U.S. FISH AND WILDLIFE SERVICE SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

Scientific Name:

Gila nigra

Common Name:

Headwater chub

Lead region:

Region 2 (Southwest Region)

Information current as of:

03/28/2013

Status/Action

___ Funding provided for a proposed rule. Assessment not updated.

___ Species Assessment - determined species did not meet the definition of the endangered or threatened under the Act and, therefore, was not elevated to the Candidate status.

___ New Candidate

_X_ Continuing Candidate

___ Candidate Removal

> ___ Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status
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> ___ Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species
>
> ___ Range is no longer a U.S. territory
>
> ___ Insufficient information exists on biological vulnerability and threats to support listing
>
> ___ Taxon mistakenly included in past notice of review
>
> ___ Taxon does not meet the definition of "species"
>
> ___ Taxon believed to be extinct
>
> ___ Conservation efforts have removed or reduced threats

___ More abundant than believed, diminished threats, or threats eliminated.

Petition Information

___ Non-Petitioned

_X_ Petitioned - Date petition received: 11/09/2009

90-Day Positive:07/12/2005

12 Month Positive:05/03/2006

Did the Petition request a reclassification? **No**

For Petitioned Candidate species:

Is the listing warranted(if yes, see summary threats below) **Yes**

To Date, has publication of the proposal to list been precluded by other higher priority listing? **Yes**

Explanation of why precluded:

Higher priority listing actions, including court-approved settlements, court-ordered and statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for this species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The Progress on Revising the Lists section of the current CNOR (http://endangered.fws.gov/) provides information on listing actions taken during the last 12 months.

Historical States/Territories/Countries of Occurrence:

- **States/US Territories**: Arizona, New Mexico
- **US Counties**:County information not available
- **Countries**:Country information not available

Current States/Counties/Territories/Countries of Occurrence:

- **States/US Territories**: Arizona, New Mexico
- **US Counties**: Gila, AZ, Graham, AZ, Yavapai, AZ, Catron, NM
- **Countries**:Country information not available

Land Ownership:

Estimated (all numbers are rounded to the nearest whole number, acres are based on 15.2 meters (m) (50 feet (ft) stream buffer) - 80 percent Federal, all Forest Service (160 river kilometers (km), 99 river miles (mi), 588 hectares (ha) 1,452 acres (ac)); estimated 5 percent State - Arizona State Lands Department, Arizona Game and Fish Department (AGFD), New Mexico Department of Game and Fish (NMDGF) (12.5 river km, 7.7 river mi, 46 ha, 113 ac); 10 percent Tribal - San Carlos Apache Tribe (50 river km, 31 river mi, 184.4 ha, 455.7 ac); estimated 5 percent private - many private landowners (12.5 river km, 7.7 river mi, 46 ha, 113 acres).

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Biological Information

Species Description:

Headwater chub (*Gila nigra*) is a moderate-sized cyprinid, usually dark gray to brown overall, silver laterally, and often with diffuse lateral lines on the sides. The body is usually slender, moderate in length, and moderately fusiform. Headwater chub are similar in appearance to Gila chub (*G. intermedia*) and roundtail chub (*G. robusta*). Headwater chub are generally smaller than roundtail chub, likely due to the smaller streams in which they occur (Minckley 1973, pp. 100-102; Sublette *et al.* 1990, pp. 126-129; Propst 1999, pp. 23-25; Minckley and DeMarais 2000, pp. 254-255; Voeltz 2002, pp. 8-11). Minckley and DeMarais (2000, pp. 5-6) provided a key to the identification of Gila, headwater, and roundtail chubs, and Dowling *et al.* (2008, pp. 41-43) analyzed the genetics of many of the existing populations of all three species and provided recommendations for management units.

