Rio Grande Cutthroat Trout
(*Oncorhynchus clarkii virginalis*)
Conservation Strategy

Photo courtesy of New Mexico Department of Game and Fish

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Citation

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RIO GRANDE CUTTHROAT TROUT CONSERVATION STRATEGY

I. BACKGROUND

Summary

Cooperative efforts to manage and conserve Rio Grande cutthroat trout have been continuing since 2003. This Conservation Strategy is a voluntary recommitment to implement these ongoing actions that will provide for the long-term viability of the Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*) by maintaining sufficient secure populations and range-wide genetic integrity of the species, while recognizing existing land uses, resource uses (including angling and other recreational opportunities), Tribal sovereignty, and private property rights. The purpose of this document is to provide specific direction that, when implemented, will conserve this species and minimize or remove the threats to its viability. This will be accomplished through an adaptive management process of implementing, monitoring and adjusting conservation measures by the Rio Grande Cutthroat Trout Conservation Team (Conservation Team).

Rio Grande Cutthroat Trout Range-wide Conservation Team

The Conservation Team is a working group of agency representatives charged with the management and protection of the Rio Grande cutthroat trout, and it includes members of the public who have committed their time to actively participate in developing this Conservation Strategy. The Conservation Team was established in 2003, when the Conservation Agreement for the Range-wide Preservation and Management of the Rio Grande Cutthroat Trout (2003 Conservation Agreement) was first signed. The Team is comprised of individuals from agencies, tribes, and private organizations and individuals. While the Team has no authority to mandate agency actions, team members develop range-wide priorities, review annual work plans, coordinate agency actions, and update and maintain a status assessment database.

Participants in the Rio Grande Cutthroat Trout Range-wide Conservation Team (* indicates the signatories to the 2003 and 2009 Conservation Agreements):

- Colorado Parks and Wildlife (CPW)*
- New Mexico Department of Game and Fish (NMDGF)*
- U.S. Forest Service (USFS)*
- U.S. Fish and Wildlife Service (FWS)*
- Mescalero Apache Nation*
- Jicarilla Apache Nation*
- Taos Pueblo*
- National Park Service (NPS)*
- Bureau of Land Management (BLM)*
- Trout Unlimited

Purpose

The Rio Grande Cutthroat Trout Conservation Team (Conservation Team) was formed to assure the long-term viability of Rio Grande cutthroat trout throughout its historical range and reduce the likelihood that Rio Grande cutthroat trout would require listing under the Endangered Species Act (ESA) of 1973, as amended. This Conservation Strategy was developed in accordance with the Conservation Agreement for Rio Grande Cutthroat Trout in the States of Colorado and New Mexico (Conservation Team 2009) (Conservation Agreement) and is intended to remove and minimize threats to the species and guide restoration efforts for the maximum benefit of the trout. Conservation and management strategies outlined in this Conservation Strategy are designed to meet the guidelines set forth by the U.S. Fish and Wildlife Service[1] (FWS) in their Policy for Evaluation of Conservation Efforts (PECE) standards. Participants in this Conservation Strategy agree to implement the conservation and monitoring actions specified herein. Commitment to implementation of this Conservation Strategy[2] will be documented through a revision and signing of an updated Conservation Agreement.

The information contained in this Conservation Strategy is intended to serve as a set of guidelines for state and Federal agencies to conserve Rio Grande cutthroat trout. It is neither a National Environmental Policy Act (NEPA) decision document, nor a Federal or state recovery plan. Any future Federal actions based on this Conservation Strategy will include NEPA compliance and compliance with other laws and regulation as needed.

Past and Existing Conservation Agreements

This Conservation Strategy is the implementation document for the Conservation Agreement for Rio Grande Cutthroat Trout that was signed by the parties in 2003 and renewed in 2009. The Conservation Agreement is a collaborative and cooperative effort among state, Federal, and Tribal resource agencies. The Conservation Agreement was designed to provide a framework for the long-term conservation of Rio Grande cutthroat trout by guiding the implementation of actions that reduce threats to the subspecies. This Conservation Strategy will be part of a renewed Conservation Agreement for the Rio Grande Cutthroat Trout. Additional information regarding authorities, governing documents, and policies may be found in the accompanying Conservation Agreement.

Duration of the Conservation Strategy

This Conservation Strategy was written to guide conservation actions for the next 10 years, although it is expected that participants will continue working on conservation of the species beyond that timeframe. The Conservation Strategy was also designed and written to be a dynamic document that can be adapted and updated to incorporate new information regarding local and regional needs of the Rio Grande cutthroat trout populations and habitats. Minor modifications may be made to the Strategy so long as they do not change the Goals and

[1] Participation by FWS in this Conservation Strategy and the related Conservation Agreement does not constitute a PECE review of any conservation efforts included in this Strategy, nor does it not predetermine any subsequent status review and listing determination by FWS under the ESA.
[2] Compliance with this strategy by agencies, private enterprises, and private individuals is strictly voluntary.

Objectives. This will allow the Conservation Team to respond to changing conditions on the ground, taking advantage of conservation opportunities that may arise. The Conservation Team will annually re-evaluate the status of Rio Grande cutthroat trout populations and habitats across its range and review progress of the strategies listed in the Conservation Strategy.

Annually, the parties involved will review the Conservation Strategy and its effectiveness to determine whether it should be revised and to update the annual operating plan (see **Annual Coordination Meeting** below). By the tenth year, the Conservation Strategy must be reviewed and either modified, renewed, or terminated.

II. RIO GRANDE CUTTHROAT TROUT INFORMATION

Taxonomy

The Rio Grande cutthroat trout, one of 14 subspecies of cutthroat trout, is native to the Rio Grande, Pecos River, and Canadian River basins in New Mexico and Colorado (Sublette *et al.* 1990; Behnke 2002).

Historical Distribution

The historical distribution of Rio Grande cutthroat trout is not known with certainty. In general, it is assumed that Rio Grande cutthroat trout occupied all streams capable of supporting[3] trout in the Rio Grande, Pecos River, and Canadian River basins (Alves *et al.* 2008) (Figure 1). The Pecos River is a tributary of the Rio Grande, so a historical connection between the two basins likely existed. Although no early museum specimens document its occurrence in the headwaters of the Canadian River, it is very likely that Rio Grande cutthroat trout inhabited this river as well (Behnke 2002). The Canadian River, which is a tributary to the Mississippi River, has no connection with the Rio Grande. It is possible that through headwater capture (a tributary from one watershed joins with a tributary from another) there may have been natural migration of fish between the Pecos and Canadian headwater streams (Behnke 2002). The Rio Grande cutthroat trout in the Pecos and Canadian River basins have long been isolated from those in the Rio Grande basin and are considered to be moderately genetically differentiated from those in the Rio Grande basin (Pritchard *et al.* 2007, Pritchard *et al.* 2008). Rio Grande cutthroat trout populations occur throughout the headwaters of the Rio Grande basin.

There is some evidence that Rio Grande cutthroat trout may have occurred in Texas (Behnke 1967; Garrett and Matlock 1991) and Mexico (Behnke 1967). However, no specimens were collected to document their presence in these locations with certainty. Their potential occupancy in these locations is based on fluvial connections and on historical articles that describe the presence of trout that could have been Rio Grande cutthroat trout.

The range of the Rio Grande cutthroat has been divided by basins into five geographic management units (GMUs) to bring a greater resolution to descriptions of population and habitat distribution and related maintenance and restoration work. These GMUs reflect the hydrologic divisions of the Rio Grande cutthroat trout historic range by river drainage. They do not

[3] Streams capable of supporting trout are those at higher elevations with lower water temperatures.

necessarily reflect important differences in genetic variability in the subspecies based on geography or adaptation to specific environments, although fish in the Pecos and Canadian GMUs do exhibit some genetic differentiation (Pritchard *et al.* 2008). Additionally, Rio Grande cutthroat trout are only known from one stream in the Caballo GMU- Las Animas Creek, where a hybridized population currently exists. The Conservation Team is managing the GMUs as separate units to maintain genetic and ecological diversity within the subspecies where it exists and to ensure representation and redundancy[4] of the subspecies across its historical range.

[4] For explanations of representation and redundancy, see section **II. Conservation Goals and Objectives** below.

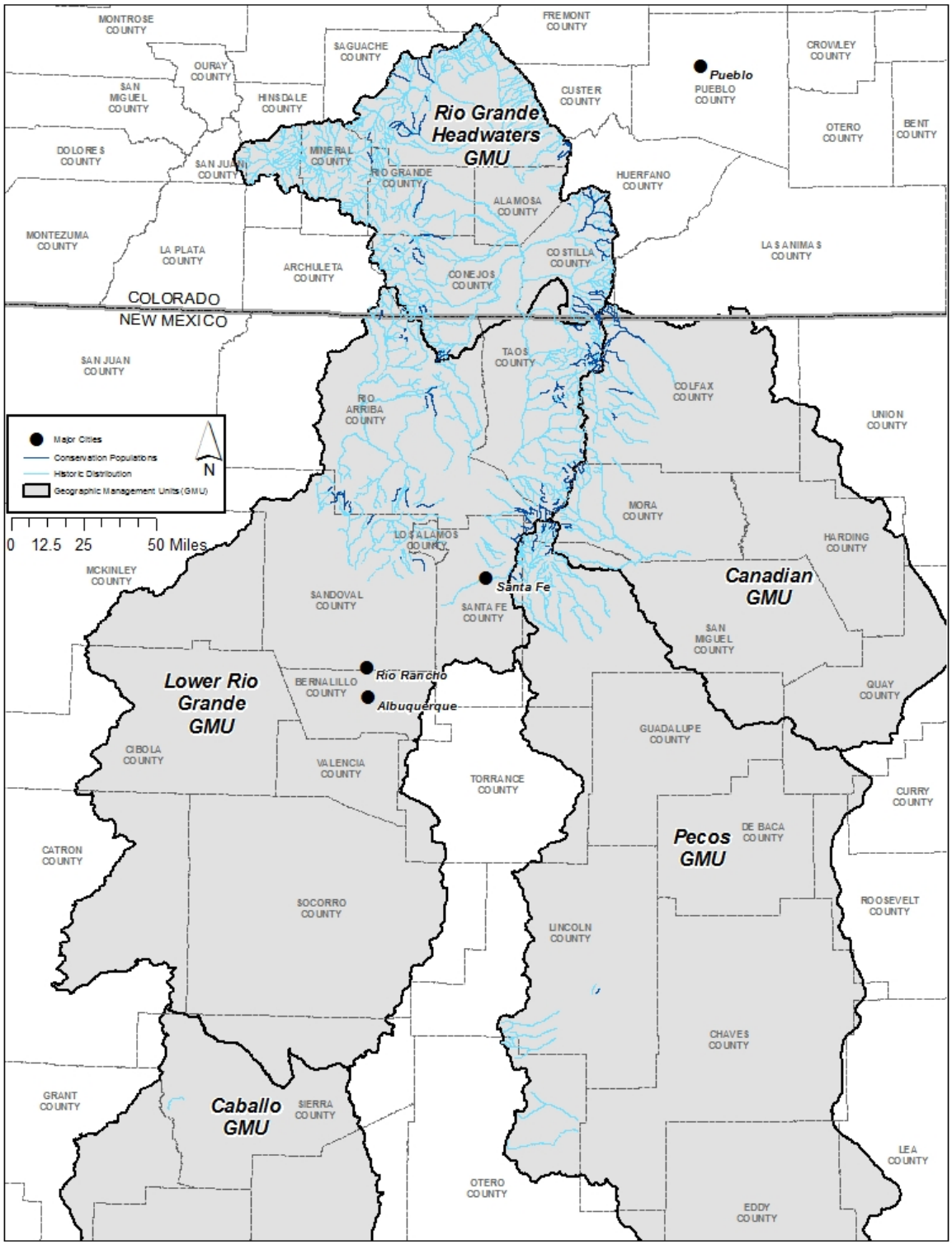

Figure 1. Presumed historical and current ranges of conservation populations of Rio Grande cutthroat trout. Map courtesy of New Mexico Department of Game and Fish and US Fish and Wildlife Service.

Current Distribution

Rio Grande cutthroat trout are not known to currently occur in Texas or Mexico. Conservation populations[5] of the subspecies are currently concentrated in elevations from 2,743–3048 m (9,000–10,000 ft) (Alves *et al.* 2008). Conservation populations of Rio Grande cutthroat trout occupy approximately 10 percent of their presumed historical habitat (Alves *et al.* 2008; Figure 1). Currently, the southernmost distribution of conservation populations occurs in the Pecos GMU in Pine Lodge Creek, Lincoln County, New Mexico. Two recreation populations[6] occur in Animas Creek, Sierra County, New Mexico, and Indian Creek on the Mescalero Apache Indian Reservation in Otero County, New Mexico.

Conservation populations are managed by the state agencies. Many Rio Grande cutthroat trout conservation populations currently occupy lands administered by Federal agencies. Of the total 1,110 km (690 mi) of occupied habitat, 698 km (434 mi) (63 percent) are under Federal jurisdiction, with the majority (59 percent) occurring within National Forests (Alves *et al.* 2008). Rio Grande cutthroat trout occupy 6.1 km (3.8 mi) of land administered by BLM, 30.5 km (19 mi) managed by NPS, and 397 km (247 mi) that are privately owned (Alves *et al.* 2008).

