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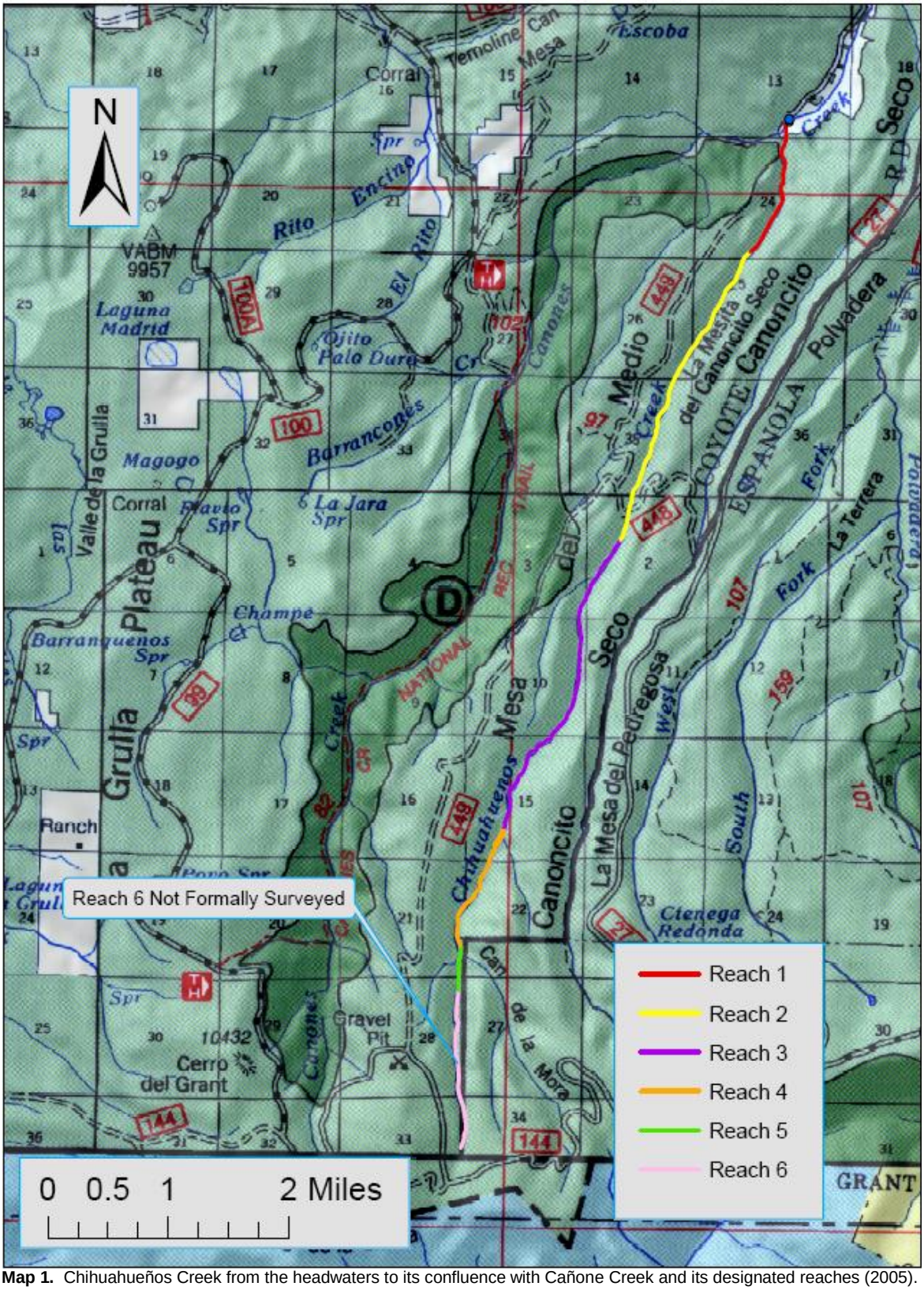


Map 1. Chihuahueños Creek from the headwaters to its confluence with Cañone Creek and its designated reaches (2005).

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

Chihuahueños Creek 2005 Stream Survey

Chihuahueños Creek begins as a series of springs in the Jemez Mountains north of the Valles Caldera at 9,800 feet. Almost 11 miles downstream and dropping nearly 2,600 feet in elevation, Chihuahueños flows into Cañones Creek. This diverse stream system flows through heavily forested areas, wide meadows, and steep canyons of the Coyote Ranger District of the Santa Fe National Forest. The Santa Fe National Forest Fisheries program conducted a stream survey of Chihuahueños Creek from June 22nd to July 20th, 2005. A total of 11.0 miles of stream was either formally surveyed or informally walked, from the mouth (T22N, R4E, Sec. 13, elev. 7,240') to the headwaters (T21N, R4E, Sec. 33, elev. 9,800').

Photo 1. Reach 1. Looking downstream towards the confluence of Chihuahueños Creek and Cañoes Creek (23-June-05).

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 (USDA FS 2002b). 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 B). 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 (see Table 1). The matrix originally was developed in the Pacific Northwest by US Fish & Wildlife Service and National Marine Fisheries Service, 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 100-meter transects and classifying fish that pass downstream (see Photo 2). Fish species are identified, placed into size categories and counted by the surveyor. Ideally, snorkel surveys include ten 100-meter transects (totaling 1 kilometer) but are occasionally composed of less (USFS 2002).

Photo 2. Reach 3, NSO 349, R171. Snorkel survey inside the first exclosure (29-June-05).

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****	<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
	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)

* NMED High Quality Coldwater Fishery prior to December 2003
[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 (see Photo 3). 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.

Photo 3. Reach 3, NSO 376, R185. C.Dentino noting an area of unstable bank (27-June-05).

BASIN SUMMARY

Table 2. Stream Summary Table for Chihuahuenos Creek.

LOCATION:			
County:	Rio Arriba		
Forest:	Santa Fe National Forest		
Districts:	Coyote		
Drainage:	Chihuahueños Creek		
Tributary to:	Cañones Creek		
Survey Began at:	T22N, R4E, S13 at 7,240 feet		
WATERSHED:			
5th HUC Code[1]:	1302010206		
Chihuahuenos Creek Watershed Area:	5,409.9 acres	8.4 square miles	
Stream Order:	3rd		
Stream Length[2]:	58,080 feet	11.0 miles	
AQUATIC BIOTA:			
Fish Species:	Rio Grande cutthroat trout[3] *(Oncorhynchus clarki virginalis)*		

[1] Hydrologic Unit Code used to identify watersheds.
[2]Stream length includes both surveyed and un-surveyed land.
[3]Listed as a Sensitive Species by the Santa Fe National Forest (1999).
[4] Hybrid trout are rainbow cutthroat mixes.

EXECUTIVE SUMMARY

Chihuahueños Creek is a 3rd order stream originating from springs draining the north side of the Jemez Mountains north of the Valles Caldera (T21N, R4E, Sec. 33, elev. 9,800'), on the Coyote District of the Santa Fe National Forest. Chihuahueños Creek travels nearly 11 miles from the headwaters to the confluence with Cañones Creek, with about 1.0 mile of dry channel at the headwaters. The formal stream survey covered 9.5 miles of flowing channel beginning above the confluence with Cañones (T22N, R4E, Sec. 13, elev. 7,240'). An additional 1.4 miles of stream was informally surveyed above reach five to a stock pond below the Forest Road 144 (T21N, R4E, Sec. 33, elev. 9,800'). Chihuahueños Creek Watershed encompasses 5,409.9 acres (8.4 square miles), owned by the Forest and private owners, and is drained by a series of springs and seeps. The most significant tributary in the watershed was Cañada de la Mora, which provided about 60% of the flow when the two joined.

Chihuahueños Creek is divided into 6 reaches, each containing relatively homogeneous habitat characteristics. Reach divisions are based on stream and valley morphology, dramatic changes in stream flow, impoundments (i.e. reservoirs), or land ownership boundaries. Reaches are numbered sequentially as the survey progresses upstream (see Table 3).

The average surveyed gradient of Chihuahueños Creek is 4.1%, or 212.5 feet of elevation gain per mile. When evaluated by reach divisions, the gradient ranges from 1.5% in Reach 3 and 4 to 15.6% in Reach 1 (see Table 9).

Table 3. Description and length of reaches on Chihuahuenos Creek.

Reach	River Miles	Landmark at Beginning and End	Land Owner
1	0.0 to 1.2	Mouth at Chihuahueños Creek to less confined valley type and change in stream type from "A" to "C".	Private Land/Forest
2	1.2 to 4.5	Increase in valley width, decrease in gradient, and change in Rosgen channel type from an "A" to "C" to an increase in valley width at the first exclosure above FR 448.	Forest
3	4.5 to 7.9	Increase in valley width at the first exclosure above FR 448 to significant dry tributary entering on left bank.	Forest
4	7.9 to 9.1	Significant dry tributary entering on the left bank to Cañada de la Mora	Forest
5	9.1 to 9.5	Cañada de la Mora to fish barrier and change in valley type.	Forest
6	9.5 to 11.0	Fish barrier and change in valley type to source. **Not formally surveyed.**	Forest

Sedimentary rocks form the colorful cliffs along parts of the Chihuahueños Creek Watershed. These rocks were deposited by water in the Mesozoic Era, also known as the Age of Dinosaurs, when this area was the shoreline of a huge sea. These rocks are primarily cliff-forming sandstones and slope-forming shales. Some of the units erode easily because they contain silt and gypsum. The rock that has washed away forms the gullies and benches around the bottoms of the cliffs (Dean 2004).

The southern part of the watershed is within the Jemez Volcanic province (see Photo 4). These are Tertiary age (the Age of Mammals, newer than the Mesozoic Era) volcanic rocks related to the Valles Caldera and other, slightly older, volcanic activity (Dean 2004). Some of the volcanic rocks have eroded and been deposited as sedimentary rocks in the lower areas. These sedimentary rocks are so new they have not really cemented together, so they are easily washed away (Dean 2004).

Stream flow in Chihuahueños Creek fluctuates between the high flow events in the spring and lesser events in the late summer to low flow in the 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 Chihuahueños Creek usually occurs in June (mid-summer), fall and winter seasons, when flow is dependent on spring sources.

There was one water diversion in Reach 1 on the right bank. Plastic, tin, and board were being used to divert flow. All of the water that was being diverted at the point of diversion was being returned to the channel due to ditch failure. No headgate was present. Numerous irragation pipes used to carry water for domestic use run along the creek and remove water from T1.

Photo 4. Reach 1, NSO 7, R4. Water diversion in Chihuahueños Creek(22-June-05).

Chihuahueños Creek is designated a high quality coldwater fishery by New Mexico Environment Department (NMED). Before 1998, Chihuahueños creek had been listed as impaired by NMED for stream bottom deposits, turbidity, reduction of riparian vegetation and streambank destabilization (records are unclear as to when this listing started). From 1998 to 2003 Chihuahueños was remained in non-support due to stream deposits and turbidity. In 2004, it was found that the stream bottom assessment had been done wrong and that Chihauhueños was in full

support despite the high levels of fine sediments (57%). In 2004 it was removed from the state 303(d) list of impared non-supporting streams (NMED 2004).

Photo 5. Reach 2, NSO 160, R78. Sediment filed riffle (25-June-05).

The 2005 stream survey data analysis was accompanied by temperature analysis at 2 thermograph, or temperature recording, sites from 2004. The thermographs were deployed by the Forest Service at the beginning of the summer and retrieved in the fall of 2004. The stream temperatures were analyzed and classified by both Forest and NMED Standards. The Forest temperature standards classify coldwater fisheries habitat as properly functioning, at risk, or not properly functioning. The NMED standards classify high quality coldwater fisheries as in full support or not supporting. Water temperatures are classified as properly functioning and in full support for both monitoring sites by Forest and NMED standards (USDA FS 2005).

Stream habitat conditions generally noted a lack of pool habitat, lack of riparian vegetation, unstable banks, and increased fine deposition in riffle habitat. This could be a limiting factor to overall stream productivity. Unstable banks measured over 2.4 miles in length, with the heaviest unnatural concentrations of instability in Reaches 2, 3, and 4. These reaches contain stream types that sensitive to disturbances (Rosgen 1996) and are being heavily grazed. This may have influenced an increase in width-to-depth ratios, downcutting of the channel, disconnection of the channel from the floodplain, loss in adjacent wetlands, and limiting the stream from developing adequate pool habitat.

Chihuahueños Creek is known to be occupied by a population of native Rio Grande cutthroat trout (RGCT). Results from 2002 genetic samples for Polvadera Creek (Cañones watershed) indicate no evidence of introgression with non-native trout (Patten 2005). This RGCT population is considered of great significance to the preservation of the species (see Fisheries section). During the 2005 snorkel survey of Chihuahueños Creek, surveyors identified native cuttroat trout as well as unknown trout. Turbidity during the survey limited sight and made identification difficult. Further population and genetic studies should be done to ensure the status of this RGCT population.

Habitat Characteristics

The 9.5 surveyed miles (50,829 feet) of Chihuahueños Creek is divided into 767 Natural Sequence Order Habitat Units (NSOs). The 362 pool habitats comprise 8.5% of the stream habitat length. There are 375 NSOs that are riffle habitat, which comprises the majority of habitat (90.2%) in Chihuahueños Creek (see Table 4). Other habitat types in Chihuahueños Creek are tributaries, falls, and side channels. Tributaries are not considered stream habitat and are excluded from length and habitat analyses.

Table 4. Stream summary information for the Chihuahueños Creek Survey 2005.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length[1] (%)	Stream Habitat[2] (%)	Properly Functioning Indicators
Pool	362	4,316	8.6	8.5	≥30%
Riffle	375	45,871	91.2	90.2	-
Culvert	2	58	0.1	0.1	-
Tributary	15	N/A	N/A	N/A	-
Falls	7	34	0.1	0.1	-
Side Channel	6	550	N/A	1.1	-
Dry Channel	0	0	0	0	-
	767	50,829	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 Rio Grande cutthroat trout streams, Chihuahueños Creek contains not properly functioning and properly functioning characteristics (see Table 5). The parameters that are **not properly functioning** include riffle sediment content, pool development, pool quality, and stream bank condition. The **properly functioning** characteristics are temperatures at both thermograph sites by NMED and Forest standards and LWD.

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	Chihuahuenos Creek Conditions
Water Quality	NMED	**Site 1) Fully Support**
		Site 2) Fully Support
Salmonid Development	Temperature 7-Day Average	**Sites 1-2) Properly Functioning**
Habitat Characteristics	Riffle Sediment	**Not Properly Functioning**
	Large Woody Debris	**Properly Functioning**
	Pool Development	**Not Properly Functioning**
	Pool Quality	**Not Properly Functioning**
Channel Condition and Dynamics	Stream Bank Condition	**Not Properly Functioning**

Red= Not Properly Functioning
Yellow = At Risk

Riffle habitat in Chihuahueños Creek is the dominant habitat, comprising 90.2% of all stream habitat types. The high relative quantity of riffle habitat reflects the lack of pool habitat.

Sediment content in riffle habitat (33.7%) was determined to be **not properly functioning** (see Table 6). Dominant substrate types are sand (33.7) and gravel (48.2%). This less than NMED's finding for stream bottom deposits in 2004. Management of Chihuahueños Creek should include mitigation strategies for sedimentation.

Table 6. Summary of habitat and substrate composition in Chihuahueños Creek.

Riffle Habitat Summary (ft)					
	# of Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max. Depth
Entire River	375	122.3	3.7	0.4	0.8

Substrate Summary (%)						
	Sand	Gravel	Cobble	Boulder	Bedrock	Total
Entire River	33.7	48.2	10.6	7.1	0.4	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Pool habitat is important over wintering, resting, and foraging habitat for fish. Pool habitat is evaluated by both quality or residual depth and area of pool habitat (by length). Pool quality is **not properly functioning** in Chihuahueños Creek with only 14% of the pool habitats with at least 1-foot residual depth. Residual depth is calculated by subtracting the pool tail crest depth from the maximum depth to determine the depth of water that would remain in the habitat if flow ceased. The pools observed in Chihuahueños Creek have an average residual depth of 0.9 feet, below the necessary depth to be considered properly functioning (see Table 7). These pools are shallow and at risk of filling. A residual pool depth of ≥1.0 feet is used as a direct indicator of long-term native fish population success in high mountain streams for Rio Grande cutthroat trout (Harig and Fausch 2000).

No pools have a maximum depth of 3 feet or more, which further accentuates the lack of quality pool habitat and indicates that existing pools are filling in. The sediment content in pools is high at 52.9%. This number may be on the increase if flows remain low in the next few years. High amounts of unstable banks is also adding sediment and creating shallow pools (see Table 8).

The relative quantity of pool habitat (8.5%) is **not properly functioning** (see Table 4). The combined relative quantity of pool and side channel habitat is 9.6% (see Table 4). Increasing pool habitat and depth in Chihuahueños Creek should be a priority in the stream's management.

Table 7. Summary of pool habitat and relative substrate in Chihuahueños Creek.

Pool Habitat Summary											
Area	# 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.
Entire River	362	11.9	3.7	1.1	0.3	0.9	38.1	51	5.4	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Area	Sand	Gravel	Cobble	Boulder	Bedrock	Total
Entire River	52.8	36.5	4.8	5.7	0.2	100.0

Red – Not Properly Functioning

Orange – Dominant Substrate

Large woody debris (LWD) is related to habitat complexity and the health of fish populations in stream habitats (Fausch and Northcote 1992). LWD density, at 37.8 pieces per mile, is **properly functioning** in Chihuahueños Creek (see Table 8). Meadow reaches, or areas with no natural recruitment of LWD, were excluded from the entire stream LWD analysis. Non-meadow reaches totaled 4.9 miles of stream and had 186 pieces of wood classified as medium and large sizes (see Photo 5). Wood classified as medium LWD must be greater than 12 inches in diameter at a length of 35 feet from the large end (or two times bankfull width). Large pieces of LWD have a diameter of greater than 20 inches at a length of 35 feet from the large end (or two times bankfull width).

Bank stability (28.7%) is **at risk** when analyzed by the length of the entire surveyed section of stream, excluding reaches with gradients greater than 4% (see Tables 8 and 9). This high number accentuates the high sediment content and loss of pools in Chihuahueños Creek.

When the length of the river is divided into reaches and then analyzed, Reaches 2, 3, and 4 are **not properly functioning** for bank stability (see Table 9). These reaches correlate with intense cattle and ATV traffic.

