Rio Grande Chub
Conservation Strategy

by the

Rio Grande Chub and Rio Grande Sucker
Conservation Team

Photo courtesy of Mary Katherine Ray, New Mexico.

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RIO GRANDE CHUB
CONSERVATION STRATEGY

I. BACKGROUND

Summary

Cooperative efforts to manage and conserve Rio Grande Chub *Gila pandora* have been ongoing for decades and were officially formalized in 2016. This Conservation Strategy is a voluntary recommitment to implement these conservation actions that will provide for the long-term viability of Rio Grande Chub 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 approaches by the Rio Grande Chub and Rio Grande Sucker Conservation Team (Team).

Rio Grande Chub and Rio Grande Sucker Conservation Team

The Team was established in 2018, when the Conservation Agreement for the Rio Grande Chub and Rio Grande Sucker (Agreement) was first signed. The Team is comprised of individuals from agencies, tribes, non-profit and private organizations. 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 Chub and Rio Grande Sucker Conservation Team are listed below.

Signatories:

- Colorado Division of Parks and Wildlife (CPW)
- New Mexico Department of Game and Fish (NMDGF)
- U.S. Forest Service (USFS)
- U.S. Fish and Wildlife Service (FWS)
- Taos Pueblo
- Texas Parks and Wildlife Department (TPWD)
- Jicarilla Apache Nation
- National Park Service (NPS)
- Bureau of Land Management (BLM)
- Turner Enterprises, Inc.
- Pueblo of Santa Ana
- Coalition of Colorado Counties

Supporting Organizations:

- Trout Unlimited New Mexico Council
- Rio Grande Water Conservation District
- Fishes of Texas Project

Purpose

The Team was formed to assure the long-term viability of Rio Grande Chub and Rio Grande Sucker throughout their historical range and reduce the likelihood that those species would require listing under the Endangered Species Act (ESA) of 1973, as amended. This Conservation Strategy (Strategy) was developed in accordance with the Agreement and is intended to remove and/or minimize threats to the species and guide restoration efforts for the maximum benefit of the Rio Grande Chub. Conservation approaches outlined in this 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. This Strategy[2] is a complement to the Agreement in which the Signatories agree to implement the conservation and monitoring approaches described herein.

The information contained in this Strategy is intended to serve as a set of guidelines for agencies, tribal entities, non-profit and private organizations to conserve Rio Grande Chub. 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 Strategy will include NEPA compliance and compliance with other laws and regulation as needed.

Past and Existing Conservation Agreements

This Strategy is the implementation document for the Conservation Agreement for Rio Grande Chub and Rio Grande Sucker that was signed by the parties in 2018. The Agreement is a collaborative and cooperative effort among state, federal, tribal resource agencies, non-profit and private organizations. The Agreement was designed to provide a framework for the long-term conservation of Rio Grande Chub by guiding the implementation of actions that reduce threats to the species. Additional information regarding authorities, governing documents, and policies may be found in the accompanying Agreement.

Duration of the Conservation Strategy

This Strategy was written to guide conservation approaches for the next 10 years (2021–2030), although it is expected that participants will continue working on conservation of the species beyond that timeframe. The 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

[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 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.

needs of Rio Grande Chub populations and habitats. Minor modifications may be made to the Strategy so long as they do not change the Goals and Objectives. This will allow the Team to respond to changing conditions on the ground, taking advantage of conservation opportunities that may arise. The Team will annually re-evaluate the status of Rio Grande Chub populations and habitats across its range and review progress of the approaches listed in the Strategy.

Annually, the parties involved will review the Strategy and its effectiveness to determine whether it should be revised and to update the annual work plan (see VI. Monitoring and Adaptive Management). By the end of the tenth year (2030), the Strategy must be reviewed and either modified, renewed, or terminated.

II. RIO GRANDE CHUB INFORMATION

Taxonomy

The Rio Grande Chub is a small minnow of the Cyprinidae family of fishes. Similar species of the genus *Gila* include Chihuahua Chub *Gila nigrescens* and Roundtail Chub *Gila robusta*. The Chihuahua Chub is known only from the Mimbres River in New Mexico (Sublette et.al. 1990, Zuckerman and Langlois 1990). The Roundtail Chub occurs in the San Juan and Gila drainages in New Mexico (Sublette et.al. 1990) and San Juan and Colorado River drainages of Colorado (Woodling 1985). Rio Grande Chub superficially resembles Roundtail Chub and Chihuahua Chub, but differs in modality of morphometric and meristic characteristics (Sublette et.al. 1990). This species is known to hybridize in nature with Longnose Dace *Rhinichthys cataractae* in the Rio Grande, Jemez River, Rio Hondo, and Rio Peñasco (Cross and Minkley 1960, Suttkus and Cashner 1981).

Historical Distribution

The first written record of what is now known as *G. pandora* was in 1779 by Father Morfi, an Irish priest who accompanied Governor Anza on a punitive expedition against the Comanche Indians (Thomas 1969). Eighty years later, Cope (1872), described Rio Grande Chub from a tributary of the Rio Grande near Sangre de Cristo Pass in the headwaters of the Rio Grande Basin, Colorado (Sublette et.al. 1990). The historical distribution of Rio Grande Chub (hereafter RGC) is not known with certainty due to the absence of complete records for historical distribution. The native range of RGC is thought to have included most streams in the Rio Grande and Pecos River Basins (Sublette et al. 1990) and the San Luis Closed Basin (Zuckerman and Bergersen 1986, Zuckerman and Langlois 1990, Rees et al. 2005). In Colorado, RGC distribution most likely included cool water streams up to about 2500 m in elevation at sites that had permanent flow, sand and gravel substrate, deep water and cover (Bestgen et.al. 2003). Early records documented the occurrence and abundance of RGC in Colorado at several locations in the San Luis Valley (Jordan 1891). Cope and Yarrow (1875) found RGC as the most abundant fish in New Mexico. In Texas, RGC are known only from a single locality in Little Aguja Creek of the Davis Mountains (Miller and Hubbs 1962), presumably established from populations transiting the Pecos River.

Current Distribution

Rio Grande Chub are native to the Rio Grande and Pecos River drainages in New Mexico and Colorado; possibly native to the Canadian drainage although it may be introduced there (Sublette et.al. 1990). Rio Grande Chub are also found in a single population in Little Aguja Creek in Jeff Davis County, Texas (Sublette et al. 1990, Koster 1957, Miller and Hubbs 1962). Populations are currently represented in the following Geographic Management Units (GMUs): Rio Grande Headwaters, Rio Grande-Elephant Butte, Rio Grande-Mimbres, Lower Pecos, Upper Pecos, and Upper Canadian (Figure 1). The species is also present outside the historical range in the Gunnison River and San Juan River drainages in Colorado. This is a result of historical and accidental stocking of RGC.

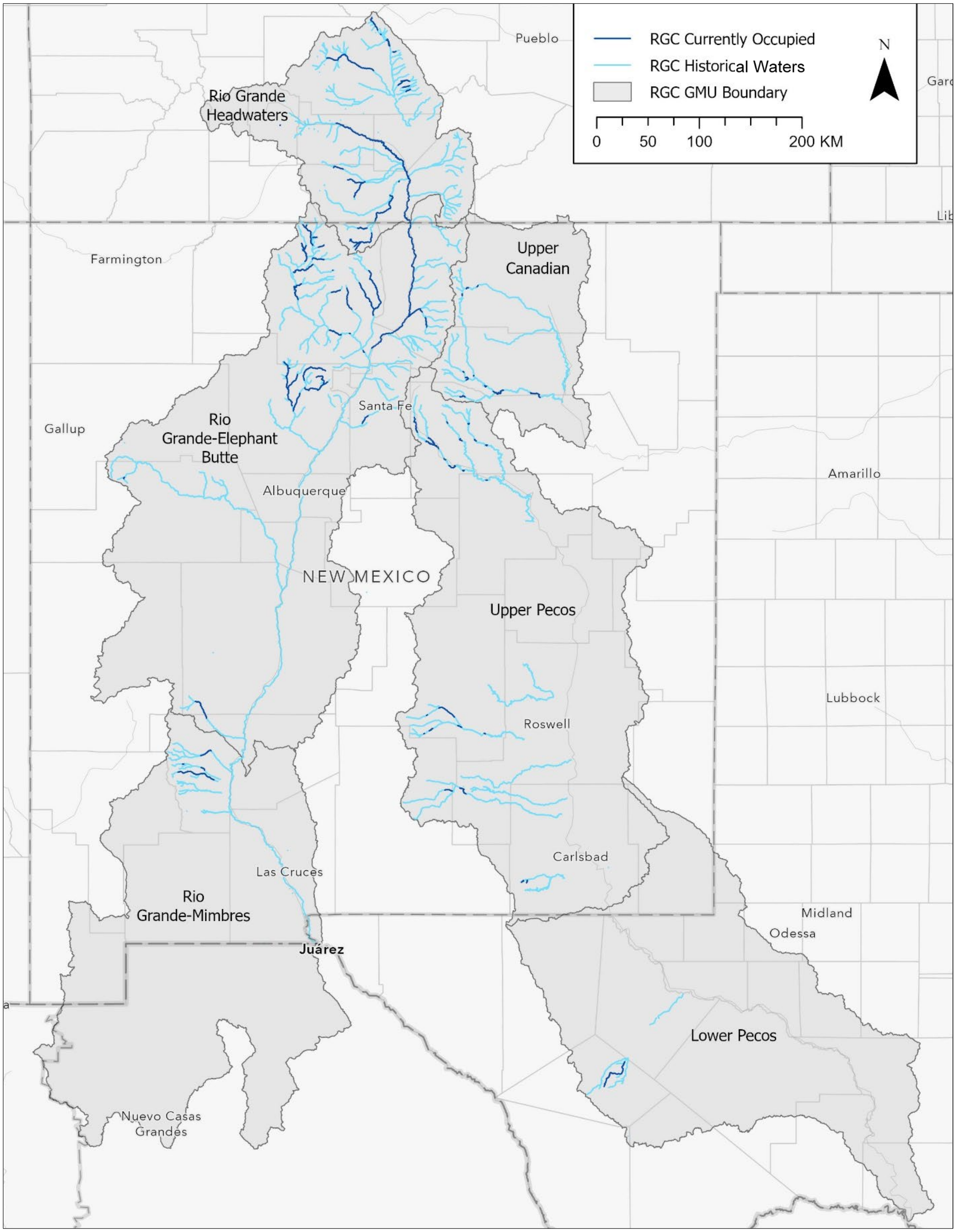

Figure 1. Range-wide distribution of Rio Grande Chub populations in the United States organized by Geographic Management Unit (GMU).