The Rio Grande Cutthroat Trout Conservation Team completed a range-wide status assessment (Alves *et al.* 2008) concerning the Rio Grande cutthroat trout. This status assessment summarized information provided by 15 fisheries professionals from Colorado and New Mexico having specific knowledge of Rio Grande cutthroat trout. Additionally, all of the data on Rio Grande cutthroat trout collected yearly by these professionals are entered into a comprehensive database (2012 database). According to these analyses, there are currently approximately 127 Rio Grande cutthroat trout conservation populations distributed in high elevation streams of New Mexico and Colorado (Table 1) (2012 database). Of these current conservation populations, 53 are considered secure populations[7]. The Lower Rio Grande GMU has the most conservation populations of the five GMUs. The Caballo GMU currently has none; the only known historical location for the species is currently unoccupied but is expected to undergo restoration in the next several years.

[5] "Conservation populations" of Rio Grande cutthroat trout are those with 10 percent or less introgression (hybridization) from nonnative trout. "Populations" of Rio Grande cutthroat trout are one or more streams containing the subspecies that are isolated in some way from other occupied streams. Sometimes a population is one stream; sometimes it is multiple connected streams.

[6] "Recreation populations" are defined as Rio Grande cutthroat trout populations managed primarily for sport fishing. Recreation populations are not included as conservation populations. Recreation populations raise public awareness and interest in the subspecies and are generally located in areas that are poor candidates for restoration as a conservation population, either due to lack of habitat to maintain the population in perpetuity, an inability to exclude nonnative trout, or societal factors.

[7] "Secure populations" are populations protected from encroachment by nonnative trout, usually by a downstream migration barrier (either natural or manmade).

Table 1. Distribution and status of Rio Grande cutthroat trout conservation populations and secure conservation populations (a subset of the conservation populations)[8].

GMU	Number of Conservation Populations	Number of Secure Conservation Populations
Canadian	11	4
Caballo	0	0
Lower Rio Grande	62	24
Pecos	12	7
Rio Grande Headwaters	42	18
Range-wide Total	**127**	**53**

Habitat and Life History

As is true of other subspecies of cutthroat trout, Rio Grande cutthroat trout are primarily found in clear cold streams but occasionally occur in lacustrine (lake or reservoir) habitats (Figure 2). They spawn as high water flows from snowmelt recede. In New Mexico, this typically occurs from the middle of May to the middle of June (NMDGF 2002). Spawning is believed to be tied to day length, water temperature, and runoff (Sublette *et al.* 1990; Behnke 2002). The size of mature females ranges from 10.7 to 26 centimeters (4.2 to 10.3 inches (in)) (Stumpff 1998). The number of eggs per female varies greatly depending on the size and age of the fish, and reports on wild fish have ranged from around 100 to over 400 (Cowley 1993; Stumpff 1998).

[8] Information on conservation populations in this table is based on the 2012 database, which is populated with data from 2011. The Conservation Team is aware that since 2011, some populations have been extirpated due to the effects of wildfire, while other populations have been restored. In order to input data accurately and allow for review, there is a significant time lag before an updated database is available. The 2012 database represents the best information available to the team.

Figure 2. Rio Grande cutthroat trout habitat, Wolf Creek, Colorado.
Photo Courtesy of Colorado Parks and Wildlife.

It is unknown whether Rio Grande cutthroat trout spawn every year or if some portion of the population spawns every other year, as has been recorded for westslope cutthroat trout (*O. c. lewisi*) (McIntyre and Rieman 1995). Likewise, while it is assumed that females mature at age 3, they may not spawn until age 4 or 5 as seen in westslope cutthroat trout (McIntyre and Rieman 1995). Sex ratio also is unknown with certainty, but based on field data, a ratio skewed towards more males might be expected (Pritchard and Cowley 2006). Although Yellowstone (*O. c. bouvieri*) (Gresswell 1995), Bonneville (*O. c. utah*) (Schrank and Rahel 2004), and westslope (Bjornn and Mallet 1964; McIntyre and Rieman 1995) cutthroat trout subspecies are known to have a migratory life history phase, it is not known if Rio Grande cutthroat trout historically had a migratory form when there was greater connectivity among watersheds, but it does not now.

Most cutthroat trout are opportunistic feeders, eating both aquatic invertebrates and terrestrial insects that fall into the water (Sublette *et al.* 1990). Other subspecies of cutthroat trout become more piscivorous (fish eating) as they mature (Moyle 1976; Sublette *et al.* 1990) and cutthroat trout living in lakes will prey heavily on other species of fish (Echo 1954). It is possible that native cyprinids (i.e., chubs, minnows, and dace) and suckers were once important prey items for Rio Grande cutthroat trout; for example, predation of Rio Grande sucker by Rio Grande cutthroat trout has been observed in Medano Creek in Great Sand Dunes National Park in Colorado (F. Bunch, Great Sand Dunes National Park, pers. comm.). Growth of cutthroat trout varies with water temperature and availability of food.

Typical of trout, Rio Grande cutthroat trout require several types of habitat for survival: spawning habitat, nursery or rearing habitat, adult habitat, and refugium (microhabitats providing spatial or temporal protection from disturbances) (Keppel *et al.* 2012). Spawning habitat consists of clean gravel (little or no fine sediment present) that ranges from 6 to 40 millimeters (mm) (0.24-1.6 in) in diameter (NMDGF 2002). Nursery habitat is usually at the stream margins where water velocity is low and water temperature is slightly warmer. Harig and Fausch (2002) found that water temperature may play a critical role in the life history of age 0 cutthroat trout (juvenile fish less than 1 year old). Streams with mean daily temperature in July of less than 7.8 degrees Celsius (ºC) (46 degrees Fahrenheit (ºF)) may not have successful recruitment (survival of individuals to sexual maturity and joining the reproductive population) or reproduction in most years. Adult habitat consists of pools with cover and riffles for food production and foraging. The primary form of refugium habitat is deep pools that do not freeze in the winter and do not dry in the summer or during periods of drought.

Nature and Extent of Threats

The following discussion includes primary factors that potentially affect Rio Grande cutthroat trout, and these factors will be addressed by conservation actions identified in this strategy. For further information, please see the most recent status assessment for the species (FWS 2011).

Habitat Loss

The historical range of Rio Grande cutthroat trout has been greatly reduced over the last 150 years. Populations have been lost because of water diversions, stream drying, dams, habitat degradation, changes in hydrology, hybridization with rainbow trout and other species of cutthroat trout, or competition with brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*) (Pritchard and Cowley 2006). These changes in environmental conditions have resulted in many historical populations being lost and those that remain being restricted to headwater streams. As described above, conservation populations are now concentrated in streams with elevations from 2,743–3048 m (9,000–10,000 ft) (Alves *et al.* 2008). These isolated high-elevation streams are subject to extreme and fluctuating environmental conditions including forest fires, freezing, and dewatering (Novinger and Rahel 2003). In addition, headwater mountain streams often lack critical resources such as deep pools (Harig and Fausch 2002) and can provide insufficient refuge from catastrophic disturbance (Pritchard and Cowley 2006). The resulting limited habitat resources causes the remaining populations to be lower in overall number of individuals and more at risk of extirpation from extreme events[9]. And because many of the remaining populations are isolated from other populations, once the subspecies is extirpated from a stream it cannot naturally be recolonized.

[9] Longer streams support larger populations of cutthroat trout (Harig and Fausch 2002; Young *et al.* 2005). Population size is a major determinant of species persistence (Reed *et al.* 2003). Population persistence decreases as population size decreases (Rieman and McIntyre 1993). In addition, long-term persistence of a population depends on having a sufficient number of individuals to avoid inbreeding depression, which decreases population resilience, and to maintain genetic variation (Franklin 1980; Frankham *et al.* 2002; Reed 2005).

Nonnative species

The introduction of nonnative trout is widely recognized as one of the leading causes of historical range reduction in cutthroat trout subspecies (Griffith 1988; Lassuy 1995; Henderson *et al.* 2000; Dunham *et al.* 2002; Peterson *et al.* 2004). Nonnative rainbow, brook, and brown trout and Yellowstone cutthroat trout have been introduced extensively throughout the range of Rio Grande cutthroat trout, and they hybridize with (rainbow and other cutthroat subspecies), compete with (brook and brown trout), and prey upon (brown trout) Rio Grande cutthroat trout. Fifty-nine of 127 conservation populations (46 percent) have nonnative trout present (2012 database).

The primary threat to Rio Grande cutthroat trout from rainbow trout and other cutthroat trout subspecies is through hybridization and introgression (Rhymer and Simberloff 1996; Muhlfeld *et al.* 2009). The genetic distinctiveness of Rio Grande cutthroat trout can be lost through hybridization (Allendorf *et al.* 2004).

To minimize the contact of nonnative trout with Rio Grande cutthroat trout, fish barriers have been constructed where natural barriers did not already exist in order to prevent nonnatives from invading from downstream to upstream headwater streams. Alves *et al.* (2008) rated the genetic risk to the 120 conservation populations that existed at the time, and 67 percent of the populations had very low risk of genetic mixing with nonnative trout, 3 percent were at low risk, 27 percent were at moderate risk, and 3 percent were at high risk.

Drought

Negative effects from the relatively short-term drought of the early 2000s were documented in 14 Rio Grande cutthroat trout populations in Colorado and New Mexico (Japhet *et al.* 2007). The number of streams affected by the drought may have been greater because only a fraction of the conservation populations are sampled in any given year. Despite the negative effects of the drought, population persistence and recovery were documented for several of these populations. Although droughts can have immediate impacts on Rio Grande cutthroat trout populations, such as reducing population numbers, they can be resilient enough to survive and return to pre-drought densities after water conditions improve. Rarely have populations been extirpated from complete stream drying, although during extreme events it could occur.

One of the factors that increases the risk of impacts associated with drought is the overall size of the stream. Very small streams (1.5-m (5-ft) wide or less) may be more susceptible to the effects of drought by increasing chances of drying, elevated water temperature, and freezing compared to larger streams. Approximately 27 conservation populations (21 percent of the current 127 conservation populations) are in streams that are 1.5 m (5 ft) or less in width throughout their entire length (2012 database). Decreased stream flow resulting from drought reduces the amount of habitat available for aquatic species, and water quality (e.g., temperature, dissolved oxygen) may become unacceptable in declining flow in small streams. However, not all small streams have equal risk of impacts from drought, as those with deeper pools are more likely to withstand some effects of drought. Small headwater streams with an inadequate number of deep pools are most likely to lose suitable habitat from drought effects. Other physical factors beyond stream

size are also important influences on the vulnerability of a stream to drought, such as watershed area, stream type, hydrology, geology, vegetation types, irrigation, and aspect.

Fire

Wildfires are a natural disturbance in forested watersheds. However, since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average frequency during the period 1970–1986; the total area burned is more than six and a half times the previous level (Westerling *et al.* 2006). In addition, the average length of the fire season during 1987–2003 was 78 days longer compared to that during 1970–1986, and the average time between fire discovery and control was 29.6 days longer (Westerling *et al.* 2006).

In the Southwest, the fire season is followed by the monsoon season (July to August). Consequently, denuded watersheds are susceptible to heavy precipitation, which can lead to severe floods and ash flows. Although fish may survive the fire, ash and debris flows that occur after a fire can eliminate populations of fish from a stream (Rinne 1996; Brown *et al.* 2001; USFS 2006; Patten *et al.* 2007). Recently, Rio Grande cutthroat trout population eradication in streams affected by fires was documented on Bandelier National Monument in Capulin Creek from the Los Conchas Fire. Wildfires can negatively impact native fish populations, but they can also eradicate nonnative fish populations and provide opportunities for founding new Rio Grande cutthroat trout populations.

Fire risk can be reduced through fuels reduction and prescribed burns. The land management agencies in New Mexico and Colorado have active programs to improve forest health. As an example, in New Mexico around 81,000 ha (~200,000 acres) underwent fuel-reduction treatment between 1987 and 2005, thereby improving watershed conditions associated with 228 km (142 mi) of streams with Rio Grande cutthroat trout populations (Ferrell 2002, FWS 2011). Such techniques have been found to reduce fire severity even under extreme weather conditions in low-elevation ponderosa pine forests (Schoennagel *et al.* 2004). The proposed Southwest Jemez project would encompass combinations of thinning and prescribed burning on a total of over 60,700 ha (~150,000 acres) of National Forest System land (actual acres will depend on funding, actual contract costs and environmental conditions suitable for prescribed burning) from 2010 through 2019.

Climate Change

Although the extent of warming likely to occur is not known with certainty at this time, the Intergovernmental Panel on Climate Change (IPCC) (2007a) has concluded that warming of the climate is unequivocal and continued greenhouse gas emissions at or above current rates would cause further warming (IPCC 2007a). The IPCC also projected that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation (IPCC 2007a). Warming in the Southwest is expected to be greatest in the summer (IPCC 2007b). Annual mean precipitation is likely to decrease in the Southwest and the length of snow season and snow depth is very likely to decrease (IPCC 2007b). Most models project a widespread decrease in snow depth in the Rocky Mountains and earlier snowmelt (IPCC 2007b).

Climate change is predicted to have four major effects on the coldwater habitat occupied by Rio Grande cutthroat trout:

(1) increased water temperature;
(2) decreased streamflow;
(3) change in the hydrograph (a graphical representation of the distribution of water discharge or runoff over a period of time); and
(4) increased occurrence of extreme events (fire, drought, and floods).

Increased Water Temperature

Water temperature influences the survival of salmonids in all stages of their life cycle. Alterations in the temperature regime from natural background conditions negatively affect population viability, when considered at the scale of the watershed or individual stream (McCullough 1999). Salmonids are classified as coldwater fish with thermal preferences centered around 15 ˚C (59 ˚F) (Shuter and Meisner 1992). High temperatures suppress appetite and growth, can influence behavioral interactions with other fish (Shrank *et al.* 2003), or can be lethal (McCullough 1999). Salmonids inhabiting warm stream segments have higher probabilities of dying from stress (McCullough 1999).

