

STREAM HABITAT SURVEY REPORT: RITO DE LOS INDIOS JUNE 7-JUNE 25, 2007



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INTRODUCTION

Rito de los Indios 2007 Stream Survey

The Rito de los Indios begins as a series of springs in the Jemez Mountains in the northeast corner of the Valles Caldera National Preserve at 9,200 feet. Over 4 miles downstream and after dropping over 600 feet in elevation, the Rito de los Indios flows into San Antonio Creek. The Rito de los Indios flows through largely meadow habitat with isolated forested habitat entirely within the Valles Caldera National Preserve. The Santa Fe National Forest Fisheries program, in conjunction with the Valles Caldera National Preserve conducted a stream survey of the Rito de los Indios from June 7 to June 25, 2007. A total of 5.1 miles of stream was either formally surveyed or informally walked, from the mouth to the headwaters.



Photo 1: A view of the Rito de los Indios Valley, looking downstream toward San Antonio Creek (7-June-2007).

The USDA Forest Service Region 3 stream survey protocol is a modified version of the Hankins/Reeves survey used in the Pacific Northwest Region. Under this protocol, streams are surveyed from the mouth upstream and the river is separated into riffle, pool, side channel, dry channel, culvert, and falls habitat types by specific attributes (USDA FS 2002b). Different habitat types require specific measurements relevant to evaluating the habitat (Appendix A,

Table 1). In addition to the habitats located in the primary stream, tributary mouths are also surveyed and classified as a seep, spring, or stream (Appendix B). All habitat types are assigned a Natural Sequence Order number (NSO) in the order that they are surveyed. The stream, as a collection of NSOs, is further organized by homogeneous sections and grouped into a sequence of reaches. Each reach is assigned a number in the order that it is surveyed and analyzed separately, as well as together for a holistic overview of the system.

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

Electroshocking surveys are another aspect of this stream inventory and are used to further understand fish populations. Electroshocking surveys evaluate fish species presence/absence, distribution within the system, relative composition, and size class analysis in selected areas of the stream. Three pass depletion surveys were used in this inventory. Protocol includes isolating individual reaches of the stream with block seines, and making at least three passes to ensure that a representative sample of fish present are collected. In this survey, reach length ranged from 150-200 ft.



Photo 2: A roughly 15 inch Brown trout captured in the Rito de los Indios (7-July-2007).

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

FACTORS	INDICATORS	Properly Functioning	At Risk	Not Properly Functioning
Water Quality	<i>Temperature – State of New Mexico Standards</i>	<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)
	<i>Temperature – Salmonid Development</i>	≤17.8°C (64°F) (7 day avg. max)	>17.8° (64°F) < 21.1° (70°F) (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 Debris¹	>30 pieces per mile, >12" diameter, > 35 feet (or twice bankfull width) in length	20-30 pieces per mile, >12" diameter, > 35 feet (or twice bankfull width) in length	<20 pieces per mile, >12" diameter, > 35 feet (or twice bankfull width) in length
	Pool Development²	≥30% pool habitat by area ³		<30% pool habitat by area ³
	Pool Quality	Average residual pool depth ≥1 foot		Average residual pool depth <1 foot
Channel Condition and Dynamics	Width/Depth Ratios by Channel Type <i>(utilize Rosgen type⁴ and range given if applicable)</i>	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 Type⁴ A, E, G B, C, F D	W/D Ratio <12 12-30 >40
	Stream Bank Condition⁵	<10% unstable banks (lineal stream bank distance)	10-20% unstable banks (lineal stream bank distance)	>20% unstable banks (lineal stream bank distance)

¹ Large Woody Debris numeric are not applicable in meadow reaches. For this survey a meadow reach can be defined as an area where there is no natural local recruitment of LWD.

² Pool Development numeric are applicable to 3rd order or larger streams.

³ Area is defined by habitat length.

⁴ Rosgen stream typing is used throughout this document to determine stream channel type, condition, and dynamics (Rosgen and Silvey 1998).

⁵ Stream Bank Condition numeric are not applicable in reaches with > 4% gradient.

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

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

condition of a stream. Survey data produces a “snapshot” in time of the stream’s habitat condition and the factors affecting it (see Photo 3). Survey information can be used to identify both degraded sections as well as ideal areas to be used as a reference or model for other similar sections of stream. By combining the historical and current information pertaining to a stream, management options can be more clearly identified, which is the goal of this document.



Photo 3: Reach 2, NSO 329 R158, Surveyors note unstable road VC13 ford (18-June-2007).

BASIN SUMMARY

Table 2. Stream Summary Table for the Rito de los Indios.

Table 2. Stream Summary Table for the Rito de los Indios.			
LOCATION:			
County:	Sandoval		
Management Unit:	Valles Caldera National Preserve		
Drainage:	Rito de los Indios		
Tributary to:	San Antonio Creek		
Survey Began at:	(LEGAL AND ELEVATION)		
WATERSHED:			
5 th HUC Code ¹ :	1302020202		
Rito de los Indios Watershed Area:	4220.01 acres	or	6.57 sq. miles
Stream Order:	2		
Stream Length:	22097 feet	or	4.18 miles
AQUATIC BIOTA:			
Fish Species:	Brown Trout (<i>Salmo Truta</i>) and Rio Grande Chub (<i>Gila Pandora</i>)		

¹Hydrologic Unit Code used to identify watersheds.

EXECUTIVE SUMMARY

The Rito de los Indios is a 2nd order stream originating from springs draining the south side of the Jemez Mountains just south of the Valles Caldera National Preserves northern boundary. The Rito de los Indios travels just over 4 miles from the headwaters to the confluence with San Antonio Creek. The formal stream survey covered 4.18 miles, beginning at the confluence with San Antonio Creek. The Rito de los Indios Watershed encompasses 6.5 square miles, owned by both the Forest Service and Valles Caldera National Preserve, and is drained by a series of springs and seeps.

The Rito de los Indios is divided into 4 reaches, each containing relatively homogeneous habitat characteristics. Reach divisions are based on stream and valley morphology, dramatic changes in stream flow, impoundments (i.e. reservoirs), or land ownership boundaries. Reaches are numbered sequentially as the survey progresses upstream (see Table 3).

The average gradient of the Rito de los Indios is 3.3%, or 176.4 feet of elevation gain per mile of stream.

Table 3. Description and length of reaches on the Rito de los Indios.

Reach	River Miles	Landmark at Beginning and End	Land Owner
1	0.0 to 2.1	Confluence with San Antonio Creek to Second Pasture Fence	Valles Caldera National Preserve
2	2.1 to 3.5	Second Pasture Fence to flow regime change at T18 and T19.	Valles Caldera National Preserve
3	3.5 to 4.2	Flow regime change to end of flow	Valles Caldera National Preserve
4	4.2 to 5.1	End of flow to VCNP/Forest Service Boundary.	Valles Caldera National Preserve

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

The 2007 stream survey data analysis was accompanied by temperature analysis at 1 thermograph, or temperature recording, sites. The thermograph was deployed by the surveyors at the beginning of the summer and retrieved in late summer of 2007. The stream temperatures were analyzed and classified by both Forest Service and NMED Standards. The Forest Service and NMED temperature standards classify coldwater fisheries habitat as properly functioning, at risk, or not properly functioning. Water temperatures are classified as **properly functioning** at the monitoring site by both Forest Service and NMED standards

Stream habitat conditions generally noted a slight lack of pool habitat with increased fine deposition in riffle habitat. This could be a limiting factor to overall stream productivity and could be further complicated by the lack of large wood structure in the stream. Unstable banks measured just less than 1.0 miles in length, with the heaviest unnatural concentrations of instability in Reaches 1 and 2. This may have influenced an increase in width-to-depth ratios, further limiting the stream from developing adequate pool habitat. Pool quality was generally low, a lack of structure in the stream results in weak pool tail crests and low residual depths. Similarly many of the riffles could actually been classified as run habitat with



Photo 4: Reach 3, NSO 419, R204, large meadow sink that is the main source of flow for Jaramillo Creek.

