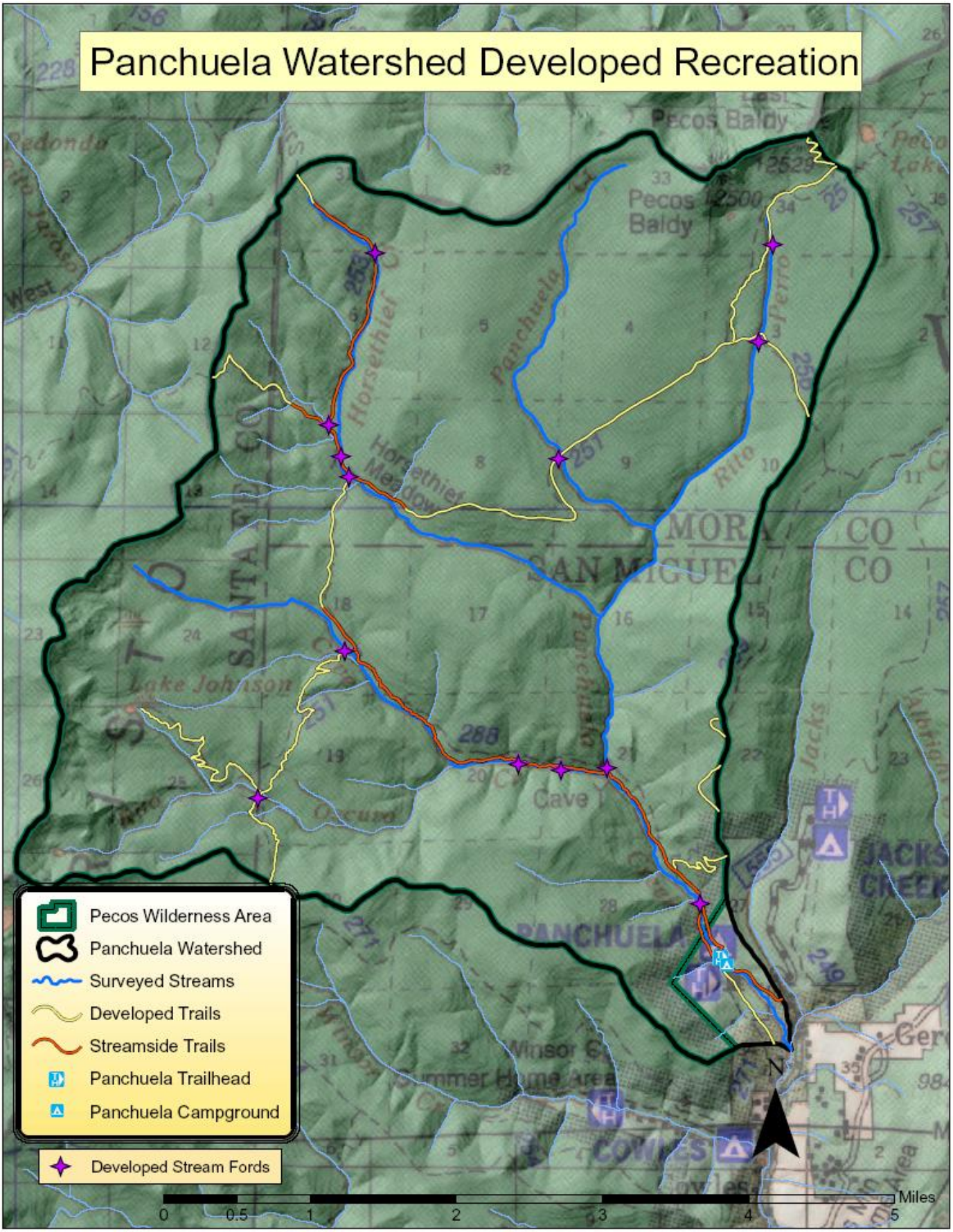


Figure 15. Panchuela Watershed Developed Recreation (trails, trailhead, campground) with indications of streamside trails and crossings.

Suggested practices to improve management through the Respect the Rio program include:

1) Dispersed campsites and trails along streams could be modified, rehabilitated and regulated by moving camping at least 100' away from the stream;
2) Some sections of stream could be designated "Day Use Only" to protect natural (i.e. Cave Creek) and cultural resources (i.e. Horsethief Meadow). Closed campsites would allow degraded riparian vegetation to re-establish;
3) Riparian vegetation could be replanted and re-established to restore riparian ecosystem function in hard hit areas;
4) Current educational signing at trailheads is excellent. To keep the mantra in mind, "take as you go" educational brochures about Leave No Trace could be provided at the trailhead kiosk. Education campfire programs could be offered at Panchuela, Cowles and Jack's Creek Campgrounds to further inform the public;
5) A person, known as a wilderness contact ranger, could patrol high use areas informing the public about benefits and proper practices necessary for low-impact, Leave No Trace recreation;
6) Establish a designated trail system in high use corridors and obliterate multiple trails. Currently, no FS Trail leads users to the caves along Cave Creek, thus an assortment of trails lead to the same location.

RECOMMENDATION SUMMARY

Education

Objective:
Educate forest users regarding the effects of their activities on the natural resources, inform them of ways to minimize impacts and promote better use of the resource.

Concerns:
Public education is one of the most important changes that must be made for management to be successful. Without education degrading activities will continue along with the associated damage. Rehabilitation programs spend millions of dollars repairing damage, but if the public isn't properly informed about a project, the money will have been spent needlessly.

Implementation methods:

1) Create a contact ranger program. A team of educators will contact forest users during intensive use times (summer), informing them of proper camping, fishing, and other recreational practices including "Leave No Trace" ethics. The team will also inform users of restoration and regulation changes occurring in the area.
2) Members of the public, including local and state decision makers, will be invited to join Forest fisheries staff in seminars focused on stream integrity, including snorkeling seminars. Special seminars will also be offered to teachers and university courses.
3) Development and implementation of K-12 classroom educational programs. Several schools are either currently or becoming interested in water quality and riparian monitoring on forest water bodies.

Riparian

Objective:
Restore a natural riparian vegetation community, promoting watershed integrity and function.

Concerns:
Currently, the riparian vegetation is degraded in the Panchuela Watershed. Land use practices including, but not limited to, dispersed recreation and grazing are causing significant impacts on the riparian zone. Reduction of riparian zone species and decreased density are examples of the current degradation. The integrity of the riparian zone is crucial to stream function and coldwater fish habitat. The current riparian vegetation and management practices should be altered to simulate and promote a healthy vegetation community.

Implementation methods include:

1) Augment current riparian area density by planting native species.
2) Grazing practices should be managed to protect the riparian area. Riparian grazing should be eliminated or highly reduced during the vegetation's growing season.
3) Reduce number and limit the use of dispersed trails and campsites within the riparian zone.

Large Woody Debris

Objective:
Increase LWD densities to within natural range of variability, improving coldwater fisheries habitat and stream integrity.

Concerns:
Large woody debris (LWD) in the Panchuela Watershed is below the desirable densities in forested reaches.

Implementation methods:

1) Arrange LWD in the floodplain and stream in strategic locations, increasing habitat complexity and fish habitat. These projects would utilize the best available science for LWD implementation to avoid previous stream improvement mistakes.

Native fish populations

Objective:
Restore and protect populations of native Rio Grande cutthroat trout in their historic range.

Concerns:
Except for the reintroduced population of Reach 15, RGCT have been extirpated from their historic range in the Panchuela Watershed. The population should be extended downstream from Reach 15 to occupy more of their historic range.

Implementation methods:

1. Work in partnership with NMGF and the communities to methodically expand the range of RGCT to downstream reaches and tying together with other streams such as Cave Creek, Rito Oscurro, Horsethief Creek, Panchuela Creek and Rito Perro.
2. Utilize natural barriers or areas of confinement, such as bedrock canyons to minimize the construction of man-made barriers.

REACH SUMMARIES

Photo 18. Panchuela Creek, Reach 2, NSO 54, P11. One of many beaver ponds that predominate habitat in the bottom of the watershed (29 June 04).

PANCHUELA CREEK

Reach 1: Mouth to Panchuela Campground

Reach 1 starts at the confluence with the Panchuela Watershed (T19N, R12E, Sec. 34, elev. 8,210') progressing upstream 0.8 miles to the downstream end of Panchuela Campground and Trailhead (T19N, R12E, Sec. 34, elev. 8,338') where the reach was broken due to change in valley morphology. The channel has an average gradient of 3.1% with minor sinuosity (1.1) and is dominated by cobble substrate forming a B3 Rosgen stream type. Reach 1 was surveyed on June 27th and 28th, 2004.

Photo 19. Reach 1, NSO 20, R10. Typical riffle habitat (27 Jun 04).

Reach 1 is bordered on the left by a meadow system in the second terrace. A steep canyon wall borders it on the RB just above the confluence. The right canyon wall experienced a high amount of natural instability due to its steep gradient. The stream bounces between these two confining features, sometimes tight to the left terrace and sometimes to the right. Pocket pools were a common feature throughout the reach due to multiple small plunges. Full spanning natural pools generally had debris jam hydraulic controls with high sediment content but were rare.

LWD was prevalent although most were characterized as small. In addition to the recorded wood, debris jams and smaller woody debris diverted and slowed down stream flow. Multiple spanners were observed with branches acting as debris collectors. Throughout the reach, LWD outside of bankfull was observed and could be potential future recruitment.

Photo 20. Reach 1, NSO 7, R5. Log jam at top of riffle, forming plunge (27 Jun 04).

The valley floor is typically open on at least one side of the stream, allowing for the formation of long side channels. Five side channels were identified in Reach 1. Two channels were over a thousand feet in length. Due to a generally flat valley floor and alluvial formation, side channels generally had intense braiding and high sinuosity, providing quality fish habitat. Multiple debris jams form deep pools with maximum depths around 2 feet. A fisherman was observed with two 8" rainbow trout while surveyors observed two 5" rainbows.

Another consistent feature in this reach were man-made log structures (see Photo). These structures were created generally from three logs. Two logs were anchored to the bank and a third log was lodged between the other two. At least 20 of these structures were observed. For the most part the structures were functioning. They created plunges that generally created pocket plunge pools and sometime full spanning pools.

Human use of this area was heavy. At the conclusion of Reach 1, Panchuela Campground is located on the left bank. Trails from the campground extend down to the mouth of the river. Angler trails followed both banks. Generally there was little erosion until the stream came close to the canyon wall on either bank. People were also accessing the stream from the mouth and coming up. A pedestrian footbridge spanned the main channel of the creek in R15.

The riparian zone was characterized by alders, willows, and confiners. There were definite breaks in the canopy over the stream. Near the top of the reach, willow dominated the riparian and hung densely over the creek.

Photo 21. Reach 1, NSO 27, P5. Plunge pool created by man-made habitat structure (28 Jun 04).

All five tributaries but one came down the LB from the meadow. All LB tribs were a series of seeps that came together to form small channels and flowed directly into a side channel (S3) near the middle of Reach 1. The seeps may be associated with an irrigation diversion found higher up on the slope.

Photo 22. Needs Info

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Nine (9)

temperatures were taken during the survey of Reach 1. The highest temperature was 60°F and the lowest was 48°F. The average stream temperature was 55.3°F.

Habitat Characteristics

Reach 1 is divided into 31 NSOs, measuring 0.8 miles (4,158 feet). Six (6) NSOs are pools, and comprise 3.9% of the stream habitat. Fifteen (15) riffles make up 58.3% of the stream habitat in Reach 2 (see Table). Five (5) side channels created a large amount of habitat (37.8%), making up for the lack of pool habitat.

Table 14. Summary of Reach 1 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	6	262	6.2	3.9	≥30%
Riffle	15	3,896	93.8	58.3	-
Culvert	0	0	0.0	0.0	-
Tributary	5	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	5	2,530	N/A	37.8	-
Dry Channel	0	0	0.0	0.0	-
Total	31	6,688	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

Photo 23. Needs info

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 1 contains characteristics that are both not properly functioning

and properly functioning. The parameters that are **not properly functioning** include pool development, sediment, and LWD density. **Properly functioning** factors include pool quality, streambank condition, and bankfull width-to-depth ratio.

Sediment content in riffle habitat (20.0% fines) is **not properly functioning** (see Table). Given the alluvial nature of Reach 1, this may be within the natural range of variability.

Table 15. Summary of riffle habitat and substrate composition in Reach 1.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width[1]	Avg Depth	Avg. Max Depth	
1	15	259.7	13.8	1.1	2.0	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
1	20.0	22.0	40.7	16.7	0.7	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

[1]- No actual measurements were taken in Reach 1, so the average width is estimated and not corrected
Red – Not Properly Functioning
Orange – Dominant Substrate

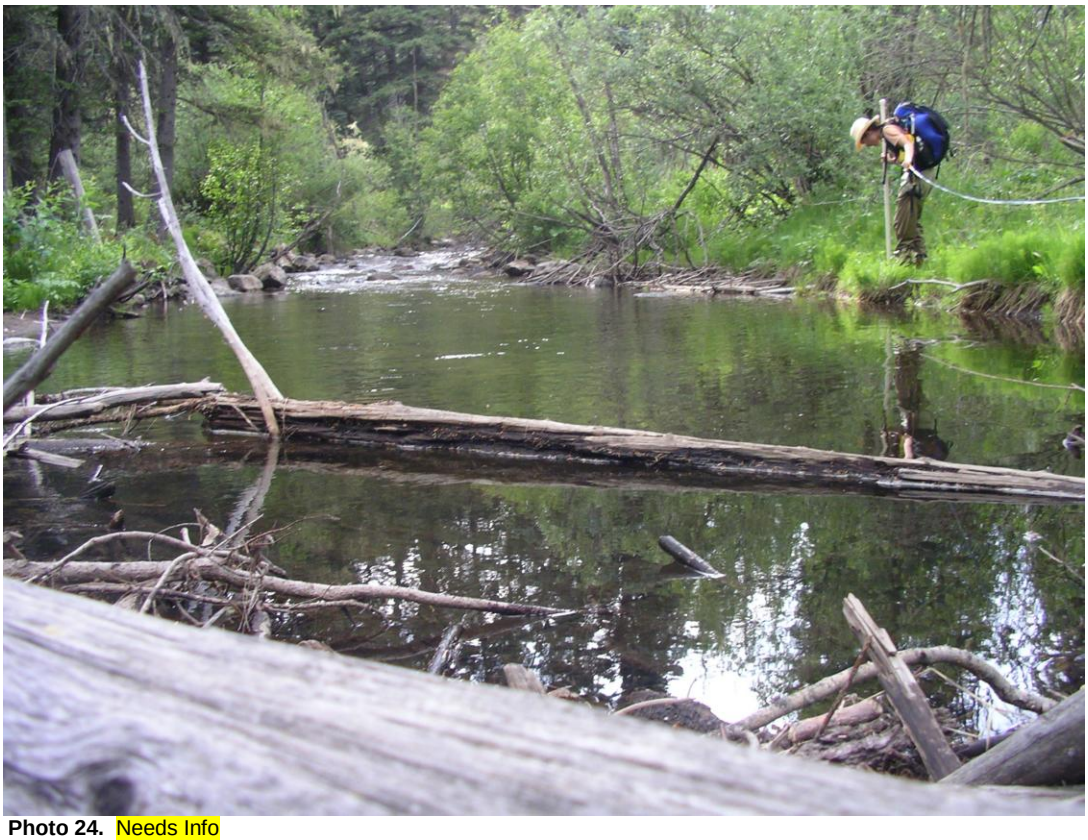


Photo 24. Needs Info

Pool development in Reach 1 is **not properly functioning,** representing only 3.9% of the stream habitat (see Table). This could be in part related to the alluvial and depositional nature of the reach. All but one pool in Reach 1 were quality pools with residual depth greater than one foot (see Table 21). One (1) pool had a maximum depth greater than 3 feet. Pool substrate was dominated by sand (34.0%).

