COLORADO RIVER BASIN CHUBS

Roundtail Chub *Gila robusta*

Gila Chub *Gila intermedia*

Headwater Chub *Gila nigra*

RECOVERY PLAN

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Santa Fe, New Mexico

November 2006

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1.0 INTRODUCTION

This Recovery Plan was developed under the authority of the New Mexico Wildlife Conservation Act (WCA) amendments of 1995, which direct New Mexico Department of Game and Fish (NMDGF) to develop recovery plans for species listed as threatened or endangered by the state [17-2-40.1 NMSA 1978]. Each recovery plan should 1) restore and maintain viable populations of a listed species and its habitat, such that the species may be delisted; 2) mitigate adverse social or economic impacts resulting from recovery actions; 3) identify social or economic benefits and opportunities; and 4) use existing resources and funding sources, to the extent possible, to implement the plan.

This Recovery Plan addresses the chubs in the Colorado River basin in New Mexico, roundtail chub *Gila robusta,* Gila chub *G. intermedia*, and headwater chub *G. nigra*, listed as endangered in New Mexico (headwater chub listed by Commission action November 2006). As required by the WCA, public information meetings were held in February 2005 in Bloomfield and Silver City, New Mexico, at the beginning of the planning process. The Advisory Committee for this Recovery Plan includes representatives from U.S. Forest Service, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, Arizona Game and Fish Department, New Mexico Environment Department, New Mexico Interstate Stream Commission, Navajo Nation Fish and Wildlife Department, BIA/Navajo Irrigation Project, Jicarilla Apache Game and Fish Department, Southern Ute Tribe, Division of Wildlife Resource Management, University of New Mexico, Center for Biological Diversity, The Nature Conservancy, Coalition of Arizona/New Mexico Counties, San Juan Water Commission, and private individuals (Appendix I).

The organization of this Recovery Plan follows that detailed in NMDGF *Guidelines for Writing Long Range, Action, and Operational Plans* (Graves 2002). Section 2.0 of this plan includes background information on the distribution, habitat requirements, biology, and ecology of roundtail, Gila, and headwater chubs. Section 3.0 contains the goal for recovery of the species, associated objective and objective parameters, issues affecting attainment of the goal and corresponding strategies. Section 4.0 contains the recovery plan implementation schedule.

2.0 BACKGROUND

Section 2.0 consists of background information on the distribution, status, habitat requirements, biology, and ecology of roundtail, Gila, and headwater chubs. This information provides the basis for assessing status, threats to persistence, and the most effective recovery strategies for the species.

2.1 NATURAL HISTORY

2.1.1 Name, Relationships, and Description

Roundtail, Gila, and headwater chubs are members of Cyprinidae, or minnow, family. Taxonomy of chubs, genus *Gila*, has been the subject of much debate. Both *G. robusta* roundtail chub (Baird and Girard 1853) and *G. intermedia* Gila chub (Girard 1856) have been recognized as valid species for over 20 years (Robins et al. 1991, Mayden et al. 1992, Minckley and DeMarais 2000, Nelson et al. 2004). Historically, *Gila robusta* has been used to encompass several forms of chub, including former subspecies *Gila r. seminuda* Virgin River chub and *G .r. elegans* bonytail (Sigler and Sigler 1996, Gerber et al. 2001), and the *Gila robusta* complex (Miller 1945, Rinne 1976). Previously, *G. grahami* (Baird and Girard 1853) was used to denote a subspecies of *G. robusta* commonly known as headwater chub (Rinne 1969, 1976). Nomenclature rules prevent the use of *grahami*, and in 2000, *G. nigra* (Cope and Yarrow 1875) was recognized as the correct name for headwater chub. Nelson et al. (2004) concurred with this designation.

Roundtail, Gila, and headwater chub are closely related; their morphologies are similar and genetically there are few differences among them. This accounts, in part, for past taxonomic uncertainty. Headwater chub is morphologically intermediate between roundtail and Gila chubs and may have ancestry from both of these species (DeMarais 1986, Minckley and DeMarais 2000). Herein species are defined, most simply by range, as in Minckley and DeMarais (2000):

> The roundtail chub is distributed throughout the Colorado River basin from Colorado and Wyoming to northern Sonora, represented by largely unstudied

forms in coastal rivers southward to the Mexico State of Sinaloa. It is less prone to using cover than Gila or headwater chubs, typically frequenting open areas in the deepest pools and eddies of middle sized to larger streams.

The Gila chub is restricted to the Gila River basin, Arizona, New Mexico, and Sonora. Typical of deep pools, marshes (e.g. beaver ponds), or cutoff floodplain pools of upper parts of small to middle-sized streams, it is strongly associated with cover such as woody debris, undercut banks, or scoured pools near obstructions.

The headwater chub is restricted to the Gila River basin, Arizona and New Mexico, in middle to headwater reaches of middle-sized streams. It also is associated with cover such as deep places near obstructions, large pools, or undercut banks.

The three chub species historically occurred throughout the Gila River basin, but no two have been collected from the same site (Minckley and DeMarais 2000). Additional historical and current range detail is presented in section 2.1.2.

Roundtail chub have streamlined, fusiform bodies, oval in cross-section, with moderately narrow caudal peduncles, deeply forked tails, and small scales. Adult roundtail chub are mottled dark gray to olive above, blending to cream below. Juvenile roundtail chub are lighter colored, light gray to silvery dorsally and white ventrally (Baird and Girard 1853, Sigler and Miller 1963, Minckley 1973). During spawning season, the abdomen and bases of pectoral, pelvic, and anal fins are bright orange to red. Breeding tubercles are present on both male and female roundtail chubs, with greater coverage on males, sometimes densely covering the entire body and fins (Muth et al. 1985). Roundtail chub have terminal mouths, extending to the front of the eye. There are typically 80-85 lateral line scales (Minckley 1973) and 9 anal fin rays. Roundtail chub can reach total lengths (TL) over 400 mm, but adults are usually 250-350 mm TL (Minckley 1973, Bestgen and Propst 1989).

Gila chub are morphologically similar to roundtail chub, but have chunky or robust bodies and tend to be slightly darker-colored than roundtail chub (Minckley 1969, 1973, Rinne 1969, 1976, DeMarais 1986). Caudal peduncle tends to be deeper in Gila chub, and scales are comparatively large and thick, and appear darkly outlined (Minckley and DeMarais 2000). Like roundtail chub, Gila chub have terminal mouths and develop orange/red-breeding coloration near bases of fins. Both males and females develop breeding tubercles. There are typically 75 lateral line scales and 8 dorsal, 8 anal, and 8 or 9 pelvic fin rays (Minckley 1973, Propst 1999). Gila chub are smaller than roundtail chub; typically, they reach 150 mm in length; females may be greater than 200 mm (Minckley 1973, Rinne 1976, Weedman et al. 1996).

Headwater chub are very similar in appearance to roundtail and Gila chubs. Not as robust as Gila chub, headwater chub tend to be more streamlined, and in lateral aspect more similar to roundtail chub. Dark gray or brown above, headwater chub often have dark longitudinal stripes on the sides (Minckley and DeMarais 2000). There are typically 73-83 lateral line scales and usually 8 dorsal and anal fin rays (Minckley and DeMarais 2000). There is no specific size range currently published for adult headwater chub, but field observations in the forks of the Gila River indicate that adult headwater chub reach 250 to 400 mm TL (Y. Paroz, NMDGF, 2005, pers. comm.).

2.1.2 Historic and Current Distribution

Roundtail chub historically occurred in the Colorado River and its tributaries from Wyoming south to the Little Colorado River confluence in Arizona. South of this, roundtail chub occurred only in primary tributaries of the Colorado River. In Mexico, it occurs in Ríos Yaqui and perhaps more southern rivers (Hendrickson et al. 1981). Throughout its range, it was historically comparatively common. Today, roundtail chub occupy only about 45% of their historical range in the Colorado River Basin (Bezzerides and Bestgen 2002).

Gila chub historically occurred in cienegas and small tributaries throughout the Gila River Basin in Arizona, New Mexico, and Sonora, Mexico (Minckley 1973, Rinne 1976, Weedman et al. 1996). Of the 30 historical stream and cienega Gila chub populations in Arizona and Sonora reported by Weedman et al. (1996), only nine are currently considered stable.

Headwater chub is also restricted to the Gila River Basin in Arizona and New Mexico, to mid- to headwater reaches of mid-sized streams (Minckley and DeMarais 2000). Like Gila chub, the number of headwater chub populations has also declined (DeMarais 1986, AZGFD 2003).

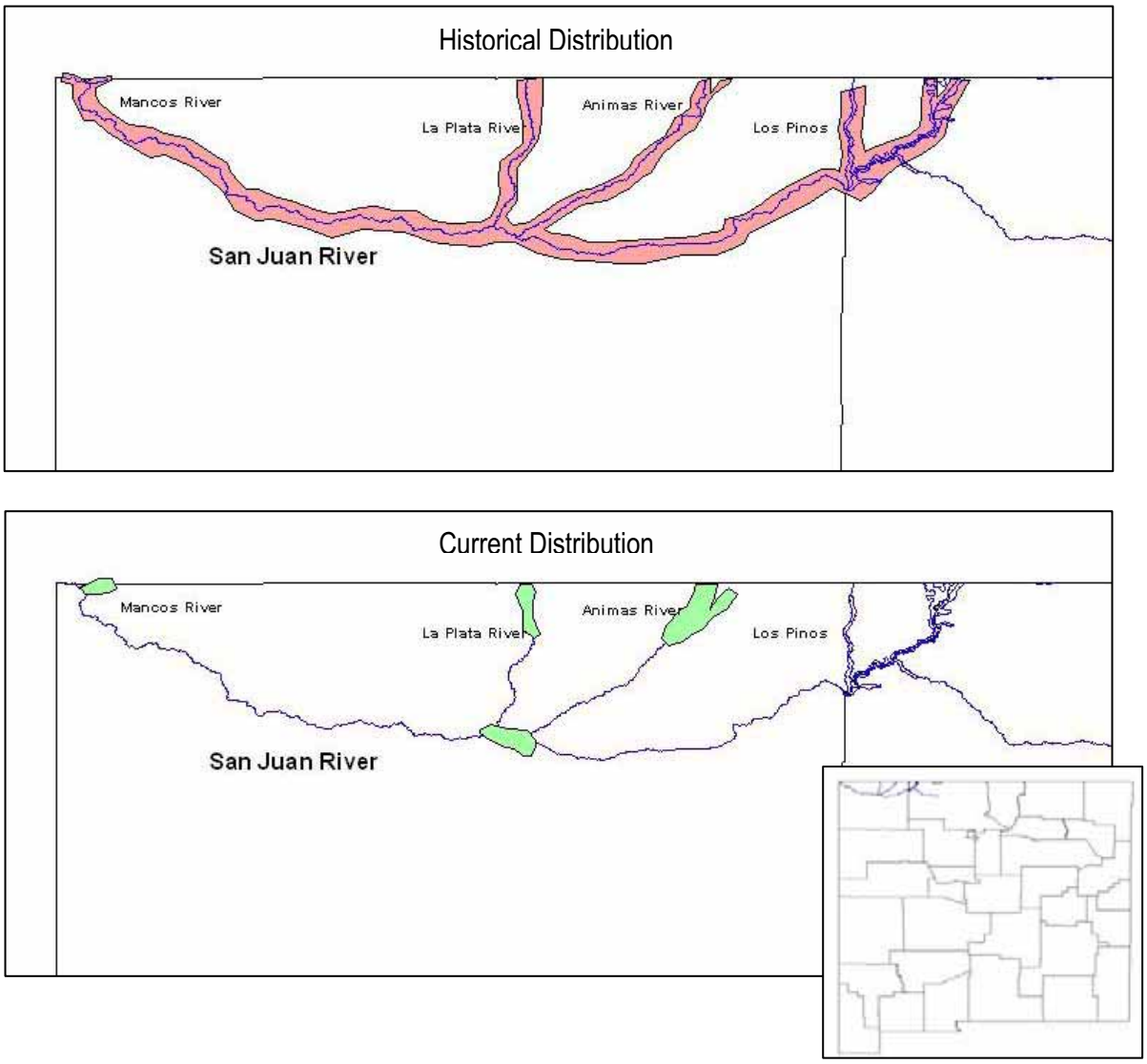
Detailed historical and current occurrence information for chubs in New Mexico is as follows:

San Juan River Basin

Although historical reports of bonytail *G. elegans,* in the San Juan River exist (Cope and Yarrow 1875), these are thought to be misidentifications of *G. robusta*, the only chub species verified in the San Juan River Basin in New Mexico and Utah (Holden and Minckley 1980, Sublette et al. 1990). Within New Mexico, the first collection of roundtail chub from the San Juan River was in 1874 (Cope and Yarrow 1875) and from its New Mexico tributaries in 1934 (Miller and Rees 2000). In the lower San Juan River, roundtail chub was uncommon and in its tributaries, including Navajo, Los Pinos, Animas, La Plata, and Mancos rivers, roundtail chub was moderately common through the early 1960s (Platania 1990, Bezzerides and Bestgen 2002; Figure 1). Since then, the number of roundtail chub captured in the San Juan Basin has drastically decreased. Roundtail chub was very abundant in Navajo Reservoir immediately after impoundment in 1962 (Olson 1967). From 1968 through 1987, roundtail chub was rarely found in the mainstem (Sublette 1977, Platania 1990) and since the early 1990s, fewer than 50 roundtail chub have been collected from the mainstem (Ryden 2006, Paroz et al. 2006)

Currently, roundtail chub is occasionally found in the San Juan River near the mouths of the Mancos and Animas rivers. Roundtail chub is absent from the San Juan River above the confluence with the Animas River to Navajo Dam. Roundtail chub is rare in the Animas River in New Mexico; recent surveys yielded only a few individuals (B. Zimmerman, Southern Ute Tribe, Division of Wildlife Resource Management, 2006, pers. comm.). Roundtail chub is occasionally found in the Mancos and La Plata rivers and in the mainstem of the San Juan River upstream of Navajo Reservoir in Colorado (M. Japhet, CDOW, 2005, pers. comm.). Currently, it appears that the San Juan and its tributaries in New Mexico do not have resident populations of roundtail chub, but rather transient individuals from Colorado.