Habitat Characteristics

The 4.18 surveyed miles (22,097 feet) of the Rito de los Indios is divided into 421 Natural Sequence Order Habitat Units (NSOs). The 184 pool habitats comprise 19.9% of the stream habitat length. There are 205 NSOs that are riffle habitat, which comprises the majority of habitat (79.3%) in the Rito de los Indios (see Table 4). Other habitat types in the Rito de los Indios are tributaries, falls, side channels, and dry channels. Tributaries are not considered stream habitat and are excluded from length and habitat analyses.

Table 4. Stream summary information for the Rito de los Indios Survey, 2007.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
<i>Pool</i>	184	4,392	19.9	19.9	≥30%
<i>Riffle</i>	205	17,533	79.6	79.3	-
<i>Culvert</i>	3	76	0.3	0.3	-
<i>Tributary</i>	26	0	N/A	N/A	-
<i>Falls</i>	1	18	0.1	0.1	-
<i>Side Channel</i>	2	78	N/A	0.4	-
<i>Dry Channel</i>	0	0	0.0	0.0	-
Total	421	22,097	100.0	100.0	-

Red – Not Properly Functioning

*Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.

**Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied Rio Grande cutthroat trout streams, the Rito de los Indios contains not properly functioning, at risk and properly functioning characteristics (see Table 5). The parameters that are **not properly functioning** include riffle sediment content, pool development, and pool quality. Stream bank condition, a consideration of bank instability, is **at risk**. Temperature is considered **properly functioning** for both water quality and salmonid development purposes. Large woody debris (LWD) is not classified because all reaches of the Rito de los Indios are considered meadow reaches and do not have a natural recruitment source for LWD

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

Factors	Indicators	Rito de los Indios Conditions
<i>Water Quality</i>	Temperature (3-Day Average)	Properly Functioning
<i>Salmonid Development</i>	Temperature (7-Day Average)	Properly Functioning
<i>Habitat Characteristics</i>	Riffle Sediment	Not Properly Functioning
	Large Woody Debris	N/A
	Pool Development	Not Properly Functioning
	Pool Quality	Not Properly Functioning
<i>Channel Condition and Dynamics</i>	Stream Bank Condition	At Risk
	Width-to-Depth Ratio	

Red= Not Properly Functioning

Yellow = At Risk

Riffle habitat in the Rito de los Indios is the dominant habitat, comprising 79.3% of all stream habitat types. The high relative quantity of riffle habitat reflects the relative lack of pool habitat. Sediment content in riffle habitat (48.9%) was determined to be **not properly functioning** (see Table 6). Dominant substrate type is sand (48.9%). Management of the Rito de los Indios should include mitigation strategies for sedimentation.

Table 6. Summary of habitat and substrate composition in the Rito de los Indios.

Riffle Habitat Summary						
	# of Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max. Depth	
Entire River	205	85.5	2.6	0.6	0.9	
Substrate Summary						
	Sand (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Total (%)
Entire River	48.9	38.2	11.4	1.5	0	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning Orange – Dominant Substrate



Photo 5: Reach 1, NSO 29, R14, looking downstream at typical riffle habitat

Pool habitat is important over wintering, resting, and foraging habitat for fish. Pool habitat is evaluated by both quality or residual depth and area of pool habitat (by length). Pool quality is **not properly functioning** in the Rito de los Indios with only 26% of the pool habitats with at least 1-foot residual depth. Residual depth is calculated by subtracting the pool tail crest depth from the maximum depth to determine the depth of water that would remain in the habitat if flow ceased. The pools observed in the Rito de los Indios have an average residual depth of 0.8 feet, below the necessary depth to be considered properly functioning (see Table 7). These pools are shallow and at risk of filling. No pools have a maximum depth of 3 feet or more, which further accentuates the lack of quality pool habitat and indicates that existing pools are filling in. The sediment content in pools is high at 56.7%. The relative quantity of pool habitat (26.0%) is also **not properly functioning** (see Table 4).

Table 7. Summary of pool habitat and relative substrate in the Rito de los Indios.

Pool Habitat Summary											
Area	# of pools	Avg. Length	Avg. Width	Avg. Max Depth	Avg. PTC	Avg. Residual	# pools/mile	# of pools w/residual depth > 1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
Entire River	184	23.9	3.1	1.1	0.4	0.8	43.9	48	11.4	0	0
Properly functioning indicator	-	-	-	-	-	≥1ft	-	-	-	-	-
Substrate Summary											
Area	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total					
Entire River	56.7	34.1	8.6	0.5	0	99.9					

Red – Not Properly Functioning

Orange – Dominant Substrate

Large woody debris (LWD) is related to habitat complexity and the health of fish populations in stream habitats (Fausch and Northcote 1992). LWD density, at 7.9 pieces per mile, is **not rated** in the Rito de los Indios (see Table 8). Meadow reaches, or areas with no natural recruitment of LWD, are excluded from the entire stream LWD analysis. The Rito de los Indios is made up entirely of non-meadow reaches. A total of 33 pieces of medium and large wood were present mostly concentrated in a small wooded section of reach 2. Wood classified as medium LWD must be greater than 12 inches in diameter at a length of 35 feet from the large end (or two times bankfull width). Large pieces of LWD have a diameter of greater than 20 inches at a length of 35 feet from the large end (or two times bankfull width). Increasing LWD presence may improve degraded factors in the stream habitat including pool development, sediment distribution, and stream temperature, but is not a viable solution in this case due to lack of natural recruitment.

Bank stability (10.5%) is **at risk** when analyzed by the length of the entire surveyed section of stream, excluding reaches with gradients greater than 4% (see Tables 8 and 9).

When the length of the river is divided into reaches and then analyzed all reaches are **at risk** for bank stability (see Table 9).

Table 8. Selected habitat characteristics of the Rito de los Indios.

Area	Pool:Riffle Ratio	Pieces of LWD per Mile ¹	Total Unstable Banks (ft)	% Unstable Banks ²
Entire River	1:1.1	7.9	13,475	10.5
Properly Functioning Indicators	-	N/A	-	<10

Yellow – At Risk

¹ Large Woody Debris analysis excludes meadow reaches, defined as reaches with no natural local recruitment of LWD.² Stream bank condition analysis excludes reaches with >4% gradient.

Reach by Reach Comparison

The 9 reaches of the Rito de los Indios contain different combinations of properly functioning, at risk, and not properly functioning characteristics. Pool habitat, bankfull width-to-depth ratio and unstable banks are parameters that are outside of properly functioning classification in at least one reach. None of the surveyed reaches are properly functioning in all categories (see Table 9).

Table 9. Reach characteristic summaries for the Rito de los Indios 2007.

Reach	Total Length (mi)	Gradient (%)	Rosgen Channel Type	Pool Habitat (%)	Riffle Habitat (%)	Side Channel Habitat (%)	Dominant Substrate in Pools	Dominant Substrate in Riffles	LWD Per Mile	Bankfull Width to Depth	Unstable Banks (%)
1	2.1	1.8	E5	28.8	70.8	0	Sand	Sand	0	2:1	10.5
2	1.4	5.9	A5	13.8	85.9	1.1	Sand	Sand	18.3	15:1	N/A ¹
3	0.7	4.8	A5	6.2	93.1	0	Sand	Sand	7.1	9:1	N/A ¹
4	Not Formally Surveyed										
Properly Functioning Indicators	-	-	-	≥30	-	-	-	-	N/A	A,E,G: <12 B,C,F: 12-30 D: >40	<10

Red= Not Properly Functioning

Yellow = At Risk

¹ Stream bank condition analysis is excluded in reaches with >4% gradient.

² Bankfull measurements unavailable.

³ Large Woody Debris analysis is excluded in meadow reaches, defined as reaches with no natural local recruitment of LWD.

The length of pool habitat is of concern in every reach of the Rito de los Indios. Even the reach with the largest quantity of pool habitat falls short of the properly functioning indicator. The relative quantity of pool habitat in reaches that are **not properly functioning** in the Rito de los Indios range from 6.2% in Reach 3 to 28.8% in Reach 1 (see Table X).



Photo 6: Reach 1: NSO 47, P28, typical small meander pool with Z. Manickam (6-June-2007).