Table 8. Selected habitat characteristics of Chihuahueños Creek.

Area	Pool:Riffle Ratio	Pieces of LWD per Mile[1]	Total Unstable Banks (ft)	% Unstable Banks[2]
Entire River	1:1	37.9	25,176	28.7
Properly Functioning Indicators	-	>30	-	<10

Yellow – At Risk
Red – Not Properly Functioning
[1] Large Woody Debris analysis excludes meadow reaches, defined as reaches with no natural local recruitment of LWD.
[2] Stream bank condition analysis excludes reaches with >4% gradient.

Photo 6. Reach 1. Typical LWD and thick vegetation across stream channel (24-June-05).

Reach by Reach Comparison

The 6 reaches of Chihuahueños Creek contain different combinations of properly functioning and not properly functioning characteristics. Pool habitat, LWD density, bankfull width-to-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 (see Table 9).

Table 9. Reach characteristic summaries for Chihuahueños Creek 2004.

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 (%)
1	1.2	15.6	A4a+	6.5	87.7	5.3	Sand	Gravel	35	10:1	1.0[1]
2	3.3	3.3	C5b	8.6	91.1	1.1	Sand	Sand	38.8	12:1	14.3
3	3.4	1.5	E4	7.0	93.0	0	Sand	Gravel	18.8[3]	21:1	33.2
4	1.3	1.5	E4	15.6	84.4	0	Sand	Gravel	1.5[3]	9:1	53.7
5	0.4	5.7	A4	5.0	94.3	0	Sand	Gravel	40	12:1	27.4[1]
6	1.4	8.1	**Not Formally Surveyed**								
Entire River	11.0	4.6	-	8.5[4,5]	90.2	1.1	Sand	Gravel/ Sand	38[3]	-	28.7[1]
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] Bankfull measurements unavailable.
[3] Large Woody Debris analysis is excluded in meadow reaches, defined as reaches with no natural local recruitment of LWD.
[4] Pool volume analysis is excluded in dry reaches.
[5] Pool volume analysis is not applicable in 2nd order stream.

The length of pool habitat is of concern in every reach of Chihuahueños Creek. Even the reach with the largest quantity of pool habitat falls short of the properly functioning indicator. The relative quantity of pool habitat in reaches that are **not properly functioning** in Chihuahueños Creek range from 5.0 % in Reach 5 to 15.6% in Reach 4 (see Table 9).

Of the 3 reaches in Chihuahueños Creek to which the LWD numeric applies all are **properly functioning** for LWD density (see Table 9).

Bankfull width-to-depth ratio in each reach is compared to the expected range for its related Rosgen stream type (see Table 9). Bankfull width-to-depth ratio is **not properly functioning** in Reach 3. Reach 5 is on the edge of the expected range for a Rosgen type A channel but can still considered **properly functioning** for bankfull width-to-depth ratio. Reach 5 is in a transitional area between a high gradient transport stream type (A) to a response stream type (C or E).

All of the three reaches analyzed for stream bank condition in Chihuahueños Creek are **not properly functioning** (see Table 9). The high percentage of eroded and unstable banks in Reach 2 is likely due to historic and current cattle grazing near and through the stream. Bank instability in Reaches 3 and 4 can be attributed to ATV use as well as heavy historic and current cattle traffic. Limiting these activities in these reaches would aid stream bank restoration in the unstable sections of Chihuahueños Creek.

Photo 7. Reach 3, NSO 459, R227. Unstable right bank with an ATV trail above (28-June-05).

Tributaries

Fifteen (15) tributaries contribute to main channel flow for the surveyed length of Chihuahueños Creek. These tributaries flow in the form of streams, springs, seeps, and spring-seep complexes into Reaches 1, 3, 4, and 5. Numerous seeps and springs were also noted in Reach 6 during the informal survey but were not included in the tributary analysis. Of the 15 tributaries, 3 are considered significant, contributing 10% or more to main channel flow (see Table 10). Flow contribution can be deceptive because of its relative and not discrete measurement.

Table 10. Summary of tributaries contributing 10% or more of the main flow of Chihuahueños Creek during the 2005 Stream Inventory.

Location		Bank	Habitat Type	Name	Percent Flow*	Time	Tributary Temp (°F)	Stream Temp (°F) and Time		Comments
Reach	Tributary Number							Below Tributary	Above Tributary	
1	1	Left	Spring	N/A	10	1641	57	56 (16:45)	56 (16:45)	Used for domestic water
4	9	Left	Stream	Cañada de la Mora	60	1432	60	N/A	N/A	Cañada contain a majority of the flow.
5	13	Left	Spring	N/A	10	1555	59	59 (1355)	N/A	

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

The most significant tributary was Cañada de la Mora, which appeared to contribute about 60% of the flow to the confluence (end of reach 4, start reach 5). Cañada de la Mora was walked for a short distance (≈300 feet) until a waterfall/fish barrier was found. Flow continues about a three quarters of a mile past the end of reach 5 and is feed by seeps and springs. No streams enter after Cañada de la Mora. Once the channel goes dry halfway through Reach 6, no water was seen until the stock pond at the head of the drainage which is feed by a small spring.

Photo 8. Reach 4. NSO 727, T9. Cañada de la Mora that enters main channel on left bank. Contributes 60% of flow (20-July-05).

The large valley that was used as a reach break for 3 and 4 did not have any water or a defined channel. This was used to break up two large reaches.

Photo 9. Reach 1, NSO 11, T1. Spring source were water is collected for domestic water use. T1 enters the left bank contributing 10% of flow (24-June-05).

Stream Flow

Chihuahueños Creek begins as a series of springs in a steep, forested channel on the north slope of the northern Jemez Mountains. From its headwaters to its confluence with Cañones Creek, Chihuahueños is joined by 3 significant unnamed tributaries and numerous smaller, unnamed tributaries. The one named tributary, Cañada de la More, flows into Chihuahueños adding about 60% of the flow to the mainstem.

The flow of Chihuahueños Creek is governed by spring snowmelt, typically spiking in late May to early June. Smaller peak flows occur after heavy precipitation events associated with the summer monsoons (July through September). These heavy flows typically flush sediment that has built up in the system downstream. However, over the last few years this region has experienced drought conditions, creating unusually low flows.

Previous measured flow data for Chihuahueños Creek is scarce. On April 20, 1999, flow was measured at an NMED monitoring site above the confluence with Cañones at 1.21 cubic feet per second (cfs). Flow measured at the same site in July was 0.12 cfs (NMED 2004b). In June 2002 Chihuahueños was modeled at 0.5cfs for a hydrologic condition assessment (Dean 2004). Habitat inventories from 1998-1993 have measured flows ranging from 1.08 to 2.7 cfs (FS Files).

The Santa Fe National Forest measured flow in Chihuahueños Creek utilizing a Swoffer 3000 Flow Meter on July 22nd, 2005, in Reach 1 (NSO 3, R2), River Mile 0.1. Flow was measured at the beginning of the formal survey. 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 7 nearly equal spaced sections. At each section, flow was taken at 60% of the depth in twenty-second intervals. The average flow was recorded from each section and related to area to calculate the stream flow. Chihuahueños Creek flow on July 22nd was 0.44 cfs.

Photo 12. Reach 6. Stock pond in the headwaters of Chihuahueños Creek (21-July-05).

Water diversions in the formally surveyed length of Chihuahueños Creek include one irrigation diversion located in Reach 1 (NSO 7, R4) about 0.1 miles upstream of the confluence (see Photo 11). The diversion structure includes plastic tarps, metal, and boards. All of the water returns to the main channel about 100 feet downstream of the point of diversion due to ditch failure. Water is also diverted out of Tributary 1 and used for domestic water by landowners downstream. Water is also collected at the head of the basin in a stock pond.

Photo 12. Reach 1, NSO 10, R6. Irrigation diversion pipes moving water from T1 to private water users downstream (22-June-05).

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 11) 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 (see Appendix A, Figure 1).

Table 11. Santa Fe National Forest and New Mexico Environment Department Water Quality Temperature Standards 2005.

Water Temperature Standards	Properly Functioning	At Risk	Not Properly Functioning
SFNF 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

Water temperature in Chihuahueños Creek was monitored from July 1st to September 30th, 2003 and 2004. Tidbit thermographs, small temperature recording devices, were strategically placed at 2 locations in Chihuahueños Creek (see Figure 1). Thermographs recorded temperatures at 4-hour intervals for the duration of their time in the river, providing over 588 temperatures for each site. Data collected by thermographs was exported to Microsoft Excel 2000 for analysis and comparison to Forest and NMED Water Quality Standards for temperature. Both standards classify water temperature in different categories with differing requirements (see Table 11).

The two temperature monitoring stations established on Chihuahueños Creek were not moved for the duration of the monitoring period. The first station was placed above the confluence with Cañones (Reach 1, River Mile 0.1). The second station was located at the FR 448 crossing (Reach 2).

Thermograph data collected between July 1st and September 30th, in 2003 and 2004, was used to determine water quality. When SFNF and NMED standards are applied to the 2003 FR 448 crossing station (the thermograph at the mouth did not record data) it was found to be properly functioning under NMED standards while functioning **at risk** for 11 days under SFNF standards (see Figure 1). When SFNF and NMED standards are applied both 2004 stations were functioning properly and in full support of a coldwater fisheries (see Figure 2).

Maximum temperature recorded was 68.6º F on 7/13/2003 at the FR 448 crossing. Maximum temperatures recorded were 61.6º F on 7/20/2004 at the mouth and 65.6 on 7/19/2004 at the FR 448 crossing. This complies with properly function conditions (NMED) and is in full support (USFS) of high quality coldwater fisheries. However, a temperature of 76ºF was observed on 7/19/2005. **This high one time temperature does not support high quality coldwater fisheries under the NMED protocol.**

Figure 1. Comparison of days not properly functioning, at risk, and properly functioning at the FR 448 thermograph station in Chihuahueños Creek between July 1st and September 30th, 2003. Water temperature categories defined by SFNF Water Quality Temperature Standards are based on seven-day average maximum.

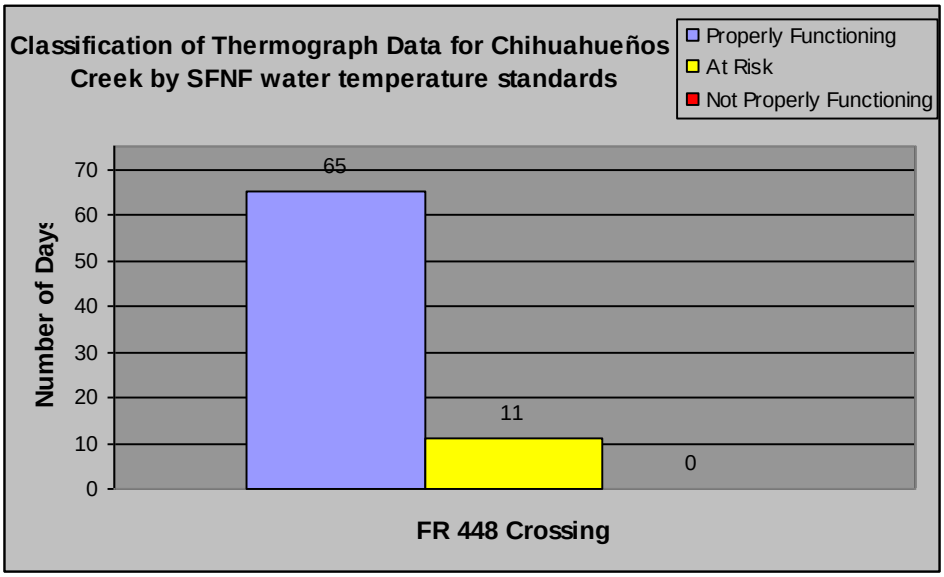
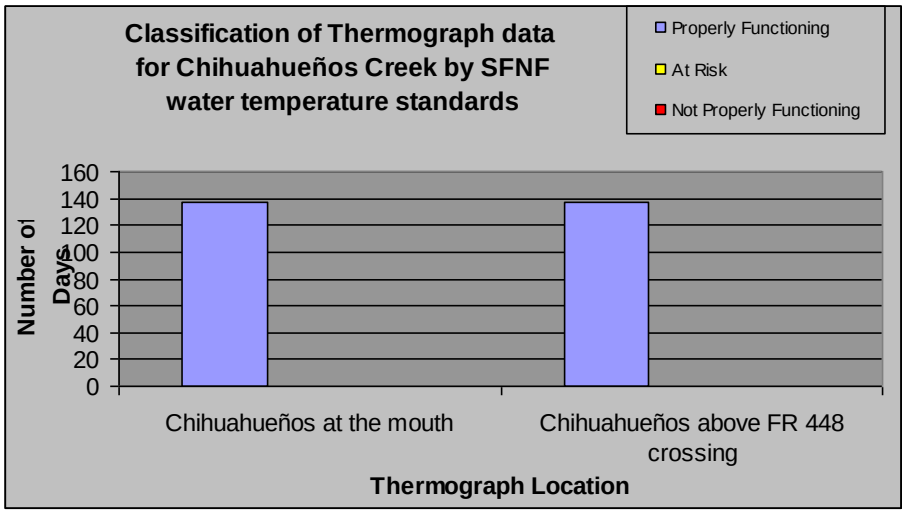
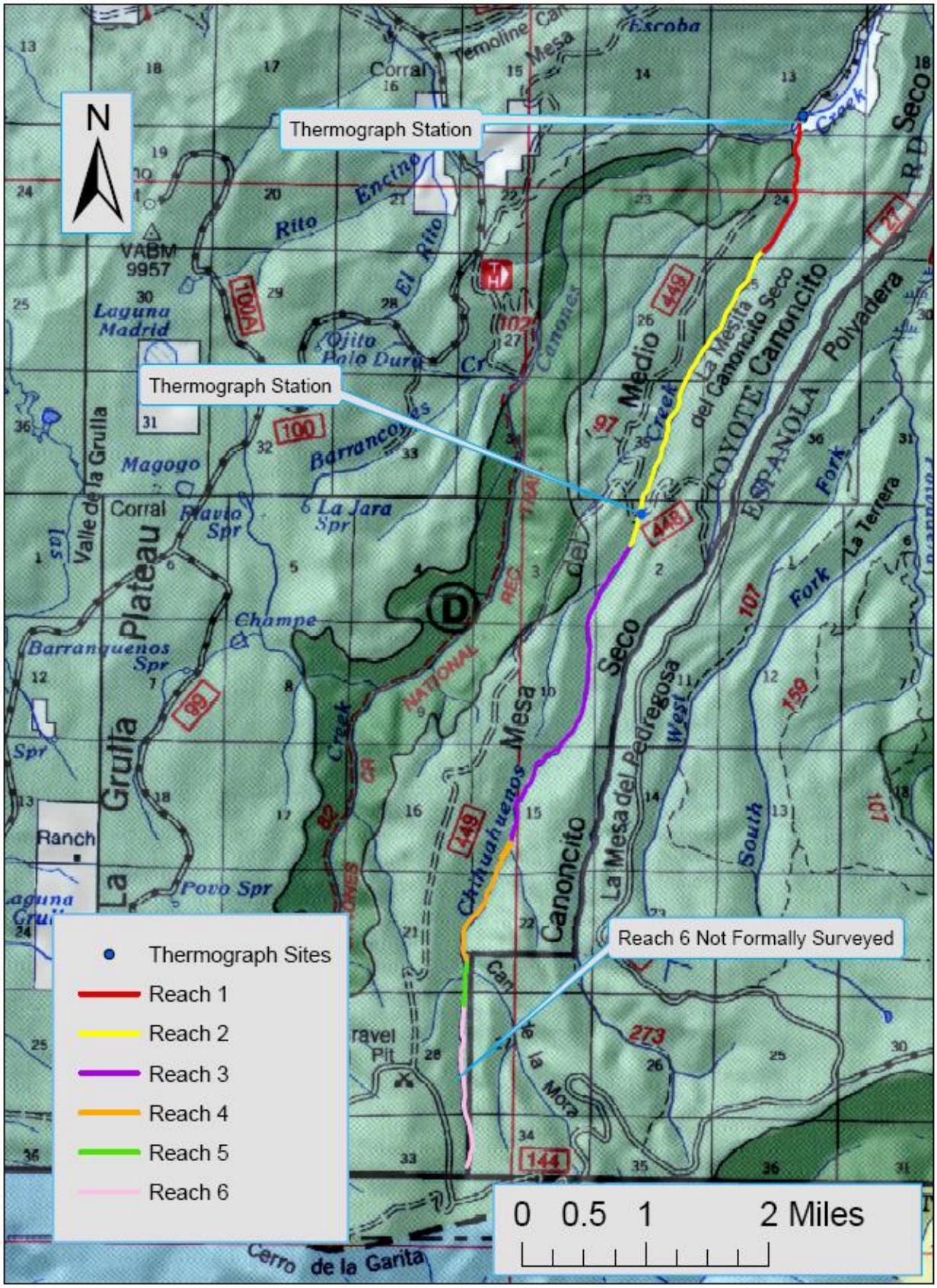


Figure 2. Comparison of days not properly functioning, at risk, and properly functioning at two thermograph stations in Chihuahueños Creek between July 1st and September 30th, 2004. Water temperature categories defined by SFNF Water Quality Temperature Standards are based on seven-day average maximum.


Classification of Thermograph data for Chihuahueños Creek by SFNF water temperature standards
Properly Functioning
At Risk
Not Properly Functioning
Number of Days
160
140
120
100
80
60
40
20
0
Chihuahueños at the mouth
Chihuahueños above FR 448 crossing
Thermograph Location

Chihuahueños 2004 Thermograph Sites

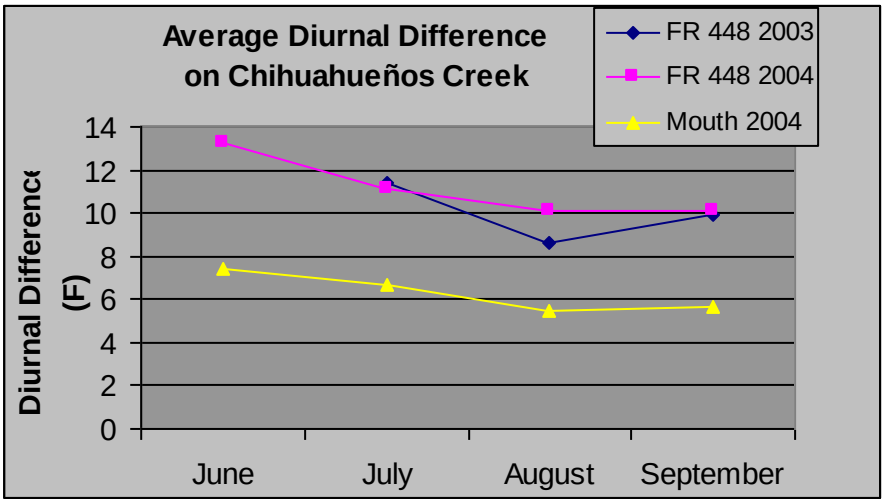


Map 2. Locations of 2004 Thermograph stations in Chihuahueños Creek.