Table 16. Summary of pool habitat and substrate composition in Reach 1.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
1	6	43.7	17.3	2.5	0.7	1.8	7.7	5	6.4	1	1.3
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
1	34.0	26.0	30.0	10.0	0.0	100.0

Orange – Dominant Substrate

Bankfull width-to-depth ratio, 13:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Large woody debris is **not properly functioning** in Reach 1. Fourteen (14) pieces of LWD in the reach create a density of nearly 18 pieces per mile (see Table). An additional 43 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools.

Bank instability is **properly functioning** in Reach 1, with 301 feet of unstable bank, or 3.6% of the reach (see Table). Most of the bank instability is associated with natural conditions with small localized areas created by heavy recreational use.

Table 17. Habitat characteristics for Reach 1.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
1	0.4:1	13:1	17.9	301	3.6
Properly Functioning Indicators	-	12<30	>30	-	<10

Red – Not Properly Functioning

Photo 25. Needs Info

Recommendations

Education

Objective:
Educate forest users regarding the effects of their activities on the natural resources, inform them of ways to minimize impacts and promote better use of the resource.

Concerns:
Public education is one of the most important changes that must be made for management to be successful. Without education degrading activities will continue along with the associated damage. Rehabilitation programs spend millions of dollars repairing damage, but if the public isn't properly informed about a project, the money will have been spent needlessly.

Implementation methods:

1) Create a contact ranger program. A team of educators will contact forest users during intensive use times (summer), informing them of proper camping, fishing, and other recreational practices including "Leave No Trace" ethics. The team will also inform users of restoration and regulation changes occurring in the area.
2) Members of the public, including local and state decision makers, will be invited to join Forest fisheries staff in seminars focused on stream integrity, including snorkeling seminars. Special seminars will also be offered to teachers and university courses.
3) Development and implementation of K-12 classroom educational programs. Several schools are either currently or becoming interested in water quality and riparian monitoring on forest water bodies.

Riparian

Objective:
Restore a natural riparian vegetation community, promoting watershed integrity and function.

Concerns:
Currently, the riparian vegetation is degraded in the Panchuela Watershed. Land use practices including, but not limited to, dispersed recreation and grazing are causing significant impacts on the riparian zone. Reduction of riparian zone species and decreased density are examples of the current degradation. The integrity of the riparian zone is crucial to stream function and coldwater fish habitat. The current riparian vegetation and management practices should be altered to simulate and promote a healthy vegetation community.

Implementation methods include:

1) Augment current riparian area density by planting native species.
2) Grazing practices should be managed to protect the riparian area. Riparian grazing should be eliminated or highly reduced during the vegetation's growing season.
3) Reduce number and limit the use of dispersed trails and campsites within the riparian zone.
4) Improve trail stream crossings to reduce stream widening and reduce sediment delivery.

Large Woody Debris

Objective:

Increase LWD densities to within natural range of variability, improving coldwater fisheries habitat and stream integrity.

Concerns:
Large woody debris (LWD) in the Panchuela Watershed is below the desirable densities in forested reaches.

Implementation methods:

1) Arrange LWD in the floodplain and stream in strategic locations, increasing habitat complexity and fish habitat. These projects would utilize the best available science for LWD implementation to avoid previous stream improvement mistakes.

Native fish populations

Objective:
Restore and protect populations of native Rio Grande cutthroat trout in their historic range.

Concerns:
Except for the reintroduced population of Reach 15, RGCT have been extirpated from their historic range in the Panchuela Watershed. The population should be extended downstream from Reach 15 to occupy more of their historic range.

Implementation methods:

1) Work in partnership with NMGF and the communities to methodically expand the range of RGCT to downstream reaches and tying together with other streams such as Cave Creek, Rito Oscurro, Horsethief Creek, Panchuela Creek and Rito Perro.
2) Utilize natural barriers or areas of confinement, such as bedrock canyons to minimize the construction of man-made barriers.

Reach 2: Panchuela Campground to Cave Creek Confluence

Reach 2 starts at the lowest end of the Panchuela Campground (T19N, R12E, Sec. 34, elev. 8,338') and progresses upstream 1.8 miles to Cave Creek where there is a significant change in stream flow (T19N, R12E, Sec. 21, elev. 8630') The channel has an average gradient of 3.1% with moderate sinuosity (1.4) and is dominated by cobble substrate forming a B3 Rosgen Stream Type. Reach 2 was surveyed from June 28th to July 8th, 2004.

The valley through which the stream passes is characterized by a slightly increased gradient. In addition the canyon walls were steep beyond the valley floor and did not level out into a meadow as in the previous reach. The increased gradient caused a faster flowing and deeper thalweg. The stream bounced from one canyon wall to the other, turning towards the opposite canyon wall with a sudden change in direction. Pocket pools were a common feature formed by both small debris jams and scouring around boulders. Debris jam formed pools were high in sediment. Undercut banks were also a common feature in riffle and pool habitat.

Photo 26. Reach 2, NSO 85, R37. Looking downstream at typical riffle habitat (7 July 04).

The riparian vegetation in this reach was characterized by willow and alder. At times the vegetation was thick and low hanging providing ample stream shade. Herbacious vegetation included frequent horsetail, cow parsnip, and hemlock.

LWD was prevalent, most of which were small and medium. In addition to the recorded wood there were multiple debris jams forming pools caused by spanners and boulders. Potential large woody debris was observed in the floodplain throughout. Several large log jams were noted (see Photo), creating pool habitat. The log jams appeared to be formed during high flow events where additional woody debris was deposited below the jam.

Photo 27. Reach 2, NSO 93, R41. Log jam complex (8 July 04).

Beaver presence also characterized Reach 2. A large beaver complex occurred in an area of the valley that was a fairly flat meadow. Three dams were observed, two of which were in a large side channel complex. This complex was characterized by young side channels just getting established and several old established channels. There was a high amount of silty deposits due to the beaver dams. The deposits were up to 2 feet deep in spots. Beaver chews and the start of small dams were also observed.

Another consistent feature in this reach were man-made log structures. These structures were created generally from three logs. Two logs were anchored to the bank and a third log was lodged between the other two. At least 30 of these structures were observed. For the most part the structures were functioning. They formed plunges that generally created pocket plunge pools and sometime full spanning pools.

Photo 28. Reach 2, NSO 48, S10. One of three ponds in major beaver complex (29 June 04).

The periodically open valley allowed for the formation of multiple side channels. These side channels were generally short and occurred in groups. The side channels were commonly multiple stable channels that braided together and were often related to overflow from log jams or beaver dams. The side channels diverted as much as 40% of the flow and provided quality fish habitat. Side channel habitat commonly included debris jams, beaver dams, and boulder-forming pools.

Photo 29. Reach 2, NSO 48, S10. Braided habitat between beaver ponds (29 June 04).

Reach 2 received heavy human pressure, associated with Panchuela Campground at the start of the reach as well as FS Trail #288. There was evidence of browning out, erosion, and trampling of vegetation due to the recreation in the campground. There were some areas of obvious stream widening. Just above the campground was an acequia, diverting about 5% of the flow into a galvanized steel pipe that released water into an open channel in the Forest Service pasture. The structure had an associated dam that was 30 feet long and 2 feet high. A non functioning fence line also comes down to the creek just above the campground. Angler's trails paralleled the creek throughout Reach 2. The Cowles Horse Trail fords the stream just below the beaver complex and causes intense widening in that habitat. There was also a non-functioning culvert sitting in the middle of a side channel at another horse crossing. The horse trail then climbs the canyon wall to Trail 288 which mostly stays in the terrace but parallels the creek. User created trails stem from the horse trail and Trail #288 to access the creek.

Five tributaries contributed flow to Reach 2. Four of the five tributaries came in from the right bank. The fifth and most significant tributary was Cave Creek, contributed 30% of the stream flow. Cave came in from the left bank and had two points of entry.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Thirteen (13) temperatures were taken during the survey of Reach 2. The highest temperature was 56°F and the lowest was 48°F. The average stream temperature was 51.7°F.

Habitat Characteristics

Reach 2 is divided into 75 NSOs, measuring 1.8 miles (9,367 feet). Twenty-one (21) NSOs are pools, and comprise 7.7% of the stream habitat. Thirty-two (32) riffles make up 72.4% of the stream habitat in Reach 2 (see Table). Seventeen (17) side channels created a moderate amount of habitat (19.9%), making up for the lack of pool habitat.

Table 18. Summary of Reach 2 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	21	905	9.7	7.7	≥30%
Riffle	32	8,462	90.3	72.4	-
Culvert	0	0	0.0	0.0	-
Tributary	5	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	17	2,320	N/A	19.9	-
Dry Channel	0	0	0.0	0.0	-
Total	75	11,687	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 2 contains characteristics that are not properly functioning, at risk and properly functioning. One parameter was **not properly functioning**: pool development. LWD was considered **at risk.** **Properly functioning** factors include pool quality, sediment, streambank condition, and bankfull width-to-depth ratio.

Sediment content in riffle habitat (14.1% fines) is **properly functioning** (see Table). Riffles were long with deep pockets associated with large substrate. There was adequate spawning gravels.

Table 19. Summary of riffle habitat and substrate composition in Reach 2.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
2	32	264.4	17.5	1.2	2.0	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
2	14.1	24.4	35.3	26.3	0.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool development in Reach 2 is **not properly functioning,** representing only 7.7% of the stream habitat (see Table). All but one pool in Reach 2 were quality pools with residual depth greater than one foot (see Table 21). Seven (7) pools (33% of the pools) had a maximum depth greater than 3 feet. Pool substrate was dominated by sand (32.0%).

Photo30. Reach 2, NSO 93, R41. Typical habitat where riffle contains pocket pool habitat associated with large substrate (8 July 04).

Table 20. Summary of pool habitat and substrate composition in Reach 2.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
2	21	43.1	17.9	2.8	0.9	1.8	11.8	20	11.3	7	3.9
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
2	32.0	29.0	22.5	12.5	4.0	100.0

Orange – Dominant Substrate

Bankfull width-to-depth ratio, 16:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Large woody debris is **not properly functioning** in Reach 2. Forty-four (44) pieces of LWD in the reach create a density of nearly 25 pieces per mile (see Table). An additional 62 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools.

Bank instability is **properly functioning** in Reach 2, with 330 feet of unstable bank, or 3.6% of the reach (see Table). Majority of bank instability is associated with Panchuela Campground.

Table 21. Habitat characteristics for Reach 2.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
2	0.7:1	16:1	24.8	330	1.8
Properly Functioning Indicators	-	12<30	>30	-	<10

Yellow – At Risk

Photo 31. Reach 2, NSO 73, P16. Large Log jam (6 pieces) forming complex habitat (29 June 04).

Photo 32. Reach 2, NSO 32, R16. Bank instability, tree scars and vegetation loss associated with Panchuela Campground (28 June 04).

Recommendations

The most influential disturbance to the riparian and stream habitats in this reach are due to recreational users. Many user created trail systems are increasing sediment delivery to the stream. These trail systems need to be closed and developed into a main trail. The reduction in user create trails will reduce sediment delivery and promote the growth of riparian vegetation. Educating the recreational users is also necessary to insure that any improvements will not be undone by poor recreational practices. Improving stream crossings will also reduce sediment delivery to the stream.

Reach 3: Cave Creek Confluence to Horsethief Creek Confluence

Reach 3 starts above the confluence with Cave Creek (T19N, R12E, Sec. 21, elev. 8630') and progresses upstream 1.3 miles to Horsethief Creek where there is a significant change in stream flow (T19N, R12E, Sec. 16, elev. 9,040') The channel has an average gradient of 6.2% with low sinuosity (1.1) and is dominated by cobble substrate forming an A3 Rosgen Stream Type. Reach 3 was surveyed from July8th to July11th, 2004.

Photo 32. Reach 3, NSO 130, R59. Typical cascading riffle habitat in confined section (10 July 04).

The valley is highly confined at the beginning of Reach 3 and widens towards Horsethief confluence. The steep canyon walls did not level out until they became mesa tops at least 150 feet above the streambed. In the highly confined section, the stream exhibited fast flowing and deep water (see Photo). Large substrate dominated this section as most fines were washed downstream by the flow. Short flat riffles and pool habitat acted as depositional areas. Bedrock formations played a significant role in the geomorphology. Water was only slowed in the

formation of pools when bedrock or boulder confined the channel causing scour or plunges. As the valley widened towards the confluence, the water flattened and slowed, creating shallow and widened habitat. Pools were still created by scouring or plunges, but these were generally formed around boulders rather than bedrock. Undercut banks occurred intermittently,

The riparian vegetation in Reach 3 was characterized by willow and alder. At times the vegetation was thick and low hanging, providing ample stream shade. Herbaceous vegetation included frequent horsetail and water hemlock.

LWD was prevalent throughout the reach. Most of the LWD in the reach was between small and medium. In addition to the recorded wood there were multiple debris jams forming pools caused by spanners and boulders. Potential large woody debris was observed in the floodplain throughout.

There were much fewer man-made structures in Reach 3, all in the lower section. No more than ten of these structures were observed. The construction of these structures also changed. The spanning log was wedged between boulders, rather than rebarred to other logs.

Photo 33. Reach 3, NSO 149, P37. Log jam (5 pieces) created complex pool habitat (11 July 04).

Two seasonal barriers were identified in Reach 3. The first was a two-tiered falls (see Photo) with the lower fall over bedrock and the upper over a log jam with a small shallow pool in between. The falls in total were approximately 10 feet high. Surveyors confirmed it was not a long-term barrier due to a side channel on the left bank. The second, more formidable barrier was a bedrock chute approximately 8 feet high with a steep gradient and high velocity water (see

Photo). Stream flow was confined at the top and dropped into two channels in the bedrock. The tight confinement and high flow led surveyors to believe this was a seasonal barrier. The bedrock formation could be manipulated to create an adequate barrier to upstream migration.

Photo 34. Reach 3, NSO 113, F1. A likely seasonal barrier to upstream migration (8 July 04).

Photo35. Reach 3, NSO 132, F2. Chute with tight confinement at top could be altered to create a migration barrier (10 July 04).

The tight valley limited in the number of side channels present in Reach 3. Side channels were generally short formations for diverted flow around logjams. No more than 20% of the flow was ever diverted by these short channels. Most were too shallow to provide fish habitat.

Human use in Reach 3 was heaviest near Cave Creek signified by a large section of brown out associated with Trail 288 fording the stream and intense recreational use of the area. Once above F1, the use was limited to a dispersed angler's trail on the right bank. This trail frequently bordered the stream coming down in particular to pools, causing some erosion problems in the terrace. The anglers' trail ran the whole length, but became less defined towards the top.

Four tributaries provided flow into Reach 3, entering primarily after the valley widened and the left bank developed marshy sections. Three of the four tributaries were seeps coming out of these wetlands. The fourth and most significant tributary was Horsethief Creek, contributing approximately 50% of the flow.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Seven (7) temperatures were taken during the survey of Reach 3. The highest temperature was 56°F and the lowest was 48°F. The average stream temperature was 53.7°F.

Photo 36. Reach 3, NSO 123, R56. Riffle habitat with spanning log plunge (10 July

04).

Habitat Characteristics

Reach 3 is divided into 45 NSOs, measuring 1.3 miles (6,644 feet). Ten (10) NSOs are pools, and comprise 7.7% of the stream habitat. Twenty (20) riffles make up 72.4% of the stream habitat in Reach 3 (see Table). Nine (9) side channels and 2 falls form the remaining habitat (11.3%).

Table 22. Summary of Reach 3 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	10	349	5.3	4.7	≥30%
Riffle	20	6,249	94.1	84.0	-
Culvert	0	0	0.0	0.0	-
Tributary	4	N/A	N/A	N/A	-
Falls	2	46	0.7	0.6	-
Side Channel	9	795	N/A	10.7	-
Dry Channel	0	0	0.0	0.0	-
Total	45	7,439	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

Photo 37. Reach 3, NSO 140, R63. Typical riffle habitat (11 July 04).

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 3 contains characteristics that are both not properly functioning and properly functioning. The parameters that are **not properly functioning** include pool

development, LWD density, and bankfull width-to-depth ratio. **Properly functioning** factors include pool quality and sediment. Streambank condition is not analyzed in high gradient reaches.