The optimum growth temperature (appetite is high and maintenance requirements low) for Rio Grande cutthroat trout is in the range of 13–15 ˚C (55.4–59 ˚F), similar to other cutthroat trout (Meeuwig *et al*. 2004; Bear *et al.* 2007; Zeigler *et al*. 2013) and their upper incipient lethal limit is around 26 ˚C (78.8 ˚F), as has been found for other subspecies of cutthroat trout (Wagner *et al*. 2001; Johnstone and Rahel 2003; Zeigler *et al.* 2013). Upper incipient lethal limit (temperature at which 50 percent of the fish can survive for 7 days) for rainbow trout ranges from 24–26 ˚C (75.2–78.8 ˚F), for brown trout 23–26 ˚C (73.4–78.8 ˚F), and for brook trout 24–25 ˚C (75.2–77 ˚F) (McCullough 1999).

Habitat loss is predicted to occur in the lower elevation stream reaches (or lower latitude streams) due to increased temperatures. As a result, Rio Grande cutthroat trout populations may be further restricted to increasingly higher elevations or more northern latitudes (Meisner *et al.* 1988; Regier and Meisner 1990; Keleher and Rahel 1996; Nakano *et al.* 1996; Rahel *et al.* 1996; Poff *et al.* 2002; Rieman *et al.* 2007).

In contrast to the potential negative impacts of water temperature increase on Rio Grande cutthroat trout, there could also be a potential benefit. Cold summer water temperatures (mean July temperature of less than 7.8 ˚C (46 ˚F)) have been found as a limiting factor to recruitment of cutthroat trout in high-elevation streams (Harig and Fausch 2002; Coleman and Fausch 2007). Cold summer water temperatures have been identified as limiting in Deep Canyon, Colorado (Pritchard and Cowley 2006) and is limiting in other waters, such as Rio de Las Trampas in New Mexico (Rogers 2013; Zeigler *et al.* 2013).

Decreased Streamflow

Current models suggest a decrease in precipitation in the southwest (Kundzewicz et al. 2007; Seager et al. 2007), which would lead to reduced stream flows and a reduced amount of habitat

for Rio Grande cutthroat trout. Streamflow is also predicted to decrease in the Southwest even if precipitation were to increase moderately (Nash and Gleick 1993; State of New Mexico 2005; Hoerling 2007). Winter and spring warming causes an increased fraction of precipitation to fall as rain, resulting in reduced snowpack, earlier snowmelt, and decreased summer runoff (Christensen et al. 2004; Stewart et al. 2005; Regonda et al. 2005). Earlier snowmelt and warmer air temperatures lead to a longer dry season, which affects stream flow. Warmer air temperatures lead to increased evaporation, increased evapotranspiration, and decreased soil moisture. These three factors would lead to decreased streamflow even if precipitation increased moderately. Climate change is likely to exacerbate the effects of decreased streamflow during drought on Rio Grande cutthroat trout.

Change in Hydrograph

Changes in air temperature and precipitation will likely lead to changes in the magnitude, frequency, timing, and duration of runoff (Poff *et al.* 2002). Spring streamflow during the last 5 decades has shifted so that the major peak now arrives 1 to 4 weeks earlier, resulting in declining fractions of flow in the spring and summer (Stewart *et al.* 2005). In Colorado, the onset of springflow has already shifted by 2 weeks (Ray *et al.* 2008). The life history of salmonids is closely tied to flow regime, runoff in particular (Fausch *et al.* 2001). A change in timing or magnitude of floods can scour the streambed, destroy eggs, or displace recently emerged fry downstream (Erman *et al.* 1988; Montgomery *et al.* 1999; Fausch *et al.* 2001). The environmental cues for Rio Grande cutthroat trout spawning are tied to increasing water temperature, increasing day length, and possibly flow, as it has been noted that they spawn when runoff from snowmelt has peaked and is beginning to decrease (Behnke 2002; Pritchard and Cowley 2006). Consequently, a change in the timing of runoff from spring to winter could disrupt spawning cues because peak flow would occur when the days are still short in length and water temperatures cold.

Increased Extreme Events

An increase in extreme events such as drought, fires, and floods is predicted to occur because of climate change (IPCC 2007a, p. 15). It is anticipated that an increase in extreme events will most likely affect populations living at the edge of their physiological tolerances. The predicted increases in incidences of extreme temperatures and wildfire may exacerbate the effects of drought and fire on Rio Grande cutthroat trout.

The extent to which climate change will affect Rio Grande cutthroat trout is not known with certainty at this time. Projections point to a range-wide impact through increased water temperatures, decreased stream flow, change in hydrograph, and an increased occurrence of extreme events, but the effect on individual populations will depend on other factors such as aspect, shading, and stream size. Range-wide, streams currently capable of supporting Rio Grande cutthroat trout are at elevations of 1,829 m (6,000 ft) and above. Currently, only about 1.6 percent of the conservation populations are in streams below 2,438 m (8,000 ft) in elevation (Alves *et al.* 2008). Climate change may affect Rio Grande cutthroat trout populations at lower

elevations more markedly than at higher elevations, although other factors such as aspect, shading, and stream size will influence the degree to which individual streams are affected.

Disease

Whirling disease is a significant concern to fishery managers in western states. Whirling disease is caused by the nonnative myxosporean parasite, *Myxobolus cerebralis*. This parasite requires two separate hosts, a salmonid fish and an aquatic worm (*Tubifex tubifex*) to complete its life cycle. Spores of the parasite are released from infected fish when they die. The spores are ingested by *T. tubifex* where they undergo transformation in the gut to produce actinosporean triactionomyxons (TAMs). Trout are infected either by eating the worms (and TAMs) or through contact with water in which TAMs are present. Once *M. cerebralis* is present, total year class failure can occur among susceptible species such as Rio Grande cutthroat trout under the proper suite of environmental conditions (Nehring 2008). Studies have shown that the proper suite of environmental conditions is not very restrictive and does not necessarily involve environmental degradation (Nehring 2008).

Laboratory (DuBey *et al.* 2007) and field (Thompson *et al.* 1999) experiments have shown that Rio Grande cutthroat trout are very susceptible to whirling disease, but fewer than five streams have been documented as infected (Patten and Sloane 2007, Alves *et al.* 2008). The most recent water body in New Mexico to test positive for whirling disease is Columbine Creek, which contains a conservation population of Rio Grande cutthroat trout. Research at Placer Creek, Colorado, demonstrated that incidence of whirling disease can be eliminated by removal of trout for three years, during which time whirling disease resistant lineages of *T. tubifex* worms are introduced to the system.

Both Colorado and New Mexico have policies and regulations in place to minimize the risk of the introduction of whirling disease into Rio Grande cutthroat trout populations. In addition, both states have regulations regarding the stocking of fish by private landowners that are designed to eliminate the importation of whirling disease-positive fish. Per regulations, it is illegal to stock fish in public waters without prior permission from a state agency.

III. CONSERVATION GOALS AND OBJECTIVES

This Conservation Strategy's goal is to develop and implement the necessary conservation measures for the Rio Grande cutthroat trout to have sufficient resiliency, representation, and redundancy to provide for long-term viability.

Goals

The overall goal of this Conservation Strategy is to provide for the long-term viability of Rio Grande cutthroat trout throughout its historical range by minimizing or removing threats to the species and promoting the conservation of Rio Grande cutthroat trout. One of the main purposes of this Conservation Strategy is to provide a framework of objectives and associated actions that can be implemented to abate threats, address information gaps, and guide monitoring efforts. Areas that currently support Rio Grande cutthroat trout will be maintained, while other areas will be managed for increased abundance, if feasible. New populations will be established where ecologically and economically feasible to increase the number of conservation populations and maintain the genetic diversity of the subspecies. The Conservation Team envisions a future where sufficient numbers of wild Rio Grande cutthroat trout populations are adequately secured through ongoing management and stewardship that the risk of extinction of the species is negligible.

The 3Rs - Resiliency, Representation, and Redundancy

The conservation status of the Rio Grande cutthroat trout will be determined through what is known as the 3Rs. Beginning in the mid-1990s, conservation biologists introduced a conceptual framework for evaluating the viability of a species using the concepts of "resiliency," "representation," and "redundancy" (Naeem 1998; Dunham *et al*. 1999; Shaffer and Stein 2000; Redford *et al.* 2011), referred to as the 3Rs. "Viability" in this context means the ability of a species to persist over the long term, and, conversely, to avoid extinction over the long term. A viable species has a sufficient degree of resiliency (self-sustaining populations), representation (genetic or environmental variability), and redundancy (multiple, strategically situated populations). On the other hand, a species that is deficient in one or more of these three characteristics will have a lower probability of being viable and, therefore, a corresponding increased risk of extinction. Together these three characteristics of resiliency, representation, and redundancy are what the Rio Grande cutthroat trout needs for viability (Table 2).

Table 2. Objectives and strategies needed to provide for long-term viability of the Rio Grande cutthroat trout.

Viability Objective	Viability Strategy
Maximize Resiliency	**Highly resilient** populations have an estimated probability of persistence of greater than **90%**.
Maximize Representation	Maximize the number of highly resilient populations within each of the 5 GMUs.
Maximize Redundancy	Maximize the number of resilient populations across the range.

Resiliency: The ability of the species to withstand stochastic events

The viability of a species is dependent on the viability of its populations, which is greatly affected by the health of those populations (Daszak *et al.* 2000; Lochmiller 1996). Healthy populations allow for recovery after stochastic events or periodic disturbances. This is the essence of resiliency. Populations lacking healthy characteristics will be less likely to bounce back and are thus less resilient.

Measuring characteristics of population health (e.g., birth versus death rates, overall population size) can inform whether any given population can absorb disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities. The degree to which a population is resilient is related to the magnitude of disturbance it can absorb (Holling 1973). Sufficient resiliency, therefore, is having population conditions that allow it to recover from periodic disturbances. Species-level resiliency is measured through the resiliency of its collective populations. Therefore, understanding population resilience for the Rio Grande cutthroat trout is critical to managing for its viability.

For populations to be resilient and successful contributors to the species as a whole, they need certain characteristics. These characteristics might include, for example, a sufficient size (influenced by the physical condition of the individuals, (Beldomenico and Begon 2010; Redford *et al.* 2011)), and a certain distribution of individuals within the population to ensure they can locate mates, and a positive growth rate—all of which can act as population health metrics. Resilient populations, therefore, contribute to species' viability; conversely, populations that lack resiliency may persist for some time, but their contribution may be limited as they may eventually be extirpated by a disturbance. In the absence of quantitative population health metrics, habitat size and quality may be used as a proxy, as a species is generally most resilient in its highest quality habitat.

The Conservation Team has determined that the Rio Grande cutthroat trout needs resilient populations throughout the GMUs to ensure single catastrophic events do not eliminate or cause the extinction of the species. The resiliency of Rio Grande cutthroat trout populations will be assessed through ongoing modeling efforts discussed below (see **Probability of Persistence Model**). Populations with an estimated probability of persistence greater than 90 percent to the year 2080 will be considered to be highly resilient. In conservation biology, a population with less than a 90 percent probability of persistence is considered vulnerable (Shaffer 1981; Mace and Lande 1991; Roberts *et al.* 2013). The Conservation Team believes 90 percent is a reasonable threshold that can be implemented practically while also providing confidence that the population will persist into the future. Populations with less than 90 percent probabilities of persistence will be examined to determine the factors decreasing persistence probabilities, and conservation measures may be taken to increase their resilience.

Representation: The ability of a species to adapt to changing environmental conditions

The viability of a species is also dependent in part on its ability to adapt and evolve to changing environmental conditions over time. Populations are the functioning unit of evolution, and individuals adapt. Therefore, the species' adaptive capabilities will be supported by the range of variation found within and between the populations comprising the species. Representation can be measured through the breadth of genetic diversity within and among populations or ecological diversity (also called environmental variation or diversity) across the species' range. This measure can inform whether a species is capable of adapting to changes (natural or human caused) in its environment. Genetic diversity and ecological diversity are not necessarily mutually exclusive, nor are they necessarily one and the same.

Sufficient representation, therefore, is having the genetic flexibility or inhabiting varying environmental conditions to allow the population(s) to respond to changing environmental conditions through adaptation in extant populations, and consequently, supporting the evolutionary potential of the species. The challenge is characterizing those combinations of genetic conditions and distribution across the landscape likely to result in viability versus those expected to lead to extinction in a changed environment. Maintaining sufficient representation to allow adaptive and evolutionary processes to proceed is needed to support species viability. This can be accomplished by having populations established in areas that represent various ecological settings within the range, and by protecting populations with varying genetic makeup to increase the chances of them being able to adapt to future conditions.

The Rio Grande cutthroat trout should be sufficiently represented in each of the five GMUs it historically occupied[10] to provide for species viability over the long term.

[10] Rio Grande cutthroat trout are only known from one stream (Las Animas Creek) in the Caballo GMU. Repatriation will be attempted in this stream but not in any other streams that are not historical locations of Rio Grande cutthroat trout in this GMU.

