Rito Penas Negras

Stream Inventory Report

Santa Fe National Forest
Jemez/Cuba Ranger Districts
Surveyed October 2005
Forest Fisheries Crew

Report By
Melissa Potter
Fisheries Biologists

Reviewed By
Sean Ferrell
Forest Fisheries Biologist

Santa Fe National Forest
Last Updated: November 2005

Versions of this document were reviewed, edited and approved by the following individual:

- Bill Britton, Forest Biologist, USDA Forest Service, Santa Fe National Forest

---

The inventory and report was fully financed by
New Mexico Game and Fish Habitat Stamp Program.

TABLE of CONTENTS

WATERSHED MAP **4**

INTRODUCTION **5**

BASIN SUMMARY **7**

EXECUTIVE SUMMARY **7**

HABITAT CHARACTERISTICS 8
REACH BY REACH COMPARISON 12
TRIBUTARIES 13
STREAM FLOW 14
WATER QUALITY 14
RIPARIAN and UPLAND VEGETATION 21
BEAVER ACTIVITY 22
FISHERIES 24
PREVIOUS SURVEYS 26
AMPHIBIAN AND REPTILE SPECIES 28
STREAM IMPROVEMENTS 28

LAND USE **30**

ROADS 31
RECREATION 31
TIMBER 31
FIRE 31
STOCK GRAZING 32

RECOMMENDATION SUMMARY **32**

RIPARIAN 32
LARGE WOODY DEBRIS 32
NATIVE FISH POPULATIONS 33

REACH SUMMARIES **34**

REACH 1: MOUTH OF RITO PEÑAS NEGRAS to UNKNOWN FENCELINE 35
Habitat Characteristics *37*
Recommendations *40*
REACH 2: UNKNOWN FENCELINE to PEÑAS NEGRAS CABIN 41
Habitat Characteristics *43*
Recommendations *45*
REACH 3: PEÑAS NEGRAS CABIN to CULVERT AT FOREST ROAD 527
47
Habitat Characteristics *49*
Recommendations *51*
REACH 4: CULVERT AT FOREST ROAD 527 to VALLEY OPENING 53
Habitat Characteristics *55*
Recommendations *58*

REACH 5: VALLEY OPENING to CONFLUENCE OF RITO PEÑAS NEGRAS AND RITO CAFÉ 59
Habitat Characteristics *60*
Recommendations *63*

APPENDIX A **64**

APPENDIX B **65**

APPENDIX C **67**

GLOSSARY **68**

LITERATURE CITED **70**

ACKNOWLEDGEMENTS **73**

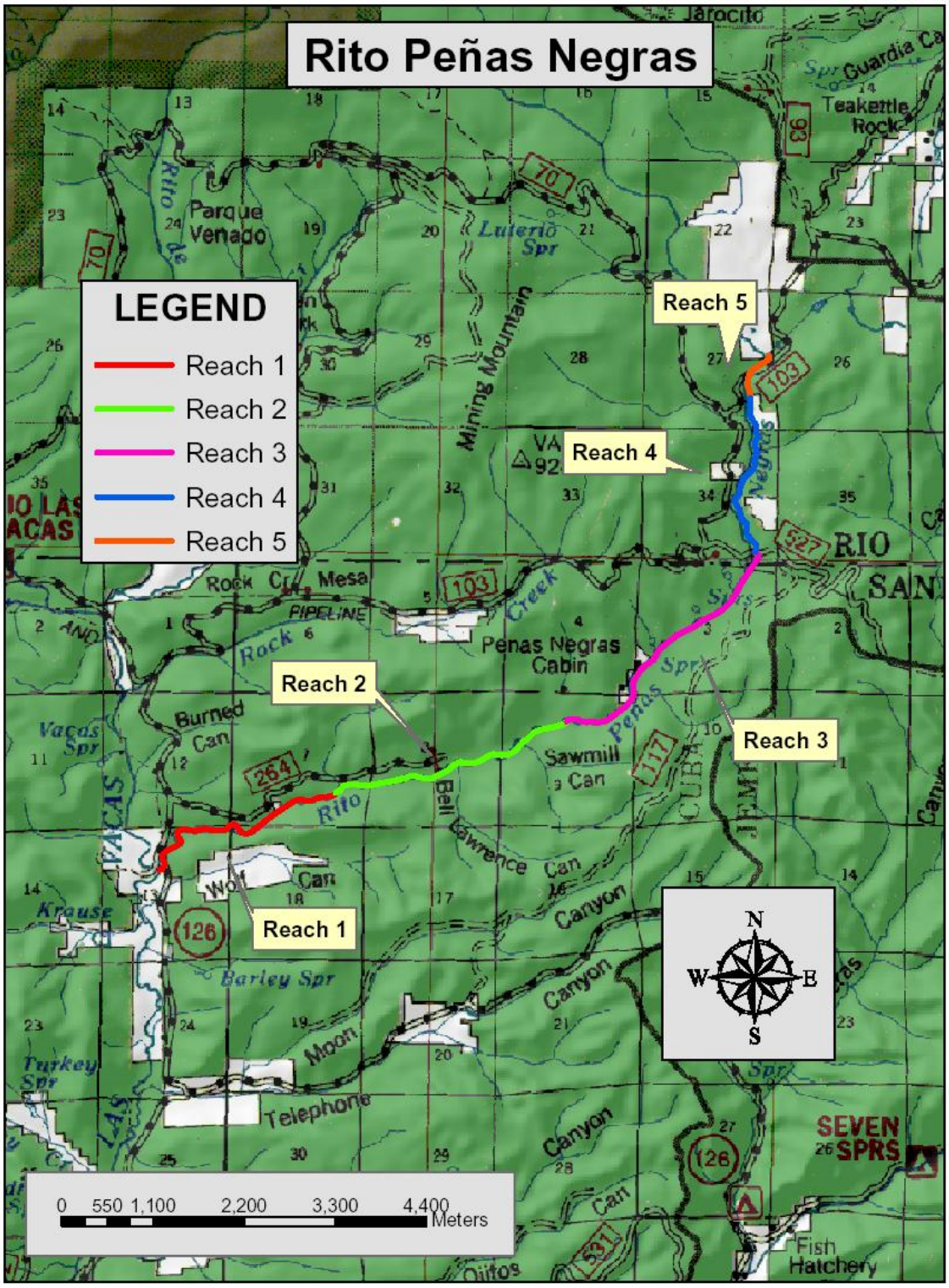


Figure 1. Rito Peñas Negras watershed map with Reach Breaks.

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

Rito Peñas Negras 2005 Stream Survey

The Santa Fe National Forest Fisheries Crew conducted a stream survey on Rito Peñas Negras during the fall of 2005. A total of 11.9 miles of stream were surveyed, from the mouth (T20N, R1E, Sec. 13 at 8,000' elevation) to the confluence (T21N, R2E, Sec. 27 at 8,700' elevation) of Rito Peñas Negras and Rito Café. Rito Peñas Negras is a 3rd order tributary to Rio de las Vacas.

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 C). All habitat types are assigned a Natural Sequence Order number (NSO) in the order that they are surveyed. The stream, as a collection of NSOs, is further organized by homogeneous sections and grouped into a sequence of reaches. Each reach is assigned a number in the order that it is surveyed and analyzed separately, as well as together for a holistic overview of the system.

A matrix of factors and indicators was developed to compare to stream habitat information collected during this survey (See Table 1). The matrix originally was developed in Region 6 (Washington and Oregon), 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.

Table 1. Matrix of Factors and Indicators of Stream Health Condition for Historic and Occupied Rio Grande Cutthroat Trout 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***	<20°C (68°F) (3 day avg. max)	≥20°C (68°F) <23°C (73.4°F) (3 day avg. max)	≥23°C (73.4°F) (3 day avg. max)
	Temperature – Salmonid Development	≤17.8°C (64°F) (7 day avg. max)	>17.8˚ (64ºF) < 21.1˚ (70ºF) (7 day avg. max)	≥21.1˚C (70˚F) (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 in length	20-30 pieces per mile, >12" diameter, >35 feet in length	<20 pieces per mile, >12" diameter, >35 feet in length
	Pool Development[2]	≥30% pool habitat by area		<30% pool habitat by area
	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 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** A, E, G B, C, F D	**W/D Ratio** <12 12-30 >40
	Streambank Condition[3]	<10% unstable banks (lineal streambank distance)	10-20% unstable banks (lineal streambank distance)	>20% unstable banks (lineal streambank distance)

[1] Large Woody Debris numeric are not applicable in meadow reaches
[2] Pool Development numeric are applicable to 3rd order or larger streams
[3] Streambank Condition numeric are not applicable in reaches with > 4% gradient

Geographical Positioning System (GPS) units are also utilized for survey data collection. Trimble Geo Explorer 3 units are used to identify special features throughout the survey (Appendix A). 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 main objectives of this survey were to: 1) collect historical information that outlines effects on stream and watershed condition; 2) collect baseline data to determine the quality of habitat and floodplain condition and sources of habitat loss in Rito Peñas Negras; 3) identify areas for possible migration barrier construction relative to Rio Grande cutthroat trout reintroduction; 4) identify restoration needs; and 5) determine fish species and distribution.

Basin Summary

Table 2. Stream Summary Table for Rio de las Vacas.

SURVEYORS:	Chuck Dentino and Melissa Potter
SURVEY DISTANCE:	62,903 feet 11.9 miles
LOCATION:	
County:	Sandoval and Rio Arriba
Forest:	Santa Fe National Forest
District:	Cuba Ranger District
Drainage:	Rio de las Vacas
Tributary to:	Rio de las Vacas
Mouth Location:	T20N, R1E, Sec. 13
WATERSHED:	
HUC Code:	1302020201
Watershed Area:	10,700.8 acres
Stream Order:	3
Stream Length:	11.9 miles
AQUATIC BIOTA:	
Fish Species:	rainbow trout, brown trout, cut-bow, Rio Grande chub, Rio Grande sucker, and Rio Grande cutthroat trout
Amphibian Species:	tiger salamander, western toad, leopard frog, and chorus frog

Executive Summary

Rito Peñas Negras is a 3rd order stream. The source of Rito Peñas Negras is largely from Rito Café, which joins Rito Peñas Negras on the left bank about a mile downstream from the headwaters of Rito Peñas Negras. The headwaters of Rito Café are located at about 9900' above sea level. It is spring-fed as well as receiving snowmelt from the San Pedro Mountains. Its confluence with Rio Peñas Negras occurs about 4 miles downstream from the headwaters. Rito Peñas Negras then flows nearly 12 miles, through the west side of the Jemez Mountain range to the confluence with the Rio de Las Vacas at 8,000' above sea level. The Rito Peñas Negras Watershed is comprised of approximately 10,700 acres (see Table 2).

Historically, Rio Grande cutthroat trout (RGCT) existed throughout both Rito Café and Rito Peñas Negras. Presently, RGCT are only found in Rito Café. Potential exists in this stream to extend the current range of this population. RGCT is currently listed on the Regional Forester's List of Sensitive Species. However, due to a decline in population distribution (less than 7% of its historic range is currently occupied); there is pressure to protect it under the Endangered Species Act (Ferrell 2002).

The 2005 survey began at the mouth of Rito Peñas Negras and continued the 11.9 miles to the confluence with Rito Café. Rito Peñas Negras was broken into 5 different reaches based on stream and valley morphology (see Figure 1). The stream reaches were numbered in an upstream progressive order.

Overall, the gradient on Rito Peñas Negras was extremely low, ranging from 0.4% in Reach 2 to 2.7% in Reach 4.

Table 3. Description and length of reaches on Rito Peñas Negras.

Reach	River Miles	Landmark at Beginning and End	Land Owner
1	0-2.8	Mouth to unknown fenceline	Private/Santa Fe National Forest (SFNF)
2	2.8-6.2	Unknown fenceline to Peñas Negras Cabin	SFNF
3	6.2-9.6	Peñas Negras Cabin to culvert at FR 527 crossing	Private/SFNF
4	9.6-11.1	Culvert at FR 527 crossing to valley opening	SFNF
5	11.2-11.9	Valley opening to confluence with Rito Cafe	SFNF

The confluence of Rito Peñas Negras and Rito Café is located in an open meadow at 8,700' above sea level. The stream flows down a wide valley for about 0.7 miles until the valley becomes extremely confined with ponderosa pine and spruce in the riparian area. This confined valley system continues downstream about 1.5 stream miles, then the valley opens up once again. The next 9.6 stream miles only cover 5.7 valley miles, which consist of wide open meadow and rangeland. The average sinuosity value for these lowest three reaches is 1.7. The sinuosity value is calculated by dividing the stream channel length by the mapped valley length. Since a stream channel is at least as sinuous as the valley floor, the value derived must be at least equal to or greater than 1.0.

Excessive fine sediment loads and high turbidity are found in Rito Peñas Negras, exacerbated by historic grazing practices, an extensive road system, past timber harvest, and dispersed recreation practices within the active floodplain.

Habitat Characteristics

During the habitat survey conducted on Rito Peñas Negras, the river was divided into 1,191 total NSOs (Habitat Units), which measured a total of 62,903 feet (see Table 4). Of the NSOs, 584 were pools, 584 riffles, 13 tributaries, 2 culverts and 8 side channels. There were no falls.

Table 4. Overall Stream Survey Summary for Rito Peñas Negras.

Entire Stream					
Stream Length Surveyed:		62,597 feet		11.9 miles	
Habitat Type	Total Number	Total Feet of Stream Habitat	% Stream Length	% Stream Habitat	Properly Functioning Indicators
Pool	584	27,692	44.2	44.0	>30%
Riffle	584	34,770	55.5	55.3	-
Culvert	2	135	0.38	0.21	-
Tributary	13	-	-	-	-
Falls	0	0	0	0	-
Side Channel	8	306	NA	0.49	-
Total	1,191	62,903	100	100	-

Riffle substrate content is important to the reproductive success of fish. The space between gravel in riffle habitat is crucial for spawning and fish development. Fine sediment fills in the space between gravel substrates and eliminates spawning habitat. The relative quantity of fine sediment in Rito Peñas Negras is **not properly functioning** by matrix standards. Riffle sediment content was 34.4% (see Table 5). The amount of fine substrate is largely due to eroding banks caused by dispersed recreation and grazing. However, the fine sediment can also be attributed to the delivery of fines from upland disturbances (roads and past timber harvests), and private land development.

Photo 1. Reach 1. NSO 223, R112. Typical Riffle Habitat (07-Oct-05).

Table 5. Summary of Riffle Habitat and Substrate Composition in Rito Peñas Negras.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max. Depth	
Entire River	584	60	4.0	0.5	0.8	

Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
Entire River	34.4	38.6	16.9	10.1	0.0	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange = dominant substrate
Red = not properly functioning

Rito Peñas Negras was **properly functioning** for pool quality. The average residual pool depth was 1.01', which meets the properly functioning indicator of ≥1' (see Table 6). Overall, the average pool was of an adequate size, and, the number of pools was above acceptable levels. Rito Peñas Negras has 44.0% pool habitat, which is above the >30% indicator that the stream is **properly functioning.** There were 49.1 pools per mile throughout Rito Peñas Negras. Although Rito Peñas Negras meets the requirement for pool quality, the number of pools with a residual pool depth ≥1' is very low. Only 225 of the 584 pools meet this requirement. There are only 3 pools that have a residual depth >3' (see Table 6). Deep pools are critical habitat for rearing, foraging, overwintering, and resting, and a lack of deep pools equates to decreased thermal protection. It is probable that this stream is losing its pool depth due to the pools being filled in with fine substrates. The dominant substrate in pools throughout the entire stream was sand, which typically fills in pools in disturbed areas (see Photo 2).

Ideally, this stream system would have deep scoured pools with undercut banks to provide shelter and protection for fish. Also there would be tall grasses and woody vegetation throughout the riparian to provide shade and thermal protection. The riffles would be dominated by gravel, with the sand remaining in the pools instead of washing into the rest of the stream from the unstable banks.

Table 6. Summary of Pool Habitat and Substrate Composition in Rito Peñas Negras.

Pool Habitat Summary											
Reach	# of Pools	Avg. Length	Avg. Width	Avg. Max. Depth	Avg. PTC	Avg. Residual Depth	Pools/Mile	# of Pools w/ Residual Depth>1'	Pools w/ Residual Depth >1"/Mile	# of Pools w/ Max. Depth >3'	# of Pools w/ Max. Depth >3'/Mile
Entire River	584	47	4.8	1.4	0.4	1.0	49.1	225	18.9	3	0.25
Properly Functioning Indicator	-	-	-	-	-	>1'	-	-	-	-	-

Substrate Summary								
	Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
	Entire River	54.9	28.8	9.7	6.6	0	100.0	

Red = not properly functioning

Rito Peñas Negras had 45.6% unstable banks throughout the entire river. Streambank condition is not applicable to streams with a gradient greater than 4%, however, the gradient was not that high on any of the reaches on Rito Peñas Negras. The streambank condition (45.6%) on Rito Peñas Negras was **not properly functioning**, as the percentage was above the indicator of <10% (see Table 7).