The Team will complete a Range-wide Status Assessment for RGC by 2023. This Status Assessment will inform the current distribution of RGC and may provide information to update the number of populations known to occupy each GMU (Table 1). Additionally, all of the historical and current data on RGC distribution summarized by the Team will be entered into a comprehensive database in 2020. The information included in the database will in turn help to inform the initial development of the Status Assessment and 10-year Assessments thereafter.

Table 1. Range-wide distribution and status of Rio Grande Chub populations organized by Geographic Management Units (GMUs) in the United States. A population is defined as one that "supports all life stages, is able to exist independent of other populations, and is not divided by complete barriers" (RGCS Working Group 2018).

GMU	Number of Populations
Lower Pecos	1
Rio Grande-Elephant Butte	25
Rio Grande Headwaters	10
Rio Grande-Mimbres	4
Upper Canadian	4
Upper Pecos	8
Range-wide Total	**52**

Habitat and Life History

Habitat

Rio Grande Chub are found in pools of small to moderate size perennial streams with a mix of cobble, gravel and sand substrate (Bestgen et.al. 2003, Platania 1991, Rinne 1995). In general, RGC inhabits streams and lakes cool enough for trout and some waters that are too warm for trout (Koster 1957). Bestgen et al. (2003) documented RGC in water temperatures less than 20.5 ºC. Although RGC occurs primarily in small streams across their range, a small aboriginal population was recently found in the mainstem of Rio Grande near Del Norte, Colorado and a large population occupies the Rio Grande in New Mexico. Rio Grande Chub is also known to inhabit irrigation ditches, canals, stock ponds, and other artificial impoundments (Zuckerman and Langlois 1990; Jones 2017). The species prefers low gradient streams with undercut banks, large woody debris, boulders and bank rip-rap, frequently associated with aquatic vegetation (Bestgen et.al. 2003, Calamusso and Rinne 1996, Woodling 1985, Zuckerman and Langlois 1990; Figures 2 and 3). In Hot Creek, Colorado, larger RGC were observed in pools, runs and below in-stream structure, while young RGC were found in extensive beds of watercress (*Nasturtium officinale*; Figure 4). In Colorado, introduced RGC thrive in lakes and impoundments where trout thrive (Zuckerman and Langlois 1990, Woodling 1985).


Figure 2. Rio Grande Chub habitat, Hot Creek, Colorado. Photo courtesy of Colorado Division of Parks and Wildlife.


Figure 3. Rio Grande Chub habitat, Rio Pueblo de Taos, New Mexico. Photo courtesy of Bureau of Land Management.

Figure 4. Aquatic vegetation such as *Nasturtium* and *Potamogeton* spp. provided instream cover for Rio Grande Chub. Photo courtesy of Colorado Division of Parks and Wildlife.

Life History

Rio Grande Chub evolved as part of a community of endemic fishes that included Rio Grande Sucker *Catostomus plebeius* and Rio Grande Cutthroat Trout *Oncorhynchus clarkii virginalis* (Langlois et.al. 1994). Early explorers in Colorado found chubs associated with Rio Grande Sucker and Rio Grande Cutthroat Trout (Cope and Yarrow 1875, Jordan 1891). In Colorado, RGC are often associated with other native species such as Longnose Dace *Rhinichthys cataractae* and Fathead Minnow *Pimephales promelas* and less frequently with Red Shiner *Cyprinella lutrensis*, Black Bullhead *Ameiurus melas*, Green Sunfish *Lepomis cyanellus*, and Flathead Chub *Platygobio gracilis*. In New Mexico, RGC are also associated with Creek Chub *Semotilus atromaculatus*, Central Stoneroller *Campostoma anomalum*, Flathead Chub, Longnose Dace, Fathead Minnow, and Western Mosquitofish *Gambusia affinis* (Sublette et al. 1990). In the Rio Grande Basin, RGC are also associated with non-native fish such as White Sucker *Catostomus commersoni*, Brown Trout *Salmo trutta*, Brook Trout *Salvelinus fontinalis*, Rainbow Trout *Oncorhynchus mykiss*, Brook Stickleback *Culaea inconstans*, Northern Pike *Esox lucius*, Yellow Perch *Perca flavescens*, and Largemouth Bass *Micropterus salmoides*.

Range-wide abundance of RGC is variable in streams depending upon habitat quality and presence of piscivorous fish species. In Colorado, abundance ranged from 37 fish/mile to 17,097 fish/mile and was directly related to habitat quality and presence of piscivorous fish species such as Brown Trout (CPW 2016). Bestgen et.al (2003) found RGC abundance was inversely related to abundance of Brown Trout in Saguache Creek in the San Luis Valley. Rio Grande Chub abundance increased downstream of the State Highway 114 bridge and was high in homeothermal spring streams such as Hot Creek and Hot Springs Ditch. In New Mexico, RGC abundance ranged from 16 fish/mile to 11,234 fish/mile in surveys conducted from 2004 to 2019 (NMDGF database records).

Very little information exists on feeding habits of RGC (Rees et.al 2005). Similar to other small minnows of the Cyprinidae family, RGC are a mid-water omnivore with a diverse diet consisting of aquatic and terrestrial insects, plankton, crustaceans and other small invertebrates, as well as a few fish, aquatic vegetation and detritus (Koster 1957, Sublette et al. 1990).

Spawning season typically occurs in late spring (March–June) in riffles of streams with no parental care or nest building (Koster 1957, Rinne 1995), however spawning was observed in June to mid-August in Rio Bonito, New Mexico (Caldwell et al. 2004). Spawning typically occurs when water temperatures range from 59 to 64 ºF. Autumnal spawning has been documented in Hot Creek, Colorado and Rio de Las Vacas, New Mexico suggesting that autumn spawning may occasionally occur when environmental conditions are suitable (Zuckerman and Langlois 1990, Rinne 1995, Bestgen et al. 2003). During the breeding season, adult RGC develop tuberculation on the fins and red-orange coloration on lower fins, sides, and along the mouth, with females tending to be brighter than males (Rinne 1995). During the spawn, female RGC broadcast eggs in riffle habitat while nearby males emit milt. The adhesive eggs attach to substrate and aquatic vegetation. At the Mumma Native Aquatic Species Restoration Facility (NASRF) in Monte Vista, Colorado, RGC held in circular tanks, deposit their eggs on coarse fiber mats. Fish culturists remove the mats and transfer the fertilized eggs to incubators. Rio Grande Chub eggs usually hatch within 6 to 9 days depending upon water temperature. Typically, RGC become sexually mature at 4 years, but precocious, sexually mature fish have been documented at 2 years old in the hatchery setting (J. Garcia, personal communication).

Little is known about the size structure of RGC populations, however the presence of multiple size classes at a site may represent relatively stable populations. Rio Grande Chub populations at Saguache and Hot Creeks and Rio San Antonio in Colorado were represented by as many as four size classes (Bestgen et.al 2003). Rio Grande Chub are usually 2.5 inches (6.25 cm) in length at the end of the first year and adults may attain lengths up to 12 inches (30 cm) (Woodling 1985). Rio Grande Chub captured in Colorado streams in 2001–2002 ranged in size from 21 to 186 mm total length (TL) and most fish captured were 31 to 50 mm TL (Bestgen et al. 2003).

Nature and Extent of Threats

The following discussion includes the major threats affecting RGC. These factors will be addressed by conservation approaches identified in this Strategy. Threats are presented in categorical fashion for clarity though in reality multiple threats may act synergistically to negatively affect RGC.

Habitat Degradation

Historical records indicate that RGC were once widely distributed and abundant across the Rio Grande Basin, however, habitat degradation was already evident in 1889 (Jordan 1891, Zuckerman and Langlois 1990). Prolonged and systematic habitat degradation in combination with other factors played a major role in the widespread extirpation of RGC and can be attributed to three main categories—habitat loss, fragmentation, and modification (Rees et al. 2005).

Habitat loss resulting from dewatering and reservoir construction is common in the Rio Grande Basin. Reductions in streamflow and alterations to the natural hydrograph have resulted from the construction of diversions and reservoirs (Rees and Miller 2005). Other forms of loss stem from contamination rendering habitats unsuitable (e.g., heavy metal pollution, agricultural runoff, sewage effluent etc.). In Colorado, heavy metal inputs from mine tailings have been identified as a potential limiting factor for RGC populations in some locations (Bestgen et al. 2003).