None of the three reaches analyzed for stream bank condition in the Rito de los Indios is **properly functioning** (see Table 9). Reaches 1 and 3 are close to the properly functioning indicator at 10.5 and 10.8% respectively. Instability in Reach 2 is the highest at 14.2%. Higher bank instability in Reach 2 can likely be attributed to closer proximity to road VC13 and slightly higher gradient. The majority of bank instability throughout the Rito de los Indios appears to be the result of historical grazing impacts. Many small cutbanks are present throughout the stream and small portions are actively contributing sediment to the stream. Most areas of instability appear to be re-vegetating and will likely be stable in the near future. Undercut banks are present throughout much of the stream and in most cases appear stable. Small areas of tension cracks and slumping undercuts are present.

Tributaries

Twenty six (26) tributaries contribute to main channel flow for the surveyed length of the Rito de los Indios. These tributaries flow in the form of streams, springs, and seeps, in Reaches 1-3. Of the 26 tributaries, 5 are considered significant, contributing 10% or more to main channel flow (see Table 10). In this survey, flow contribution is an ocular estimate performed by surveyors

and can be deceptive since it is a relative measurement. There are no named tributaries to the Rito de los Indios.

Table 10. Summary of tributaries contributing 10% or more of the main flow of the Rito de los Indios during the 2004 Stream Inventory.

Location		Bank	Habitat Type	Name	Percent Flow*	Time	Tributary Temp (°F)	Stream Temp (°F) and Time		Comments
Reach	Tributary Number							Below Tributary	Above Tributary	
1	6	Left	Stream	N/A	10	10:30	56	50 (10:30)	50 (10:30)	Left bank stream contributes 10% flow.
2	18	Right	Spring	N/A	25	15:45	54	N/A	58 (15:45)	Originates below large rock slide on right valley slope.
2	19	Left	Stream	N/A	10	15:45	56	58 (15:45)	N/A	Crosses road VC13, end of Reach 2.
3	21	Right	Spring	N/A	15	16:00	50	54 (16:00)	60 (16:00)	Large thermal influence, may share same source as T18.
3	25	Left	Stream	N/A	25	14:30	56	56 (14:30)	56 (14:45)	Most significant of several tributaries originating from meadow "sink".

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

Several spring-seep complexes in Reaches 1 and 2, while not individually significant to flow, cumulatively may contribute significant flow to the Rito de los Indios. Many of these springs and seeps have been significantly trampled by large game and may be contributing sediment directly to the Rito de los Indios.

The final tributaries counted on this survey represent the source of flow for the Rito de los Indios. The source of flow for the Rito de los Indios is a large wet meadow estimated in size at 300 x 750 ft. The meadow appears to be a sink for at least two high-contribution stream tributaries and one seep tributary. This meadow flows into the stream in only two visible places. T25 (NSO 406), stemming from the downstream end of the meadow, is the only noted tributary directly feeding the Rito de los Indios. This stream's flow contribution is estimated to be 25%. T26 (NSO 412) is a small left bank stream tributary 225 feet upstream from T25. The flow contribution of T26 is estimated at 2%. It is likely that additional water is seeping into the creek through both overland and underground flow.



Photo 7: Reach 2, NSO 356 T18, Left bank stream tributary, main stem of the Rito de los Indios is on the right (18-June-2007).

The presence of numerous small spring and seep tributaries throughout the Rito de los Indios may mean that significant groundwater contributions are being made to the Rito de los Indios. It is likely that some spring and seep tributaries were not observed by surveyors due to the fact that tributaries were low flow and obscured by tall grasses and other streamside vegetation.

Water Temperature

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

Fish growth, health, and reproduction are affected by water temperature. Fish are very sensitive to water temperature due to temperature specific enzymes. As water temperature increases, so does fish performance. Although fish have increased performance with temperature, they also approach a lethal limit. No lethal temperature information is currently available for RGCT.

Another high elevation, arid cutthroat subspecies, Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), indicated an upper limit for growth and long-term survival is somewhere between 71.6 and 73.4°F. These temperature limits were based on optimal conditions with high food availability and good water quality, not taking into account the other stressors that may exist in stream environments. It is possible that the actual lethal limits are lower due to water chemistry and other environmental factors (Dunham 1999).

Cutthroat trout reproduction is affected by temperature. Smith et al (1983) compared egg quality of cutthroat trout in a variety of water temperatures. Eggs in cold water were expelled easily and were in good condition. In warm water the eggs were expelled with difficulty, were cloudy or opaque and often broken. Eggs spawned from two-year-old adults exhibited 74% viability in cold water while in warm water only 6.9%.

Forest standards (noted as SFNF in Table 11) are based on seven-day average maximum temperatures and are stricter than the NMED standards. While it is stricter, the Forest standard is more in line with approaches taken by U.S. Fish and Wildlife Service and NOAA Fisheries across the western United States. It also allows the SFNF to be more pro-active in improving watershed conditions for native fish as well as ameliorating impairments to water quality before a stream is listed as impaired on the 303(d) list.

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

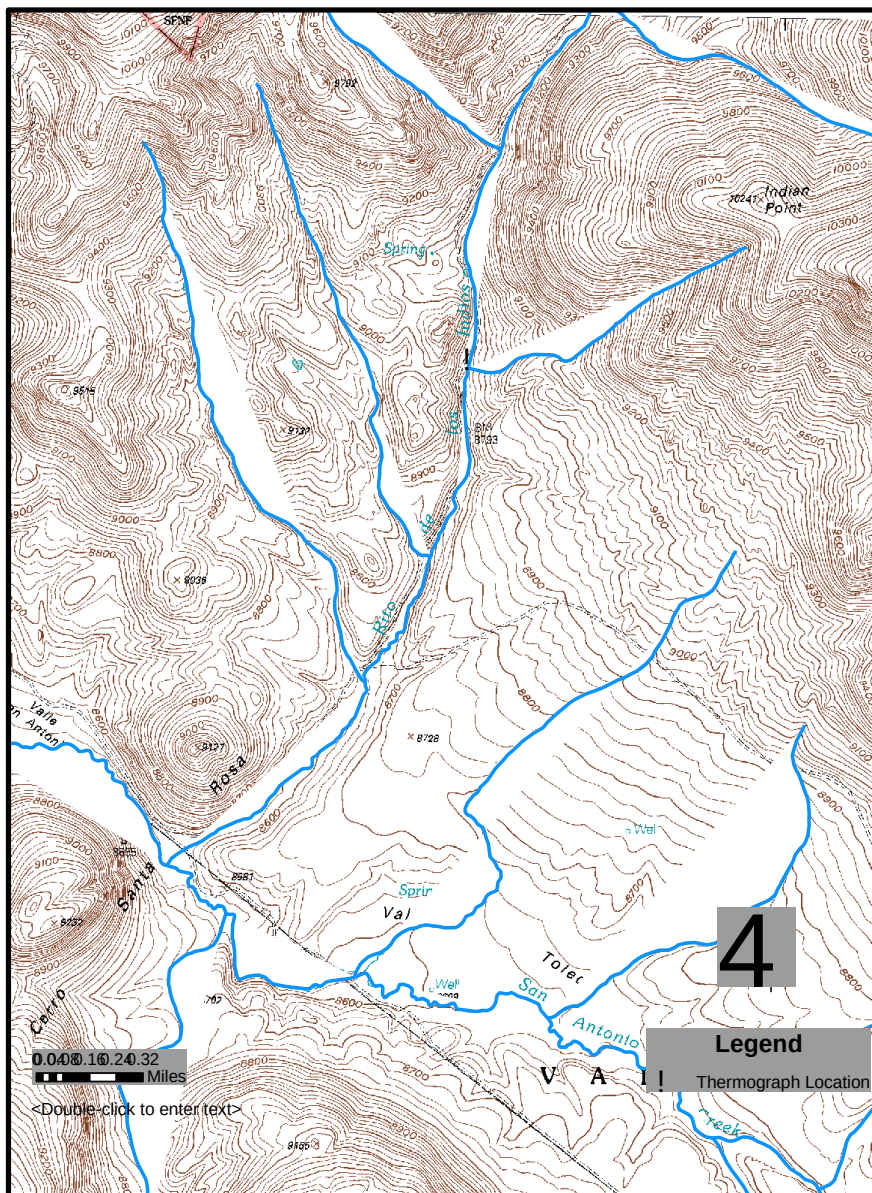
Table 11. Santa Fe National Forest and New Mexico Environment Department Water Quality Temperature Standards 2002.