Sediment content in riffle habitat (5.5% fines) is **properly functioning** (see Table). Riffles were long with deep pockets associated with large substrate. There were adequate spawning gravels.

Table 23. Summary of riffle habitat and substrate composition in Reach 3.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
3	20	312.5	18.5	1.2	2.1	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
3	5.5	25.0	34.5	29.5	5.5	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool development in Reach 3 is **not properly functioning,** representing only 4.7% of the stream habitat (see Table). All pools in Reach 3 were quality pools with residual depth greater than one foot (see Table 21). Half of the pools had a maximum depth greater than 3 feet. Pool substrate was mixed but dominated by cobble (28.0%).

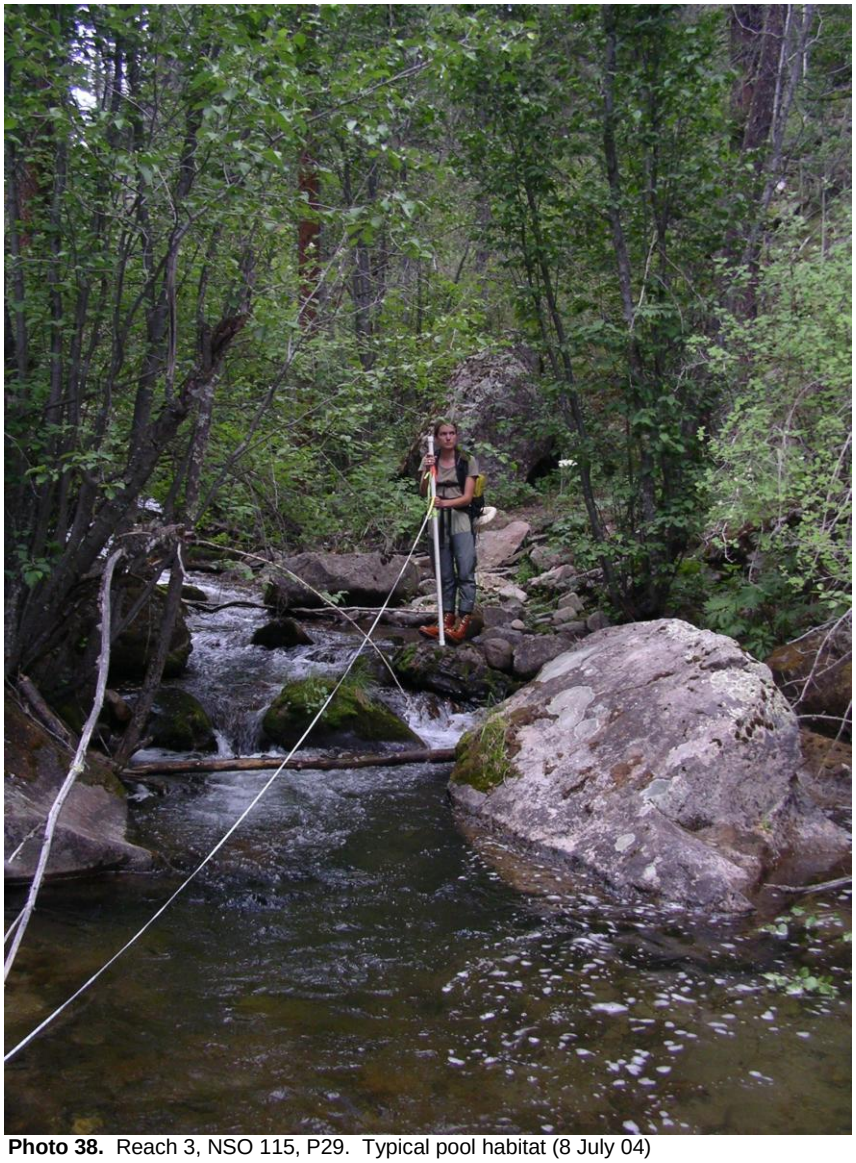


Photo 38. Reach 3, NSO 115, P29. Typical pool habitat (8 July 04)

Table 24. Summary of pool habitat and substrate composition in Reach 3.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
3	10	34.9	15.5	3.3	0.9	2.4	7.9	10	7.9	5	4.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total	
3	18.0	26.0	28.0	22.0	6.0	100.0	

Orange – Dominant Substrate

Bankfull width-to-depth ratio, 25:1, is outside the expected range for the related Rosgen stream type classification and is therefore **not properly functioning** (see Table 22). This is likely due to surveyor error conducting the bankfull measurement in the flatter portion of the reach.

Large woody debris is **not properly functioning** in Reach 3. Twenty-one (21) pieces of LWD in the reach create a density of nearly 17 pieces per mile (see Table). An additional 69 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools.

Bank instability is not analyzed due to high gradient (>4%). Only 8 feet of unstable bank was observed in association with the Trail #288 ford (see Table).

Table 25. Habitat characteristics for Reach 3.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
3	0.5:1	25:1	16.7	8	0.06[1]
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning
[1] Not analyzed due to gradient >4%

Photo 39. Reach 3, NSO 149, P37. Log jam at top of reach (11 July 04).

Photo 40. Reaches 3 and 4, NSOs 150 & 151, R67 & T14. Horsethief Creek enters on LB, contributing half the flow (11 July 04).

Recommendations

The most influential disturbance to the riparian and stream habitats in this reach are due to recreational users. Many user created trail systems are increasing sediment delivery to the stream. These trail systems need to be closed and developed into a main trail. The reduction in user create trails will reduce sediment delivery and promote the growth of riparian vegetation. Educating the recreational users is also necessary to insure that any improvements will not be undone by poor recreational practices. Improving stream crossings will also reduce sediment delivery to the stream. The main area that needs to be rehabbed is around the confluence with Cave Creek.

There is a natural chute within this reach that may be altered to create a barrier. This barrier might be an excellent location to create an upstream population of Rio Grande cutthroat trout. It would provide a large metapopulation that may one day be brought down into the Pecos River.

Reach 4: Horsethief Creek confluence to Rito Perro confluence

Reach 4 starts above the confluence with Horsethief Creek (T19N, R12E, Sec. 16, elev. 9,040') and progresses upstream 0.9 miles to Rito Perro where there is a significant change in stream flow (T19N, R12E, Sec. 9, elev. 9,400') The channel has an average gradient of 7.7% with low sinuosity (1.2) and is dominated by gravel substrate forming an A4 Rosgen Stream Type. Reach 4 was surveyed on July12th, 2004.

Photo 41. Reach 4, NSO 181, R80. Typical riffle habitat in upper section, looking upstream (12 July 04).

The valley was characterized by wider, flatter canyon walls which narrowed and became steeper in the upper half of Reach 4. The gradient of the valley floor was still steep; although shallower, wider riffles were more common (associated with the valley shape). Typically longer stretches of shallow riffles were separated by short, steeper stretches of stream containing higher percentages of boulder. The stream also exhibited increased sinuosity in the bottom half of Reach 4. Channel-spanning pools and silt deposits were less common. Deep pocket plunge pools associated with small debris jams and boulders were a prominent feature. The main channel became more confined and less sinuous in the upper half of Reach 4, causing more undercut banks.

The riparian vegetation in Reach 4 was characterized by willow, alder, and conifers. At times the vegetation was thick and low hanging, providing ample stream shade. Dead conifers dominated taller vegetation in the upper part of Reach 4. Herbaceous vegetation included frequent horsetail.

LWD was prevalent in large quantities throughout the reach, most prominently in the more confined upper half. Most of the LWD in Reach 4 was between small and medium, although large LWD presence increased towards Rito Perro. Large quantities of debris has deposited on the banks as well as in the form of dozens of debris jams. Potential large woody debris was observed in the floodplain throughout.

Multiple side channels were encountered, and these were generally short and stayed close to the main channel. Debris jams and increased boulder presence caused braiding in both the main channel and side channels.

Photo 42. Reach 4, NSO 168, S36. Typical side channel, entering on left (12 July 04).

Human use was very light as angler trails became scarce due to rugged terrain and thick blowdown.

Three tributaries contributed flow to Reach 4. Two of the three tributaries present were small, marshy streams which came in from the left bank. The third and most significant tributary was Rito Perro, contributing approximately 50% of stream flow to Panchuela Creek.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Three (3) temperatures were taken during the survey of Reach 4. The highest temperature was 50°F and the lowest was 46°F. The average stream temperature was 48°F.

Habitat Characteristics

Reach 4 is divided into 33 NSOs, measuring 0.9 miles (4,671 feet). Seven (7) NSOs are pools, and comprise 2.7% of the stream habitat. Twenty-one (21) riffles make up 85.6% of the stream habitat in Reach 4 (see Table). Nine (9) side channels created a moderate amount of habitat (11.7%), making up for the lack of pool habitat.

Table 26. Summary of Reach 4 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	7	142	3.0	2.7	≥30%
Riffle	21	4,529	97.0	85.6	-
Culvert	0	0	0.0	0.0	-
Tributary	3	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	9	620	N/A	11.7	-
Dry Channel	0	0	0.0	0.0	-
Total	33	5,291	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 4 contains characteristics that are not properly functioning and properly functioning. The parameters that are **not properly functioning** include pool development and bankfull width-to-depth ratio. **Properly functioning** factors include pool quality, LWD, and sediment. Streambank condition is not analyzed in high gradient reaches.

Photo 42. Reach 4, NSO 152, R68. Typical riffle habitat in lower part of reach, looking upstream (12 July 04).

Sediment content in riffle habitat (2.9% fines) is **properly functioning** (see Table). Riffles were long with pocket pools associated with large substrate. Spawning habitat was prevalent throughout.

Table 27. Summary of riffle habitat and substrate composition in Reach 4.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
4	21	323.5	10.4	1.0	1.8	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
4	2.9	45.0	34.3	17.9	0.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Pool development in Reach 4 is **not properly functioning,** representing only 2.7% of the stream habitat (see Table). All but one pool in Reach 4 were quality pools with residual depth greater than one foot (see Table 21). No pools had a maximum depth greater than 3 feet. Pool substrate was dominated by mid-sized substrate, predominantly gravel (42.9%).

Photo 43. Reach 4, NSO 163, P40. Typical pool habitat with spawning gravels in tail crest (12 July 04).

Table 28. Summary of pool habitat and substrate composition in Reach 4.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
4	7	20.3	13.0	2.1	0.7	1.4	7.9	6	6.8	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
4	10.0	42.9	34.3	12.9	0.0	100.0

Red – Not Properly Functioning
Orange – Dominant Substrate

Bankfull width-to-depth ratio, 16:1, is outside the expected range for the related Rosgen stream type classification and is therefore **not properly functioning** (see Table 22). This is likely due to surveyor error conducting the bankfull measurement in the flatter portion of the reach.

Large woody debris is **properly functioning** in Reach 4. Seventy-seven (77) pieces of LWD in the reach create a density of over 87 pieces per mile (see Table). An additional 106 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools.

Bank instability is not analyzed due to high gradient (>4%). There was no observed bank instability.

Table 29. Habitat characteristics for Reach 4.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
4	0.3:1	16:1	87.0	0	0.0[1]
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning
[1] Not analyzed due to gradient >4%

Photo 44. Reach 4, NSO 159, R71. Boulder braiding and woody debris loading (12 July 04).

Photo 45. Reaches 4 and 5. Confluence of Panchuela Creek and Rito Perro (entering RB; June 2003).

Recommendations

There are no management recommendations for this reach.

Reach 5: Rito Perro confluence to end of tight canyon

Reach 5 starts above the confluence with Rito Perro (T19N, R12E, Sec. 9, elev. 9,400') and progresses upstream for 0.6 miles through a tight canyon until the valley floor widens (T19N, R12E, Sec. 9, elev. 9,800') The channel has an average gradient of 13.3% with low sinuosity (1.2) and is dominated by boulder substrate forming an Aa+2 Rosgen Stream Type. Reach 5 was surveyed on July 26th, 2004.

Photo 46. Reach 5, NSO 196, R86. Steep gradient, large substrate and woody debris loading typify Reach 5 (26 July 04).

The river valley was highly confined and steep with valley walls never more than 50 feet from the stream banks. The steep gradient in this reach led to riffles with multiple plunges. Plunge pools were the dominant pocket pool habitat in Reach 5. Boulder armoring also created pocket scour pools. Channel spanning pools were primarily plunge pools with plunges over boulder or bedrock features. Undercut banks were also common in the reach in stream bends.

Four seasonal barriers were observed in Reach 5. Of these only the first (F3) was thought to be a formidable barrier to migration. F3 was a two tiered falls system with a short riffle in the middle (see Photo). The lower boulder falls was approximately 8 feet high with no pool at the base and depth at splash was 0.8 feet. The upper bedrock falls was 5 feet high. A pool was present at the base of this falls with a 1.4' depth at splash. The second feature (F4) was a bedrock chute approximately 6 feet high and 16 feet long with a depth at splash ranging from 0.8 to 1.0 feet. F5 was an 8-foot plunge over boulder and bedrock. This falls was stair like with multiple small tiers where fish could rest (although there was no pool at its base). F6 consisted of two bedrock chutes connected by a short riffle. Its total height was 25 feet, but had a gradient of only 25%. Fish were observed throughout Reach 5.

Photo 47. Reach 5, NSO 189, F3. Seasonal migration barrier with no pool at base (26 July 04).

In addition to the steep gradient, numerous spanners, debris jams, log jams, and large woody debris were the defining elements of Reach 5, providing most of the stream cover and creating pocket pools and plunges. Five log jams were observed in the lower half of Reach 5. Potential LWD was dense on both canyon walls. Due to the steep nature of the canyon walls, all dead fall with end up in or over the stream.

Side channels occurred throughout Reach 5 of various lengths usually associated with log or debris jams. There was minimal braiding associated with boulders and debris jams.

Two tributaries contributed flow to Reach 5, entering on the RB canyon wall from a meadow system above. T18 contributed 15% of the flow and ran parallel to the creek for several NSOs with multiple entries.

Riparian vegetation in this reach was primarily mixed conifer with some alder. The vegetation did not provide much direct stream shading.

Photo 48. Reach 5, NSO 192, T18. RB trib contributing 15% of the flow from meadow source (26 July 04).

Several fish were observed in this reach. One adult and 5 sub-adults were observed, but species could not be identified.

Human impacts on this Reach were minimal. Some trash was observed, but there were no visible impacts on stream health.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Four (4) temperatures were taken during the survey of Reach 5. The highest temperature was 49°F and the lowest was 45°F. The average stream temperature was 47°F.

Habitat Characteristics

Reach 5 is divided into 34 NSOs, measuring 0.6 miles (3,003 feet). Ten (10) NSOs are pools, and comprise 4.6% of the stream habitat. Thirteen (13) riffles make up 82.9% of the stream habitat in Reach 5 (see Table). Five (5) side channels and 4 falls form the remaining habitat (12.5%).

Table 30. Summary of Reach 5 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	10	148	4.9	4.6[3]	≥30%
Riffle	13	2,692	89.6	82.9	-
Culvert	0	0.0	0.0	0.0	-
Tributary	2	N/A	N/A	N/A	-
Falls	4	163	5.4	5.0	-
Side Channel	5	245	N/A	7.5	-
Dry Channel	0	0	0.0	0.0	-
Total	34	3,248	100.0	100.0	-

[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.
[3] Pool Development numeric is not applicable in 2nd order or less stream segments.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 5 contains characteristics that are properly functioning. **Properly functioning** factors include pool quality, LWD, and sediment. Streambank condition is not analyzed in high gradient reaches. Bankfull measurements were not taken in Reach 5. Pool quantity is not analyzed in stream segments 2nd order or less.