Many historical habitats are fragmented by anthropogenic barriers including irrigation diversions, dams and culverts. Entrainment of fish in irrigation ditches may serve as a major source of mortality in RGC, especially for larval fish who are weak swimmers and subject to drift. Habitats can also be isolated by dewatered sections of stream stemming from water extraction, drought, and their synergistic effects. Fragmentation threatens RGC population persistence by increasing the risks of genetic bottlenecks, creating vulnerability to stochastic events and reducing the ability for recolonization after local extirpations (Rees et al. 2005). Additionally, short and isolated reaches rarely contain the full suite of habitats to support all life stages of fish and their ability to feed, grow, and reproduce. Connectivity of variable habitat types is critically important (Schlosser and Angermeier 1995).

Habitat modification is the most prevalent form of habitat degradation threatening RGC. Altered flow regimes resulting from agricultural and domestic water development are common in the Rio Grande Basin. Water extraction and storage modifies the natural flow regime as defined by the timing, frequency, magnitude and duration of flows (Poff et al. 1997). These natural flow dynamics formed and maintained the complex habitat types that created the evolutionary template for RGC. Consequently, deviations from the natural flow regime cause shifts in habitat types and loss of natural complexity. Under these new conditions, adaptive mismatches between the environment and life history strategies of RGC may exist. For example, sequestration of high spring flows may reduce inundation of floodplain areas that serve as refugia for larval RGC. Common changes in flow regime in the Rio Grande Basin include reduced magnitude and duration of spring peak flows and altered summer base flows. Additionally, groundwater extraction for agriculture is common, which has been shown to reduce stream flows, constrict fish habitat and reduce connectivity for Cyprinid species in stream systems on the eastern plains of Colorado (Falke et al. 2011; Perkin et al 2017).

Changes to geomorphology that threaten RGC populations include channelization, scouring, and removal of complexities such as large wood and boulders that may interfere with water delivery and infrastructure, but provide quality habitat for RGC (Rinne 1995, Bestgen et al. 2003). Channelization homogenizes physical habitat and reduces features such as pools and undercut banks, which are favored mesohabitats for RGC (Bestgen et al. 2003). It can also increase stream velocity and exacerbate channel incision, leading to reduced connectivity to the floodplain that provides warm, low velocity and nutrient rich conditions important for larval RGC. Floodplain connectivity also provides important biochemical processes, sediment storage, and fluxes of energy and nutrients for aquatic and terrestrial ecosystems (Helfman 2007, Wohl 2014).

Overgrazing of riparian areas influences stream geomorphology and can affect the quality of habitats occupied by RGC (Rees et al. 2005). Common system responses to overgrazing include loss of riparian vegetation, destabilization of banks, increased channel width/depth ratios, and increased sedimentation (Rinne 1988). Sedimentation can decrease the suitability of spawning habitat by smothering eggs and can negatively affect the invertebrate production—an important food source for RGC (Koster 1957, Rees et al. 2005). Reduced riparian vegetation may also decrease the number of terrestrial insects falling into streams, possibly representing a large proportion of the diet of RGC, as has been shown with salmonids (Baxter et al. 2005, Saunders and Fausch 2007). Overgrazing may also affect water quality. For example, the synergistic effects of livestock grazing causes stream temperatures to warm, threatening populations living near the upper end of their thermal tolerance.

In addition to direct modification of the habitat or flow regime, a variety of human activities within a watershed can indirectly result in habitat degradation. Stream form and function integrates processes occurring not only at the scale of the stream channel, but also of the surrounding watershed (Wohl 2014). Consequently, physical, chemical, and biological components of habitat are influenced by a wide array of actions across the landscape. Road building and improper timber harvest (for example, without appropriate riparian buffers) can degrade water quality mainly through increased sedimentation in streams causing impaired reproduction, physiology and disease resistance, and reducing food availability and foraging efficiency. Overgrazing and/or urbanization of upland areas can increase compaction and reduce infiltration capacity of soils. These relationships have significant implications for groundwater recharge that provides cool and steady base flows to stream habitats. Given the climatic extremes in the Rio Grande Basin (interannual temperature range: -50 to 93°F; Todd et al. 2016, Zuckerman and Langlois 1990), reliable groundwater inputs may help to maintain thermally acceptable conditions for RGC.

Non-native Species

The presence of non-native fishes threatens RGC populations through a variety of mechanisms including predation, competition for resources, and hybridization (Rinne 1988, Zuckerman and Langlois 1990, Bestgen et al. 2003, Rees et al. 2005). Among these, predation poses the greatest risk to RGC populations. Non-native salmonids, especially Brown Trout, are widespread in historical RGC habitat and may have similar thermal and habitat preferences. Bestgen et al. (2003) determined that Brown Trout and RGC were positively associated at the stream level, but negatively associated at the site level, suggesting that predation may be limiting RGC distribution. Some observations suggest that lower salmonid abundance may be mediated by warmer temperatures, providing more acceptable conditions for RGC survival even if temperatures are warmer than optimal. Northern Pike are particularly voracious predators that inhabit the main stem of the Rio Grande and its larger tributaries. Northern Pike have shown affinities for targeting soft-rayed fishes, have high consumptive demands, and are capable of consuming a wide breadth of prey sizes due to their large gape size (Johnson et al. 2008). Other non-native species that likely predate on various life stages of RGC include Channel Catfish *Ictalurus punctatus*, Green Sunfish, Lake Trout *Salvelinus namaycush*, Largemouth Bass, and Walleye *Sander vitreus*, though these relationships are poorly understood.

In addition to predation, competitive interactions may play a significant role in limiting RGC populations. In the San Luis Valley of Colorado alone, over 50 introduced species have been identified, many of which have the potential to directly compete with RGC (Zuckerman and Behnke 1986). These species may compete for food resources directly and/or modify food web structure in a way that indirectly affects RGC. They may also compete for important habitat types (e.g., spawning, cover from predators, drought refugia). These negative interactions may be particularly strong in disturbed systems, as has been shown for a variety of other ecosystems (Helfman 2007). Introduced species with generalist life-history strategies may outcompete the more specialized RGC. Some commonly introduced species (e.g., Common Carp *Cyprinus carpio*) are known to modify habitats and cause cascading effects that may negatively affect various life stages of RGC (Weber and Brown 2009).

Hybridization may pose a risk to RGC, especially with the threat of accidental introduction of species in the *Gila* genus. Hybridization with Roundtail Chub has been documented in the San Juan River drainage following the accidental introduction of RGC. Non-native *Gila* species have not been documented in the Rio Grande watershed to date. A few cases of hybridization between RGC and Longnose Dace have been documented, though both are native to the Rio Grande Basin (Sutkus and Cashner 1981). Because this introgression appears rare, it is not thought to be a large risk to RGC populations.

Drought

Drought conditions have the potential to affect RGC populations. For example, the severe drought of 2001 and 2002 may have limited RGC occurrence at several sites in the San Luis Valley (Bestgen et al. 2003). The severity of the response to drought is largely dependent upon the specific characteristics of the affected waters. Larger streams are more resilient to drought effects than smaller systems, while small streams are susceptible to drying, freezing, and changes in water temperature and other critical water quality parameters (e.g., pH, dissolved oxygen). Small streams already affected by habitat modification are particularly sensitive to drought effects. Stream geomorphology and the size and abundance of perennial pool habitats play a critical role in how populations of RGC respond to drought. Systems with numerous large and deep pools provide sufficient refugia until hydrologic conditions improve. Other important factors that can mitigate drought effects include watershed area, stream type, hydrology, geology, vegetation types, and aspect.

Because RGC can persist in novel habitats, especially in the absence of major predators, the creation and maintenance of artificial habitats may provide suitable conditions for survival, especially during drought conditions. Stock ponds, irrigation ditches and canals that are augmented with groundwater may provide thermally suitable and sufficient flows to create stable conditions for RGC, which are known to survive and reproduce in a variety of lotic and lentic systems.

Fire

While wildfire is a natural landscape process, the frequency, intensity, size, and length of the fire season has increased in response to land management practices, fire suppression, and anthropogenic climate change (Abatzoglou and Williams 2016, Westerling et al. 2006). While fire plays an important role in maintaining habitat heterogeneity and biological diversity (Hurteau et al. 2014), larger, more intense fires and their indirect effects can threaten aquatic species. Whitney et al. (2015) evaluated various ecological metrics following consecutive fires in southwestern New Mexico and found reduced biomass in six out of seven native fishes, including significant reductions of Roundtail Chub. Wildfire-related population declines can be associated with direct fire effects (e.g., increased temperature, pH and nutrient concentrations), but are often attributed to post-fire, indirect effects such ash and debris flows following large rain events. This is particularly salient in the Southwest U.S, where monsoonal rain events typically follow the peak fire season (May–June). Landscapes devoid of vegetation become destabilized and vulnerable to large ash and debris flows that can kill fish, modify habitat, and alter food web structure (Rinne 1996). Populations of RGC may be negatively affected by large and/or consecutive fires especially in situations where suitable habitat is limited. The direct and indirect effects of fire are largely dependent on stream size, whereby larger volume streams are more buffered against negative effects (Whitney et al. 2015). Population resilience to the effects of fire will be greater in larger, complex, and well-connected systems as they are more likely to contain adequate refugia and more potential for dispersal and recolonization after isolated extirpations (Rieman and Dunham 2000).