Redundancy: The ability of a species to withstand catastrophic events

The viability of a species is dependent in part on the species ability to recover following a catastrophic event either by having populations that are unaffected or by having populations that can bounce back following such an event. Therefore, this aspect of viability is supported by the duplication and distribution of populations in such a configuration that allows the species to withstand catastrophic events, thereby retaining sufficient redundancy. Redundancy enhances viability through the spreading of risk (Carroll *et al.* 2010; Redford *et al.* 2011). Redundancy protects against unpredictable and catastrophic events for which adaptation at the individual or population level is unlikely. Sufficient redundancy requires having enough populations distributed across the landscape to provide a margin of safety for the species to withstand catastrophic events.

Probability of Persistence Model

The conservation status of the Rio Grande cutthroat trout, like other inland cutthroat trout, has traditionally been evaluated with a Population Health Index (Alves *et al.* 2008, Hirsch *et al.* 2006). Limitations of that approach have inspired a shift toward modeling population persistence with Bayesian Networks (BN) in an effort to bring more quantitative information to bear in a flexible framework better suited for incorporating new information as it becomes available (Rogers 2013). BN models are useful because they support logical reasoning based on existing knowledge, and they are able to incorporate uncertainty (Marcot *et al.* 2001; Newton *et al.* 2007; Peterson *et al.* 2013). Furthermore, BN models have already been used in previous applications to explore the threat of climate change (Jay *et al*. 2011) and address various fisheries management decisions (Peterson *et al.* 2008; Peterson *et al*. 2013; Roberts *et al*. 2013). The goal for the development of the initial BN model was to mimic the Population Health Index by evaluating the probability of future persistence in the short term (over the next 30 years) of individual Rio Grande cutthroat trout populations given specific threats to the subspecies. This initial Rio Grande cutthroat trout BN model (Rogers 2013) was originally developed for a sister taxa, the Colorado River cutthroat trout (Roberts *et al*. 2013) and forms the foundation for future modeling efforts specific to Rio Grande cutthroat trout. The initial model uses Rio Grande cutthroat trout specific data and input from resource managers.

Since the 2002 candidate status review, occupied stream length has been used as one of the measures to estimate population health of Rio Grande cutthroat trout (FWS 2002). At that time, it was thought that a minimum stream length of 9.3 km (5.8 mi) was needed to support a viable population of cutthroat trout (Hilderbrand and Kershner 2000). This minimum stream length was one of several factors used to evaluate Rio Grande cutthroat trout population health. A recent BN model for Colorado River cutthroat trout populations evaluated stream segments greater than 7.7 km (4.8 mi) and found that they had a high probability of persistence to 2080 (Roberts *et al.* 2013). Since our current BN is largely modeled after the methods used in that study, we also used 7.7 km (4.8 mi) as a criteria to evaluate the health and viability of Rio Grande cutthroat trout populations. In stream segments below 7 km (4.3 mi), Rio Grande cutthroat trout populations have a lower probability of persistence. It is important to note that stream length is not a simple indication of resilience; populations in stream sections less than 7 km (4.3 mi) may also be very resilient, and those in stream sections greater than 7 km (4.3 mi)

may not be highly resilient. Future modeling efforts will incorporate a more nuanced analysis of how stream length relates to population resilience.

The results from streams instrumented with temperature loggers suggest that none currently exceed the weekly maximum temperature (26 ºC (79 ºF)) for Rio Grande cutthroat trout survival (Rogers 2013, Zeigler *et al*. 2013). Only 2 of the 54 populations evaluated had 30-day chronic water temperatures that were above or below ideal levels. Even if a stream temperature increase of 2 ºC were incorporated into the model to account for future climate change, only 5 populations would move out of the optimal growth category and into the declining or low growth categories (Rogers 2013). Since stream temperature was outside the ideal range for just two populations of the 54 instrumented streams examined, this preliminary analysis suggests that water temperature is not a major limiting factor for Rio Grande cutthroat trout conservation populations at this time. The flexible nature of the BN modeling approach will allow more rigorous climate modeling to be incorporated in future efforts to consider effects on population persistence over longer time horizons in the face of a changing climate.

A third factor to consider when evaluating the resiliency of current conservation populations is the presence of nonnative trout species occupying the same streams. As discussed above (see **Nature and Extent of Threats**), nonnative trout species hybridize or compete with Rio Grande cutthroat trout. Sympatry of Rio Grande cutthroat trout populations with nonnative trout species reduces population resiliency and causes them to be at greater risk. Because the initial BN model did not incorporate the presence of nonnative species specifically, the Conservation Team removed any streams that are sympatric with nonnative trout species from consideration as resilient populations at this time.

Rogers (2013) identifies a number of limitations to the initial BN used for Rio Grande cutthroat trout. Therefore, in the future, additional factors and considerations will be included in a larger, more complex BN model that incorporates actual Rio Grande cutthroat trout population survey numbers, stream intermittency data, presence of refugia, stream temperature, and other factors. Inclusion of additional stressors will likely drive down the estimated probability of persistence in many streams, but the Rio Grande Cutthroat Trout Conservation Team welcomes efforts that further our understanding of the subspecies, and recognizes that these reductions do not reflect a reduction in population health but rather a more accurate representation of the true resilience of Rio Grande cutthroat trout populations. The Team will continue to implement the best available science to drive management decisions.

Objectives

The following objectives are included in the 2013 Conservation Agreement and have been the objectives of the Conservation Team since the original Conservation Agreement was signed.

Objective 1: Identify and characterize all Rio Grande cutthroat trout conservation populations and occupied habitat. All waters with Rio Grande cutthroat trout populations will be identified, and known populations and their habitat will be monitored to detect changes. Complete genetic analyses on known or suspected Rio Grande cutthroat trout populations.

Objective 2: Secure and enhance conservation populations. Secure and, if necessary, enhance all known and suspected conservation Rio Grande cutthroat trout populations.

Objective 3: Restore populations. Increase the number of stream populations by restoring Rio Grande cutthroat trout within their native range. Local restoration goals and approaches will be developed to meet this objective.

Objective 4: Secure and enhance watershed conditions. Maintain and, if necessary, improve watershed conditions for Rio Grande cutthroat trout, including development of protocols for monitoring.

Objective 5: Public outreach. Develop and implement a public outreach effort specifically addressing Rio Grande cutthroat trout conservation.

Objective 6: Data sharing. Continue to build and maintain the Rio Grande cutthroat trout geographic information system (GIS) so that information can readily be shared between and among agencies and jurisdictions.

Objective 7: Coordination. Maximize effectiveness of Rio Grande cutthroat trout conservation efforts by coordinating signatory agency efforts toward achieving a common goal.

IV. CONSERVATION EFFORTS TO DATE

Interagency Coordination

Management of Rio Grande cutthroat trout has been ongoing for decades, and conservation of the subspecies is a high priority in both states, for conservation and recreational value. The Rio Grande cutthroat trout is the State Fish of New Mexico and an important species for recreational angling in both states. Since the Conservation Agreement was first signed in 2003, the Conservation Team has served to formalize the conservation efforts for the subspecies and provided a forum for interstate and interagency coordination and management. Restoration methods have been developed, formalized, implemented, and adjusted collaboratively since the Conservation Team's establishment, and coordinated management has resulted in the restoration of 13 populations in the last 10 years. The Rio Grande cutthroat trout database was established through the Conservation Agreement and has served as a data repository for all surveys, restorations, habitat work, or barrier maintenance. The sharing and pooling of data among the signatories into a single database has allowed the Team to comprehensively assess the conservation status of Rio Grande cutthroat trout and adjust methods as necessary.

Restoration in New Mexico

In New Mexico, NMDGF began investigating the apparent decline of Rio Grande cutthroat trout during the 1960s and 1970s. A Rio Grande cutthroat trout biologist position was created in 1989 and tasked to coordinate management and conservation efforts of the subspecies for the State. Restoring Rio Grande cutthroat trout to historical habitat requires a large amount of time and manpower, and under the guidance of the Rio Grande cutthroat trout biologist, numerous stream restorations, population surveys, genetic investigations, nonnative species removals, barrier constructions and maintenance, and wildfire rescues have been successfully implemented. The Conservation Agreement has been a catalyst to jumpstart State conservation efforts, underscoring the importance of Rio Grande cutthroat trout to managers and the public. From 2006 to 2012, NMDGF expended, on average, approximately $310,000 per year on conservation and management activities and $400,000 per year on Rio Grande cutthroat trout rearing at Seven Springs State Hatchery. Since 2002, 14 restoration projects have been initiated or completed under the guidance of New Mexico's Rio Grande cutthroat trout biologist (Appendix A). In 2012, a second permanent position was assigned to provide full-time assistance with program activities. On the National Forests, over $1.5 million has been spent on habitat improvement projects, surveys, restorations, and genetic and disease monitoring. The National Forests in New Mexico contribute to conservation of the species by building and repairing barriers, population and habitat monitoring, maintenance and enhancement of pasture fences, non-native removal, and Rio Grande cutthroat trout education (Appendix A).

Restoration in Colorado

In 1973, Colorado listed the Rio Grande cutthroat trout as a State threatened species. Recovery goals were established, and, after an 11-year period of conservation activities, the species was delisted in 1984 (CPW 1992). Rio Grande cutthroat trout is presently designated a species of special concern in Colorado. Conservation activities have been ongoing since 1984 including

population monitoring, restoration projects, broodstock development, genetic testing, barrier construction and habitat improvement (Appendix A). From 2002 to 2011, CPW expended $792,000 on conservation and management activities. Colorado Parks and Wildlife employs an area Aquatic Biologist, and Rio Grande cutthroat trout management is a high priority of the position. Additionally, FWS Partners for Wildlife Program, USFS, NPS, and BLM expended over $1.5 million on habitat improvement projects in Colorado. Since 2002, 4 restoration projects resulting in 5 new conservation populations have been initiated or completed in Colorado. Stream restorations and other conservation actions for the trout continue to be implemented.

Public Education and Outreach

In New Mexico, NMDGF has used several outlets to inform the public about Rio Grande cutthroat trout. Annually, NMDGF produces about 270,000 Fishing Rules and Information booklets to inform anglers about current angling regulations, which includes information regarding Rio Grande cutthroat trout. NMDGF also publishes a newspaper insert titled "New Mexico Wildlife" and produces a television show titled "New Mexico Wild." Both the newspaper and television show are available statewide and have featured Rio Grande cutthroat trout restoration projects. Newer technology such as the NMDGF website and Facebook are available for treatment notices and regulation changes regarding Rio Grande cutthroat trout. NMDGF continues to participate in other public outreach efforts such as public meetings, classroom and local club presentations, "Trout in the Classroom" programs, fishing clinics, and providing signage along Rio Grande cutthroat trout streams. Some examples include signs along Comanche Creek discussing habitat and species restoration; a Rio Grande cutthroat trout costume used for educational events; and Rio Grande cutthroat trout identification pamphlets produced by USFS, BLM, and NMDGF.

In Colorado, CPW has produced a Rio Grande cutthroat trout brochure that describes conservation biology, distribution, and management and conservation actions. Additionally, Colorado has an online fishing atlas that guides anglers to various waters throughout the state including some cutthroat trout recreation waters. Other outreach efforts in Colorado include presentations at fishing clinics and conservation camps where biologists highlight conservation efforts for native fish, including Rio Grande cutthroat trout. On CPW's website, a page is dedicated to cutthroat trout.

As a hands-on approach to public education, the FWS's New Mexico Fish and Wildlife Conservation Office sponsor the Native Fish in the Classroom (NFIC), an environmental education program. Fifth-grade students from several elementary schools learn about natural resource conservation by raising and later releasing native fish into their native habitat. Half of the participating schools raise Rio Grande cutthroat trout fingerlings provided by the Seven Springs Hatchery. Through NFIC, students are given an opportunity to learn the value of aquatic ecosystems by developing personal connections to their native fish. The staff provides technical assistance, classroom presentations, and leads activities throughout the semester. In addition to the NFIC project, staff participates in community outreach efforts including field trips to a river/stream, environmental camps, and community fairs. These events allow for discussion about biology, conservation, native species, and threatened and endangered species.

In 2002, Santa Fe National Forest staff developed a Rio Grande Cutthroat Trout Lifecycle game, and developed a Spanish version in 2006. Additionally, a curriculum was developed supporting the game and correlated to standards set by New Mexico State Department of Education. The Santa Fe National Forest has distributed the game and curriculum to numerous schools and annually provides Rio Grande cutthroat trout education in classrooms, at local festivals, Kid's Fishing Days, and at Water Festivals in Albuquerque, Rio Rancho, and Santa Fe to highlight the importance of Rio Grande cutthroat trout and the threats to the species. The Santa Fe National Forest has also developed a Rio Grande cutthroat trout mascot, "Carlos Cutthroat," which is a full suit resembling a cutthroat trout and often accompanies the classroom presentations. The Santa Fe National Forest has also designed and printed a temporary tattoo for kids featuring a Rio Grande cutthroat trout as part of the Respect the Rio program.

Summary

Range-wide, the total estimated expenditures for Rio Grande cutthroat trout exceeds $12 million since 2002. The Conservation Team members have demonstrated a longstanding commitment to Rio Grande cutthroat trout management that has resulted in the range-wide improvement in the viability of the species.

V. CONSERVATION MEASURES

The specific conservation measures that will be implemented by the Conservation Team are outlined below, organized under the seven Strategic Objectives. An itemized table of the conservation measures for each objective and GMU are provided in Appendix B.

Objective 1: Identify and characterize all Rio Grande cutthroat trout conservation populations and occupied habitat.

Agencies Responsible: Primarily the states, with assistance from all signatories

Actions:

1.1 Populations will generally be monitored every 5 years. Population monitoring will include density estimates for all fish species detected (i.e., number of fish/km of stream) and habitat characterization. Length of occupied habitat shall be determined based on a combination of on-the-ground surveys, maps of perennial waters, and previous information.