Looking at stream temperatures across elevation can also distinguish areas in need of temperature mitigation. On a typical system, stream temperature should increase as elevation decreases. Chihuahueños Creek does not follow this pattern. During the time the thermographs were placed in the creek daily maximum temperatures at the mouth (elev. 7,240') were found to be higher than the daily maximum temperature recorded at the higher elevation site at FR 448 crossing (elev. 8760) 66% of the time. This indicates that the lack of shade cover and undercut banks are increasing temperatures in the meadow reaches.

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, 2004 on Chihuahueños Creek, diurnal difference ranged from 9.9°F at the thermograph station at FR 448 to 7.2°F at the thermograph station at the mouth. Diurnal temperature fluctuations were significantly greater at the FR 448 Thermograph Station during survey the entire time the thermograph was collecting data (see Figure 3).

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



The 2005 stream inventory revealed intense cattle use above FR 448 in Reaches 3, 4, and 5 in the long meadows that run along the stream. This section of stream had trampled banks and little streamside vegetation and undercut banks to provide shade and regulate stream temperatures. The streamside vegetation in this meadow was on average 1-3 inches high.

The Mouth Thermograph Station (Reach 1) was likely cooler due to the stream running through a shaded canyon for 4.5 miles before draining into Cañones Creek. This canyon had more alder, willow and herbaceous vegetation providing shade. It also had less evidence of recent cattle use likely due to the steep rugged nature of the canyon. In same place of Reach 1 the vegetation was to thick to walk through.

Photo 14. Reach 3. Typical heavily grazed meadow upstream from the Thermograph Station at FR 448. Notice the lack of shade cover and protection from thermal heating and evaporation (28-June-05).

Water temperatures are increasing in the meadows and it is likely due to the lack of riparian vegetation. Water quality and riparian vegetation should be management considerations. With Chihuahueños being one of the few remaining native trout waters temperature mitigation strategies should be applied to protect the integrity of one of the few remaining populations.

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; stores water in the stream banks, increasing available water and stream flow duration; and 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 Chihuahueños Creek.

Chihuahueños Creek woody riparian vegetation is dominated by alde, willow, and New Mexico locust which are especially important for providing shade in the lower reaches and parts of the meadows in the middle reaches. Narrowleaf cottonwood is also present in the Reach 1. Juniper and ponderosa pine are present intermittently along the entire stream in Reaches 1 and 2. Reaches 3 and 4 have primarily meadow vegetation, including grasses, sedges, spruce, and cinquefoil. Spruce-fir forest and large aspen stands dominate the upper reaches.

Vegetation upland (or outside of the riparian zone) is generally ponderosa pine forest in the lower and middle reaches of Chihuahueños Creek. Upland vegetation in the higher elevation reaches includes mixed conifer, spruce-fir, and aspen.

Beaver Activity

Evidence of once abundant beaver activity in Chihuahueños Creek were found throughout Reaches 2, 3, and 4. Reaches contained old blown out beaver dams with dead trees and debris surrounding them. One dam in Reach 3 was breached but still holding back some stagnant water. No new beaver activity was observed. Beaver activity was noted as well in a 1974 survey Chihuahueños (Reach 3) (Propst and McInnis 1975). While there is no current beaver activity in Chihuahueños Creek, it is clear that beavers have been previously active throughout the 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).

Photo 15. Reach 3, NSO 495, R245. Looking downstream at old beaver dam with an inactive pond above (29 Jun 04).

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

Historically and currently, Rio Grande cutthroat trout (RGCT), *Oncorhynchus clarki virginalis,* are the only trout species found in the Chihuahueños Watershed. This cutthroat subspecies is currently listed as a sensitive species on the Santa Fe National Forest.

Currently, a small population of RGCT exists in Chihuahueños Creek (see Figure 4). RGCT are able to hybridize with rainbow trout and other cutthroat trout. New Mexico Department of Game and Fish (NMDGF) determined from genetic samples in 2004 that these trout are not pure RGCT. This population is a cross between Yellowstone cutthroat and RGCT (Patten 2006). This population is still considered a Reserve Conservation Population which is defined as having at least 90% genetic purity. Reserve Conservation Populations “are a high priority for long range conservation management” (NMDGF 2002).

Snorkelers in the 2005 survey observed a small RGCT population and were unable to identify one fish. Conditions in Chihuahueños Creek were often very poor for snorkeling. Any disruptions in the creek would increase the turbidity and decrease visibility making fish sightings and identification very difficult. Reach 1 has very steep gradients and is thought to be a fish barrier to non-native fish that are found down stream in Cañones. Chihuahueños may have a pure population of cutthroat trout and further studies need to be done to determine their status.

Table 13. Fish distribution determined by USFS snorkel surveys (2005).

Fish Species	Native/Non-Native	Observed Distribution by Reach[1]	Estimated Distribution by Reach[2]
Rio Grande cutthroat trout	Native	2 and 3	2 through 5
Rainbow trout[3]	Non-Native	NA[3]	2 through 5
Hybrid trout[3]	Non-Native	NA[3]	2 through 5
Unknown	-	3	2 through 5

[1]Fish presence observed in snorkel surveys.
[2] Fish presence observed in snorkel and habitat surveys and extrapolated presence based on barrier locations.
[3] Due to poor visibility fish identification was not always possible resulting in unknown fish observations. Further fish population distribution and genetic sampling are recommended

Only Reaches 2 and 3 were snorkeled in this survey. Reach 1 is an uncertain barrier to fish migration in Chihuahueños Creek due to gradient. Falls up to 4.5 feet high along with an average gradient of 15.6% likely make fish migration difficult if not impassable. Therefore, it is assumed that fish species observed above Reach 1 are present in Reaches 2 through 5. Fish were observed from the banks in all of the surveyed reaches, except in Reach 5. Although no fish were observed in Reach 5, it is believed that they use the lower end of the reach due to no barriers and lower gradients.

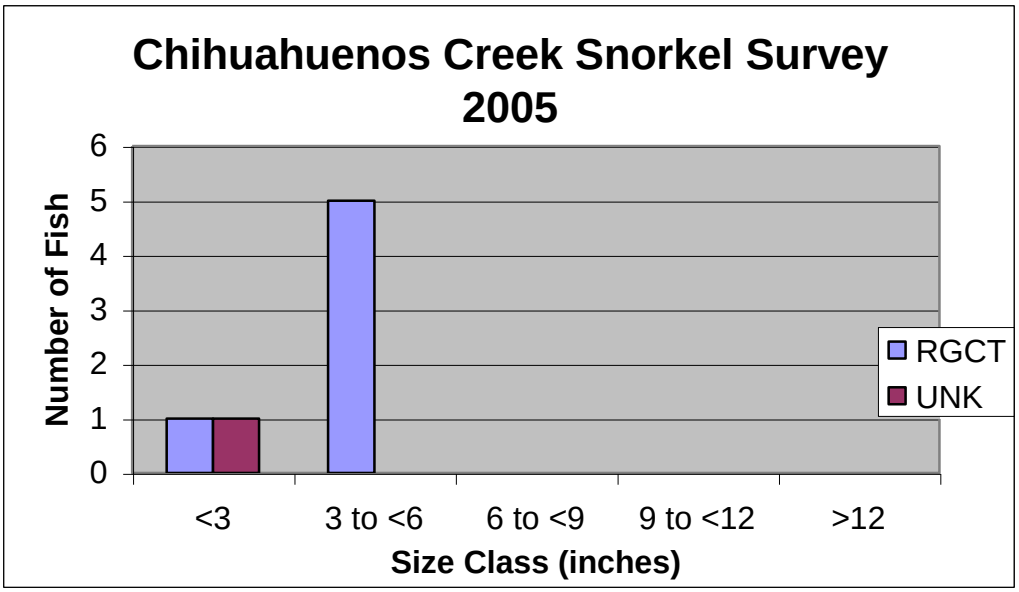
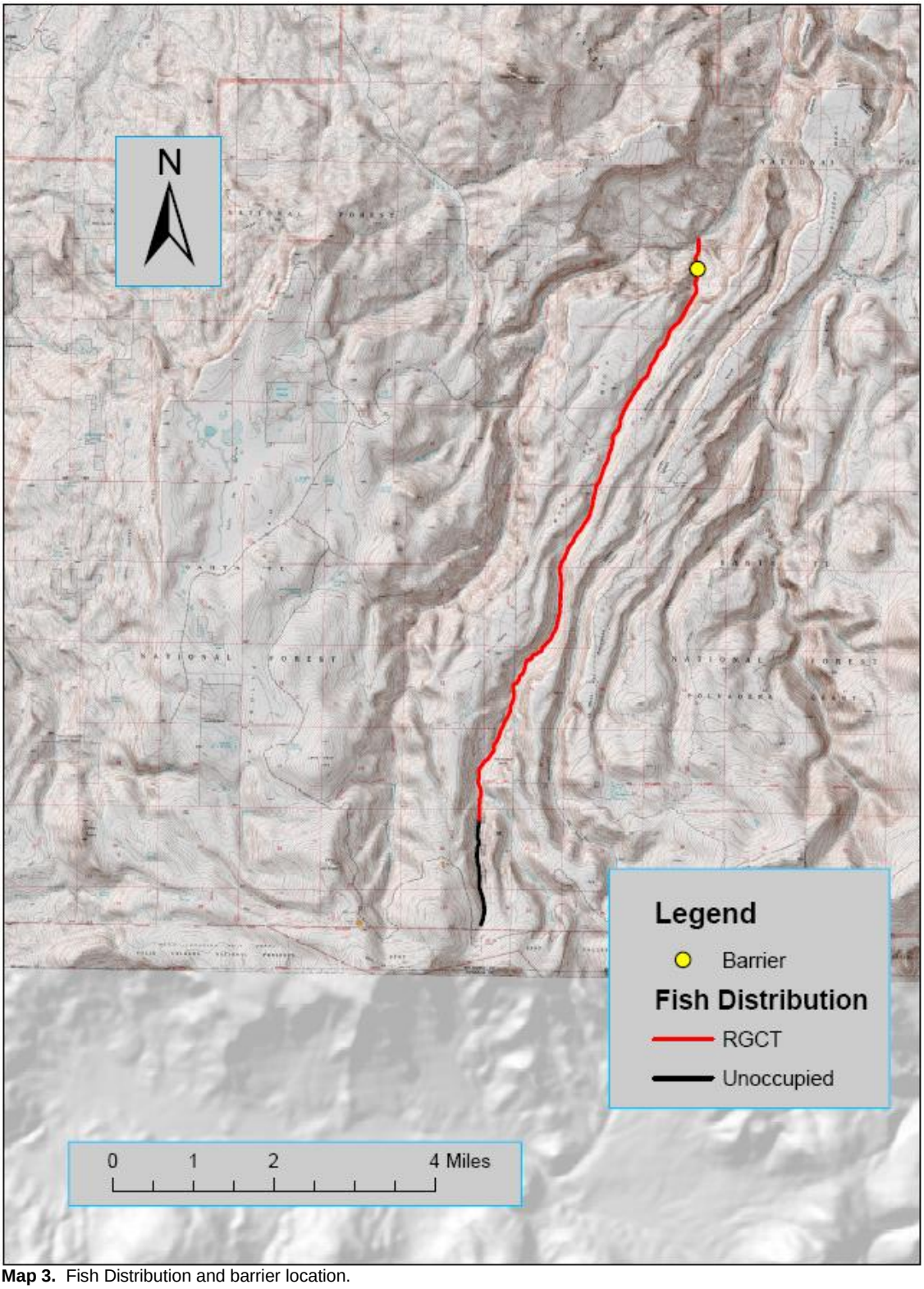


Figure 4. The number of trout by species and size class for the snorkel survey conducted during the summer of 2005 on Chihuahueños Creek.

Changing habitat conditions have also been recorded throughout Chihuahueños Creek Watershed. A 1974 survey by Propst and McInnis (1975) survey of East Fork Chihuahueños Creek found few RGCT and noted that "bank stability on all sites was extremely poor". The lack of riparian vegetation and heavy grazing in the upper meadows was noted as contributing to unstable banks. Their recommendations were to plant riparian vegetation in these areas as well as not increase cattle grazing because of the instability of the RGCT population. During the previous (1974) survey the crew noticed numerous fish around and in beaver ponds. During the 2005 survey no beaver ponds were observed and fish observations were few.

The survey conducted in 1993 also noted degraded conditions starting near FR 448 and extending all the way up to Cañada de la Mora. Riparian vigor was low and showing signs of stress. Raw banks were actively eroding and slumping into the creek.

Chihuahueños Creek 2005



Map 3. Fish Distribution and barrier location.

Previous Surveys

Previous surveys include a 1975 RGCT habitat survey conducted by New Mexico State and Colorado State Universities of Chihuahueños Creek (Reaches 3,4, and 5 in the 2004 survey), a General Aquatic Wildlife Systems (GAWS) Level 3 survey was conducted in 1989 (Reaches 2,3, and 4 in the 2004 survey) by the Santa Fe National Forest (SFNF), a 1993 Hankin and Reeves Basin-Wide Visual Estimation Technique (H&R BVET) survey by the SFNF, and 2002 survey of a portion of Chihuahueños Creek for the Canjilon Creek – Rio Chama Hydrologic Condition Assessment (HCA).

All but one of previous surveys was done in more site specific areas and did not cover longer reaches of stream. There for it is hard to make direct comparisons between the previous surveys and the 2005 survey. However, what are comparable are the end results and the discussions that have resulted from the surveys. The 1993 survey had reaches that were similar to the 2005 survey, but the complete report was not available so comparisons could not be made.

The 1975 survey of Chihuahueños Creek noted cattle grazing its effects were found through all the reaches surveyed. They noted beaver ponds and found those areas to have the higher numbers of fish. Their results showed that the habitat is "extremely poor" for the native Rio Grande Cutthroat trout. Most fish observed were less than 15 centimeters due to the poor habitat. Bank stability was also "extremely poor" with the sole cause being cattle grazing along the water the entire length of the stream. Their discussion and management suggestions include the following:

> One, cattle grazing should be reduced if not eliminated to stop the erosion of stream banks. Second, riparian vegetation should be planted to increase protection of fish from direct sunlight and high water temperatures. Thirdly, gabin structures should be placed in several areas along the stream to help improve the poor pool-riffle ration as well as provide more habitat for trout.

The 1989 survey did not have a report associated with it. Data that was found was collected using a code. Without the manual used for data collection further comparisons are postponed.

The 1993 survey using the Hankin and Reeves method had similar reach breaks, except for Reach 5, which was much shorter in 2005. Reach 1 was noted as being very steep with thick vegetation and found to be the reach in the best condition during the survey. In Reach 2 starts to show signs of degradation near the FR 448 crossing. Cattle, degraded banks, and reductions in vegetation were found at the upper end of the reach approaching the 448 road crossing. Reach 3 contains riparian cattle exclosures that had vigorous vegetation growth when compared to conditions outside the exclosure. The upper end of the reach contained "numerous raw exposed or otherwise actively eroding streambanks". Vegetation growth was found to be poor and showing signs of stress from grazing. Beaver activity was found in this reach. Reach 4 showed signs of recent beaver activity. Slumping and degraded banks were found in the upper parts of the reach along with channel incision. Floodplains were found to be non-functional. Reach 5 was longer in the 1993 survey and went from the "C" channel and into the "A". The 2005 survey ended at the end of the "C" channel. Below the steeper channel the vegetation and stream bank condition was found to be in poor shape in 1993. Both surveys found a deep and incised channel extending to the top of the meadow to a head cut where the channel becomes more intact and connected to the floodplain. Table X shows the differences between the two surveys. It is

important to note that the 1993 survey did ocular estimates of length resulting in differences between the two surveys despite reaches (other than Reach 5) having similar starting and ending points.

Comparing the two surveys shows a difference in the pool to riffle length ratio. The ratio of pool to riffle length ratio in the 1993 survey was 1:3.5' were as the 2005 survey observed 1:10.6'. Sediment was also comparable with the 1993 survey noting sand more often as the dominant than in the 2005 survey. Both surveys noted either sand or gravel as the dominant substrate in most of the reaches (Table x). Overall the comparison shows a reduction in pool habitat and a reduction in sand throughout Chihuahueños Creek. One explanation for this may be to due the loss of beaver in the system. Recent beaver activity was noted in the 1993 survey, but not the 2005. Active beavers in Chihuahueños Creek would have been maintaining dams and increasing the amount of pool habitat while collecting fine sediment. Another explanation for why less sand was observed in 2005 may be that the numerous roads in the watershed have slowly started to vegetate and are less erosive. Slopes that were likely clear-cut in the 1970s and 1980s have grown back very thick and may be providing more slope stability and acting as vegetation filter for sediment moving off slopes and the numerous roads. Also, the 2005 survey data in the Table X only includes riffle habitat. The 1993 data likely includes both pools and riffles which would likely account for smaller particles.

Table X. Comparisons made between the 1993 survey and the 2005 survey.

Reach		Total Length (mi)		Percent Pool Habitat		Percent Riffle Habitat		Dominant Substrate (dominant/subdominant)*	
1993	**2005**	**1993**	**2005**	**1993**	**2005**	**1993**	**2005**	**1993**	**2005**
1	1	1.2	1.2	18.3	6.5	81.7	87.7	Sand/Cobble	Gravel/Cobble
2	2	2.3	3.3	14.9	8.6	85.1	91.1	Sand/Gravel	Sand/Gravel
3	3	2.1	3.4	19.0	7.0	81.0	93.0	Sand/Gravel	Gravel/Sand
4	4	2.2	1.3	16.3	15.6	83.7	84.4	Gravel/Sand	Gravel/Sand
5	5	0.9	0.4	38.4	5.0	61.6	94.3	Gravel/Sand	Gravel/Sand
Entire		8.7	9.6	22.2	8.5	77.7	90.2		

*Sediment in the 2005 only includes riffle habitat.