Climatic/Stochastic Factors

Global climate change exerts an overarching effect on freshwater ecosystems that modifies and acts synergistically with hydrologic, thermal, fire and drought dynamics. According to the Intergovernmental Panel on Climate Change (IPCC), anthropogenically derived greenhouse gas concentrations have risen drastically from pre-industrial levels and are extremely likely to have been the dominant cause of observed warming since the mid-20th century (IPCC 2014). Global temperatures have warmed approximately 1°C from pre-industrial times and, given the current trajectory, are expected to rise another 0.5°C by the year 2040 (IPCC 2018). In North America, mean annual stream temperatures have warmed at rates between 0.009 and 0.07°C per year, correlated with rising air temperatures (Kaushal et al. 2010). Changes in mean temperature may be accompanied by increased frequency of extreme climatic events, leading to more stochastic thermal and precipitation regimes that will in turn influence freshwater ecosystems (Lynch et al. 2016, Whitney et al. 2016). In the Southwest U.S., temperatures are projected to rise between 1.4 and 3.1°C by 2041–2070, while droughts and heat waves are predicted to become more frequent and intense. In addition, winter snowpack and streamflow are predicted to be reduced overall (Melillo et al. 2014).

Climate change is predicted to have four major effects on the habitat occupied by RGC:

(1) increased water temperature;
(2) decreased streamflow;

(3) change in the flow regime; and
(4) increased occurrence of extreme events (fire, drought, and floods).

Increased Water Temperature
Temperature has long been recognized as the most important variable affecting fish physiology, wherein metabolic rates and energy budgeting are directly tied to temperature in the vast majority of fishes (Brett 1971). Metabolic processes in fishes are evolutionarily linked to long-term, specific thermal regimes and alterations in these thermal regimes can lead to deleterious physiological changes (Pörtner and Knust 2007). Because biochemical reactions are temperature dependent, virtually all aspects of fish physiology are influenced by changing temperature including growth, reproduction, and activity (Ficke et al. 2007). Research about the temperature requirements of RGC is currently lacking, although some evidence suggests that temperature may limit RGC populations. For example, Bestgen et al. (2003) noted that the highest water temperature in occupied RGC habitat was 20.5°C during their study. The mainstem of the Rio Grande in southern Colorado commonly exceeds 20°C, and no RGC were observed in that section, but just downstream of the border in the Rio Grande Gorge reach of New Mexico, temperatures cool and historical records indicate that RGC reappear at reasonable numbers. In many locations, RGC may be living near their upper thermal tolerance and further increases in temperature may cause populations to decline if thermal refugia are unavailable. Cooler temperatures may only be found at higher elevations where some habitat parameters may be insufficient for RGC (e.g., steeper gradient, reduced pool size) and negative interactions with non-native salmonids may exist. Conversely, range expansion could occur at the upstream end of streams, as water temperatures warm and potentially become more suitable. More information about RGC thermal requirements is needed for RGC to better understand these temperature relationships.

Decreased Streamflow
An analysis of the upper Rio Grande Basin found that the precipitation has changed through time. April 1st snow water equivalent has declined by about 25% in the period of 1958–2015 and a greater percentage of the total precipitation falls as rain. Furthermore, models predict a reduction in late winter and spring snowpack, leading to depleted runoff and soil moisture (Melillo et al. 2014). Lower water yield could also be magnified by warming temperatures that would increase evapotranspiration rates. Synergistically, these conditions could lead to extended dry seasons which would be exacerbated by habitat modification in an already arid Rio Grande Basin (Whitney et al. 2016). Consequently, RGC habitat is likely to be reduced in size and complexity through time and this may eliminate populations already living in habitats with marginal flows.

Change in Flow Regime
Changes in temperature, precipitation, and extreme events could affect the magnitude, frequency, timing, and duration of flows (Poff et al. 2002). Spring peak flows shifted by 1–4 weeks earlier in the period from 1948 to 2002 in western North America, leading to lower late summer flows (Stewart et al. 2005). Life history strategies in RGC were evolved in response to natural flow regimes. Spawning phenology of fishes is largely governed by hormonal cascades mediated by photoperiod, temperature, and perhaps flow (Pankhurst and Munday 2011). A shift in the timing and magnitude of spring floods may cause RGC to spawn at suboptimal times as compared to

historical conditions. Sensitive early life-stages of RGC (eggs and larvae) may be subject to scouring and entrainment in unsuitable habitats under this scenario. Lower base flows in late summer, especially under drought conditions, present a number of water quality problems (temperature, pH, dissolved oxygen) and in extreme cases, some streams may completely dry. In addition to changes in the timing of spring flows, more frequent high-intensity rain events may also present a threat to RGC populations. The IPCC determined that the frequency and intensity of heavy precipitation events has likely increased in North America (IPCC 2014). This increase in flashiness has the potential to flush various life stages of fish out of suitable habitat. Inundation of floodplain areas followed by rapid drops in flows may entrain fish in areas susceptible to drying.

Increased Extreme Events
According to the IPCC, climate change is likely to increase the frequency and magnitude of extreme events such as drought, fire, and floods (IPCC 2014, Melillo et al. 2014). Models predict that a doubling of burned area will occur in the southern Rockies by the end of the century (Litschert et al. 2012). High variability and the synergistic effects of extreme events is likely to threaten aquatic ecosystems and specifically RGC. It is uncertain how RGC populations will respond to increased extreme events, though outcomes will likely depend on the specific local conditions and population demographics. Characteristics such as stream size, elevation, aspect, shading, and hydrology will influence the response of individual populations. Populations living near their physiological tolerances or in already degraded habitats will be the most threatened by these events.

The extent to which climate change will affect RGC is not known with certainty at this time. Projections point to range-wide effects 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 RGC are at elevations of 1,676 m (5,500 ft) to 2,805 m (9,200 ft). Climate change may affect RGC populations at lower elevations more markedly than at higher elevations, although other site-specific factors may influence the degree to which individual streams are affected. Again, more information on how hydrological conditions affect this species is needed to best predict the effects of a changing climate.

III. CONSERVATION GOALS AND OBJECTIVES

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

Goals

The overall goal of this Strategy is to provide for the long-term viability of RGC throughout its historical range by minimizing or removing threats and promoting the conservation of the species. One of the main purposes of this Strategy is to provide a framework of objectives and associated management approaches that can be implemented to abate threats, address information gaps, and guide monitoring efforts. Areas that currently support RGC 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 populations and maintain the genetic diversity of the species. The Team envisions a future where sufficient numbers of wild RGC 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

To assess RGC viability, we will use the three conservation biology principles of resiliency, representation, and redundancy. Beginning in the mid-1990s, conservation biologists introduced this conceptual framework for evaluating the viability of a species (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). Redford et al. (2011) articulated these concepts as “maintaining multiple populations across the range of the species in representative ecological settings, with replicate populations in each setting. These populations should be self-sustaining, healthy, and genetically robust---and therefore resilient to climate and other environmental changes.” While these biodiversity principles (representation, resiliency, and redundancy) combine to provide security for a species to persist on the landscape, they also are a proxy of a species’ viability. Viability describes the ability of a species to persist over time and avoid extinction.

Resiliency supports the ability of the species to withstand environmental and demographic stochasticity (for example, wet or dry, warm or cold years); representation supports the ability of the species to adapt over time to long-term changes in the environment (for example, climate changes); and redundancy supports the ability of the species to withstand catastrophic events (for example, droughts, wildfires). In general, the more redundant and resilient a species is and the more representation it has, the more likely it is to sustain populations over time, even under changing environmental conditions. With these principles, we will identify the species' ecological requirements for survival and reproduction at the individual, population, and species levels, and describe the beneficial and risk factors influencing the species' viability. This Strategy is designed to protect and enhance the characteristics of resiliency, representation, and redundancy, which would constitute the main components of RGC viability (Table 2).

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

Viability Objective	Viability Strategy
Maximize Resiliency	Maintain large populations with sufficient genetic variation and minimize threats to these populations to increase their likelihood of persistence in the face of stochastic events.
Maximize Representation	Maximize the size and range of each highly resilient population within each of the six GMUs to maintain the species across the gradient of suitable habitats and thereby increase the likelihood that genetic diversity and adaptive capacity are retained.
Maximize Redundancy	Maximize the number of resilient populations within each of the six GMUs in order to increase the likelihood of species-level persistence across the range, if individual populations are extirpated.

Objectives

The following objectives are included in the 2018 Conservation Agreement and have been the objectives of the Team since the original Agreement was signed.

Objective 1: Identify and characterize all Rio Grande Chub and Rio Grande Sucker populations and occupied habitat. Identify all waters with RGC and Rio Grande Sucker populations. Monitor known populations and their habitat to detect changes over time.

Objective 2: Secure and enhance populations. Secure and, if necessary, enhance all known populations.

Objective 3: Restore populations. Increase, as necessary, the number of populations by restoring RGC and Rio Grande Sucker within their native range. Local restoration goals and approaches will be developed to meet this objective.

Objective 4: Secure and improve watershed conditions. Maintain and, if necessary, improve watershed conditions and instream habitat for RGC and RGS.

Objective 5: Conduct public outreach. Develop RGC and RGS public outreach efforts and combine with Rio Grande Cutthroat Trout outreach.

Objective 6: Share data. Build and maintain the RGC and Rio Grande Sucker Geographic Information System (GIS) Database so that information can readily be shared between and among agencies and jurisdictions.

Objective 7: Facilitate and improve coordination. Maximize effectiveness of RGC and Rio Grande Sucker conservation efforts by coordinating and increasing synergy of Signatory efforts toward achieving a common goal.