Water Temperature Standards	Properly Functioning	At Risk	Not Properly Functioning
SFNF 7-Day Average Max.	≤ 64 °F	64 to 70 °F	> 70° F
NMED 3-Day Average Max.	< 68 °F	68 to < 73.4 °F	≥ 73.4 °F

Water temperature in the Rito de los Indios was monitored from July 6th to August 16th, 2007. A tidbit thermographs, a small temperature recording device, was strategically placed at a locations in the Rito de los Indios. Thermographs recorded temperatures at 1-hour intervals for the duration of their time in the river, providing over 1800 temperatures for the site. Data collected by the thermograph was exported to Microsoft Excel 2000 for analysis and comparison to Forest and NMED Water Quality Standards for temperature. Both standards classify water temperature as properly functioning, at risk, or not properly functioning, but with different requirements (see Table 11).

The temperature monitoring stations established on the Rito de los Indios was not moved for the duration of the monitoring period. The station was located just below the first river ford of road VC13 (Reach 2, River Mile 2.8).

Thermograph data indicated that the Rito de los Indios is **properly functioning** for temperature using both SFNF and NMED standards.



Map 1: Location of temperature monitoring station on the Rito de los Indios.

Riparian and Upland Vegetation

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

Rito de los Indios woody riparian vegetation is largely present only in Reach 2 and is dominated by alder, birch, and willow, which are especially important for providing shade in this reach. Reaches 1 and 3 have primarily meadow vegetation, including grasses, sedges, thistle, stinging nettle, mint, and clover.

Vegetation upland (or outside of the riparian zone) is generally ponderosa pine forest in the all reaches of the Rito de los Indios. Aspen is also present in the upland community.



Photo 8: Reach 1, NSO 47 P28, Typical condition of riparian grass community with Z. Manickam (6-June-2007).

Beaver Activity

Evidence of once abundant beaver activity in the Rito de los Indios is present in Reach 2. No intact beaver dams were observed, but many collapsed dams were noted throughout Reach 2. Several of these dams have aggraded the stream channel and in some cases have helped reconnect the channel with its historical floodplain. Other historical evidence of beaver activity including old stumps and debris was noted throughout reach 2. While there is no current beaver activity in the Rito de los Indios, it is clear that beavers have been previously active throughout the watershed. Additionally a beaver was observed at the confluence of the Rito de los Indios on the first day of the survey, (June 7, 2007).

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

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

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



Photo 9: Reach 2, NSO 276 P132, looking upstream at historic beaver dam with Z. Manickam, note channel aggradation above dam (13-June-2007).

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

Beaver activity also has an effect on the riparian vegetation within proximity of the ponds, as well as the water table. Beaver activity increases the surface area of ponds by several hundred times, which is highly influential on the surrounding riparian vegetation (Clements 1991). The increased surface area allows for storage of water in the banks and floodplain. The storage of water in the soil and floodplain increases the water table and stores water for times of low flow. During late summer low flow conditions, water stored in the banks provides cool water to moderate flow and extreme temperatures (Parker *et al.* 1985).

While storing water, beaver dams also reduce extreme flows and related disturbance. The dams moderate flow during flood periods. This moderation reduces bank erosion related to flood events, improving bank stability in downstream areas (Olson and Wayne 1994).

Beavers consume large quantities of riparian vegetation or woody supplies in their diet, as well as for the construction and maintenance of their habitat. Consumption rates for beaver populations are higher than the regeneration rates of riparian vegetation. Beaver tend to occupy an area until the surrounding supplies are consumed and then move on to a new section of river within or outside of the watershed. Once a beaver leaves, high nutrient content in the area allows for fast regeneration of consumed riparian vegetation. Over time, the area will regenerate and be ready for a beaver to return in future years (DeByle 1985).

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

Fisheries

As with most of the rivers in New Mexico, extensive stocking practices with non-native trout species has led to a drastic change in species assemblages. Historically, Rio Grande cutthroat trout (RGCT), *Oncorhynchus clarki virginalis*, was the only trout species found in the Rito de los Indios Watershed. This cutthroat subspecies is currently listed as a sensitive species on the Santa Fe National Forest.

No records were found of direct stocking of non-native trout in the Rito de los Indios and it seems likely that non-native trout have entered the Rito de los Indios through stocking downstream in San Antonio Creek. Currently no Rio Grande Cutthroat trout exist in the Rito de los Indios.

In the summer of 2007 a total of five sites in the Rito de os Indios were surveyed by electroshocking. Sites were selected in reaches 1 and 2 and ranged in length from 150 to 183 feet (See Table 11). Care was taken during site selection to ensure that survey sites contained approximately equal amounts of pool and riffle habitat.

Table 12: Summary of physical parameters for all survey sites on the Rito de los Indios.

Site	1	2	3	4	5
Date	2-Jul-07	2-Jul-07	2-Jul-07	2-Jul-07	2-Jul-07
Start Time	900	1045	1245	1400	1530
Reach #	1	1	2	2	2
Length (ft)	161	183	168	177	150
Average Width (ft)	3	3	2.8	2.8	2.8
Site Area (ha)	0.004487217	0.005100377	0.004370159	0.004604275	0.003901928

Fish abundance was generally high in the Rito de los Indios. A total of 179 fish were collected at all survey sites. Only two species were represented and the population was almost monotypic consisting of 178 Brown trout (*Salmo trutta*) and 1 Rio Grande Chub (*Gila pandora*). The low abundance of prey fish may indicate that the brown trout population within the Rito de los Indios is above its carrying capacity and has removed the prey fish populations from the stream.

Length frequency distributions give fisheries managers a visual representation of the population structure within a given body of water. Length frequency provides insight into reproductive success and when couple with young:adult ratios can be a powerful tool of fisheries management. The length frequency distribution (see Figure X) shows a population that is loaded with medium sized individuals with relatively few small, young individuals. This information coupled with a below average young to adult ratio of 0.268 indicates that natural reproduction may be a problem in the Rito de los Indios.

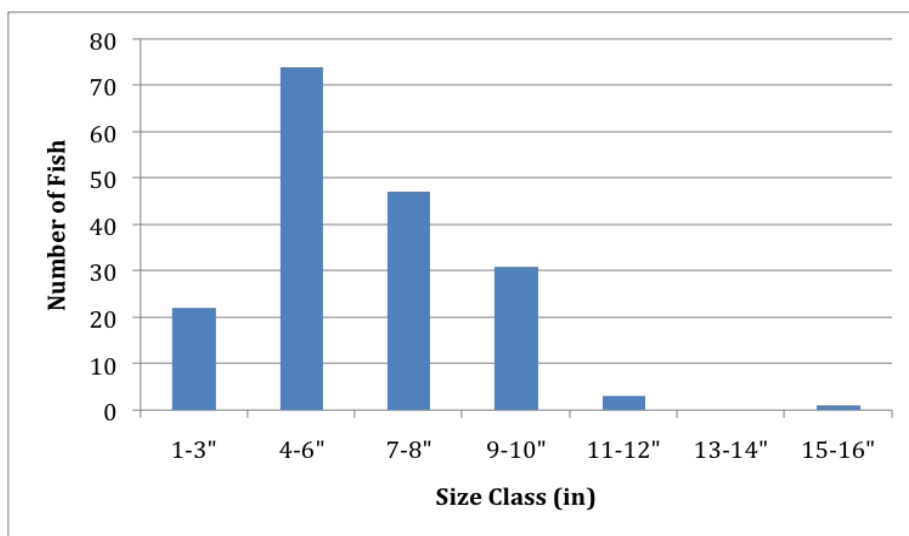


Figure 1: Length frequency distribution of all brown trout captured in the Rito de los Indios, 2007.