The 2002 HCA riparian and wetland area survey covered 5.5 miles of stream. The start of the survey was approximately 2 miles above the confluence and the private land. It was found that only 9% of the reaches evaluated had properly functioning conditions. It was found that 82% of the survey was functioning with an upward trend with the rest functioning at risk with no apparent trend.

Discussion

Looking back at the past surveys and comparing them to the 2005 survey results in similar conditions in the same areas. There does not appear to be any trend of improvement or further derogation. Current conditions are well below Forest standards and requirements needed to support populations of Rio Grande Cutthroat trout.

Wildlife Species

Chihuahueños Creek Watershed is home to a diverse array of wildlife, including the sensitive species Rio Grande cutthroat trout. The lower part of the watershed contains habitat for peregrine falcon, a sensitive species, and the headwaters contain potential habitat for northern goshawk, also listed as sensitive (Orr 2005). Other wildlife in the watershed include but are not limited to chorus frogs, canyon tree frogs (lower reaches), woodhouse toads, and tiger salamanders. (Orr 2004). Beaver did inhabit the drainage, but no evidence of new beaver activity was found during the 2005 survey.

Stream Improvements

In 1990, two riparian exclosures that include bank stabilization structures were built in Reach 3 (above FR 448). The exclosures in Chihuahueños Creek provide the best stream habitat and bank stability in that reach. The log structures were placed in the creek and along the banks to provide pool habitat and bank stability. Some of the logs are getting old and rotten and are hard to pick out. The banks in the exclosure have healed very well, but are still being trampled by cows that make inside and graze along the banks. Overall use in the fence is light. Grasses and sedges along the banks in the exclosure are 6 to 18inches and are less grazed than any other part of stream formally surveyed. A 2004 fish population survey done by the New Mexico Game and Fish department noted a dramatic increase in fish numbers inside the exclosures when compared to sampling done outside of the exclosures (Patten 2004). The 2005 snorkel survey also noted increased in fish numbers in the exclosed areas.

Photo 15. Reach 3. NSO 372, P177. Exclosure boundary, notice the vegetation and stream banks inside compared to outside. (27 July 05).

Stream improvements planned for Chihuahueños Creek include maintaining the 2 exclosures and reducing the ATV use in the drainage that occurs along and in the stream at various points.

LAND USE

Summarized from Michael Dussinger, Coyote District Archaeologist

Human occupation of the watershed and north central New Mexico is documented from the Paleoindian Period (ca. 10000 B.C. to 5000 B.C.) to the present. The cultural history of this portion of the state reflects the unique regional location of the area, which is transitional between the Colorado Plateau Province and the Southern Rocky Mountain Province (Fenneman 1931).

Paleoindian (ca. 11500 B.C. to 5000 B.C.) and Archaic (ca. 5500 B.C. to A.D. 200)

Paleoindians are thought to have lived in small, mobile bands that moved across the landscape with some frequency to hunt now extinct mega-fauna, including mammoths and bison. Subsistence was supplemented by the hunting of smaller mammals and gathering of wild plants (Cordell 1979). These nomadic hunters probably developed a much broader hunting and gathering subsistence strategy during the Archaic in response to climatic changes that occurred at the end of the Pleistocene (Irwin-Williams 1979). Archaic populations most likely lived in small groups for most of the year, moving often and exploiting a wide variety of wild plants and animals with the changing seasons (Stuart and Gauthier 1981). Later Archaic subsistence strategies included horticulture as well.

Ancestral Eastern Puebloan (A.D. 600 to A.D. 1540)

The Ancestral Eastern Puebloan Period is most often characterized by a dependence on agriculture (supplemented by hunting and gathering), use of the bow and arrow, ceramic production, pithouse to large pueblo architecture, population increase, sedentism, changes in political and social organization, and nucleation of populations in large villages.

The early Puebloan Period is defined by a shift in subsistence strategies. Sites in the Upper Rio Grande area tend to be small and dispersed, and occupation appears to be seasonal and short term. Puebloan sites from the latter half of this period are larger and denser and show new ceramic and architectural styles, including aggregation into masonry or adobe room pueblos (Cordell 1979). During this period lower elevation areas were at times abandoned and highland areas were more intensively utilized (Stuart and Gauthier 1981).

Historic/Pueblo V (A.D 1540 to present)

The Historic Period, also called the Pueblo V Period, is characterized by larger pueblo sites, substantial population movement (Stuart and Gauthier 1981) and the arrival of the Spanish.

North central New Mexico experienced the full extent of the impact of Spanish culture with the Coronado expedition of 1540 and the Oñate expedition of 1598 (Hill 1990). The introduction of European diseases, new religion and economic systems, warfare, and famine severely reduced Native American populations and settlements in the region from the late 1500s through the 1600s. Following the Pueblo Revolt of 1680 and Diego de Vargas' subsequent Spanish reconquest in 1692, the Spanish established more missions and more settlers started utilizing the area for cattle grazing, farming and hunting. The Spanish government granted free title tracts of land to Spanish colonists to promote settlement and land development in northern New Mexico. Grants were also made to Pueblo Indian groups (Scurlock 1981).

Hispanic settlement north of Abiquiu grew in the early 19th century. The community of Gallina, originally called Jacquez, was settled northwest of the Chihuahueños Creek Watershed in 1818 by Antonio Ortiz (Julyan 1995). The community of Coyote has its roots in the settlements of Coyote Valley and Coyote Canyon that were established around 1862 (Julyan 1995). The community of Llaves, originally named Maestas, was established in the early 20th century. These small communities, along with Youngsville, continue to subsist to some extent on the extraction of resources from the land, including cattle and sheep ranching, logging, and farming.

While Spanish rule of the region came to a close in 1821, new markets for wool and sheep brought increased colonial sheep herding and the development of large commercial sheep operations. Settlements in northern New Mexico grew until the U.S. annexed New Mexico in 1846. The 1848 Treaty of Guadalupe Hidalgo included a promise to honor all valid pre-existing Spanish land grants, but many of these were nullified or reduced with the involvement of the U.S. Government, land speculators, and lawyers. According to sociologist C. Knowlton, "Much of the land now included in the National Forest System in northern New Mexico was once part of the many Spanish and Mexican land grants in the region. When the Forest Service acquired these lands, these use rights were not acknowledged. The loss of grazing lands and the resources of the mountain forests brought poverty to a large number of Spanish-American village people" (Knowlton 1970). Shepherds found themselves at the mercy of landowners and many became tenant herders. It is unclear when Chihuahueños Creek Watershed was transferred to Forest Service ownership and management.

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 have been associated with decreased fry emergence and 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 FS 2000).

Chihuahueños Creek Watershed has four different types of management areas concerning road density. Management Area A emphasizes providing dispersed recreation opportunities, maintaining visual quality and timber/firewood production, and requires a road density of 1.0-2.5 miles/square mile Management Area G emphasizes wildlife habitat protection and improvement as well as forage and firewood production and requires a road density of 0.3-1.5 miles/square mile. Management Area E emphasizes providing dispersed recreation opportunities, maintaining visual quality and timber/firewood production, and requires a road density of 1.0-2.5 miles/square mile. Management Area L emphasizes providing semi-primitive non-motorized recreation opportunities; while there is no specified density standard, the management objective is to close currently existing roads, which one would assume is 0.0 miles/square mile. Moreover, the Santa Fe National Forest Plan seeks to evaluate the riparian zone within Management Area L for opportunities specifically related to threatened or endangered species recovery (USFS 1997). Chihuahuenos Creek Watershed has 48.9 miles of road. This leads to a road density of 5.8 miles/square mile, which is not within the standards for Area A, G, E, and L. When roads per

mile is broken down by management area only management area G (0.013 sq miles) is in compliance with the standards of the Forest Plan (see Table X).

Table x. Road densities in the Chihauhueños watershed.

Management Area	Miles of Road	Area in Square Miles	Roads per Square Mile	Roads per Square Mile Required by Forest Plan
A	30.3	6.05	5.0	1-2.5
E	16.1	2.09	7.7	1-2.5
G	0.0	0.01	0.0	0.3-1.5
L	2.5	0.23	10.6	0.0
Total	48.9	8.4	5.8	-

Red-Roads per square mile exceeds Forest Plan requirements.

Crisscrossing of old logging roads are numerous in the headwaters of Chihuahueños Creek. A majority of these roads are closed but likely still adding sediment into the creek. Forest Road 448 parallels and crosses Chihuahueños Creek and is likely the largest source of sediment input from roads in the drainage. Near the creek crossing, the FR 448 road surface on the west side of the creek has been washed away leaving the surface very rough with road surface\sediment being washed though a dispersed campsite and into the creek. Other than FR 448 most of the roads are away from the creek. There were remnants of old logging roads downstream of FR 448 near the creek, but they were grassed over and have closed themselves. Roads in the watershed were associated with logging that existed from the early 1900s to the 1980s.

Photo x. Reach 2, NSO 290, R142. Old road crossing with unstable banks. Old road is vegetated except at the crossing which is being trampled (26-June-05).

Recreation

Hunting is one of the most popular recreational activities in Chihuahueños Creek. Other possible recreational uses of the watershed include fishing, horseback riding, motorcycle use, hiking, and camping. Local ranchers tending to cows on ATVs were the only people observed along Chihuahueños. Hunters were observed driving FR 448 and FR 449 but were no seen outside of their vehicles. Old worm containers were found along the banks indicating that Chihuahueños does receive fishing pressure.

Chihuahueños Creek experiences very little dispersed recreational. There is one large unnamed system trail (no number, but on old maps) entering in reach 4. This trail is mainly used by ATVs by the local ranchers and hunters. A significant user created trail heads up and downstream from FR 448. The trail downstream is mainly used by cattle while the trail heading upstream is used by cattle and ATVs. The trail starts to fade out above Cañanda de la Mora and is non-existent by the end of Reach 5. Between FR 448 and the end of reach 5 there are numerous stream crossings causing stream bank instability and channel widening.

Photo 17. Reach 3. NSO 478, P229. ATV trail crossing Chihuahueños Creek causing bank instability and channel widening (28-June- 2005).

There are no developed recreation sites within the canyon, and only one dispersed site was observed during the survey at the FR 448 crossing (Reach 2). The camp site is within 5 feet of the stream bank in some places. This site probably sees only low use, although use increases during the fall hunting season.

Timber

Forest in the Chihuahueños Creek Watershed consists primarily of ponderosa pine (*Pinus ponderosa*), spruce, fir, aspen, and juniper. Timber harvests have gone on for as long as people have inhabited the region. From the early 1900s to 1970s/80s heavy logging took place in the area. An old logging road extended all the way up to headwaters. With most of the timber

removed from the drainage the trees that have grown back are of the same age making the drainage ripe for major fire.

Fire

Historically, fire has played an important role in the pine 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 Jemez Mountains has declined since the beginning of human fire suppression measures.

Chihuahueños has not seen any recent natural fire or prescribed burns making the drainage very think with an even aged size class and ripe for a major fire.

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 FS 1996). Grazing on public lands has occurred for nearly a century. The Chihuahueños Creek Watershed has one grazing allotment Mesa del Medio, managed by the Coyote District (see Figure 8) New Allotment Management Plans will be written for this allotment in 2006 (Dixon 2005).

Table 17. Range Allotments within the Chihuahueños Watershed and their overall use.

Allotment	Total Acres	Acres within Chihuahuenos	Permitted Head (cow/calf pairs)	Authorized Use				
				2004	2003	2002	2001	2000
Mesa del Medio	17,316	4,039	148	133	105	148	140	138
Chicoma	xxxx	1,325						

Mesa del Medio Allotment is 17,316 acres with 4,039 within the Chihuahueños Watershed accounting for 75% of the watershed. Chicoma is xxxx acres and has 1,325 acres within the watershed. Less than 1% (45 acres in the headwaters) of the watershed is not in an allotment. Steeper sections of the lower watershed within the Mesa del Medio are not suitable for grazing and do not receive over grazing like the upper three quarters watershed.

Photo 17. Reach 4. NSO 607, P292. Cattle were found licking unstable banks along Chihuahueños Creek increasing bank instability and channel widening (20-July- 2005).

Heaviest use (duration and numbers) is located in the meadow reaches (Reaches 2,3, and 4). This is indicative of collected data, representing unnaturally high bank instability (see Photo 18) in Reaches 2 (14.3%), 3 (33.2%), and 4 (53.7%). Reaches 1, the upper half of 5, and 6 had less use than meadow reaches due to steep ground, thick forest, and poor forage. However, Reach 5 did have a considerable amount of unstable bank (27.4%) with a majority of it observed in the meadow found at in the lower half of the reach. No use was observed until the very upper end of the watershed where the stock pond is. Chihuahueños was dry below the pond and it appeared that the cattle were entering the pond from the sides on an old logging road.

Table 18. Pasture rotation, timing and use in relation to direct grazing on reaches.

Reach	Allotment Name	Pasture	Average Timing[1]	Avg. Authorized Use[1]
1-6	Mesa del Medio	Riparian	10 Days (June) [1]	133
5 and 6				

[1] Trespass could be occurring

Timing in this allotment appears to season long in Chihuahueños. Cattle were observed in the riparian area throughout the entire survey from June 22nd through July 20th.

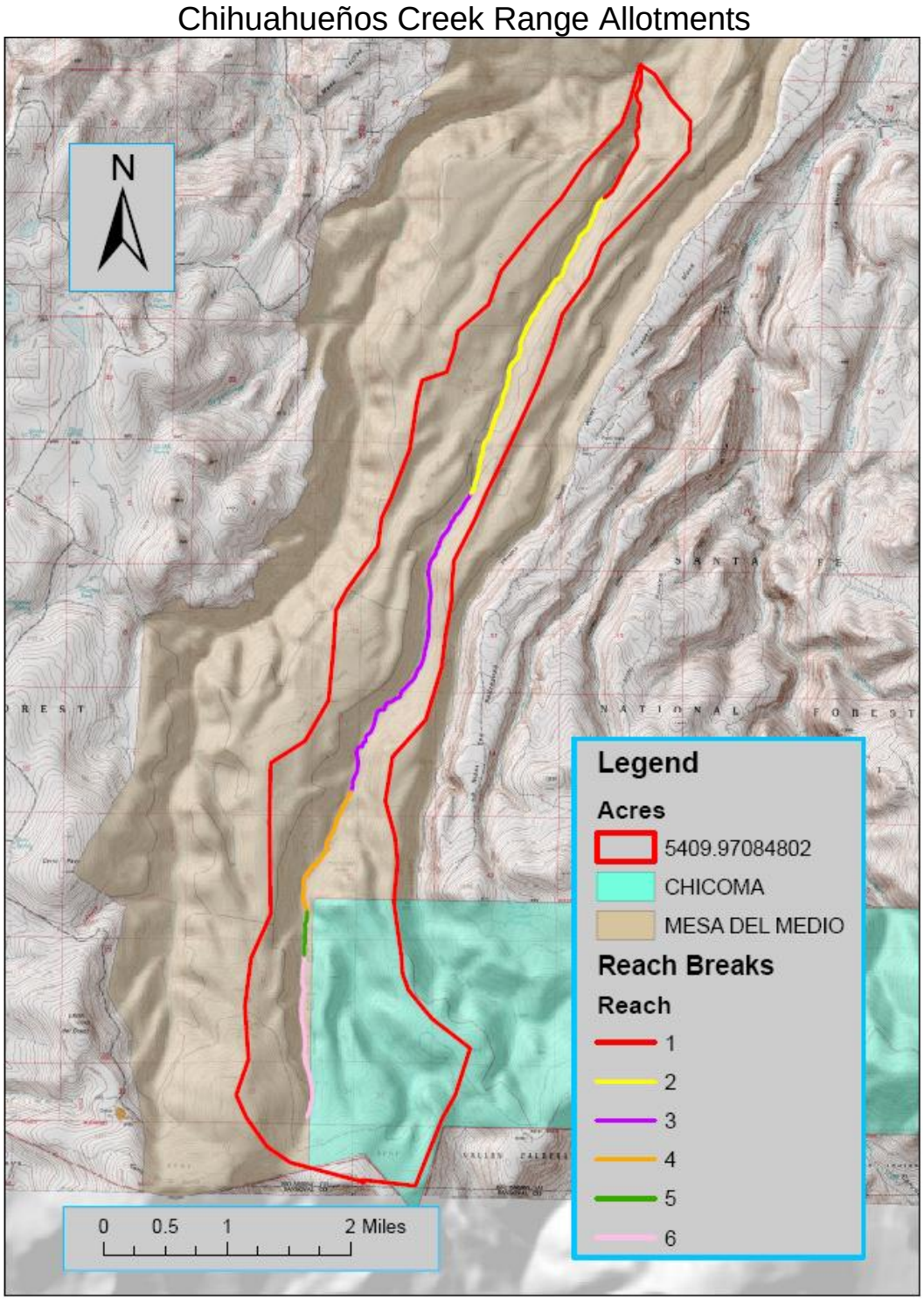


Figure 8. Range Allotment boundaries associated with high bank instability within the Chihuahueños Watershed.

Photo 18. Reach 4, NSO 562, R278. Cow with broken leg found stuck in Chihuahueños Creek (17-June-05).

RECOMMENDATION SUMMARY

Riparian

Objective:

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

Concerns:

Currently, riparian conditions are degraded in Reaches 2, 3, , 7 and 8 (most significantly in 5, 7, and 8). This is evident in the reduction in species diversity and vegetation density, draining of wetlands, and unnaturally high bank instability. Grazing and ATV use have had the most significant impact on the riparian zone. 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 stabilize, stimulate and promote a healthy vegetation community.

Implementation methods:

1) In the forthcoming OHV Management Plan, prohibit off-road vehicle use in the watershed, including conversion of Trails 107 and 238 to non-motorized use. In the interim, establish a CFR that would bridge this need.
2) In the forthcoming Four Allotments Management Plan, alter grazing practices to protect the riparian area. Riparian grazing should be eliminated or highly reduced during the vegetation's growing season. This can be accomplished through seasonal use, rest rotation, range riding and riparian exclosure fencing. More specifically, the current admin exclosure fences in Reach 3 could be extended to include all of the reach as well as Reach 4, providing water gaps in strategic locations. In addition, walk throughs or step overs should be provided for the recreating public.