1.2 Genetic analyses will be completed on known or suspected Rio Grande cutthroat trout populations that have not yet been genetically tested. Additional analyses will be conducted to update the genetic status of conservation populations where warranted.

1.3 Specific streams to be monitored or genetically analyzed will be discussed every year at the Annual Coordination Meeting (see below) and coordinated by the Conservation Team members. Each year an Annual Work Plan will be completed at the Annual Coordination Meeting. Streams to be worked on in the first year are identified in the current 1-Year Plan in Appendix B.

Objective 2: Secure and enhance conservation populations.

Multiple Rio Grande cutthroat trout conservation populations currently exist in each GMU except Caballo[11]. Securing conservation populations from known threats, such as nonnative fish and disease, will help ensure population persistence across the range (resiliency and redundancy), as well as provide the subspecies with representation across its historical range. A secure population is one with no nonnative fish and a downstream barrier to prevent their introduction. The number of currently secure populations by GMU is shown in Table 1.

Agencies Responsible: State and Federal agencies

Actions: Depending on the needs of the specific stream, these efforts may include, but are not limited to:

2.1 Restrict introduction of nonnative fish species near existing populations.

[11] No current conservation population occurs in the Caballo GMU, and there are historical records for only one population in the area. NMDGF is currently planning to restore a population to this GMU.

2.2 Restrict spread of disease and invasive species.

2.3 Remove nonnative fish species.

2.4 Regulate angling and enforcing regulations.

2.5 Construct in-channel barriers.

2.6 Maintain sources of genetically pure Rio Grande cutthroat trout.

Objective 3: Restore populations.

Agencies Responsible: States as lead with assistance from all signatories

Actions: These efforts include:

3.1 Take restoration actions, as necessary, to maintain secure Rio Grande cutthroat trout populations as shown in Table 1.

3.2 Establish new highly resilient secure conservation Rio Grande cutthroat trout populations distributed among the GMUs as shown in Table 3.

3.3 When restoring populations, ensure that genetic purity of the subspecies and diversity is maintained among the basins and

3.4 Enhance and/or maintain habitat for new populations

Various lengths of stream will be considered for restoration[12], depending on the distribution and status of other populations within the GMU. Large populations that encompass long stretches of habitat provide security from extirpation (resiliency), while smaller populations provide the species security across the landscape (redundancy). For example, if a GMU has a number of populations clustered together, a stream far from that cluster may be identified as a candidate for restoration that is perhaps shorter than other potential reintroduction streams. This would provide the species redundancy within the GMU, reducing the species' vulnerability to the same stochastic event that could affect the clustered populations.

Establishing or maintaining populations among different GMUs will reduce the likelihood of the subspecies being eliminated by stochastic events. This will be accomplished by establishing larger and more complex populations across the range of the subspecies, providing geographic representation in occupied habitats and reducing the likelihood any single catastrophic event will jeopardize the subspecies. If the number of populations distributed among GMUs is not feasible, changes may be addressed in future updates to the strategy. Populations that are free from nonnative trout competition and predation, potential hybridization, and secured by a migration barrier are more likely to persist into the foreseeable future.

One important factor to consider in determining where to implement future restoration efforts is the risk of wildfire. To better understand how Rio Grande cutthroat trout populations could be

[12] "Restoration" in this Conservation Strategy means eliminating nonnative fish, securing the restored stream section with a downstream fish barrier, and reintroducing Rio Grande cutthroat trout to the reach.

affected by wildfire, The Nature Conservancy was contracted by NMDGF to perform a wildfire risk analysis in 2013. Models using landscape scale variables (e.g., forest type, years since last burn) were developed to determine the likelihood of a catastrophic flow event as well as the intensity or severity of such an event. Wildfire risk was determined for each Rio Grande cutthroat trout population, but also at watershed, sub-watershed, and GMU scales. Final products of this contract include a report, map book, and GIS shape files (Miller and Basset 2013). These products improve our understanding of the wildfire risks to specific populations and help to guide restoration and recovery efforts.

Conservation populations of Rio Grande cutthroat trout with a probability of persistence greater than 90 percent (according to the initial BN model) and not sympatric with nonnative salmonids are currently distributed in 4 of the 5 GMUs (Table 3). The number of these populations per GMU provides a conservation target for the restoration of future populations over the next 10 years as a result of implementation of this Conservation Strategy. However, if two highly resilient populations are connected, effectively turning two or more highly resilient populations into one large interconnected population, the number of target populations necessary for the GMU may be reduced (such that development of large, interconnected populations is not discouraged in order to count as additional populations). The table of all current populations by GMU is in Appendix C.

The Conservation Team has determined that the Rio Grande cutthroat trout needs enough resilient populations in each GMU to withstand stochastic events and continue to be represented throughout its historical range. The number of current conservation populations and their distribution per GMU is shown in Table 3 along with the conservation targets to be accomplished over the next 10 years under this Conservation Strategy. The targets are provided as a range to accommodate variable conditions in the field that may enhance or limit restoration opportunities.

Table 3. Current number of populations and population restoration goals for this 10-year Conservation Strategy per GMU[13].

GMU	Populations to be Restored	All Current Conservation Populations		Populations Above 90% Probability of Persistence and no Nonnative Salmonids	
		Current	Total After Restoration	Current	Total After Restoration
Canadian	1-3	11	12-14	6	7-9
Caballo[14]	0-1	0	0-1	0	0-1
Lower Rio Grande	3-5	62	65-67	32	35-37
Pecos	1-3	12	13-15	5	6-8
Rio Grande Headwaters	6-8	42	48-50	17	23-25
Range-wide Total	**11-20**	**127**	**138-147**	**60**	**71-80**

Objective 4: Secure and enhance watershed conditions.

Agencies Responsible: All land management signatories

Actions:

4.1 Protection and enhancement of riparian and instream habitat through grazing and timber management, among others.

4.2 Development and implement a habitat monitoring protocol to evaluate Rio Grande cutthroat trout habitat conditions (Appendix D)

4.3 Using data from habitat monitoring develop strategies to move Rio Grande cutthroat trout habitat towards properly functioning conditions.

- Reduce wildfire risk through fuels reduction and timber management plans.

[13] The number of current highly resilient populations will be updated when the new Rio Grande cutthroat trout BN modeling results are available.

[14] In the Caballo GMU, Rio Grande cutthroat trout restoration will be attempted in Las Animas Creek. If the restoration is unsuccessful due to factors beyond the Conservation Team's control (for example, water chemistry is no longer suitable for the species) and these factors cannot be overcome, restoration will not occur elsewhere in the GMU where the species was not historically known to occur.

- Conduct land management actions so that stream patterns, geometry, and habitats are maintained or improved toward robust stream health.

4.4 Develop and implement a fire and drought contingency plan (Appendix E)

4.5 During plan revision, update resource management plans as necessary to address threats to Rio Grande cutthroat trout habitat and enhance watershed conditions.

The maintenance of high quality Rio Grande cutthroat trout habitat is important to the continued existence of this species. Protection of existing habitat and improvement of habitat, in certain areas, are necessary components of this Conservation Strategy and the maintenance and improvement of the resilience of populations in changing climatic conditions. Healthy watersheds can minimize incidence of fire, flooding, and reduce the severity of drought, increasing the likelihood Rio Grande cutthroat trout populations would survive these events. With this consideration, land management activities will be conducted in such a manner as to protect all stream habitats, including occupied and potential Rio Grande cutthroat trout habitat, and minimize fire risk. Land management activities are currently practiced according to the Carson, Santa Fe, and Rio Grande National Forest Land and Resource Management Plans, and BLM Resource Management Plans. During scheduled revisions, the forests and BLM field offices will evaluate the current Land and Resource Management Plans and update as necessary to provide adequate protection for Rio Grande cutthroat trout with current best management practices. Land management activities that would result in the loss of habitat or cause a reduction in long-term habitat quality will be avoided.

A large amount of habitat improvement work has been completed to date on Federal and private lands including projects such as developing off-stream water sources, fencing riparian areas, placing instream structures to enhance habitat complexity, stabilizing stream banks, riparian plantings, constructing fish migration barriers, closing or relocating roads, culvert removal and/or replacement, improving road runoff and stabilizing road surfaces. Instream habitat improvement allows for increases in population sizes, thereby increasing population resiliency.

Large scale watershed condition (sixth code HUC) was evaluated for all USFS lands in 2011. The factors that were evaluated include:

1. Water Quality
2. Water Quantity
3. Aquatic Habitat
4. Aquatic Biota
5. Riparian/Wetland Vegetation
6. Roads and Trails
7. Soils
8. Fire Regime or Wildfire
9. Forest Cover
10. Rangeland Vegetation
11. Terrestrial Invasive Species
12. Forest Health

These evaluations are scheduled to be done every five years. Range-wide, a large proportion of the watershed conditions within the forests that have Rio Grande cutthroat trout are rated as "functioning at risk," which means that they exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition (USFS 2011). These ratings may not be indicative of the habitat within specific areas that contain Rio Grande cutthroat trout which generally only occupy a small portion of streams within the sixth code HUCs but are a starting point to evaluate range-wide conditions. Watershed Action Plans were developed for priority watersheds within each forest that concentrates management activities. Priority watersheds are the designated watersheds where restoration activities will concentrate on the explicit goal of maintaining or improving watershed condition. The current priority watersheds do not necessarily have conservation populations within them; however, the selected priority watersheds should be updated every five years.

A monitoring protocol has been drafted to document aquatic habitat conditions across all Rio Grande cutthroat trout waters (Appendix D). The protocol was designed to develop a standardized approach that is efficient in both field application and database management, can be repeated from one year to the next, produces comparable data across the range of Rio Grande cutthroat trout, and yields credible information. The intent of the protocol is to conduct the habitat assessment at the time of population monitoring, or, if time constraints do not allow, at least within the same field season. The final protocol will be utilized by cooperating partners to bring consistency to habitat monitoring but is not intended to replace more detailed habitat assessments such as Proper Functioning Condition (PFC), Multiple Indicator Monitoring (MIM), Basin-Wide Stream Habitat Inventory, or other methods. Habitat assessments and habitat improvements are reported in the annual accomplishment reports but the actual data or detailed project report is maintained by the respective agency that conducted the inventory or completed the improvement project. A list of upcoming habitat monitoring and enhancement efforts is included in Appendix B.

Objective 5: Public outreach.

Agencies Responsible: All signatories

Actions Taken:

5.1 Increase awareness of Rio Grande cutthroat trout conservation efforts

5.2 Increase and publicize angling opportunities for Rio Grande cutthroat trout

Public outreach is a critical component to the successful conservation and management of any species. It is vital that the public is informed and allowed to comment on efforts to conserve and manage Rio Grande cutthroat trout. Public outreach should not only inform and educate, but also listen to the public. Public outreach should portray information such as status of the species, restoration efforts, regulations, and socioeconomic factors.

Angling regulations can be an effective fishery management tool to protect fish, if necessary. Fishing regulations in New Mexico and Colorado appropriately manage recreational angling. For example, many of the streams with Rio Grande cutthroat trout are "catch and release."

Those that are not have a two (New Mexico) or four (Colorado) fish limit. Many of the streams with pure populations of Rio Grande cutthroat trout are remote and angling pressure is light.

Objective 6: Data sharing.

Agencies Responsible: States as lead with assistance from all signatories

Actions:

6.1 The Annual Coordination Meeting will be held to update the database with data regarding populations, habitat, genetic status, presence of nonnatives, and other factors.

6.2 The database will be maintained regularly and shared between signatories.

The Rio Grande cutthroat trout database is a crucial component of the work of the Conservation Team. Because it is a central repository of all population and habitat information, it can be used for all manner of analyses of a single population, a GMU, or the species as a whole. The coordination and collaboration that led to the database's early development demonstrates the commitment of the signatories to Rio Grande cutthroat trout conservation.

Objective 7: Coordination.

Agencies Responsible: All signatories

Actions:

7.1 Attend the Annual Coordination Meeting.

7.2 Coordinate the Annual Work Plan among agencies.

7.3 Report results of monitoring.

7.4 Assess whether the Conservation Strategy is achieving its goals and make any changes necessary to ensure goals are being met.

VI. MONITORING AND ADAPTIVE MANAGEMENT

Monitoring

Monitoring will be of two types: implementation and effectiveness. Implementation monitoring will consist of assessing the status and progress of all conservation actions identified in this Conservation Strategy. This type of monitoring will be documented at the Annual Coordination Meeting to ensure the Conservation Team is making expected progress. Effectiveness monitoring will consist of assessing the effectiveness of the conservation actions that have been completed to date compared to the previous year's annual work plan. Both implementation and effectiveness monitoring will be reviewed at the annual meeting of the Rio Grande Cutthroat Trout Conservation Team. Although this is not a formal Adaptive Resource Management plan, the Conservation Team has the ability to respond to changing conditions and updates in scientific approaches. The Annual Coordination Meeting serves as the forum for adapting conservation measures as necessary to changing conditions. Appendix B lists the monitoring actions that will be taken under this Conservation Strategy.

Annual Coordination Meeting

Every year of the Agreement, CPW and NMDGF will convene a meeting of the Conservation Team for an annual review of conservation activities. Additional meetings may be called as necessary to fulfill the commitments of this Conservation Strategy.