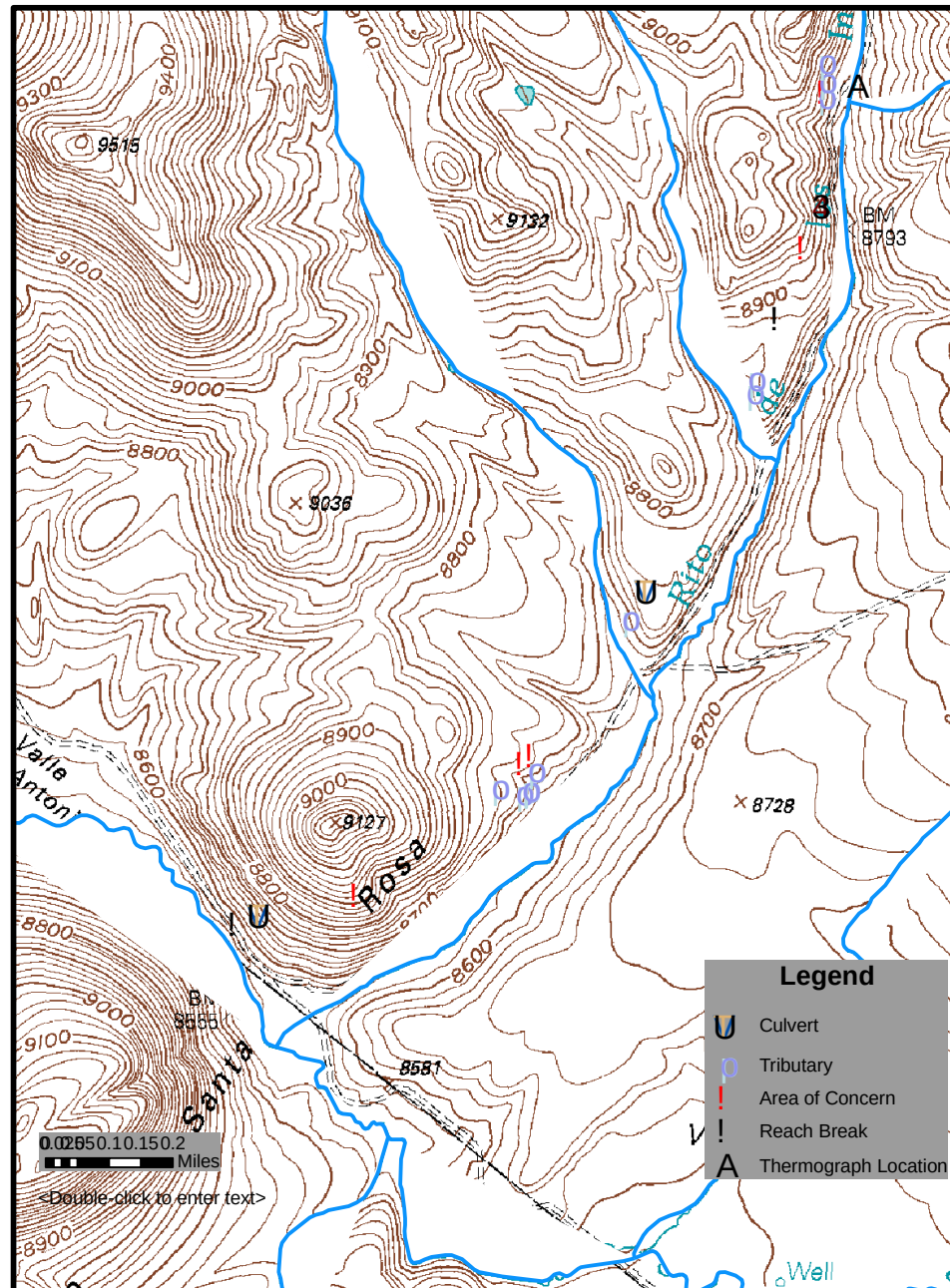
A simple population estimate can be used to calculate number of brown trout contained within the Rito de los Indios. The estimate is calculated at 7,924 brown trout per hectare (See Table 13) and is well above the average population density seen in similar sized streams in Northern New Mexico (Aquatic Consultants Inc, 2003).

Standing crop is a measure of biomass per surface area and can be used in conjunction with population estimates and length frequency distributions to add confidence to conjectures made by fisheries managers. The standing crop estimate of brown trout in the Rito de los Indios is 1,141 kilograms per hectare and is well above the average for similar sized streams in northern New Mexico. An above average standing crop and an above average population density combined with a lower than average young to adult ratio indicate that the population of brown trout in the Rito de los Indios is likely above its natural carrying capacity.

Table 13: Population indices for brown trout in the Rito de los Indios with averages for similar streams in northern New Mexico when available.

Index	Rito de los Indios	Average
Young:Adult Ratio	0.268	3.15
Stream Population Estimate	178	N/A
Population Estimate (#/ha)	7924	2004
Stream Total Biomass (kg)	25.64	N/A
Standing Crop (kg/ha)	1141.38	74

Reach 1: Confluence of Rito de los Indios and San Antonio River to Second Pasture Fence-line



Map 2. Reach 1 of the Rito de los Indios.

Reach 1 was surveyed from June 6 to June 11, 2007. It begins at the confluence of Rito de los Indios and the San Antonio River, and ends 2.16 miles upstream at the second pasture fence-line. The end-point was chosen due to a decrease in valley width, and defined fence-line marker. Most of Reach 1 is flat meadowland with grasses, dandelion, and sedges. Sedges were present both in and out of the channel. Aquatic vegetation is also prevalent and often appears in dense clumps. The channel is well-defined with a significant amount of sinuosity. Many of the meanders have created scour pools found in varying degrees of development. Undercutting is very abundant, particularly in the first half of the reach. Maximum depth of undercuts is 1.5 ft. Valley confinement, woody vegetation, shading, and terrestrial boulders only appear sporadically for a short distance above the VC14 culvert (NSO 183 C2). Stream width varies from 1 ft to 5 ft with an average of 3.3 ft. Channel morphology appears to be a Rosgen E5 Channel given its sinuosity of 1.59, gradient of 1.8%, and dominant substrate of sand (47.1%). The bankfull width to depth ratio is 1.9.

Fish and wildlife were fairly abundant in reach 1. A beaver was seen at the start of Reach 1 at the confluence with the San Antonio River. At least five Garter snakes were observed along the banks near and in the water. Mating mayflies, a dense group of grasshoppers, and other terrestrial insects were noted. Several fish were also encountered. Most were 3-6 inch trout. A dead 9" brown trout, healthy in appearance, was discovered. The cause of death is unknown. Several areas of the riparian zone, especially around the tributaries and wetlands, showed recent and historic signs of grazing, trampling, and wallowing. Given the dominant presence of Elk dung, it is likely that these grazers are responsible for the more recent riparian impacts. The historic presence of domestic grazers is also readily apparent due to the large amounts of historic cutbanks, tension cracking and slumping. Almost all of the historically disturbed area is at least partially re-vegetated but a significant portion still contributes sediment.



Photo 10: Reach 1, NSO 14 P7, 20 feet of typical left bank instability with J. Nelson (6-June-2007).

A total of eight tributaries were counted in Reach 1. Three seep tributaries exist in the Reach. The first has created a large spongy marshland (roughly 75 ft long and 130 ft wide) with pockets of standing water. A sulphurous odor was detected. The other two seeps are smaller and not accompanied by such a large wetland area. They are also characterized by having small standing pools of water. Flow for the tributaries is roughly 1%. Five spring tributaries were observed within the second half of the Reach. They range in flow from 2%-10%. One may have been created by a change in water flow after the construction of road VC14.

An historic earthen dam exists roughly 825 ft. into the reach. The dam is not longer functioning and the earth that spanned the stream has eroded, leaving behind two mounds roughly 12 feet apart and 12 ft in height on opposite sides of the stream. The left-bank mound connects to VC13. A large wetland exists upstream of the feature with substantial standing water and small pools. Sedges dominate this region. The substrate of the wetland above the dam is dominated by very fine silt. Below the dam the channel is noticeably wider and shallower.



Photo 11: Reach 1, NSO 46 R23, looking upstream at non-functioning, historic dam with Z. Manickam streamside (6-June-2007).

Several small side channels were noted in comments but were not counted as NSOs due to a lack of woody vegetation. It is likely that some of them are stable because a well established grass community, similar to the rest of the valley floor, is present on the islands. None of the side channels were of significant length.