Figure 1. Roundtail chub distribution in the San Juan River Basin.



In 2001, the Jicarilla Apache Nation Game and Fish Department collected roundtail chub from Navajo River, a tributary to the San Juan River above Navajo Dam, where the species had not been collected since 1976 (J. White, Jicarilla Game and Fish, 2005, pers. comm.).

Zuni River Basin

Roundtail chub was first collected in the Zuni River in 1851 (Baird and Girard 1853) and subsequently only by H. W. Henshaw in 1873 (USNM 16635, National Museum of Natural History, Washington, D.C.). Roundtail chub have been found elsewhere in the Little Colorado River basin, in the Little Colorado River, Chevelon Creek, and East Clear Creek (Voeltz 2002). Populations remain in East Clear and Chevelon creeks, although these are reported to be threatened (Voeltz 2002).

Gila River Basin

Roundtail chub once occurred throughout the mainstem of the Gila and San Francisco rivers in southwestern New Mexico (Figure 2). While longtime residents of the area have said that roundtail chub were moderately common and widespread in the San Francisco River below Frisco Hot Springs (Bestgen and Propst 1989), the species has not been documented in the San Francisco River since 1948 (MSB Z1730, Z1731, Z1738, University of New Mexico, Museum of Southwestern Biology, Albuquerque, NM; Table 1). Recent records for *G. robusta* are incidental or absent. A study in the mainstem Gila River in 1983 and 1984 found that roundtail chub accounted for less than 2% of the total catch (Montgomery and SWCA 1985). At NMDGF permanent monitoring sites on the mainstem of the Gila River, where annual sampling has occurred since 1987, near Riverside, Middle Box, and Lower Box sites, roundtail chub was found at the Riverside site in 1991 (Table 1; Paroz et al. 2006). The U.S. Forest Service (USFS) has collected roundtail chub from the mainstem of the Gila River sporadically since 1994 (NMDGF collection permit #3138 reports; J. Monzingo, USFS, 2005, pers. comm.).

Although few historical records exist for Gila chub in New Mexico, it was at least present in the Gila River drainage in Duck Creek, Turkey Creek, Mule Creek, and San Simon Cienega, and in the San Francisco River drainage in headwaters and cienegas such as Apache Creek and Tularosa River (Rinne 1976, Bestgen and Propst 1989, Propst 1999; Figure 3). The population in Turkey

Figure 2. Roundtail chub distribution in the Gila River Basin.

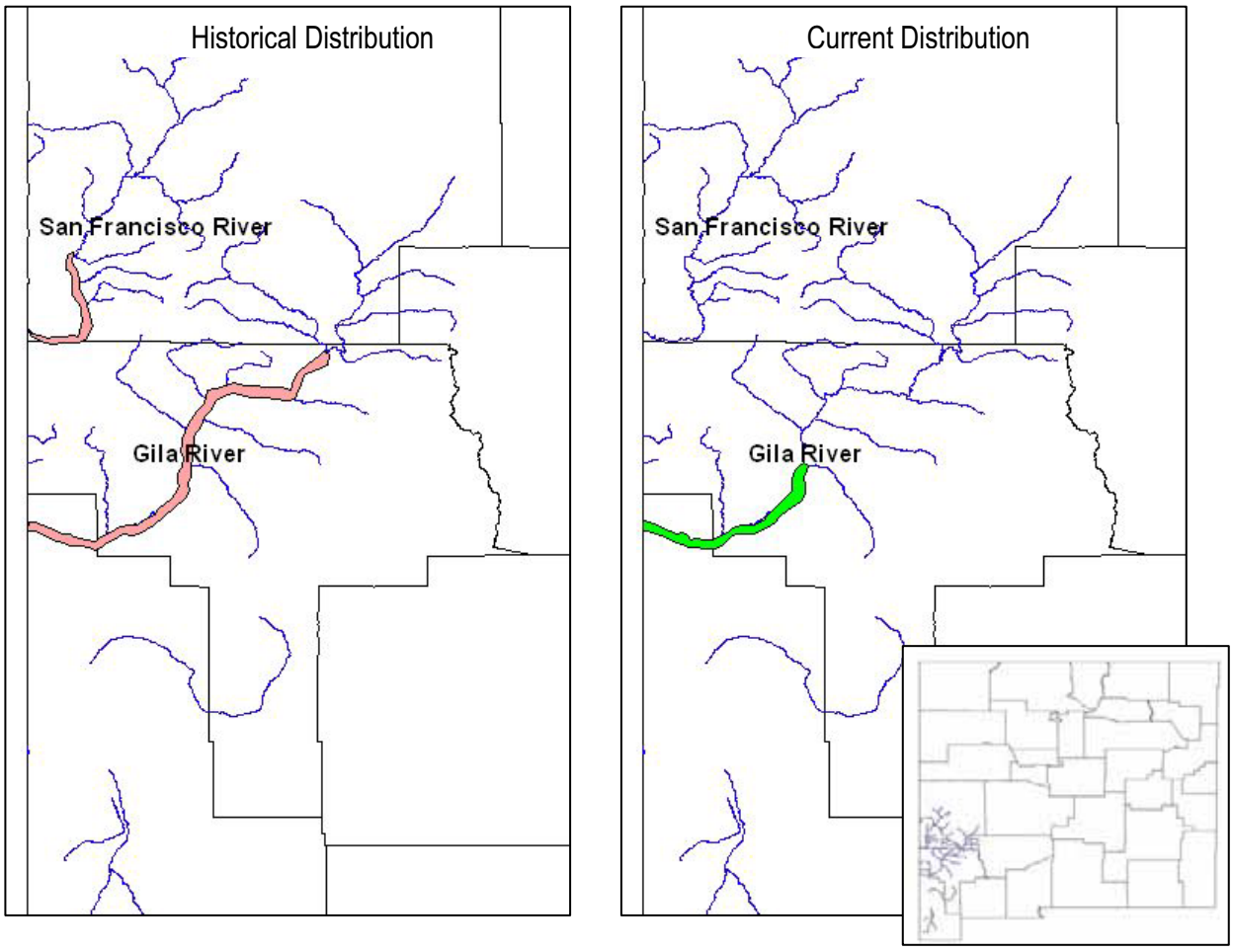
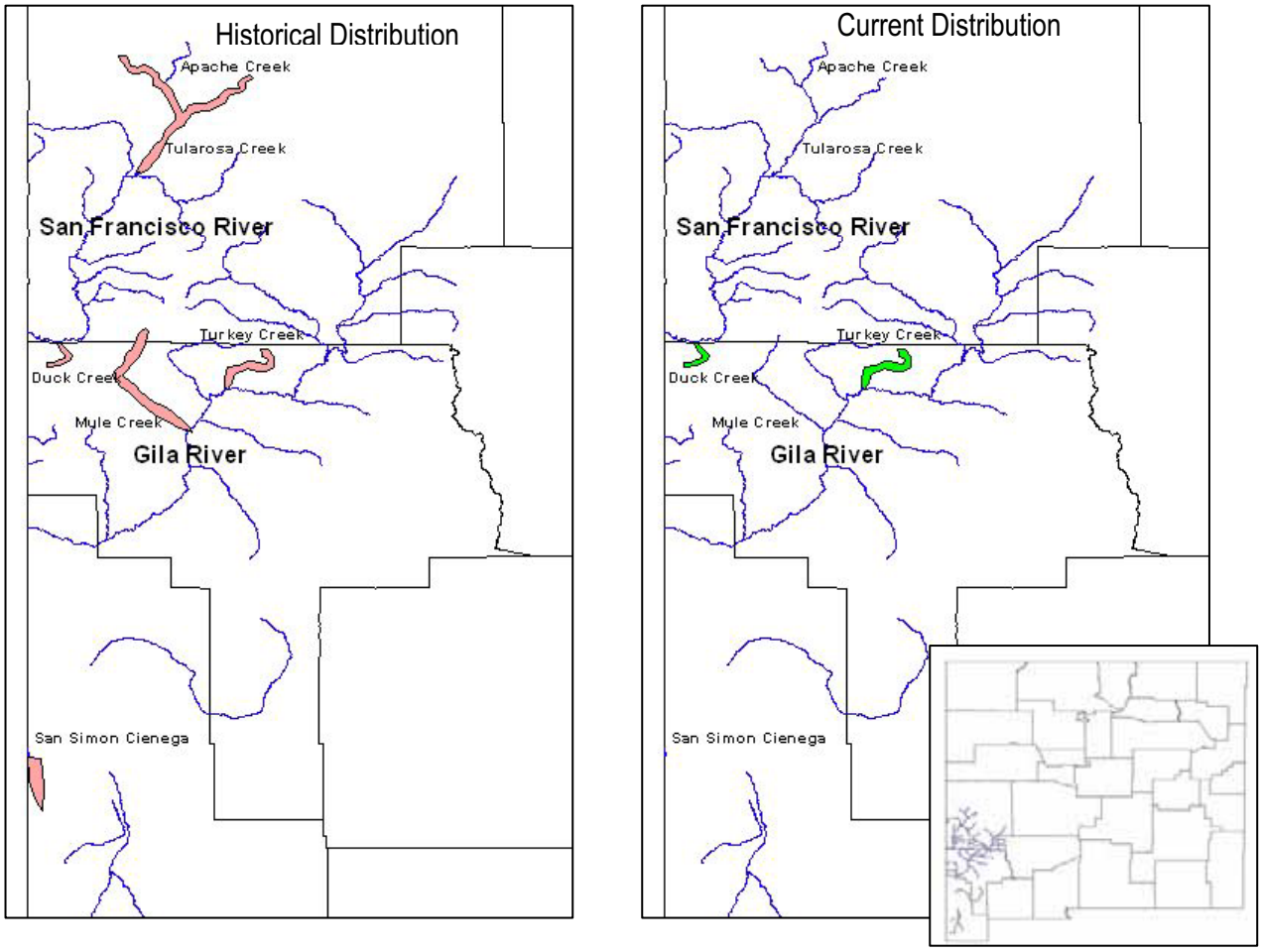


Figure 3. Gila chub distribution in the Gila River Basin



Creek is the only documented extant population of Gila chub in New Mexico, although a population may persist in Mule Creek.

Historical distribution of headwater chub in the Gila River basin of New Mexico is uncertain, principally because of it being treated as roundtail chub in all but the most recent collections (Figure 4). In New Mexico, the three forks of the Gila River currently contain headwater chub. New Mexico Department of Game and Fish annual monitoring at three permanent sites in the forks indicates that though headwater chub were regularly found through the 1990s, headwater chub are declining or absent in the past five years (Table 1; Paroz et al. 2006).

Table 1. Occurrence of chubs at permanent monitoring sites in the Gila River basin. R = roundtail chub, H = headwater chub, - indicates that sites was not sampled.

	YEAR																
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
San Francisco R., Glenwood R.S.																	
Gila River, Riverside Area				R									-				
Gila River, Middle Box	-	-	-	-	-	-	-	-	-				-				
Gila River, Lower Box	-	-	-	-	-	-	-	-	-				-				
West Fork Gila River, Cliff Dwellings	-			H	H	H		H				H		H		H	H
Middle Fork Gila River, Trailhead	H	H	H	H	H	H	H	H	H	H	H	H		H	H	H	
East Fork Gila River, Fall Spring	H	H	H	H	H	H	H	H	-	H	H	H	H	H			H

2.1.3 Habitat Requirements

Roundtail chub are typically found in mid-sized to large streams in cool to warmwater mid-elevation streams (Minckley 1973, Bestgen and Propst 1989). Roundtail chub generally are found in "deep complex pool systems," where a few deep (greater than 1 m) pools with cover (boulders, woody debris) are intermixed with riffles, runs, and eddies (Bestgen and Propst 1989, Propst 1999, White 2005; Figure 5). Roundtail chub are primarily captured in the deep pools, but movement studies indicate that they utilize the riffles and eddies in the morning and late afternoon, perhaps for feeding (White 2005). Juvenile roundtail chub tend to be closer to banks

Figure 4. Headwater chub distribution in the Gila River Basin.