Annual Reporting

In cooperation with and approval by all involved parties, the Conservation Team will record and distribute an annual report that consists of:

A. The minutes of the annual meeting encompassing the discussion regarding status of the species and actions accomplished,

B. An updated Summary of Activities table (Appendix B) showing the past year's accomplishments,

C. Results of the annually updated status assessment database, and

D. Proposed or planned activities for the next field season (Annual Work Plan).

In addition to the annual report, every 5 years the Conservation Team will complete the Rio Grande cutthroat trout range-wide Status Assessment as described in the Conservation Agreement.

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APPENDIX A. Conservation Actions Ongoing and Completed for Rio Grande Cutthroat Trout (RGCT) since 2000 by Conservation Team

Project	Responsible Party	Scheduled Year of Completion	Cost Estimate	Project Status	Description
Conservation Actions in Colorado					
Costilla Creek / Glacier Lake Reclamation	CPW	2002	$29,371	Complete	Removed all fish in the treatment area and reintroduced native Rio Grande cutthroat trout
Big Springs Creek Reclamation	CPW	2003	$10,200	Complete	Removed all fish in the treatment area and reintroduced native Rio Grande sucker and Rio Grande cutthroat trout
Conejos River, Lake Fork Reclamation	CPW	2004	$22,150	Complete	Removed all fish in the treatment area and reintroduced native Rio Grande sucker and Rio Grande cutthroat trout
Placer Creek Reclamation	CPW	2007	$35,384	Complete	Removed all fish in the treatment area and reintroduced native Rio Grande sucker and Rio Grande cutthroat trout
Placer Creek Reclamation	CPW	2009	$32,400	Complete	Removed all fish in the treatment area and reintroduced native Rio Grande sucker and Rio Grande cutthroat trout. Sampling in 2008 revealed that trout survived the 2007 treatment.
Genetic Testing ($9,000 Annually)	CPW	2002 - 2011	$90,000	Ongoing	Assess genetic purity of RGCT populations
Cutthroat trout production ($7,500 Annually)	CPW	2002-2011	$75,000	Ongoing	10 year total cost to produce 1,056,042 fingerling RGCT, not including stocking costs
Operations Cost ($16,631 Annually)	CPW	2002 - 2011	$166,310	Ongoing	Supplies, equipment, travel
Fish Biologist and student labor ($50,000 Annually)	CPW	Ongoing	$500,000	Ongoing	Population sampling, coordination, database management, etc.
Senior Fish Biologist - RGCT Labor ($17,000 Annually)	CPW	Ongoing	$170,000	Ongoing	Population sampling, coordination, database management, etc.

Project	Responsible Party	Scheduled Year of Completion	Cost Estimate	Project Status	Description
Drake Barrier Project	FWS - Partners for Fish & Wildlife	2003	$7,500	Complete	Construction of new fish barrier on Carnero Creek
Cuates, Torcido, Jaroso and Placer Creek Fish Barriers	FWS - Partners for Fish & Wildlife	2006	$110,000	Complete	New barriers on Cuates, Torcido, & Jaroso Creeks
Repair TU barriers on Placer Creek	FWS - Partners for Fish & Wildlife	2009	$16,190	Complete	Repair of 3 barriers built by TU on Placer Creek
Alamosito Creek Barrier	FWS - Partners for Fish & Wildlife	2010	$11,532	Complete	New Rock Barrier and repair barrier on Cuates Creek
Big Springs Creek Fen Protection	USFS	2007	$3,500	Complete	Protected important fen/spring source from grazing impacts
Big Springs Creek Culvert replacement(s)	USFS	2009	$36,125	Complete	Replaced two road culverts to allow fish passage
Big Springs Creek Picnic Area Improvement	USFS	2010	$5,000	Complete	Installed foot bridges across main spring source to reduce impacts to spring and reduce sedimentation
Big Springs Creek Barrier Repair	USFS	2011	$4,500	Complete	Completed maintenance on existing barrier
Middle Fork Carnero Creek Barrier Construction	USFS	2002	$12,000	Complete	Constructed fish migration barrier
Middle Fork Carnero Creek Storm King Culvert Replacement	USFS	2010	$12,500	Complete	Replaced Storm King road culvert to allow fish passage
Middle Fork Carnero Creek Road Closures	USFS	2011	$2,500	Complete	Closed and barricaded two unauthorized roads in the riparian area
Middle Fork Carnero Creek 41G Culvert Replacement	USFS	2012	$23,415	Complete	Replace culvert on FSR 41G that will allow fish passage
Middle Fork Carnero Creek Spring Developments	USFS	2012	$29,000	Complete	Two spring development projects to augment stream flow

Project	Responsible Party	Scheduled Year of Completion	Cost Estimate	Project Status	Description
North Fork Carnero Creek Road Culvert Replacement	USFS	2009	$12,050	Complete	Replaced road culvert to allow fish passage
Prong Creek Culvert Replacement	USFS	2009	$24,000	Complete	Replaced two road culverts to allow fish passage
Cave Creek Culvert Removal	USFS	2010	$4,500	Complete	Removed road culvert that was not fish passable and replaced with a hardened crossing
Wolf Creek Culvert Repair	USFS	2010	$22,500	Complete	Modified existing railroad culvert barrier that protects historical RGCT population
Lake Fork Conejos Barrier Repair	USFS	2005	$12,400	Complete	Increased height of barrier and installed concrete splashpad
La Garita Creek Evaluation	USFS/BLM	2008	$10,000	Complete	Assessment work to evaluate if drainage is suitable for RGCT reintroduction
La Garita Creek Culvert Replacement	USFS/BLM	2008	$63,000	Complete	Replaced three road culverts to allow fish passage
Genetic Analysis	USFS	2001-2003	$24,700	Complete	Provide funding for RGCT genetic analysis for populations in CO
Stream Crossing Assessments	USFS/BLM	2006 - 2007	$15,000	Complete	Conducted stream crossing assessments on all Core/Cons Core RGCT streams
Fish Biologist - Labor RGCT Program Management ($15,000 Annually)	USFS/BLM	2002 - 2011	$150,000	Ongoing	Fish Bio's commitment to RGCT activities and projects
Ponds removed at Sand Creek, Great Sand Dunes National Park and Preserve	National Park Service	2012	$500,000	complete	National Park Service removed constructed ponds on Sand Creek to break whirling disease cycle and prepare for reclamation of RGCT
Sand Creek Reclamation project	National Park Service	2016	$550,000	ongoing	NEPA compliance to start in 2014
2002 - 2011 Total RGCT Costs in Colorado			**$2,717,727**		

Project	Responsible Party	Scheduled Year of Completion	Cost Estimate	Project Status	Description
Conservation Actions in New Mexico					
Costilla Creek / Glacier Lake Reclamation	NMDGF	2002	$75,000	Complete	Remove all fish in the treatment area and reintroduce native Rio Grande cutthroat trout
Rio Capulin Reintroduction	NMDGF	2006	$10,000	Complete	Stocked RGCT post-fire
Comanche Creek Barrier Construction	USFS/Trout Unlimited (TU)	2007	$75,000	Complete	Constructed fish migration barrier
Pinelodge Creek	NMDGF	2008	$5,000	Complete	Stocked RGCT post-fire
Comanche Creek	NMDGF	2008	$200,000	Complete	Remove all fish in the treatment area and reintroduce native Rio Grande cutthroat trout
Costilla Creek	NMDGF	2008	$15,000	Complete	Remove all fish in the treatment area and reintroduce native Rio Grande cutthroat trout
Santistevan Creek Culvert Modification	Turner Enterprises, Inc. (TEI)	2009	$4,500	Complete	Constructed fish migration barrier
Santistevan Creek/Casias Lakes	NMDGF	2010	$25,000	Complete	Remove all fish in the treatment area and reintroduce native Rio Grande cutthroat trout
Santa Clara Creek Restoration Project	FWS	2010	$136,500	Complete	Remove all fish in the treatment area and reintroduce native Rio Grande cutthroat trout
#2 Creek Barrier Construction	TEI	2010	$70,069	Complete	Constructed fish migration barrier
#2 Creek	NMDGF	2011	$45,000	Complete	Remove all fish in the treatment area and reintroduce native Rio Grande cutthroat trout
Allen Creek Barrier Construction	TEI	2012	$13,753	Complete	Constructed fish migration barrier
Dominguez Creek Culvert Modification	TEI	2012	$4,500	Complete	Constructed fish migration barrier

Project	Responsible Party	Scheduled Year of Completion	Cost Estimate	Project Status	Description
Allen Creek	NMDGF	2012	$5,000	Complete	Remove all fish in the treatment area and reintroduce native Rio Grande cutthroat trout
Dominguez Creek	NMDGF	2012	$3,000	Complete	Remove all fish in the treatment area and reintroduce native Rio Grande cutthroat trout
Alamitos Creek Barrier Construction	USFS/TU	2012	$60,000	Complete	Constructed fish migration barrier
Genetic Testing ($15,000 annually)	NMDGF	2002-2012	$115,000	Ongoing	Assess genetic purity of RGCT populations
7 Springs Hatchery Operating Budget	NMDGF	2002-2012	$4,400,000	Ongoing	Rear RGCT for conservation and recreation stocking
RGCT Program Operational Costs	NMDGF	2002-2012	$2,900,000	Ongoing	Operational costs associated with RGCT program not specifically listed
Comanche Creek Habitat Restoration	USFS	2002 - 2012	$120,000	Ongoing	Instream and riparian habitat improvements
Tanques Creek Barrier Construction	USFS/TU	2013	$64,600	Ongoing	Constructed fish migration barrier
RGCT Education	USFS	2005-2011	$211,997	Ongoing	Developed a Rio Grande Cutthroat Trout Lifecycle game & curricula. Developed a RGCT mascot, "Carlos Cutthroat." Designed a temporary tattoo for kids featuring a Rio Grande cutthroat trout as part of the Respect the Rio program.
Habitat Inventory of upper Rio Cebolla, Rio Nambe, Rio Capulin, Rio Mora, Cañones, Rio de las Vacas, Rio Frijoles, Pecos River, Chihuahueños Creek, Polvadera Creek, Cave Creek, Rio Puerco, Capulin Canyon	USFS	2001-2011	$350,000	Ongoing	161 miles of habitat inventory in Rio Grande cutthroat trout occupied streams, using USFS Region 3 Stream Habitat Inventory protocol

Project	Responsible Party	Scheduled Year of Completion	Cost Estimate	Project Status	Description
Temperature Monitoring of Cañones Creek, Capulin Creek, Chihuahueños Creek, Polvadera Creek, Jack's Creek, La Jara Creek, Rio Cebolla, Rio de las Vacas, Rio del Oso, Rio Frijoles, Rio Medio, Rio Mora, Rio Puerco, Rito Peñas Negras, Cave Creek, Dalton Creek, Doctor Creek, Rio Nambe, Peralta Creek	USFS	2001-2011	$20,000	Ongoing	Thermograph placement & download for temperature monitoring in Rio Grande cutthroat trout streams.
Cañones Creek Habitat Improvement	USFS	2004	$49,750	Complete	Large woody debris was placed in the stream and on the floodplain to create instream habitat, reduce cattle trampling on the streambanks, and close off an ATV trail across the stream. A livestock water trick tank was built to pull cattle away from the stream and into the uplands.
Rio Cebolla Willow Planting	USFS	2005	$5,500	Complete	Willows were planted along the Rio Cebolla to stabilize stream banks, provide shade to the stream, and expand beaver population along the river corridor
Rio de las Vacas Barrier Repair	USFS	2009	$10,000	Complete	Increased height of barrier and repaired splashpad
Peralta Canyon Watershed Habitat Improvement Project	USFS	2009	$25,000	Complete	1) Ballards were placed at the end of FR280 to keep full-size vehicles and ATVs from accessing the stream; 2) livestock/elk exclusion fencing was placed around an area designated by the fisheries biologist where the ungulate impacts have caused braiding and sediment into stream; 3) large wood debris was added to the stream by dropping >12-14" trees across stream and in riparian corridor; 4) a bridge crossing was placed on the trail at Peralta Creek.
Polvadera Creek Riparian Improvements	USFS	2009	$20,000	Complete	Road closure via installation of a boulder barrier & repair of riparian fence to keep cattle out; completed by YCC through §319 grant
Rio Cebolla Riparian Improvements	USFS	2009	$17,000	Complete	4 new gates along 5.5 miles of the upper Rio Cebolla to keep cattle & OHVs out of stream; funded through §319 grant

Project	Responsible Party	Scheduled Year of Completion	Cost Estimate	Project Status	Description
Rito Café Stream Habitat Improvements	USFS	2009	$10,000	Complete	The goal of the project was to improve stream habitat by increasing the amount of large woody debris in and adjacent to approx. 3.8 miles of Rito Penas Negras and Rito Cafe.
Rio Cebolla Riparian Improvements	USFS	2011	$16,700	Complete	Protect sustaining & restore degraded habitat; cleared encroaching conifer from 5 acres of historical meadows along the upper Rio Cebolla. To increase water availability, increase grasses and forbs and water filtration in the riparian area.
Rio Cebolla Riparian Improvements	USFS	2011	$5,000	Complete	Protect sustaining & restore degraded habitat; 16 volunteers from New Mexico Trout repaired fencing along the Rio Cebolla to prevent cattle and vehicles from accessing the riparian meadows on the Rio Cebolla upstream of McKinney Dam.
Cañones Creek Riparian Improvements	USFS	2010	$60,000	Complete	Water-bar and reconstruct portions of the Cañones National Recreation Trail (#97), along with portions of trails on Mesa del Media and Mesa Escoba, which drain into Cañones Creek
Polvadera Creek Riparian Improvements	USFS	2011	$2,500	Complete	Protect sustaining & restore degraded habitat; repaired three miles of riparian fence damaged during flooding following the 2010 South Fork wildfire
Wildfire coordination and BAER assessments for the South Fork, Pacheco, and Las Conchas wildfires	USFS	2010-2011	$10,000	Complete	Coordinated work around RGCT streams with Las Conchas, Pacheco, and South Fork Fire Incident Mgt Teams, District Resource Advisors, and Burned Area Emergency Response Teams
Fish Biologist & Student- Labor RGCT Program Management ($15,000 Annually)	USFS	2002 - 2011	$200,000	Ongoing	Fish Biologist's commitment to RGCT activities and projects