3) Promote beaver recolonization through augmentation of current riparian density with planting native willow (only in areas where grazing has been eliminated or drastically decreased).

Native Fish Populations

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

Concerns:
It appears that the RGCT population in Chihuahueños Creek has decreased due to the loss of beaver and the habitat they create and the filling in of pools. During a previous (1975) survey the crew noticed numerous fish around and in beaver ponds. During the 2005 survey no beaver ponds were observed and fish observations were few. Trout require deep, clean, and cool pools during drought conditions, over wintering, and for spawning. Of the remaining population, productivity levels are low due to high sediment deposition, loss of spawning gravels, limited pool volume, and stresses associated with poor habitat conditions.

Implementation methods:

1) In the forthcoming Four Allotments Management Plan, alter grazing practices to protect the riparian area. Riparian grazing should be eliminated or highly reduced during the vegetation's growing season. This can be accomplished through seasonal use, rest rotation, range riding and riparian exclosure fencing. More specifically, the current admin exclosure fences in Reach 3 could be extended to include all of the reach as well as Reach 4, providing water gaps in strategic locations. In addition, walk throughs or step overs should be provided for the recreating public.
2) Promote beaver recolonization through augmentation of current riparian density with planting native willow (only in areas where grazing has been eliminated or drastically decreased).
3) Establish permanent snorkeling stations to monitor fish populations over time.

REACH SUMMARIES

Photo 19. Reach 7, NSO 188, R78. Large section of bank instability (25 Jul 04).

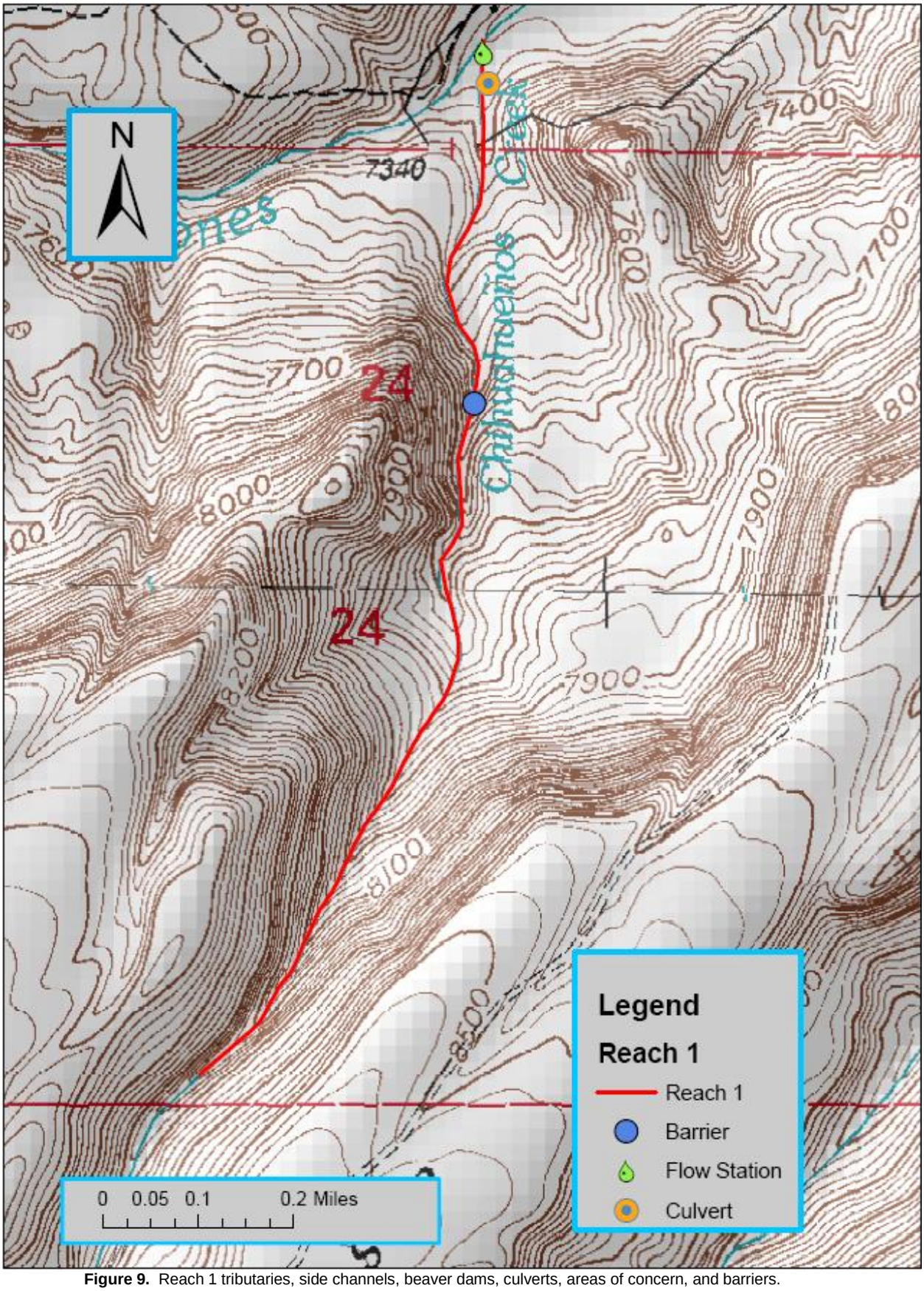


Figure 9. Reach 1 tributaries, side channels, beaver dams, culverts, areas of concern, and barriers.

Reach 1: Mouth of Chihuahueños Creek to Change in Valley and Stream Type

Reach 1 of Chihuahuenos Creek was surveyed on June 22th through June 24th, 2005. Reach 1 begins at the confluence of the Chihuahueños and Cañones Creeks on private land (T22N, R4E, Sec. 13, elev. 7,240') and ends at the change in valley and stream type (T22N, R4E, Sec. 24, elev. 8,220'), 1.2 miles upstream. The average gradient was 15.6%, with a sinuosity of 1.01, bankfull width to depth ratio of 10, and a dominant riffle substrate of gravel (37.6%) and cobble (26.1%). The Rosgen stream type is A4a+. Flow near the beginning of Reach 1 (NSO 5, R3) was measured at 0.44 cfs.

The first ten NSOs were less confined with lower gradient (≈4-6%). The valley width then decresed to 20-40' wide and the gradient increased to 10-16%. The reach was ended the valley became wide and the stream gradient decreased. An unknown fish was not observed until the upper half of the reach and are assumed to have come from upstream due to the steep gradients in the lower parts of the reach that maybe acting as a barrier.

Nearly equal numbers of riffles (59) and pools (54) are evenly distributed throughout Reach 1. This reach has 4 side channels adding 350 feet of habitat to Reach 1. In some case side channels may offer fish passage around chutes and falls.

There is one culvert in Reach 1. It is a set of three round pipes placed parallel to one another. All of the pipes are 15 ft. long and approximately 1 ft. diameter. These culverts are undersized and not functioning. Water is going around and underneath the pipes. This is in an area of low gradient, and does not appear to cause any sort of barrier, however the culverts should be replaced with a larger pipe that will adequately handle base flows as well as bankfull flows.

Photo 33. Reach 1, NSO 4, C1. Culvert found on a small piece of private land (22-June-05).

Two tributaries were found in this reach. Both seeps enter in the left bank. The first tributary is like a seep were it enter the creek, but further upstream where the drainage is more confined it is more like a spring with a channel. The spring is being used for domestic water on private land below. An ATV trail parallels and crosses the spring to the spring boxes that are collecting the water at its source and is likely used for maintenance of the collection boxes.

An irrigation ditch diversion was found in the lower reach. It was diverting water into ditch for about 100 feet. All of the water then returned to the main channel due to ditch failure.

Reach 1 has a total of forty-two (42) pieces of large woody debris. This reach was very thick with vegetation. LWD recruitment was more likely near the beginning and end of the reach. The middle section of the reach contains very thick vegetation, but the trees are all small and would not count as LWD if they entered the system. The density of down wood, standing snags, and thick vegetation could be disastrous for the creek in the event of a fire.

An ATV trail runs along the lower part of the reach on the left bank. At one point the trail is next to the creek and there is a crossing leading to private property, but for the most part it is not causing bank instability. Once the ATV trail leaves Chihuahueños it follows T1 up to numerous spring boxes that are collecting domestic water used by landowners below. No trails were observed in the very steep and confined middle section of this reach. At upper end of the reach where the valley opened and the gradient decreased numerous cow trails were found.
Many sections of the stream in this reach are well shaded. Streamside woody vegetation in the lower part of Reach 1 consists of alder, willow, birch, narrowleaf cottonwood, juniper, oak, locust, and aspen. Ferns, thimbleberry, twisted stock, and grasses were cound in the understory.

Photo 34. Reach 1, NSO 11, T1. ATV trail crossing tributary. Trail ends at the source of the spring where water is collected and piped downstream for domestic water use by private land owners (22-June-05).

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 1. The highest temperature was 57°F and the lowest was 48°F. The average stream temperature was 53°F.

Habitat Characteristics

Reach 1 is divided into 123 NSOs, measuring 1.2 miles (6,274 feet). Fifty-four (54) NSOs are pools, and comprise 6.5% of the stream habitat. Fifty-nine0 (59) riffles make up 87.7% of the stream habitat in Reach 1 (see Table 19).

Table 19. 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	54	428	6.8	6.5	≥30%
Riffle	59	5,811	92.7	87.7	-
Culvert	1	15	0.2	0.2	-
Tributary	2	200	NA	N/A	-
Falls	3	20	0.3	0.3	-
Side Channel	4	350	N/A	5.3	-
Dry Channel	0	0	0.0	0.0	-
Total	123	6,624	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 both not properly functioning and properly functioning. The parameters that are **not properly functioning** include pool development, pool quality, and sediment. Bank stability was not analyzed due to steep gradient (>4%). **Properly functioning** factors include bankfull width-to-depth ratio and LWD.

Sediment content in riffle habitat (25.9% fines) is **not properly functioning** (see Table 20). In normal years sediment is flushed down by the high flows during spring run-off. 2005 experienced a good spring runoff and sediments should have been washed downstream. A channel that steep containing fines that high is a indication that large amounts of sediment are being continuously added to the stream from upstream reaches and/or that there was an amount of fines in the stream that was so large that the spring runoff couldn't clean the stream.

Photo 36. Reach 1, NSO 38, F1. Fall (4.5') without pool present at the base. Likely a fish barrier (23-June-05).

Table 20. Summary of habitat and substrate composition in riffle habitat of Reach 1.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg Depth	Avg. Max Depth	
1	59	98.5	5.2	0.4	0.8	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
	25.9	27.6	26.1	19.2	1.2	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Photo 33. Reach 1, NSO 92, S3. Side channel on left bank. Notice the high amounts of sand and gravel in the pool (23-June-05).

Pool development in Reach 1 is **not properly functioning,** representing just 6.5% of the stream length (see Table 19). Eleven (11) of 54 pools in Reach 1 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 sand (39.1%), which is likely filling the pools and reducing pool quality.

Table 21. Summary of pool habitat and substrate percentages 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	54	7.9	4.3	1.2	0.2	0.9	45.0	11	9.2	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
	Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
	1	39.1	29.1	14.4	17.2	0.2	100.0

Red – Not Properly Functioning
Orange – Dominant Substrate

Large woody debris density in Reach 1 is **properly functioning**. A total of forty (42) pieces of LWD are in the reach, resulting in 35 pieces per mile (see Table 22). Reach 1 has good LWD recruitment in the lower and upper parts of the reach.

Stream bank condition was not analyzed as the gradient for Reach 1 was greater than 4% (15.6%).

Bankfull width-to-depth ratio, 10:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Table 22. Habitat characteristics of Reach 1.

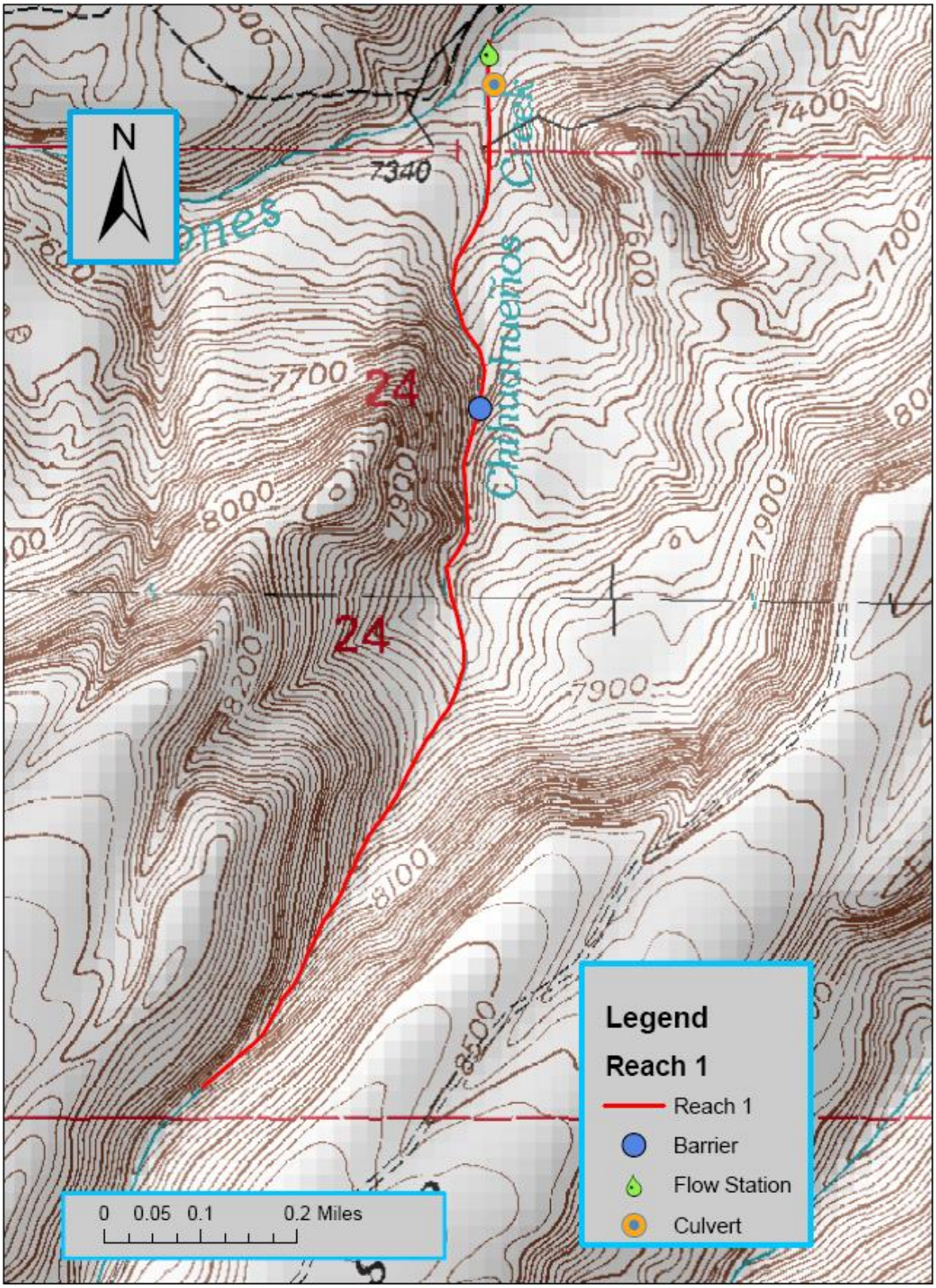
Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
1	1:1.1	10:1	35	129	1.0
Properly Functioning Indicators	-	<12	>30	-	N/A

Red – Not Properly Functioning

Recommendations

Improve areas where the ATV trail is close to the creek or crosses tributaries to reduce sediment. In the upper part of the reach directional falling along the banks could discourage cattle from trampling banks.

Photo 37. Reach 1, NSO 56, R27. Thick Vegetation found throughout Reach 1 (23-June-05).



Map xxx. Reach 1 of Chihuahueños Creek.

Reach 2: Change in Valley and Stream Type to Change in Valley Type and Management

Reach 2, surveyed June 25 to27, 2005, begins at the change in valley and stream type (T22N, R4E, Sec. 24, elev. 8,220'). Reach 2 ends 3.3 miles upstream at a change in valley type and management (T21N, R4E, Sec. 2, elev. 8800'). The reach break was determined by change in valley type and the amount of cattle grazing occurring in the area. Stream channel gradient is 3.3%, with a sinuosity value of 1.3, bankfull width-to-depth ratio of 12:1 , and a dominant riffle substrate of sand (40.8%) and gravel (35.5%). Reach 2 can be classified as a Rosgen stream type C5b.

Equal number of riffles (111) and pools (111) are evenly distributed throughout Reach 2. Reach 2 had side channels and one culvert at the road FR 448 crossing. The culvert, with a jumping distance of 0.2 and an estimated gradient of 2-3%, was not seen as a fish barrier. The culvert was bent and only had a diameter of 4 feet. The culvert is large enough for the wetted width, but not large enough for the bankfull events (occurrence once every 1.5 years) and flooding and it is recommend that it be replaced.

Photo 33. Reach 2, NSO 283, P133. Unstable bank adding sediment into the creek (25-June-05).

Cattle trails are found on both banks throughout the reach often near the creek with numerous crossings. A corral is located just downstream of the FR 448 crossing. An abandoned road crossing without a culvert was found in the upper part of the reach. An ATV trail that is frequently used heads upstream from FR 448 to access the meadows above. Numerous trails and trail crossings in conjunction with the sandy soils may be causing sedimentation and increased bank instability in the reach.

Sign of old beaver chewed wood was observed as well as several old blown out beaver dams. No new beaver activity was observed. It doesn't appear that these old beaver ponds are currently adding sediment to the creek (except where the banks were trampled by cattle).

Photo 34. Reach 2. Old beaver dam. No new activity was observed (26-June-05).

Many sections of the stream in this reach are well shaded due to the valley shape. Vegetation in this reach mainly consists of grasses and sedges along the banks with pine and spruce making up the overstory. The shrub component starts to give way to grasses and sedges. Hill slopes thick with trees and ground litter make conditions ripe for fire.

Several fish were observed in this reach, but due to murky water no positive identifications could be made.