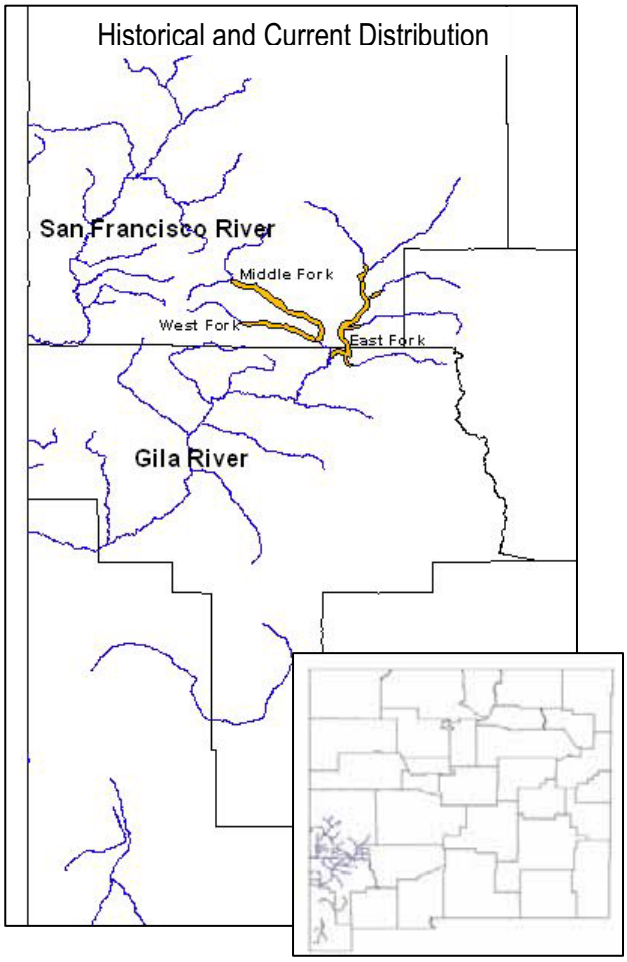


Figure 5. Examples of a.) roundtail, b.) Gila, and c.) headwater chubs' habitats in New Mexico.

a. Potential roundtail chub habitat in the La Plata River, San Juan River basin, New Mexico. Photo S.M. Carman 2006.

b. Occupied Gila chub habitat in Turkey Creek, Gila River basin, New Mexico. Photo Y.M. Paroz, 2004.

c. Occupied headwater chub habitat in the East Fork, Gila River, New Mexico. Photo D.L. Propst 2005.

in shallower water, often utilizing bank cover (Bestgen and Propst 1989). Roundtail chub often congregate in one pool, yet are absent from adjacent, similar habitats (Minckley 1973, Bestgen and Propst 1989).

Gila chub typically occupies deep pools in small streams and cienegas, commonly near cover such as vegetated undercut banks, woody debris, root wads, and boulders (Propst 1999, Minckley and DeMarais 2000). Gila chub also has been found in artificial impoundments in Arizona (Weedman et al. 1996). Juvenile Gila chub are often found among aquatic vegetation in shallow water, moving to moderate-velocity habitats as they mature (Propst 1999).

Headwater chub utilize habitat similar to that of Gila chub, occupying pools and runs in small streams near cover (Bestgen and Propst 1989). In the Gila River Basin, Bestgen and Propst (1989) found headwater chub at elevations of 1,325 m to 2,000 m with water temperatures to 26.5° C and water velocities less than 20 cm/sec. Although their habitat preferences are similar, there is no documented instance where Gila chub and headwater chub have been found together in the same habitat (Minckley and DeMarais 2000).

2.1.4 Food Habits

Roundtail chub are omnivorous, opportunistic feeders, primarily consuming a variety of aquatic and terrestrial invertebrates (Vanicek and Kramer 1969, Bestgen 1985). Aquatic plants, detritus, and fish also are reported in the diet (Schreiber and Minckley 1981, Bestgen 1985). Roundtail chub in the San Juan River appeared to utilize wide areas (more than 30 m) for feeding (White 2005).

Gila chub are also omnivorous (Griffith and Tiersch 1989). There may be an ontogenetic prey shift, with smaller individuals feeding on organic debris and aquatic plants, and larger, adult fish feeding on invertebrates and small fish (Rinne and Minckley 1991). Gila chub adults are more active, and presumably feed more, during crepuscular periods (Rinne and Minckley 1970). Stomach analysis from Fossil Creek, Arizona specimens indicates that headwater chub is also omnivorous, consuming mainly aquatic and terrestrial invertebrates, supplemented with plant material, detritus, and fish (Neve 1976, Bestgen 1985, Rinne and Minckley 1991).

2.1.5 Reproductive Biology and Growth

Roundtail chub spawning generally occurs in spring and early summer. Both males and females develop breeding colors and tubercles during spawning season, with male coloration tending to be more intense. In the Green River, Colorado and Utah, presence of gravid and ripe fish indicated that spawning occurred from late June through early July, although length-frequency histograms indicated only mid-June spawns (Vanicek and Kramer 1969). Temperatures during these times were approximately 18° C. In the Yampa River, Colorado, ripe females and males have been collected in mid-July when water temperatures ranged from 17 to 19° C (Muth et al. 1985).

Roundtail chub spawning occurs primarily over clean gravel, sometimes sand and silt (Neve 1976, Minckley 1981). Minckley (1981) reported movement of large numbers of males over spawning sites prior to spawning, presumably clearing substrate of debris. Several males collect in a suitable spawning area and are joined by a ripe female. Two males flank her, quickly vibrate their caudal regions, and then release sperm simultaneously with the release of eggs (Minckley 1981, Brouder 2001). Fecundity varies with fish size, ranging from 1000-4300 mature eggs in 100-269 mm TL females in Fossil Creek, Arizona (Neve 1976) to 14,163-45,124 mature eggs in 299-368 mm TL females in the Gila River (Bestgen 1985). Eggs are adhesive and demersal (Sigler and Miller 1963, Constanz 1981, Muth et al. 1985, Kaeding et al. 1990).

Eggs are reported to hatch after 126-156 hours (Muth et al. 1985). Bestgen (1985) reported roundtail chub growth of around 70 mm TL in the first year, then approximately 50 mm TL per year until age 4 when annual growth begins to slow in the Gila River watershed. Bestgen (1985) contended that roundtail chub growth is dependant upon habitat size; i.e. Turkey Creek chubs were smaller than those from the mainstem of the Gila River. The size variation reported by Bestgen has now been explained as variation among species; what are currently recognized as headwater and Gila chub populations were studied along with roundtail chub populations (Minckley and DeMarais 2000, Voeltz 2002).

Although roundtail chub has been reported living up to 20 years of age (Scoppetone 1988), largest and oldest individuals are most commonly around 7-10 years of age and about 400 mm TL (Bezzerides and Bestgen 2002). Roundtail chub mature between 2-5 years of age.

Gila chub reproductive behavior is similar to that reported for roundtail chub (Bestgen 1985). Spawning typically occurs from late spring into summer (Minckley 1973, Griffith and Tiersch 1989). Breeding coloration (i.e. red-orange coloration) is reportedly more intense in Gila chub than roundtail or headwater chub (Minckley 1969, Rinne 1969, Minckley 1973). Spawning by Gila chub typically occurs over beds of submerged vegetation or root wads, with males flanking a female as reported for roundtail chub (Minckley 1973).

In Redfield Canyon, Arizona, Gila chub displayed rapid growth during the first year, to approximately 90 mm TL (Griffith and Tiersch 1989). Female Gila chub usually are larger than males, reaching 250 mm TL compared to 150 mm TL at maturity. Studies in Arizona indicated that Gila chubs in their first year, 80-95 mm TL, may participate in spawning (Griffith and Tiersch 1989; Nelson 1993). Typically, Gila chub reach maturity in the second year (Griffith and Tiersch 1989).

Headwater chub spawning is similar to roundtail and Gila chub spawning (Bestgen 1985). Both males and females develop spawning coloration and tubercles, males more intensely. In the Gila River basin, Bestgen and Propst (1989) observed ripe females and males congregated in pools in late spring to summer. Afternoon water temperatures for spawning in the East Fork of the Gila River were 22 °C (Bestgen 1985). Headwater chub growth is probably similar to roundtail and Gila chubs, with rapid growth occurring in the early years, and then slowing with maturity. Headwater chub mature between 2 and 5 years of age.

2.1.6 General Habits

Movement by roundtail chub is not well documented and studied. Studies in the Lower Colorado River Basin suggest very little movement (0.0-5.7 km) (Bryan and Robinson 2000, Brouder et al. 2000), yet studies in the Upper Colorado River Basin documented extensive movements (average maximum displacement of 33.9 km) of roundtail chub during spawning

season (Kaeding et al. 1990). A recent study, tracking 6 roundtail chub in the Navajo River, a tributary of the San Juan River, found that roundtail chub make substantial spawning migrations (White 2005); roundtail chub moved between the Navajo and San Juan rivers and within each river between pool and riffle habitats. The average distance moved between contacts was 650 m and the maximum was over 13 km.

Beyers et al. (2001) reported that in the Colorado River, roundtail chub moved further during night than day. In the Navajo River, limited night sampling indicated that roundtail chub were more active during the day (White 2005). Seasonal movement of roundtail chub has been reported in Aravaipa Creek (Siebert 1980) and Verde River (Brouder et al. 2000). Movements were believed to take advantage of optimal thermal conditions and were generally less than 100 m. In the Navajo River, movements of at least one fish were thought to be toward wintering habitats (White 2005). Similar seasonal movements were not observed in the Gila River drainage (Bestgen et al. 1987).

Adult Gila chub are usually more active during crepuscular periods while young are active throughout the day (Rinne and Minckley 1970; Minckley 1973; Griffith and Tiersch 1989; Weedman et al. 1996). Little is known about seasonal movement of Gila and headwater chubs.

2.1.7 Diseases/Parasites

Chub species appear to be highly susceptible to infection by parasites. Specimens of roundtail chub in Aravaipa, Canyon, and Oak creeks, Arizona, were found infected by several parasites, most commonly the cestode, *Isoglaridacris bulboocirrus* (Mopame 1981). Other parasites reported were the protozoan "ich", *Ichthyophthirius multifilis*, yellow grub, *Clinostomum marginatum*, trematode flatworms, *Ornithodiplostomum ptychocheilus* and *Plagioporus* sp., and nemotodes, *Dacnitoides* sp. and *Rhabdochona* sp. Roundtail chub appeared to be more susceptible to infection by the copepod *Lernaea* sp. than Sonora *Catostomus insignis* or desert *Pantosteus clarki* suckers in the Salt River basin (James 1968). Heavy infestation of *Lernaea* was also reported in the lower Verde and Green rivers (Vanicek 1967, Bryan et al. 2000). In the Verde River, roundtail chub condition ($K=[length/weight^3] \times 10^5$) increased as abundance of *Gyrodactlus* sp. infestation decreased, indicating parasites had a negative effect on growth and

condition of the species (Robinson et al. 1998, Voeltz 2002). Although parasites of Gila and headwater chub have not been reported, they are probably susceptible to the same parasites as roundtail chub.

2.1.8 Population Dynamics

Fish surveys in the late 1980s in the San Juan River and its tributaries produced 19 roundtail chub specimens, of which 15 were young-of-year or juveniles (Platania 1990). Although the presence of young fish confirmed reproduction, no adult fish was captured. Since that survey, few roundtail chubs have been collected from the San Juan River basin and very few of these fish were adults (Ryden 2003). In the Animas River in New Mexico, two sub-adult roundtail chub were collected in 2002, but sampling from 2003 through 2005 has yielded no additional collection (B. Zimmerman, Southern Ute Tribe, Division of Wildlife Resource Management, 2006, pers. comm.).

Size structure of roundtail chub populations in the Gila River appears to have changed with decreasing numbers of fish. In the Gila River, below Mogollon Creek, fish greater than 200 mm TL were common over 50 years ago (Bestgen and Propst 1989). In surveys since the early 1980s, when roundtail chub were found, fish greater than 200 mm were very rare. Long-term (1988-2000) roundtail chub monitoring data in Westwater Canyon, Utah, indicate that frequent shifts in size distributions are common, even when abundance estimates remain level (Hudson and Jackson 2003).

The Gila chub population in Turkey Creek above the barrier waterfalls represents the largest and only multiple age-class population in New Mexico known (Bestgen and Propst 1989). Recent NMDGF surveys (Paroz et al. 2006) indicated that Gila chub were still present here, although comparatively few individuals, ranging from 50 to 200 mm TL, were collected. Recent wildfire induced ash flows greatly diminished abundance in Turkey Creek.

Size distributions appear to change frequently in populations of headwater chub in the forks of the Gila River. In the upper East Fork, Bestgen and Propst (1989) found only headwater chub > 175 mm TL in 1983, whereas earlier collections contained a range of sizes (Rinne 1976). In

the past few years, only adult headwater chub were collected in the East Fork and there has been a decrease in age one and younger fish in the Middle Fork (Paroz et al. 2006).

2.1.9 Associated Species

Roundtail chub has been associated with many different species across its broad historical range (Propst 1999). In the San Juan River, roundtail chubs were found with Colorado pikeminnow *Ptychocheilus lucius,* speckled dace *Rhinichthys osculus*, flannelmouth sucker *Catostomus latipinnis*, and bluehead sucker *Catostomus discobolus*. The type specimen from the Zuni River was found with Zuni bluehead sucker *Catostomus discobolus yarrowi* and speckled dace. In the Gila River, roundtail chub historically occurred with longfin dace *Agosia chrysogaster*, spikedace *Meda fulgida*, speckled dace, loach minnow *Tiaroga cobitis*, desert sucker, and Sonora sucker.

Throughout much of the current range of roundtail chub, nonnative species are common. In the San Juan, this includes common carp *Cyprinus carpio*, channel catfish *Ictalurus punctatus*, red shiner *Cyprinella lutrensis*, and fathead minnow *Pimephales promelas* (Brooks et al. 2000, Ryden 2000). In the tributaries to the San Juan River, including Animas and La Plata rivers, nonnative species also include brown trout *Salmo trutta*, rainbow trout *Oncoryhnchus mykiss*, black bullhead *Ictalurus melas*, and green sunfish *Lepomis cyanellus* (NMDGF collection permit #3004, S.M. Carman, NMDGF, 2006, pers. obs.).

In the Gila River, the most abundant nonnative species is red shiner, although presence of red shiner in the Gila River is not thought to impact negatively roundtail chub through competition or predation (Bestgen and Propst 1989). Introduced predators in the Gila River include channel catfish, flathead catfish *Pylodictis olivaris*, smallmouth bass *Micropterus dolomieu*, rainbow trout, and brown trout (Bestgen and Propst 1989). Surveys indicated roundtail chubs are no longer found in areas of the Gila River drainage in New Mexico where introduced predators are present (Bestgen and Propst 1989).