Taxonomy:

Gila nigra was first described from Ash Creek and the San Carlos River in east-central Arizona in 1874 (Cope and Yarrow 1875, p. 663). The taxonomic history of the three Gila River basin chubs (headwater, roundtail, and Gila chub), as well as that of the other Colorado River basin Gila, has been confusing, and these three Gila River species have been variously classified as different species, as subspecies of *Gila robusta*, or as part of a "*Gila robusta* complex" (see Miller 1945, p. 108; Holden 1968, pp. 37-38; Rinne 1969, pp. 1-69; Holden and Stalnaker 1970, p. 409; Rinne 1976, pp. 65-99; Smith *et al*. 1977, p. 613; DeMarais 1986, p. 111; Rosenfeld and Wilkinson 1989, p. 232; Dowling and DeMarais 1993, pp. 444-446; Douglas *et al*. 1998, pp. 163-165; Minckley and DeMarais 2000, pp. 251-256; Gerber *et al*. 2001, pp. 2028-2037). A summary of the nomenclature can be found in Voeltz (2002). Headwater chub is nevertheless currently a valid taxon at the species level, and is recognized as a distinct species on the American Fisheries Societys most recent list of accepted common and scientific names of fishes (Nelson *et al*. 2004, p. 71).

Habitat/Life History:

Headwater chubs occur in the middle to upper reaches of moderately-sized streams (Minckley and DeMarais 2000, p. 255). Bestgen and Propst (1989, pp. 402-410) examined status and life history of chubs in the Gila River drainage in New Mexico and found that habitats containing both Gila and headwater chubs consisted of tributary and mainstem habitats in the Gila River at elevations of 1,325 m (4,347 ft) to 2,000 m (6,562 ft). Maximum water temperatures for habitats of the Gila, headwater and roundtail chub vary from 20° to 27°C (68° to 81°F), with minimum water temperatures of 7° C (45°F) (Bestgen and Propst 1989, pp. 402-410; Barrett and Maughan 1995, pp. 304-305). Typical adult habitats containing both Gila and headwater chub consisted of nearshore pools adjacent to swifter riffles and runs over sand and gravel substrate, with young of the year and juveniles using smaller pools and areas with undercut banks and low velocity (Bestgen and Propst 1989, pp. 402-410). Spawning in Fossil Creek (which contains both roundtail and headwater chub) occurred in spring and was observed in March in pool-riffle areas with sandy-rocky substrates (Neve 1976, pp. 13-14). Neve (1976, pp. 10-12) reported that the diet of headwater chub included aquatic insects, ostracods, and plant material.

Historical Range/Distribution:

The historical distribution of headwater chub in the lower Colorado River basin is poorly understood because of the lack of early collections and the historical widespread manmade changes to aquatic ecosystems that likely altered their distribution prior to comprehensive surveys (habitat alteration and nonnative species introductions (Girmendonk and Young 1997, p. 50; Voeltz 2002, p. 19). The headwater chub was historically more common throughout its range (Minckley 1973, pp. 100-104; Bestgen and Propst 1989, pp. 405-406); Propst 1999, p. 23. Voeltz (2002, pp. 81-87) estimating historical distribution based on museum collection records, agency database searches, literature searches, and discussion with biologists, found that headwater chub likely occurred in a number of tributaries of the Verde River, most of the Tonto Creek drainage, much of the San Carlos River drainage, and parts of the upper Gila River in New Mexico (Voeltz 2002, p. 82-83). Voeltz (2002, p. 83) estimated that headwater chub historically occupied approximately 500 km (312 mi) in Arizona (AZ) and New Mexico (NM).

Current Range Distribution:

The species currently occurs in the same areas, but has a smaller distribution. The species occupies the East, Middle, and West forks of the Gila River (Carman 2006, p. 4-10; Stefferud et al. 2009, pp. 8-9), and may occupy lower Turkey Creek below a barrier in that stream (Dowling et al. 2008, p. 57, Dowling 2012, p. 1, Brooks 2012a p. 1) and the Gila River below the forks area in New Mexico, although these fish have not been definitively identified (Stefferud et al. 2009, pp. 10-11). The Miller Fire in the upper Gila Forks/Turkey Creek (NM) drainage in 2011 resulted in minor ash flows in these streams. Gila chub and headwater chub were salvaged from Turkey Creek (NM), prior to ash flows and surveys in October, 2011, in the Gila Forks area documented reduced fish populations but headwater chub were still present (NMGFD unpub. data). Ash flows post-fire in Turkey Creek (NM) were limited and repatriation of the salvaged fish occurred in April 2012 (Gilbert 2012a, p. 1, Brooks 2012a, p. 1). In Arizona, headwater chub are believed to currently occupy tributaries of the Verde River including Fossil Creek, East Verde River (including tributaries The Gorge, Pine Creek, and Webber Creek), Wet Bottom Creek, and Deadman Creek; and Tonto Creek and several of its tributaries (Buzzard Roost, Dinner, Gordon, Gunn, Haigler, Marsh, Rock, Spring, Turkey Creeks) (Voeltz 2002, pp. 81-87; Stefferud et al. 2009, pp. 11-23). New surveys in 2011 and 2012 were completed for several streams (see Table 2 and supporting material) Surveys in November 2011 re-documented headwater chub in Turkey Creek (AZ) (Grosch and Makinster 2011, p. 2) and were followed up by additional surveys in 2012 (Makinster et al. 2012a, p. 4) that found multiple size classes and no nonnative fish present. Scheduled surveys of Deadman Creek were not completed in 2011 or 2012 and the status of that stream after wildfires remains unclear. Headwater chub may still occur in Ash Creek and the San Carlos River, although recent survey information for these streams is unavailable because San Carlos Tribal survey information is proprietary and confidential (Voeltz 2002, pp. 81-87).

In our 2008 assessment, we included the upper West Clear Creek population of Gila sp. as headwater chub. Our decision to do so was questioned by Stefferud et al. (2009, pp. 14-15). The taxonomic status of Gila sp. in upper West Clear Creek has still not been definitively resolved. Dowling (2010, p. 2) indicates that the chub there is not assignable to either roundtail chub or headwater chub and additional morphometric study is needed. The upper West Clear Creek population was included in the 2008 assessment as headwater chub. Based on information from Dr. Dowling and the lack of any additional information since 2008, we are not including this population as headwater chub in this assessment. It is important to note that the upper West Clear Creek Gila sp. population is robust and largely secure (there are some non-native trout present but impacts to habitat are limited) and would be a significant population for whichever species it is eventually assigned to.

Recently completed genetic research includes recommendations for management units for headwater chub, as well the related Gila and roundtail chubs (Schwemm 2006, p. 93; and Dowling et al. 2008, pp. 41-43) that identify all populations as having a unique backgrounds and each should be maintained independently to

preserve unique genetic variation and maximize evolutionary potential. Additional genetic and morphometric evaluations on the three-species complex are needed to refine species range.

Population Estimates/Status:

The decline of the headwater chub has been noted in both scientific literature (Bestgen and Propst 1989, p. 404-407) and in State agency reports (Girmendonk and Young 1997, p. 49; Bezzerides and Bestgen 2002, pp. 30-33; Voeltz 2002, pp. 81-84), Paroz and Propst 2007, p. 20, Propst et al. 2009, p. 7-13). The AGFD completed a status review of headwater chub in 2002, which was peer-reviewed by Federal agency personnel, university researchers, and experts on the headwater chub (Voeltz 2002). Stream-specific distribution and status information for roundtail and headwater chub populations in the lower Colorado River basin was gathered from published literature; unpublished agency reports, records, manuscripts, and files; scientific collecting permit reports; personal communications with knowledgeable biologists; and academic databases. Based on this comprehensive information on all available current and historical survey records, AGFD estimated historical and current ranges of the headwater chub and found that the species had declined significantly from historical levels. The AGFD report also used a classification system, as described below in Table 1, to report status and threat information, which defined populations based on the abundance and recruitment of the population by stream reach and presence or absence of obvious threats.

The AGFD provided additional surveys on six populations for the current 2012 assessment and these are described below.

Table 1. Definitions of status description categories used to describe the status of headwater chub populations (from Voeltz 2002).

Voeltz (2002, p. 83) concluded that headwater chub are known to occupy only 40 percent of their former range, and have an unknown distribution on another 10 percent of their former range. Our 2011 assessment (U.S. Fish and Wildlife Service (Service) 2011) utilized information from the 2006 12-month finding (71 FR 53756, Service, September 12, 2006). Voeltz (2002), Stefferud et al. (2009), and AGFD (2009) examined recent survey information in terms of the criteria for status categories as provided in Table 1. Assignment to status categories in Voeltz (2002) and subsequent annual assessments were made based on the best available information, which, in some cases, was very limited. As additional surveys are made to clarify the extent of headwater chub within a stream, the status may change.