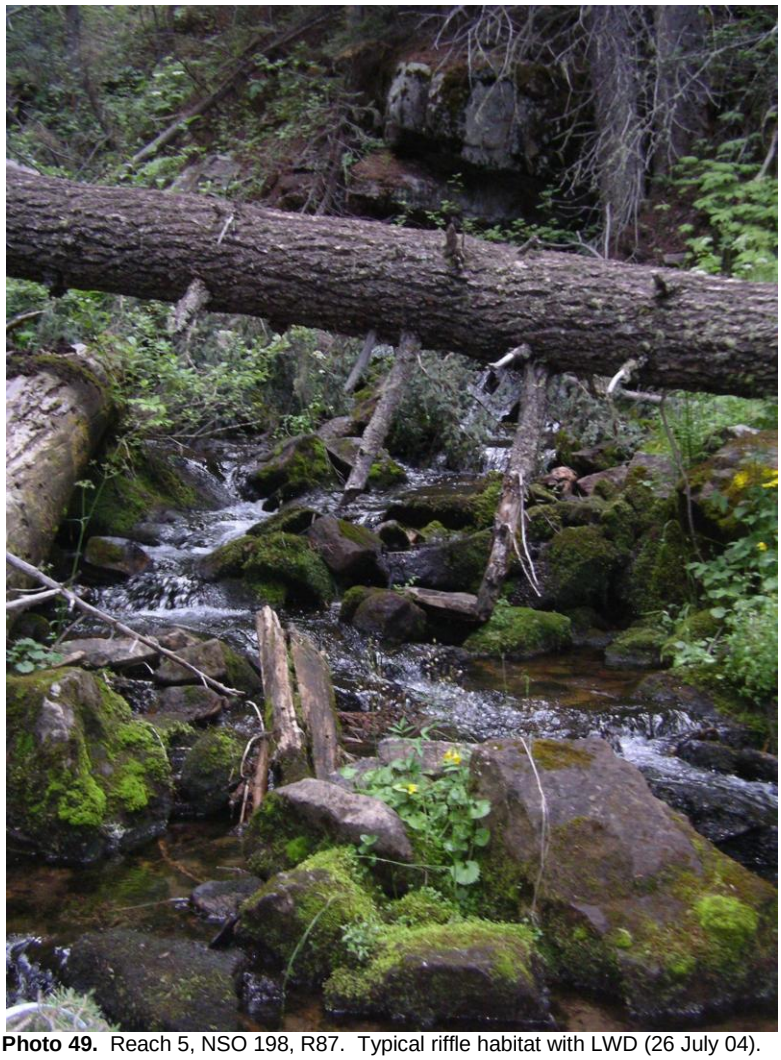


Photo 49. Reach 5, NSO 198, R87. Typical riffle habitat with LWD (26 July 04).

Photo 50. Reach 5, NSO 195, F4. 16' long chute typifies steep gradient of reach (26 July 04).

Sediment content in riffle habitat (10.0% fines) is **properly functioning** (see Table). Riffles were mostly tumbling cascades with pocket pools associated with large substrate. Spawning gravels were available in short sections, typically associated with pocket pool tailouts.

Table 31. Summary of riffle habitat and substrate composition in Reach 5.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
5	13	207.1	8.6	0.8	1.6	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
5	10.0	26.9	29.2	31.5	2.3	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool development in Reach 5 represents only 4.6% of the stream habitat (see Table). All pools in Reach 5 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). No pools had a maximum depth greater than 3 feet. Pool substrate was mixed, dominated by larger cobble and boulder (27.0%).

Table 32. Summary of pool habitat and substrate composition in Reach 5.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
5	10	14.8	9.0	2.0	0.6	1.4	17.6	10	17.6	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total	
5	22.0	23.0	27.0	27.0	1.0	100.0	

Orange – Dominant Substrate

Bankfull width-to-depth ratio measurements were not taken.

Large woody debris is **properly functioning** in Reach 5. Seventy-eight (78) pieces of LWD in the reach create a density of over 137 pieces per mile (see Table). An additional 81 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools.

Bank instability is not analyzed due to high gradient (>4%). There was no observed bank instability.

Table 33. Habitat characteristics for Reach 5.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
5	0.8:1	N/A[2]	137.1	0	0.0[1]
Properly Functioning Indicators	-	<12	>30	-	<10

[1] Not analyzed due to gradient >4%
[2] No bankfull measurements were taken

Recommendations

There are no management recommendations for this reach.

Photo 51. Reach 5, NSO 208, R90. Log jams (11 pieces) were prevalent (26 July 04).

Reach 6: End of tight canyon to Trail 251 crossing

Reach 6 starts above the tight canyon where the valley begins to widen (T19N, R12E, Sec. 9, elev. 9,800') and progresses upstream for 0.7 miles to the Trail 251 crossing (T19N, R12E, Sec. 9, elev. 10,050') where the valley widens further. The channel has an average gradient of 6.8% with moderately high sinuosity (1.7) and is dominated by cobble substrate forming a B3c Rosgen Stream Type. Reach 6 was surveyed on August 8th and 9th, 2004.

Photo 52. Reach 6, NSO 249, R107. Typical steeper gradient riffle (9 Aug 04).

The valley begins to open, increasing from around 50 feet to around 160 feet in areas. Through the reach the gradient of the canyon walls becomes shallower and shorter. The shallow gradient allowed for the formation of some marshy areas along the bank. The increasingly open valley allowed for a high sinuosity. The creek flowed at a decreased but steep gradient with the associated boulder armoring and undercut banks, but there were an increasing number of shallow flat riffles. Pocket pools were frequent associated primarily with scouring and plunges. Channel spanning pools were also primarily due to plunges and scours.

The riparian vegetation in this reach was primarily mixed conifer. No willow or alder were observed in Reach 6. Through most of the reach, the canopy partially shaded the stream.

LWD in Reach 6 was dense. Small and medium pieces predominated. Debris were numerous throughout creating some pocket pools, side channels, and slowing flow. Sediment deposition was frequently associated with debris jams. Spanners occurred frequently providing additional stream shade. Potential LWD was common, especially in the steeper areas.

Human use of this reach was light due to inaccessibility. The top of the reach was an exception to this trend due to the Forest Service Trail 251 (Skyline Trail) crossing. Near the trail crossing were browned out areas due to dispersed camping and user created trails. Just below the trail crossing was a pile of sawed logs, possibly meant to be a stream ford.

Two sub-adult fish of unknown species were observed in the middle of Reach 6.

Only one side channel was observed in Reach 6. This short side channel was formed by a debris jam. There was also infrequent braiding associated with boulders and debris jams.

Five tributaries contributed flow to Reach 6 and generally occurred in infrequent marshy areas along the bank. Four of the five contributed no more than 5% flow as they were small seeps with low surface flow. T24 was an exception to this trend. This complex of seeps coming out the right bank for 300 feet contributed approximately 15% of stream flow.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Eight (8) temperatures were taken during the survey of Reach 6. The highest temperature was 49°F and the lowest was 44°F. The average stream temperature was 47°F.

Habitat Characteristics

Reach 6 is divided into 40 NSOs, measuring 0.7 miles (3,694 feet). Eighteen (18) NSOs are pools, and comprise 6.8% of the stream habitat. Sixteen (16) riffles make up 92.2% of the stream habitat in Reach 6 (see Table). One (1) short side channel formed an additional 0.9% of stream habitat.

Table 34. Summary of Reach 6 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	18	254	6.9	6.8[3]	≥30%
Riffle	16	3,440	93.1	92.2	-
Culvert	0	0	0.0	0.0	-
Tributary	5	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	1	35	N/A	0.9	-
Dry Channel	0	0	0.0	0.0	-
Total	40	3,729	100.0	100.0	-

[1] Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2] Percent Stream Habitat calculated using all stream habitat types except tributary.
[3] Pool Development numeric is not applicable in 2nd order or less stream segments.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 6 contains characteristics that are properly functioning. **Properly functioning** factors include pool quality, LWD, sediment and bankfull width-to-depth. Streambank condition is not analyzed in high gradient reaches. Pool quantity is not analyzed in stream segments 2nd order or less.

Photo 53. Reach 6, NSO 249, R107. Typical flatter gradient riffle (9 Aug 04).

Sediment content in riffle habitat (5.6% fines) is **properly functioning** (see Table). Riffles were a combination of low gradient and steeper rapids with pocket pools associated with large substrate. Spawning gravels were prevalent throughout, including pool tailouts.

Table 35. Summary of riffle habitat and substrate composition in Reach 6.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
6	16	215.0	6.0	1.4	0.7	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
6	5.6	30.6	36.9	26.9	0.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Photo 54. Reach 6, NSO 224, P56. Typical pool habitat (8 Aug 04).

Pool development in Reach 6 represents only 6.8% of the stream habitat (see Table). Sixteen of out the 18 pools in Reach 6 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). No pools had a maximum depth greater than 3 feet. Pool substrate was mixed, dominated by gravel (30.0%).

Table 36. Summary of pool habitat and substrate composition in Reach 6.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
6	18	15.9		1.9	0.5	1.4	25.7	16	22.9	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
	Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
	6	21.3	30.0	29.4	19.4	0.0	100.0

Orange – Dominant Substrate

Bankfull width-to-depth ratio, 18:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Large woody debris is **properly functioning** in Reach 6. Fifty (50) pieces of LWD in the reach create a density of over 71 pieces per mile (see Table). An additional 78 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools.

Bank instability is not analyzed due to high gradient (>4%). There was no observed bank instability.

Table 37. Habitat characteristics for Reach 6.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
6	1.1:1	18:1	71.5	0	0.0[1]
Properly Functioning Indicators	-	12<30	>30	-	<10

[1] Not analyzed due to gradient >4%

Photo 55. Reach 6, NSO 251, R108. Typical wood recruitment (9 Aug 04).

Recommendations

There are no management recommendations for this reach.

Reach 7: Trail 251 Crossing to Headwater Source

Reach 7 starts at the Trail 251 crossing (T19N, R12E, Sec. 9, elev. 10,050') and progresses upstream for 2.2 miles to the headwater source which consisted of a series of seeps of springs (T19N, R12E, Sec. 5, elev. 10,500'). The channel has an average gradient of 3.9% with high sinuosity (2.2) and is dominated by cobble substrate forming a C3 Rosgen Stream Type. Reach 7 was surveyed on August 9th and 10th, 2004.

Photo 56. Reach 7, NSO 314, R133. A. Kiep approaches conclusion of Panchuela Creek in a cobble riffle before the headwater source in a meadow (10 Aug 04).

Reach 7 runs through an increasingly open valley system. At the onset of Reach 7, shallow valley walls confined the creek. These walls gradually dropped away then returned intermittently to confine the creek on one side or other, but rarely both. At the conclusion of Reach 7, shallow rolling hills interspersed with marshy meadows formed the valley floor. The gradient within this reach was much shallower. The stream was highly sinuous within the open canyon characterized by long stretches of flat riffle and short stretches of increased gradient and boulder confinement. Channel spanning pools were infrequent in this reach due to the small watershed size. Pools were primarily formed by debris jams backing up water and scouring around boulders. Pocket pools were common throughout and were formed by plunges, scouring, and debris jams.

The riparian vegetation within Reach 7 was primarily mixed conifer with low herbaceous ground cover. No willow or alder were observed. In the marshy meadow areas, vegetation was primarily

tall grasses and false skunk cabbage. At points these two riparian types overlapped. Riparian canopy in Reach 7 was more open, allowing for the growth of algae in the stream. Algal cover become more dense as the headwaters were approached. The algae seemed to collect a lot of sediment which clouded up the stream when disturbed.

Human use of this reach was light. At the Forest Service Trail 251 crossing, the creek widened 1.5 times greater than its natural width. Little human impacts were seen upstream from the trail crossing.

Photo 57. Reach 7, NSO 257, R111. Trail 251 ford crossing signifies beginning of Reach 7. Note: stream widening and mudding associated with crossing (9 Aug 04).

LWD density in Reach 7 was naturally lighter due to the more open valley. Smalls and mediums were still predominate. Potential LWD, in the form of spanners, were observed frequently throughout the reach, especially in areas were one of the canyon walls approached the creek. These spanners provided stream shade cover. Potential LWD was also found along the banks.

No fish were observed in this reach. They appeared to have dropped out due to high gradient and smaller watershed size, but no natural barriers were determined.

Twenty (20) tributaries contributed flow to Reach 7, generally associated with areas of marshy meadow. These areas often had multiple channels flowing into the stream which surveyors referred to as complexes from the same source. Subterranean flow may have contributed to flow in the meadows. Tributary complexes became more significant as the headwaters were approached. Some of the tributaries coming out of these meadows were marshy and had very low flow; others were more stream-like with gravely substrates.

Side channels were infrequent in Reach 7. They were generally short and associated with log or debris jams. There was also infrequent braiding associated with boulders and debris jams.

The headwaters occurred in association with two marshy meadows. The channel was highly confined, narrower and deeper in the meadows. Often widths didn't exceed two feet. The meadows were separated by short stretches of shallow, cobbly riffle. The spring source which contributed the bulk of flow to the stream was located at the top of the last cobbly riffle. It was approximately 8 feet wide, with lots of moss growing in it. Beyond the spring source, the stream narrowed considerably, passing through the second meadow where the stream divided into multiple tributaries associated with the marshy meadow. The largest of these tributaries was followed and assumed to be the stream. This tributary ended in a small seep about 60 feet beyond the meadow.

Photo 58. Reach 7, NSO 317, R135. End of survey. Seepy meadow source of Panchuela Creek (10 Aug 04).

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Eight (8) temperatures were taken during the survey of Reach 6. The highest temperature was 51°F and the lowest was 42°F. The average stream temperature was 46.9°F.

Habitat Characteristics

Reach 7 is divided into 63 NSOs, measuring 2.2 miles (11,444 feet). Thirteen (13) NSOs are pools, and comprise 1.4% of the stream habitat. Twenty-five (25) riffles make up 97.3% of the stream habitat in Reach 7 (see Table). Five (5) side channel formed an additional 1.3% of stream habitat.

Table 38. Summary of Reach 7 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	13	162	1.4	1.4[3]	≥30%
Riffle	25	11,282	98.6	97.3	-
Culvert	0	0	0.0	0.0	-
Tributary	20	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	5	153	N/A	1.3	-
Dry Channel	0	0	0.0	0.0	-
Total	63	11,597	100.0	100.0	-

[1] Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2] Percent Stream Habitat calculated using all stream habitat types except tributary.
[3] Pool Development numeric is not applicable in 2nd order or less stream segments.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 7 contains characteristics that are properly functioning. **Properly functioning** factors include pool quality, LWD, sediment and bankfull width-to-depth. Streambank condition is not analyzed in high gradient reaches. Pool quantity is not analyzed in stream segments 2nd order or less.

Photo 59. Reach 7, NSO291, R124. Typical riffle in meadow habitat (10 Aug 04).

Photo 60. Reach 7, NSO 288, R123. Looking downstream at typical riffle in forested stretch (10 Aug 04).

Sediment content in riffle habitat (22.4% fines) is **not properly functioning** (see Table). Although, this is likely within the natural range of variability associated with the combination of a small watershed size, erosive nature of the granitic formation along the slopes of Pecos Baldy, and a lower gradient. Riffles were a combination of low gradient and steeper rapids with pocket pools associated with large substrate. Spawning gravels were prevalent throughout, including pool tailouts.

Table 39. Summary of riffle habitat and substrate composition in Reach 7.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
7	25	451.3	5.4	0.6	1.2	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
7	22.4	32.0	34.8	10.8	0.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Pool development in Reach 7 represents only 6.8% of the stream habitat (see Table). Ten (10) out of the 13 pools in Reach 7 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). No pools had a maximum depth greater than 3 feet. Pool substrate was mixed, dominated by gravel (36.4%).

Table 40. Summary of pool habitat and substrate composition in Reach X.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
7	13	14.7	6.0	1.6	0.4	1.2	6.0	10	4.6	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total	
7	19.1	36.4	32.7	11.8	0.0	100.0	

Orange – Dominant Substrate

Photo 60. Reach 7, NSO 313, R132. Narrow, entrenched E type channel located in the meadow sections (10 Aug 04).

Bankfull width-to-depth ratio, 28:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Large woody debris is **at risk** in Reach 6. Sixty-five (65) pieces of LWD in the reach create a density of 30 pieces per mile (see Table). An additional 178 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools. LWD is likely within the natural range of variability.