Gila chub was historically found with longfin dace, Sonora sucker, desert sucker, Gila topminnow *Poeciliopsis occidentalis*, and speckled dace (Griffith and Tiersch 1989, Propst

1999). Nonnative fish found in Gila chub habitat include channel catfish, flathead catfish, red shiner, fathead minnow, green sunfish, western mosquitofish *Gambusia affinis*, and common carp (Weedman et al. 1996). Surveys by the Forest Service in 2001 found rainbow trout and speckled dace with Gila chub (J.A. Monzingo, USFS, 2005, pers. comm.). Recent NMDGF surveys found only speckled dace with Gila chub in Turkey Creek (D.L. Propst, NMDGF, 2005, pers. comm.).

Headwater chub occurs with native longfin dace, loach minnow, spikedace, Sonora sucker, desert sucker, and speckled dace (Paroz et al. 2006). Recent surveys indicated nonnative species found in headwater chub habitat include fathead minnow, rainbow trout, brown trout, black bullhead *Ameiurus melas*, yellow bullhead *A. natalis*, channel catfish, western mosquitofish, green sunfish, bluegill *Lepomis macrochirus*, smallmouth bass, and largemouth bass *Micropterus salmoides* (Paroz et al. 2006). Flathead catfish *Pylodictis olivaris* was found in the West and East forks Gila River for the first time in 2003 and 2005 respectively (J.A. Monzingo, USFS, 2005, pers. comm.)

2.2 HISTORICAL PERSPECTIVE

2.2.1 Habitat trends

San Juan River

The San Juan River is the second largest tributary to the Colorado River. From its origins in the San Juan Mountains of Colorado, the river flows approximately 50 km to the New Mexico border, then 305 km to Four Corners (New Mexico, Colorado, Utah, Arizona) where it exits the state. Historically, the San Juan River was a typical southwestern stream, characterized by large spring peak and summer-winter low base flows, with large, short-duration spikes caused by summer and autumn rainstorms.

Soil erosion, caused by intensive livestock grazing, in the basin contributed to large quantities of sediment entering the watershed in the late 1800s and early 1900s (Miser 1924, Graf 1987, Gellis et al. 1991). Aerial photographs of the watershed taken in 1935 by the USDA Soil Conservation Service indicated the river had a braided, broad, sandy channel with little or no riparian

vegetation. After 1940, there was a significant reduction in sediment load in the basin, because in part of establishment of nonnative tamarisk *Tamarisk chinensis* and Russian olive *Elaeagnus angustifolia* (Bliesner and Lamarra 2000).

In addition to elevated sediment loading and establishment of nonnative riparian vegetation, other human-induced modifications dramatically altered the San Juan River basin, especially in the past 60 years. Several multi-state compacts to control and divide water, beginning in 1922 with the Colorado River Compact, apportioned Colorado River water between Upper and Lower Basin states and Mexico. The 1948 Upper Basin Agreement provided "for the equitable division and apportionment of the use of the waters of the Colorado River System" among Arizona, Colorado, New Mexico, Utah, and Wyoming. Following this agreement, development of Upper Basin water was begun through the Colorado River Storage Project Act of 1956, which included construction of Navajo Dam on the San Juan River between 1958 and 1963. The purposes of impoundments enabled by this act were to regulate flow of the Colorado River; store water for beneficial consumptive uses; make it possible for states of the Upper Basin to use the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively; provide for the reclamation of arid and semiarid land; control of floods; and generation of hydroelectric power. Navajo Dam is primarily used to regulate the flow of the San Juan River and provide flood control, but impounded water is also used for irrigation. Although this dam was essential for development of water resources, construction and operation of the dam significantly altered the river ecosystem. Flows were largely controlled and stabilized, and water temperatures increased (Bliesner and Lamarra 2000).

Currently, the San Juan River in New Mexico upstream of Shiprock is largely a single channel with cobble substrate; downstream of Shiprock, the channel is braided with cobble and sand substrate. Flows are regulated largely by Navajo Dam; near the unregulated Animas River confluence, flow is more natural. Run habitats are most common, followed by riffles. Riparian vegetation is mainly nonnative salt cedar and Russian olive and native cottonwood *Populas fremontii* and willow *Salix* sp.

Several diversion structures are on the mainstem San Juan River, including Fruitland Diversion and power plant diversion dams operated by Public Service Company of New Mexico and Arizona Public Service, which divert flow and fragment habitats. Anthropomorphic impacts to water quality include agricultural contamination, primarily through irrigation return flows, oil and gas development, and urban development, including street runoff, sewage effluent, and hardening of the watershed. Specific water quality concerns include high levels of selenium, which naturally occurs in the watershed, and polycyclic aromatic hydrocarbons (NMED/SWQB 2004).

In 1991, the San Juan River Basin Recovery Implementation Program (SJRRIP) was begun to conserve native fish species (principally Colorado pikeminnow and razorback sucker *Xyrauchen texanus*) while allowing water development (SJRRIP 1995). After several years of research and discussion, flow recommendations were made to provide operational criteria for Navajo Dam to enhance quality and quantity of habitats needed by endangered fishes (Holden 2000). Reoperation of Navajo Dam with these recommendations began in 1992 and included maintenance of 500 cubic feet per second (cfs) base flow and spring releases to provide peak flows of particular rates (cubic feet per second) at specified frequency and duration to meet life history needs of target species. Recommendations to improve habitat also included fish passages at diversions. Importance of these habitat recommendations for roundtail chub has not been evaluated. High spring flows to maintain habitat quality (e.g. sediment flushing) and base flow of at least 500 cfs to maximize backwater habitat for Colorado pikeminnow and razorback sucker were the focus of Navajo Reservoir re-operations.

Historically, the Navajo, Animas, La Plata, and Mancos rivers were perennial tributaries to the San Juan River in New Mexico. The development of water rights over the past century has led to decreased in-stream flows in these tributaries and currently only the Navajo, Mancos, and Animas rivers are perennial, although the La Plata River is permanently watered in reaches (B. Wegener, BLM, 2006, pers. comm.). Like the mainstem San Juan River, riparian areas of these rivers are heavily infested with salt cedar and Russian olive.

Under the Colorado River Basin Project Act of 1968, the Animas-La Plata Project was authorized in order to provide irrigation and municipal and industrial water supplies to the Colorado Ute Tribes, Animas-La Plata Water Conservancy District, State of Colorado, Navajo Nation, San Juan Water Commission, and La Plata Conservancy District. Construction of water controlling structures was scheduled to begin in the 1980s, but negotiations with water users, environmental groups, and federal managers, including incorporation of the Colorado Ute water rights settlement, delayed the final project proposal and implementation until 2000 (Public Law 106-554). The final project was scaled down and includes structural components of Ridges Basin Dam and Reservoir, Durango Pumping Plant, and Ridges Basin Inlet conduit, for an average annual depletion of 57,100 acre-feet from the Animas River. Nonstructural components of the final project include the Colorado Ute Tribes acquiring existing water rights from McElmo Creek and Mancos, La Plata, Animas, Florida, and Pine River basins. Construction, which began in 2005, is expected to be complete in 2008 and the reservoir filled in 2011.

The Final Environmental Impact Statement on the Project, completed in 2000, included a 1999 Biological Opinion from the U.S. Fish and Wildlife Service (USFWS) (USFWS 2000). Although the Biological Opinion did not directly address roundtail chub, flow changes in both mainstem San Juan River and its tributaries will likely affect chub. The Biological Opinion stated that although the project contained projected return flows to the La Plata River, these are non-binding and not likely to occur. The conclusion of the Biological Opinion, concerning the two federally-listed fish species, Colorado pikeminnow and razorback sucker, in the San Juan River basin, was that "operations of the Project …without offsetting measures may affect [Colorado pikeminnow and razorback sucker] in the San Juan River and critical habitat." Potential impacts in the driest years include reductions in adult fish habitats, spawning habitats, and nursery habitats. The Biological Opinion stated that as long as the flows designed to mimic the natural hydrograph are enforced in the San Juan River below Navajo Dam, there should not be a negative affect on the San Juan River.

Zuni River

A tributary to the Little Colorado River, Zuni River headwaters and mainstem occur in McKinley County, New Mexico and largely on Zuni Pueblo lands. Post-European settlement changes to the landscape and subsequent effects on the watershed are well-documented (see *Zuni*

River Watershed Plan, NRCS 1998, for summary). The Zuni River watershed was extensively logged and overgrazed in the late 1800s and early-to-mid 1900s, resulting in severe degradation of the natural resources in the area. Impacts from mass removal of vegetation included increased surface erosion, gullying, headcutting, wide stream discharge fluctuations, and less retention of water in the system. Impacts were so severe that the Pueblo of Zuni brought litigation against the United States government in the early 1970s. The settlement, the Zuni River Watershed Act of 1990, seeks to restore tribal lands damaged because of upstream misuse of resources. Subsequent to degradation in the early twentieth century, the Zuni River was dammed for flood control, irrigation storage, and recreational fishing. These reservoirs inundated habitats and prevented or diminished fish movement among habitats. Additionally, water withdrawals for irrigation and human consumption led to decreased surface discharge.

Currently, habitat of sufficient quality and quantity for roundtail chub is lacking in the watershed. Continuous flow is not present from the headwaters downstream to the Arizona/New Mexico border; surface flow is generally only continuous during heavy spring run-off. Many stream reaches are dry except near perennial springs. The mainstem of the Zuni River is low-gradient and meandering and headwaters are higher gradient, with pools common at bases of bedrock cascades (Propst and Hobbes 1996).

Land ownership in the upper Zuni River watershed is a checkerboard of USFS (Cibola National Forest) and private lands. All the lower courses of the ríos Nutria, Pescado, and Zuni to the Arizona/New Mexico border are within the Zuni Indian Reservation.

Gila River

The Gila River rises in the Mogollon Mountains of southwestern New Mexico and flows westward into Arizona. The San Francisco River, a tributary of the Gila River, beginning in east-central Arizona, flows east into New Mexico, and then south and west back into Arizona. Mainstem areas of the Gila and San Francisco rivers, where roundtail chub historically lived, have not been subject to the degree of habitat alteration as many other rivers in the American Southwest. No major dams are present on the Gila River (including San Francisco River) in New Mexico and there is no urban development. Flows are continuous, except during irrigation

withdrawals during drought in the Cliff-Gila Valley of the Gila River. In Cliff-Gila Valley, water is diverted for irrigation. There are two lowhead diversion dams on the San Francisco River. Diversions cause the San Francisco River in the Alma Valley to be seasonally dry. Livestock grazing is the major land use and bank instability is common in most mainstem areas of the watershed. Livestock grazing has been excluded along the river corridors throughout most of the Gila National Forest (J.A. Monzingo, USFS, 2005, pers. comm.). Although much of the upland around mainstems of Gila and San Francisco rivers is managed by USFS, canyon bottoms and valleys are mainly privately owned.

Headwaters of the Gila River, which Gila or headwater chub may occupy, occur primarily in mid-elevations on USFS lands. These streams tend to be moderate gradient with scour pool and cobbled riffle habitats. Past wildfire suppression has contributed to several intense wildfires in recent years, including Divide Fire in 1989, Bonner Fire in 1994, Cub Mountain Fire in 2002, and Dry Lakes Complex Fire Use and Turnbo fires in 2003 (J. Monzingo, USFS, 2005, pers. comm.). Ash flows associated with these wildfires have negatively impacted much of the drainage occupied by headwater and Gila chub, primarily in West Middle, and East forks Gila River and Turkey Creek.

Historically large cienegas occurred along middle and lower reaches of the Gila River and its tributaries in New Mexico, including Duck Creek and San Simon Cienega, where Gila chub were historically found. Groundwater pumping, surface water draining, and livestock grazing led to degradation and loss of these habitats.

2.2.2 Population trends

San Juan River

Roundtail chub was moderately common in the San Juan River tributaries prior to 1960 and rarely found in the mainstem San Juan River (Platania 1990). Since then, populations have drastically declined. Between 1987 and 1989, 19 roundtail chub were taken from the San Juan and Mancos rivers in New Mexico (Platania 1990). More recent surveys (1991 to 2004) have found few roundtail chub in the San Juan River basin (Ryden 2003). Populations are reportedly absent from the San Juan River between Navajo Dam and the Animas River confluence (Ryden

2003). Individuals are found rarely in the Animas River (B. Zimmerman, Southern Ute Tribe, Division of Wildlife Resource Management, 2006, pers. comm.), and are thought to be from the Florida River (a tributary to the Animas River in Colorado), which has a resident population of roundtail chub (Miller and Rees 2000). Roundtail chub are very rare in the San Juan River downstream of the Animas River confluence and there is thought to be no resident population (Ryden 2003). Roundtail chub are occasionally found in the Mancos and La Plata rivers in New Mexico and in the San Juan River and Navajo River upstream of Navajo Dam. In 2000, surface runoff after a forest fire at Mesa Verde National Park entered the Mancos River and killed native fishes, including roundtail chub. After prolonged drought, some of the surviving roundtail chub were relocated from the Mancos River in Colorado to the Colorado Division of Wildlife J.W. Mumma Native Species Facilities. Before the river dried up in 2002. Progeny from these fish were reintroduced to the Mancos River in 2003 by the Colorado Division of Wildlife (M. Japhet, CDOW, 2005, pers. comm.).

Zuni River

The type specimen of roundtail chub (Baird and Girard 1853) was collected from the Zuni River, but the species has not been collected there in over 100 years. Roundtail chub is presumed extirpated from the Zuni River in New Mexico.

Gila River

Prior to 1950, roundtail chub were found in the Gila River mainstem from the Arizona-New Mexico border upstream to the confluence of the forks (Bestgen and Propst 1989). Today, collections of roundtail chub are rare and persistence of a viable population is doubtful. Roundtail chub has not been found in the San Francisco River since 1948 and the population there is considered extirpated (Voeltz 2002).