Photo 35. Reach 2, NSO 339, C2. Culvert at the FR 448 crossing is likely impeding fish movement (27-June-05).

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 2. The highest temperature was 60°F and the lowest was 47°F. The average stream temperature was 54.1°F.

Habitat Characteristics

Reach 2 is divided into 225 NSOs, measuring 3.3 miles (17,501 feet). One hundred eleven (111) NSOs are pools, and comprise 8.5% of the stream habitat. One hundred eleven (111) riffles make up 90.1% of the stream habitat in Reach 2 (see Table 19).

Table 19. 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	111	1,510	8.6	8.5	≥30%
Riffle	111	15,948	91.1	90.1	-
Culvert	1	43	0.3	0.3	-
Tributary	0	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	2	200	N/A	1.1	-
Dry Channel	0	0	0.0	0.0	-
Total	225	17,701	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 both not properly functioning,

at risk, and properly functioning. The parameters that are **not properly functioning** include pool development, pool quality, and sediment. **At risk** factors include unstable banks. **Properly functioning** factors include bankfull width-to-depth ratio and LWD.

Sediment content in riffle habitat (40.8% fines) is **not properly functioning** (see Table 20). In normal years sediment is flushed down by the high flows during spring run-off. A good runoff in the spring of 2005 indicates that large amounts of sediment are being continuously added to the stream and/or the amounts of fines in the stream are so large that the spring runoff couldn't clean the stream. Pool quality is being lost as pools fill in with sediment. Fines in pools was 60.8%.

Photo 34. Reach 2, NSO 286, R140. Unstable banks with high amounts of fine sediment in the channel (26-June-05).

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

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
2	111	143.7	5.3	0.4	0.8	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
	40.8	35.5	12.2	10.9	0.6	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Pool development in Reach 2 is **not properly functioning,** representing just 8.5% of the stream length (see Table 19). Twenty two (22) of 111 pools in Reach 2 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 sand (60.9%).

Table 21. Summary of pool habitat and substrate percentages 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	111	13.6	4.8	1.2	0.3	0.9	33.6	22	6.7	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
2	60.9	26.3	4.2	8.1	0.5	100.0

Red – Not Properly Functioning
Orange – Dominant Substrate

Large woody debris density in Reach 2 is **properly functioning**. A total of one-hundred-twenty-eight (128) pieces of LWD are in the reach, resulting in 38.8 pieces per mile (see Table 22). Reach 2 has a lot of LWD recruitment and has a high potential for LWD in future years. Large woody debris is a key factor in pool development and is related to the substandard pool development in the reach.

Bankfull width-to-depth ratio, 12:1, is within the expected range for the related Rosgen stream type classification and is therefore **properly functioning** (see Table 22).

Table 22. Habitat characteristics of Reach 2.

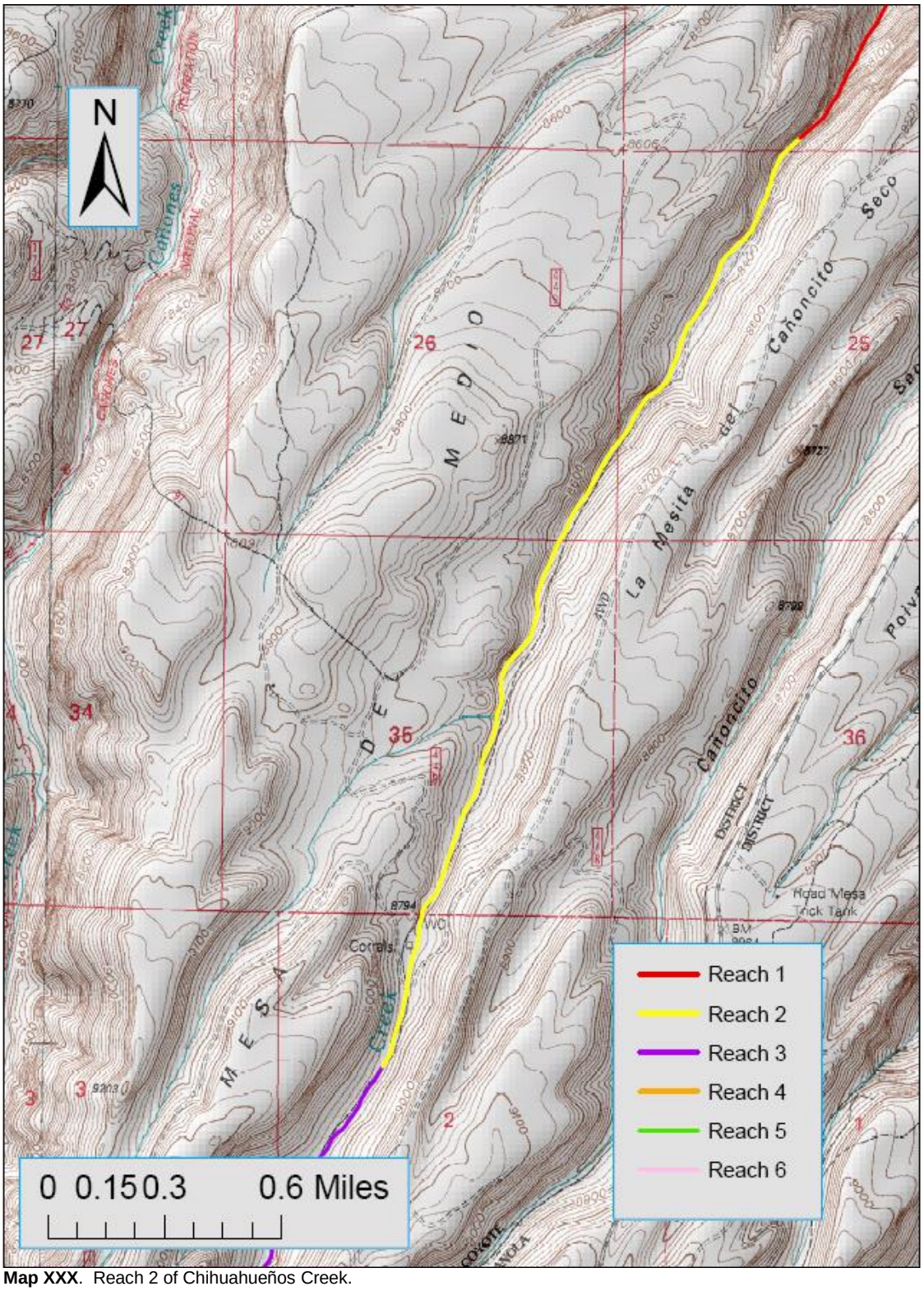
Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
2	1:1	12:1	38.8	5,007	14.3
Properly Functioning Indicators	-	12-30:1	>30	-	<10

Yellow – Functioning at Risk

Recommendations

Reduce the amount of cattle trails and trampling along both banks either by reducing numbers, changing or reducing grazing times in the allotment, and/or falling trees across cattle trails to discourage use of trails on the stream banks. Utilizing the forthcoming OHV Management Plan, it is recommended that a closure be established to keep all motorized vehicle use out of the riparian area.

Photo 37. Reach 2, NSO 335, P159. Bank instability, trampling, ATV track though the creek, and a dispersed camping site (27-June-05).



Map XXX. Reach 2 of Chihuahueños Creek.

Reach 3: Change in Valley Type and Management to Significant Valley Entering on Left Bank

Reach 3 was surveyed June 27 to 28, 2005. The reach begins at a change in valley type and management (T21N, R4E, Sec. 2, elev. 8800'), and ends 3.4 miles upstream at a significant valley entering on left bank (T22N, R4E, Sec. 15, elev. 9,060'). Although Reach 3 characteristics continue, the reach was broken because of the length of the reach. Most of Reach 3 is a wide meadow with grasses and sedges along both banks. The channel is only confined in a few areas by the hill slope, but often is confined by the degraded channel. The channel morphology is closest to a Rosgen E channel, but appears to departing to a C channel due to down cutting, disconnection of the floodplain, and loss of meander likely caused by historic and current grazing. In some parts of the reach it appears that the down cutting has caused a drop in the water table as dryer site plants can be found along the banks. Stream channel gradient is 1.5%, sinuosity is 1.2, bankfull width to depth was 21:1, and the dominant riffle substrate is gravel (53.7%) and sand (38%). The Rosgen stream type is E4.

Reach 3 is unique because it contains 4 cattle exclosures which contains bank stabilization and fish structures. These stream improvements were likely put in during the late 80s or early 90s. Some of these were helping bank stabilization, but many of them were doing nothing at all to help the unstable banks. The exclosure fence was doing the most to improve bank stability by keeping cattle off of the recovering banks. The fence appeared to be in good shape yet cows were getting in. During the survey the crew observed a full grown bull cow jump a section of completely intact section of fence!

Photo 34. Reach 3, NSO 372, P177. Looking from inside the riparian exclosure to the outside upstream (27/June-05).

The difference between areas inside and outside the exclosure is dramatic. Inside the exclosure undercut banks are abundant, the channel is narrow and deep, and grasses and sedges are high and almost growing over the channel in some places. There is much more cover for fish along the undercut banks as well as more protection from thermal heating and evaporation. A new floodplain and meander pattern are developing. The substrate has more gravels and less sand. Outside the exclosure there is a dramatic increase in the channel width and decreases in water depth, bank stability and vegetion cover.

Photo 34. Reach 3, NSO 373, R183. Area of unstable bank in between two exclusures where cattle access the creek (27-June-05).

Cattle grazing and vegetation loss can result in stream bank instability and can initiate a shift in stream type. E4 channels are considered to have a very high sensitivity to disturbance with high streambank erosion potential (Rosgen 1996). Bankfull was taken in an area of Reach 5 with good indicators and representative disturbances from cattle. Throughout the reach there were large amounts of bank trampling, poor vegetation and grasses, and evidence of channel widening at cattle and ATV fords, further supporting the departure of the E channel to a C. The low sinuosity value may be affected by degrading of the channel and another indication of departure.

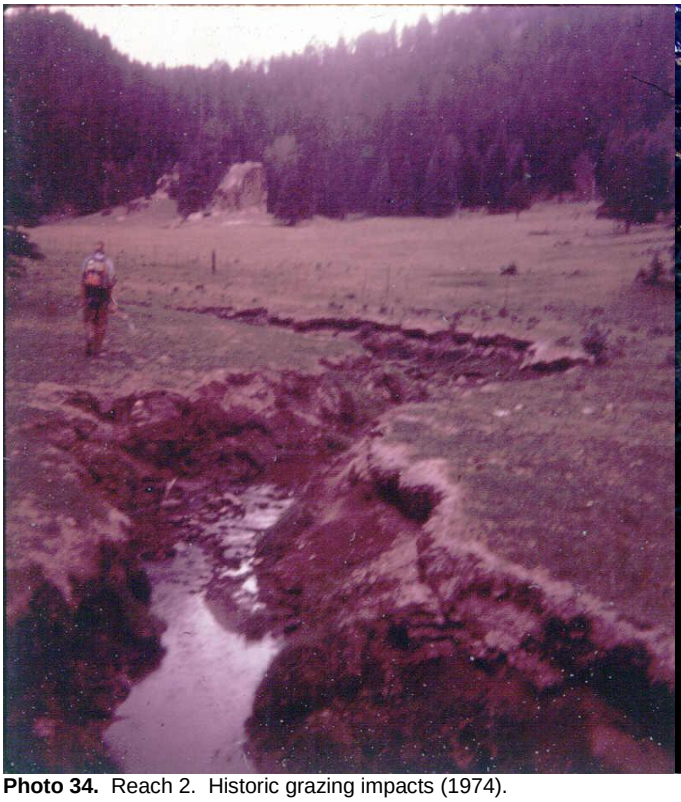


Photo 34. Reach 2. Historic grazing impacts (1974).

Photo xx. Reach 2. Same area as the historic 1974 photo. Area is inside the exclosure. Notice how the banks have recover since 1974 due to the reduction of cattle use (29-June-05).

This reach of Chihuahuenos is easily accessible as evidenced by signs of human disturbance. Litter is much more common. There is an ATV trail paralleling the entire length of Reach 3, which crosses through the creek several times. The creek continues to be paralleled, often on both banks of the creek, by game/cattle trails.

Photo 38. Reach 3, NSO 469, R232. ATV crossing Chihuahueños Creek (28 Jun 05).

Only one tributary entering on the left bank contributes about 5% flow to Chihuahueños.

Sign of old beaver chewed wood was observed as well as several old blown out beaver dams. No new beaver activity was observed. It doesn't appear that these old beaver ponds are currently adding sediment to the creek (except where the banks were trampled by cattle). Reach 3 had the largest dams. One of the blown out dams was still holding water even though it was disconnected from the main flow.

Photo 39. Reach 3, NSO 495, R245. Large beaver pond no longer active yet still holding some off channel water (27-June-05).

Photo x. Historic photo of large beaver pond in reach 3 (1974).

Sixty four pieces of wood were found in this reach despite it being mainly a meadow reach. In some sections of the reach the stream would be along the toe of the slope or pass through small forested patches of spruce. Most of the wood was observed near the start of the reach as the valley width was opening. Most of the vegetation in this reach consisted of grass and sedges with the occasional spruce tree. There was little to no overhead shade cover throughout the entire reach.

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 68°F and the lowest was 48°F. The average temperature was 59°F.

Habitat Characteristics

The 3.4 miles (17,775') of Reach 3 is divided into 190 NSOs (see Table 23). Ninety-three (93) NSOs are pool habitat and comprise 7.0% of the stream habitat. Riffles comprise 93.0% of stream habitat (96 NSOs).

Sediment content in riffle habitat (38.0% fines) is **not properly functioning** (see Table 20). In normal years sediment is flushed down by the high flows during spring run-off. A good runoff in the spring of 2005 indicates that large amounts of sediment are being continuously added to the stream and/or the amounts of fines in the stream are so large that the spring runoff couldn't clean the stream. Pool quality is being lost as pools fill in with sediment.

Table 23. 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	93	1,239	7.0	7.0	≥30%
Riffle	96	16,536	93.0	93.0	-
Culvert	0	0	0.0	0.0	-
Tributary	1	N/A	N/A	N/A	-
Falls	0	0	0	0	-
Side Channel	0	0	N/A	0	-
Dry Channel	0	0	0	0	
Total	190	17,775	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]Excluded from analysis due to dry reach

When compared to the matrix of factors and indicators of stream condition for historic and occupied Rio Grande cutthroat trout streams, Reach 3 is **not properly functioning** including pool quality, pool quantity, sediment content, width-to-depth ratio, and stream bank condition. Large Woody Debris analysis is excluded in meadow reaches, defined as reaches with no natural local recruitment of LWD.

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

Riffle Habitat Summary (ft)

Reach	# Riffles	Avg. Length	Avg. Width	Avg Depth	Avg. Max Depth
3	96	172.3	2.7	0.5	0.9

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
3	38.0	53.7	7.4	0.9	0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Pool development is low in Reach 3. The 93 pools comprise only 7.0% of the stream habitat (see Table 23). These pools are **not properly functioning** for pool quality with an average residual depth of 0.9 feet (see Table 25). Sediment within these pools was primarily sand (51.0) and gravel (45.3). Only 11 of the 93 pools had a residual depth greater than 1 foot and none had a maximum depth greater than three feet.

Table 25. Summary of pool habitat and substrate percentages 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	93	13.3	3.6	1.3	0.3	0.9	27.4	11	3.2	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
3	51.0	45.3	3.4	0.3	0	100.0

Red – Not Properly Functioning
Orange – Dominant Substrate

Stream bank condition was **not properly functioning** 33.2% of the banks being unstable. Cattle trampling, ATVs, and naturally sandy soils are causing bank instability.

Photo 34. Reach 3, NSO 445, R220. Trampled unstable bank (27-June-05)

LWD density was 18.8 pieces per mile, but analysis is excluded in meadow reaches.

Bankfull width-to-depth ratio is not functioning properly due to intense trampling along the banks which has caused the channel to widen, downcut, and straighten. Observations of the valley and undisturbed sections of channel suggest Chihuahueños is moving from a Rosgen E channel to a C channel due to the change in characteristics. In the exclosure areas the channel is reverting back to a classic E channel shape. The channel was analyzed as an E channel.