Bank instability is **properly functioning** in Reach 7, with 18 feet of unstable bank, or 0.1% of the reach (see Table). Majority of bank instability is associated with the Trail 251 crossing.

Table 41. Habitat characteristics for Reach 7.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
7	0.5:1	28:1	30.0	18	0.1
Properly Functioning Indicators	-	12<30	>30	-	<10

Yellow – At Risk

Photo 61. Reach 7, NSO 267, R115. Typical large wood recruitment (9 Aug 04).

Recommendations

There are no management recommendations for this reach.

CAVE CREEK

Reach 1: Mouth to Caves

Reach 1 of Cave Creek starts at the mouth (T19N, R12E, Sec. 21, elev. 8630') and progresses upstream 0.6 miles where it goes underground, becoming part of a cave system (T19N, R12E, Sec. 20, elev. 8,840') The channel has an average gradient of 6.8% with low sinuosity (1.04) and is dominated by gravel substrate forming an B3c Rosgen Stream Type. Reach 1 was surveyed on July 28th and 29th, 2004.

Photo 62. Reach 1, NSO 32, R15. Source of Reach 1 flow resurfacing at depth rod from cave system (29 July 04).

Reach 1 begins as a wide alluvial fan but gradually becomes tighter and iss never wider than 100 feet, exhibiting a moderately steep gradient. Sections of stream exhibited undercut banks, while others boulder armoring was noted. In addition, bedrock features appeared along the banks periodically. These formations created deep channels and associated pocket pools. Channel spanning pools were generally plunge or scour pools associated with boulder confinement or bedrock.

Riparian vegetation consisted primarily of alders and willows in Reach 1. This vegetation provided stream shade throughout. Horsetail was a common herbaceous plant near the top of Reach 1.

LWD within Reach 1 was scarce and were relatively small. Debris jams were more frequent, creating pools and slowing down flow throughout the reach.

Human use of Reach 1 was heavy. Trail 288 (Cave Creek Trail) paralleled the stream, primarily staying on the upper flood terrace but in places approached the stream. At these points there was evidence of human use along the creek with short sections of instability and some areas of brown out. These features became more common near the top of Reach 1 associated with the proximity to the caves. In addition there were several man-made structures in the stream. Some of these structures were functioning, creating small plunges, but most were not.

Photo 63. Reach 1, NSO 30, R14. Dispersed recreation damage indicated by vegetation loss and bank instability (29 July 04).

Several fish were observed in Reach 1, one sub-adult and one juvenile of unknown species.

Reach 1 had was evidence of beaver activity in the middle section. A small dam creating a pool was observed to have beaver-chewed willow, but it was unclear if the dam was beaver built.

No tributaries were observed within Reach 1. Seven side channels were recorded in Reach 1. Some of them were associated with debris jams.

The top of Reach 1 exhibited a unique feature. On the right bank was a side channel with very low flow. This appears to be a high flow channel. The rest of the stream goes underground where water bubbles out of the bottom of a bedrock wall. A series of caves at the beginning of

Reach 3 funnel most of the stream's flow underground, resurfacing at the bedrock wall. The subterranean flow could be considered a seasonal fish barrier, since the surface channel is primarily dry.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Five (5) temperatures were taken during the survey of Reach 1. The highest temperature was 48°F and the lowest was 46°F. The average stream temperature was 47.2°F.

Habitat Characteristics

Reach 1 is divided into 32 NSOs, measuring 0.6 miles (3,105 feet). Eleven (11) NSOs are pools, and comprise 8.2% of the stream habitat. Fifteen (15) riffles make up 82.7% of the stream habitat in Reach 1 (see Table). Six (6) side channels formed an additional 9.1% of stream habitat.

Table 42. Summary of Reach 1 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	11	281	9.0	8.2	≥30%
Riffle	15	2,824	91.0	82.7	-
Culvert	0	0	0.0	0.0	-
Tributary	0	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	6	310	N/A	9.1	-
Dry Channel	0	0	0.0	0.0	-
Total	32	3,415	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 1 contains characteristics that are not properly functioning and properly functioning. The parameters that are **not properly functioning** include pool development and LWD. **Properly functioning** factors include pool quality, bankfull width-to-depth ratio, and sediment. Streambank condition is not analyzed in high gradient reaches.

Sediment content in riffle habitat (6.7% fines) is **properly functioning** (see Table). Riffles are long with mid-sized substrate, creating pocket pools. Spawning gravel is prevalent, especially in pool tailouts.

Table 43. Summary of riffle habitat and substrate composition in Reach 1.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
1	15	188.3	10.1	0.9	1.7	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
1	6.7	35.3	29.3	19.3	9.3	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Photo 64. Reach 1, NSO 15, R7. Typical riffle habitat (28 July 04).

Pool development in Reach 1 is **not properly functioning,** representing only 8.2% of the stream habitat (see Table). All pools in Reach 1 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). Two pools had a maximum depth greater than 3 feet. Pool substrate was mixed, dominated by gravel (36.4%).

Photo 65. Reach 1, NSO 27, P11. Typical pool habitat (29 July 04).

Table 44. Summary of pool habitat and substrate composition in Reach 1.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
1	11	25.5	12.6	2.5	0.7	1.8	18.7	11	18.7	2	3.4
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
1	20.0	40.9	20.9	11.8	6.4	100.0

Orange – Dominant Substrate

Photo 66. Reach 1, NSO 30, R14. Small woody debris complex (29 July 04).

Bankfull width-to-depth ratio, 16:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Large woody debris is **not properly functioning** in Reach 1. Three (3) pieces of LWD in the reach create a density of over 5 pieces per mile (see Table). An additional 12 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools.

Bank instability is not analyzed due to high gradient (>4%). There was limited bank instability, majority associated with dispersed recreational use.

Table 45. Habitat characteristics for Reach 1.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
1	0.7:1	16:1	5.1	41	0.7[1]
Properly Functioning Indicators	-	12<30	>30	-	<10

Red – Not Properly Functioning
[1] Not analyzed due to gradient >4%

Recommendations

The most influential disturbance to the riparian and stream habitats in this reach are due to recreational users. Many user created trail systems are increasing sediment delivery to the stream. These trail systems need to be closed and developed into a main trail. The reduction in user create trails will reduce sediment delivery and promote the growth of riparian vegetation. Educating the recreational users is also necessary to insure that any improvements will not be undone by poor recreational practices. Improving stream crossings will also reduce sediment delivery to the stream.

Reach 2: The Caves

Reach 2 starts at the subterranean section where a discontinuous high flow side channel begins (T19N, R12E, Sec. 20, elev. 8,840') and progresses upstream 0.1 mile where the main flow enters the top most cave (T19N, R12E, Sec. 20, elev. 8,880') The channel has an average gradient of 5.8% with low sinuosity (1.1) and is dominated by cobble substrate forming an A3 Rosgen Stream Type. Reach 2 was surveyed on July 29th, 2004.

Photo 67. Reach 2, NSO 33, S7. The upper cave (June 2002).

Reach 2 had one NSO: a primarily discontinuous side channel where the main flow filtered through a cave system. Surveyors were only able to inventory the side channel. The side channel measured 689 feet (0.13 miles) and had a small amount of flow at the beginning (maximum depth 0.4 feet). The flow seeps out of the right bank about 50 feet up the channel. The channel is bone dry for another 250 feet, acting as a seasonal barrier to upstream migration.

The remainder of Reach 2 had flowing water that was portioning off into the cave system. About 40% of the total stream flow enters the lower cave. The upper cave had three main entrances with the remaining 60% of the total stream flow entering this cave. In the area between the two caves, the maximum depth was 0.8 feet; average 0.5 feet; and the width approximately 10 feet.

Photo 68. Reach 2, NSO 33, S7. The remaining flow enters the lower cave (29 July 04).

Human use of this area is heavy. Well established dispersed trails come down from Trail 288 to the caves. These trails cause areas of erosion along the creek. In addition, the trails lead to areas of brown out used for dispersed camping and picnicking.

Photo 69. Typical brown out associated with accessing the caves (29 July 04).

LWD in this reach was particularly heavy towards the top. The section of stream just below the upper cave had the highest density.

Recommendations

Photo 70. Reach 2, NSO 33, S7. Dry channel acts as a seasonal barrier to migration (29 July 04).

The most influential disturbance to the riparian and stream habitats in this reach are due to recreational users. Many user created trail systems are increasing sediment delivery to the stream. These trail systems need to be closed and developed into a main trail. The reduction in user create trails will reduce sediment delivery and promote the growth of riparian vegetation. Educating the recreational users is also necessary to insure that any improvements will not be undone by poor recreational practices. Improving stream crossings will also reduce sediment delivery to the stream.

Reach 3: Upper Cave to Rito Oscuro Confluence

Reach 3 starts at the upper cave (T19N, R12E, Sec. 20, elev. 8,880') and progresses upstream 0.6 miles to the confluence with Rito Oscuro (T19N, R12E, Sec. 20, elev. 9,010') The channel has an average gradient of 4.4% with low sinuosity (1.2) and is dominated by cobble substrate forming an A3 Rosgen Stream Type. Reach 2 was surveyed on August 13th, 2004.

Photo 71. Reach 3, NSO 56, P18. Rito Oscuro (NSO 57, T1) enters on left, marking the end of Reach 3 (13 Aug 04).

The valley was characterized by its steep walls and narrow width. The valley was observed to be around 80 feet across. The river moved freely within the valley floor and was generally against one or the other canyon walls. An additional cave complex was noted in the lower end of Reach 3, diverting 30% of the stream flow underground.

Reach 3 started off with a gradual climb that created shallow riffles and frequent pocket pools associated with debris jams and scouring. Over the course of Reach 3, the valley's gradient increased, changing the morphology of the stream. Riffles had increasingly run-like stretches and pocket pools were more frequently created by plunges. Boulder armoring became a more frequent feature. Channel spanning pools were generally associated with debris jams as hydraulic control and acted as depositional areas.

Riparian vegetation in the lower part of Reach 3 was dense and provided much stream cover. Willow and alders were the primary woody vegetation with some mixed conifer. Progressing upstream, willows declined until at the top of the reach they were no longer observed. Alder and

mixed confiner became the dominant woody species. Stream cover decreased progressing upstream. The more open canopy allowed for the growth of a dense floor of herbaceous vegetation.

LWD within this reach increased in density as the gradient increased. Multiple spanners were present within Reach 3 along with potential LWD along the banks as well as small debris jams. One log jam was noted.

Side channels were numerous in Reach 3, mostly at the downstream end of the reach. Side channels were short (no more than 50 feet) and were generally associated with debris jams that diverted main channel flow. Some braiding was also observed in Reach 3.

Fish were frequently observed throughout Reach 3. Five juveniles, seventeen sub-adults, and seven adults of unknown species were recorded.

Human use of Reach 3 was intermediate and was associated with access provided by FS Trail 288. The trail parallels the creek throughout Reach 3, although it is generally far back from the stream. Multiple user-created trails spur off Trail 288 down to the creek. The most dense concentration of trails were observed in association with the caves. The trails generally did not impact the creek, although some sort sections of instability were observed in the terrace of the right bank. Brown out areas were observed in association with this popular area.

Rito Oscuro was the only tributary that provided surface flow to Cave Creek in Reach 3, contributing 50% of the flow.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Two (2) temperatures were taken during the survey of Reach 3 with temperatures ranging from 49°F to 51°F.

Habitat Characteristics

Reach 3 is divided into 24 NSOs, measuring 0.6 miles (2,954 feet). Seven (7) NSOs are pools, and comprise 6.9% of the stream habitat. Seven (7) riffles make up 84.7% of the stream habitat in Reach 3 (see Table). Nine (9) side channels formed an additional 8.4% of stream habitat.

Table 46. Summary of Reach 3 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	7	223	7.5	6.9	≥30%
Riffle	7	2,731	92.5	84.7	-
Culvert	0	0	0.0	0.0	-
Tributary	1	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	9	271	N/A	8.4	-
Dry Channel	0	0	0.0	0.0	-
Total	24	3,225	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 3 contains characteristics that are not properly functioning, at risk, and properly functioning. Two **not properly functioning** parameters were exceeded: Pool development and bankfull width-to-depth ratio. LWD was **at risk. Properly functioning** factors include pool quality and sediment. Streambank condition is not analyzed in high gradient reaches.

Sediment content in riffle habitat (7.1% fines) is **properly functioning** (see Table). Riffles are long with mid to large-sized substrate, creating pocket pools. Spawning gravel is prevalent, especially in pool tailouts.

Table 47. Summary of riffle habitat and substrate composition in Reach 3.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
3	7	390.1	8.9[1]	0.8	1.8	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
3	7.1	31.4	40.0	21.4	0.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

[1]- No actual measurements were taken in Reach 1, so the average width is estimated and not corrected
Orange – Dominant Substrate

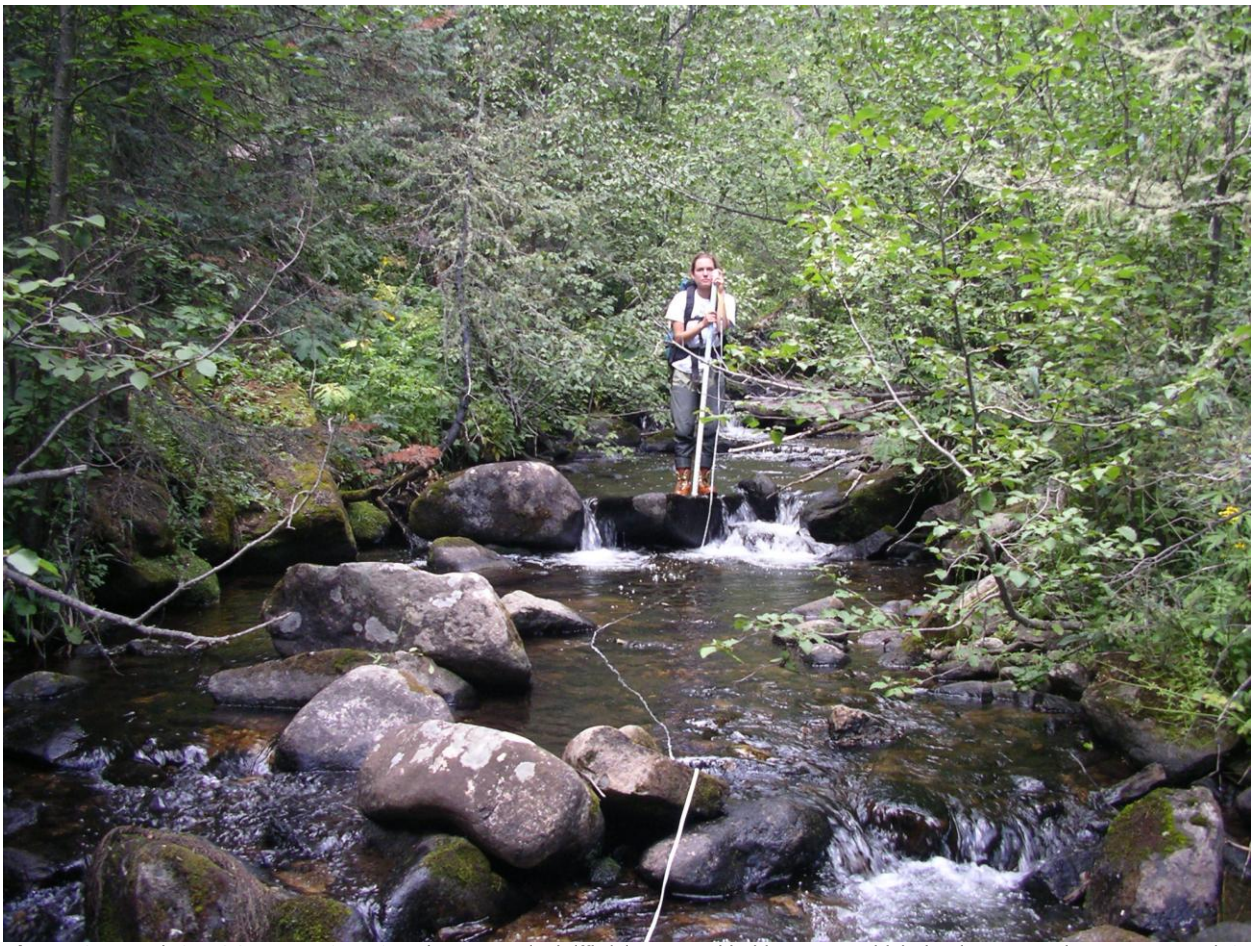


Photo 72. Reach 3, NSOs 45 & 46, R19 and P15. Typical riffle/plunge pool habitat. Note: thick riparian vegetation component (13 Aug 04).