Historical records indicate that Gila chub populations were found in Gila River drainage in Duck, Turkey, and possibly Mule creeks and San Simon Cienega, and in the San Francisco River drainage in headwaters and cienegas such as Apache Creek and Tularosa River (Rinne 1976, Bestgen and Propst 1989, Propst 1999). The only extant New Mexico population is in Turkey

Creek, a Gila River tributary, although a population may occur in Mule Creek, a tributary of San Francisco River downstream of Hardin Cienega in Arizona.
Historical distribution of headwater chub is uncertain. Recent surveys (1980 to present) documented headwater chub populations in the forks of the Gila River, but viability of each is questionable (Paroz et al. 2006).

2.2.3 Use and demand trends

Traditionally, roundtail chub was considered a sport fish (Koster 1957) and chubs were utilized as a food source during the Depression according to a longtime resident of the San Francisco River area (pers. comm. to D.L. Propst, NMDGF, 1985). Currently, as roundtail, Gila, and headwater chubs are listed as endangered under the Wildlife Conservation Act, fishing for the species is prohibited and a permit must be granted for scientific collection. The Navajo and Jicarilla Apache nations also have restrictions on take of roundtail chub.

2.2.4 Past management

Little to no management occurred for roundtail chub prior to 1975. As part of construction of Navajo Dam, a large fish-poisoning project took place in 1962 that confirmed and reportedly killed substantial populations of roundtail chub downstream as far as Farmington (Olson 1962, Holden 2000). Stocking of nonnative species in the San Juan River also began about this time, including stocking channel catfish.

Roundtail chub was first listed in New Mexico as Threatened in 1975 and uplisted to Endangered in 1996 (19 NMAC 33.1). Protection under the Wildlife Conservation Act is limited to 'take'; there is no critical habitat designation or regulatory protection of occupied or potentially occupied habitats. Roundtail chub is listed as a species of special concern by Arizona, Utah, Wyoming, and Colorado. The Navajo Nation also lists roundtail chub as Endangered (Group 2) (No.RCMA-31-01 2001) and the Republic of Mexico lists it as a rare species (SDS 1994). In 2003, USFWS was petitioned by the Center for Biological Diversity and Sky Island Alliance to list a distinct population segment of roundtail chub in the lower Colorado River basin as Endangered. In April 2006, after reviewing the status and threats to the species, USFWS found that listing is not warranted for the roundtail chub [FR 71 26007 26017].

Gila chub was listed as Endangered by New Mexico in 1978 (19 NMAC 33.1). Gila chub was identified as Threatened by Arizona in 1988 and then reclassified as Wildlife of Special Concern in 1996. The Republic of Mexico lists it as Endangered (SDS 1994). In November 2005, USFWS designated Gila chub as Endangered with Critical Habitat throughout its range [70 FR 66663 66721]. Critical habitat in New Mexico is limited to Turkey Creek. The American Fisheries Society lists Gila chub as a species of concern (Williams et al. 1989).

Headwater chub was approved for listing as Endangered by the New Mexico State Game Commission in November 2006. The species is not identified in Arizona as a Wildlife of Special Concern, although it was previously protected inasmuch as it was taxomically included with roundtail chub. In 2003, USFWS was petitioned to list headwater chub, along with roundtail chub, as endangered species. In April 2006, headwater chub was listed as a Candidate species by USFWS throughout its range [71 FR 26007 26017].

In 1991, the San Juan River Basin Recovery Implementation Program (SJRRIP) was begun to conserve native fishes, particularly federally-listed Colorado pikeminnow and razorback sucker, in the San Juan Basin while proceeding with water development. As part of this effort, several studies on native fishes in the basin were completed, many of which included information on roundtail chub habitat associations. Additionally, the San Juan River is monitored annually as part of SJRRIP, providing current information on the status of roundtail chub in the river. Several management efforts associated with SJRRIP may affect conservation of roundtail chub and include re-operation of Navajo Dam to mimic a natural flow regime and efforts to remove nonnative species.

Neighboring state and tribal agencies have begun hatchery propagation and restoration of chubs. The Colorado Division of Wildlife has been working with the Jicarilla Apache Tribe to produce and restore roundtail chub into San Juan River tributaries to their lands (M. Japhet, CDOW, 2005, pers. comm.; J. White, Jicarilla Apache Game and Fish Department, 2005, pers. comm.). The Arizona Game and Fish Department has several programs for rescuing, rearing, and reestablishing Gila chub and roundtail chub (Desert Fishes Team 2003).

In 2003, New Mexico, Arizona, Colorado, Utah, Wyoming and Nevada entered into *Range-wide Conservation Agreement for Roundtail Chub, Bluehead Sucker, and Flannelmouth Sucker* (Colorado River Fish and Wildlife Council 2004) for the purpose of proactively and cooperatively protecting and recovering these species. As part of the Agreement, each state must design a Conservation Strategy for the species within their legal boundaries, as well as participate in the drafting of the *Range-wide Conservation Strategy for Roundtail Chub, Bluehead Sucker, and Flannelmouth Sucker*. This Recovery Plan serves as New Mexico's strategy for roundtail chub.

2.3 HABITAT ASSESSMENT

2.3.1 Current Status

San Juan River

Habitat in the San Juan River has been compromised by more than forty years of regulated flows. As part of the SJRRIP, reservoir releases are regulated to mimic a natural flow regime, and this should help restore habitat for roundtail chub. Since re-operation of the dam, roundtail chub preferred habitat (slow velocity types including pool, debris pool, rootwad pool, eddy, edge pool, and riffle eddy habitats) made up approximately 0.51% in 2001 and 0.62% in 2002 of the total wetted area (Bliesner and Lamarra 2003). While preferred habitat of roundtail chub (deep, complex pool systems with cover) is rare in the mainstem of the San Juan River, it is more common in the tributaries, such as the Animas and La Plata rivers.

Water quality in the San Juan River basin has been degraded by resource extraction, hydromodification, agriculture, removal of riparian vegetation, streambank destabilization, and overall watershed condition (NMED/SWQB 2004). Currently there are 136 assessed river miles listed in the *2004-2006 State of New Mexico Integrated Clean Water Act §303(d)/§305(b) Report* as "Not Supporting" all of their designated uses. The most common reasons for this are pollution from selenium, nutrients, and pathogens, and elevated temperature (NMED/SWQB 2004). Although not documented, these factors may impair survival of roundtail chub that move to the San Juan River from tributaries or diminish reproduction and recruitment success of those that remain in the river.

Zuni River

Severe degradation of the Zuni River watershed occurred as a consequence of domestic livestock overgrazing, excessive timber harvest, and indiscriminate road construction (see *Zuni River Watershed Plan*, NRCS 1998, for a summary). Although these activities occurred in the late 1800s and early 1900s, subsequent erosion, gullying, headcutting, and loss of water continued to cause degradation of the watershed, including roundtail chub habitat. Extensive information on condition of the Zuni River watershed outside of the Zuni Indian Reservation was collected as part of the *Zuni River Watershed Plan* (NRCS 1998) and is summarized herein. Average sediment yield (0.32 acre-feet per year) is moderate for the southwestern U.S. Approximately 205 acre-feet per year of sediment are produced in the watershed outside of the Zuni Reservation, delivering about 96 acre-feet per year to the reservation, where it contributes to sedimentation in the river and reservoirs. Approximately 26% of total sediment is produced by channel erosion, 32% by gully and road erosion, and 42% by sheet and rill erosion. Comparison of aerial photographs taken in 1935 and 1991 indicated that road density increased 40 to 130% in subwatersheds of the Zuni River.

The principal uses of surface and ground water within the Zuni River watershed are human consumption, livestock, and irrigation. Diverting water for agricultural use is the primary purpose of five impoundments and several other reservoirs act as flood control structures. Reservoirs trap eroded sediments and many of the reservoirs are now shallow, eutrophic ponds or wetlands with little or no storage capacity. Sediment trapping by these impoundments has also changed the character of the river by altering channel morphology and substrate composition. Flow in the Zuni River is intermittent and the large pools reported historically where fish could survive when flow was minimal are now shallow and ephemeral.

Gila River

Mainstem reaches of Gila and San Francisco rivers in New Mexico, where roundtail chub historically lived, have not been subject to the degree of habitat alteration as many other rivers in the Southwest. The Gila River is unique in being the only free-flowing (not regulated by impoundment) river in New Mexico. Flow, in general, is continuous, except during irrigation withdrawals during drought in the Cliff-Gila Valley. There are two lowhead diversion dams

present on the San Francisco River. The San Francisco River in the Alma Valley is seasonally dry because of water diversions. Livestock grazing is the major land use and bank instability is common throughout the mainstem areas of the watershed. Although much of the land around the Gila and San Francisco rivers is managed by the USFS, canyon bottoms and valleys are mainly privately owned. Livestock grazing has been excluded along river corridors throughout most of the Gila National Forest and USFS is collaboratively implementing management strategies, including fire, off-highway vehicle, and livestock management, with public and private interests (J. Monzingo, USFS, 2005, pers. comm.).

Headwater and cienega habitats where Gila chub were historically found have been impacted by dewatering and livestock grazing. Currently many such habitats are seasonally dry and extant cienega habitats have been degraded by groundwater pumping, draining, and livestock grazing. Large portions of West and Middle forks drainages have been impacted by ash flows associated with wildfires in the past ten years. Headwaters of the Gila River drainage, which Gila or headwater chub might occupy, occur primarily on USFS lands.

Water quality in the Gila River basin is higher than most other areas of New Mexico. The *2004-2006 State of New Mexico Integrated Clean Water Act §303(d)/§305(b) Report* indicated that the greatest problems in the watershed are excessive nutrients, siltation, and high temperatures, such that in many areas, coldwater fisheries are no longer supported (NMED/SWQB 2004).

2.3.2 Projections

San Juan River

The San Juan River basin has experienced a significant increase in human population in recent years, which leads to increased pressure on natural resources. From 1990 to 2000, the population of San Juan County, New Mexico increased by 24.2%, and the population of Farmington increased by nearly 7000 people between 1990 and 2003, with the majority of the growth between 2000 and 2003 (Census 2000 Demographic Profile for San Juan County, Bureau of Business and Economic Research, UNM). The development of water rights through the Animas-La Plata Project could impact water availability in the San Juan River basin. Although there has been a significant increase in population growth and potential resource impacts in the basin,

SJRRIP provides a forum for cooperation between water users and native aquatic species interests.

Zuni River

Like most of the American southwest, McKinley County has recently experienced significant human population increase. From 1990 to 2000, county population increased 23%, to 74,798 people (Census 2000 Demographic Profile for McKinley County). Although population densities are low compared to more developed urban areas, growth is expected to continue over the coming decades, leading to increased pressures on the landscape. In headwaters, there has been increased interest in land subdivision and development. Increased residential water use may further reduce aquifers that sustain spring systems and perennial reaches within the drainage. Secondary effects of development, such as increased waste, domestic animals, and nonnative species, may have negative impacts on habitat as well. Urbanization, including road construction, vegetation removal, and building construction may lead to increases in siltation and sedimentation in the system, negatively impacting the fish community (Scott et al. 1986, Weaver and Garman 1994).

There is strong interest in Zuni River conservation from local constituents. The McKinley County Natural Resources Conservation Service has helped several area landowners get involved in programs such as the Conservation Reserve Program through the Farm Service Agency. This program sets aside valuable riparian areas from agriculture and ranching through lease agreements and cost-share incentives. There is increased interest in the Zuni River watershed from resource management agencies as well. The Surface Water Quality Bureau (SWQB) of New Mexico Environment Department (NMED) conducted a water quality assessment of the Zuni River watershed in 2004, including water chemistry, aquatic biology, and habitat surveys. Zuni Pueblo is working closely with NMED to complete this assessment and establish regular water quality standards and monitoring protocols.

Gila River

Human population growth in the Gila River basin has varied greatly over the past 10 years. In Catron County, where the San Francisco River and headwaters of Gila River lie, the population

grew 38.2% between 1990 and 2000, whereas Grant County, where mainstem Gila River and several tributaries lie, there was only a 12% increase. The differences in population increase exemplify the various issues facing this watershed. Although there has been a significant increase in second homes and "ranchettes" in the watershed, much area remains protected from development by the Gila National Forest and Wilderness, Bureau of Land Management, New Mexico Department of Game and Fish and State Lands Office. Despite recent growth, human population in the Gila River watershed is comparatively very low and there are no large urban areas.

The Gila and San Francisco rivers have been largely unimpacted by reservoirs and dams. Luna Lake, near Alpine Arizona, impounds headwaters of the San Francisco River prior to its entering New Mexico. Public Law 108-451, passed in December 2004, clarified the 1968 Colorado River Basin Project Act and solidified the right of New Mexico to develop up to 14,000 acre-feet per year from the Gila River, in exchange for Central Arizona Project water. The legislation does not require development of Gila River water, but instead provides funding to evaluate and implement steps to secure future water needs for southwest New Mexico (which might include water development). Although no formal steps have been taken to develop Gila River waters, there is strong concern about impacts to native fish if water development was to occur. In other regulated and developed waters in the American southwest, removal and control of water has led to great reductions or loss of native fish faunas.