Photo 2. Reach 1. NSO 76, P38. Chuck standing in typical pool (07-Oct-05).

Table 7. Habitat Characteristics for Rito Peñas Negras

Reach	Pool:Riffle Ratio	Avg. Riffle Width:Avg. Riffle Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	Percentage of Unstable Banks
Entire River	1:1	12:1	19.3[1]	57,114.5	45.6
Properly Functioning Indicators	-	-	>30	-	<10

Red = not properly functioning

[1]This numeric does not take into account meadow (1,2,3, and 5) reaches.

The large woody debris density for the Rito Peñas Negras was 19.3 pieces per mile (see Table 7). However, Reach 4 was the only forested reach, and therefore, was the only reach where LWD could be analyzed. The total average LWD per mile indicates that the river is **not properly functioning** for LWD. A properly functioning stream must have >30 pieces of LWD per mile.

One of the factors in the low amounts of LWD in Rito Peñas Negras can be attributed to fire suppression. Since LWD recruitment is mostly localized recruitment, only large disturbance events could increase the amount of LWD recruitment. In the forest type found in the Jemez Mountains, fires are one of the most common disturbance events. Fire suppression has hindered

the extent of natural fires, which has reduced the amount of LWD recruitment. Some other disturbance events that might assist in LWD recruitment are: Insect outbreaks, which have been reduced due to insecticide use; windstorms, which are not common in this region; and landslides, which have limited impact on this watershed due to its geology (Gregory *et al* 2003).

Another factor contributing to the low amounts of LWD is due to wood removal. During the 1920's, a railroad was constructed along the Rio de las Vacas. This railroad connected logging camps along Rio de las Vacas to the sawmill in Gilman. The railroad was active until the 1940's when several railroad trestles were washed out during a flood. During this time heavy amounts of logging were occurring in the Rio de las Vacas Watershed (Chris Jenkins, personal communication). A stream survey report written in 1972 recommended that logjams be removed from Rio de las Vacas, as they impeded fish movement and created "bad" fish habitat (FS Files). It is likely that much of the LWD found in the stream was removed during this time. In addition, LWD has been removed for fuelwood.

Reach by Reach Comparison

Rito Peñas Negras was divided into 5 different reaches. Table 8 has summarized the habitat characteristics for each reach and the entire river.

Table 8. Reach by Reach Summary for Habitat Characteristics for the Rito Peñas Negras.

Reach	Total Length (Miles)	% Gradient	Rosgen Stream Channel Type	% Pool Habitat	% Riffle Habitat	% Side Channel Habitat	Dominant Substrate in Pools	Dominant Substrate in Riffles	LWD per Mile	Bankful W: D Ratio	% Unstable Banks
1	2.8	1.4	C5	49.8	50.2	0	Sand	Gravel	5.7[1]	14:1	47.4
2	3.4	0.4	E5	50.0	49.7	0	Sand	Sand	9.7[1]	5:1	56.1
3	3.4	1.3	C5	48.5	48.5	1.2	Sand	Gravel	0.9[1]	18:1	42.6
4	1.5	2.7	B5	46.7	46.7	2.0	Sand	Gravel	19.3	11:1	35.7
5	0.7	1.2	E4	47.8	47.8	3.0	Sand	Gravel	0.0[1]	4:1	25.9
Entire River	11.8	1.4	-	48.6	48.6	1.24	Sand	Gravel	19.3[1]	-	41.54
Properly Functioning Indicators	-	-	-	>30	-	-	-	-	>30	A,E,G: <12 B,C,F: 12-30 D: >40	<10

Red = Not Properly Functioning
[1]LWD/Mile criteria are not applicable in meadow reaches

All 5 reaches of the Rito Peñas Negras are **not properly functioning** for bank stability. The indicator for a properly functioning stream is <10 % unstable bank. Reach 2 has the highest percent of unstable bank at 56.1%, which is a total of 20,150 feet (see Table 8). There is also a lot less cattle grazing throughout Reach 4 due to the confined valley floor and higher presence of timber, however, the percent of unstable bank is still 35.7 %, which is excessively high.

The only reach with any calculable large woody debris (LWD) is Reach 4 with a density of 19.3 pieces per mile, with 24 pieces of medium and large wood. Reaches 1, 2, 3, and 5 are meadow reaches with no local recruitment of LWD. Meadow reaches are excluded from LWD analysis and the lengths of these reaches are not included in the stream average.

Tributaries

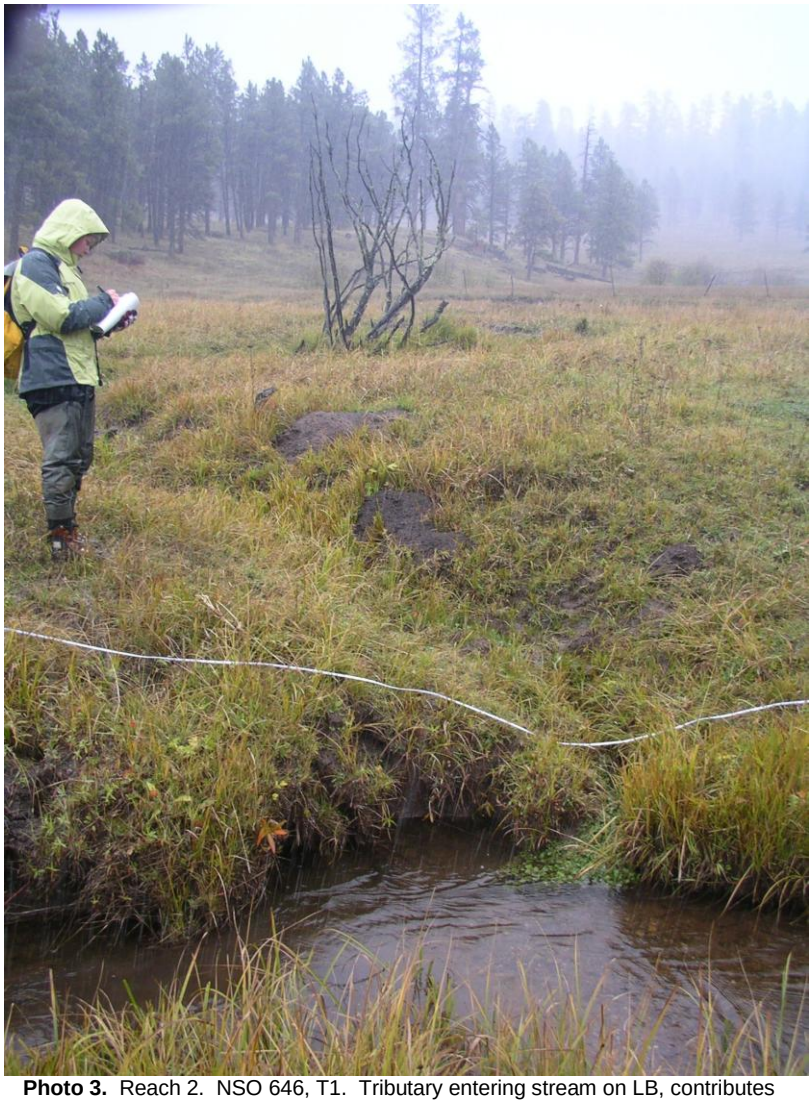


Photo 3. Reach 2. NSO 646, T1. Tributary entering stream on LB, contributes less than 5% of flow (10-Oct-05).

Rito Peñas Negras has 13 tributaries including seeps, streams and springs. Only one of these tributaries contributes over 5% flow to the main stream. A complete chart of all of the tributaries recorded is located in Appendix C.

Table 9. Tributariy contributing 5% or greater of the main channel flow in the Rito Peñas Negras

Reach	Habitat Number	Bank	Type	Name	Percent Flow	Time	Tributary Temp (F)	Stream Temp (F)
3	T2	LB	Spring	-	5	915	38	38

Stream Flow

Peak flows in Rito Peñas Negras are governed by snowmelt, typically spiking in the spring, usually late May to early June. The river is spring-fed at its headwaters. Low flow often persists from late summer until the snowmelt in the spring. However, Rito Peñas Negras Watershed typically receives monsoon events in July through September. During monsoon events small spikes in stream flow are observed. A flow measurement was taken at the beginning of the survey on October 6, 2005, upstream of the confluence with Rio de las Vacas, measuring 0.685cfs . Low stream flow measurements may be attributed to the 20-year drought conditions.

No lakes, ponds, or irrigation ditches were recorded in the Rito Peñas Negras survey. There is a reservoir on Rito Peñas Negras, upstream from the survey area.

Water Quality

Water temperature is a key aspect of water quality in a stream environment. Stream temperature is determined by a combination of factors including solar radiation, air temperature, riparian vegetation cover, ground water, stream discharge, channel shape, orientation and climate.

On the Santa Fe National Forest (SFNF) stream temperature is managed for the success of cold water fisheries. Cold water fish species include salmonids and non-game species such as longnose dace, fathead minnow, Rio Grande chub and Rio Grande suckers. Among the salmonids present on the SFNF (non-native rainbow, brown, brook and cutthroat trout), the only native is Rio Grande cutthroat trout (see Photo 4). Rio Grande cutthroat trout (RGCT) are listed on the Regional Forester's Sensitive Species List in Region 3. SFNF stream temperature standards have been designed to optimize the life history of this fish.

Photo 4. Rio Grande cutthroat trout.

RGCT growth, health and reproduction are all affected by water temperature. Typically, as water temperature increases, so does fish performance. Although fish exhibit increased performance with temperature, there is also a lethal temperature threshold. No lethal temperature information is currently available for RGCT, so information has been related from other dry climate inland cutthroat trout species like the Lahontan cutthroat trout (*Oncorhynchus clarki henshawi)*. The Lahontan cutthroat trout had a 100% survival rate at 75.2°F (24°C), but declined to 35% at 78.8°F (26°C). Mortality was 100% within 48 hours at 82.4°F (28°C). The upper limit for growth and long-term survival is somewhere between 71.6 (22°C) and 73.4°F (23°C) (Dunham 1999). 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.

Cutthroat trout reproduction is also 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 the coldwater while in warm water only 6.9%.

RGCT survival is affected not only by daily maximum temperatures but also daily temperature fluctuation (diurnal difference). Under natural conditions stream temperatures can fluctuate up to 36°F (20°C). It is thought that dramatic changes in temperature put stress on the fish living in the system. Several studies conducted on Lahontan cutthroat trout support this assumption. Dickerson and Vineyard (1999) found that juvenile cutthroat subjected to fluctuation temperatures from 68-78.8°F (20-26°C) grew, but not as much as juveniles held at a constant temperature of 68°F (20°C). Meeuwig et al (2004) found that juveniles experiencing fluctuation temperatures from 53.6- 75.2°F (12-24°C) also grew less than juveniles held at lower constant temperatures. These studies do not set up threshold fluctuation levels for a decline in the fitness of cutthroat trout, but do demonstrate that diurnal difference can affect the growth and success of these fish and thus should be considered in a temperature management plan.

The maintenance of cool stream temperatures necessary for the success of a coldwater fishery depends on many factors. Protection from excessive solar radiation is one of the most important. A healthy riparian zone provides stream shade that blocks solar radiation. Healthy stream systems also frequently have deep undercut banks that protect the stream surface from solar radiation. Historic management practices on the SFNF have led to a decline in riparian health. Cattle browsing on riparian vegetation and collapsing the fragile undercut banks have exposed more stream surface to solar radiation. Brown out areas where riverside vegetation has been removed by dispersed often unmanaged recreational uses (including fishing, camping, and ATV use) also exposes more of the stream to the sun. Typically, a degraded stream system will display increased maximum daily stream temperatures as well as high daily temperature fluctuation.

Stream temperature is also affected by elevation. In a healthy system as elevation decreases stream temperatures generally increase. It has been believed that RGCT are rarely found below 5500 feet due to this natural phenomenon (Hatch *et. al* 1998).

According to a report written by New Mexico Environmental Department (NMED) concerning the water quality of all tributaries to the Jemez River, Rito Peñas Negras as only **partially supporting.** The lowered status is due to the large amount of gravel recorded through a pebble count. However, all other water quality standards were not concerning, including temperature and amounts of dissolved constituents such as oxygen (Hopkins, 1998).

Forest standards (noted as SFNF in Table 12) 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 two factors. First, temperature cannot exceed 23°C (73.4^{o}F) for more than an hour during deployment of a thermograph. Also, a stream cannot exceed 20°C (68°F) for more than three hours, on three or more consecutive days (see Table 11). Forest temperature standards are derived from research done on inland cutthroat trout and salmonid development. NMED 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. Data between June 1st and September 30th is used for maximum water temperature standards analysis to identify high temperatures that occur in summer months.

The earliest recording of temperature over the duration of a summer was recorded in 2003. Two temperature monitoring stations were established on Rito Peñas Negras. The stations were not moved for the duration of the monitoring period. Thermographs recorded temperatures at 4-hour intervals. The first station was placed near the mouth of the creek (River Mile 0.3). This thermograph recorded temperatures from June 12th through October 23rd, 2003. The second station was placed near the Sandoval/ Rio Arriba County Line (RM 6.6). This station recorded temperatures from July 10th through October 23rd, 2003.

Thermograph data collected between June 12th and September 30th, 2003 was used to determine water quality. When SFNF standards are applied, Thermograph Station 2 was **at risk** and Thermograph Station 1 was **not properly functioning** (see Figure 2). Thermograph Station 2 had more properly functioning days than at risk days. Thermograph Station 1 had more days not properly functioning than properly functioning.

Thermograph Station 2 was also **at risk** days when NMED standards were applied. Thermograph Station 1was again classified as **not properly functioning** (see Figure 3). The number of at risk days at the Thermograph Station 2 was significantly less than the number of properly functioning days. Thermograph Station 1 had more properly functioning days than not properly functioning days and at risk days combined.

Looking at stream temperature across elevation can distinguish areas in need of temperature mitigation. On a typical system, temperature should increase as elevation decreases. Rito Peñas Negras does follow this pattern. On July 31st, maximum temperatures varied from 67.6°F at Thermograph Station 2 (elevation 8600') to 74.8°F at Thermograph Station 1 (elevation 8000'). This may be due to natural conditions (upwellings, coldwater springs, differing valley formations and aspect, etc.).

Figure 2. A comparison of not properly functioning, at risk, and properly functioning days two thermograph sites on Peñas Negras between June 12th and September 30th, 2003. Water temperature categories defined by SFNF Water Quality Temperature Standards are based on a seven-day average maximum.