Pool development in Reach 3 is **not properly functioning,** representing only 6.9% of the stream habitat (see Table). All pools in Reach 3 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). No pools had a maximum depth greater than 3 feet. Pool substrate was mixed, dominated by gravel (34.3%).

Table 48. Summary of pool habitat and substrate composition in Reach 3.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
3	7	31.9	12.6	2.0	0.6	1.4	12.5	7	12.5	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
	Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
	3	31.4	34.3	20.0	14.3	0.0	100.0

Orange – Dominant Substrate

Bankfull width-to-depth ratio, 24:1, is outside the expected range for the related Rosgen stream type classification and is therefore **not properly functioning** (see Table 22). This may be due to surveyor error.

Large woody debris is **at risk** in Reach 3. Sixteen (16) pieces of LWD in the reach create a density of nearly 29 pieces per mile (see Table). An additional 17 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools.

Photo 73. Reach 3, NSO 54, R22. Typical large wood deposition (13 Aug 04).

Bank instability is not analyzed due to high gradient (>4%). There was no bank instability observed.

Table 49. Habitat characteristics for Reach 3.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
3	1:1	24:1	28.6	0	0.0[1]
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning
Yellow – At Risk
[1] Not analyzed due to gradient >4%

Recommendations

The most influential disturbance to the riparian and stream habitats in this reach are due to recreational users. Many user created trail systems are increasing sediment delivery to the stream. These trail systems need to be closed and developed into a main trail. The reduction in user create trails will reduce sediment delivery and promote the growth of riparian vegetation. Educating the recreational users is also necessary to insure that any improvements will not be undone by poor recreational practices. Improving stream crossings will also reduce sediment delivery to the stream.

Reach 4: Rito Oscuro confluence to Significant LB Tributary

Reach 4 starts upstream from Rito Oscuro confluence (T19N, R12E, Sec. 20, elev. 9,010') and progresses upstream 1.3 miles to the confluence with an unnamed significant left bank tributary (T19N, R12E, Sec. 18, elev. 9,680') The tributary is located 180 feet upstream from FS Trail 251 crossing. The channel has an average gradient of 9.6% with moderate sinuosity (1.3) and is dominated by cobble substrate forming an A3 Rosgen Stream Type. Reach 4 was surveyed on August 13th and 14th, 2004.

Photo 74. Reach 4, NSO 64, R25. FS Trail #288 parallels creek tightly in places (13 Aug 04).

The valley tightens quickly above Rito Oscuro confluence. The right bank remained more open during the early part of the reach, but eventually the valley became highly confined (approximately 30 feet across). Along with the tighter valley walls came an increased gradient of the valley floor. The stream did exhibit sinuousity within these confines.

Progressing upstream, the valley gradually became shallower and wider. Stretches of shallow riffle were separated by areas of significantly steeper gradient and more highly confined channel. Cobble and boulder armoring as well as undercut banks were observed. Numerous pocket pools caused by scouring, plunges, and debris jams were observed. In the lower half of Reach 4, most pools featured debris jams as hydraulic controls. More scour pools and plunge pools were observed in the upper half.

Riparian vegetation within Reach 4 was primarily alder and mixed conifer. Willow was virtually absent from the riparian zone replaced by heavy herbaceous ground cover. Several meadows were present in the uppermost end of Reach 4 where wetland vegetation species were observed.

Fish were seen frequently throughout Reach 4. Juveniles, subadults, adults, and large adults were present.

LWD was more frequent in the downstream end of Reach 4. Trail clearing may have also contributed to some LWD loading in the lower half (many were observed with sawed off ends). Small debris jams were frequent and decreased in intensity progressing upstream. Some uncountable spanners were observed.

Human use within Reach 4 was concentrated at the top where FS Trail #251 (Skyline Trail) crosses the stream. The stream ford caused widening and bank instability. A small user-created trail bordered the left bank for about 50 feet above the crossing, causing some brownout in the terrace.

Photo 75. Reach 4, NSO 99, R34. FS Trail #251 ford with significant widening and mudding along banks (14 Aug 04).

Side channels were frequent in the upper half of Reach 4. Most were no more than 50 feet long, and often caused by debris jams diverting stream flow.

Eleven tributaries contributed flow to Reach 4 and were most common near the end of the reach. The most significant tributary created the reach break, providing 40% of the stream flow.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Four (4) temperatures were taken during the survey of Reach 4. The highest temperature was 52°F and the lowest was 48°F. The average stream temperature was 49.5°F.

Habitat Characteristics

Reach 4 is divided into 24 NSOs, measuring 0.6 miles (2,954 feet). Seven (7) NSOs are pools, and comprise 6.9% of the stream habitat. Seven (7) riffles make up 84.7% of the stream habitat in Reach 4 (see Table). Nine (9) side channels formed an additional 8.4% of stream habitat.

Table 50. Summary of Reach 4 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	10	131	1.9	1.7	≥30%
Riffle	13	6,836	98.1	91.2	-
Culvert	0	0	0.0	0.0	-
Tributary	11	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	13	530	N/A	7.1	-
Dry Channel	0	0	0.0	0.0	-
Total	47	7,497	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

Photo 76. Reach 4, NSO 75, R28. Typical habitat (14 Aug 04).

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 4 contains characteristics that are not properly functioning, at risk, and properly functioning. Two **not properly functioning** parameters were exceeded: Pool development and bankfull width-to-depth ratio. LWD was **at risk. Properly functioning** factors include pool quality and sediment. Streambank condition is not analyzed in high gradient reaches.

Sediment content in riffle habitat (7.1% fines) is **properly functioning** (see Table). Riffles are long with mid to large-sized substrate, creating pocket pools. Spawning gravel is prevalent, especially in pool tailouts.

Table 51. Summary of riffle habitat and substrate composition in Reach 4.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
4	13	525.8	6.7[1]	0.7	1.6	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
4	11.5	30.0	33.1	23.8	1.5	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

[1]- No actual measurements were taken in Reach 1, so the average width is estimated and not corrected
Orange – Dominant Substrate

Photo 77. Reach 4, NSO 79, P24. Typical pool habitat (14 Aug 04).

Pool development in Reach 4 is **not properly functioning,** representing only 1.7% of the stream habitat (see Table). All pools in Reach 4 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). One pool had a maximum depth greater than 3 feet. Pool substrate was mixed, dominated by gravel (34.3%).

Table 52. Summary of pool habitat and substrate composition in Reach 4.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
4	10	13.1	8.4	2.0	0.4	1.6	7.6	10	7.6	1	0.8
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total	
4	23.0	40.0	19.0	18.0	0.0	100.0	

Orange – Dominant Substrate

Bankfull width-to-depth ratio, 24:1, is outside the expected range for the related Rosgen stream type classification and is therefore **not properly functioning** (see Table 22). This may be due to surveyor error.

Large woody debris is **at risk** in Reach 4. Twenty-seven (27) pieces of LWD in the reach create a density of over 20 pieces per mile (see Table). An additional 92 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools.

Photo 78. Reach 4, NSO 75, R28. Large wood collecting in tight portion of reach (14 Aug 04).

Bank instability is not analyzed due to high gradient (>4%). There was minimal bank instability observed associated with the FS Trail 251 crossing.

Table 53. Habitat characteristics for Reach 4.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
	0.8:1	24:1	20.5	16	0.1[1]
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning
Yellow – At Risk
[1] Not analyzed due to gradient >4%

Recommendations

The most influential disturbance to the riparian and stream habitats in this reach are due to recreational users primarily at and around the Trail 251 crossing. Many user created trail systems are increasing sediment delivery to the stream. These trail systems need to be closed and developed into a main trail. The reduction in user create trails will reduce sediment delivery and promote the growth of riparian vegetation. Educating the recreational users is also necessary to insure that any improvements will not be undone by poor recreational practices. Improving stream crossings will also reduce sediment delivery to the stream.

Reach 5: Significant LB Tributary to Headwaters

Reach 5 starts upstream from the unnamed significant left bank tributary confluence (T19N, R12E, Sec. 18, elev. 9,680') and progresses upstream 1.6 miles to a wet meadow that sources Cave Creek with a series of seeps and springs (T19N, R11E, Sec. 24, elev. 10,500') Reach 5 begins 180 feet upstream from FS Trail 251 crossing. The channel has an average gradient of 9.9% with low sinuosity (1.2) and is dominated by gravel substrate forming an A4 Rosgen Stream Type. Reach 5 was surveyed on September 6th and 7th, 2004.

Photo 79. Reach 5, NSO 115, R41. Typical riffle habitat (6 Sep 04).

At the start of Reach 5, the valley is open and shallow. Progressing upstream , the valley tightens to as little as 50 feet wide and the gradient increases. Interspersed shallow terraces were observed throughout. Further out, canyon walls raised sharply.

Small marshy areas were frequent. One open marshy meadow was observed for approximately 1000 feet in the middle of Reach 5. In this area, the river valley widened to about 150 feet. The remaining 800 feet of Reach 5 climbs out of a tight canyon into an open meadow about 300 feet wide. In the last 300 feet, the stream fans out into a complex of springs and seeps that is the headwaters for Cave Creek.

In the confined canyon, steep gradient created cascades with pocket pools created by scouring and plunges with areas of boulder braiding between. Short sections of wider, shallower riffle ran

through areas of less gradient. Stream banks were armored by boulders and cobble; otherwise, banks were undercut. In the two meadow sections in this reach the stream becomes more entrenched and narrow with deeply undercut banks, like an E channel. The channel spanning pools in Reach 5 were primarily scour pools.

The riparian zone in Reach 5 was dominated by mixed conifer with an open canopy. In sections willow and alder appeared, providing more stream cover. In the first meadow section, willow, grasses, and forbs dominated the riparian, providing dense stream cover. Most of the willow observed in Reach 5 was small.

LWD was frequent most of which was in the small category. Potential LWD in the floodplain and spanners were observed throughout, especially in areas with steeper gradient. Debris jams were plentiful and frequently created a hydraulic control for pocket pools.

Photo 80. Reach 5, NSO 115, R41. Dispersed campsites were clustered on the valley bottom associated with FS Trail #251. This campsite is within 60 feet of Cave Creek (6 Sep 04).

Human use in Reach 5 was minimal, but in localized areas had obvious effects. Human impacts were observed in lower Reach 5 where FS Trail #251 (Skyline Trail) parallels the creek. In general, the trail is at least 50 feet away from stream's edge. At NSO 115, R41 the trail turns and moves up the canyon wall out of the Cave Creek Watershed. Near this area the trail comes within 15 feet of the stream and there is a cluster of small campsites and dispersed trails (see Photo).

Photo 81. Reach 5, NSO 109, R38. Rio Grande cutthroat trout caught in Cave Creek. Only fish species observed in upper reaches of the creek (6 Sep 04).

Fish were observed frequently in Reach 5 until a steep pitch appeared to prevent upstream migration (NSO 131, R47; see Photo). This gradient barrier begins approximately 900 stream feet from the point that FS Trail #251 leaves the valley floor. All age classes were observed. One fish was caught by surveyors and identified as a Rio Grande cutthroat trout (see Photo). Surveyors believe the rest of the fish observed were also cutthroat based on behaviors and morphological characteristics.

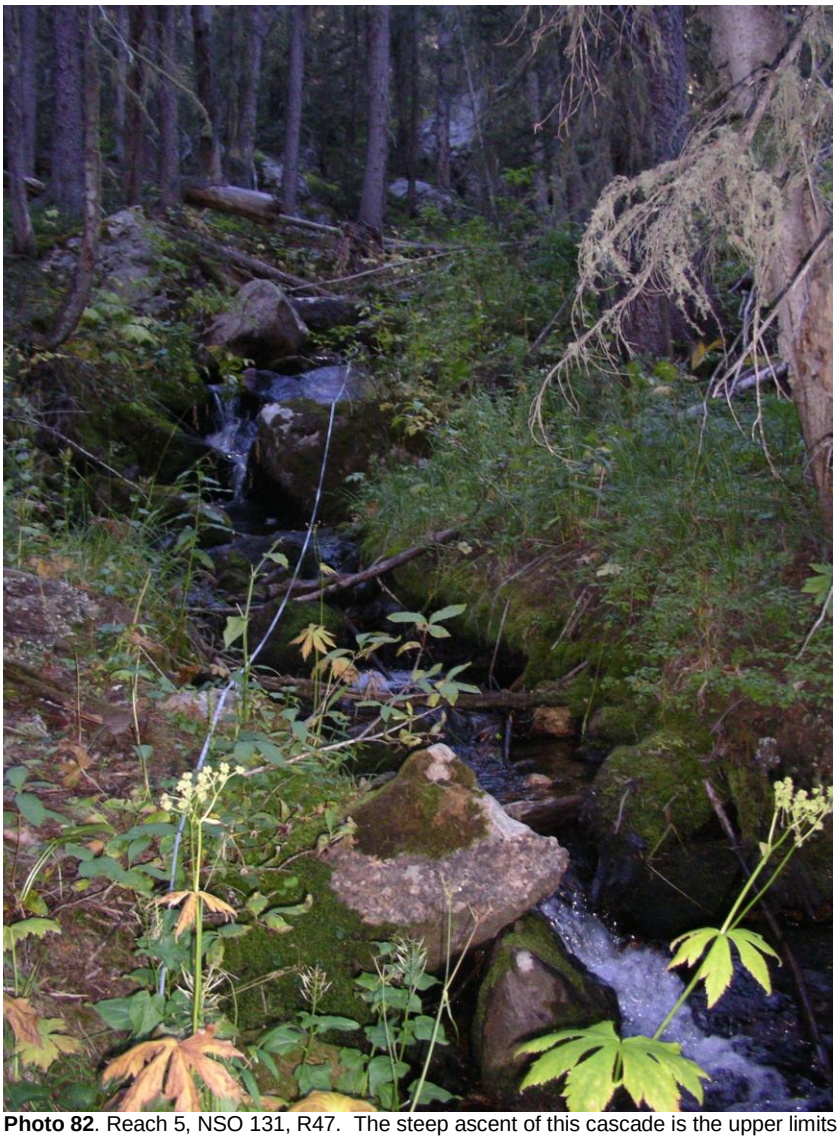


Photo 82. Reach 5, NSO 131, R47. The steep ascent of this cascade is the upper limits of fish (6 Sep 04).

Five unremarkable side channels were observed in Reach 5. Twenty-three (23) tributaries contributed flow to Reach 5, a majority of which were located in association with the headwater source (see Photo). Six contributed significant flow (>10%).

Photo 83. Reach 5, NSO 172, R59. The headwater source of Cave Creek and end of survey (7 Sep 04).

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Four (4) temperatures were taken during the survey of Reach 5. The highest temperature was 52°F and the lowest was 48°F. The average stream temperature was 49.5°F.

Habitat Characteristics

Reach 5 is divided into 24 NSOs, measuring 0.6 miles (2,954 feet). Seven (7) NSOs are pools, and comprise 6.9% of the stream habitat. Seven (7) riffles make up 84.7% of the stream habitat in Reach 5 (see Table). Nine (9) side channels formed an additional 8.4% of stream habitat.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 5 contains characteristics that are properly functioning. **Properly functioning** factors include pool quality, LWD, sediment and bankfull width-to-depth. Streambank condition is not analyzed in high gradient reaches. Pool quantity is not analyzed in stream segments 2nd order or less.