Almost the entire reach was dominated by grassy riparian zones. No woody vegetation was noted until almost 1.7 stream miles into the reach. At this point there was a short (~300 ft.) section with several mature conifers streamside providing sparse shade. Discounting shade provided by undercut banks, this was the only shade in the reach. The lack of woody vegetation and trees is consistent with the fact that no large woody debris (LWD) were counted within the reach. Undercut banks were common, undercuts ranged in depth from 0.1 ft. to 1.5 ft.

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. A total of 45 temperatures were taken during the survey of Reach 1. The readings ranged from 46 to 63°F with an average temperature of 54 degrees.

Habitat Characteristics

The 2.1 stream miles (10,925 ft) of Reach 1 are divided into 241 NSOs (see Table 13). 117 NSOs in this reach are riffle habitat, comprising 70.8% of the stream length. Pools make up 28.8% of the stream habitat and are counted as 114 habitat units. Two (2) culverts make up the remaining 0.4% of the habitat. Reach 1 is **not properly functioning** for pool habitat development.

Table 13. Summary of Reach 1 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length ¹ (%)	Stream Habitat ² (%)	Properly Functioning Indicators
<i>Pool</i>	114	3145	28.8	28.8	≥30%
<i>Riffle</i>	117	7740	70.8	70.8	-
<i>Culvert</i>	2	40	0.4	0.4	-
<i>Tributary</i>	8	N/A	N/A	N/A	-
<i>Falls</i>	0	0	0	0	-
<i>Side Channel</i>	0	0	N/A	0	-
<i>Dry Channel</i>	0	0	0	0	-
Total	241	10925	100.0	100.0	-

Red – Not Properly Functioning

¹Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.

²Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 1 contains both not properly functioning and properly functioning characteristics. Parameters that are **not properly functioning** include pool development, and sediment content, bank stability, and pool quality. **Properly functioning** characteristics include bankfull width-to-depth ratio.

Riffle habitat is **not properly functioning** for sediment content. Sediment content in riffles, 47.1%, greatly exceeds the standard (see Table 14).

Table 14. Summary of riffle habitat and substrate composition in Reach 1.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg Depth	Avg. Max Depth	
1	117	66.2	3.0	0.7	1.0	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
1	47.1	46.4	6.4	0.1	0	
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning

Yellow – Dominant Substrate

Pool development calculated by habitat length is **not properly functioning** in Reach 1 (see Table 14). The 114 pools comprise 28.8% of the stream habitat, which is just below the matrix standard. These pools are **not properly functioning** for pool quality with an average residual depth of 0.8 feet (see Table 145). Sediment within these pools was primarily sand. Of the 114

pools present, only 17 have a residual depth greater than 1 foot (14.9% of pool habitat) with no pools having a maximum depth greater than 3 feet.

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

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth ≥1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
1	114	27.6	3.0	1.3	0.5	0.8	52.9	17	7.9	0	0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-
Substrate Summary (%)											
	Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total				
	1	53.3	40.6	5.9	0.2	0	100.0				

Red – Not Properly Functioning
Yellow – Dominant Substrate

Reach 1 is a meadow reach so LWD density was not analyzed.

Stream bank condition is **not properly functioning** in Reach 1 with 10.6% instability (see Table 16). This is just above the threshold, 10.0%, for properly functioning. The majority of the instability within this reach comes from historic cattle grazing.

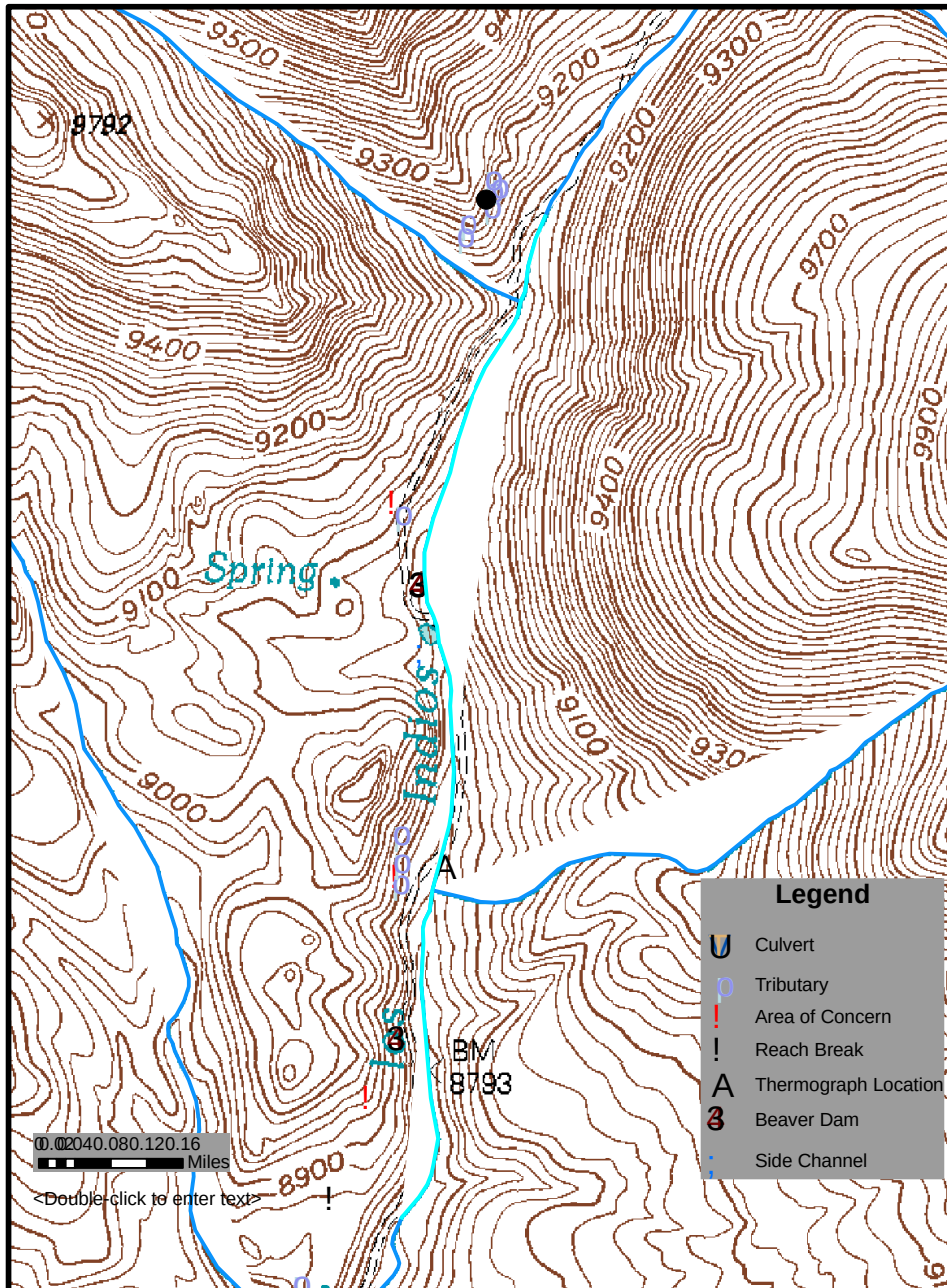
The bankfull width-to-depth ratio, 1.9:1, is within the expected range for the related Rosgen stream classification and is therefore **properly functioning** (see Table 15).

Table 16. Habitat characteristics for Reach 1.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
1	1:1	1.9:1	0	2315	10.6
Properly Functioning Indicators	-	<12:1	N/A	-	<10

Red – Not Properly Functioning

Reach 2: Second Pasture Fence-line to Flow Regime Change Above T18 & T19



Map 3: Reach 2 of the Rito de los Indios

Reach 2 was surveyed from June 13 to June 18, 2007. It begins at the second pasture fence and ends 1.4 miles upstream at NSO 358 T19 where the flow regime noticeably decreases. In addition, this end-point was chosen due to a slight increase in valley width.