For the 2012 published assessment, we added new surveys in Arizona from 2011 (Grosch and Makinster 2011 (preliminary surveys for Turkey, Dinner, and Buzzard Roost Creeks), Makinster et al. 2011a and b (East Verde River), c (preliminary surveys for Webber Creek), d (Pine Creek)) and information from pre-and post-fire monitoring in New Mexico.

Changes in status category for 2012 for four streams were the result of new information obtained from surveys or other sources. Surveys on the East Verde River from Ellison Creek to the Highway 87 bridge (Makinster et al. 2011a, p 3-4) documented a robust headwater chub population in the river. Further surveys below the bridge to Doll Baby Ranch documented fewer headwater chub and a robust non-native fish population (Makinster et al. 2011a, p 13) dominated by green sunfish. Within the Ellison Creek-Highway 87 reach, headwater chub made up 34 percent% of the total fish captured, with all natives combined equaling 66 percent of the total fish captured (Makinster et al. 2011a, p 4). Headwater chub ranged in size from approximately 50 mm to 230 millimeters (mm) (2 to 9 inches (in)) for these surveys in June, 2011. In a mark-recapture exercise in the vicinity of Ellison Creek (Makinster et al. 2011b, p 3), headwater chub again

showed a robust population with multiple size classes represented. This new information allows a change to ST for the upper surveyed area based on a robust population and limited nonnative species present.

Surveys in Pine Creek confirmed the presence of headwater chub (Makinster et al. 2011d, p. 2-3) with at two size classes captured and larger fish seen. Of the total fish captured, green sunfish and yellow bullhead made up 81 percent of the catch, with headwater chub only seven percent. Crayfish were also abundant. Based on this survey, while there is evidence of recruitment, the dominance of the non-native species populations suggests a status of UT for this population is appropriate.

For this 2013 assessment, we are adding new surveys and final surveys for some sites visited in 2012. The headwater chub status for Buzzard Roost and Turkey (AZ) creeks was confirmed (Makinster et al. 2012a, p. 4) as was Spring Creek (Overton et al. 2012, p. 4), Rock Creek (Mosher et al. 2012a, ppp. 3-4). Buzzard Roost and Turkey Creekscreeks support good populations of headwater chub and did not have any nonnative fish predators present. The small size of these streams and future water supply is of concern to their supporting the populations (Turkey Creek has 0.6 km (0.[.36 mile)] wetted area and Buzzard Roost has 1.1 km (0[.66 mile))]) (Makinster et al. 2012, pp. 5-6), although both are hydrologically connected bythe the larger Rock Creek, which enables fish in the three streams to move between sites. Rock Creek supports a robust native fish community throughout its 13.5 km (8 mile) length with only a few green sunfish and brown trout in the lower sections. Mechanical removal of green sunfish from Rock Creek is proposed for 2013. Rock Creek is tributary to Spring Creek, which has abundant green sunfish and yellow bullheads throughout its length, along with a robust population of chub (Overton et al. 2012, pp. 3-5). While the lack of nonnatives in Turkey, Buzzard Roost, and upper Rock Creek support changing these streams from SS, the presence of robust populations of green sunfish and yellow bullheads in lower Rock Creek and Spring Creek without any barrier to movement upstream is of significant concern. Future planning for this drainage includes a fish barrier in Spring Creek that will protect these four creeks from nonnative fish. For these reasons, we continue to consider Rock and Spring Creeks ST.

We are suggesting the removal of Dinner Creek as a stand-alone population. Carveth (2007, p. 1) documented chub in the lower portion of the creek; however, the last two surveys (Grosch and Makinster 2011, p. 1) and Makinster et al. 2012a, p.4) did not document any water in the creek or in its drainage. Dinner Creek likely only flows temporarily with snowmelt or monsoon rains and cannot support a permanent population of chub. Dinner Creek is a tributary to Spring Creek, and chub from Spring Creek can utilize Dinner Creek when water is available.