IV. CONSERVATION EFFORTS TO DATE

Team Coordination

Management of RGC has been ongoing for decades and conservation of the species is a high priority across its range. The RGC has been designated special status within multiple state and federal agencies. Since the Agreement was first signed in 2018, the Team has served to formalize the conservation efforts for the species and provided a forum for interstate and interagency coordination and management. Coordinated management has resulted in the restoration of at least three naturally reproducing RGC populations. Restoration methods have been developed, formalized, implemented, and will continue to be adjusted collaboratively. The RGC database was established through the Agreement and will serve 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 RGC and adjust methods as necessary.

Range-wide Restoration

Through coordination among Team members, restoration efforts have occurred across the distribution of RGC. This collaboration has included research and monitoring of existing populations, hatchery broodstock development, and habitat improvements. Habitat improvement work that has been completed to date on federal, state, and private lands includes: fencing of riparian areas to protect them from grazing, installation of instream structures to enhance habitat complexity, stream bank stabilization, riparian plantings, construction of fish migration barriers, road closures or relocations, culvert removal and/or replacement, beaver transplants, improving road runoff and stabilizing road surfaces. These efforts are described below and can be found in Appendix A. Commitments to future restoration efforts are listed in Appendix B.

Restoration in Colorado

Rio Grande Chub is listed as a Tier 1 Species of Greatest Conservation Need in the State Wildlife Action Plan for Colorado (CPW 2015). Conservation activities have been ongoing since 1992 including population monitoring, broodstock development, stocking, genetic testing, non-native species removal, barrier removals, and habitat improvements. From 1992 to 2020, CPW expended $1,854,003 on conservation and management activities. Colorado Division of Parks and Wildlife employs two biologists that place high priority on the management of RGC, including a Native Aquatic Species Biologist for the Southwest Region and an Area Aquatic Biologist for the San Luis Valley. Additionally, BLM, FWS, and USFS expended over $1.5 million on habitat improvement projects in Colorado. Since 1992, RGC have been reintroduced in eleven waters to create new populations or augment existing populations. Since 1992, RGC have been reintroduced through stocking in multiple waters to create new populations. The maintenance of hatchery broodstocks and identification of potential habitats for reintroduction are ongoing.

Restoration in New Mexico

The Conservation Team and formalized Agreement have served to bolster RGC conservation efforts in New Mexico. From 2007 to 2020, NMDGF expended over $2 million on RGC conservation and management activities (Appendix A). New Mexico Department of Game and Fish employs one biologist and one supervisor that are responsible for managing and conserving RGC populations. The BLM in NM conducts annual population monitoring and habitat assessments throughout the state that include the Assessment, Inventory, and Monitoring National Aquatic Monitoring Framework (Aquatic AIM), Proper Functioning Condition (PFC), Multiple Indicator Monitoring (MIM), and USFS Region 3 Stream Inventory protocols. The National Forests in NM, Valles Caldera National Preserve (VALL), and Turner Enterprises, Inc. (TEI) also contribute to conservation of the species by conducting population and habitat monitoring (Appendix A). Collaboration among NMDGF, TEI, and USFS Rocky Mountain Research Station has helped to develop innovative tools such as environmental DNA (eDNA) techniques for population monitoring. Finally, multiple signatories (e.g., TEI, VALL) have successfully repatriated historically occupied waters. Similar efforts are ongoing, as reclamation of the Rio Costilla drainage is almost complete and plans include repatriation of RGC.

Many projects in Colorado, New Mexico, and Texas have been conducted to improve watershed conditions across the range of RGC, including managed fire to decrease future wildfire risks, range management improvements, forest thinning, road improvements and decommissioning, and riparian and instream habitat improvements. For example, the Interagency Rio Chama Aquatic Habitat Project, including nearly one mile of BLM property, has increased instream habitat diversity, provided velocity refuges, and increased bank stability with native riparian plantings. Through a partnership with the BLM, NMDGF conducted instream habitat restoration on the Rio Bonito that should benefit RGC populations. On the Forests, the Watershed Condition Framework (WCF) has served to guide assessments of watershed condition and helped to prioritize and implement restoration work (USDA 2011), as was recently completed on San Antonio Creek in the Jemez drainage. In all, Team members have expended over $4.3 million on habitat improvement projects in New Mexico (Appendix A).

Restoration in Texas

In Texas, RGC is listed as State Threatened and TPWD is working with landowners and conservation partners on land management and restoration strategies. These efforts include conservation planning that identified Native Fish Conservation Areas (NFCA) in the region. Focal watersheds identified through regional NFCAs have guided TPWD and partners to prioritize specific aquatic and riparian areas for restoration, science, and conservation needs. Texas Parks and Wildlife Department partners with land trusts and landowners through the Texas Farm and Ranch Lands Conservation program to establish easements on working lands that also benefit state fish and wildlife resources. Recently, a 7,229 acre easement was established within the Lower Pecos range of RGC. Biologists with TPWD continue to provide landowners with technical guidance on stewardship strategies and conservation best management practices to restore and conserve upland, riparian, and aquatic habitats and associated species in the region.

Public Education and Outreach

In Colorado, CPW has produced a RGC factsheet that contains species descriptions, distributions, preferred habitat conditions, management recommendations and habitat scorecards (CPW 2019). This resource is intended to guide the development of wetland and riparian habitat improvement projects, assist grant writers in adequately describing project benefits to RGC, and facilitate project evaluation pre- and post-restoration. Colorado Parks and Wildlife also provides opportunities to students at Saguache High School to assist in electrofishing surveys in Saguache Creek. This field trip raises awareness for RGC conservation and other native species by educating local students about the value of native aquatic ecosystems and teaching students about the ecology of RGC. Other educational opportunities include tours of the Native Aquatic Restoration Facility in Alamosa, where RGC can be observed and staff can discuss the biology and culture of the species.

In Colorado, the BLM San Luis Valley Field Office provides environmental education programs both in schools and in the field, providing hands-on learning on the importance of healthy aquatic habitats for supporting native species, and uses native fish costumes (RGC, Rio Grande Sucker and Rio Grande Cutthroat Trout) in local parades and festivals to promote awareness and appreciation of native fish. Within Colorado, Rio Grande National Forest staff facilitate outdoor education events for middle and high school students that include education and information on native fish that include RGC.

In New Mexico, NMDGF has produced multiple native fish posters that feature RGC. In addition, the NMDGF website and social media sites are available for reaching the public. The Information and Education Division of NMDGF has created educational pamphlets (Wildlife Notes) about New Mexico's native species, including RGC. Biologists with NMDGF also participate in other public outreach efforts including public meetings and classroom presentations at local schools.

The BLM Taos Field Office provides environmental education for high school students throughout northern New Mexico as part of the Envirothon discussing aquatic ecology and native aquatic species. BLM also mentors middle school students with aquatic ecology yearly at the Taos Soil Water Conservation District Science Conservation Camp and the Taos Charter School Science Program.

In Texas, TPWD will partner with the Nature Conservancy, landowners, and the Fishes of Texas Project team to create outreach and educational material for a variety of audiences including the public through social media outreach, conservation professionals with technical and species information, and presentations to regional landowners and stakeholder groups.

Summary

Range-wide, the total estimated expenditures for RGC exceeds $10 million since 1992. The Team has demonstrated a longstanding commitment to RGC management that has resulted in the range-wide improvement in the viability of the species.

V. CONSERVATION APPROACHES

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

Objective 1: Identify and characterize all Rio Grande Chub and Rio Grande Sucker populations and occupied habitat

***Signatories Responsible*:** Primarily the states, with assistance from all signatories

Approaches:

1.1 Design and conduct surveys and monitoring with appropriate techniques for Rio Grande Chub populations and their habitats.

1.2 Characterize Rio Grande Chub populations (including size, distribution, demographics, and genetic diversity).

1.3 Determine life history, habitat requirements, and conservation needs for Rio Grande Chub. This information includes the extent of threats posed by non-native species that compete with, prey upon, or hybridize with Rio Grande Chub.

An understanding of the current distribution, habitat needs, and threats to RGC populations is the first step toward identifying and implementing meaningful conservation actions. This knowledge will be gained through characterizing all known populations and their associated habitats and monitoring these populations through time to detect any changes. Information on the size and genetic diversity of populations will help in evaluating the ability of individual populations to withstand stochastic events (i.e., resiliency). Determining the number and distribution of populations will aid in understanding the species' ability to preserve its genetic diversity and life histories (i.e., representation and redundancy). Furthermore, much information on the biological and ecological requirements of individuals and populations is still needed to inform management actions. These approaches will enable the Team to evaluate the long-term viability of the species and are essential to securing, enhancing, and restoring RGC populations and their habitats.

Objective 2: Secure and enhance populations

***Signatories Responsible*:** All signatories

***Approaches*:**

2.1 As warranted, restrict stocking of non-native species that are a known threat to Rio Grande Chub and suppress or remove these species where they are sympatric with Rio Grande Chub.

2.2 Construct in-channel fish barriers to restrict non-native fish movement and remove barriers to facilitate Rio Grande Chub passage as needed.

2.3 Maintain existing captive populations of Rio Grande Chub and evaluate the need for additional ones.

2.4 Restrict spread of disease and invasive species.

2.5 Regulate angling and baitfish collection and use to minimize effects on Rio Grande Chub.

Though we are still working to fully understand the magnitude of threats, the Team believes that reducing threats from non-native and invasive species will help ensure population persistence of RGC across the range. Improving fish passage can result in population growth and increased connectivity between populations, thereby enhancing a population's resiliency. In addition, the establishment of refuge or hatchery populations will serve to enhance the long-term persistence of the species (redundancy and representation). The total number of known current populations within each GMU is identified in Table 1 and distribution of these populations is shown in Figure 1.