2.4 POPULATION ASSESSMENT

2.4.1 Current Populations

San Juan River

Status of roundtail chub in the San Juan River watershed varies greatly by river/stream. In tributaries such as the Mancos and La Plata rivers, populations may persist in diminished numbers. A small population persists in the river upstream of Navajo Reservoir. In most of the San Juan River mainstem downstream of Navajo Reservoir and Animas River, roundtail chub is absent. The absence of roundtail chub in these reaches is attributed to fish poisoning prior to the closure of Navajo Dam, habitat loss and fragmentation, modified thermal regime, and predation

by nonnative fish (Holden 2000). The presence of nonnative channel catfish is thought to be particularly detrimental. Channel catfish are one of the most common fish found in the San Juan River (Ryden 2003) and predation both on them and by them is thought to have hindered recovery of Colorado pikeminnow and razorback sucker (Vanicek and Kramer 1969, Marsh and Brooks 1989, Holden 2000). Catfish predation has negative impacts on other native fish populations, such as humpback chub *Gila cypha* in the Little Colorado River in Arizona (Marsh and Douglas 1997). Most likely, decline of roundtail chub in the San Juan is a consequence of a combination of these factors.

The recent discovery of a remnant roundtail chub population in Navajo River on Jicarilla Apache Nation is encouraging. The existence of this population twenty years since the last documented occurrence indicates that there is much still to be understood about habitat preferences and biology of the species.

Zuni River

Roundtail chub have not been found in the Zuni River since 1853. Reasons for the elimination of the species there are unknown, but likely attributable to modification and loss of habitat.

Gila River

Roundtail chub has not been found since 1948 in the San Francisco River and is rare or absent in the Gila River. The only documented population of Gila chub occurs in Turkey Creek above a series of waterfalls. Headwater chub is still regularly found in the forks of the Gila River, but its numbers are declining.

The decline of chubs in the Gila River basin has been attributed mainly to the introduction of nonnative species such as catfish and bass. Although inspection of stomach contents of these nonnative predators from the East and Middle forks and Turkey Creek did not reveal chub remains, there was very little spatial overlap of chubs and nonnative predators (Bestgen and Propst 1989). It appears that the presence of these nonnative predators has had a very deleterious effect on chubs in the Gila River basin, and coupled with habitat loss because of drought, has led to their rarity in the area.

2.4.2 Projections

San Juan River

There are several efforts underway to remove known threats for roundtail chub in the San Juan River. Since 1992, Navajo Dam has been operated to mimic a natural hydrograph, which should lead to increased habitat quality and quantity for native fishes. Nonnative predators have not been stocked in the river since 1987 and the mechanical removal of nonnative fishes from selected river segments, particularly channel catfish, began in 2000. Active management to improve the environment for native fishes in the San Juan River basin provides an opportunity to restore viable roundtail chub populations to the basin. However, because there are currently no resident populations of roundtail chub in the San Juan River mainstem, natural reestablishment of the species is unlikely.

Zuni River

Roundtail chub has not been found in the Zuni River in over 100 years and there is no evidence it persists. Its restoration there will require repatriation to suitable habitats.

Gila River

Roundtail and Gila chubs are very rare in the Gila River basin. With removal of threats to their survival, such as nonnative fishes, there is a possibility that populations could recover. In the San Francisco River, where neither species has been found in many years, restoration of viable populations will require repatriation. Headwater chub populations are currently present and the removal of threats, such as nonnative fishes, should increase their viability.

2.5 ECONOMIC IMPACTS

The counties of New Mexico where roundtail chub recovery efforts could occur include those in the San Juan River basin (San Juan County), the Zuni River watershed (McKinley County), and the Gila and San Francisco River basins (Catron and Grant Counties). A comparison of the major demographic and economic indicators for each county is presented in Table 2.

2.5.1 Positive Impacts

In the past, when natural resources were thought abundant, the environment-vs.-economy view was common. Today, as natural resources are quickly diminishing, the health of many economies depends on having a healthy environment (ECONorthwest 2002). Several factors influence this view, including cost of cleaning-up environmental problems, quality of life value of healthy ecosystems, and growth in the service industry. However, determining economic value of conservation is still a difficult process. By evaluating use and non-use values of environmental assets, total economic value of conservation activities, such as recovery of chubs, can be calculated. Use values include both Direct Use Value, such as recreation activities, and Indirect Use Value, such as ecological function of a system. Non-use values include Option Value, ability to have this resource in the future, Bequest Value, value of passing on the resource, and Existence Value, value of knowing the resource exists (Munasinghe 1992, Bulte and Van Kooten 2000, Hughey et al. 2003). While many of these values are difficult to assign, there is little argument that the public values nature and is willing to place dollar amounts on conservation, through taxes, legislation, and other means.

Some Direct Use Values are available for New Mexico: in 2001, state residents and non-residents spent about $1 billion on wildlife-associated recreation, including fishing, hunting, and wildlife-watching activities in New Mexico (USFWS 2003). Additionally, studies are available that estimate the Willingness To Pay (WTP) of households for the conservation of natural resources, such as instream flow and endangered species. Using the Contingent Valuation Method, a hypothetical market is made which allows the public to place a monetary value on the preservation of natural resources (Mitchell and Carson 1989). For example, a survey was sent to households both in the region (Four Corners area) and the throughout the U.S. to determine the WTP value for conserving nine fish in six rivers in the area by improving habitat (Loomis 1998). The mean WTP was estimated to be $265 per household per year. Other studies, which have focused on individual species, found values lower, for instance a mean WTP of $29/household/year for Rio Grande silvery minnow *Hybognathus amarus* (Barrens et al. 1996) and $8/household/year for Colorado pikeminnow (Cummings et al. 1994) (see Loomis and White 1996 for a review). Looking at a variety of species and studies, Loomis and White (1996) found that WTP varies with the projected species population changes, the visitation rate of the

household to the area, and the frequency of payment. No specific studies have been completed on public valuation of chubs in New Mexico, but it is clear from studies on similar species and habitats, that the public does place monetary value on conservation of species.

In addition to direct positive benefits of conserving and restoring chubs in New Mexico, there are also secondary benefits. Because recovery of roundtail, Gila, and headwater chubs will likely lead to rehabilitation and protection of areas surrounding the habitat, an increase in wildlife and recreational opportunities, not only immediately at the site, but throughout a larger area, might be expected. These positive impacts increase natural resource tourist activities, such as hunting, fishing, hiking, and camping in the area. This leads to increases in local accommodation and food service sectors, as well as retail trade sectors. Throughout the western United States, similar shifts in industry have occurred, leading to a trend away from extraction sectors, such as mining and timber, toward tourism and service sectors (Ingram and Lewandrowski 1999). Habitat conservation, because of chubs recovery, will work toward accomplishing the goals of ongoing-local conservation efforts, such as the *Zuni Conservation Plan,* the *Zuni River Watershed Plan*, and the SJRRIP. Through combining efforts to restore chub habitats in the watersheds, greater work can be accomplished and future litigation and restitution activities may be limited. Roundtail, Gila, and headwater chubs habitat improvement may decrease many negative effects that resulted from severe degradation of watersheds in the past, including reduced renewable resources and loss of water. Side effects of habitat conservation and restoration may include reduced erosion and increased vegetation. These changes will lead to more forage and better range for livestock, as well as improved roundtail, Gila, and headwater chubs' habitat.

Working cooperatively with federal, state, local, tribal, and non-profit agencies, and private individuals also has positive economic value. In addition to avoiding duplicative efforts and funding, cooperation now can avoid increased restrictions in the future. Gila chub is listed federally as Endangered and headwater chub is a candidate for federal listing. By working cooperatively to recover the species and habitats, additional listing under the Endangered Species Act and possible subsequent restrictions and actions might be avoided. Recovery of roundtail,

Gila, and headwater chubs also may contribute to conservation and recovery of other imperiled and rare species in the area.

2.5.2 Negative Impacts

Protection and conservation of roundtail, Gila, and headwater chubs requires preservation and enhancement of extant populations and restoration of historic populations and habitats. This may include modifications on sport fish management, livestock grazing, timber harvest, and water withdrawal and distribution practices. These practices, when improperly implemented, have been shown to be detrimental to each of these species. Reductions of these activities may have short-term negative economic impacts. In the long-term, less expenditure will be needed to rectify environmental consequences, and therefore, there will be an economic benefit to recovery (ECONorthwest 2002). Residential and commercial development, as well as the infrastructure needed to support development, such as road improvement and water development, also may have negative impacts on the species. Completion of these activities using methods that minimize impacts on roundtail, Gila, and headwater chubs habitat may incur additional costs, but again, the long-term economic benefits of environmental planning are recognized (ECONorthwest 2002). Inclusion of multiple resource users and land managers into the recovery process is intended to mitigate these effects. Recovery actions under the WCA and this plan are voluntary and economic effects will only be upon those entities willing to implement recovery actions. Therefore, direct economic effects cannot be predicted precisely.

2.6 SPECIAL CONSIDERATIONS

2.6.1 San Juan River Basin Recovery Implementation Program

The San Juan River Basin Recovery Implementation Program (SJRRIP) began in 1991 to conserve endangered fish in the San Juan River while proceeding with water development. Participants in the program include USFWS, U.S. Bureau of Reclamation (BOR), U.S. Bureau of Land Management (BLM), U.S. Bureau of Indian Affairs (BIA), states of New Mexico and Colorado, water development interests in Colorado and New Mexico, Jicarilla-Apache Nation,

Table 2. Comparison of the major demographic and economic indicators for New Mexico counties with roundtail, Gila, and headwater chub historic or current occurrences. All data are from the 2000 Census report, except *, from the New Mexico Department of Labor, April 2004, and **, from the New Mexico Department of Agriculture, 2000.

Watershed	County	Human Population	Median Age (years)	Average Annual Salary	Unemploy-ment Rate*	# of Farms **	Major Agriculture **	Major Industries
San Juan	San Juan	113,801	31.0	$29,028	5.8%	666	Corn for Grain	Education, Health and Social Services; Retail; Agriculture, Forestry, Fishing, Hunting and Mining
Zuni	McKinley	74,798	26.9	$25,855	6.9%	224	Cattle	Education, Health and Social Services; Retail; Public Administration
Gila	Grant	31,002	38.8	$23,014	9.9%	154	Cattle	Education, Health and Social Services; Agriculture, Forestry, Fishing, Hunting and Mining; Retail
	Catron	3,543	47.8	$23,150	8.0%	236	Cattle	Agriculture, Forestry, Fishing, Hunting and Mining; Education, Health and Social Services; Construction

Ute Mountain Ute, Southern Ute, and Navajo Nation Indian tribes. Although the SJRRIP was specifically begun for recovery of Colorado pikeminnow and razorback sucker, the research and management objectives of the SJRRIP include the "maintenance and enhancement of the native fish community of the San Juan River", including roundtail chub (SJRRIP 1995).

In 2000, a Program Evaluation Report was published, summarizing 7-years (1991-1997) of research for the SJRRIP (Holden 2000). The research efforts showed that roundtail chub did "not have a significant mainstem population" and the development of roundtail chub populations was specifically identified in the Future Program Direction. Sub-objectives include stocking, augmentation, and studies to determine habitat use and spawning areas of roundtail chub. As a participant in the SJRRIP, New Mexico will be contributing to the completion of this task with this recovery plan.

2.6.2 Three Species Agreement

In 2004, the wildlife management agencies of Utah, Colorado, Wyoming, Nevada, Arizona, and New Mexico signed the *Range-wide Conservation Agreement For Roundtail Chub, Bluehead Sucker, And Flannelmouth Sucker* to "to expedite implementation of conservation measures for [the three species] throughout their respective ranges as a collaborative and cooperative effort among resource agencies" (Colorado River Fish and Wildlife Council 2004). Each agency committed to the development and implementation of a conservation and management strategy for the species within their state. This recovery plan serves as the New Mexico conservation strategy for roundtail chub.

2.6.3 Comprehensive Wildlife Conservation Strategy

New Mexico Department of Game and Fish recently completed the Comprehensive Wildlife Conservation Strategy (CWCS) in fulfillment of federal requirements to receive State Wildlife Grant (SWG) funding (NMDGF 2006). One purpose of SWG funding and CWCS is to promote conservation actions before federal listing is necessary; CWCS will guide conservation efforts to be more strategic, holistic and pro-active. The New Mexico Department of Game and Fish identified Species of the Greatest Conservation Need for New Mexico, including roundtail, Gila, and headwater chubs. This recovery plan will assist in planning for and recovery of these chubs.

2.6.4 Federal Jurisdiction and PECE Planning

The U.S. Fish and Wildlife Service was petitioned to list roundtail, Gila, and headwater chubs as endangered in 2003. Gila chub was listed as Endangered with Critical Habitat in November 2005, and headwater chub was listed as a Candidate species in April 2006. New Mexico Department of Game and Fish is committed to working closely with USFWS in conservation of all three chub species. Although the impetus and direction for this recovery plan originates from New Mexico state laws and regulation, and not current or proposed federal listing, NMDGF is taking into consideration the federal Policy for Evaluation of Conservation Efforts (PECE) guidelines during the development of this plan, as it may eventually affect federal listing [68 FR 15100]. This policy outlines the standards USFWS will use when evaluating the effects current or planned conservation efforts will have on listing of a species and provides guidance to other agencies and groups in developing agreements or plans that may preclude federal listing.

2.6.5 Tribal Interests and Sovereignty

Several historical and current populations of roundtail chub occur on tribal lands. The State of New Mexico recognizes the sovereignty of Native American Indian tribes and as such, does not have jurisdiction over wildlife species on tribal lands. The intention of this plan is to work as partners with the tribes, including the Jicarilla Apache Nation, Navajo Nation, and Zuni Pueblo, to achieve recovery of the species, both on and off Indian lands.

United States Secretarial Order 3206 details the responsibilities of Federal agencies concerning the Endangered Species Act when Tribal interests are involved, including the management of candidate species. Native American tribes are recognized as sovereign, appropriate governmental entities to manage their resources and as such, the Order instructs Federal agencies to defer to tribal conservation and management plans.