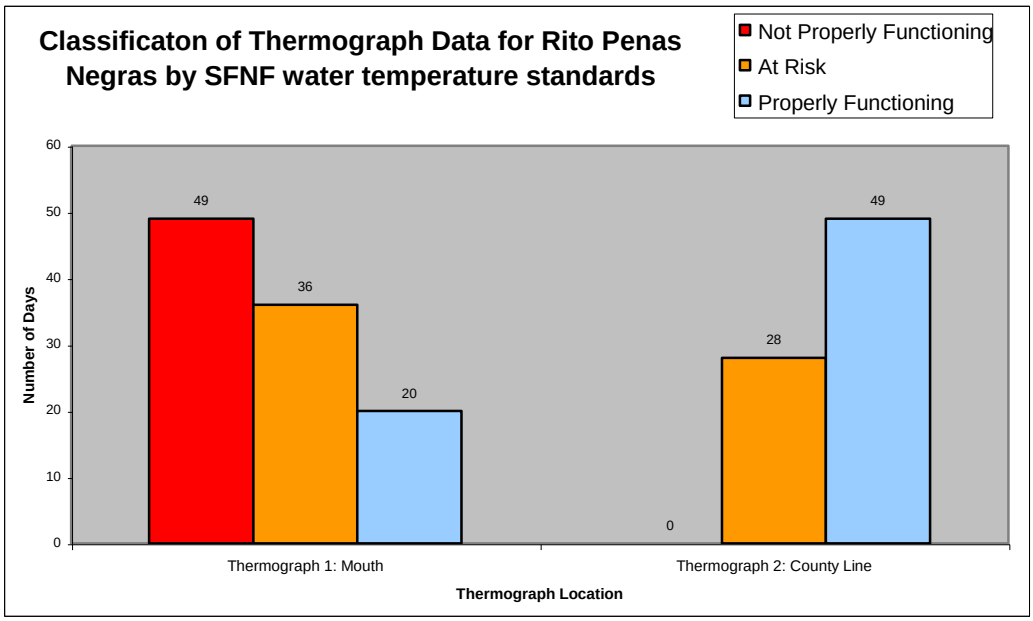
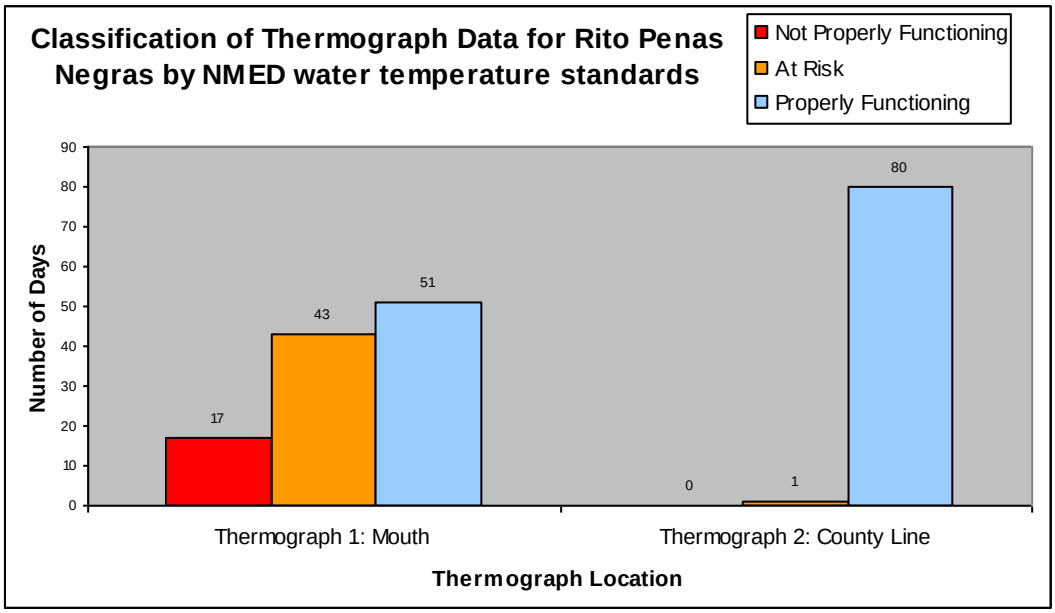
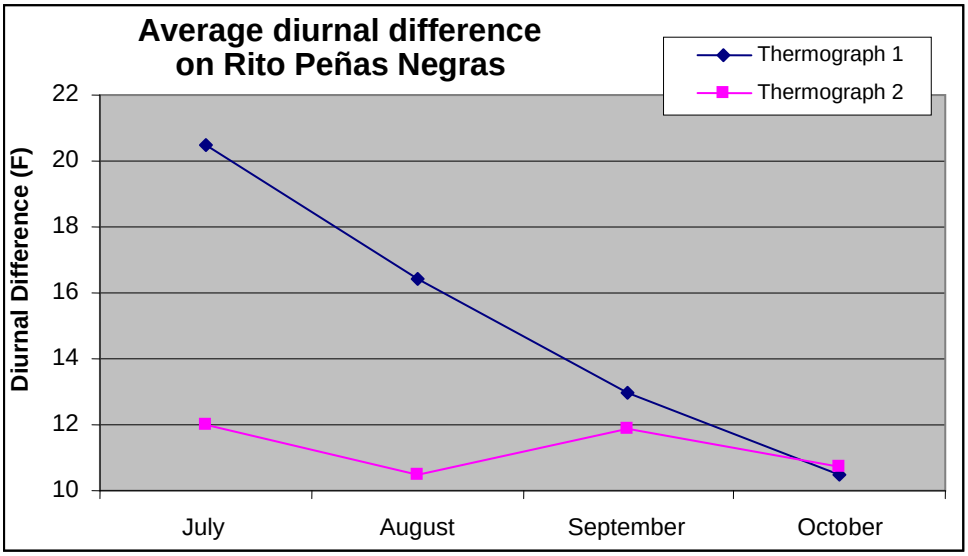


Figure 3. A comparison of **not properly functioning**, **at risk**, and **properly functioning** days two thermograph sites on Peñas Negras between June 12th and September 30th, 2003. Water temperature categories defined by NMED Water Quality Temperature Standards are based on a three-day average maximum.



Diurnal difference was analyzed from the thermograph stations. Diurnal difference is a measure of daily stream temperature fluctuation. It is determined by subtracting the minimum daily temperature from the maximum. Again on July 31st, 2003, diurnal difference ranged from 15.0°F at the Thermograph Station 2 (elevation 8600') to 19.2°F at Thermograph Station 1 (elevation 8000'). The monthly average of diurnal difference for the two stations showed a similar pattern. Thermograph 1 was fluctuated significantly more than Thermograph 2 (see Figure 36).

Figure 4. Diurnal difference average by month for two thermograph stations on Rito Peñas Negras (2003).



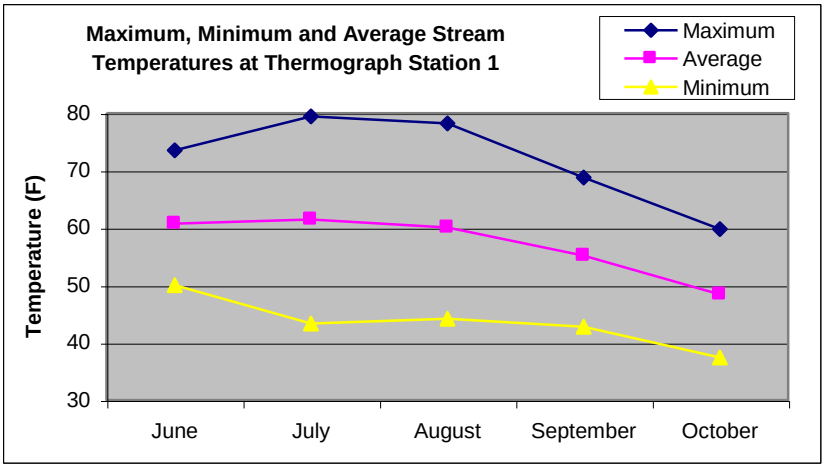
The **at risk** and **not properly functioning** classification of both sites by NMED and SFNF standards implies that water temperature should be a management consideration for Rito Peñas Negras. Temperature mitigating strategies should be applied to protect the integrity of the coldwater fishery.

Thermograph Station 1 monitored 6.3 stream miles. This section of Rito Peñas Negras passes through an open meadow system primarily managed by the Forest Service. Thermograph data collected in 2003 determined Rito Peñas Negras at the mouth is **not properly functioning**. By SFNF standards it was not properly functioning 49 days (46.7% of days) and at risk 36 days (34.3 % of days) out of 105 days. By NMED standards the station was not properly functioning 17 days (15.6% of days) and at risk 43 days (39.4% of days) out of 109 total days.

Maximum stream temperatures were recorded in July (see Figure 37). Temperatures peaked at 79.5°F on July 3rd, 2003. Stream temperatures then decreased steadily until the thermograph was pulled in October.

Average monthly diurnal difference peaked in July (see Figure 36). The maximum daily diurnal difference of 34.6°F was observed on July 9th. The minimum daily diurnal difference of 3.6°F occurred on October 3rd

Figure 5. Maximum, minimum and average temperatures for each month for the thermograph station at the Mouth in 2003.

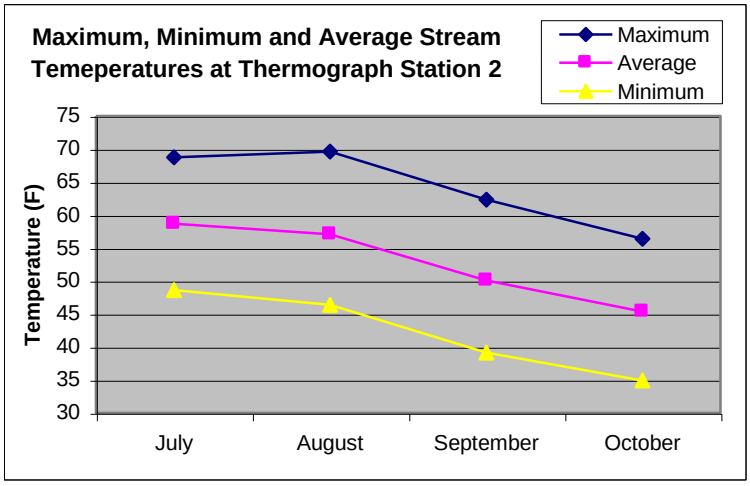


Thermograph Station 2 monitored 5.2 stream miles. The thermograph only monitors a short stretch of Rito Peñas Negras (less than ¼-mile). Most of the stream miles monitored belongs to Rito Café. This section of stream is managed by Forest Service and private landowners. The stream flows primarily through an open canyon. Thermograph data collected in 2003 determined Rito Peñas Negras at the county line was **at risk**. By NMED standards it had 1 day at risk out of 81 days (1.2% of total days). SFNF standards classified 28 days out of 77 at risk (36.4% of days).

Photo 6. Peñas Negras at County Line (10-Jul-03). Thermograph marked by blue flagging.

Maximum stream temperatures were recorded in August (see Figure 5). Temperature peaked at 69.6°F on August 3rd, 2003. After August, temperatures decreased steadily until the thermograph was pulled in October.

Figure 6. Maximum, minimum and average temperatures for each month for the thermograph station at the County Line in 2003.



Average monthly diurnal difference peaked in July and again in September (see Figure 6). The maximum daily temperature fluctuation of 16.8°F occurred on August 3rd. The minimum daily diurnal difference of 3.9°F was recorded on October 2nd.

The second complete set of records for an entire summer were recorded from June 1st to October 11th, 2005. Records were taken at 1-hour intervals during this time period. The thermograph was placed in Reach 1 near the confluence with Rio de las Vacas. Data collected by the thermographs was exported to Microsoft Excel 2000 for analysis and comparison to water quality standards (see Table 10).

Table 10. SFNF and NMED water quality temperature standards.

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

Data collected from the single thermograph station was compared to Forest and New Mexico Environment Department (NMED) Water Quality Standards for temperature. SFNF classifies water temperature as properly functioning, at risk, or not properly functioning (see Table 10). However, NMED classifies water quality standards as not supporting, or full supporting, based on the two aforementioned temperature factors (see Table 10).

When Forest standards were applied, the Rito Peñas Negras was **not properly functioning**, as there were 17 out of 122 days when the temperature exceeded 70°F (see Figure 7). According to NMED standards, Rito Peñas Negras is **not supporting.** The stream was listed as not supporting

because the thermograph data showed that the temperature on the stream exceeded 68°F for over three hours on three or more consecutive days, even though the temperature never exceeded 73.4°F. Factors creating the elevated temperatures at this station must be mitigated to insure the viability of coldwater fish populations.

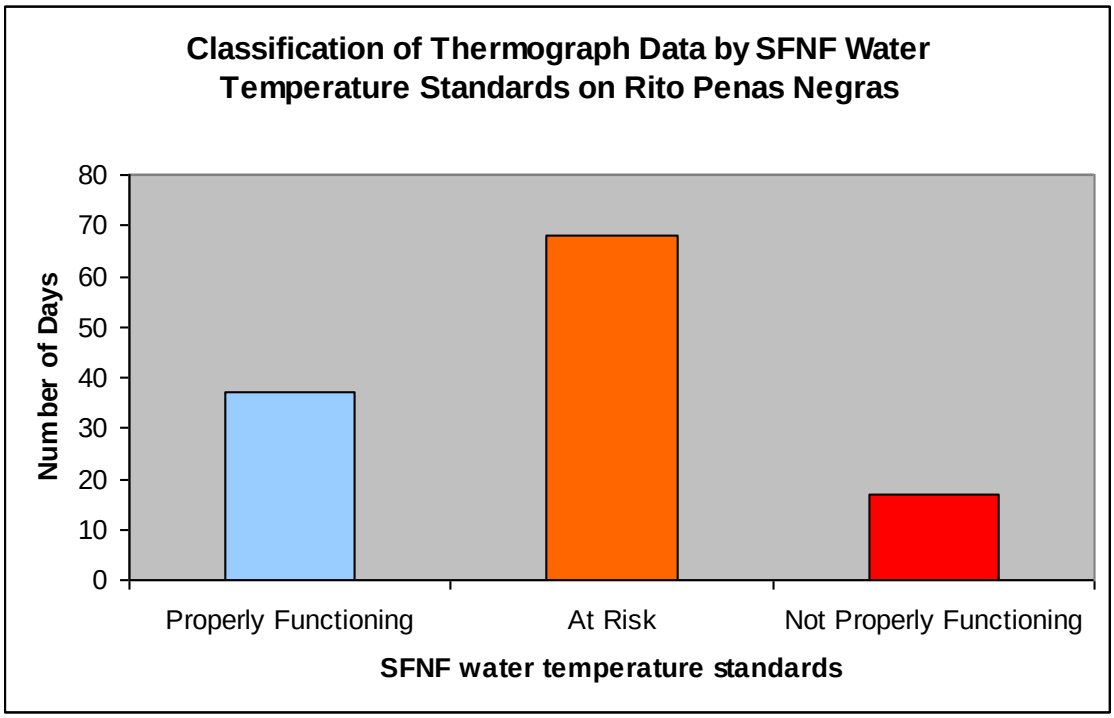


Figure 7. Classification of Thermograph Data from 2005 by Santa Fe National Forest Temperature Standards.

Diurnal, or daily high to low temperature fluctuations, were also analyzed for the thermograph station on Rito Peñas Negras. The average diurnal difference was 9.3°F. The maximum diurnal difference was 13.7°F on 26-Sep-05 (62.26°F high and 48.61°F low).

Riparian Vegetation

Throughout Rito Peñas Negras, alder and willow species dominate the riparian vegetation. Grasses are present throughout, which help stabilize stream banks. Pine and spruce are present in the upper sections of Reach 3 and particularly Reach 4 (see Photo 7).

In Reach 1, cinquefoil was observed in the riparian. Cinquefoil is a native species that is associated with dry sites. Finding cinquefoil in the riparian area is a red flag. The riparian area is being converted from a wet to a dry site, usually associated with major disturbances such as overgrazing and soil compaction. Cattle were observed in all of the reaches and are likely the cause of the disturbance.

Photo 7. Reach 5. NSO 1131, R556. Looking upstream with pine in riparian (26-Oct-05).

Beaver Activity

Old beaver dams were found in Reaches 1, 2, 3, and 4. Many of these old dams are now blown out, leaving woody debris along the banks. Reach 4 had the only active beaver dams present. There was also a beaver dam complex in Reach 4, which consisted of six small dams dispersed over 405 feet of stream length. Signs of past beaver activity were observed throughout reaches 1, 2, 3 and 4.

Two active beaver dams were recorded on Reach 4 of Rito Peñas Negras. The lower dam created a pool 12 feet wide and estimated to be 3 feet deep. The upper dam created a pool that spanned the 30 foot wide valley floor, and was estimated to be 4.5 feet deep. This dam was approximately 5.5 feet tall (see Photo 24).

At the upper dam there was a skid trail made from the beaver dragging wood down the steep right bank. The skid trail went approximately 200 feet in the woods where there were over 20 fallen aspen trees with fresh beaver chew (see Photos 8 and 9).

Beavers should be restored to Rito Peñas Negras. However, before beavers are placed back in the watershed, focus should be placed on riparian restoration. First, riparian vegetation must be allowed to establish in the floodplain. There is a definite lack of lush woody species, such as willow, cottonwood, aspen, and alder. These species are present, but not in the quantities necessary to support a thriving beaver population. Once the riparian species return, then beavers can naturally recolonize Rito Peñas Negras. The dams that they build create essential habitat that RGCT and other native fish depend on for rearing and over-wintering habitat.

Photos 8 and 9. Reach 4, NSO 991 P490. (left) Beaver skid trail on left bank that extends 200ft into timber. (right) Fresh beaver chew on aspen at the top of the skid trail (25-Oct-05).

While the beaver's role in a watershed has been misunderstood by the public, land managers and biologists, studies over the last few decades conclude that beaver 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 only until recently (FS Files).