Objective 3: Restore populations

***Signatories Responsible*:** States as lead with assistance from all signatories

***Approaches*:**

3.1 Establish new, highly resilient, and secure Rio Grande Chub populations distributed among the GMUs.

3.2 When restoring populations, ensure that genetic diversity is maintained within and among the GMUs.

Establishing populations among different GMUs will reduce the likelihood of the species being eliminated by stochastic events. Restoration efforts that result in larger and more complex populations across the range would provide geographic representation in occupied habitats and reduce the likelihood that any single catastrophic event will jeopardize the species. Population restoration goals will be developed after the initial status assessment is completed.

Restoration goals will reflect consideration of how the current species' distribution influences its long-term persistence. Large populations that encompass long stretches of habitat provide security from extirpation (resiliency), while smaller populations provide the species security across the landscape (redundancy). Various lengths of stream will be considered for restoration, depending on the distribution and status of other populations within the GMU.

Objective 4: Secure and improve watershed conditions

***Signatories Responsible*:** All land management signatories, with assistance from all signatories

***Approaches*:**

4.1 Protect and improve riparian and instream habitat conditions in locations that contain or could potentially support Rio Grande Chub. These actions could include instream and riparian habitat restoration and grazing, timber, and land management practices that secure or improve habitat quality for Rio Grande Chub.

4.2 Update resource management plans during plan revision processes to address threats to Rio Grande Chub habitat and enhance watershed conditions.

4.3 Conduct surveys to monitor Rio Grande Chub habitat conditions using a standardized habitat monitoring protocol.

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

4.5 Work with water managers to secure sufficient instream flow for all life stages.

Enhancing existing RGC habitat and maintaining high-quality habitat is important to the continued persistence of this species. Improvement and protection of existing habitat are necessary components of this Strategy and serve to maintain and increase resiliency of populations in changing climatic conditions. The Team is working with researchers to better understand specific habitat needs of RGC. The current theory is that watershed health and stream condition measures used by the land management agencies can provide a good indication of habitat conditions for RGC. A standardized habitat monitoring protocol will also be developed and implemented to assist in determining habitat requirements.

Healthy watersheds can minimize incidence of catastrophic or severe fire, flooding, and reduce the severity of drought, increasing the likelihood RGC populations would survive these events. With this consideration, land management activities will be conducted to protect all habitats, including occupied and potential RGC habitat, and minimize fire risk. 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 RGC 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.

All USFS Forests that contain native populations of RGC (Rio Grande, Carson, Santa Fe, Cibola, and Lincoln) are currently revising their Forest plans. The draft plans have categorized RGC as a Species of Conservation Concern (SCC). Species of Conservation Concern are those species that are native to and known to occur on the Forest and for which there is substantial concern about their ability to persist in the Forest based on best-available science. There are specific desired conditions, objectives, standards, and guidelines to enhance and protect the habitats that these SCC occupy. In addition, the Southwestern region of the USFS recently put forth a Riparian and Aquatic Strategy that helps guide and prioritize management.

Objective 5: Conduct public outreach

Signatories Responsible: All signatories

Approaches:

5.1 Increase awareness of Rio Grande Chub conservation efforts and the importance of native fish.

5.2 Educate the public concerning baitfish regulations and the importance of restricting transportation of fish between waterbodies.

5.3 Promote and publicize angling opportunities for Rio Grande Chub.

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 RGC. Public outreach should not only inform and educate, but also elicit the public's ideas and (possibly) concerns about RGC conservation. Public outreach should convey information such as status of the species, restoration efforts, and regulations. Increasing public awareness of RGC and other native fish could reduce negative effects on these species (e.g., polluting, discarding of nongame fish, illegal transportation, etc.).

State fishing regulations provide strict rules for transportation of live game fish and the use of baitfish. Prohibiting the spread of disease and non-native competitors and predators will benefit RGC and other native aquatic species. Rio Grande Chub cannot be used as baitfish in New Mexico or Colorado (NMAC 19.31.10.14; CPW Regulations, Ch 1, Art. I, #104(H)(2)) Harassment, taking or possession is prohibited in Colorado (CPW Regulations (2020), Ch. 10, Art. I, #1000(A). Texas regulations regarding the regulation of Threatened and Endangered as well as non-game species include 31 TAC §65.171 and 31 TAC Ch 57E. Guidance is also given to the public through the Texas Outdoor Annual.

Objective 6: Share data

Signatories Responsible: States as lead with assistance from all signatories

Approaches:

6.1 Establish and maintain a database of information on Rio Grande Chub.

6.2 Update the database annually and share data among signatories. Data collected on current populations including distribution, habitat, genetic status, and conservation activities will be included in these updates.

The RGC database is a crucial component of the work of the 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. This effort will aid in producing a Status Assessment with the most accurate information on the species. The coordination and collaboration that led to the database's development demonstrates the commitment of the signatories to RGC conservation.

Objective 7: Facilitate and improve coordination

Signatories Responsible: All signatories

***Approaches*:**

7.1 Attend the Annual Meeting. Every year of the Agreement, CPW and NMDGF will convene a meeting of the Team to review conservation activities.

7.2 Report results and coordinate monitoring and restoration activities among signatories.

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

7.4 Identify opportunities to coordinate with Rio Grande Cutthroat Trout Conservation Team.

The development of the Team and signing of the Agreement in 2018 formalized conservation efforts for the species and has provided a forum for coordination and management among agencies, tribal entities, non-profit and private organizations. The Annual Meeting provides an opportunity to further this collaboration through coordinated restoration efforts and is important to ensuring range-wide conservation of the species. Collaboration with other conservation groups, and specifically the Rio Grande Cutthroat Conservation Team, provides an opportunity to efficiently share resources across multiple species and translates into more successful conservation outcomes.

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 approaches identified in this Strategy. This type of monitoring will be documented at the Annual Meeting to ensure the Team is making expected progress. Effectiveness monitoring will assess whether the conservation approaches are achieving the Conservation Goal and Objectives outlined in the Strategy (also see Conservation Approach 7.3). Both implementation and effectiveness monitoring will be reviewed at the Annual Meeting of the Team. Although this is not a formal Adaptive Resource Management Plan, the Team has the ability to respond to changing conditions and updates in scientific approaches. The Annual Meeting serves as the forum for adapting conservation approaches as necessary to changing conditions. Appendix B lists the monitoring actions that will be taken under this Strategy.

Annual Meeting

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

Annual Reporting

In cooperation with and approval by all involved parties, the 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, the Team will complete the RGC Range-wide Status Assessment every 10 years as described in the Agreement.

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APPENDIX A. Conservation Actions Ongoing and Completed for Rio Grande Chub (RGC) since 1992 by the Rio Grande Chub and Rio Grande Sucker Conservation Team

Project	Responsible Party	Timeframe	Cost Estimate	Project Status	Description
Conservation Actions in Colorado					
Construct Riparian Exclosures on the Rio Grande	BLM	2000–	$100,000	Ongoing	Construct riparian exclosures to improve riparian conditions; 11 exclosures completed
Develop and Maintain RGC Ponds at Blanca Wetlands	BLM	2005–	$85,000	Ongoing	Annual monitoring and management; pond rehabilitation
Public Education and Outreach	BLM	2004–	$25,000	Ongoing	Design and purchase of native fish costumes; attendance at festivals and water events; youth education days
Restoration Projects and Studies	CPW	1992–	$128,200	Ongoing	Operational costs for restoration and research
RGC Genetic Assessment	CPW/Pisces/ Douglas	2002–2016	$47,748	Completed	Assessed population genetic health of RGC
RGC Hatchery Production/Broodstock Maintenance	CPW/NASRF/ SW Region	1992–	$879,755	Ongoing	Operational costs to maintain brood, produce and stock progeny
RGC Outreach	CPW	1992–	$10,000	Ongoing	Development of brochure and educational programs
RGC Program Operational Costs (population monitoring)	CPW	1992–	$788,300	Ongoing	Operational costs associated with RGC program not specifically listed
Annual monitoring	USFWS	2015–	$87,000	Ongoing	Includes both annual monitoring plus post construction salvage efforts
Baca NWR Research	USFWS	2018–2019	$45,000	Completed	USGS study to investigate water temperature and intermittent/ephemeral status across Baca NWR
Development of Population Estimates	USFWS	2018–	$34,000	Ongoing	Quantitative data analysis by CSU to generate population estimates for RGC
Engineering Design for Channel Work	USFWS	2016–2020	$12,500	Ongoing	Staff fish passage engineer to approve designs, field approval of projects