Table 54. Summary of Reach 5 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	16	244	3.0	2.9[3]	≥30%
Riffle	24	8,023	97.0	95.2	-
Culvert	0	0	0.0	0.0	-
Tributary	23	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	5	160	N/A	1.9	-
Dry Channel	0	0	0.0	0.0	-
Total	68	8,427	100.0	100.0	-

Red – Not Properly Functioning
[1] Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2] Percent Stream Habitat calculated using all stream habitat types except tributary.
[3] Pool Development numeric is not applicable in 2nd order or less stream segments.

Sediment content in riffle habitat (11.3% fines) is **properly functioning** (see Table). Riffles are long with mid -sized substrate, creating pocket pools. Spawning gravel is prevalent, especially in pool tailouts.

Table 55. Summary of riffle habitat and substrate composition in Reach 5.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
5	24	334.3	4.8	0.6	1.1	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
5	11.3	43.8	25.0	20.0	0.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Photo 84. Reach 5, NSOs 166 & 167, T33 & R56. Riffle habitat with alluvium from significant LB tributary (40% flow; 7 Sep 04).

Photo 85. Reach 5, NSO 141, R51. Typical riffle habitat (7 Sep 04).

Pool development in Reach 5 represent only 2.9% of the stream habitat (see Table). All pools in Reach 5 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). One pool had a maximum depth greater than 3 feet. Pool substrate was mixed, dominated by gravel (34.3%).

Table 56. Summary of pool habitat and substrate composition in Reach 5.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
5	16	15.3	5.9	1.5	0.3	1.2	10.1	12	7.7	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total	
5	17.5	40.6	20.0	21.3	0.6	100.0	

Orange – Dominant Substrate

Bankfull width-to-depth ratio, 11:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Large woody debris is **not properly functioning** in Reach 5. Twenty-one (21) pieces of LWD in the reach create a density of over 13 pieces per mile (see Table). An additional 57 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools. Given the forest type, aspect and elevation, LWD may be within the range of natural variability.

Bank instability is not analyzed due to high gradient (>4%). There was minimal bank instability observed associated with the proximity of FS Trail 251.

Table 57. Habitat characteristics for Reach 5.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
5	0.7:1	11:1	13.4	5	0.03[1]
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning
Yellow – At Risk
[1] Not analyzed due to gradient >4%

Recommendations

The most influential disturbance to the riparian and stream habitats in this reach are due to recreational users occurring at and around the Trail 251 crossing. Many user created trail systems and campsites are increasing sediment delivery to the stream. These trail systems need to be closed and developed into a main trail. The reduction in user create trails will reduce sediment delivery and promote the growth of riparian vegetation. Educating the recreational users is also necessary to insure that any improvements will not be undone by poor recreational practices. Improving stream crossings will also reduce sediment delivery to the stream.

Photo 86. Reach 5, NSO 144, R52. Typical habitat in more open valley (7 Sep 04).

HORSETHIEF CREEK

Reach 1: Mouth to Horsethief Meadow

Reach 1 starts at the mouth and confluence with Panchuela Creek (T19N, R12E, Sec. 16, elev. 9,040') and progresses upstream 1.9 miles to Horsethief Meadow where a significant tributary (25% flow) enters on the right bank (T19N, R12E, Sec. 8, elev. 9,680'). The channel has an average gradient of 6.4% with moderate sinuosity (1.3) and is dominated by cobble substrate forming an A3 Rosgen Stream Type. Reach 1 was surveyed on July15th and September 3rd and 4th, 2004.

Photo 87. Reach 1, NSO 63, R27. Steeper, cascading habitat (3 Sep 04).

The valley was characterized by steep tight canyon walls. The mouth was wide, typical of an alluvial fan but quickly narrowed above the confluence. Despite the narrow canyon, Horsethief exhibited significant sinuousity, moving between both canyon walls. Marshy areas would appear if one side of the valley was open. The steep nature of Reach 1 created high gradient riffles confined by boulders and shallow flat riffles separated by plunges. Channel spanning pools were present in large numbers created by plunges over debris jams and boulders as well as a few scour pools. Boulders lining the banks in pools were frequently undercut near the top of the habitat. Pocket pools were common formed by small plunges and boulder scouring. Some undercutting of banks was observed associated with the sinuosity of the stream.

Riparian vegetation in Reach 1 was characterized by conifers. Alder and willow appeared infrequently and disappeared entirely halfway through Reach 1. The canopy over the stream was generally open although there were some sections of alder and willow cover along with LWD providing shade. Dead conifers dominated the overstory. Herbaceous vegetation included frequent horsetail.

LWD was prevalent in large quantities, most which was between small and medium. Several log jams were observed in Reach 1. Large quantities of debris were noted on the banks as well as frequent debris jams. Potential large woody debris was observed in the floodplain.

Ten side channels in Reach 1 were generally short (no more than 40 feet long) and formed by debris jams diverting flow. Braiding also occurred in Reach 1 caused by debris and boulders.

Human use in Reach 1 was concentrated at the top where the canyon widens and approaches Horsethief Meadow. Several fire rings were observed along with areas of brownout. Some erosion in the stream bank terrace was also associated with recreational use. Two man-made log structures were observed in the lower section of Reach 1 and occurred again at the top. A dispersed campsite was noted at the confluence of Horsethief and Panchuela. A faintly defined angler's trail along the lower part of the reach moved from bank to bank, but did not seem to cause instability.

Photo 88. Reach 1. Eastern brook trout (7 Sep 04).

Many fish were observed in Reach 1. A range of age classes was observed including juvenile, sub-adult, adult and large adult. They were primarily found in pocket pools and pools. Species were identified in follow-up snorkeling as non-native German brown trout and eastern brook trout. Snorkeling indicated that brook trout appeared to be the dominant species.

One five (5) foot high waterfall with a good jump pool was located in Reach 1. Fish were observed both up and downstream from the waterfall. It may act as a seasonal barrier and has potential to be modified to prevent upstream migration (see Photo).

Six tributaries were observed in Reach 1. In the first half mile tributaries were totally absent. There were two significant tributaries T3 that contributed 10% of flow and T6 contributing 25% of flow. Reach 1 was broken above T6 due to a change in flow regime.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Ten (10) temperatures were taken during the survey of Reach 1. The highest temperature was 53°F and the lowest was 46°F. The average stream temperature was 50.7°F.

Photo 89. Reach 1, NSOs 44 & 45, P20 and F1. 5' drop acts as seasonal barrier to migration; Note: 2.2' deep at splash (3 Sep 04).

Habitat Characteristics

Reach 1 is divided into 85 NSOs, measuring 1.9 miles (10,051 feet). Thirty-two (32) NSOs are pools, and comprise 6.2% of the stream habitat. Thirty-six (36) riffles make up 90.2% of the stream habitat in Reach 1 (see Table). Ten (10) side channels formed an additional 3.5% of stream habitat.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 1 contains characteristics that are not properly functioning, at risk, and properly functioning. Two **not properly functioning** parameters were exceeded: Pool development and bankfull width-to-depth ratio. **Properly functioning** factors include pool quality, sediment and LWD. Streambank condition is not analyzed in high gradient reaches.

Table 58. Summary of Reach 1 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	32	649	6.5	6.2	≥30%
Riffle	36	9,392	93.4	90.2	-
Culvert	0	0	0.0	0.0	-
Tributary	6	N/A	N/A	N/A	-
Falls	1	10	0.1	0.1	-
Side Channel	10	360	N/A	3.5	-
Dry Channel	0	0	0.0	0.0	-
Total	85	10,411	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

Photo 90. Reach 1, NSO 30, R34. Typical riffle habitat clogged with woody debris in lower gradient section (4 Sep 04).

Sediment content in riffle habitat (17.5% fines) is **properly functioning** (see Table). Riffles are long with mid -sized substrate, creating pocket pools. Spawning gravel is prevalent, especially in pool tailouts.

Table 59. Summary of riffle habitat and substrate composition in Reach 1.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
1	36	260.9	8.7	0.8	1.7	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
1	17.5	31.7	33.9	16.9	0.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool development in Reach 1 is **not properly functioning,** representing only 6.2% of the stream habitat (see Table). All but three pools in Reach 1 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). Two pools had a maximum depth greater than 3 feet. Pool substrate was mixed, dominated by gravel (30.9%).

Table 60. Summary of pool habitat and substrate composition in Reach 1.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
1	32	20.3	10.6	2.2	0.5	1.7	16.8	29	15.2	2	1.1
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
1	24.4	30.9	23.8	20.3	0.6	100.0

Orange – Dominant Substrate

Photo 91. Reach 1, NSO 7, P3Typical plunge pool habitat (15 July 04).

Bankfull width-to-depth ratio, 19:1, is outside the expected range for the related Rosgen stream type classification and is therefore **not properly functioning** (see Table 22). This is likely due to surveyor error.

Large woody debris is **properly functioning** in Reach 1. Eight-seven (87) pieces of LWD in the reach create a density of nearly 46 pieces per mile (see Table). An additional 160 small pieces were counted, providing microhabitat in the form of cover and scoured pocket pools. Given the forest type, aspect and elevation, LWD may be within the range of natural variability.

Bank instability is not analyzed due to high gradient (>4%). There was no bank instability observed.

Table 61. Habitat characteristics for Reach 1.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
1	0.9:1	19:1	45.7	0	0.0[1]
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning
[1] Not analyzed due to gradient >4%

Photo 92. Reach 1, NSO 42, R20. Typical habitat with debris loading (3 Sep 04).

Recommendations

There are no management recommendations for this reach.

Reach 2: Horsethief Meadow

Reach 2 starts above the mouth of the significant tributary (T6) at the entrance to Horsethief Meadow (T19N, R12E, Sec. 8, elev. 9,680') and progresses upstream 1.1 miles where the stream leaves Horsethief Meadow entering a tight valley (T19N, R12E, Sec. 7, elev. 9,860'). The channel has an average gradient of 3.1% with moderate sinuosity (1.3) and is dominated by cobble substrate forming an A3 Rosgen Stream Type. Reach 2 was surveyed on September 3rd, 2004.

Photo 93. Reach 2, NSO 86, R37. The lower end of Horsethief Meadow (4 Sep 04).

Reach 2 starts in a wide shallow canyon that flattens into a meadow (Horsethief Meadow). For the first half mile of Reach 2 an intermittent terrace is located along the right bank, averaging about 15 feet in height. Beyond the terrace is a wide flat section of meadow. The left bank throughout the first half mile is still tight to the left canyon wall. Stream morphology in this section is more typical of a canyon reach with shallow and wide riffles and frequent pocket pools. Once the terrace drops, Reach 2 enters the larger portion of Horsethief Meadow on the right bank.

Immediately above the FS Trail #251 (Skyline Trail) crossing, the creek makes a sharp turn northward and a canyon wall begins to build along the right bank and the meadow switches to the left bank. In the wider portion of Horsethief Meadow, Reach 2 morphology shifts. The channel narrows and becomes increasingly entrenched with banks as high as 3.5 feet. Riffles become more run-like with fewer channel-spanning pools and no pocket pools. Near the top of

Reach 2, a canyon wall approaches the right bank and a terrace builds along the left, separating the stream from the rest of the meadow.

Riparian vegetation varies in Reach 2 as the river shape changes. In the beginning and end of Reach 2, mixed conifers dominate along with intermittent clumps of willow. In the more open meadow sections, willow and grasses dominate the riparian zone providing dense cover over the stream. Willow in the lower portion of Horsethief Meadow (below FS Trail 251 crossing) is dwarfed and growing low to the ground. Willow becomes significantly taller after the stream turns northward. At the top of Reach 2, willow grows densely along the terrace.

Photo 94. Reach 2, NSO 101, R45. A Kiep stands in stream to indicate height of banks and vegetation (4 Sep 04).

LWD was observed primarily in the more canyon type section of Reach 2 (the top and bottom of the reach). Most of the LWD in this reach was classified as small.

Human use was heavy throughout Reach 2. FS Trail #251 parallels the lower portion of Reach 2 on the right bank; and FS Trail 253 spurs off 251 and parallels the creek through part of the meadow. Both of these trails cross the creek once creating areas of instability. A dispersed trail continues paralleling Horsethief Creek on the right bank above FS Trail 288 crossing. Five large dispersed campsites were observed along the lower part of Reach 2. Three of these sites were located within 50 feet of the stream. Recreational users of these campsites have created large areas of brown out. They have also created many short trails down to or crossing Horsethief. Man-made structures were observed throughout Reach 2. Many of these structures had v-notches carved out to funnel water into a concentrated area. These structures generally had pools below them and created most of the pools observed in the meadow.

Photo 95. Reach 2, NSO 98, R43. Dispersed campsite as seen from LB of stream (4 Sep 04).

Fish were observed throughout the survey of Reach 2 and were confirmed to be eastern brook trout in a snorkeling survey. All age classes were observed.

No side channels were observed in Reach 2. Three (3) significant tributaries contributed flow to Reach 2, entering on the left bank (T8 contributed 30% of flow; T11 10%; and T15 40%). Reach 2 was broken just above T15 due to a change in stream flow regime.

Temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. Two (2) temperatures were taken during the survey of Reach 2. The highest temperature was 48°F and the lowest was 46°F. The average stream temperature was 47°F.

Habitat Characteristics

Reach 2 is divided into 25 NSOs, measuring 1.1 miles (5,897 feet). Five (5) NSOs are pools, and comprise 1.4% of the stream habitat. Eleven (11) riffles make up 98.6% of the stream habitat in Reach 2 (see Table). Nine (9) tributaries contributed flow to Reach 2.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 2 contains characteristics that are not properly functioning, at risk, and properly functioning. Two **not properly functioning** parameters were exceeded: Pool

development and bankfull width-to-depth ratio. **Properly functioning** factors include pool quality, sediment and LWD. Streambank condition is not analyzed in high gradient reaches.

Table 62. Summary of Reach 2 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	5	83	1.4	1.4	≥30%
Riffle	11	5,814	98.6	98.6	-
Culvert	0	0	0.0	0.0	-
Tributary	9	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	0	0	N/A	0.0	-
Dry Channel	0	0	0.0	0.0	-
Total	25	5,897	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

Sediment content in riffle habitat (12.7% fines) is **properly functioning** (see Table). Riffles are long with mid-sized substrate, creating pocket pools. Spawning gravel is prevalent, especially in pool tailouts.

Photo 96. Reach 2. NSO 96, R41. Typical riffle habitat. Note: loss of vegetation on RB associated with dispersed camping area (4 Sep 04).

Table 63. Summary of riffle habitat and substrate composition in Reach 2.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
2	11	528.5	4.3	0.7	1.6	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
2	12.7	55.5	30.9	0.9	0.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool development in Reach 2 is **not properly functioning,** representing only 1.4% of the stream habitat (see Table). All pools in Reach 2 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). No pools had a maximum depth greater than 3 feet. Pool substrate was primarily small, dominated by gravel (48.0%).

Photo 97. Reach 2, NSO 99, P35. Typical pool habitat associated with man-made plunge structure (4 Sep 04).

Table 64. Summary of pool habitat and substrate composition in Reach 2.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
2	5	16.6	5.3	1.9	0.4	1.5	4.5	5	4.5	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
2	24.0	48.0	18.0	10.0	0.0	100.0

Red – Not Properly Functioning
Orange – Dominant Substrate

Bankfull width-to-depth ratio, 3.6:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22). This is likely due to surveyor error.

Large woody debris is removed from analysis for Reach 2 as it is a meadow reach. Meadow reaches are defined as reaches with no natural recruitment of LWD.

Bank instability is **properly functioning** at 0.9%, well below the <10% standard.

Table 65. Habitat characteristics for Reach 1.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
2	0.5:1	3.6:1	14.5[1]	56	0.9[1]
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning
[1] Large Woody Debris analysis is excluded in meadow reaches, defined as reaches with no natural local recruitment of LWD.

Recommendations

The most influential disturbance to the riparian and stream habitats in this reach are due to recreational users. Many user created trail systems are increasing sediment delivery to the stream. These trail systems need to be closed and developed into a main trail. The reduction in user create trails will reduce sediment delivery and promote the growth of riparian vegetation. Educating the recreational users is also necessary to insure that any improvements will not be undone by poor recreational practices. Improving stream crossings will also reduce sediment delivery to the stream.