Beavers have many affects 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 affects 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 dams, decreases the waters 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 ninety percent in studied streams (Olson 1994). Nitrogen and phosphorus containing sediments also settle, making beaver ponds a nutrient sink for a stream system. The storage of nutrient laden soil in sediment reduces eutrophication in nutrient rich systems. In low nutrient systems, such as headwater streams, the nutrient storage in pond sediment creates a time-release system increasing productivity. After the beaver leaves an area and the pond drains, the nutrient rich soil is utilized by riparian vegetation to produce dense riparian areas.

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 affect 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. 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 1994).

Beavers do 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 will 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, but are generally absent in streams with only abandoned 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 affects 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 1994).

Fisheries

Fish species found in Rito Peñas Negras include the native fish assemblage of Rio Grande sucker *(Catastomus plebius)*, and Rio Grande chub *(Gila pandora).* Non-native species include German brown trout (*Salmo trutta)* and rainbow trout (*Oncorhynchus mykiss).*

Historically Rio Grande cutthroat trout (*Oncorhyncus clarki virginallis)* were recorded in Rito Peñas Negras; presently, they only occur in Rito Café and Rio de las Vacas. Reports as recent as 1989 show that Rio Grande cutthroat trout were the dominate species found in Rito Penas Negras. However, non-native German brown trout were recorded at that time as well.

Photo 10. Rio Grande chub found in Rio de las Vacas in 1972.

Introduction of brown and rainbow trout has reduced the range of the native population of RGCT within the Rito Peñas Negras Watershed. RGCT is a species that needs high water quality to survive. RGCT is the State Fish of New Mexico and has been placed on the Regional Forester's list of sensitive species. Range-wide, the numbers of RGCT have dropped dramatically over the last century. At one time, RGCT inhabited nearly all the cool, clear mountain lakes and streams of the Rio Grande basin in Colorado and New Mexico. Now, there are small fragmented populations remaining in headwater streams, less than 7% of their historic range. Some other causes of the decline of the RGCT are due to a decrease in stream productivity from habitat degradation and dewatering of streams for irrigation. The Jemez Mountains provides a stronghold for RGCT, as seen in San Pedro Parks Wilderness and the Cãnones Watershed.

In 1983, the Santa Fe National Forest fisheries biologist recommended stocking of rainbow trout. He states in a memo "rainbows are more easily caught by anglers than brown trout, but are not as easily caught as cutthroats." This same biologist said in 1984 that "maybe if the district (Cuba) was aware that angling is an important resource, they would be more willing to make an effort to increase it." This same person stated, "Trout production in (Rio de las Vacas) is low and does not provide a fishery. Trout numbers average 1 brown trout per 15 linear feet of stream and 1 rainbow trout per 80 linear feet of stream" (FS Files). The low density of fish is due to a multitude of factors mostly attributed to the predacious nature of German brown trout and poor habitat and water quality conditions.

In 1962, NMG&F released a statewide fisheries investigation that included Rio Puerco, Rio de las Vacas, Rito de las Palomas, Rio las Perchas, and Clear Creek. In this document they state "…Rio las Vacas and lower Clear Creek are the only streams capable of maintaining a fish population…*the upper Rio las Vacas (is) overpopulated with cutthroat trout.* Brown trout and rainbow trout are recommended for lower Clear Creek and lower Rio las Vacas. The catchable-size rainbow plantings should be minimized as much as possible and an effort be made to establish brown trout populations…It was also recommended that these streams be treated with rotenone to control development of the undesirable species" (FS Files).

Photo 11. Rio Grande sucker found in Rio de las Vacas in 2001.

The "undesirable" species are non-game fish, such as native Rio Grande sucker and chub. In 1959, a document reports, "The lower Vacas has a large population of suckers and minnows. These undesirable species constitute nearly 85% of the present population." (FS Files) Further studies by NMG&F in 1962 confirmed, "The predominant fish species in the lower Rio las Vacas are the mountain sucker (*Pantosteus plebeius*) (now known as Rio Grande sucker) and the Rio Grande chub (*Gila nigrescens*). Game fish present include the rainbow trout and the brown trout." (FS Files)

Previous Surveys

A stream inventory of Rito Peñas Negras was conducted in 1993 by the Santa Fe National Forest. This survey also utilized the Hankin and Reeves survey methods. The 1993 survey began at the Forest Boundary just above the private land (T20N, R1E, Sec. 13) and ended 6.6 miles upstream at the Forest Road 103 crossing (T21N, R2E, Sec. 27). The stream was divided into two reaches, which roughly correspond with the 5 reaches recognized in the 2005 survey (see Table 14). The complete reach summaries from the 1993 survey are available in Appendix B.

The 1993 survey had 194 pools and 208 riffles (see Table 11). In the 2005 survey, 584 pools and 584 riffles were identified. The average length of pool habitat was 92.4 feet in 1993, which is about twice the average pool length found in 2005 (47.4 feet). The average riffle length was 129.5 in 1993, which is again about twice the length found in 1995 (59.5 feet). In the 1993 survey, pools accounted for 40% of the stream length and riffles 60%. This corresponds to the 2005 survey in which pools accounted for 44.2% of the stream length and riffles were 55.5%.

Table 11. Overall Stream Summary for Rito Peñas Negras Survey 1993.

Habitat Type	Total Number	Total Feet of Stream Habitat	% Stream Length	Properly Functioning Indicators
Pool	194	17,930	40.0	>30%
Riffle	208	26,936	60.0	-
Culvert	Not Counted	-	-	-
Tributary	Not Counted	-	-	-
Falls	Not Counted	-	-	-
Side Channel	Not Counted	-	-	-
Total	402	44,866	100	-

There is a large difference in the total lengths between the 1993 and 2005 surveys. The 1993 crew surveyed a total of 8.5 miles compared to 11.9 miles surveyed in 2005. This is most likely explained by a difference in survey technique. The protocol for the 1993 survey only required estimates of stream length, where the 2005 crew actually measured the length of each habitat unit.

Due to this difference in length, it was not accurate to measure LWD per mile, instead it was only possible to analyze number of pieces per reach. Both Reaches 1 and 2 in the 1993 survey had more LWD than the 2005 survey. Reach 1 in the 1993 survey had 63 pieces of LWD, compared with 11 pieces in Reaches 1, 2 & 3 in the 2005 survey. In 1993, Reach 2, had 70 pieces of LWD, compared with 24 pieces in Reaches 4 & 5 in the 2005 survey (see Table 12).

The protocol used to identify woody debris in the 1993 survey may have included counting standing trees that looked like potential LWD (leaners) as well as downed wood in the floodplain. If this was the case, it could help explain the elevated numbers. The 2005 survey did not include leaners or downed wood outside of bankfull.

Table 12. Comparative look at 2005 survey and 1993 survey

Reach		Total Length (mi)		Percent Pool Habitat		Percent Riffle Habitat		Dominant Riffle Substrate		Pieces Large LWD	
1993	2005	1993	2005	1993	2005	1993	2005	1993	2005	1993	2005
1	1, 2 & 3	6.6	9.5	43.5	46.0	56.6	54.0	Sand/ Gravel	Sand/ Gravel	63	11
2	4 & 5	1.9	1.7	27.7	32.1	71.9	67.9	Gravel/ Cobble	Sand/ Gravel	70	24

Habitat is another variable comparable across the two surveys (see Table 13). This table indicates while volume of both pools and riffles remained relatively the same. Pool quality decreased in the last 12 years. This is indicated by a reduction in residual pool depth; most notably in Reaches 1-3 (2005) from 1.8’ to 1.0’. The decrease in residual pool depth can be attributed to sediment filling in the pools.

Table 13. Comparative look at stream depths.

Reach		Max Pool Depth		Residual Depth		Max Riffle Depth	
1993	2005	1993	2005	1993	2005	1993	2005
1	1, 2 & 3	2.7	1.4	1.8	1.0	1.1	0.8
2	4, 5	1.9	1.4	1.2	1.0	1.1	0.7

Amphibian and Reptile Species

Although no amphibian or reptile species were recorded during the survey, several species were assumed to be found throughout the watershed, including tiger salamanders, western toad, leopard frog, and chorus frog.

Stream Improvements

Remnants from past stream improvement efforts still exist on Rito Peñas Negras and were observed during the 2005 survey. Some of these improvements include manmade dam structures, Gabion structures, and manmade bank structures to improve stability.

Several manmade structures were recorded on the upper end of Reach 1, and continue into Reach 2. Manmade erosion structures were recorded on three separate NSO's (270, 287, 289). These structures consisted of logs perpendicular to the stream flow, and covered in black tarp, or logs parallel to stream flow and held in place with rebar (see Photo 12).

Photo 12. Reach 1. NSO 270, P135. Manmade stream bank stability structures. Logs wrapped in black tarp (08-Oct-05).

Five manmade dam structures were also recorded on Reach 1. All were causing widening and none were forming pools (see Photo 9).

Many different kind of manmade structures and rehabilitation projects have occurred on Reach 2 as well. Approximately 80 feet of manmade erosion structures were recorded on NSO's 553 and 554. These structures consist of rocks placed on the banks and covered with chicken wire. The chicken wire is held in place with T-posts (see Photo 10).

There are two manmade check dams (NSO 559 and 564) on Reach 2. Both are working well, and have agraded the channel 3 to 3.5 feet. These dams have brought the water level of the stream closer to the floodplain (see Photo 13).

Photo 13. Reach 2. NSO 559, R279. Chuck at check dam. Dam is working well and has agraded the channel 3.5' (09-Oct-05).

Throughout NSO 580 to 602 there are four manmade log structures; one upstream "V"-structure and three downstream "V"-structures. Although all of the structures are forming pools, they are also causing widening (see Photo 14).

Photo 14. Reach 2. NSO 590, P295. Upstream V with v-notch cut out. Structure is creating a pool, but also causing widening (10-Oct-05).

LAND USE

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 to 5000 B.C.)

The Paleoindian period is characterized by a nomadic band of people who frequently moved across the landscape according to their strategy of hunting now extinct megafauna such as mammoth and bison. Very few paleoindian sites have been recorded in northern New Mexico which could indicate that the area was not frequently visited.

Archaic (ca. 5500 B.C. to A.D. 200)

Due to the climatic and environmental changes that occurred at the end of the Pleistocene, the nomadic, megafauna hunters developed a much broader subsistence strategy. During the Archaic period, hunting and foraging activities were conducted across a range of ecosystems. The people of the Archaic period began to use different landscapes according to seasons. This involved utilizing upper elevations during the summer and migrating to lower elevations in the fall and winter.

Ancestral Puebloan/Eastern Anasazi (ca. A.D. 400 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 (Boyd 2004).

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).

North-central New Mexico was visited and utilized by many prehistoric populations, including the Utes, Apaches, and Navajos, however, this use may have been seasonal and short-term. This area was mainly uninhabited by sedentary group until the appearance of the early Spanish explorers in the mid-16th century (Boyd 2004).

Historic (A.D. 1540 to present)

The Historic period in New Mexico began with Coronado's expedition. However, it was much later that the Spanish began to settle in the river valleys around the Guadalupe watershed. By the mid 1800's sheep herding began to replace the previous subsistence farming techniques. At this time, the region witnessed intensive sheep grazing throughout the early 1900's. Other livestock were also grazed in this area.

There are some recorded sites in the Rito Penas Negras watershed, however, they consist mostly of scattered lithic materials (Boyd, personal communication). There are no recorded structures or remnants of sedentary people. The survey crew witnessed a tombstone, however, there was no record of it in the archaeology files, so age and identification is not known.

Roads

Recreation

Timber

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 Forest Service 1996). Grazing on public lands has occurred for nearly a century. There are 8 pastures that run along 8.5 miles of the Rito Peñas Negras. These eight pastures contain 11,861 acres of range. The Cuba Ranger District in the Santa Fe National Forest manages all eight of the pastures. Of the 8.5 miles, 6.3 miles of stream segments are within pastures that are grazed under a rotational grazing system between the months of June and October (grazing season). Cattle can be in these pastures for more than 10 days at a time but would not exceed 45 days in a grazing season. A meager 0.8 of the 8.5 miles are completely excluded from grazing by fences.

Recommendation Summary

Riparian

Objective:

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

Concerns:

Currently, the riparian vegetation is degraded throughout Rito Peñas Negras. Grazing has had significant impact on the riparian zone in this area. Reduction of riparian zone species diversity and decreased vegetation density are examples of the current degradation. The integrity of the riparian zone is crucial to stream function and coldwater fish habitat. The current riparian vegetation and management practices should be altered to stimulate and promote a healthy vegetation community.

Implementation methods:

1) Augment current riparian area density by planting native species.
2) Ensure that construction of range facilities and maintenance of range improvement projects will be evaluated and executed to have no adverse effects on threatened and endangered species.
3) Remove fences and loose wires as they are abandoned.
4) Reconstruct broken fences to prevent excess forage use by livestock from adjacent allotments.

Large Woody Debris (LWD)

Objective:

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

Concerns:

Large woody debris (LWD) in Rito Peñas Negras is below the desirable densities in the forested reach (Reach 4).

Implementation methods:

1) Arrange LWD in the floodplain and stream in strategic locations, increasing habitat complexity and fish habitat. These projects would utilize the best available science for LWD implementation to avoid previous stream improvement mistakes.
2) To decrease tree density to a more natural level, riparian thinning could be implemented while leaving downed trees in the active floodplain.

Native Fish Populations

Objective:

Restore and protect populations of native RGCT in their historic range.

Concerns:

Although native RGCT only exist in Rito Café, the population could be extended to include Rito Peñas Negras. There are large populations of non-native brown trout and some rainbow trout in this stream, due to stocking in the Rio de Las Vacas.

Implementation methods:

1. Conduct electrofishing surveys to determine the range of all the native and non-native species in Rito Peñas Negras and Rito Café.
2. Work in partnership with New Mexico Game and Fish and the communities to methodically expand the range of RGCT to downstream reaches and tie together with other streams such as Rio de las Vacas and Rio Guadalupe.
3. Ensure that cattle grazing within riparian pastures that border stream segments containing Core Conservation Populations of Rio Grande cutthroat trout will be scheduled to avoid disturbance during spawning season (mid-May through mid-June).
4. Ensure that allotment fence management meets wildlife standards to allow easy migration and passage.

Beaver

Objective:

Restore populations of beaver to Rito Peñas Negras.

Concerns:

Only two active beaver dams exist on the Rito Peñas Negras, though is a large amount of evidence of past beaver populations.

Implementation methods:

1. Restore native vegetation to the riparian area through willow planting projects.
2. Allow the land to rest from grazing while the vegetation is re-established.

Reach Summaries

Photo 15. Reach 1. NSO 13, R7. Hwy 126 bridge crossing over Rito Peñas Negras (06-Oct-05).