Project	Responsible Party	Timeframe	Cost Estimate	Project Status	Description
Conservation Actions in Colorado					
Fish Passage Study	USFWS	2015	$55,968	Completed	SWCA conducted a fish passage and habitat study on three of the creeks (Crestone, Cottonwood, and Willow)
Hot Springs Ditch Restoration	USFWS (Partners for Wildlife)	2006–2010	$80,059	Completed	Riparian fence, pond construction, diversion structures and instream habitat improvement
Infrastructure Replacement	USFWS	2015–	$900,600	Ongoing	Replaced six culverts, two water control structures
Monitoring Equipment (sampling, antennas)	USFWS	2015–	$95,850	Ongoing	Equipment costs
Monthly Remote Antenna Maintenance/Download	USFWS	2015–	$7,200	Ongoing	Personnel costs to download/maintain remote antennas on Baca NWR
Personnel costs: Director Fellow's Program	USFWS	2019	$24,000	Completed	Baca NWR hired a DFP intern to set up and implement a temperature study on Baca NWR
RGC Genetic Assessment	USFWS (SNARRC)	2018–	$14,397	Ongoing	Assess population genetic health of RGC
Riparian vegetation restoration – Crestone Creek	USFWS	2012–2018	$80,000	Completed	Constructed three ungulate-proof exclosures
Set up Remote Antenna Monitoring System, development of Database	USFWS	2016	$52,905	Completed	Install, maintain (1 year) and download PIT tag readers; develop Access Database, queries for all movement data
1992–2020 Total RGC Costs in Colorado			**$3,553,482**		

Project	Responsible Party	Timeframe	Cost Estimate	Project Status	Description
Conservation Actions in New Mexico					
Population Monitoring and Habitat Assessments	BLM	2004–2020	$370,000	Ongoing	Costs associated with annual population monitoring and habitat assessments
Public Education and Outreach	BLM	2007–2020	$30,000	Ongoing	Costs associated with environmental education including hours, travel, and supplies
Rio Bonito Habitat improvement Project	BLM	2018–2019	$20,000	Completed	Funds attributable to RGC portion of a habitat restoration project on the Rio Bonito
Rio Chama Aquatic Habitat Project	BLM	2018–2020	$10,000	Completed	Costs associated with environmental compliance and travel
eDNA Marker Development	NMDGF/TEI	2016–2017	$40,000	Completed	Development of environmental DNA markers to assess presence of RGC
Fish Passage Structure on Pecos River at Lisboa Springs Hatchery	NMDGF	2020	$365,797	Completed	Provides fish passage for RGC, including a fish ladder during low flows
RGC Database Development	NMDGF	2018–2020	$40,000	Completed	Creation and population of RGC and RGS database
RGC Genetic Assessments	NMDGF/NMSU /USFWS	2013–	$12,200	Ongoing	Assess population genetic health of RGC
RGC Outreach	NMDGF	2016–	$20,000	Ongoing	Native Fish poster development; programs with local schools
RGC Program Operational Costs	NMDGF	2013–	$198,000	Ongoing	Operational costs associated with RGC program not specifically listed
Rio Costilla Habitat Improvement Project	NMDGF	2016–2017	$620,000	Completed	Cost of instream improvements to habitat including channel shaping, substrate, plantings
Rio Costilla Native Fish Restoration Project	NMDGF	2007–	$1,078,000	Ongoing	Barrier construction, personnel and equipment costs associated with removing all fish in the treatment area and reintroducing native RGC
Ladder Ranch Population and Habitat Monitoring	TEI	2007–	$50,000	Ongoing	Costs associated with annual population monitoring and habitat assessments

Project	Responsible Party	Timeframe	Cost Estimate	Project Status	Description
Conservation Actions in New Mexico					
Native Fish in the Classroom Program	USFWS/USFS	2016–	$80,000	Ongoing	Implementing the Native Fish in the Classroom program in several local schools highlighting native fish species including RGC
Riparian and Stream Habitat Restoration Projects on USFS Lands	USFS	2013–	$3,700,000	Ongoing	Stream and riparian restoration work within RGC habitat (e.g., Rio San Antonio, Rio Cebolla, San Antonio Creek)
2004–2020 Total RGC Costs in New Mexico			**$6,633,997**		

Project	Responsible Party	Timeframe	Cost Estimate	Project Status	Description
Conservation Actions in Texas					
Texas Farm and Ranch Lands Conservation Easements	TPWD/The Nature Conservancy	2016–	$335,250	Ongoing	Establishment of conservation easement of 7,229 acres within the range of RGC
2016–2020 Total RGC Costs in Texas			**$335,250**		
1992–2020 TOTAL RGC COSTS			**$10,522,729**		

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

1-Year Plan, 2021, Rio Grande Chub Conservation Strategy

Conservation Approaches		GMU					
		Rio Grande Hdws	Rio Grande-EB	Rio Grande-Mimbres	Upper Pecos	Lower Pecos	Upper Canadian
Objective 1: Identify and characterize all RGC populations and occupied habitat							
1.1	Population and habitat monitoring	Conduct surveys on Rio Grande and Crestone Creek Continue to look for previously undiscovered extant populations	Conduct surveys on Santa Fe River, Upper Rio Grande, Rio Chama	Conduct surveys on Palomas, Seco, and Las Animas Creeks	Monitor Rio Bonito population in BLM's restoration reach	Conduct survey on Little Aguja Creek	Conduct surveys on Sapello River
1.2	Characterize populations (e.g., size, distribution, genetic diversity)	Collect genetics samples in Rio de los Pinos, Rio San Antonio and other locations as appropriate	Surveys to determine current occupancy Analyze genetic samples from Fenton Lake	Determine occupancy on Palomas, Seco, and Las Animas Creeks	eDNA/e-fishing for presence: Rio Hondo, Rio Ruidoso, Eagle Creek, Agua Chiquita, Gallinas River	Survey to determine current occupancy Analyze genetic samples if state funds are available	Collect genetic samples: Sapello River, Cimarron River; determine if populations are aboriginal
1.3	Determine life history, habitat requirements, and conservation needs	Evaluate backwater habitats on Rio Grande	Conduct research on interspecific interactions with non-natives in Jemez drainage (Texas Tech)				

	Conservation Approaches	GMU: Rio Grande Hdws	Rio Grande-EB	Rio Grande-Mimbres	Upper Pecos	Lower Pecos	Upper Canadian
Objective 2: Secure and enhance RGC populations							
2.1	Restrict stocking of nonnative fish species, as warranted; suppress or remove where sympatric	CPW Regulations: Chapter 0, Article VII, #013 Release of Aquatic Wildlife CPW: removals of non-native salmonids in Crestone and San Luis creeks, when encountered	NMDGF Regulations: NMAC 19.35.7 - Importation of live non-domestic animals, birds, and fish Physical removals of Green Sunfish, Largemouth Bass and Bluegill from lower Las Animas			TPWD Regulations may include: 31 TAC Ch 57A, 31 TAC Ch 57C, 31 TAC Ch 52	NMDGF Regulations: NMAC 19.35.7 - Importation of live non-domestic animals, birds, and fish
2.2	Construct in-channel fish barriers and remove barriers to facilitate passage	Evaluate potential for barrier at McIntire Spring and complete NEPA analysis Continue to remove culvert barriers at Baca NWR	Evaluate findings of 2020 Share with Wildlife project identifying barriers to movement				
2.3	Maintain existing captive populations and evaluate the need for additional	Continue to manage captive broodstock at NASRF and augment periodically			Look for potential habitat to serve as refugia for Rio Bonito population		
2.4	Restrict 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 TPWD regulations may include: 31 TAC Ch 57A, 31 TAC Ch 57C, 31 TAC §57.1000, and 31 TAC §57.1001					
2.5	Regulate angling and baitfish enforcement	CPW Regulations: Chapter 1, Article II, #108 Special Regulation Waters NMAC 19.31.4.11: Daily bag, possession limits, and requirements or conditions; NMAC 19.31.10.14 Fishing TPWD regulations may include: 31 TAC §65.171 and 31 TAC Ch 57E					

Conservation Approaches		GMU					
		Rio Grande Hdws	Rio Grande-EB	Rio Grande-Mimbres	Upper Pecos	Lower Pecos	Upper Canadian
Objective 3: Restore RGC populations							
3.1	Establish new RGC populations	Continue to look for opportunities to establish populations	Identify source populations to translocate into Costilla Reservoir	Identify suitable habitat for additional population (e.g., Palomas Creek)		Work with partners and landowners to explore potential opportunities to establish populations	
3.2	Ensure genetic diversity is maintained within and among GMUs	Conduct genetic analysis on select populations, replicate populations with known genetic structure (e.g., Rio Bonito, Alamosa Creek)					
Objective 4: Secure and improve watershed conditions							
4.1	Protect and improve riparian and instream habitat conditions	Work with Baca staff to create enhanced refuge pools on Willow and Cottonwood Creeks Construct additional exclosures on the Rio Grande Natural Area	Creation and implementation of USFS - Southwestern Region Aquatic and Riparian Strategy Completion of compliance and implementation of projects on Carson, Santa Fe, and Cibola NFs under Northern NM Riparian Restoration Environmental Assessment Continue conducting assessments of watersheds under the Watershed Condition Framework (WCF) Continue discussions with ranch managers to consider riparian health when assessing livestock use of pasture				
4.2	Update resource management plans to address RGC threats	Updating USDA Forest Plans on all NM Forests with desired conditions and objectives for riparian habitat CO: RGNF – Revised Forest Plan completed in 2020, includes language to support RGC Conservation Complete BLM SLVFO Resource Management Plan Revision pre-analysis					
4.3	Conduct surveys using the habitat monitoring protocol	Develop standardized habitat monitoring protocol Conduct fish & habitat monitoring for RGC streams affected by wildfires					
4.4	Develop and implement a fire and drought contingency plan						
4.5	Work with water managers to secure sufficient instream flow	TEI: Continue discussions with ranch managers and staff to consider health of RGC & RGS populations					