Project	Responsible Party	Scheduled Year of Completion	Cost Estimate	Project Status	Description
Carson National Forest-wide population monitoring	USFS	2001-2012	$26,800	Complete	Population monitoring of Frijoles creek, Palociento creek, Comanche creek, Tio Grande, Santa Barbara, San Cristobal, La Press, San Antonio, Angostura, Tanques, Arose, La Junta, Policarpio, Alamitos, Cabresto Creek, Frijoles, Agua Piedra, Comales, Osha, La Presa, Sardinas.
Carson National Forest-wide exotic removals	USFS	2001-2012	$7,000	Ongoing	Removal of nonnative trout from Frijoles creek, Luna creek, Tio Grande creek, Palociento creek, Santa Barbara drainage, Tanques, Palociento
Wild spawn	USFS	2001-2012	$6,000	Complete	Field spawn of wild Rio Grande cutthroat trout from El Rito creek and Policarpio
Barrier maintenance	USFS	2001-2012	$12,000	Ongoing	Maintain and improve fish migration barriers on Palociento creek, Frijoles creek, Tio Grande Creek, Tanques creek
Comanche Barrier Hydrological analysis contract	USFS	2001	$10,000	Complete	Contract for hydrological analysis of potential barrier sites along Comanche creek in preparation of barrier design and construction.
North Ponil/ McCrystal creek habitat inventory	USFS	2004	$18,200	Complete	Habitat inventory survey done to facilitate future habitat improvement projects
Watershed improvement project to improve RGCT habitat and water quality in Rito de la Olla and Comanche creek.	USFS	2003 -2010	$22,800	Complete	Closing 12 miles of road and drainage improvement to reduce sediment in Rito de la Olla, and construction of 2 miles of exclosure on Comanche creek. Riparian willow exclosures
Fish Migration study	USFS	2003	$2,000	Complete	Collected and analyzed data using Fish passage and Fish Xing software to determine If selected culverts were acting as fish migration barriers.
Santa Barbara restoration.	USFS	2003	$9,000	Complete	Population surveys, macroinvertebrate collection and analysis, genetic collection, and removal of nonnative trout.
Rio Costilla restoration	USFS	2002-2012	$99,900	Ongoing	NEPA clearance for habitat improvement projects, Population monitoring, barrier permit acquisition, habitat restoration.

Project	Responsible Party	Scheduled Year of Completion	Cost Estimate	Project Status	Description
Carson National Forest genetics and disease monitoring	USFS	2002-2004	$9,600	Complete	Collecting genetics Carson National Forest-wide and collecting fish forest wide to have disease analysis done.
McCrystal Creek habitat improvement project	USFS	2002	$11,000	Complete	Riparian exclosures installed to reduce grazing impacts on McCrystal Creek.
Aquatics program administration associated with RGCT	USFS	2002-2010	$180,000	Ongoing	Aquatics program Manager and Forest Fisheries Biologist committed to RGCT activities and projects ($20,000 annually)
Alamitos barrier	USFS	2011-12	$5,800	Ongoing	NEPA clearance to construct Migration Barrier.
2001 – 2012 Total RGCT Costs in New Mexico			**$9,357,184**		
2001 – 2012 TOTAL RGCT COSTS			**$12,074,911**		

APPENDIX B. Conservation Actions to be Implemented under the Conservation Strategy.

1-Year Plan, 2014, Rio Grande Cutthroat Trout Conservation Strategy

Conservation Actions		GMU				
		Rio Grande Hdws.	Lower Rio Grande	Pecos	Canadian	Caballo
Objective 1: Identify and characterize all RGCT Core and Conservation Populations and Occupied Habitat.						
1.1	Population Monitoring	Placer Creek, South Placer Creek, Middle Placer Creek, Grayback Creek, North Trinchera Creek, South Trinchera Creek, , Bernardino Creek	CPW: East Costilla Creek, West Costilla Creek, Glacier Lake NMDGF: Capulin Creek, Guaje Canyon, Polvadera Creek, Comanche Creek	Bonito Creek		Las Animas Creek
1.2	Genetic Analysis	Placer Creek, Alamosito Creek, Jaroso Creek, Bernardino Creek, Lake Fork Conejos, Roaring Fork	CPW: Nabor Creek NMDGF: Rio Lucero	Jack's Creek, Bear Creek or other to be determined		
Objective 2: Secure and enhance conservation populations.						
2.1	Restricting introduction of nonnative fish species	CPW Regulations: Chapter 0, Article VII, #013 Release of Aquatic Wildlife; Appendix C Cutthroat Trout Waters NMAC 19.35.7: Importation of live non-domestic animals, birds, and fish				
2.2	Restricting spread of disease and invasive species	Colorado Parks and Wildlife Commission Police D-9; CPW Regulations: Chapter 0, Article VII, #014 NMAC 19.30.14: Providing for the control and prevention of the spread of aquatic invasive species in New Mexico				
2.3	Removing nonnative fish species	Alamosito Creek	NMDGF: Rio Cebolla			

Conservation Actions		GMU				
		Rio Grande Hdws.	Lower Rio Grande	Pecos	Canadian	Caballo
2.4	Regulating angling and enforcement	CPW Regulations: Chapter 1, Article II, #108 Special Regulation Waters NMAC 19.31.4.11: Daily bag, possession limits, and requirements or conditions				
2.5	Constructing in-channel barriers	Identify suitable locations for barriers on Trinchera Creek	Beaver Lake Creek barrier construction		Evaluate barrier on South Ponil Creek	
2.6	Maintaining sources of genetically pure RGCT	Identify new donor population for broodstock at Haypress Lake	Field spawn in Powderhouse Creek, Alamitos Creek, and Policarpio Creek. Continued hatchery propagation.	Rescue Macho creek fish in response to Tres Lagunas Fire		
Objective 3: Restore RGCT Populations						
3.1	Establishing and/or maintaining RGCT populations (Table 3)	Prepare, including NEPA analysis for Roaring Fork/Haypress Lake project, Trinchera Creek Project. Continue assessment of Sand Creek, including initiation of NEPA	Reintroduce RGCT to Allen Creek			Prep for Las Animas Creek restoration project
3.2	Maintaining genetic purity of the species among the basins	Conduct genetic analysis on selected populations, continued use of triploid rainbow trout throughout New Mexico, broodstock developed to maintain basin-scale lineages				
Objective 4: Secure and enhance watershed conditions						

Conservation Actions		GMU				
		Rio Grande Hdws.	Lower Rio Grande	Pecos	Canadian	Caballo
4.1	Enhancing and protecting instream and riparian habitat	-Improve road drainage in Big Spring Creek watershed -Remove & replace culverts in East Pass Creek -Close unauthorized roads in riparian areas -Implement riparian management in the La Garita Hills Analysis Area	Grassy Creek and Chuckwagon Creek riparian and instream restoration	BAER planning & implementation for Tres Lagunas & Jarosa wildfires		
4.2	Developing and implementing habitat monitoring protocol	Continue to develop habitat monitoring protocol Follow-up fish & habitat monitoring for RGCT streams impacted by wildfires				
Objective 5: Public Outreach						
5.1	Public Outreach	Trout in the Classroom RGCT rearing and release, oral presentation at Gila/Rio Grande chapter of Trout Unlimited meeting, "Respect the Rio" program on Santa Fe NF, Rio Grande cutthroat trout lifecycle curriculum at Water Festivals in Albuquerque, Rio Rancho, Santa Fe (~ 1,000 kids & adults); and local community events (~ 300 kids & adults) Rio Grande Hdws.: Oral presentations to San Luis Valley chapter of Trout Unlimited, Beaver Creek, Conejos County and Costilla County Youth Naturally conservation camps. Publish conservation strategy and agreement on CPW website.				
Objective 6: Data Sharing						
6.1	Annual meeting will be held for database updates	Annual database update meeting, March 2013, Monte Vista, CO				
6.2	Maintaining and sharing database between signatories.	Continue contract with database manager				

Conservation Actions		GMU				
		Rio Grande Hdws.	Lower Rio Grande	Pecos	Canadian	Caballo
Objective 7: Coordination						
7.1	Attending annual range-wide coordination meeting	Annual Meeting, January 2013, Alamosa, CO				
7.2	Coordinating annual work plan among agencies	Maintain relationships and coordinate annual work plans among agencies through personal communication and meeting attendance				
7.3	Reporting results of monitoring	Compile Accomplishments Report for 2012, enter monitoring data into range-wide database				
7.4	Assessing success of Conservation Strategy and making changes as needed	Complete 5 year Status Assessment Report; Renew Conservation Agreement				

10-Year Plan, 2014-2024, Rio Grande Cutthroat Trout Conservation Strategy

Conservation Actions		GMU				
		Rio Grande Hdws.	Lower Rio Grande	Pecos	Canadian	Caballo
Objective 1: Identify and characterize all RGCT Core and Conservation Populations and Occupied Habitat.						
1.1	Population Monitoring	Monitor 10 populations/year	Monitor 10 populations	Monitor 8 populations	Monitor 5 populations	Monitor one population every couple of years
1.2	Genetic Analysis	Collect genetic specimens as necessary to determine purity of populations	Collect genetic specimens as necessary to determine purity of populations	Collect genetic specimens as necessary to determine purity of populations	Collect genetic specimens as necessary to determine purity of populations	Collect genetic specimens as necessary to determine purity of populations
Objective 2: Secure and enhance conservation populations.						
2.1	Restricting introduction of nonnative fish species	CPW Regulations: Chapter 0, Article VII, #013 Release of Aquatic Wildlife; Appendix C Cutthroat Trout Waters NMAC 19.35.7: Importation of live non-domestic animals, birds, and fish				
2.2	Restricting spread of disease and invasive species	Colorado Parks and Wildlife Commission Police D-9; CPW Regulations: Chapter 0, Article VII, #014 NMAC 19.30.14: Providing for the control and prevention of the spread of aquatic invasive species in New Mexico				
2.3	Removing nonnative fish species	Conduct non-native trout removals as necessary.	Conduct nonnative fish removals on an annual or biannual basis			
2.4	Regulating angling and enforcement	CPW Regulations: Chapter 1, Article II, #108 Special Regulation Waters				

Conservation Actions		GMU				
		Rio Grande Hdws.	Lower Rio Grande	Pecos	Canadian	Caballo
2.5	Constructing in-channel barriers	Improve or install barriers to facilitate possible restoration projects	Improve or install barriers to facilitate possible restoration projects	Improve or install barriers to facilitate possible restoration projects	Improve or install barriers to facilitate possible restoration projects	Improve or install barriers to facilitate possible restoration projects
2.6	Maintaining sources of genetically pure RGCT	Maintain genetic purity of broodstocks	Continue field and hatchery spawn operations	Continue field and hatchery spawn operations	Continue field and hatchery spawn operations	Continue field and hatchery spawn operations
Objective 3: Restore RGCT Populations						
3.1	Establishing and/or maintaining RGCT populations (Table 3)	Restore 6-8 conservation populations,	Restore 3-5 conservation populations	Restore 1-3 conservation populations	Restore 1-3 conservation population	Restore 1 conservation population
3.2	Conduct genetic analysis on selected populations, continued use of triploid rainbow trout statewide, broodstock developed to maintain basin-scale lineages					
Objective 4: Secure and enhance watershed conditions						
4.1	Enhancing and protecting instream and riparian habitat	Habitat enhancement on up to 5 miles of RGCT stream, continue culvert & barrier assessments, repairs, and replacements	Habitat enhancement on 5 miles of RGCT stream; 20 acres of watershed/riparian protection	Habitat enhancement on 5 miles of RGCT stream; 20 acres of watershed/riparian protection		
4.2	Developing and implementing habitat monitoring protocol	Implement habitat monitoring protocol Fish & habitat monitoring for RGCT streams impacted by wildfire Fish and habitat monitoring on RGCT streams associated with forest management activities.				

Conservation Actions		GMU				
		Rio Grande Hdws.	Lower Rio Grande	Pecos	Canadian	Caballo
Objective 5: Public Outreach						
5.1	Public Outreach	Trout in the Classroom RGCT rearing and release, "Respect the Rio" program on Santa Fe NF, publicize fishing opportunities for RGCT, present information at NGO and other public meetings Rio Grande cutthroat trout lifecycle curriculum at Water Festivals in Albuquerque, Rio Rancho, Santa Fe (annually ~ 1,000 kids & adults); local community events (annually ~ 300 kids & adults); updated Forest website with curriculum and education materials Rio Grande Hdws.: Oral presentations to San Luis Valley chapter of Trout Unlimited, Beaver Creek, Conejos County and Costilla County Youth Naturally conservation camps. Update RGCT conservation brochure. Publish conservation strategy and agreement on CPW website.				
Objective 6: Data Sharing						
6.1	Annual meeting will be held for database updates	Attend annual database update meeting				
6.2	Maintaining and sharing database between signatories.	Maintain, improve, and update range-wide database				
Objective 7: Coordination						
7.1	Attending annual range-wide coordination meeting	Attend annual range-wide coordination meeting				
7.2	Coordinating annual work plan among agencies	Maintain relationships and coordinate annual work plans among agencies through personal communication and meeting attendance				
7.3	Reporting results of monitoring	Compile Accomplishments Reports, enter monitoring data into range-wide database				
7.4	Assessing success of Conservation Strategy and making changes as needed	Complete 5 year Status Assessment Report; Renew Conservation Agreement				

APPENDIX C. Status of Current Conservation Populations of Rio Grande cutthroat trout.