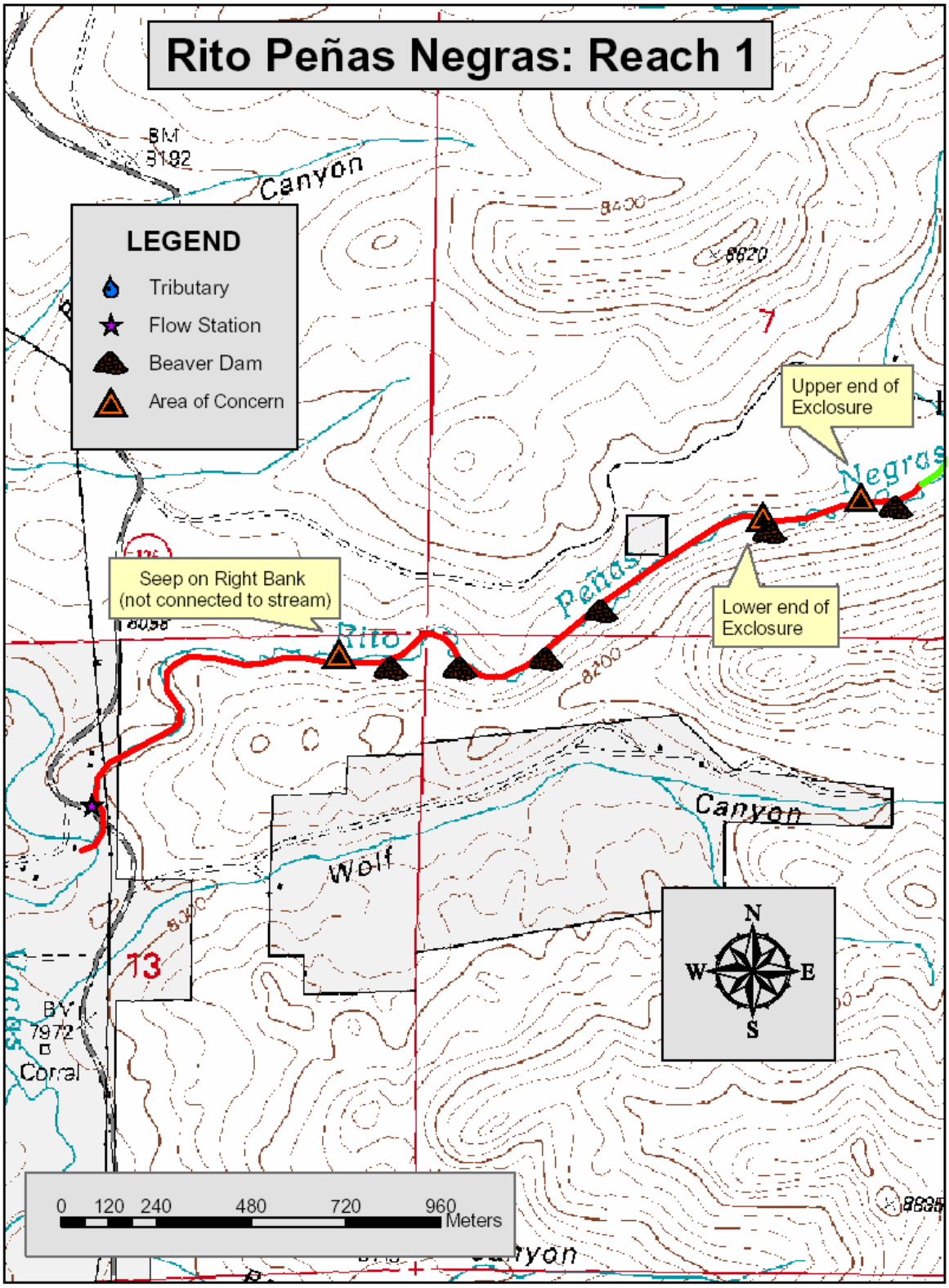


Figure 8. Reach 1 tributaries, beaver dams, areas of concern and the flow station.

Reach 1: Mouth of Rito Peñas Negras to Unknown Fenceline

Reach 1 begins at the confluence of Rito Peñas Negras with Rio de las Vacas. The survey of this reach began on October 6, and ended on October 8, 2005. The mouth is located at 8,000' above sea level (T20N, R1E, Sec. 13) and continues for 2.8 miles to 8,120' (T20N R2E Sec 7). Reach 1 has an average gradient of 1.4%. The stream flows through open meadow with sand-dominated substrate. Due to the extreme sinuosity (1.69), the river crosses the valley floor multiple times and is against the valley slope on either side at occasional points. The Rosgen channel type for this reach is C5.

The riparian community consists of mostly grasses and sedges. There are occasional clumps of two or three alder, but overall, both alder and willow were limited throughout Reach 1. The valley slopes were forested with spruce, ponderosa pine, and aspen.

Non-native German brown trout were observed in this reach. It is likely that the native assemblages of fish are found in this reach, except for RGCT.

Five blown-out beaver dams were observed on Reach 1. A vacant beaver den is located in this reach.

Several manmade structures were recorded on the upper end of Reach 1, and continue into Reach 2. Manmade erosion structures were recorded on three separate NSO's (270, 287, 289). These structures consisted of logs perpendicular to the stream flow, and covered in black tarp, or logs parallel to stream flow and held in place with rebar (see Photos 12 and 16).

Photos 16. Reach 1. NSO 287, R144. Manmade stream bank stability structures consisting of logs parallel to stream flow, held in place with rebar (08-Oct-05)

Five manmade dam structures were also recorded on Reach 1. All were causing widening and none were forming pools (see Photo 17).

Photo 17. Reach 1. NSO 292, P246. Manmade dam structure across stream; not forming pool and causing widening (08-Oct-05).

Thermograph data collected from June 1st to September 30th, 2005 determined that the mouth of Rito Peñas Negras was **not properly functioning**, exceeding the SFNF standards 17 out of 122 days recorded (see Figure 11).

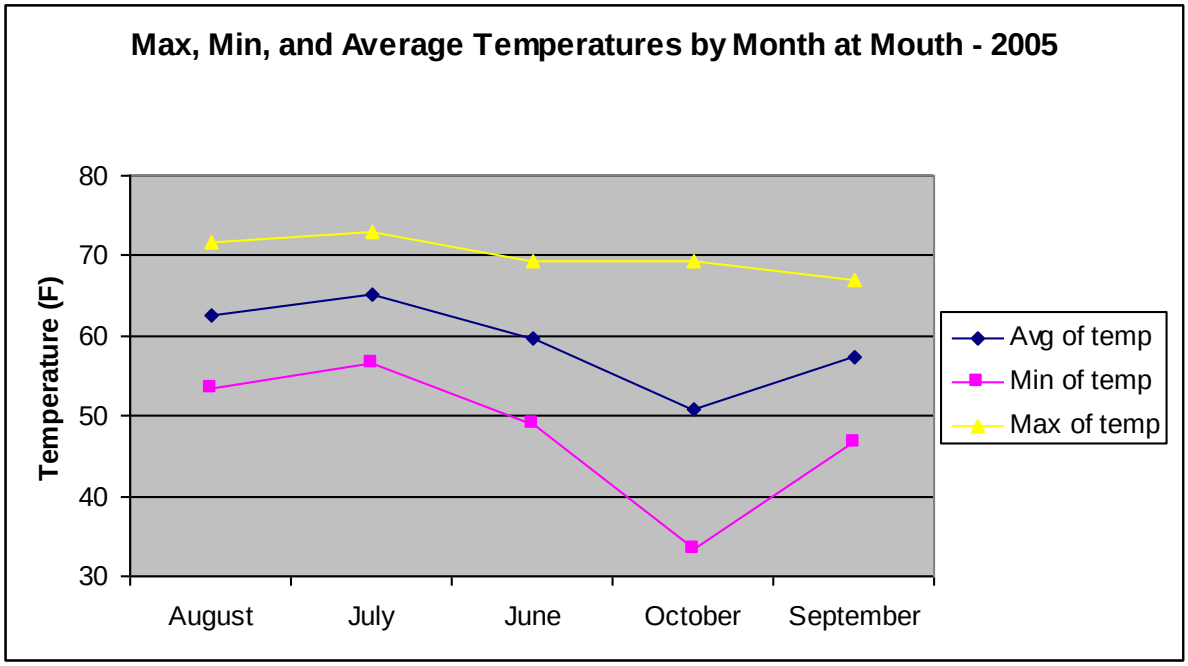


Figure 11. Maximum, minimum and average temperatures by month at mouth of Rito Peñas Negras.

Water temperatures were measured at the start and end of each day, as well as, at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column in main channel habitats during the survey (grab samples). The 12 water temperature samples ranged between 43 and 58°F. Average grab sample temperature was 52.1^{o}F.

Habitat Characteristics

During the habitat survey conducted on Reach 1, the river was broken up into a total of 317 NSOs, measuring 14,786 feet in length. Of the 317 NSOs, 49.4% were pools and 50.6% were riffles (see Table 14). There were no side channels or tributaries in Reach 1. Much of the pools were filled in with sediment, which contributes to the low quality of the pools.

Table 14. Overall Stream Summary for Reach 1.

Reach 1					
Stream Length Surveyed:	14,786	2.8 miles			
Gradient:	1.3		**Rosgen Channel Type:**	C5	
Habitat Type	**Total Number**	**Total Feet of Stream Habitat**	**% Stream Length**	**% Stream Habitat**	**Properly Functioning Indicators**
Pool	158	7,303	49.4	49.4	>30%
Riffle	159	7,483	50.6	50.6	-
Culvert	0	0	0	0	-
Tributary	0	-	-	-	-
Falls	0	0	0	0	-
Side Channel	0	0	-	0	-
Total	317	14,786	100	100	-

When compared to the matrix of factors and indicators of stream health condition for historic and occupied RGCT streams, Reach 1 is **not properly functioning** for all criteria in the categories of habitat characteristics and channel condition, except pool development, pool quality, and bankfull W:D ratio. The amount of LWD was omitted from analysis, as this is a meadow reach.

Riffles in Reach 1 are **not properly functioning** for average sediment amounts, with 31.3% sand, which exceeds the <20% criterion (see Table 15). Reach 1 is a low gradient reach, and because of the velocity of stream flow, this reach is conducive for the settlement of fine substrates. Sand is typically collected in reaches with a gradient this low.

Much of the sediment input becomes excessive due to the large areas of unstable bank. Most of the bank instability is directly related to trampling from cattle. Although only 3 cow trail crossings were recorded in Reach 1, there were extensive cow trails that paralleled both banks.

Table 15. Summary of Habitat and Substrate Percentages for Riffles in Reach 1

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max. Depth	
1	159	47.1	3.7	0.5	0.7	

Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
1	31.3	44.0	15.4	9.4	0.0	100
Properly Functioning Indicators	<20	-	-	-	-	-

Orange = dominant substrate
Red = not properly functioning

Reach 1 was **properly functioning** for pool quality. The average residual pool depth was 1.1', exceeding the properly functioning indicator of 1.0' (See Table 16). Overall the average pool was of adequate quality. Reach 1 was **properly functioning** for pool quantity, with the amount of pool habitat at 49.1%. Although, only 46% of the pools recorded exceeded 1.0 residual depth, with only one pool with max depth greater than 3 feet, indicating that pools are filling in with sediment.

Table 16. Summary of Habitat and Substrate Percentages for Pools in Reach 1.

Pool Habitat Summary											
Reach	# of Pools	Avg. Length	Avg. Width	Avg. Max. Depth	Avg. PTC	Avg. Residual Depth	Pools/Mile	# of Pools w/ Residual Depth>1'	Pools w/ Residual Depth >1"/Mile	# of Pools w/ Max. Depth >3'	# of Pools w/ Max. Depth >3'/Mile
1	158	46.2	4.2	1.4	0.4	1.1	56.4	72	25.7	1	0.4
Properly Functioning Indicators	-	-	-	-	-	≤1'	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
1	53.2	29.8	9.9	7.2	0.0	100	

Orange = dominant substrate

Reach 1 was a meadow reach and therefore, large woody debris was not analyzed.

Rito Peñas Negras was **not properly functioning** for stream bank condition with 47.4% unstable banks throughout the entire reach (see Table 17). A properly functioning reach must have <10% unstable banks.

The bankfull width-to-depth ratio for Reach 1 is 14:1, which is within 12-30:1, and is considered **properly functioning** for a "C" Channel (see Table 17).

Table 17. Habitat Characteristics for the Reach 1.

Reach	Pool:Riffle Ratio	Bankfull Width: Depth	Pieces of LWD per Mile	Total Unstable Banks	Percentage of Unstable Banks
1	1:1	14:1	5.7	14,002.30	47.4
Properly Functioning Indicators	-	12-30:1	>30[1]	-	<10

Red = Not Properly Functioning
[1]LWD/Mile criteria are not applicable in meadow reaches.

Recommendations

Reach 1 is a candidate for restoration. The heavy grazing pressure in the floodplain has degraded the riparian areas, as well as the stream itself. Cattle trampling has caused soil compaction, which prevents riparian vegetation from re-establishing in these areas as well as stream widening. The riparian pastures along this section of Rito Peñas Negras should be rested to allow riparian species to revegetate the raw exposed banks, and provide stability.

Photo 18. Reach Break. NSO 317, R159. Identity of fenceline unknown. Note: grass much taller on upstream side of fence where pasture has been rested (08-Oct-05).

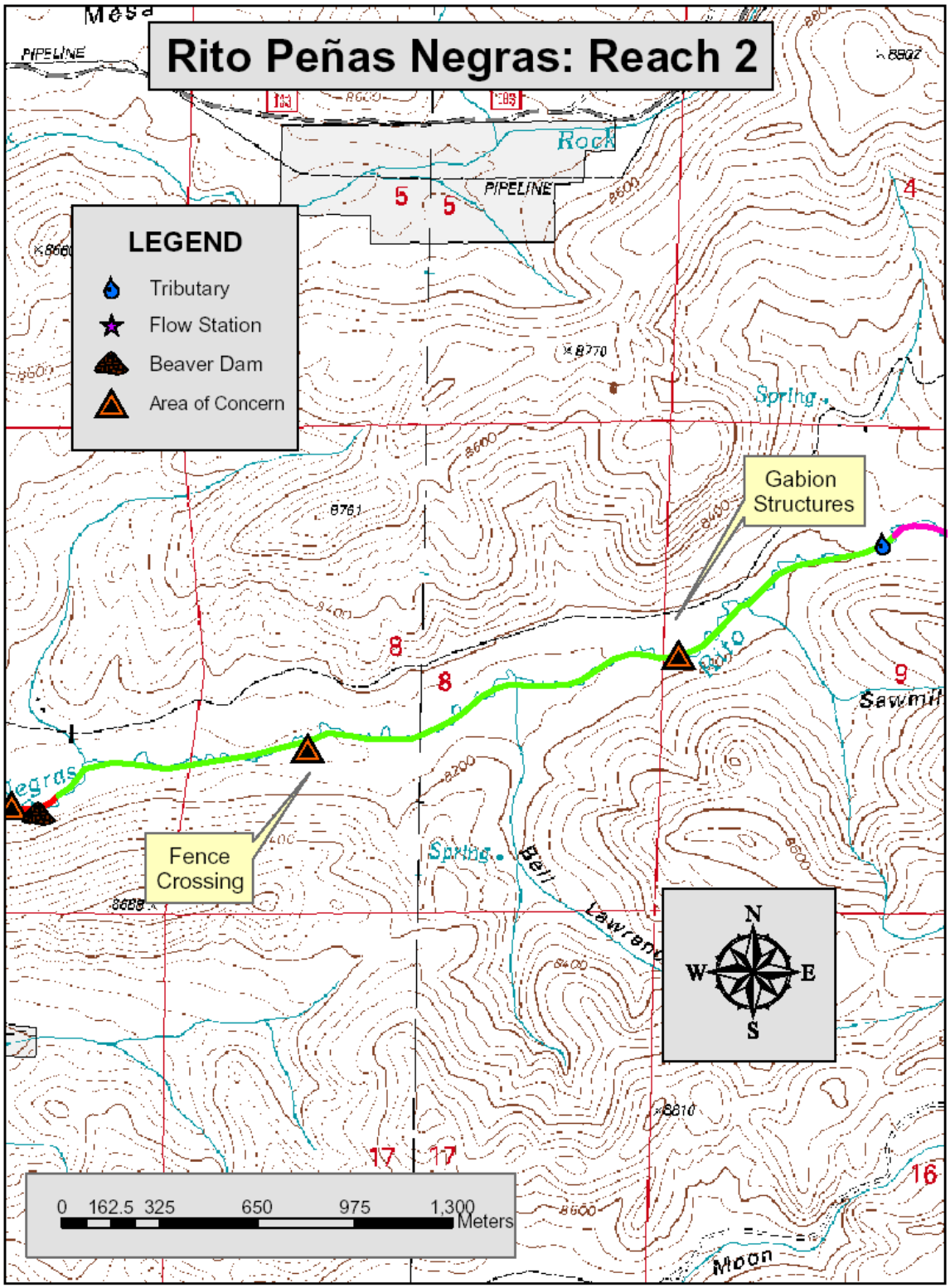


Figure 12. Reach 2 tributaries, beaver dams, areas of concern and the flow station.

Reach 2: Unknown Fenceline to Peñas Negras Cabin

The survey of Reach 2 began on October 8 and continued through October 10, 2005. The start of the reach is located at 8,120' above sea level (T20N, R2E, Sec. 7) and continues for 1.9 miles to 8,200' elevation (T20N, R2E, Sec. 9). This reach is nearly flat and highly sinuous (1.83), with an average gradient of 0.4%. The substrate is dominated by sand. The Rosgen channel type for this reach is E5.

The riparian community consists mostly of grasses and sedges. There were almost no willow or alder, and therefore no shade cover. The stream was not close enough to the valley on either side to have any ponderosa pine, aspen or spruce in the riparian area. The lack of large woody species as well as deep-rooted grasses along the banks is a large contributor to the high percent of unstable bank in this reach.

Non-native German brown trout, as well as native Rio Grande sucker and Rio Grande chub were observed.

Many different kind of manmade structures and rehabilitation projects have occurred on Reach 2 in the past. Approximately 80' of manmade erosion structures were recorded on NSO 553 and 554. These structures consist of rocks placed on the banks and covered with chicken wire. The chicken wire is held in place with T-posts (see Photo 19).