Wet Bottom Creek was surveyed and a robust population was documented (Mosher et al. 2012b, p. 4, Burger and Gill 2012, pp. 6-7) with nonnative speciesnonnatives present, particularly green sunfish in the lower reaches and access by smallmouth bass to the upper reaches. Without an effective barrier, this stream cannot be considered SS. We are considering this stream ST.

Tonto Creek between Gunn Creek and Gisela was surveyed and no chubs were found and nonnative predators were abundant (Avenetti et al. 2012b, p. 3). Burger (2010, p. 1) also looked downstream of Gisela and saw a couple of chub but there had been high water earlier and they may have been washed downstream. Tonto Creek from the headwater to Bear Flat Campground was also resurveyed and no chubs were found (Makinster et al. 2011e, p. 3). These areas have no recent documentations for chub. Surveys in the known occupied area (Bear Flat to Hells Gate to Gisela) are scheduled for future years. The four reaches of Tonto Creek have different status determinations; E for the headwaters to Bear Flat (this is appropriate given the E status for Christopher Creek which joins Tonto Creek in this reach),) UT for Bear Flat-Hells Gate and Hells Gate to Gisela (based on surveys from 2007 and 2008), and UN for Gisela to Roosevelt Lake (based on no chub found in recent surveys).
Gunn Creek was resurveyed (Avenetti et al. 2012c, pp. 2-3) and multiple year classes were found in less than one kilometer of stream with robust green sunfish populations downstream that limit potential expansion of the population. Population information supports a status of ST; however, b ased on the limited habitat area, we are considering this stream only provisionally ST pending more information on water use in the drainage.

Gordon Creek was also resurveyed (Mosher et al. 2012c, p. 2) and no chubs were found. Following on Kerns 2008 survey (Kern 2008, p. 6) where only a few chub were found in the lowermost reaches, and that the 2000 surveys (Voeltz 2002, p. 64) found them in the 0.4 km sampled area in multiple size classes. T, this population has apparently declined and we suggest downgrading from ST to UT. Additional surveys of lower Gordon Creek are planned for 2013. Surveys of Marsh Creek confirmed Marsh Creek as ST (Avenetti et al. 2012a, p. 3).

Surveys in 2011 (Makinster et al. 2011d, p. 2) and 2012 (Overton et al. 2012b, p.4) did not document any headwater chub in Webber Creek. There is only one record for Webber Creek (Bagley 2002, p. 8) and none have been found since. Upper Webber Creek supports trout and speckled dace but headwater chub have not been recorded there (Gill 2008, p. 3). Habitat appears to be suitable and other native fish are present with limited nonnatives and options to restock this stream from the adjacent East Verde River may be considered. It remains UT due to the potential for a small population to persist and the opportunity to restock.

In July, 2011, smallmouth bass were found to have invaded Fossil Creek due to flood damage to the fish barrier that compromised its effectiveness (Crowder 2011, p. 1). A temporary barrier was put into place to constrain the upstream movement of the bass. Mechanical removal efforts reduced the bass population, but did not eliminate the species from above the permanent barrier In September, 2012, AGFD, Service,FWS and other partners renovated Fossil Creek to remove the smallmouth bass and that effort was apparently successful. Repairs to the permanent barrier were completed in March, 2013. Genetics monitoring of the headwater and roundtail chub populations in Fossil Creek indicates that while the headwater chubs are expanding their numbers and range in the creek, roundtail chub numbers are declining (Dowling and Marsh 2009, pp. 1-2). Although the Forest Service has not completed its recreation plan for Fossil Creek, we believe the status of this stream should remain SS now that bass have been eliminated and the integrity of the barrier restored. Livestock grazing in the allotment that includes the creek is under a new allotment management plan (Service 2009) that addresses livestock access to the creek.