2.6.6. Multiple Uses of the Gila River Basin

The Gila River basin contains not only native chubs, but recreationally-valued nonnative sport fish, such as smallmouth bass and channel catfish. Comments received on previous drafts of this Recovery Plan indicated a variety of views on removal of nonnative species, particularly sport fishes, as an appropriate management tool for recovery of chubs in the Gila River basin.

Research on recovery of endangered fish species indicates that many nonnative fish species are detrimental to native fish populations and that removal of nonnative species is essential to conservation and recovery of imperiled species, including chubs (see Clarkson et al. 2005 for a review). Removal of nonnative species may be unpopular with some anglers, but for recovery of Gila River basin chubs, which is the goal of this document, it is a necessary tool. The CWCS identifies removal of nonnative predators and competitors (along with water management) as a primary strategy for conservation of native species in the Gila River basin. The New Mexico Department of Game and Fish no longer stocks nonnative warmwater sports fish, such as smallmouth bass and channel catfish, in the Gila River. In developing and implementing management activities to benefit imperiled species, NMDGF recognizes there are potentially competing expectations for sport fishes and native fishes, and that a balanced approach is necessary. Thus, where feasible and necessary to achieve recovery objectives, efforts must be made to eliminate or suppress abundance of problem nonnative fishes (including sport fishes). However, complete removal or significant suppression of nonnative species from substantial portions the Gila River basin is unrealistic and unachievable. Recovery strategies for chubs, as detailed in Section 3.2, should focus on areas where nonnative fishes are uncommon or where suppression or elimination of problem nonnative fishes has a reasonable chance of success. In accomplishing this task, sport fishing in some stream reaches will be diminished, but considerable opportunities will remain in a large portion of the Gila River basin, and management flexibility to maintain populations of nonnative sport fish will be optimized only when the status of imperiled Gila River basin fishes is improved.

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3.0 MANAGEMENT STRATEGY

Section 3.0 contains the management goal and objectives for roundtail, headwater, and Gila chubs recovery. This section also details the problems and opportunities affecting attainment of the stated objectives and the broad strategies that will be employed to surmount these issues and reach the objectives.

3.1 MANAGEMENT GOAL AND OBJECTIVE

Goal:

Roundtail, Gila, and headwater chub populations are secure and self-sustaining across their historical ranges in New Mexico.

Objective:

That by 2015, viable populations of roundtail, Gila, and headwater chubs in New Mexico will be secure within their historic ranges in the San Juan and Gila river basins, including multiple populations of each species within each basin, sufficient to downlist the species to "threatened" under the New Mexico Wildlife Conservation Act by 2015, and de-list by 2025.

Objective Parameters:

Genetic, demographic, and other characteristics of existing populations will be determined to identify appropriate units for management activities.

In the San Juan Basin by 2008
In the Gila Basin by 2010

All existing populations of roundtail chub in the Gila and San Juan river basins and Gila and headwater chub in the Gila River basin will be secure and self-sustaining as indicated by appropriate demographic and genetic parameters. At a minimum, this will include an indication of dynamically viable populations of sufficient size and distribution to buffer against losses due to stochastic events.

Threats, including both known and yet to be identified, that negatively impact current populations and that preclude expansion throughout the historical range will be removed or reduced such that the species may be restored to areas of historical occupancy and self-sustaining numbers.

Sufficient self-sustaining, secure populations will be present throughout historic range in New Mexico such that no human-caused or natural event(s) threaten(s) the security of the species. This will include, at a minimum, functionally independent multiple age-class populations of each species within each basin, including, but not limited to:

- Two or more populations of roundtail chub in the San Juan River basin in New Mexico
- At least one population of roundtail chub in the mainstem of the Gila River in New Mexico

- At least one population of Gila chub, in addition to the population in Turkey Creek, in the Gila or San Francisco river basins in New Mexico
- At least one population of headwater chub in each of forks of the Gila River, New Mexico.

3.2 MANAGEMENT ISSUES AND STRATEGIES

Issue 1. Lack of Current and Historical Distribution Information. *Lack of precise information concerning current and historical habitats and populations of roundtail, Gila, and headwater chubs in the San Juan, Zuni, and Gila river basins prevents comprehensive protection, recovery, and re-establishment of the species. Uncertainty regarding phylogenetic relationships and distributions of chub species in the Gila River Basin in particular confuses the understanding of historical distribution and has made determining appropriate areas for recovery efforts problematic.*

Strategy 1. Determine historical distributions of chub species in the San Juan, Zuni, and Gila river basins in New Mexico, including, but not limited to:

San Juan River: Los Pinos River, Animas River, La Plata River, Mancos River, and San Juan River mainstem;
Zuni River: Zuni River mainstem;
Gila River: Duck Creek, Turkey Creek, Little Creek, Mule Creek, San Simon Cienega, Apache Creek, Tularosa River, San Francisco River, and Gila River mainstem and forks

Strategy 2. Survey potential habitats in the San Juan and Gila river basins utilizing existing information and programs when practicable, where populations were reported recently or historically, including, but not limited to:

San Juan River: Los Pinos River, Animas River, La Plata River, Mancos River, and San Juan River mainstem;
Gila River: Duck Creek, Turkey Creek, Mule Creek, San Simon Cienega, Apache Creek, Tularosa River, San Francisco River, and Gila River mainstem and forks

Strategy 3. Support research to determine distribution, and phylogenetic, ecological, taxonomic, and other relationships of chub species in the Gila River basin in New Mexico and Arizona.

Issue 2. Limited Populations and Distributions. *Currently, there are few roundtail chub populations in several semi-isolated areas in the San Juan River Basin in New Mexico. There is no extant population of roundtail chub in the Gila River, although remnant individuals may persist. Documented Gila chub populations in the Gila River basin are limited to Turkey Creek. Headwater chub persists in the forks of the Gila River, although numbers are less than were present historically. These extremely low numbers make roundtail, Gila, and headwater chubs susceptible to elimination by natural perturbations, such as wildfire, or human induced disturbances, such as nonnative species and angling.*

Strategy 1. Survey the San Juan and Gila river watersheds, using existing information and programs when possible, to determine better the location and geographic extent of extant populations, including, but not limited to:

San Juan River: Los Pinos River, Animas River, La Plata River, Mancos River, and San Juan River mainstem;
Gila River: Turkey Creek, Mule Creek, Gila River mainstem and Gila River forks

Strategy 2. Identify constraints to population abundance and distribution and remove or reduce impediments to natural expansion.

Strategy 3. Determine minimum number and size of populations and required demographics needed for recovery.

Strategy 4. Determine and implement appropriate monitoring programs, using and augmenting existing programs where necessary, to provide current data on status of extant populations.

Strategy 5. Establish secure, managed, replicate populations of all existing lineages.

Strategy 6. Work with neighboring states and other agencies to establish genetically managed broodstock in a hatchery facility for possible augmentation or re-establishment of populations.

Strategy 7. Establish additional roundtail and Gila chubs populations in ecologically appropriate, secure habitats within their historical ranges, as necessary to achieve the goal of this recovery plan, potentially including, but not limited to:

San Juan River: Animas River, La Plata River, Mancos River, and San Juan River mainstem;
Zuni River: Zuni River mainstem
Gila River: Duck Creek, San Simon Cienega, Apache Creek, Tularosa River, and Gila River mainstem

Issue 3. Habitat Loss. *Changes in watershed conditions have resulted in altered flow regimes, channel morphology, and water quality, leading to degraded and limited habitat for roundtail, Gila, and headwater chubs.*

Strategy 1. Identify and determine habitat requirements for all life history stages of roundtail, Gila, and headwater chubs in the San Juan and Gila river basins.

Strategy 2. Support efforts within existing programs to enable habitat restoration and protection for recovery. Programs include, but are not limited to:

San Juan River Basin Recovery Implementation Program
Central Arizona Project
Three Species Rangewide Conservation Agreement Effort
New Mexico Comprehensive Wildlife Conservation Strategy
State, Federal, Tribal, Municipal, and Private Land and Water Management Plans

Strategy 3. Identify and secure resources to promote habitat restoration and protection.

Strategy 4. Rehabilitate, restore, and secure historical habitats where chub restoration is possible, including, but not limited to:

San Juan Watershed: San Juan River tributaries and mainstem
Gila Watershed: Apache Creek, Tularosa River, Mule Creek, Duck Creek, San Simon Cienega

Strategy 5. Inform private and public landowners about practices that promote diverse, functional aquatic and riparian habitats.

Strategy 6. Inform private and public landowners about how to protect chub habitat, including but not limited to management of water, vegetation, soil, and fire and assist with the implementation of such practices.

Strategy 7. Identify and secure funding to promote habitat restoration and protection.

Strategy 8. Establish formal agreements with willing participants to enhance habitat and/or populations for recovery of chubs, including but not limited to, management of water and land.

Issue 5. Use of Species. *Roundtail, Gila, and headwater chubs were historically considered sport fish. Currently, roundtail, Gila, and headwater chubs are legally protected in New Mexico from take, but there is little public awareness. Angling pressure may be a threat to the recovery of the species as chub species may be caught as discarded as bycatch.*

Strategy 1. Include in New Mexico Fishing Proclamation physical descriptions, distribution maps, restriction on take, and proper catch-and-release techniques for roundtail, Gila, and headwater chubs.

Strategy 2. Update angling regulations to prohibit take of headwater chub.

Strategy 3. Inform the public about the biology and conservation of chubs.

Issue 6. Aquatic Fauna Dominated by Nonnative Species. *Native species, such as chubs, dace and suckers, have generally declined and have been replaced by nonnative species. Nonnative species may present threats to roundtail, Gila, and headwater chubs through competition, habitat modification, and predation.*

Strategy 1. Determine the distribution and abundance of nonnative species in the San Juan and Gila river watersheds and the physical barriers to their expansion, utilizing existing information and programs, when possible.

Strategy 2. Investigate the impacts, particularly competition, habitat modification, and predation, of nonnative species on roundtail, Gila, and headwater chubs, utilizing existing information and programs when possible.

Strategy 3. Determine areas of the San Juan and Gila river watersheds where limited nonnative species distribution and abundance may provide opportunities for chub restoration.

Strategy 4. Work with sport fish managers to coordinate native and nonnative fish management and identify stream areas expressly for recovery of native species.

Strategy 5. When appropriate and feasible, remove nonnative species that present a threat to roundtail, Gila, and headwater chubs.

Strategy 6. Prevent the introduction of nonnative species into the watersheds utilizing existing information and programs when possible.

Strategy 7. Support efforts to re-establish the historical native aquatic community in ecologically appropriate habitats in the San Juan and Gila river basins utilizing existing programs when possible.

Strategy 8. Inform local resource users about the impacts of nonnative species on chub species.

Issue 7. Information Gaps. *Paucity of detailed abiotic and biotic information, such as water quality tolerances, preferred habitat for specific life stages, and genetic and demographic structure can lead to speculative management and unsupportable goals.*

Strategy 1. Support research to determine the tolerance of roundtail, Gila, and headwater chubs to water quality parameters, particularly those that may be altered during and after forest fires.

Strategy 2. Investigate the cause of the decline of roundtail chub in the Gila River, including, but not limited to, impacts from nonnative species and changes in flow regime and suitable habitat.

Strategy 3. Support research to determine genetic and demographic structure of chub populations in the Gila River Basin.

Strategy 4. Support research to determine specific habitat needs of larval, juvenile, and adult roundtail, Gila, and headwater chubs in New Mexico, including spawning habitat.

Strategy 5. Support research to determine other aspects of roundtail, Gila, and headwater chubs life history, ecology, and biology necessary for the successful recovery of the species.

Strategy 6. Utilize information gained to direct conservation efforts for roundtail, Gila, and headwater chubs recovery.

Issue 8. Fragmented Management. *Stewardship of roundtail, Gila, and headwater chubs habitat and management of populations falls under the control of several tribal, federal, and state agencies and private organizations and individuals. While various formal and informal programs exist for rehabilitation and conservation of natural resources in the San Juan and Gila river watersheds, there is little consistency or collaboration among entities. This can lead to conflicting goals, duplication of efforts, and inconsistency and sometimes conflict among management entities.*

Strategy 1. Work within existing programs to recover roundtail, Gila, and headwater chub populations and enhance habitats, including, but not limited to:

San Juan River Basin Recovery Implementation Program
Three Species Conservation Agreement Efforts
Central Arizona Project
Comprehensive Wildlife Conservation Strategy
Existing Federal and State Recovery Plans, including Colorado pikeminnow, razorback sucker, Gila trout, loach minnow, and spikedace

Strategy 2. Establish formal agreements with private, state, federal, and tribal interests and agencies to implement this plan, including funding and sharing of resources.

Strategy 3. Encourage participation of federal and tribal agencies in the Three Species Rangewide Agreement and individual State Strategies.

Strategy 4. Support the establishment of a geospatially explicit database to track population trends of roundtail chub rangewide in fulfillment of the Three Species Rangewide Agreement.

Strategy 5. Create a recovery implementation team of stakeholders to coordinate efforts among landowners and agencies and guide the direction of conservation efforts.

Strategy 6. Coordinate with existing local conservation and management groups to facilitate coordinated, comprehensive management of the entire Gila Watershed, including working with recovery efforts for Gila trout, spikedace, and loach minnow.

Strategy 7. Inform local agencies, landowners, and users about the life history and conservation of roundtail, Gila, and headwater chubs and recovery efforts on their behalf.

Strategy 8. Inform organized angling groups about life history and conservation of roundtail, Gila, and headwater chubs.

Strategy 9. Identify and secure funding to promote the goals of this recovery plan.