Photo 19. Reach 2. NSO 554, R278. Bank stability rehabilitation on both the right and left bank (09-Oct-05).

There are two manmade check dams (NSO 559 and 564) on Reach 2. Both are working well, and have agraded the channel 3 to 3.5 feet. These dams have brought the water level of the stream closer to the floodplain (see Photo 13).

Throughout NSO 580 to 602 there are four manmade log structures; one upstream "V"-structure and three downstream "V"-structures. Although all of the structures are forming pools, they are also widening the channel (see Photo 14).

Water temperatures were measured at the start and end of each day, as well as, at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column in main channel habitats during the survey (grab samples). The 17 water temperature samples ranged between 44 and 56°F. Average grab sample temperature was 50.0^{o}F.

Habitat Characteristics

During the habitat survey conducted on Reach 2, the river was broken up into a total of 332 NSOs, measuring 18,177 feet in length. Of the 332 NSOs, approximately 50.0% were pools. Riffles accounted for 49.7% of the stream habitat (see Table 18). One tributary (spring) was recorded on Reach 2. It was 0.5 foot wide, over 100 feet in length and was contributing 1% of flow. There are no side channels in this reach.

When compared to the matrix of factors and indicators of stream health condition for historic and occupied RGCT streams, Reach 2, is **not properly functioning** for all criteria in the categories of habitat characteristics and channel condition, except polo quality, pool development, and bankfull W:D ratio. The amount of LWD was omitted from analysis, as this is a meadow reach.

Table 18. Overall Stream Summary for Reach 2.

Reach 2					
Stream Length Surveyed:		18,177 feet		3.4 miles	
Gradient:	0.4		**Rosgen Channel Type:**	E5	
Habitat Type	**Total Number**	**Total Feet of Stream Habitat**	**% Stream Length**	**% Stream Habitat**	**Properly Functioning Indicators**
Pool	166	8,374	46.1	46.1	>30%
Riffle	165	9,803	53.9	53.9	-
Culvert	0	0	0	0	-
Tributary	1	-	-	-	-
Falls	0	0	0	0	-
Side Channel	0	0	-	0	-
Total	332	18,177	100	100	-

Riffles in Reach 2 are **not properly functioning** for average sediment amounts, with 44.9% fines (sand, silt, and clay,), which exceeds the <20% criteria (see Table 19). Reach 2 is a low gradient reach (0.4%), and because of the velocity of the stream flow, this reach is conducive for the settlement of fine substrates. Sand is typically collected in reaches with low gradients, such as Reach 2.

Much of the sediment input is also due to the large areas of unstable bank (56.1%). Most of the bank instability is directly related to trampling from cattle. Reach 2 has 6 cow trail crossings, as well as cow trails that parallel both banks.

Table 19. Summary of Habitat and Substrate Percentages for Riffles in Reach 2.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max. Depth	
2	165	50.8	3.0	0.5	0.8	

Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
2	44.9	44.4	8.3	2.4	0.0	100
Properly Functioning Indicators	<20	-	-	-	-	-

Orange = dominant substrate
Red = not properly functioning

Reach 2 was **properly functioning** for pool quality, with an average residual pool depth of 1.1', which exceeds the minimum of >1' (see Table 20). Overall, the average pool was of adequate quality. Reach 2 was also **properly functioning** for pool quantity, with the amount of pool habitat at 46.1%. Although, only 42% of the pools recorded exceeded 1.0 residual depth, with no pools with max depth greater than 3 feet, indicating that pools are filling in with sediment (see Photo 20).

Photo 20. Reach 2. NSO 422, R212. Typical pool filled in with sediment (08-OCT-05).

Table 20. Summary of Habitat and Substrate Percentages for Pools in Reach 2.

Pool Habitat Summary											
Reach	# of Pools	Avg. Length	Avg. Width	Avg. Max. Depth	Avg. PTC	Avg. Residual Depth	Pools/Mile	# of Pools w/ Residual Depth>1'	Pools w/ Residual Depth >1"/Mile	# of Pools w/ Max. Depth >3'	# of Pools w/ Max. Depth >3'/Mile
2	166	59.1	4.1	1.5	0.5	1.1	48.8	70	20.6	0	0
Properly Functioning Indicators	-	-	-	-	-	≤1'	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
2	71.7	22.2	4.3	1.8	0.0	100	

Orange = dominant substrate

Reach 2 was **properly functioning** for pool formation, with the amount of pool habitat at 46.1% which is well above the necessary level of ≥30% pool habitat standard. The dominant substrate in the pools of Reach 2 was sand at 71.7% (see Table 20).

Table 21. Habitat Characteristics for the Reach 2.

Reach	Pool:Riffle Ratio	Bankfull Width: Depth	Pieces of LWD per Mile	Total Unstable Banks	Percentage of Unstable Banks
2	1:1	5:1	9.7	20,150.2	56.1
Properly Functioning Indicators	-	<12	>30[1]	-	<10

Red = Not Properly Functioning
[1]LWD/Mile criteria are not applicable in meadow reaches

LWD was excluded from the analysis since this was a meadow reach.

Rito Peñas Negras was **not properly functioning** for stream bank condition with 56.1% unstable banks throughout the entire reach. A properly functioning stream must have <10% unstable banks (see Table 21).

The bankfull width-to-depth ratio for Reach 2 being 5:1, which is less than 12, is considered **properly functioning** for an "E" Channel.

Recommendations

Reach 2 is a candidate for restoration. The heavy grazing pressure in the floodplain has degraded the riparian areas, as well as the stream itself. The cattle trampling (see Photo 21) has caused soil compaction, which prevents riparian vegetation from re-establishing in these areas as well as stream widening. The riparian pastures along this section of Rito Peñas Negras should be rested to allow riparian species to revegetate the raw exposed banks, and provide stability.

Photo 21. Reach 2. NSO 350, R176. Cow Trail crossing with stadia rod (08-Oct-05).

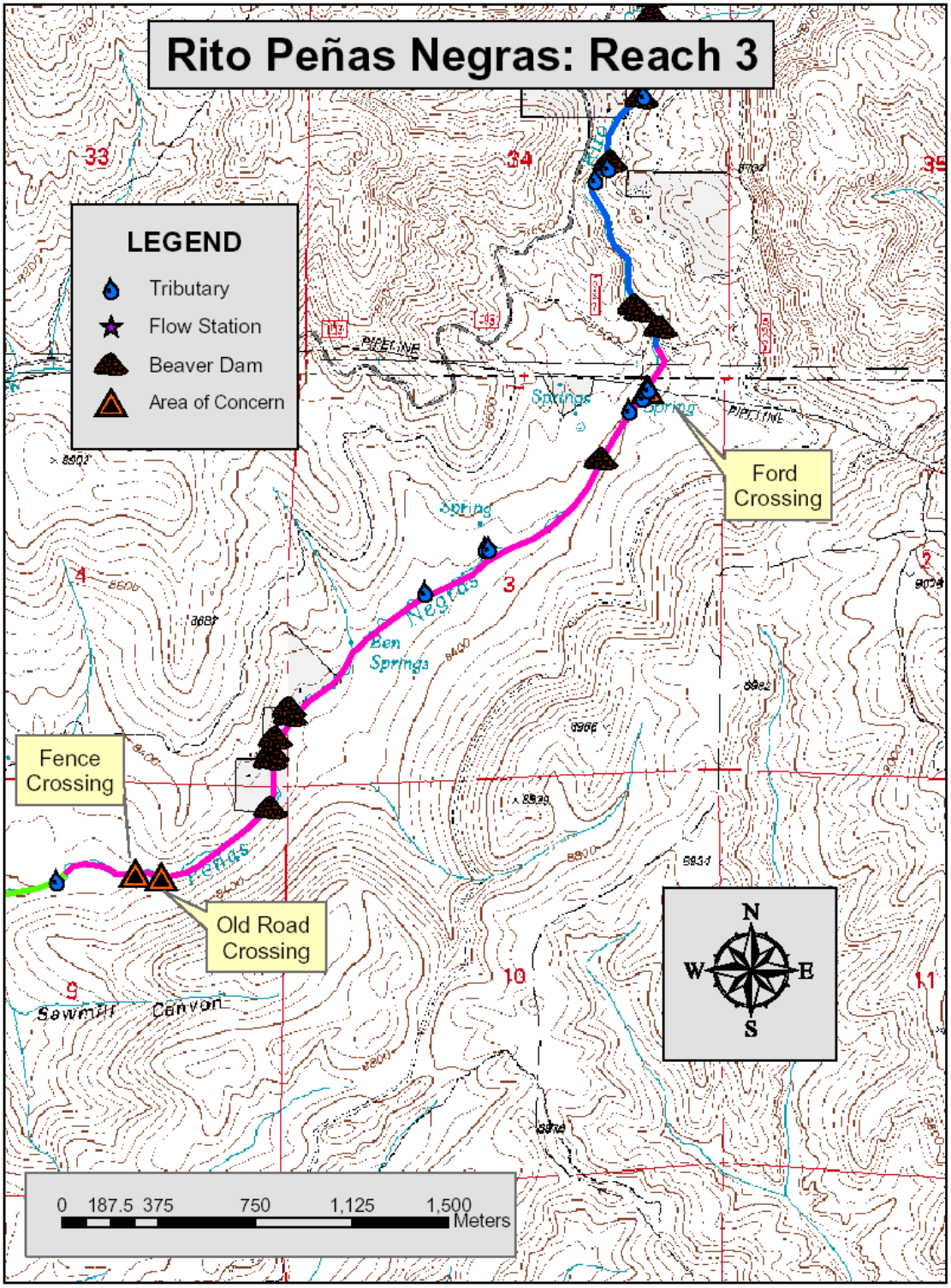


Figure 13. Reach 3 tributaries, beaver dams, areas of concern and the flow station.

Reach 3: Peñas Negras Cabin to Culvert at FR 527

The survey of Reach 3 started on October 10 and was completed on October 24, 2005. This reach starts at 8,200' above sea level (T20N R2E Sec 9) and continues upstream for 2.1 miles to 8,440' elevation (T19N R2E Sec 9). Reach 3 had a moderately low gradient (1.3%) and high sinuosity (1.66). The Rosgen channel type for this reach is a C5 type channel. The stream substrate is dominated by sand.

Reach 3 is a meadow reach; however, the riparian area is much denser than Reaches 1 and 2. Thick bunches of alder with some willow line both banks, providing excellent shade cover. Due to high sinuosity, the stream crosses the valley floor multiple times and is against the valley slope on either side at occasional points. At these points, pine and spruce were recorded in the riparian.

Six old beaver dams were observed on this reach; most of them were blown out at the time of this survey. However, there was one dam still holding together, creating a nice pool (see Photo 22).

Photo 22. Reach 3. NSO 754, P376. Old beaver dam, still intact and forming pool (11-Oct-05).

Water temperatures were measured at the start and end of each day, as well as, at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column in main channel habitats during the survey (grab samples). The 15 water temperature samples ranged between 38 and 47°F. Average grab sample temperature was 43.6^{o}F.

Habitat Characteristics

During the habitat survey conducted on Reach 3, the river was broken up into a total of 326 NSO's, measuring 18,045 feet in length (see Table 22). Of the 326 NSOs, approximately 35.2% were pools. Riffles accounted for another 64.0% of the NSO's. Side channels make up a very small part, 0.8%, of the stream habitat.

Table 22. Overall Stream Summary for Reach 3.

Reach 3					
Stream Length Surveyed:		18,045		3.4 miles	
Gradient:	1.3		**Rosgen Channel Type:**	C5	
Habitat Type	**Total Number**	**Total Feet of Stream Habitat**	**% Stream Length**	**% Stream Habitat**	**Properly Functioning Indicators**
Pool	157	6,403	35.5	35.2	>30%
Riffle	158	11,642	64.5	64.0	-
Culvert	0	0	0	0	-
Tributary	6	-	-	-	-
Falls	0	0	0	0	-
Side Channel	4	136	-	0.75	-
Total	325	18,181	100	100	-

There are six tributaries in Reach 3. Tributary 2 (NSO 842) is a spring that is contributing about 5% of flow. It joins the Rito Peñas Negras on the left bank. The temperature was the same as the main channel (38°F). The other five tributaries on Reach 3 contributed less than 5% of flow.

When compared to the matrix of factors and indicators of stream health condition for historic and occupied RGCT streams, Reach 3 is **not properly functioning** for all criteria of habitat characteristics and channel condition except pool development and bankfull W:D ratio.

Riffles in Reach 3 are **not properly functioning** for average sediment amounts, with 31.5% fines (sand, silt, and clay,), which exceeds the <20% criteria. Riffles are dominated by gravel (see Table 23). Reach 3 is a lower gradient reach, and because of the velocity of the stream flow, this reach is conducive for the settlement of fine substrates. Sand is typically collected in reaches with a gradient as low as the gradient found in Reach 3.

Table 23. Summary of Habitat and Substrate Percentages for Pools in Reach 3.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max. Depth	
3	158	73.7	4.0	0.5	0.8	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
3	31.5	37.9	21.7	8.7	0	100
Properly Functioning Indicators	<20	-	-	-	-	-

Orange = dominant substrate
Red = not properly functioning

Much of the sediment input becomes excessive due to the large areas of unstable bank. Most of the bank instability is directly related to trampling from cattle. Reach 3 has 18 cow trail crossings, as well as cow trails that parallel both banks. There is a ford crossing (see Photo 23) contributing to bank instability and stream widening.

Photo 23. Reach 3, NSO 964, R4788. Ford crossing stream, causing unstable bank and widening (24-Oct-05).

Reach 3 was **not properly functioning** for pool quality, with an average residual pool depth of 0.95', which does not exceed the minimum of ≥1'. Overall the average pool was of adequate quality, and the amount of pool habitat in Reach 3 was above acceptable levels. Reach 3 was **properly functioning** for pool formation, with the amount of pool habitat of 35.2%, which is above the necessary level of ≥30% pool habitat for a properly functioning stream (see Table 24). Although, only 34% of the pools recorded exceeded 1.0 residual depth, with no pools with max depth greater than 3 feet, indicating that pools are filling in with sediment.

Table 24. Summary of Habitat and Substrate Percentages for Pools in Reach 3

Pool Habitat Summary											
Reach	# of Pools	Avg. Length	Avg. Width	Avg. Max. Depth	Avg. PTC	Avg. Residual Depth	Pools/Mile	# of Pools w/ Residual Depth>1'	Pools w/ Residual Depth >1"/Mile	# of Pools w/ Max. Depth >3'	# of Pools w/ Max. Depth >3'/Mile
3	157	40.8	4.9	1.4	0.4	0.95	46.2	54	15.9	0	0
Properly Functioning Indicators	-	-	-	-	-	≤1'	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
3	53.0	26.4	13.3	7.3	0.0	100	

Orange = dominant substrate
Red = not properly functioning

LWD was excluded from the analysis since this is a meadow reach.

Reach 3 was **not properly functioning** for stream bank condition with 42.6% unstable banks throughout the entire reach. A properly functioning reach must have <10% unstable banks (see Table 25).

The bankfull width-to-depth ratio for Reach 3 being 18:1, which is within 12-30:1, is considered **properly functioning** for a "C" Channel (see Table 25).

Table 25. Habitat Characteristics for the Reach 3.

Reach	Pool:Riffle Ratio	Bankfull Width: Depth	Pieces of LWD per Mile	Total Unstable Banks	Percentage of Unstable Banks
3	1:1	18:1	0.9	15,366.3	42.6
Properly Functioning Indicators	-	12-30:1	>30[1]	-	<10

Red = Not Properly Functioning
[1]LWD/Mile criteria are not applicable in meadow reaches

Recommendations

Reach 3 is a candidate for restoration. The heavy grazing pressure in the floodplain has degraded the riparian areas, as well as the stream itself. The cattle trampling (see Photo 24) has caused soil compaction, which prevents riparian vegetation from re-establishing in these areas as well as stream widening. The riparian pastures along this section of Rito Peñas Negras should be rested to allow riparian species to revegetate the raw exposed banks and provide stability.

Photo 24. Reach 3. NSO 894, R445. Cow Trial crossing contributing to abundant fines in substrate (24-Oct-05).