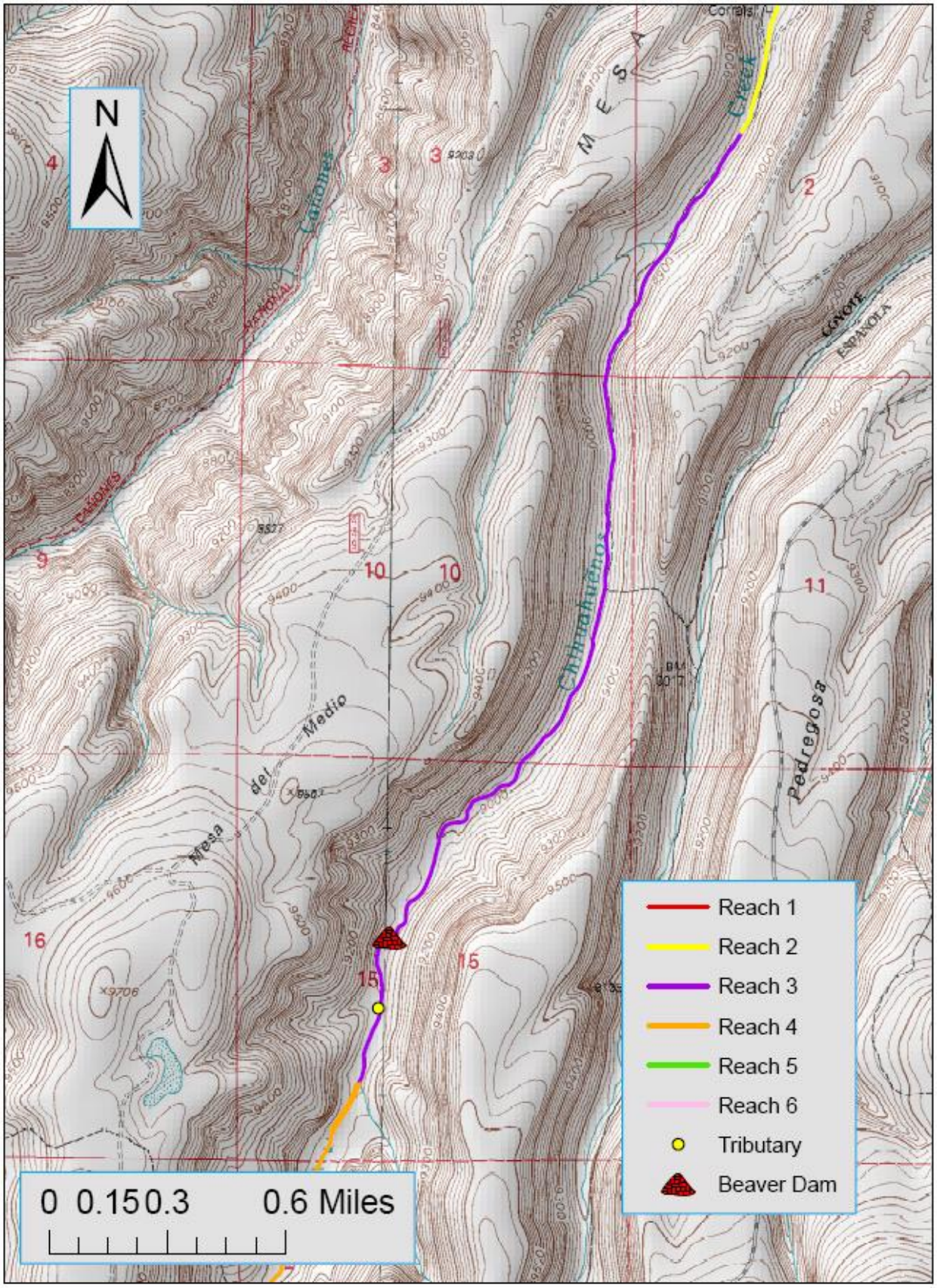
Table 26. Habitat characteristics of Reach 3.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
3	1:1	21:1	18.8*	11,812	33.2
Properly Functioning Indicators		<12	N/A		<10

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

Recommendations

Sensitive banks and heavy grazing have resulted in unstable banks and increased amounts of fine sediments. Improvements in bank stability and sediment could be achieved by changing the grazing and travel management in the drainage. Grazing practices should be managed to protect the riparian area. Riparian grazing should be eliminated or highly reduced in the valley bottom of Chihuahueños during the vegetation's growing season. This can be accomplished through seasonal use, rest rotation, range riding and/or riparian exclosure fencing. The exclosure areas are improving, but are a long way from recovery. Annual or biannual inspections and fence maintenance needs to be done to ensure the success of the restoration project. By allowing the riparian to recover, banks should stabilize with taller grasses and denser shrub vegetation. This will also promote recolonization of beaver which will aggrade the channel and reconnect it with the floodplain, elevate the water table, increase pool volume, better distribute fines, and provide adequate fish habitat. ATVs should be eliminated or restricted to one trail with a reduced amount of stream crossings. ATVs should limited to the trail and not allowed along the stream banks or in wet meadows. Utilizing the forthcoming OHV Management Plan, it is recommended that a closure be established to keep all motorized vehicle use out of the riparian area.



Map xxx. Reach 3 of Chihuahueños Creek.

Reach 4: Significant Valley Entering on Left Bank to Cañada de la Mora

Reach 4 was surveyed July 19 to 20, 2005. The reach begins at a significant valley entering on the left bank (T22N, R4E, Sec. 15, elev. 9,060'), and ends 1.2 miles upstream at the largest tributary, Cañada de la Mora (T21N, R4E, Sec. 21, elev. 9160'). Although Reach 3 characteristics continue, the reach was broken because of the length of the reach. Stream channel gradient is 1.5%, sinuosity was calculated as 1.2, width-to-depth ratio was 9:1, and stream substrate was predominantly gravel (69.4%) and sand (27.5%) in riffle habitat. The channel morphology is closest to a Rosgen E channel, but appears to departing to a C channel due to down cutting, disconnection of the floodplain, and loss of meander likely caused by historic and current management. Reach 4 can be classified as a Rosgen stream type E4.

This reach of Chihuahuenos is easily accessible as evidenced by signs of human disturbance. Litter is much more common. There is an ATV trail paralleling the entire length of Reach 4, which crosses through the creek several times. The creek continues to be paralleled, often on both banks of the creek, by game/cattle trails. A trial that is being used by ATV enters the valley on the west slope from FR 449.

Photo 38. Reach 4, NSO 539, R267. Reach break at dry tributary with large rock outcrop on right bank (19-July-05).

Reach 4 had six tributaries entering in the form seeps and one stream with most of them entering near the end of the reach. The only stream encountered during the survey was Cañada de la Mora, which is the reach break for the end of Reach 4. Cañada de la Mora enters on the left bank and contributes about 60% of the flow to Chihuahueños. Cañada de la Mora flows out of a very steep canyon and it is likely a fish barrier. Fish likely inhabit the lower 200 to 300 feet before the steep grade and falls limit their movement upstream.

It was unclear if there has been beaver activity in Reach 4. There were some mounds that may have been from old beaver ponds, but they weren't obvious like they were in the lower reaches. No new beaver activity was observed.

Photo 39. Reach 4, NSO 556, R275. Typical view of the sinuous channel in Reach 4 (19-July-05).

Cattle grazing and vegetation loss can result in stream bank instability and can initiate a shift in stream type. E4 channels are considered to have a very high sensitivity to disturbance with high streambank erosion potential (Rosgen 1996). Bankfull was taken in an area of Reach 5 with good indicators and representative disturbances from cattle. Throughout the reach there were large amounts of bank trampling, poor vegetation and grasses, and evidence of channel widening at cattle and ATV fords, further supporting the departure of the E channel to a C. The low sinuosity value may be affected by degrading of the channel and another indication of departure.

Photo 40. Reach 4, NSO 552, R273. Cattle and ATV crossing causing unstable banks and increased amounts of sediment, thermal heating, and evaporation (19-July-05).

Two pieces of wood were found in this reach. Most of the reach was in a meadow with no possible recruitment for LWD.

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 4. The highest temperature was **76°F** and the lowest was 50°F. The average temperature was 59°F. **A one time temperature greater than 73.4°F results in Chihuahueños not being in full support of a coldwater fisheries** by NMED standards.

Habitat Characteristics

The 1.2 miles (6,648') of Reach 4 is divided into 189 NSOs (see Table 23). Ninety-one (91) NSOs are pool habitat and comprise 15.6% of the stream habitat. Riffles comprise 84.4% of stream habitat (92 NSOs).

Sediment content in riffle habitat (27.5% fines) is **not properly functioning** (see Table 20). In normal years sediment is flushed down by the high flows during spring run-off. A good runoff in the spring of 2005 indicates that large amounts of sediment are being continuously added to the stream and/or the amounts of fines in the stream are so large that the spring runoff couldn't clean the stream. Pool quality is being lost as pools fill in with sediment.

Table 23. 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	91	1,035	15.6	15.6	≥30%
Riffle	92	5,613	84.4	84.4	-
Culvert	0	0	0.0	0.0	-
Tributary	6	N/A	N/A	N/A	-
Falls	0	0	0	0	-
Side Channel	0	0	N/A	0	-
Dry Channel	0	0	0	0	
Total	189	6,648	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]Excluded from analysis due to dry reach

Photo 40. Reach 4, NSO 692, T5. Seep entering on the right bank with ATV tracks and cattle trail (19-June-05).

When compared to the matrix of factors and indicators of stream condition for historic and occupied Rio Grande cutthroat trout streams, Reach 4 is **not properly functioning** including pool quality, pool quantity, sediment content, temperature, and stream bank condition. Large Woody Debris analysis is excluded in meadow reaches, defined as reaches with no natural local recruitment of LWD.

Table 24. Summary of habitat and substrate composition in riffle habitat of Reach 4.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg Depth	Avg. Max Depth	
4	92	61.0	2.0	0.4	0.7	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
4	27.5	69.4	2.4	0.7	0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Pool development is low in Reach 4. The 93 pools comprise only 15.6.0% of the stream habitat (see Table 23). These pools are **not properly functioning** for pool quality with an average residual depth of 0.7 feet (see Table 25). Sediment within these pools was primarily sand (53.1) and gravel (44.7). Only 7 of the 91 pools had a residual depth greater than 1 foot and none had a maximum depth greater than three feet.

Table 25. Summary of pool habitat and substrate percentages 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	91	11.4	2.5	1.1	0.3	0.7	75.8	7	5.8	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)							
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total	
4	53.1	44.7	1.1	1.1	0	100.0	

Red – Not Properly Functioning
Orange – Dominant Substrate

Stream bank condition was **not properly functioning** with 53.7% of the banks being unstable. Instability is caused by cattle trampling, ATV, and naturally sandy soils. Reach 4 had the highest amount of unstable banks throughout the survey.

Photo 40. Reach 4, NSO 607, P292. Typical bank instability (19 July 05).

LWD density was 1.7 pieces per mile, but analysis is excluded in meadow reaches

Bankfull width-to-depth ratio is **functioning properly**. Reach 4 has not downcut as much as reach 2 and 3 and is mostly still connected with the floodplain. Beaver dams in reach 3 may have kept the channel from degrading in Reach 4 despite the unstable banks and heavy cattle occupation. Without beaver present in the system providing grade control and continued heavy grazing it is likely that this channel will downcut and straighten. The channel is likely to continue departing from a Rosgen E channel into a C channel.

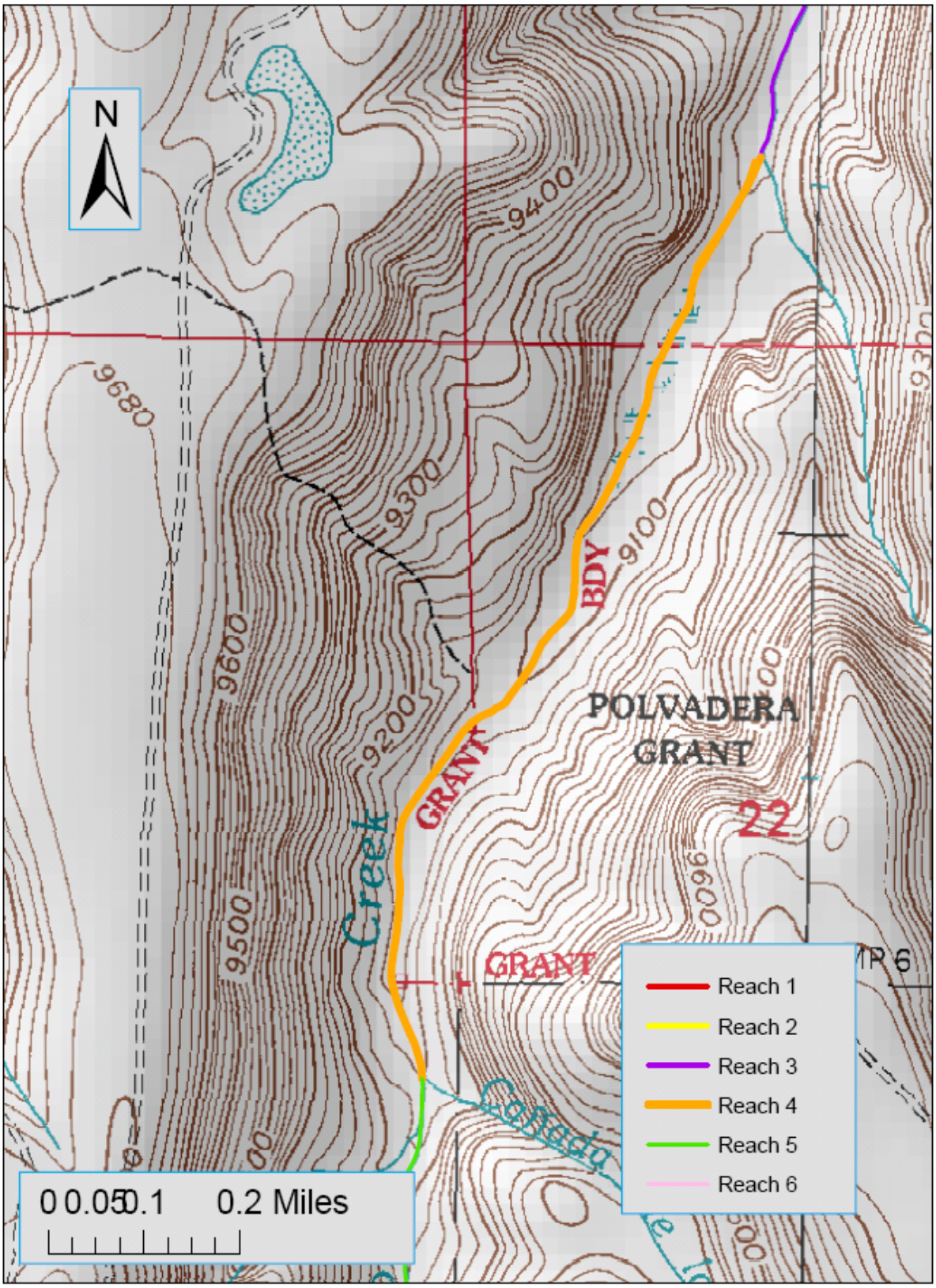
Table 26. Habitat characteristics of Reach 4.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
4	1:1	9:1	1.7*	7,141'	53.7
Properly Functioning Indicators		<12	N/A		<10

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

Recommendations

Sensitive banks and heavy grazing have resulted in unstable banks and increased amounts of fine sediments. Improvements in bank stability and sediment could be achieved by changing the grazing and travel management in the drainage. Grazing practices should be managed to protect the riparian area. Riparian grazing should be eliminated or highly reduced in the valley bottom of Chihuahueños during the vegetation's growing season. This can be accomplished through seasonal use, rest rotation, range riding and/or riparian exclosure fencing. By allowing the riparian to recover, banks should stabilize with taller grasses and denser shrub vegetation. This will also promote recolonization of beaver which will elevate the water table, increase pool volume, better distribute fines, and provide adequate fish habitat. ATVs should be eliminated or restricted to one trail with a reduced amount of stream crossings. ATVs should limited to the trail and not allowed along the stream banks or in wet meadows. Utilizing the forthcoming OHV Management Plan, it is recommended that a closure be established to keep all motorized vehicle use out of the riparian area.



Map xx. Reach 4 of Chihuahueños Creek.

Reach 5: Cañada de la Mora to Fish Barrier and Change in Valley Type

Reach 5 was surveyed July 20, 2005. The reach begins at Cañada de la Mora (T21N, R4E, Sec. 21, elev. 9160') and end at a fish barrier and a change in valley type (T21N, R4E, Sec. 21, elev. 9,280'). The Reach starts in a valley that is somewhat open and mainly meadow and then turns into a confined forested valley. The channel is entrenched at the start, but after some drops and a significant headcut the channel becomes less entrenched and more connected with the floodplain (see Photo X). Channel gradient is 5.7%, sinuosity 1.1, and bankfull width-to-depth ratio 12. This reach can be classified as a Rosgen stream type A4 (57.7% gravel). Reach 5 is a transition area from a meadow stream type to a steep and confined valley type. Stream types A, B, C, and E can be seen in this short reach. A stream type of A was chosen due to the high average gradient and low sinuosity.

Photo X. Reach 4, NSO 741, F4. Headcut where channel becomes degraded downstream. Rosgen channel type would be a C below and a E above (20 July 2005).

Photo X. Reach 4, NSO 742, R364. Above headcut where the channel becomes a Rosgen E channel (20 July 2005).

Cattle grazing and vegetation loss can result in stream bank instability and can initiate a shift in stream type (Rosgen 1996). E5 channels are considered to have a very high sensitivity to disturbance with high streambank erosion potential (Rosgen 1994). Bankfull was taken in an area of Reach 5 with good indicators and less disturbance from cattle. In the lower half of the reach there were large amounts of bank trampling, poor vegetation and grasses, and evidence of channel widening, further supporting the departure of the E channel to a C channel. The low sinuosity value may be affected by valley confinement but may also be another indication of a degrading channel and departure.

Photo 42. Reach 5, NSO 744, P355. Channel has moved from an E channel to a B channel with increasing confinement and gradient.

Reach 5 contains 17 riffle units, 13 pools, 6 tributaries, and four falls. Vegetation drastically changes in this reach from a grassy meadow to a dense forest. Substrate changed to include large boulders, though gravel was still dominant in riffles, in the A channel portion of the reach. LWD dramaticly going from the meadow part of the reach and into the forest. The possibility of LWD recruitment is low in the lower half of the reach and very high in the second half.

Vegetation has been grazed extensively in the lower half of the reach, while gradient, forage, and the thick forest limit grazing above the meadow. Trampling is present in the lower part of the reach. 27.4% of the banks in Reach 5 were unstable, most of which were a result of trampling or streamside cattle trails in the lower part of the reach.

Photo 43. Reach 5, NSO 736, F6. A channel type and possible fish barrier. (20 July 05).

No fish were observed in Reach 5. It is likely that the headcut, low flows, and gradient are limiting the fish distribution.

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 5. The highest temperature was 62°F and the lowest was 57°F. The average stream temperature was 61°F.

Habitat Characteristics

The 0.4 stream miles (2,081 ft) of Reach 5 is divided into 40 NSOs (see Table 27). Ten (17) NSOs in this reach are riffle habitat, comprising 94.3% of the stream length. Pools make up a meager 5.0% of the stream habitat. Four (4) falls are in this reach, comprising of 0.7% of the habitat and preventing fish migration upstream.

Table 27. 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	13	104	5.0	5.0	≥30%
Riffle	17	1,963	94.3	94.3	-
Culvert	0	0	0.0	0.0	-
Tributary	6	N/A	N/A	N/A	-
Falls	4	14	0.7	0.7	-
Side Channel	0	0	N/A	0	-
Dry Channel	0	0	0.0	0.0	-
Total	40	2,081	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 5 contains both not properly functioning and properly functioning characteristics. Parameters that are **not properly functioning** include pool development, pool quality, and sediment content. **Properly functioning** characteristics include bankfull width-to-depth ratio. Stream bank condition analysis is excluded in reaches with >4% gradient.

Riffle habitat is **not properly functioning** for sediment content. Sediment content in riffles, 22.9%, exceeds the standard (see Table 28). However, Reach 5 had the lowest amount of sediment of all the reaches surveyed. The informally surveyed Reach 6 was steep and was not being heavily utilized by cattle and ATV traffic. Steeper gradients and less upstream disturbances are resulting in a less fines entering Reach 5.