4.0 IMPLEMENTATION SCHEDULE

Section 4.0 contains the Implementation Schedule for the Recovery Plan. Section 4.1 identifies specific tasks to be implemented to meet the strategies identified in Section 3.2 (Management Issues and Strategies). These are grouped by major categories (survey, research, etc.), and individual tasks are prioritized within each group. Several tasks will be ongoing and thus marked with a bullet.

Section 4.2 presents a suggested time-line for the Implementation Schedule. Anticipated costs, including staffing, for these tasks will be addressed in an Operational Plan, to be developed following final approval of the Recovery Plan by the State Game Commission.

4.1 IMPLEMETATION TASKS

❖ Define historical and current distribution of chubs in New Mexico and when possible, expand current distributions to include historic areas

- Develop and maintain relationships with local landowners and management agencies to obtain permission to complete necessary surveys.

1. Determine historical distribution of chub species in the San Juan, Zuni, and Gila river basins, including tributaries, through literature and database searches and discussion with local landowners, managers, and anglers.
2. Identify and survey potentially occupied habitats.
3. Determine possible areas within historical distribution that are appropriate for chub repatriation.

❖ Improve knowledge of historical and current populations of roundtail, Gila, and headwater chub and replicate and establish additional populations as appropriate

- Monitor each chub population at least annually.

1. Develop appropriate protocols to monitor status of populations of roundtail, Gila, and headwater chubs.
2. Identify constraints to population abundance and distribution.
3. Determine minimum number and size of populations required for recovery.
4. Establish secure, managed, replicate populations of all existing lineages of each species.
5. Augment populations where necessary.
6. Establish additional populations where possible.

❖ Improve knowledge of historical and current habitats of roundtail, Gila, and headwater chubs

- Monitor changes in historical and current habitats.

1. Survey all historical and current habitats.
2. Determine preferred habitats of chubs.
3. Identify and secure resources to promote habitat restoration and protection.
4. Rehabilitate, restore, and secure historical habits where chub restoration is possible .

❖ Use of Species

- Inform the public the biology and conservation of chub species.

1. Include in the New Mexico Fishing Proclamation physical descriptions, photos, distribution maps, restriction on take, and proper catch-and-release techniques for chubs.
2. Update angling regulations include prohibitions on take of headwater chub.

❖ Removal of Constraints on Chub Recovery

- Support efforts to re-establish the historical native aquatic community in appropriate habitats.
- Prevent the introduction of nonnative species into watersheds occupied by chubs.

1. Determine the distribution and abundance of nonnative species in the San Juan and Gila river watersheds.
2. Determine physical barriers that prevent or may prevent spread of nonnative species and chubs in historical and current habitats.
3. When appropriate, remove co-occurring nonnative species that present a threat to chub populations.

❖ Information Gaps

- Apply new information to management.

1. Support research to determine tolerance of chubs to water quality parameters, particularly those that may be altered during and after forest fires.
2. Investigate the cause of the decline of chubs in the San Juan and Gila river watersheds, including but not limited to nonnative species and changes in flow regime and suitable habitat.
3. Support research to determine genetic and demographic structure of chub populations.
4. Support research to determine specific habitat needs of larval, juvenile, and adult chubs.

❖ Coordination

- Continue to work within existing programs to recover chub and enhance habitat, including the San Juan River Basin Recovery Implementation Program and the Central Arizona Project.
- Continue to actively participate in the Rangewide Three Species Agreement and encourage federal, tribal and local participation.
- Seek funding and resources to implement this plan.

1. Work with existing users and managers of the watersheds and co-occurring species, including but not limited to, NMDGF Fisheries Division and San Juan River Basin Recovery Implementation Program, to coordinate multiple uses of the San Juan and Gila river basins while completing chubs recovery.
2. Establish formal agreements with private, state, federal, and tribal interests and agencies to implement this plan.
3. Implement an outreach effort for angling groups about life history and conservation of chubs.
4. Implement an outreach effort to inform local agencies, landowners, and users about the life history and conservation of roundtail, Gila, and headwater chubs and recovery efforts.

4.2 SAN JUAN RIVER BASIN RECOVERY PLAN IMPLEMENTATION TASKS TIME-LINE

	2007		2008		2009		2010		2011		2012		2013	
	Develop And Maintain Relationships With Landowners And Managers													
Distribution	Historical Search	Potential Surveys	Historical Search	Potential Surveys							Repatriate			
	Monitor Populations At Least Annually													
Populations			Develop Monitoring Protocols	Monitor	Identify Constraints	Monitor	Determine Population Minimums	Monitor		Monitor	Evaluate Supple-Mentation	Monitor	Evaluate Supple-Mentation	Monitor
	Monitor Changes In Current And Historical Habitats													
Habitat		Surveys		Survey Potential	Determine Preferred Habitat	Survey Potential	Evaluate Potential	Survey Potential	Evaluate Potential	Implement Changes To Potential	Implement Changes To Potential	Implement Changes To Potential		
	Support Efforts To Restore Historical Aquatic Communities/Prevent Introduction Of Nonnative Species													
Removal of Constraints		Nonnative Surveys		Surveys – Including Potential	Determine Barriers	Survey – Including Potential	Evaluate Impacts In Current	Remove In Current		Removal In Current And Potential	Evaluate Removal	Removal In Current And Potential	Evaluate Removal	Removal In Current And Potential
	Inform The Public On Chub Fishing Regulations													
Use	Update Fishing Regs						Evaluate Fishing Regs						Evaluate Fishing Regs	
	Utilize New Information For Management													
Information Gaps/ Research	Chub Tolerance To Water Quality Parameters				Investigate Reasons For Declines		Genetic And Demographic Structure		Specific Habitat Needs				Additional Research As Needed	
	Work With Existing Managers, Users, And Programs For Multiple Uses Of Watershed/Seek Funding For Implementation/Continue To Participate In Three Species Agreement, SJRRIP													
Coordination	Formal Cooperative Agreement		Angling Outreach		Public Outreach		Angling/ Public Outreach		Angling/ Public Outreach		Angling/ Public Outreach		Angling/ Public Outreach	

GILA RIVER BASIN RECOVERY PLAN IMPLEMENTATION TASKS TIME-LINE

	2007		2008		2009		2010		2011		2012		2013	
	Develop And Maintain Relationships With Landowners And Managers													
Distribution	Historical Search	Surveys-Headwater/ Gila	Historical Search	Surveys – Roundtail								Repatriate		Repatriate
	Monitor Populations At Least Annually													
Populations					Develop Monitoring Protocols	Monitor	Identify Constraints	Monitor	Determine Population Minimums	Monitor	Evaluate Supple-Mentation	Monitor	Evaluate Supple-Mentation	Monitor
	Monitor Changes In Current And Historical Habitats													
Habitat		Survey – Headwater/ Gila		Survey - Roundtail	Determine Preferred Habitat	Survey Potential – Headwater/ Gila	Evaluate Potential	Survey Potential - Roundtail	Evaluate Potential	Implement Changes To Potential	Implement Changes To Potential	Implement Changes To Potential	Implement Changes To Potential	Implement Changes To Potential
	Support Efforts To Restore Historical Aquatic Community/Prevent The Introduction Of Nonnative Species													
Removal of Constraints		Nonnative Surveys		Surveys – Including Potential	Determine Barriers	Survey – Including Potential	Evaluate Impacts In Current	Remove In Current		Removal In Current And Potential	Evaluate Removal	Removal In Current And Potential	Evaluate Removal	Removal In Current And Potential
	Inform The Public On Chub Fishing Regulations													
Use	Update Fishing Regs						Evaluate Fishing Regs						Evaluate Fishing Regs	
	Utilize New Information For Management													
Information Gaps/ Research	Chub Tolerance To Water Quality Parameters			Investigate Reasons For Declines			Genetic And Demographic Structure			Specific Habitat Needs			Additional Research As Needed	
	Work With Existing Managers, Users, And Programs For Multiple Uses Of Watershed/Seek Funding For Implementation/Continue To Participate In Three Species Agreement, SJRRIP													
Coordination	Formal Cooperative Agreement		Angling Outreach		Public Outreach		Angling/ Public Outreach		Angling/ Public Outreach		Angling/ Public Outreach		Angling/ Public Outreach	

5.0 APPROVALS

This Recovery Plan for the Colorado River Basin Chubs (roundtail chub *Gila robusta*, Gila chub *Gila intermedia*, and headwater chub *Gila nigra*) is approved by:

Lisa Kirkpatrick — 11/21/06

Lisa Kirkpatrick, Conservation Services Division Chief
New Mexico Department of Game and Fish

Date

Bruce C Thompson — 11-29-06

Bruce C. Thompson, PhD., Director and Secretary to the Commission
New Mexico Department of Game and Fish

Date

11-27-06

Leo V. Sims II, Chairman
New Mexico Department of Game and Fish

Date

APPENDIX I

SUMMARY OF PUBLIC INVOLVEMENT ON THE COLORADO RIVER BASIN CHUBS RECOVERY PLAN

Wildlife Conservation Act

The Wildlife Conservation Act (WCA) [17-2-40.1 NMSA 1978] directs the New Mexico Department of Game and Fish (NMDGF) in the process to be followed for the recovery of endangered and threatened species. Public participation in the recovery plan is detailed in the WCA and includes initial public information meetings, the formation of an Advisory Committee and public review of the document prior to submission to the State Game Commission.

Public Information Meetings

The public meeting is the first step in the Recovery Plan process. Public meetings are held to provide opportunities for individuals and private and public entities to express views about the development of the recovery plan and attendant social or economic impacts, if any, which may result from implementation of the recovery plan. At the meetings, background information about the listing, an explanation of the process, and probably content in general terms of the recovery plan is presented and participation in the recovery plan advisory committee is solicited. Meetings for the Colorado River Basin Chubs Recovery Plan were advertised through mailings to private and public organizations, agencies, and individuals, legal advertisements (Albuquerque Journal, Silver City Daily Press, and Farmington Daily Times for 10 days prior to each meeting) and NMDGF press releases.

16 February 2005, 6 pm – Bloomfield 8 participants, including representatives from water development and angling interests and state, tribal and federal agencies

21 February 2005, 6 pm – Silver City 6 participants, including private landowners, anglers, and Forest Service representatives

Advisory Committee

As directed by the WCA, the Advisory Committee is composed of all those who are willing to participate on the recovery plan, including affected local governments, tribal governments, landowners, state and federal agencies and other interested individuals and organizations. Following the public meetings, NMDGF sent letters to individuals and public and private agencies formally seeking participation on the Advisory Committee. The Advisory Committee for the Colorado River Basin Chubs Recovery Plan consisted of twenty-six individuals from academia, federal, state, tribal, and local agencies, conservation organizations, water development interests, and private landowners:

Howard Brandenburg – University of New Mexico
Chris Cantrell – Arizona Game and Fish Department
Anne Davis – New Mexico Environment Department
Mike Farrington – University of New Mexico
Noah Greenwald – Center for Biological Diversity
Michelle Harrington – Center for Biological Diversity
Howard Hutchinson – Coalition of Arizona/New Mexico Counties

Randy Kirkpatrick – San Juan Water Commission
Albert Lapahie – Navajo Nation Fish and Wildlife Department
Ron Maes – U.S. Forest Service
Mark McKinstry – U.S. Bureau of Reclamation
Nic Medley – New Mexico Interstate Stream Commission
Jerry Monzingo – U.S. Forest Service
Marilyn Myers – U.S. Fish and Wildlife Service
Kirk Patten – New Mexico Department of Game and Fish
Michael Robinson – Center for Biological Diversity
Dutch Salmon – New Mexico State Game Commission
Gary Schiffmiller – New Mexico Environment Department
Raymond Smith – BIA/Navajo Nation Irrigation Project
Larry Sullivan – Private Landowner
Barney Wegener – Bureau of Land Management
Jim White – Jicarilla Apache Nation Department of Game and Fish
Steve Whiteman – Southern Ute Tribe, Division of Wildlife Resource Management
Peter Wilkenson – New Mexico Interstate Stream Commission
Viola Willeto – Navajo Nation Department of Fish and Wildlife
Ben Zimmerman – Southern Ute Tribe, Division of Wildlife Resource Management

Comments also received from Jerome Stefferud and Robert Clarkson

The Advisory Committee assisted in the development of the plan through reviews of drafts, contribution of management ideas, and identification of potential problems and opportunities related to recovery. The Background and Situation Analysis section of the Recovery Plan was circulated for review beginning in June 2005 and comments were incorporated in the text. Meetings to discuss and draft the Management Strategy section were held in Farmington on 25 July 2005 and in Silver City on 1-2 August 2005. Drafts of the Recovery Plan, including the Management Strategy were circulated to the Advisory Committee for review beginning in September 2005 and incorporated into the draft Recovery Plan. Following the completion of the Headwater Chub Listing Investigation, the final draft of the Colorado River Basin Chubs Recovery Plan was circulated to the Advisory Committee and the public for final review in September through October 2006. Edits from the Advisory Committee members, NMDGF staff, and public review are reflected in the final approved version of the Recovery Plan.

Additional Public Participation

In addition to the announcements of the public meetings and solicitation for participation on the Advisory Committee, many individual communications (e-mails, phone calls, site visits) were made to local landowners, conservation organizations, and government agencies to engage them in the recovery planning process. The general public, as well as public and private organizations, had the opportunity to comment on the Colorado River Basin Chubs Recovery Plan from 21 September through 25 October 2006. Announcements of the public comment period were mailed to individuals and agencies and provided in NMDGF press releases. The Recovery Plan was available electronically on the NMDGF website as well as in hard copy by request. Comments were incorporated into the final draft presented to the New Mexico State Game Commission.

New Mexico State Game Commission Approval

As directed by the WCA, the Recovery Plan was presented to the State Game Commission for final approval on 16 November 2006 in Farmington. The Recovery Plan was accepted as presented at the meeting, subject to final formatting and layout for printing.