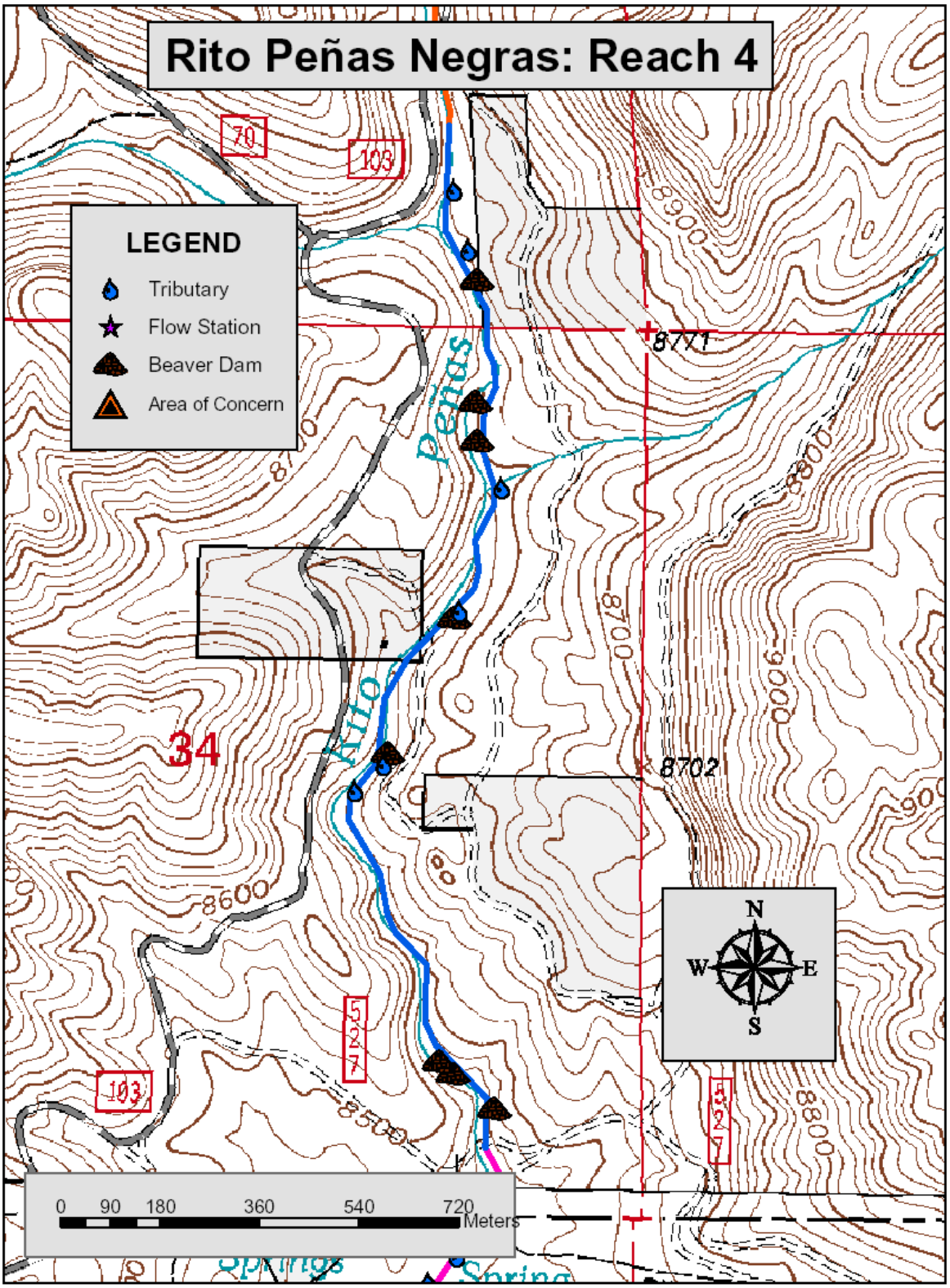


Figure 14. Reach 4 tributaries, beaver dams, areas of concern and the flow station.

Reach 4: Culvert at FR 527 to Valley Opening

Reach 4 begins where the stream enters a very confined canyon, after crossing under FR 527. The survey of this reach began on October 24, 2005 and continued through October 25, 2005. This reach starts at 8,440' (T19N, R2E, Sec. 9) and continues 1.5 miles to 8,660' above sea level (T21N, R2E, Sec. 27). The average gradient for this reach is 2.7%. The Rosgen channel type for this reach is B5. The stream substrate is dominated by sand.

Photo 25. Reach 4. NSO 976, C1. Culvert under FR 527 crossing (24-Oct05).

Four blown out beaver dams as well as one vacant beaver den were recorded in Reach 4. Also, two (2) active beaver dams were observed during the survey (see Photo 26), both had signs of fresh beaver chew and were creating pools upstream. One beaver dam has caused a pool large enough to span the valley floor (approximately 30 feet).

Photo 26. Reach 4, NSO 991 P490. Active beaver dam forming 30 foot pool with 5 foot drop (25-Oct-05).

The riparian community for Reach 4 consisted of some willow, alder, spruce, and pine. Much of the reach was located in a very confined valley that allowed for the forest vegetation to encroach on the riparian area.

Water temperatures were measured at the start and end of each day, as well as, at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column in main channel habitats during the survey (grab samples). The 7 water temperature samples ranged between 37 and 47°F. Average grab sample temperature was 42.1^{o}F.

Habitat Characteristics

During the habitat survey conducted on Reach 4, the river was broken up into a total of 150 NSOs, measuring 8,128 feet in length. Of the 1.5 miles, approximately 30.3% were pools and 67.2% were riffles. Side channels make up a very small part, 1.5%, of the stream habitat (see Table 26).

Table 26. Overall Stream Summary for Reach 4.

Reach 4					
Stream Length Surveyed:		**8,128 feet**	1.5 miles		
Gradient:	2.7		**Rosgen Channel Type:**		B5
Habitat Type	**Total Number**	**Total Feet of Stream Habitat**	**% Stream Length**	**% Stream Habitat**	**Properly Functioning Indicators**
Pool	70	2,500	30.8	30.3	>30%
Riffle	70	5,539	68.1	67.2	-
Culvert	1	89	1.1	1.1	-
Tributary	6	-	-	-	-
Falls	0	0	0	0	-
Side Channel	3	120	-	1.5	-
Total	150	8,248	100	100	-

When compared to the matrix of factors and indicators of stream health condition for historic and occupied RGCT streams, Reach 4 is **not properly functioning** for bank stability, large wood and bankfull.

Riffles in Reach 4 are **properly functioning** for average sediment amounts, with 19.0% fines (sand, silt, and clay), which does not exceed the <20% criteria. The riffles are dominated by gravel (see Table 27).

Table 27. Summary of Habitat and Substrate Percentages for Riffles in Reach 4.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max. Depth	
4	70	79.1	5.4	0.4	0.7	

Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
4	19.0	30.4	28.9	21.7	0.0	100
Properly Functioning Indicators	<20	-	-	-	-	-

Orange = dominant substrate

Reach 4 was **properly functioning** for pool quality, with an average residual pool depth of 1.1', which exceeds the minimum of >1' for a properly functioning stream. Overall the average pool was of adequate quality, and the amount of pool habitat in Reach 4 was above acceptable level. The dominant substrate in pools was sand, making up 44.0% of the substrate (see Table 28). The amount of sediment in this reach can be attributed to the high percentage of unstable bank (see Photo 27). Although, only 33% of the pools recorded exceeded 1.0 residual depth, with three (3) pools with max depth greater than 3 feet, indicating that pools are filling in with sediment.

Table 28. Summary of Habitat and Substrate Percentages for Pools in Reach 4.

Pool Habitat Summary											
Reach	# of Pools	Avg. Length	Avg. Width	Avg. Max. Depth	Avg. PTC	Avg. Residual Depth	Pools/ Mile	# of Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1"/Mile	# of Pools w/ Max. Depth >3'	# of Pools w/ Max. Depth >3'/Mile
4	70	35.7	6.1	1.4	0.3	1.1	46.7	23	15.3	3	2
Properly Functioning Indicators	-	-	-	-	-	<1'	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
4	44.0	29.1	14	13.1	0.0	100	

Orange = dominant substrate

Photo 27. Reach 4. NSO 1007, P498. Typical Pool in Rito Penas Negras (25-Oct-05).

Reach 4 is the only reach on the Rito Peñas Negras that is not a meadow reach, therefore it is the only reach where LWD could be analyzed. This reach was **not properly functioning** with 19.3 pieces of LWD per mile (see Table 29).

LWD aids in creating pool habitat through the natural scouring action of the stream flow. The lack of LWD in the reach can be attributed to removal of LWD from fish bearing streams. It was a common practice, several decades ago, to remove LWD from streams. Logjams were seen as barriers to fish passage. A report made by the Santa Fe National Forest Fisheries Biologist recommends removing logjams, as they created a barrier to fish movement (FS Files). However, LWD does not hinder fish movements. In fact LWD is an essential part of pool formation, and is critical in providing fish habitat. Historic fire suppression practices may be a reason for the lack of LWD in this reach. Fire ecology is an important part of the landscape in New Mexico. Large fires would remove the under story, and open up the canopy for ponderosa pine, the dominant species in this reach. Fires assist in natural LWD recruitment for streams in this region. The dying trees would eventually fall into the stream channel. The stream would then move the LWD during floods, settling in stream margins or in the channel, creating pool and side channel habitat. The lack of major fires over the last century has greatly diminished the amount of LWD in New Mexico streams.

Reach 4 is **not properly functioning** for streambank condition at 35.7%, which exceeds the <10% standard (see Table 29).

The bankfull width-to-depth ratio for Reach 4 was 11.:1 and does not exceed the >12:1 standard; thus, it is considered **not properly functioning** for a "B" channel (see Table 29). Although this may be within the natural range of variability.

Table 29. Habitat Characteristics for the Reach 4.

Reach	Pool:Riffle Ratio	Bankfull Width: Depth	Pieces of LWD per Mile	Total Unstable Banks	Percentage of Unstable Banks
4	1:1	11:1	19.3	5,805.4	35.7
Properly Functioning Indicators	-	>12:1	>30	-	<10

Red = Not Properly Functioning

Recommendations

Reach 4 is a candidate for restoration. The heavy grazing pressure in the floodplain has degraded the riparian areas, as well as the stream itself. The cattle trampling has caused soil compaction, which prevents riparian vegetation from re-establishing in these areas as well as stream widening. The riparian pastures along this section of Rito Peñas Negras should be rested to allow riparian species to revegetate the raw exposed banks and provide stability.

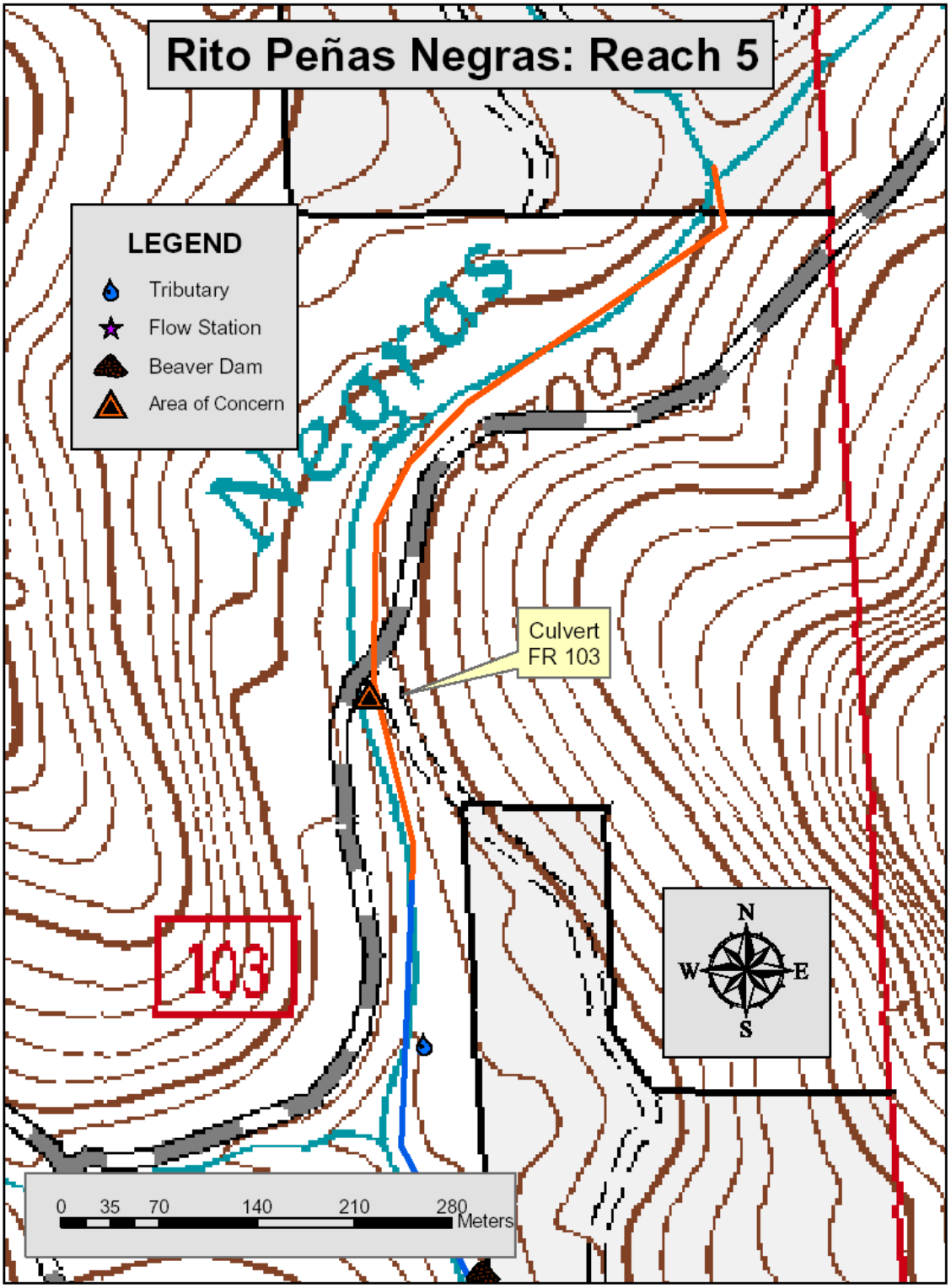


Figure 15. Reach 5 tributaries, beaver dams, areas of concern and the flow station.

Reach 5: Valley Opening to Confluence of Rito Peñas Negras and Rito Café

The survey of Reach 5 was done on October 26, 2005. This reach starts at 8,660 above sea level (T21N, R2E, Sec. 27) and continues 0.7 miles to 8,700' above sea level (T21N, R2E, Sec. 27). Reach 5 has a moderately low gradient (1.1%) and a very high sinuosity (1.51). The Rosgen channel type for this reach is E4. The stream substrate was dominated by gravel.

Only one blown out beaver dam was observed in Reach 5. There were no other signs of past or present beaver activity.

The riparian area for Reach 5 consists mainly of various grasses. There were limited numbers of willow, but lots of alder. The very last two pine trees in the riparian area were on the left bank at the break between Reaches 4 and 5 (see Photo 28).

Water temperatures were measured at the start and end of each day, as well as, at random intervals during the survey using a handheld alcohol thermometer. Main channel temperature readings were taken in the water column in main channel habitats during the survey (grab samples). The four water temperature samples ranged between 37 and 53°F. Average grab sample temperature was 42.1^{o}F.

Photo 28. Reach 5, NSO 1,126 P554. Last two pine trees on left bank before transition into meadow with thick alder (26-Oct-05).

Habitat Characteristics

During the habitat survey conducted on Reach 5, the river was broken up into a total of 67 NSOs, measuring 3,461 ft in length. Of the 0.7 miles, 48.6% is pool habitat, and 50.0% is riffle habitat. Side channels make up a very small part, approximately 1.4%, of the stream habitat. There was one culvert recorded in this reach (see Photo 29).

Photo 29. Reach 5. NSO 1,146, C2. Culvert at FR117 crossing (26-OCT-05).

When compared to the matrix of factors and indicators of stream health condition for historic and occupied RGCT streams, Reach 5 is **not properly functioning** for all indicators of habitat characteristics and channel condition except pool development and bankfull. The amount of LWD was omitted from analysis as this is a meadow reach.

Table 30. Overall Stream Summary for Reach 5.

Reach 5					
Stream Length Surveyed:		**3,461**	0.7 miles		
Gradient:	1.10%		**Rosgen Channel Type:**		E4
Habitat Type	**Total Number**	**Total Feet of Stream Habitat**	**% Stream Length**	**% Stream Habitat**	**Properly Functioning Indicators**
Pool	32	1,683	48.6	47.9	>30%
Riffle	32	1,732	50.0	49.3	-
Culvert	1	46	1.3	1.3	-
Tributary	0	-	-	-	-
Falls	0	0	0	0	-
Side Channel	2	50	-	1.4	-
Total	67	3,511	100	100	-

Riffles in Reach 5 are **not properly functioning** for average sediment amounts, with 23.1% fines (sand, silt, and clay), which exceeds the <20% criteria (see Table 31). The riffles are dominated by gravel. Reach 5 is a low gradient reach, and because of the low velocity of the stream flow, this reach is conducive for the settlement of fine substrates. Sand is typically collected in reaches with a gradient as low as the gradient found in Reach 5.