Table 28. Summary of habitat and substrate composition in riffle habitat of Reach 5.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg Depth	Avg. Max Depth	
5	17	115.5	3.6	0.3	0.6	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
5	22.9	57.7	10	9.4	0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Pool development calculated by habitat length is **not properly functioning** in Reach 5 (see Table 27). The 13 pools comprise only 5.0% of the stream habitat, which is well below the matrix standard. These pools are **not properly functioning** for pool quality with an average residual depth of 0.7 feet (see Table 29). Sediment within these pools was primarily sand (55.0%). Of the 9 pools present, none have a residual depth greater than 1 foot and none have a maximum depth greater than 3 feet.

Table 29. Summary of pool habitat and substrate percentages 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	13	8.0	2.7	0.9	0.2	0.7	32.5	0	0	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-

Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
5	55.0	35.9	3.8	5.3	0.0	100.0

Red – Not Properly Functioning
Orange – Dominant Substrate

LWD density was **properly functioning** with 40 pieces per mile. A majority of the wood in this reach comes from the steeper and forested upper half of the reach. The lower half that was in the meadow had little LWD and chance for recruitment.

Stream bank condition analysis is excluded in reaches with >4% gradient. However in the lower half of the reach where the gradient is lower there are significant areas of channel instability and thsis should be a concern.

Photo 40. Reach 5, NSO 743, R364. Bank instability and trampling in a degraded channel (20-July-05).

Bankfull width-to-depth ratio, 12:1, is just above the expected range for the related Rosgen stream classification, but is considered **properly functioning** (see Table 30).

Table 30. Habitat characteristics of Reach 5.

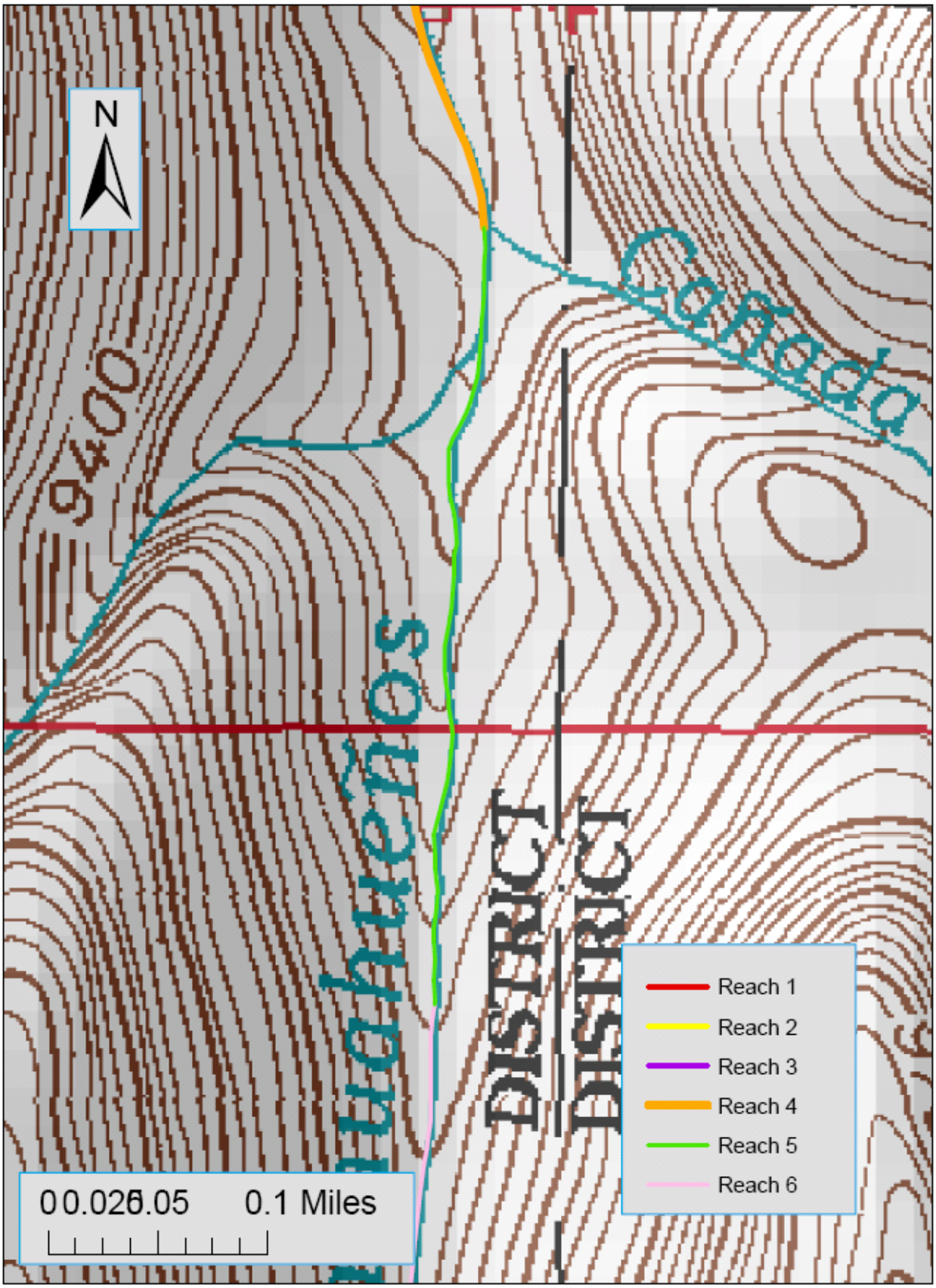
Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
5	1:1.3	12:1	40	1,142	27.4*
Properly Functioning Indicators	-	<12:1	>30[1]	-	N/A

Red – Not Properly Functioning
*Stream bank condition analysis is excluded in reaches with >4% gradient.

Photo 45. Reach 5, NSO 738, T11. Tributary on left bank with a cattle trail. T11 contributes approximently 5% flow to Chihuahueños Creek (20-July-05).

Recommendations

The loss of beaver activity and a degraded channel has lowered the water table, creating lowered flows which in drought years likely do not sustain flow. During higher flow conditions, the introduced sediments from upland and valley bottom grazing into this natural depositional area limits stream biota productivity. In order to increase productivity, grazing practices should be managed to protect the riparian area. Riparian grazing should be eliminated or highly reduced in the valley bottom of the Chihuahueños Pasture during the vegetation's growing season. This can be accomplished through seasonal use, rest rotation, range riding and/or riparian exclosure fencing. There may be an opportunity to exclude grazing by extending the administrative riparian exclosure fence downstream from Reach 6. By allowing the riparian to recover, banks should stabilize with taller grasses and denser woody vegetation. This will also promote recolonization of beaver, which will elevate the water table, increase pool volume, better distribute fines, and provide adequate fish habitat.



Map xx. Reach 5 of Chihuahueños Creek.

Reach 6: Fish Barrier and Change in Valley Type to Headwaters

Reach 6 was informally surveyed on July 21, 2005. It begins at the fish barrier (T21N, R4E, Sec. 21, elev. 9,280') and continues up stream to the stock pond below FR 144 (T21N, R4E, Sec. 33, elev. 9,800'). Reach 6 is 1.4 map miles (7,392') long and has a map gradient of 8.1%. The reach appeared to be a Rosgen A3/4 channel type.

The valley type is very steep and confined in this section. No fish were observed in this reach. Water depths were very shallow and likely not able to support fish. Numerous seeps entering on both banks create the flow in this channel. Water in the channel ended about two-thirds the way through the reach. From there channel was less defined, yet there were areas where you could see that high flows have gone through. The reach ended at a stock pond at the head of the drainage which was feed by a small spring. The area around the pond has being heavily utilized by cattle and possibly elk. Trails along the Reach 6 appeared to be only used by elk. It didn't appear that there were any cattle going above the fish barrier or much below the stock pond from above. Grasses were found to be about knee high in small meadows found in the canyon.

Photo 40. Reach 6 (informally surveyed). One of the many seeps entering on right bank (20-July-05).

Stream bank was in very good condition. The only unstable bank that was observed was from the occasional elk trail. At these trail crossings, the trail comes straight down one side, crosses, and heads straight up the other side. There is no trampling along the banks. This was some of the thickest forest we had seen, and is likely good cover for elk from FR144 and the ATV traffic in the meadows. The obvious sources for sediment input in Reach 6 were the trampled area around the stock pond and FR 144 that contours around the top of the basin.

LWD and recruitment was plentiful. The forest was thick with down wood, snags, and live spruce. This amount of thick vegetation could be disastrous for the creek in the event of a fire.

Photo 40. Reach 6 (informally surveyed). Small opening with great grass cover, LWD, and bank stability (20-July-05).

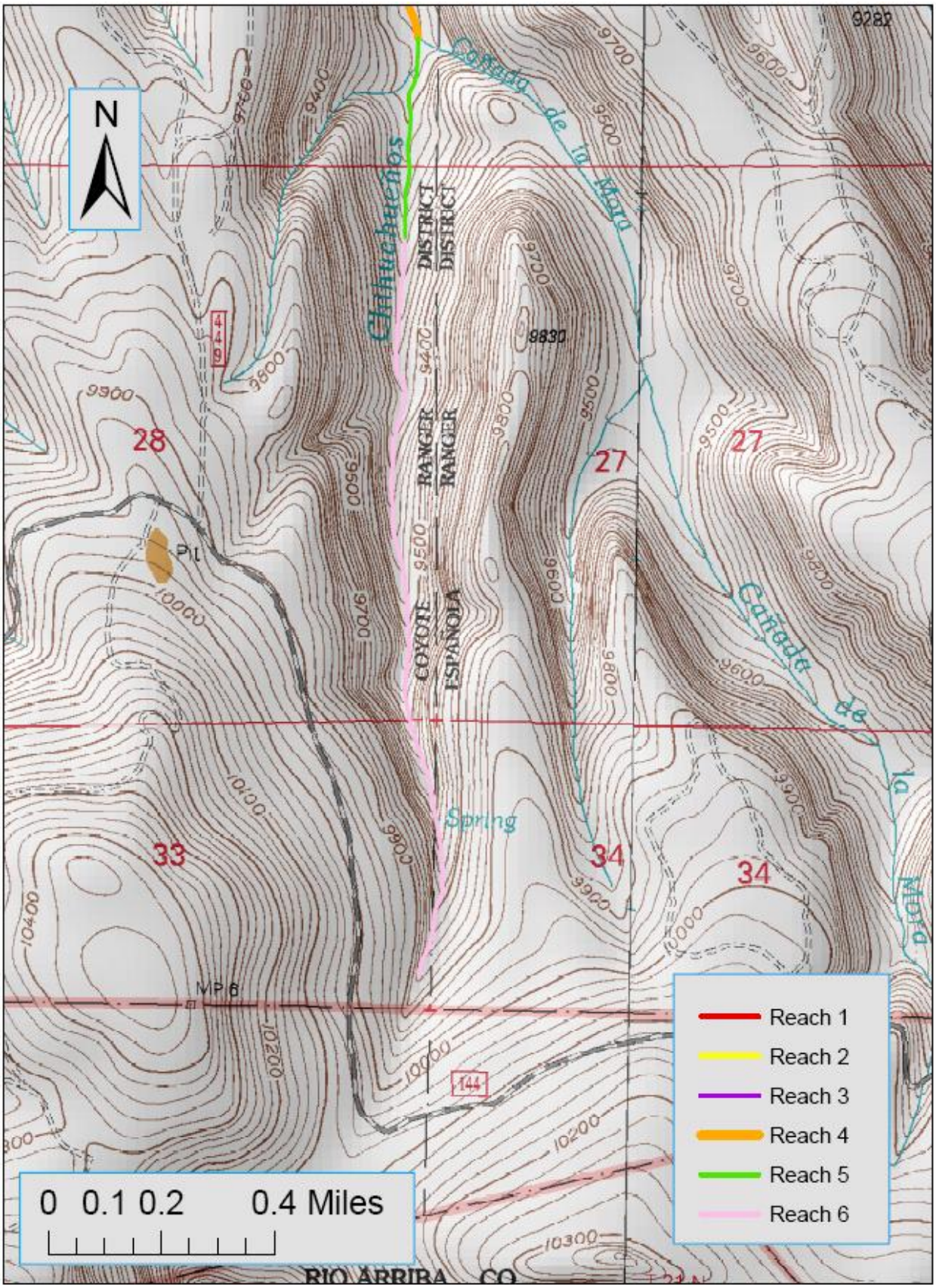
Recommendations

FR 144 should be maintained in such a way as to reduce road surface runoff. Proper road maintenance keeps road material on the road and out of the drainages. Culverts should be maintained and kept clean to ensure proper drainage. Overall FR 144 in good shape but sould be on a maintenance schedule due to the high amount of traffic it receives.

The upper watershed has a very thick even aged spruce stand and it could be disastrous for the creek in the event of a fire. Thinning or allowing small amounts of fire enter the watershed might help reduce the fuel loading that has taken place.

Photo 52. Reach 6 (informally surveyed). Thick forest with steep slopes are found

in Reach 6 (20-July-05).



Map xx. Reach 6 of Chihuahueños Creek not formally surveyed.

APPENDIX A:

Supporting Information

Table A1. Summary of measurements and estimations used in the Region 3 Hankins/Reeves stream survey protocol (Stream Inventory Handbook April 2002).

Measurements	Estimations
Maximum depth of pools, riffles, and side channels	Average depth of riffles
Depth of pool tail crest	Substrate percentages in bankfull width
One bankfull width depth transect per reach	Average wetted width of riffles and pools*
Number of large woody debris within bankfull	Length of bank instability
Surveyor collected main channel and tributary water temperature and time	Total length, wetted width, and maximum depth of side channels
Thermograph collected water temperature (Recorded every four hours)	Length of first habitat unit of tributaries and percent stream flow contribution

*Width estimations were corrected by the comparison of a minimum of 10% measured habitats in each reach to the related estimates. This technique was used to produce correction factor for each reach, which was then applied to analysis of the widths of that reach and the entire stream analysis.

Table A2. Feature types collected by Trimble Geo Explorer 3 GPS units.

Reach Breaks	Tributary Mouth
Woody Debris Jams (of 3 or More Pieces)	Barriers to Fish Passage
Areas of Concern (Major Erosion, Road Crossings, Etc…)	Side Channels (only longer than 10 times the wetted width of the main channel)
Beaver Dams (If Active and over 1' in Height)	Thermograph Stations
Snorkel Survey Transect Locations	Culverts
Flow Stations	Water Temperature Monitoring Stations

APPENDIX B:

Tributaries

Table B1. Summary of Tributaries in 2005 Chihuahueños Creek Stream Survey

Reach	NSO	Habitat type/ Number	Bank	Type	Name	Trib. Temp	Time	Date	Est. % Flow	Comments/GPS
1	11	T01	Left	Sring	-	57	1641	22-June-05	10	
1	15	T02	Left	Seep	-	61	1708	22-June-05	1	
3	510	T03	Left	Seep	-	52	1453	28-June-05	5	
4	648	T04	Left	Seep	-	-	-	20-July-05	-	
4	692	T05		Seep	-	75	1130	20-July-05	-	
4	715	T06		Seep	-	62	1258	20-July-05	-	
4	725	T07	Right	Seep	-	-	1330	20-July-05	-	
4	726	T08	Right	Seep		53	1337	20-July-05	-	62 below, 61 above
4	727	T09	Left	Stream	Cañada de la Mora	60	1432	20-July-05	60	
5	731	T10	-	-		-	-	20-July-05	-	
5	738	T11	Right	Seep		82	1508	20-July-05	5	
5	739	T12	-	Seep		-	-	20-July-05	-	
5	751	T13	Left	Spring	-	59	1555	20-July-05	10	59 below
5	754	T14	Right	Seep Complex	-	-	-	20-July-05	-	
5	756	T15	-	Seep	-	-	-	20-July-05	1	

APPENDIX C:

1993 Stream Survey Reach Summaries

GLOSSARY

Eutrophication: Having waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces dissolved oxygen content and often causes the extinction of other organisms.

Gabion Structures: Wire boxes filled with cobble or larger sized substrate to create "walls" and used for bank stability. Much like riprap, these structures have equally adverse effects as streams adjust to this hardening.

Hybridization: The result of a genetic cross between different species. In the fish populations of New Mexico, Rio Grande cutthroat trout when in contact with rainbow trout will cross breed to produce cut-bows. Hybridization destroys the genetic purity of Rio Grande cutthroat trout populations.

HUC Code: Hydrologic Unit Code used to identify watersheds.

Large Woody Debris (LWD): Wood that is within the bankfull channel for a habitat unit and is above the minimum size requirement. Woody debris is classified into categories with relation to length and diameter. The smallest wood classified in this survey must be greater than 6 inches in diameter at a length of 20 feet from the largest end. For analysis only wood with a diameter of greater than 12 inches at a length of 35 feet from the large end are used (designated as medium and large pieces).

Large Woody Debris Jams: A minimum of 3 pieces of LWD interacting within the bankfull channel.

Meadow Reach: Predominance of valley formation has meadow characteristics, which includes lacking trees in the active floodplain. No LWD recruitment within the reach.

Natural Sequence Order (NSO): A division system used to classify stream habitats. Each habitat is assigned a unique NSO number in consecutive order from the mouth upstream.

Response Reach: Low-gradient and/or constricted reaches typically located downstream from high gradient transportation reaches. Response reaches are noted for their channel and habitat formation caused by upstream factors.

Riparian Vegetation: Stream bank or streamside vegetation; influenced by wet conditions associated to a high water table or live water.

Riprap: A loose assemblage of broken stones erected in water or on soft ground as a foundation. Riprap is used to improve bank stability in streams, but has other and occasionally adverse effects.

Seep: A tributary with very slow flow, often associated with draining wet meadows

Spring: A flowing tributary with a source within 100 feet from the stream channel.

Stream: All tributaries that are not classified as a seep or spring. Usually streams are associated with a distinct drainage and have a more significant flow than the other tributary types.

Stream Habitat (%): A calculation of relative habitat types, which includes culverts, falls, pools, riffles and secondary channels. Tributary habitats are not included in the calculation.

Stream Length (%): A calculation of relative main channel habitat types, which includes culverts, falls, pools, and riffles. Tributary and secondary channel habitats are not included in the calculation.

Transport Reach: High gradient and non-constricted reaches that act as a conveyor belt of source materials, such as large wood, substrate and fine materials.

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