Reach 3: Horsethief Meadow to the Headwaters

Reach 3 starts where the narrow canyon begins at the end of Horsethief Meadow (T19N, R12E, Sec. 7, elev. 9,860') and continues upstream for 1.6 miles to the headwaters of Horsethief Creek (T20N, R12E, Sec. 31, elev. 10,400'). The channel has an average gradient of 6.4% with moderate sinuosity (1.3) and is dominated by gravel substrate forming an A2 Rosgen Stream Type. Reach 3 was surveyed on September 4th, 2004.

Photo 98. Reach 3, NSO 111 R48. Typical riffle above significant tributary T15. (5 Sep 04).

Reach 3 begins with a meadow in the terrace of the left bank and a forested canyon wall on the right bank. This canyon wall moves away from the stream intermittently allow room for short meadows and marshy areas to develop along the creek. Within the first 1500 feet the left canyon wall moves in and the canyon tightens to about 80 feet across. Above the area of constriction intermittent meadows form at first with dense willow vegetation and later just grasses. Over the last half mile of the Reach the canyon becomes increasingly confined with periodic terraces along the creek at about 20 feet high. Throughout the Reach the gradient increases, especially over the last half mile. Reach 3 ends at the headwaters of Horsethief Creek. In this area the canyon walls are tight to the stream banks. A small stream provides all the flow at this point. Above the stream dry channel continues. It was not surveyed due to time constraints.

Throughout Reach 3 the stream morphology reflects that of the river valley. In the meadow sections the stream become more entrenched and narrow. The wooded canyon sections the stream is a more open shallow riffle with pocket pools and channel spanning pools created by a mix of scouring, plunges and debris jams.

Plant composition throughout the riparian zone also reflected valley morphology. In the more canyon-like areas mixed conifers and some intermittent willow clumps dominated. In these areas the stream had an open canopy. The meadow sections grasses and dense willow provided dense stream cover. Some algae was observed growing within the stream in this Reach.

LWD was frequent throughout Reach 3, especially as the stream canyon narrowed towards the top of the Reach. Most of the LWD in the Reach was classified as small. Potential LWD in the floodplain, spanners and debris jams were frequent throughout the reach.

Photo 99. Reach 3, NSO 118 R51. Stream enters a more wooded steeper area (5 Sep 04).

Two side channels were recorded in Reach 3. S11 was associated with one of the marshy meadows. It was approximately 150 feet long and contained about half the stream flow. S12 also contained about half the stream flow, but it was only 30 feet long. Some braiding of the main channel occurred in the meadow areas.

Human use of Reach 3 was significantly less than in Reach 2. Within the first .25 miles the dispersed trail on the right bank disappears. FS Trail 253 parallels the stream along the left bank

generally within 100 feet of the stream. This trail is not maintained and sees only intermittent use. The lack of maintenance has lead to the creation of short dispersed trails around barrier on the trail. Its crosses the stream about 1.2 miles up the Reach and continues along the right bank shortly before moving up the canyon wall.

Photo 100. Reach 3, NSO 150, R63. Headwaters/Spring source of Horsethief Creek (5 Sep 04).

Fish were observed up to the last .3 miles of Reach 3. At this point the stream became to shallow to provide habitat. Most of the fish observed were less than 6 inches. The species was not identified.

Seventeen (17) tributaries were recorded in Reach 3. They became increasingly numerous as the headwaters were approached. Within the first 1500 feet of the reach surveyors believed water was coming in from the marshy areas along the right bank although only one tributary was actually observed. Four significant tributaries were observed in the Reach: T17 contributed 10% of stream flow, T19% contributed 40%, T20 15%, and T22 15% of stream flow.

Habitat Characteristics

Reach 3 is divided into 40 NSOs, measuring 1.6 miles (8,565 feet). Five (5) NSOs are pools, and comprise 1.0% of the stream habitat. Eleven (16) riffles make up 97.9% of the stream habitat in Reach 3 (see Table). 2 Side channels make up 2.1% of the available habitat. Seventeen (17) tributaries contributed flow to Reach 3.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 3 contains characteristics that are not properly functioning, at risk, and properly functioning. Two **not properly functioning** parameters were exceeded: Pool development and bankfull width-to-depth ratio. **Properly functioning** factors include pool quality, sediment and LWD. Streambank condition is not analyzed in high gradient reaches.

Table 66. Summary of Reach 2 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	5	90	1.0	1.0	≥30%
Riffle	16	8,475	99.0	96.9	-
Culvert	0	0	0.0	0.0	-
Tributary	17	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	2	180	N/A	2.1	-
Dry Channel	0	0	0.0	0.0	-
Total	25	8,745	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

Sediment content in riffle habitat (13.8% fines) is **properly functioning** (see Table). Riffles are long with mid-sized substrate, creating pocket pools. Spawning gravel is prevalent, especially in pool tailouts.

Table 67. Summary of riffle habitat and substrate composition in Reach 2.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
3	16	529.7	2.8	0.4	1.1	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
3	13.8	45.0	33.1	8.1	0.0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool development in Reach 3 is **not properly functioning,** representing only 1.0% of the stream habitat (see Table). All pools in Reach 3 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). No pools had a maximum depth greater than 3 feet. Pool substrate was primarily small, dominated by gravel (36.0%).

Bankfull width-to-depth ratio, 3.6:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22). This is likely due to surveyor error.

Table 68. Summary of pool habitat and substrate composition in Reach 2.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
3	5	18	5.6	1.7	0.3	1.4	3.1	5	3.1	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
	Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
	3	28.0	36.0	30.0	6.0	0.0	100.0

Red – Not Properly Functioning
Orange – Dominant Substrate

Large woody debris is **functioning at risk** for Reach 3 with 26.9 pieces of LWD per mile, just below the standard for properly functioning of 30 pieces per mile.

Bank instability is **properly functioning** at 0.2%, well below the <10% standard.

Table 69. Habitat characteristics for Reach 1.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
3	0.3:1	NA	26.9	18	0.2
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning

Recommendations

The most influential disturbance to the riparian and stream habitats in this reach are due to recreational users. Many user created trail systems are increasing sediment delivery to the stream. These trail systems need to be closed and developed into a main trail. The reduction in user create trails will reduce sediment delivery and promote the growth of riparian vegetation. Educating the recreational users is also necessary to insure that any improvements will not be undone by poor recreational practices. Improving stream crossings will also reduce sediment delivery to the stream.

Rito Perro
Reach 1: Confluence with Panchuela Creek to Unnamed Trib

Reach 1 starts at the confluence with Panchuela Creek (T19N, R12E, Sec. 21, elev. 9,610) and continues upstream for 1.0 miles to the confluence with an unnamed tributary where a significant stream flow regime change occurs (T20N, R12E, Sec. 10, elev. 10,000'). The channel has an average gradient of 7.0% with moderate sinuosity (1.3) and is dominated by cobble substrate forming an A3 Rosgen Stream Type. Reach 1 was surveyed on July 24th and 25th, 2004.

Photo 101. Reach 1. NSO 1 R1. Looking upstream at Rito Perro from confluence (24 July 2004).

The valley through which the stream passes is characterized by a steep narrow canyon (a width at most approximately 80'). Within these confines the stream was sinuous throughout the reach. This sinuosity created some undercut banks. In other parts of the channel was highly confined by boulder armoring. Pocket pools were formed by debris jams, plunges, and scouring. These plunge pools were present throughout the reach. Channel spanning pools were formed primarily by plunges over boulders. Plunges were found throughout all riffles, and were formed by debris jams as well as boulders.

The riparian vegetation in this reach was characterized by mixed conifer forests. Willow was absent and alder was found only occasionally. Herbaceous vegetation included frequent twinberry, wild rose or raspberry, and lots of other stuff and grasses.

LWD was prevalent throughout the reach. Most of the LWD in this reach was small to medium sized. In addition to the recorded wood there were multiple debris jams forming pocket pools caused by spanning logs and boulders. Potential large woody debris was observed in the

floodplain throughout the reach. Spanning logs were also a common feature within the reach. Near the middle of the reach was a large log jam.

Photo 102. Reach 1. NSO6. R3. Typical riffle within this reach with LWD present (24 July 2004)

One potential barrier to migration was identified within this reach. This potential barrier consisted of a boulder log complex with an approximate plunge height of 5 feet. A small pool was present at the base of the plunge. The permanence of this structure is uncertain as it was primarily formed by debris.

There was no evidence of human use of this reach, probably due to its inaccessibility. Manmade structures were absent.

Side channels were primarily associated with debris jams diverting water flow. All but one of these side channels were short due to the tight canyon. Tributaries were present throughout the reach, although the last the greatest concentration of them occurred within the last 800 feet. Generally tributaries were small seeps, entering from marshy ground adjacent to the stream channel and contributed very little flow. The last tributary was estimated to contribute about 60% of the total stream flow. The reach was broken above this reach due to a drastic change in stream flow regime.

Habitat Characteristics

Reach 1 is divided into 62 NSOs, measuring 1.1 miles (5,535feet). Fifteen (15) NSOs are pools, and comprise 2.9% of the stream habitat. Twenty five (25) riffles make up 92.7% of the stream habitat in Reach 3 (see Table). Six (6) side channels make up 4.4% of the available habitat. Sixteen (16) tributaries contributed flow to Reach 1.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 1 contains characteristics that are not properly functioning, at risk, and properly functioning. Two **not properly functioning** parameters were exceeded: Pool development and bankfull width-to-depth ratio. **Properly functioning** factors include pool quality, sediment and LWD. Streambank condition is not analyzed in high gradient reaches.

Table 70. Summary of Reach 1 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	15	169	2.0	2.9	≥30%
Riffle	25	5,366	98.0	92.7	-
Culvert	0	0	0.0	0.0	-
Tributary	16	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	6	253	N/A	4.4	-
Dry Channel	0	0	0.0	0.0	-
Total	25	8,745	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

Sediment content in riffle habitat (13.8% fines) is **properly functioning** (see Table). Riffles are long with mid-sized substrate, creating pocket pools. Spawning gravel is prevalent, especially in pool tailouts.

Table 71. Summary of riffle habitat and substrate composition in Reach 2.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
1	25	214.6	7.4	0.8	1.6	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
1	0.4	34.4	38.4	25.6	1.2	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool development in Reach 1 is **not properly functioning,** representing only 2.9% of the stream habitat (see Table). Pools in Reach 1 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). No pools had a maximum depth greater than 3 feet. Pool substrate was primarily small, dominated by gravel (32.3%).

Bankfull width-to-depth ratio, 14:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Table 72. Summary of pool habitat and substrate composition in Reach 2.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
1	15	13	7.5	1.9	0.7	1.3	13.6	12	10.9	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
1	10	32.3	29.2	28.5	0.0	100.0

Red – Not Properly Functioning
Orange – Dominant Substrate

Large woody debris is **properly functioning** for Reach 1 with 45.5 pieces of LWD per mile, well above the standard for properly functioning of 30 pieces per mile.

Bank instability is **properly functioning** at 0% well below the <10% standard.

Table 73. Habitat characteristics for Reach 1.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
3	1:1.7	14:1	45.5	0	0
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning

Recommendations

There are no management recommendations for this reach

Reach 2: Unnamed Tributary to

Reach 2 at the confluence with an unnamed tributary (t16) (T19N, R12E, Sec. 21, elev. 10,000) and continues upstream for 0.7 miles to the end of a dry channel (T20N, R12E, Sec. 31, elev. 10,400'). The channel has an average gradient of 10.5% with moderate sinuosity (1.3) and is dominated by cobble substrate forming an A3 Rosgen Stream Type. Reach 2 was surveyed on August 7th, 2004.

The valley through which the stream passes is characterized by a steep narrow canyon which becomes shallower at the top of this reach. The valley gradually narrowed and then widened near a marshy meadow towards the end of Reach 2. The stream exhibited a steep gradient throughout. It was highly sinuous with undercutting occurring and armoring of the banks by both cobble and boulders. Numerous pocket pools formed from scouring, plunges, and debris jams were observed throughout the reach. Few channel spanning pools were observed due to the high gradient and low streamflow.

Photo 103. Reach 2. NSO 63. R27. Typical riffle within this reach (24 July 2004).

The riparian vegetation was primarily mixed conifer with small, grassy, herbaceous ground cover. No willow or alder were present in this reach.

LWD was prevalent throughout the reach. Small pieces were dominant. Potential LWD on the banks and frequent spanners were observed.

A meadow of 100 feet long and 80 feet wide was found towards the top of the reach, after which the channel ran dry. The meadow was especially wet and marshy at the bottom, where a system

of seeps contributed 100% to the flow of the creek. The ensuing dry channel stretched for approximately 1600 feet. Vegetation found in the meadow consisted primarily of tall grasses and fake skunk cabbage.

Photo 104. Reach 2. NSO 69. R29. Log Jam in Reach 2 (24 July 2004).

No fish were observed in this reach.

Human use in this reach was light. Forest Service Trail 256 crosses the upper end of the dry channel, but little impacts were observed.

The dry channel was largely overgrown by grassy vegetation. It showed no signs of moisture until approximately 50 feet below the renewed streamflow.

Numerous tributaries were observed, entering primarily from the right bank. These usually contributed less than 10% of the stream flow, with the exception of two significant tributaries T25 and T26. Some braiding and side channels were also present in this reach.

One log jam was observed in this reach.

Habitat Characteristics

Reach 2 is divided into 24 NSOs, measuring 0.7 miles (3,825 feet). Two (2) NSOs are pools, and comprise 0.8% of the stream habitat. Six (6) riffles make up 52.4% of the stream habitat in Reach 2 (see Table). Three (3) side channels make up 2.0% of the available habitat. One (1)

Dry channel makes up 38.1% of the length of this reach. Eleven (11) tributaries contributed flow to Reach 2.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 2 contains characteristics that are not properly functioning, at risk, and properly functioning. Two **not properly functioning** parameters were exceeded: Pool development and bankfull width-to-depth ratio. **Properly functioning** factors include pool quality, sediment and LWD. Streambank condition is not analyzed in high gradient reaches.

Table 74. Summary of Reach 1 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	2	32	0.8	0.8	≥30%
Riffle	6	2196	57.4	52.4	-
Culvert	0	0	0.0	0.0	-
Tributary	11	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	3	83	N/A	2.0	-
Dry Channel	1	1597	41.8	38.1	-
Total	25	4191	100.0	100.0	-

Red – Not Properly Functioning
[1]Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.
[2]Percent Stream Habitat calculated using all stream habitat types except tributary.

Sediment content in riffle habitat (10% fines) is **properly functioning** (see Table). Riffles are long with mid-sized substrate, creating pocket pools. Spawning gravel is prevalent, especially in pool tailouts.

Table 75. Summary of riffle habitat and substrate composition in Reach 2.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
2	6	366	5.5	0.6	1.2	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
2	10	30	35	25	0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool development in Reach 1 is **not properly functioning,** representing only 0.8% of the stream habitat (see Table). Pools in Reach 1 were **properly functioning** for quality with residual depth greater than one foot (see Table 21). No pools had a maximum depth greater than 3 feet. Pool substrate was primarily small, dominated by cobble (50%).

Bankfull width-to-depth ratio, 24:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Table 76. Summary of pool habitat and substrate composition in Reach 2.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
2	2	16	5.0	1.4	0.3	1.1	2.9	1	1.4	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total	
2	0	20	50	30	0.0	100.0	

Red – Not Properly Functioning
Orange – Dominant Substrate

Large woody debris is **properly functioning** for Reach 1 with 45.5 pieces of LWD per mile, well above the standard for properly functioning of 30 pieces per mile.

Bank instability is **properly functioning** at 0% well below the <10% standard.

Table 77. Habitat characteristics for Reach 1.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
3	1:3	24:1	34.3	0	0
Properly Functioning Indicators	-	<12	>30	-	<10

Red – Not Properly Functioning

Recommendations

There are no management recommendations for this reach.

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