Much of the sediment input becomes excessive due to the large areas of unstable bank. Most of the bank instability is directly related to trampling from cattle. Reach 5 had 7 cow trail crossings, as well as cow trails that parallel both banks.

Table 31. Summary of Habitat and Substrate Percentages for Riffles in Reach 5.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max. Depth	
5	32	54.1	4.0	0.5	0.8	

Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
5	23.1	50.6	15.9	10.3	0.0	100
Properly Functioning Indicators	<20	-	-	-	-	-

Orange = dominant substrate
Red = not properly functioning

Reach 5 was **not properly functioning** for pool quality, with an average residual pool depth of 0.9', which does not exceed the minimum of ≥1' for a properly functioning stream. Overall the average pool was not of adequate quality, although the amount of pool habitat in Reach 5 was above acceptable level. The dominant substrate in pools was sand, making up 52.8% of the substrate (see Table 32). Due to this observation, it can be determined that the pools within this reach have begun to fill in with fines. These fines are being transported from an upstream source and localized areas within Reach 5.

Reach 5 was **properly functioning** for pool formation, with 47.9% pool habitat, which is above the necessary level of ≥30% pool habitat for a properly functioning stream. Although, only 16% of the pools recorded exceeded 1.0 residual depth, with no pools with max depth greater than 3 feet, indicating that pools are filling in with sediment.

Table 32. Summary of Habitat and Substrate Percentages for Pools in Reach 5.

Pool Habitat Summary											
Reach	# of Pools	Avg. Length	Avg. Width	Avg. Max. Depth	Avg. PTC	Avg. Residual Depth	Pools/Mile	# of Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1"/Mile	# of Pools w/ Max. Depth >3'	# of Pools w/ Max. Depth >3'/Mile
5	32	52.5	4.6	1.2	0.4	0.9	45.7	5	7.1	0	0
Properly Functioning Indicators	-	-	-	-	-	≥1'	-	-	-	-	-

Substrate Summary								
	Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
	5	52.8	36.3	7.2	3.8	0.0	100	

Orange = dominant substrate
Red = not properly functioning

LWD was excluded from the analysis since this was a meadow reach.

Rito Peñas Negras was **not properly functioning** for stream bank condition with 25.9% unstable banks throughout the entire reach. A properly functioning reach must have <10% unstable banks (see Table 33).

The bankfull width-to-depth ratio for Reach 5 is 4:1, which is less than 12, and is considered **properly functioning** for an "E" Channel (see Table 33).

Table 33. Habitat Characteristics for the Reach 5.

Reach	Pool:Riffle Ratio	Bankfull Width: Depth	Pieces of LWD per Mile	Total Unstable Banks	Percentage of Unstable Banks
5	1:1	4:1	0.0	1,790.3	25.9
Properly Functioning Indicators	-	<12	>30[1]	-	<10

Red = Not Properly Functioning
[1]LWD/Mile criteria are not applicable in meadow reaches.

Photo 30. Reach 5. NSO 1191, R585. Rito Peñas Negras and Rito Café confluence (looking upstream, 26-OCT-05).

Recommendations

Reach 5 is a candidate for restoration. The heavy grazing pressure in the floodplain has degraded the riparian areas, as well as the stream itself. The cattle trampling has caused soil compaction, which prevents riparian vegetation from re-establishing in these areas as well as stream widening. The riparian pastures along this section of Rito Peñas Negras should be rested to allow riparian species to revegetate the raw exposed banks and provide stability.

APPENDIX A:

Supporting Information

Table 1. 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 2. 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:
Reach Summaries from 1993 Rito Peñas Negras Survey

In June of 1993, a Hankin & Reeves BVET survey was conducted in Peñas Negras. The stream was divided into two reaches using the Rosgen Stream Type Classification System. Gradient and substrate were the primary criteria used in determining these breaks. This survey was was supplemented with two fish population estimates (see SALMONID POPULATION ESTIMATES and SALMONID DISTRIBUTION). In addition to the work completed in 1993, four General Aquatic Wildlife Survey stations, complete with accompanying fish population estimates, were done in 1989 (see appropriate entries under GAWS in this document). The 1993 Hankin & Reeves BVET survey included a total of 34,883 feet (6.6 miles) of stream, starting just above private land in the northeast ¼ of Section 13 and ending at Forest Road 103 crossing.

Reach 1 (equivalent to Reaches 1, 2 and 3 in 2005)

Reach 1 of Rito Peñas Negras is a classic example of a Rosgen "C" stream type (Type "C5" or "C6", see figure 2). This reach begins as the Forest Boundary, just above private land, in Section 13 and ends at Forest Road 527 crossing in section 3(see figure 1). The approximate length of this reach is 34,883 feet. Sinuosity is very high as the stream meanders through the large dry meadow (this meadow is wet in some area of sections 9 and 3) which dominates this reach. One sinuosity value of 3.2 was recorded (this value represents the lateral distance feet for every 1 foot of linear distance traveled). Riparian vegetation is made up predominantly of grasses with some forbs represented. Few if any woody species such as willow or alder were recorded. Valley bottom width varies between 150-350 feet but is both narrower and wider in a few areas. Upland communities are made up of Ponderosa Pine, Gamble Oak, spruce, and some aspen. Riparian area width averages approximately 12 feet. Average water width is approximately 6.8 feet, while the average maximum depth is 1.8 feet. Flow was estimated to be 7.5 cubic feet per second. Water was turbid with or without the influence of thunderstorm events. Substrate is composed of what one would expect to find in a low gradient meandering channel, sand and gravel.

The stream channel in Reach 1 is very incised. These conditions appear most severe in sections 7, 8, and 9, where the channel is incised up to ten feet. The down cutting and resulting incisement of this stream leaves doubt as to whether the floodplain is at all functional (There is little difference between active channel width and water width). The surrounding dry meadow does not appear to be wetted every two years (or so) as one would expect under undisturbed conditions. There is an electrical exclosure in place in the northeast ¼ of section 9 (see figure 1). Conditions within the exclosure are more stable than those observed outside but, much natural healing must occur before this system regains an acceptable degree of functionality. When this survey was conducted, one cow was observed inside the exclosure, where the electric fence is only single stranded as it crosses the stream. Much evidence of past beaver activity is present in Reach 1. Beaver chews and old dams can be seen throughout the reach. Many dams and ponds have long since filled in with fine sediments, making it difficult to distinguish them from a natural river terrace. Their origin is revealed by the tell-tale chewing on logs seen protruding from the ground and in those areas where the stream has cut into banks and uncovered other

woody materials. Other than this woody material, which is associated with beaver activity, very little habitat enhancing woody materials are present.

Reach 2 (equivalent to Reaches 4 and 5 in 2005)

Reach 2 includes the area between Forest Road 527 crossing in section 3 and Forest Road 103 crossing in section 27 (see Figure 1). This section is made up predominately of a "B3" Rosgen Stream Type (see Figure 3). Gradient is moderate and substrate is composed of a cobble bed with gravel, some sand and small boulders. The total length of this reach is approximately 10,675 feet. After crossing Road 527 (and the upper end of Reach 1) woody species begin to make their presence. Alder is plentiful within the first 100 feet above Forest Road527 crossing. The vegetative community type for this reach is Alnus tenuifolia. Riparian width averages approximately 35 feet. In contrast to reach 1, this reach is in good condition. Vegetation appears to be in vigorous condition, stream banks are stable and the floodplain appears functional. The pool to riffle ration was approximately 1:2, water with averaged 6.78 feet, and the average maximum depth is 1.51 feet. Total effective fish cover was 56.5%. The two most common cover types were substrates and undercut stream banks. Woody material also contributes toward fish cover but not to the extent that the others do.

Appendix C: Tributaries

Reach Number	NSO Number	Habitat Number	Bank	Type	Name	% Flow	Date	Time	Trib Temp	Stream Temp	Comments
2	645	T1	Left	Spring		1	10-Oct-05	1330	43	44	
3	842	T2	Left	Spring		5	12-Oct-05	910	38	38	
3	887	T3	Left	Spring		<5	24-Oct-05	1200	52	41	
3	890	T4	Right	Spring		<5	24-Oct-05	1200	43	41	
3	955	T5	Left	Spring		<5	24-Oct-05	1500	51	47	
3	962	T6	Left	Seep		<1	24-Oct-05				Too shallow to get temp.
3	965	T7	Left	Spring		1	24-Oct-05	1520	49	45	
4	1019	T8	Right	Seep		<1	25-Oct-05				Too shallow to get temp.
4	1025	T9	Right	Spring		<1	25-Oct-05	1135	45	37	
4	1047	T10	Right	Seep		<1	25-Oct-05				Too shallow to get temp.
4	1066	T11	Right	Seep		<1	25-Oct-05	1410			Too shallow to get temp.
4	1105	T12	Right	Spring		1	25-Oct-05	1555	56	47	
4	1118	T13	Right	Spring		1	25-Oct-05				Too shallow to get temp.

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: Streambank 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.

LITERATURE CITED

Behnke, R. 1982. Personal Correspondence to Robert Patterson on file in SFNF Fisheries File. Associate Professor of Fishery Biology.

Belovsky, G. E. 1984. Summer diet optimization by beaver. Amer. Mid. Nat. 111:209.

Brodie, J. 1996. Bureau of Land Management. Environmental Education Homepage. www.blm.gov/education/riparian/define.html

Clements, C. 1991. Beavers and riparian ecosystems. Rangelands 13:277.

Dickerson, B. R., and G. L. Vinyard. 1999. Effects of chronic temperatures and diel temperatures on the survival and growth of Lahontan cutthroat trout. Transactions of the American Fisheries Society 128:516-521.

Dunham, J. 1999. Stream temperature criteria for Oregon's Lahontan cutthroat trout *Oncorhynchus clarki henshawi*. Department of Biology and Biological Resources Research Center University of Nevada.

Fausch, K. D., and T. G. Northcote. 1992. Large woody debris and salmonid habitat in a small coastal British Columbia stream. Canadian Journal of Fisheries and Aquatic Sciences 49: 682-693.

Fenneman, Nevi M. 1931. Physiography of Western United States. Maple Press. New York.

Ferrell, S. 2002. "Rio Grande Cutthroat Trout Candidate Status Review – Response Paper." USDA, Forest Service; Santa Fe National Forest.

Fry, E. 2003. Email communication on file in the SFNF Fisheries Files. Area Fisheries Manager, New Mexico Department of Game and Fish.

Furniss, M. J., T.D. Foelofs, and C.S. Yee. 1991. Road construction and maintenance. In: Meehan W. R. (ed.). Influences of Forest and Rangeland Management on salmonid fishes and their habitats. Special Publication 19. Bethesda, MD: American Fisheries Society: 297-323.

Gard, R. 1961. Effects of beaver on trout in Sagenhen Creek, California. J. Wildl. Manage. 25:221.

Grayson, R.B., S.B. Haydon, M.D.A. Jayasuriya, and B.L. Finlayson. 1993. Water quality in mountain ash forests; separating the impacts of roads from those logging operations. Journal of Hydrology 150:459-480.

Hill, David V. 1990. The Pinabetal/Pinabetosa Cultural Resource Survey in Jarosa Drainage. Ms on file, USDA Forest Service, Southwest Region, Albuquerque, New Mexico (SFNF Report No. 1988-10-108B).

Hopkins, Scott. 1998. Special Water Quality Survey of the Jemez River and Tributaries. Surface Water Quality Bureau New Mexico Environment Department. Santa Fe, New Mexico.

Huey, W. 1956. New Mexico beaver management. Bul. No. 4, N.M. Dept. Game and Fish, Santa Fe, New Mexico.

Irwin-Williams, Cynthia. 1973. The Oshara Tradition: Origins of Ancestral Puebloan Culture. Eastern New Mexico University Contributions in Anthropology, Vol. 5, No. 1. Eastern New Mexico University, Portales.

Irwin-Williams, Cynthia. 1979. Post-Pleistocene Archaeology, 7000-2000 B.C. In Handbook of North American Indians, Volume 9, Southwest. Edited by A. Ortiz, Smithsonian Institution, Washington, D.C.

Jester, D., and H. McKirdy. Evaluation of trout stream improvement in New Mexico. N. M. State University and U.S. Forest Service (No Date).

Julyan, Robert H. 1995. The Place Names of New Mexico. The University of New Mexico Press, Albuquerque.

Kessel, John L. 1987. Kiva, Cross and Crown: The Pecos Indians and New Mexico 1540 – 1840. University of New Mexico Press, Albuquerque.

Knowlton, Clark S. 1970. Violence in New Mexico: A Sociological Perspective. California Law Review. vol. 58, no. 4.

Olson, R., and H. Wayne. 1994. Beaver: Water resources and riparian habitat manager. University of Wyoming, Laramie, Wyoming.

Parker, M., F. J. Wood, B. H. Smith, and R. G. Elder. 1985. Erosional down cutting in lower order riparian ecosystems: Have historical changes been caused by the removal of beaver? Pgs. 35-38, In: Riparian Ecosystems and Their Management: Reconciling Conflicting uses. North American Riparian Conference, Gen. Tech. Rep., USDA Forest Service, April 16-18, University of Arizona, Tucson.

Propst, D. L., and M. McInnis. 1975. An analysis of stream containing native Rio Grande cutthroat trout, *Salmo clarki virginalis*, on the Santa Fe National Forest.

Rosgen, D., and L Silvey. 1998. Field guide for stream classification. Wildland Hydrology. Pagosa Springs, CO.

Scurlock, Dan. 1981. Ethnohistoric Investigations. In High Altitude Adaptations along Redondo Creek: The Baca Geothermal Project, edited by C. Baker and J. Winter, pp 129 - 160. Office of Contract Archaeology, University of New Mexico, Albuquerque

Smith, C. E., W. P. Dwyer, and R.G. Piper. 1983. Effect of water temperature on egg quality of cutthroat trout. Progressive Fish Culturist 45:176-178.

Stuart, David E., and Rory P. Gauthier. 1981. Prehistoric New Mexico: Background for Survey. New Mexico State Historic Preservation Division, Santa Fe.

Sublette, J., M. Hatch, M. Sublette. 1990. The Fishes of New Mexico. The New Mexico Department of Game and Fish: 62-65, 68-70.

USDA Forest Service Documents:

1993. Cañones Creek Stream Inventory. Jemez Springs, NM.

1993. Summary of Genetic Testing Results on Selected Populations of Rio Grande cutthroat trout in New Mexico. Jemez Springs, NM.

2000. History of Sampling for Whirling Disease in New Mexico Waters. Jemez Springs, NM.

2000. Santa Fe National Forest TES Species List. Santa Fe, NM.

2002. Rio Grande cutthroat trout status review for US Fish and Wildlife Service.

2002. Stream Inventory Handbook Level I and II. Region 3 Version 2.0. Santa Fe National Forest Fisheries Files. Santa Fe National Forest. Jemez Springs, NM.

2002. Conservation agreement for the Rio Grande cutthroat trout between and among New Mexico Department of Game and Fish, USDA Forest Service and USDI Fish and Wildlife Service. Southwest Regional Office.

2003. Environmental Assessment. Peñas Negras, Ojito Frio, Palomas, and Vacas Range Allotment Analysis.

USDI Fish and Wildlife Service. 2002. Candidate Status Review for Rio Grande Cutthroat Trout. Federal Register, 50 CFR Part 17. Vol. 67, No. 112: 39936-39947. June 11, 2002.

2004. Pollywog, Chiquito, Llaves, Ojitos, and Gurule Range Allotment Permit Re-issuances Cultural Resource Report. Cuba Ranger District.

Acknowledgements

The Santa Fe National Forest Fisheries Program would like to deeply thank the following people and organizations for their support and assistance. David Allen from the Cuba Ranger District for providing us camping. Richard Montoya from the Cuba Ranger for information regarding dispersed camping, fire and private land. Scott Hopkins from the New Mexico Environmental Department for all the information on water quality. Sean Ferrell for his invaluable guidance. Erica Nevins for her GIS expertise. Jennifer Boyd for her timely archaeology contribution. We would also like to thank all the private landowners for allowing us to survey through their property. Last, we would especially like to thank the New Mexico Habitat Stamp Program for funding this project.