In the lowermost portions of Reach 2 the vegetation remains very similar to the vegetation throughout Reach 1. Here streamside vegetation consists of grasses, sedges, mint, dandelions, thistle and other small meadow plants. Trees (primarily conifers) begin to appear on the flood plain approximately 750 ft. into the reach. The first trees to appear are small Ponderosa Pines and spruce trees. Aspen saplings were observed in the upper half of the reach, and mature Aspen were noted along valley slopes. Within the wooded area in the upper half of the reach, the stream substantially broadens and becomes more shallow. As the valley width decreases, trees, woody debris, and undergrowth provide shade for the creek. Contrastingly, in the lower half of the reach, trees do not provide significant shade to the creek. Woody undergrowth primarily consists of alder and in a few instances birch. No willow was observed. Accompanying the increase in mature trees in the floodplain is an increase in boulders present both in the creek and in the floodplain. As in Reach 1, marshy banks and wetland areas were common – often due to water diversions caused by old beaver dams.

Valles Caldera road VC13 fords the stream in two places in Reach 2. In each location the road has altered the path of the stream as well as significantly widened it. It is evident that these road fords are sources of sediment in the stream. Fish, including trout fry, were observed in both road crossings along with mayflies, mosquito larvae and various aquatic beetles. After the second road ford VC13 climbs the left valley slope and is well above the stream. Overall the road is in much closer proximity to the stream than in Reach 1 and is contributing sediment throughout the reach.



Photo 12: Reach 2, NSO 341 R164, Sediment from road VC13 entering stream with J. Nelson (18-June-2007).

Fish and wildlife were abundant throughout Reach 2. Numerous fish were seen while surveying – most likely brown trout ranging in size from fry to large adults. Wildlife present includes many garter snakes in and around the stream, abundant elk signs, and robust insect communities. Evidence of historic trampling and grazing is present in and around tributaries and marshy areas. Recent grazing and trampling evidence is less abundant

Eleven tributaries are located in Reach 2. Most are low flow seeps or seep complexes, but two streams and one high flow spring are present as well. The majority of the seeps and springs are concentrated near the top of the reach and their small size and low flow suggest that others may

exist but were overlooked. Tributaries 18 and 19 are located at the extreme top of the reach and combine to provide roughly 30-45% of total stream flow below.

Large woody debris appeared for the first time in Reach 2. A total of 34 medium and large pieces were counted within the reach, as well 17 small pieces. This is a drastic increase from Reach 1 where no pieces were observed. Many pieces of LWD are firmly lodged in marshy stream banks and are stabilizing both pools and riffles. The possibility of additional LWD recruitment in Reach 2 is excellent. Several spanners were noted, and downed trees already exist in great numbers on the floodplain and on valley slopes.

One waterfall is present in Reach 2. The waterfall has a length of 18 feet, a width of four feet and a height of 6 feet. It is not considered a barrier to upstream migration because of many small pocket pools, which could be used as landings by fish traveling upstream. Gradient is estimated at 80%.



Photo 14: Reach 2, NSO 343 F1, looking upstream at waterfall with Z. Manickam (18-June-2007).

Water temperatures were measured at random intervals during the survey using a handheld thermometer. Main channel temperature readings were taken in the water column. A total of 42 temperatures were taken during the survey of Reach 2. The readings ranged from 50° to 70° F with an average temperature of 57.9° F.

Habitat Characteristics

The 1.4 stream miles (7,343 ft) of Reach 2 are divided into 117 NSOs (see Table 16). 54 NSOs in this reach are riffle habitat, comprising 85% of the stream habitat. 49 pool habitats make up 13.7% of the stream habitat. The remainder of the stream habitat consists of two side channels (1.1%) and one waterfall (0.2%). Reach 2 is **not properly functioning** for pool habitat development.

Table 16. Summary of Reach 2 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length ¹ (%)	Stream Habitat ² (%)	Properly Functioning Indicators
<i>Pool</i>	49	1016	13.8	13.7	≥30%
<i>Riffle</i>	54	6309	85.9	85	-
<i>Culvert</i>	0	0	0	0	-
<i>Tributary</i>	11	N/A	N/A	N/A	-
<i>Falls</i>	1	18	0.3	0.2	-
<i>Side Channel</i>	2	78	N/A	1.1	-
<i>Dry Channel</i>	0	0	0	0	-
Total	117	7421	100.0	100.0	-

Red – Not Properly Functioning

¹Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.

²Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of stream condition factors and indicators for historic and occupied RGCT streams, Reach 2 contains both “not properly functioning” and “properly functioning” characteristics. Parameters that are **not properly functioning** include pool development, and sediment content, bank stability, and pool quality. **Properly functioning** characteristics include bankfull width-to-depth ratio and sufficient LWD abundance.

Here, riffle habitat is **not properly functioning** because its sediment content of 46.5% greatly exceeds the standard of 20%. (see Table 17).

Table 17. Summary of riffle habitat and substrate composition in Reach 2.

Riffle Habitat Summary (ft)						
Reach	# Riffles	Avg. Length	Avg. Width	Avg Depth	Avg. Max Depth	
2	54	116.8	2.8	0.69	0.99	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
2	46.5	34.1	17.4	2.0	0	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning

Yellow – Dominant Substrate

Pool development calculated by habitat length is **not properly functioning** in Reach 2 (see Table 18). The 49 pools comprise 13.7% of the stream habitat, which is just below the matrix standard. These pools are **not properly functioning** for pool quality with an average residual depth of 0.9 feet (see Table 17). Sediment within these pools was primarily sand. Of the 49

pools present, 21 have a residual depth greater than 1 foot (53% of pool habitats) with no pools having a maximum depth greater than 3 feet.

Table 18. Summary of pool habitat and substrate composition in Reach 2.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
2	49	20.7	2.7	1.3	0.4	0.9	35	21	15	0	0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-
Substrate Summary (%)											
	Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total				
	2	51.6	36.5	11.8	0	0	100				

Red – Not Properly Functioning
Yellow – Dominant Substrate

Stream bank condition is **at risk** in Reach 2 with 14.2% instability (see Table 18). This is just above the threshold, 10.0%, for properly functioning. The majority of the instability within this reach comes from valley-wall and bank erosion caused by rain, wind, and trampling (Elk and come historic cattle grazing).

The bankfull measurements were taken in a heavily wooded section of the reach and are likely unrepresentative of the entire reach given its heterogeneous topography. The width-to-depth ratio, 15:1, is within the expected range for the related Rosgen stream classification and is therefore **properly functioning** (see Table 19).

Table 19. Habitat characteristics for Reach 2.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
2	1:1	15 : 1	31	2089	14.2
Properly Functioning Indicators	-	X<Y	>30	-	<10

Red – Not Properly Functioning
Yellow – At Risk

Reach 3: Left Bank Stream Tributary to End of Flow

Map X: Reach 3 of the Rito de los Indios

Reach 3 was surveyed June 18 thru June 21, 2007. The reach begins upstream of two significant spring tributaries – the first from right-bank (T18), and the second from left-bank (T19) – and ends 0.70 miles upstream at a wet meadow where stream flow terminates. Reach 3 alternates between partially forested and meadow terrain. Stream channel gradient is 4.3%. Sinuosity value was calculated as 1.1. Bankfull width was measured as 4.5 ft. This may not be entirely representative measurement given the stream's highly varied bank structure caused by historical trampling and land-management practices. Bankfull width-to-depth ratio was determined to be 9.0:1. Based on gradient, sinuosity, and substrate, Reach 3 can be classified as a Rosgen stream type A5.



Photo 15: Reach 3, NSO 386 R186, typical indistinct, non-sinuuous riffle in Reach 3 with J. Nelson (21-June-2007).

Reach 3 is divided into 21 pools and 34 riffle units. The streamside vegetation alternated between open meadows and densely wooded sections. Low-lying vegetation is abundant in Reach 3 and consists of primarily sedge, grass, mint, dandelion, forbs, moss, stinging nettle, raspberry, strawberry, and various succulent forbs. Conifers (spruce and fir) are plentiful in the

wooded sections and are the predominant woody vegetation in the floodplain. Conifer roots frequently enter the channel in these sections and create and/or shelter pools. Aspen are also present and occasionally appear on the floodplain. Elk signs, such as droppings, grazing, and trampling, were observed throughout the reach. In contrast to previous reaches no fish were noted. Several pools contained algae, mayfly larvae, and aquatic beetles. Tadpoles were present at more stagnant pools in the wet meadow at the top of flow. A turkey displaying territorial behavior was observed.