Headwater chub in New Mexico continue to be affected by wildfires. In 2011, the Miller Fire burned in the Turkey Creek (NM) drainage and prompted salvage of both Gila and headwater chub from the stream. The salvage removed 277 headwater chub from the lower portion of the creek before post-fire runoff events occurred. The salvaged fish ranged from 66 to -278mm (2.5 to 11 in), representing at least three size classes (Gilbert 2012a, p. 1). Examination of the specimens indicates they were more akin morphologically to headwater or roundtail chub, while the upper Turkey Creek chub were more Gila chub-like (Mata 2012, p. 1). Most of these fish were returned to the lower portion of the creek in April, 2012 (Brooks 2012, p. 1); however 30 were sacrificed for morphological and genetic examination (along with 20 Gila chub from above the barrier) to assess the correct species determination. Until the examinations are funded and completed, we will continue to consider the lower Turkey Creek (NM) as headwater chub and as UT based on the evidence of recruitment.

The most recent summary report (Monié et al. 2012, pp. 12-22) documents the presence of headwater chub in one or more of the Three Forks areas since 2008. The 2012 Whitewater/Baldy Fire affected the upper watershed of the West Fork Gila River and ash/sediment flows moved down the West and Middle Forks in July 2012. Pre-fire surveys in the West Fork in June, 2012 detected 18 chub of various sizes. October 2012 surveys in the West and Middle Forks collected no chub. The East Fork population is not robust and the effects of this fire may be very significant to the chub population (Monié et al. 2012, p. 1). We continue to consider this population as UT due to wildfire risks and abundant nonnative predatory fish (yellow bullheads and smallmouth bass particularly) in all three streams.

We conclude that the headwater chub now occurs in 22 of 26 streams where it has been documented. Populations were completely extirpated (E) from three streams and upper Tonto Creek (most recently in the 1990s in Rye Creek) and we no longer consider Dinner Creek to be a population. The extant populations are in four drainages (San Carlos River (2), Tonto Creek (9), Upper Gila (4), and Verde River (7)). Three of the four Upper Gila populations are connected (the Forks populations), the two San Carlos populations are

probably connected, the Tonto Creek populations are in two clusters; Gordon, Haigler, Marsh and Tonto Creeks in the upper drainage and the four Spring Creek basin and Gunn Creek populations in the middle portion of the drainage, and the Verde populations have one cluster of four on the East Verde River and the remaining two are isolated from each other. We estimate that the extant stream segments represent only 40 to 50 percent of the species former range (approximately 200 km (125 mi) of 500 km (312 mi)) in Arizona and New Mexico.

Using this new information, we have updated our status categories in Table 2. Of the 22 extant populations, 3 are SS, 7 are ST, 7 are UT, and 5 have UN status (Table 2). Because the status of several populations has changed from 2006 as the result of new information, we present the status history in Table 2.

Table 2: Status categories for headwater chub populations 2006 to 2013.

Population	**12-mo 2006**	**CNOR 2008**	**CNOR 2010**	**CNOR 2011**	**CNOR 2012**	**CNOR 2013**	**Rationale for 2013**
Ash Creek	UN	UN	UN	UN	UN	UN	On Tribal lands, no information to assess status
Buzzard Roost	STST	ST	ST	ST	ST	SS	Makinster et al. 2012a documented robust population
Christopher Creek	E	E	E	E	E	E	No change
Deadman Creek	ST	ST	ST	UN	UN	UN	No new surveys completed after major wildfire
Dinner Creek	-	-	ST	UN	UN	-	Makinster et al. 2012a documented no water in drainage. Likely only used by Spring Creek fish when water present. Not considered a population as of 2013
East Verde River	UT	UT	UT	UT	ST	ST	Makinster et al. 2011b showed robust population near Ellison Creek and above HWY 87. Threats continue.
Fossil Creek	UT	SS	SS	SS	SS	SS	Smallmouth bass removed September 2012. Downing and Marsh 2009 documented 75% of chub in Fossil Creek were headwater chub. Population is robust. Recreation issues being addressed by USFS.
Gordon Creek	ST	ST	ST	ST	ST	ST	Kern 2008 found chub only in lowest reach near Haigler Creek. Mosher et al. 2012b found no chub in any part of creek.
Gorge Canyon (The Gorge)	-	-	UN	UN	UN	UN	Only one survey extant