Conservation Approaches		GMU					
		Rio Grande Hdws	Rio Grande-EB	Rio Grande-Mimbres	Upper Pecos	Lower Pecos	Upper Canadian
Objective 5: Conduct public outreach							
5.1	Increase awareness of RGC conservation efforts	Conduct outreach efforts with local elementary-high schools (e.g., Saguache and Taos County High Schools), colleges, and on Taos Pueblo Use social media to promote conservation efforts					
5.2	Educate the public concerning baitfish regulations and restricting fish translocation between waters						
5.3	Promote and publicize angling opportunities	Develop sign or social media post to educate public of opportunities to fish for RGC					
Objective 6: Share data							
6.1	Establish and maintain RGC database	Complete population of range-wide database					
6.2	Update the database annually and share data among signatories	Continue contract with database manager (WYGISC); update to reflect current conditions					

Conservation Approaches		GMU					
		Rio Grande Hdws	Rio Grande-EB	Rio Grande-Mimbres	Upper Pecos	Lower Pecos	Upper Canadian
Objective 7: Facilitate and improve coordination							
7.1	Attend Annual Meeting	Annual Meeting, January 2021, virtual meeting hosted by CPW					
7.2	Report results and coordinate monitoring and restoration	Maintain relationships and coordinate among agencies through personal communication and meeting attendance; compile accomplishments report for 2020					
7.3	Assess Conservation Strategy goals and make changes as needed	Complete Conservation Strategy					
7.4	Identify opportunities to coordinate with RGCT Team	Discuss repatriation of RGC in recently restored habitats (e.g., Costilla Reservoir)					

Conservation Approaches		GMU					
		Rio Grande Hdws	Rio Grande-EB	Rio Grande-Mimbres	Upper Pecos	Lower Pecos	Upper Canadian
Objective 1: Identify and characterize all RGC populations and occupied habitat							
1.1	Population and habitat monitoring	Monitor 3–4 occupied waters annually	Monitor at least four occupied waters annually	Monitor at least three occupied waters annually	Monitor at least two occupied waters annually	Monitor the one population once every five years	Monitor one population annually
1.2	Characterize populations (e.g., size, distribution, genetic diversity)	Collect and analyze genetic samples on newly discovered populations as needed	Employ eDNA techniques to determine distribution Analyze genetic diversity of 50% of populations	Estimate abundance of populations every five years	Estimate abundance of populations every five-years Analyze genetic diversity of all known populations	Estimate abundance of populations every five-years Analyze genetic diversity of all known population if state funds are available	Estimate abundance of populations every five years Analyze genetic diversity of all known populations
1.3	Determine life history, habitat requirements, and conservation needs	PIT tag study at Baca NWR, measure habitat parameters at survey sites	Continue to support research on life history, habitat suitability, and interactions with non-natives				
Objective 2: Secure and enhance RGC populations							
2.1	Restrict stocking of non-native fish species, as warranted; suppress or remove where sympatric	CPW Regulations: Chapter 0, Article VII, #013 Release of Aquatic Wildlife NMDGF Regulations: NMAC 19.35.7 - Importation of live non-domestic animals, birds, and fish TPWD Regulations may include: 31 TAC Ch 57A, 31 TAC Ch 57C, 31 TAC Ch 52 Continue mechanical removal of Brown Trout at Hot Creek					
2.2	Construct in-channel fish barriers and remove barriers to facilitate passage	Remove and replace culverts on Crestone Creek (Baca NWR) Construct barrier at McIntire Spring	Improve, install, or remove other barriers to facilitate restoration				

Conservation Approaches		GMU: Rio Grande Hdws	Rio Grande-EB	Rio Grande-Mimbres	Upper Pecos	Lower Pecos	Upper Canadian
2.3	Maintain existing captive populations and evaluate the need for additional	Maintain and augment broodstocks at NASRF	Identify opportunities to maintain off-channel refugial populations and replicate at-risk populations in these habitats (e.g., Rio Bonito, Bluewater Creek)				Identify refugial habitat for populations as needed (if aboriginal)
2.4	Restrict 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 TPWD regulations may include: 31 TAC Ch 57A, 31 TAC Ch 57C, 31 TAC §57.1000, and 31 TAC §57.1001					
2.5	Regulate angling and baitfish enforcement	CPW Regulations: Chapter 1, Article II, #108 Special Regulation Waters NMAC 19.31.4.11: Daily bag, possession limits, and requirements or conditions; NMAC 19.31.10.14 Fishing TPWD regulations may include: 31 TAC §65.171 and 31 TAC Ch 57E					
Objective 3: Restore RGC populations							
3.1	Establish new RGC populations	Restore 1–2 populations Evaluate possible new habitats for native fish at Great Sand Dunes (including Sand Creek, Cold Creek, Big and Little Spring Creeks); McIntire Spring	Restore 3–5 populations (in particular replication of Alamosa Creek, Bluewater Creek, and other populations as identified)	Restore at least one population (e.g., lower Palomas Creek)	Restore 1–2 populations (in particular replication of Rio Bonito, and other populations as identified)	Evaluate possible habitats for replication of only population	Restore one population (if aboriginal)
3.2	Ensure genetic diversity is maintained within and among GMUs	Conduct genetic analysis on select populations, replicate populations with known genetic structure (e.g., Rio Bonito, Alamosa Creek)					

Conservation Approaches		GMU					
		Rio Grande Hdws	Rio Grande-EB	Rio Grande-Mimbres	Upper Pecos	Lower Pecos	Upper Canadian
Objective 4: Secure and improve watershed conditions							
4.1	Protect and improve riparian and instream habitat conditions	Maintain Hot Creek State Wildlife Area Remove and replace culverts on Crestone Creek (Baca NWR) Conduct erosion control work, gully restoration and Zeedyk projects Habitat protection of four miles of the Rio San Antonio (Rio Grande del Norte Natl Monument) Construct exclosures on Rio Grande within the Rio Grande Natural Area	Nine miles of stream habitat improvement on Carson (Rio Grande del Rancho), Cibola (Bluewater Creek), and Santa Fe NFs (Rio Cebolla, San Antonio Creek) 80,000 acres of thinning/prescribed burning/sagebrush treatments in the Rio Grande del Norte Natl Monument 15 acres of Watershed/riparian protection along the Rio Chama WSR	Consider new land management approaches which may increase perennial water conditions to support RGC where they currently exist on TEI-owned properties and where appropriate to establish new populations (e.g., Costilla Creek)	Watershed improvement projects on Lincoln NF within priority watersheds	Work with regional landowners on voluntary conservation stewardship strategies and conservation best management practices	
4.2	Update resource management plans to address RGC threats	Address RGC threats in Forest Management Plans, BLM Riparian Management Plans, Statewide Fisheries Management Plan, etc. Complete BLM SLVFO Resource Management Plan Revision, include language to support RGC conservation					
4.3	Conduct surveys using the habitat monitoring protocol	Implement habitat monitoring protocol Conduct fish & habitat monitoring for RGC streams affected by forest management and BLM management activities					
4.4	Develop and implement a fire and drought contingency plan	Implement fire and drought contingency plan Conduct fish & habitat monitoring for RGC streams affected by wildfires					

Conservation Approaches		GMU					
		Rio Grande Hdws	Rio Grande-EB	Rio Grande-Mimbres	Upper Pecos	Lower Pecos	Upper Canadian
4.5	Work with water managers to secure sufficient instream flow	Coordinate with the Colorado Water Conservation Board to implement instream flow rights where appropriate Work with private landowners to utilize existing water rights to benefit RGC Active FS programs to secure water rights Implement BLM's instream flow rights where appropriate					
Objective 5: Conduct public outreach							
5.1	Increase awareness of RGC conservation efforts	Coordinate with Outreach divisions to develop RGC brochures, activities, articles; update and edit existing CPW brochures Seek opportunities to broaden programs like "Native Fish in the Classroom" to include RGC					
5.2	Educate the public concerning baitfish regulations and restricting fish translocation between waters	CPW: Chapter 1, Article 1,104.H.1 regulation regarding Take, Possession and Use of Fish, Amphibians, and Crustaceans for bait, personal or commercial use NMDGF: 2020–2021 NM Fishing and Rules Info TPWD: 2021 Texas Outdoor Annual					
5.3	Promote and publicize angling opportunities	NMDGF: Feature RGC angling in materials on agencies' websites, Facebook page, magazines, etc.					
Objective 6: Share data							
6.1	Establish and maintain RGC database	Continue contract with database manager (WYGISC)					
6.2	Update the database annually and share data among signatories	Provide data annually to update the range-wide database; share data at Annual Meeting					

Conservation Approaches		GMU					
		Rio Grande Hdws	**Rio Grande-EB**	**Rio Grande-Mimbres**	**Upper Pecos**	**Lower Pecos**	**Upper Canadian**
Objective 7: Facilitate and improve coordination							
7.1	Attend Annual Meeting	Signatories and supporting organizations will attend Annual Meeting, hosted by CPW and NMDGF in alternating years Encourage attendance of other interested stakeholders					
7.2	Report results and coordinate monitoring and restoration	Maintain relationships and coordinate among signatories and engage outside stakeholders; compile annual reports					
7.3	Assess Conservation Strategy goals and make changes as needed	Complete Conservation Strategy and first Status Assessment; renew Conservation Agreement					
7.4	Identify opportunities to coordinate with RGCT Team	Restore habitat and populations of RGC & RGS (e.g., Costilla Reservoir, Sand Creek); broaden RGCT outreach to include RGC & RGS					

APPENDIX C. 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 Chub prior to returning to the threatened water body?
5) Is it feasible to hold rescued Rio Grande Chub 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, such as a complete health inspection, and genetic assessments.

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 Chub to a more stable part of the watershed

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