The most notable feature of Reach 3, is the wetland meadow found at the head of the stream (end of the reach). It is very large – estimated 750ft by 300 ft. The meadow appears to be a sink for at least two high-contribution stream tributaries and one seep tributary. This meadow flows into the stream in only two visible places. T25 (NSO 406), stemming from the downstream end of the meadow, is the only noted tributary directly feeding the Indios. This stream's flow contribution is estimated to be 25%. T26 (NSO 412) is a small left bank stream tributary 225 feet upstream from T25. The flow contribution of T26 is estimated at 2%. It is likely that additional water is seeping into the creek.



Photo 16: Reach 3 NSO 419 R204, Rito de los Indios valley with marshy source and J. Nelson (21-June-2007).

The meadow is dense with sedges and contains standing water throughout. At least six pools exist in the meadow; some stagnant, and others with very low-flow. All pools are very silty, muddy, and have poorly defined boundaries due to bank instability (some trampling evidence was clear). Pool 183 (NSO 418) was the last pool observed that showed any evidence of a channel upstream. The “channel” was 10 ft long and quickly dispersed back into the meadow. Most other pools with flow were observed receiving water from all sides rather than from one distinct point. Light grazing and bear droppings were also noted in this area. On the left bank of the meadow, on the valley wall above VC13, is an old corral and a decrepit truck.

The canyon starts off relatively confined (~150 ft.) at the start of the reach and widens further upstream (~500ft.). The widest section occurs at the wet meadow –the source of flow.

Seven tributaries were encountered in Reach 3 (4 seeps and 3 streams). Some of the seep tributaries were complexes of several small seeps. The abundance of small, sometimes nearly imperceptible tributaries suggests that additional small springs and seeps may have been overlooked (this is particularly true in and around the wet meadow).

Debris jams, low-lying vegetation, and tree roots are commonly found in the channel while LWD is not very abundant. One road ford and one barbed-wire fence-line were encountered. Also, what appeared to be an old, overgrown road traced the majority of Reach 3’s stream length above the road ford along the right valley wall.

Habitat Characteristics

The 0.7 stream miles (3741 ft) of Reach 3 are divided into 63 NSOs (see Table 20). 34 NSOs in this reach are riffle habitat, comprising 93.1% of the stream habitat. 21 pool habitats make up 6.2% of the stream habitat. The remainder of the stream habitat consists of one culvert (0.7%). Reach 3 is **not properly functioning** for pool habitat development.

Table 20. Summary of Reach 3 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length ¹ (%)	Stream Habitat ² (%)	Properly Functioning Indicators
<i>Pool</i>	21	231	6.2	6.2	≥30%
<i>Riffle</i>	34	3484	93.1	93.1	-
<i>Culvert</i>	1	26	0.7	0.7	-
<i>Tributary</i>	7	N/A	N/A	N/A	-
<i>Falls</i>	0	0	0	0	-
<i>Side Channel</i>	0	0	N/A	0	-
<i>Dry Channel</i>	0	0	0	0	-
Total	63	3741	100.0	100.0	-

Red – Not Properly Functioning

¹Percent Stream Length calculated with only riffle, pool, culvert, falls, and dry channel habitat types.

²Percent Stream Habitat calculated using all stream habitat types except tributary.

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

development, sediment content, and pool quality. **Properly functioning** characteristics include bankfull width-to-depth ratio.

Here, riffle habitat is **not properly functioning** because its sediment content of 53.2% greatly exceeds the standard of 20%. (See Table 21).

Table 21. Summary of riffle habitat and substrate composition in Reach 3.

Riffle Habitat Summary (ft) ¹						
Reach	# Riffles	Avg. Length	Avg. Width ¹	Avg Depth	Avg. Max Depth	
3	34	102.5	1.9	0.4	0.7	
Substrate Summary (%)						
Reach	Sand	Gravel	Cobble	Boulder	Bedrock	Total
	53.2	34.2	10.3	2.3	0	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning

Yellow – Dominant Substrate

1. Corrected average width was calculated using only 6 measured units

Note: three wetland riffles were not included in calculation of average width, average depth and average max depth due to lack of defined channel.

Pool development calculated by habitat length is **not properly functioning** in Reach 3 (see Table 22). The 21 pools comprise 6.2% of the stream habitat, which is well below the matrix standard. These pools are **not properly functioning** for pool quality with an average residual depth of 0.7 feet (see Table 21). Sediment within these pools was primarily sand. Of the 21 pools present, 2 have a residual depth greater than or equal to 1 foot, and no pools having a maximum depth greater than 3 feet.

Table 22. Summary of pool habitat and substrate composition in Reach 3.

Pool Habitat Summary											
Reach	# Pool Habitats	Avg. Length (ft)	Avg. Width (ft) ¹	Avg. Max Depth (ft)	Avg. PTC (ft)	Avg. Residual Depth (ft)	Pools per mile	# Pools w/ Residual Depth >1'	Pools w/ Residual Depth >1'/mi.	# Pools w/ Max Depth >3'	Pools w/ Max Depth >3'/mi.
3	21	11	3.5	0.9	0.2	0.7	29.6	2	2.8	0	0
Properly Functioning Indicators	-	-	-	-	-	≥1.0	-	-	-	-	-
Substrate Summary (%)											
Reach		Sand	Gravel	Cobble	Boulder	Bedrock	Total				
3		65.2	25.2	8.1	1.4	0	99.9				

Red – Not Properly Functioning

Yellow – Dominant Substrate

1: Corrected average width was calculated using only 6 measured units.

Stream bank condition is **not classified** in Reach 3 because the stream gradient is greater than 4% (see Table 23). The amount of bank instability was measured as 10.8%. The majority of the instability within this reach comes from valley wall and bank erosion caused by rain, wind, and trampling (elk and historic cattle grazing).

The bankfull measurements were taken in a typical meadow section of the reach. The bankfull width to depth ratio is 9.0:1 and is considered **properly functioning**.

Table 23. Habitat characteristics for Reach 3.

Reach	Pool:Riffle Ratio	Avg. Bankfull Width:Depth	Pieces of LWD per mile	Total Unstable Banks (ft)	% Unstable Banks
3	0.62	9.0:1	7.1	805	10.8
Properly Functioning Indicators	-	X<Y	>30	-	<10

Red – Not Properly Functioning

Yellow – At Risk

Reach 4: End of Flow to Valles Caldera National Preserve Boundary

Reach 4 begins above the wet meadow source of the Rito de los Indios and extends to the Valles Caldera National Preserve/Forest Service Boundary. Reach 4 was not formally survey because of a lack of flow. A short reconnaissance hike was completed on July 25, 2007. Reach 4 very obviously receives virtually no flow, the channel has well established grass communities in the bottom and in some places the channel is nearly non-existent. High intensity precipitation likely cause the channel to flow but no recent evidence was observed. Portions of the wet meadow/spring complex which marked the end of Reach 3 extend into the lower portions of Reach 4 but these portions join the stream down-valley from the reach break.

Evidence of historical development and human habitation is immediately evident on the floodplain. An old wood structure on the left bank appears to have once been a sawmill or some other part of a timber operation. An old, non-functional earth tank is associated with this structure. Many old saw logs are visible, some appear to be scattered randomly while it is apparent that some were decked at some point in time. A large pile of mill scrap is streamside on the right bank.



Photo 17: Reach 4, historic structure which may be associated with historic timber operations (21-June-07).

The gradient increases throughout Reach 4, as the gradient increases the valley width decrease. Stream side vegetation shifts to from open meadow to spruce and aspen. Valley width narrows drastically, down to 15-20 feet. VC13 continues streamside all the way to the VCNP/FS boundary. The road has been blocked up to this point by fallen trees and receives no vehicle traffic.

A road crossing above the sawmill site indicates that a road once forked off of VC13 and went up the right valley slope. This road is not used anymore and the crossing has stabilized.

The grass on the Forest side of the VCNP/FS boundary fence is uniformly shorter than on the VCNP side. No recent grazing evidence was observed on the forest side of the boundary.

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

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