Asterisks (*) indicate a population has a higher than 90 percent probability of persistence with no nonnative salmonids present. Information on conservation populations in this table is based on the 2012 database, which is populated with data from 2011. The Conservation Team is aware that since 2011, some populations have been extirpated due to the effects of wildfire, while other populations have been restored. In order to input data accurately and allow for review, there is a significant time lag before an updated database is available. The 2012 database represents the best information available to the team.

Population ID	Stream Names	GMU	Factors	
			Occupied Stream Length (km)	Nonnative Salmonids Present?
11080001cp001	Ricardo, Elk, Gold, Leandro, Vermejo	Canadian	69.3	Yes
11080001cp002	Little Vermejo	Canadian	11.9	Yes
11080001cp003	Leandro	Canadian	3.1	Yes
11080002cp001	McCrystal, North Ponil*	Canadian	15.2	No
11080002cp002	South Ponil*	Canadian	15.2	No
11080002cp003	Middle Ponil*	Canadian	9.6	No
11080002cp005	Clear*	Canadian	7.5	No
11080004cp001	Luna East Fork	Canadian	6.8	Yes
11080004cp002	Luna West Fork	Canadian	4.6	Yes
11080004cp003	Rito Murphy*	Canadian	6.8	No
11080004cp004	Santiago*	Canadian	6.6	No
13010001cp002	West Alder	Headwaters	7.2	Yes
13010002cp001	San Francisco*	Headwaters	25.3	No
13010002cp002	Cat*	Headwaters	15.1	No
13010002cp003	Rhodes Gulch	Headwaters	3.5	No
13010002cp004	Torsido	Headwaters	10.4	Yes
13010002cp005	Jim	Headwaters	10.2	Yes
13010002cp006	Cuates*	Headwaters	6.1	No
13010002cp007	Jaroso*	Headwaters	9.3	No
13010002cp008	Jaroso	Headwaters	6.2	Yes
13010002cp009	Torcido*	Headwaters	13.2	No
13010002cp010	Alamosito	Headwaters	4.9	Yes
13010002cp011	Vallejos	Headwaters	22.5	Yes
13010002cp012	Trinchera, Deep Canyon	Headwaters	18.9	Yes
13010002cp014	Trinchera North Fork	Headwaters	11.5	Yes
13010002cp015	West Indian, South Fork West Indian	Headwaters	17.1	Yes
13010002cp016	Placer, Middle Placer, South Placer, Grayback*	Headwaters	45.7	No
13010002cp016	Lower (Placer, Sangre De Cristo, Wagon)	Headwaters	63.0	Yes
13010002cp017	Little Ute	Headwaters	2.7	No
13010002cp018	Cuates	Headwaters	5.5	Yes
13010002cp019	Torcido	Headwaters	3.3	No
13010002cp020	Alamosito	Headwaters	0.8	Yes
13010003cp001	Medano*	Headwaters	28.8	No
13010004cp001	Whale*	Headwaters	4.2	No
13010004cp002	East Pass Creek*	Headwaters	11.2	No

Population ID	Stream Names	GMU	Factors	
			Occupied Stream Length (km)	Nonnative Salmonids Present?
13010004cp003	Cross, Jacks*	Headwaters	12.9	No
13010004cp003	Lower (Cross, Jacks)	Headwaters	18.5	Yes
13010004cp004	East Middle*	Headwaters	4.9	No
13010004cp006	Big Springs*	Headwaters	4.1	No
13010004cp007	Carnero Middle Fork*	Headwaters	11.3	No
13010004cp008	Carnero North Fork*	Headwaters	13.0	No
13010004cp010	Carnero South Fork	Headwaters	22.7	Yes
13010004cp011	Miners, Prong	Headwaters	13.0	Yes
13010004cp012	Cave	Headwaters	10.2	Yes
13010005cp001	Tio Grande	Headwaters	7.6	Yes
13010005cp002	Tio Grande	Headwaters	4.5	Yes
13010005cp003	Tanques	Headwaters	2.9	Yes
13010005cp004	Rio Nutritas	Headwaters	5.1	Yes
13010005cp006	Osier*	Headwaters	5.9	No
13010005cp007	Lake Fork Conejos	Headwaters	1.0	No
13010005cp008	Lake Fork Conejos*	Headwaters	4.0	No
13010005cp009	Rio De Los Pinos	Headwaters	0.9	No
13010005cp010	Cascade*	Headwaters	4.7	No
13020101cp001	Costilla, East Costilla, West Costilla, State Line*	LowerRG	14.6	No
13020101cp002	Costilla, Frey, Glacier, Patten*	LowerRG	15.2	No
13020101cp003	Powderhouse*	LowerRG	6.2	No
13020101cp004	Powderhouse	LowerRG	2.1	Yes
13020101cp005	La Cueva*	LowerRG	5.1	No
13020101cp006	Comanche, Gold, Grassy, Holman, LaBelle*	LowerRG	44.7	No
13020101cp007	Chuck Wagon, Comanche, Fernandez*	LowerRG	8.6	No
13020101cp007	Lower (ChuckWagon, Comanche, Fernandez)	LowerRG	5.5	Yes
13020101cp008	Ute*	LowerRG	13.8	No
13020101cp009	Cabresto	LowerRG	13.7	Yes
13020101cp010	Bitter	LowerRG	2.9	No
13020101cp011	Columbine, Deer, PlacerFk, Willow*	LowerRG	10.7	No
13020101cp011	Lower (Columbine, Deer, Placer Fork, Willow)	LowerRG	7.1	Yes
13020101cp012	San Cristobal*	LowerRG	6.5	No
13020101cp013	Yerba	LowerRG	4.7	Yes
13020101cp015	Italianos*	LowerRG	3.8	No
13020101cp016	Gavilan	LowerRG	3.4	Yes
13020101cp017	Rio Hondo South Fork	LowerRG	6.3	Yes
13020101cp018	Tienditas	LowerRG	3.2	Yes
13020101cp019	Frijoles	LowerRG	5.0	Yes

Population ID	Stream Names	GMU	Factors	
			Occupied Stream Length (km)	Nonnative Salmonids Present?
13020101cp020	Palociento	LowerRG	3.9	Yes
13020101cp021	Rio Grande Del Rancho	LowerRG	4.3	Yes
13020101cp022	Rito La Presa*	LowerRG	9.1	No
13020101cp022	Lower (Rito La Presa)	LowerRG	5.8	Yes
13020101cp023	Policarpio*	LowerRG	4.8	No
13020101cp024	Osha*	LowerRG	8.8	No
13020101cp025	Rito Angostura*	LowerRG	6.4	No
13020101cp026	Alamitos*	LowerRG	4.1	No
13020101cp026	Lower (Alamitos)	LowerRG	7.3	Yes
13020101cp027	Rio Santa Barbara Middle Fork	LowerRG	7.0	Yes
13020101cp028	Rio Santa Barbara East Fork	LowerRG	4.1	Yes
13020101cp029	Rio Santa Barbara	LowerRG	14.5	Yes
13020101cp030	Rio De Las Trampas	LowerRG	8.2	No
13020101cp031	Rio San Leonardo*	LowerRG	5.8	No
13020101cp032	Rio De La Cebolla, Rio De La Truchas*	LowerRG	17.2	No
13020101cp034	Rio Quemado*	LowerRG	16.8	No
13020101cp035	Jicarita*	LowerRG	4.1	No
13020101cp036	Indian	LowerRG	2.8	Yes
13020101cp037	Rio Medio	LowerRG	13.1	Yes
13020101cp038	Rio Frijoles, Rio Jaroso	LowerRG	12.5	Yes
13020101cp040	Rio Molino*	LowerRG	5.6	No
13020102cp001	Nabor*	LowerRG	5.9	No
13020102cp002	Little Willow	LowerRG	3.7	Yes
13020102cp003	Poso	LowerRG	3.9	Yes
13020102cp004	Jaroso*	LowerRG	8.0	No
13020102cp005	Canjilon*	LowerRG	8.1	No
13020102cp006	El Rito*	LowerRG	12.7	No
13020102cp007	El Rito	LowerRG	5.3	Yes
13020102cp008	Canones*	LowerRG	10.7	No
13020102cp009	Polvadera*	LowerRG	13.1	No
13020102cp010	Rio Del Oso, Rito De Abiquiu, Rito Del Oso*	LowerRG	12.5	No
13020102cp011	Wolf	LowerRG	0.6	Yes
13020102cp012	Wolf East Fork*	LowerRG	3.7	No
13020201cp001	Capulin*	LowerRG	12.0	No
13020201cp002	Medio Dia Creek	LowerRG	0.7	No
13020202cp001	Rio Cebolla	LowerRG	7.3	Yes
13020202cp002	Rito De Las Palomas	LowerRG	6.9	Yes
13020202cp003	Las Vacas, Anastacio, De Las Perchas*	LowerRG	4.5	No
13020202cp003	Lower (Las Vacas, Anastacio, De Las Perchas)	LowerRG	15.4	Yes
13020204cp001	La Jara*	LowerRG	4.4	No

Population ID	Stream Names	GMU	Factors	
			Occupied Stream Length (km)	Nonnative Salmonids Present?
13020204cp002	Rito De Los Pinos	LowerRG	2.3	Yes
13020204cp003	Rio Puerco*	LowerRG	14.4	No
13060001cp001	Rio Mora	Pecos	2.4	Yes
13060001cp002	Rio Mora Tributary	Pecos	3.2	Yes
13060001cp003	Rio Valdez*	Pecos	3.7	No
13060001cp004	Pecos River*	Pecos	6.3	No
13060001cp005	Rito Del Padre, Rito Maestas	Pecos	9.9	Yes
13060001cp006	Rito Los Esteros	Pecos	2.5	Yes
13060001cp007	Jacks*	Pecos	11.3	No
13060001cp008	Cave	Pecos	2.7	Yes
13060001cp009	Macho	Pecos	3.4	No
13060001cp010	Dalton*	Pecos	6.7	No
13060001cp011	Bear*	Pecos	5.6	No
13060005cp001	Pinelodge	Pecos	3.9	No

APPENDIX D. Draft Habitat Monitoring Protocol

Stream Name:_____ **Code:**_____ **Station #**_____

Location:_____ **Date:**_____

Reach Location: **UTM Start:** Easting_____Northing_____

UTM Finish: Easting_____Northing_____

Personnel:_____

Station Length:_____ **Average Width:**_____ **Water Temp:**_____

Bank Stability: **Right Bank** High (100-90%) Moderate (75-90%) Low (0-75%)

Left Bank High (100-90%) Moderate (75-90%) Low (0-75%)

Streambank vegetative cover (circle): > 25% <25%

Substrate: Sand/Silt**%**_____Gravel%_____Cobble%_____Boulder%_____

Pool:_____% **Riffle:**_____% **Stream Shade:** _____%

General Riparian Condition Comments:

_____

_____

General Comments:

_____

APPENDIX E. Fire and Drought Contingency Plans

Despite habitat enhancement and population restoration, fire and drought will still occur in the region. In the event of fire or drought, the consideration points presented below are a guide for resource managers; other strategies and options may be available. Points to consider prior to intervention include:

1) Is there an eminent threat to the population?
2) Is the population genetically unique (relic) or is it a replicated population?
   - If a relic population, have replicated populations been established and are they safe from the current threat?
3) Would the action cause more harm than good? (e.g. stress associated with electrofishing, handling and transport vs. likelihood of population extirpation)
4) What is the likely timeframe needed to hold Rio Grande cutthroat trout prior to returning to the threatened water body?
5) Is it feasible to hold rescued Rio Grande cutthroat trout for the time projected for recovery?
6) Can required policies and regulations be adhered to in a timeframe that will allow for salvage to occur? e.g. fish health inspection.
7) How accessible are the salvage and secondary water locations?
8) Is the threatened area safe for personnel and will the Fire Incident Commander or Forest Service allow access to the area?

Fire

The available options during and after a wildfire are often limited at best. Not one approach is considered better than the other, but rather what will work best for the threatened population. Previous strategies used by the states of Colorado and New Mexico are:

1) No action
2) Salvage and isolate at a state fish hatchery (temporary).
3) Salvage and transplant to a fishless creek
4) Salvage and house in an isolation unit (Colorado)

Options 2 thru 4 will often require additional actions to comply with state fish health regulations, and ensure genetic purity, such as a complete health inspection and PIT tagging.

Drought

The threats posed by drought can be less time sensitive, but the challenges for successful salvage are equally difficult. In a majority of cases, drought is not localized but rather widespread so the possibility of finding a water body not under the same stressors will be limited, if at all possible. Previous strategies used by the states of Colorado and New Mexico are:

1) No action
2) Salvage and isolate at a state fish hatchery (temporary)

3) Salvage and transplant to a fishless creek
4) Salvage and house in an isolation unit (Colorado)
5) Salvage and re-locate Rio Grande cutthroat trout to a more stable part of the watershed

Options 2 thru 4 will often require additional actions to comply with state fish health regulations, and ensure genetic purity, such as a complete health inspection and PIT tagging.