Gunn Creek	UT	UT	UT	UT	UT	ST	Avenetti et al. 2012c found multiple age classes of chub in upper ~1 km of creek. Limited water in drainage and downstream nonnatives.
Haigler Creek	ST	ST	ST	ST	ST	ST	No new survey information
Horton Creek	E	E	E	E	E	E	No change
Marsh Creek	ST	ST	ST	ST	ST	ST	Avenetti et al. 2012a found chub at all 6 sites but robust green sunfish population in lower 4 sites
Pine Creek	-	-	UN	UN	UT	UT	Makinster et al. 2011d documented small population in lower reach with many sunfish present
Rock Creek	ST	ST	ST	ST	ST	ST	No new survey information
Rye Creek	E	E	E	E	E	E	No change
San Carlos River	UN	UN	UN	UN	UN	UN	On Tribal lands, no information to assess status
Spring Creek	ST	ST	ST	ST	ST	ST	Overton et al. 2012a documented multiple year classes and nonnative predators present
Tonto Cr. Upper BF-HG HG-Gisela Gisela-Lake	UT	UT	UT	UT	UT	E UT UT UN	Avenetti et al. 2012b surveyed Gisela to Gunn Creek and no chubs found. Survey of upper Tonto to Bear Flat (Makinster et al. 2011e) again found no chub present in that reach. No new survey information in occupied reach from Hells Gate to Gisela
Turkey Creek AZ	-	-	ST	UN	ST	SS	Makinster et al. 2012a survey found extant population with no nonnative species present but habitat very limited.
Upper Gila Forks (East, Middle, and West as one population)	UT	ST	UT	UT	UT	UT	Miller and Whitewater Baldy fires ma have affected West Fork population. Monie et al. 2012 documented chub still present 2010-2011; post-fires survey in Fall 2012 in West and Middle Forks found no chub after ash flows went through.
							Fish salvaged before

Turkey Creek NM	-	-	UN	UN	UT	UT	post-Miller fire runoff in 2011 (Gilbert 2012a) and returned April 2012 (Brooks 2012a). Whitewater-Baldy fire in summer 2012 had minor effect to watershed (Brooks 2012b)
Webber Creek	UT	UT	NONE	UT	UT	UT	Makinster et al. 2011d and Overton et al. 2012b surveys did not detect chubs in stream; very small population possibly still present
Wet Bottom Creek	UN	UN	UT	UN	UN	ST	Mosher et al. 2012a documented multiple year classes in ~1.5 upper creek. Robust green sunfish population in lower portion of creek.

The survey data on all headwater chub populations are not sufficiently rigorous to identify population cycles over time. The populations remain extant, and for most, nonnative species have been present for a considerable time. Whether or not the populations can remain extant in the presence of the current suite of nonnative fish and crayfish is unknown, particularly if other threats such as drought and wildfire continue at the current levels. We believe they are persisting in the face of current threats, but that does not necessarily mean those threats are less significant because of it. Imminent threats from water diversion in the East Verde River add additional concerns for that population and the Webber Creek population connected to it (USFS 2011). No new nonnative species are in the Arizona sites, and those there are maintaining their populations. New survey information from Arizona streams indicates that some populations are in better condition than previously believed; however, that does not indicate actual improvement in status, but rather that our assessment of the status may not have been correct. For New Mexico, use of additional information not used in 2008 indicates the status of the headwater chub was not correctly identified and the correct status is less than was assumed. Overall, our understanding of this species population status is increasing.

Threats

A. The present or threatened destruction, modification, or curtailment of its habitat or range:

Within the historical range of the headwater chub, much of the stream habitat has been destroyed or degraded, and loss of this habitat continues today (Tellman et al. 1997, pp. 159-170; Propst 1999, p. 25; Voeltz 2002, pp. 87-89). At certain locations, activities such as groundwater pumping, surface water diversions, impoundments, dams, channelization (straightening of the natural watercourse typically for flood control purposes), improper livestock grazing, wildfire, agriculture, mining, roads, logging, residential development, and recreation all contribute to riparian and cienega (wetland) habitat loss and degradation in Arizona and New Mexico (Tellman et al. 1997, pp. 159-170; Propst 1999, p. 25; Voeltz 2002, pp. 87-89; Carman 2006, p. 30). These activities and their effects on headwater chub are discussed in further detail below.

Water withdrawal. Headwater chub has been eliminated from much of its historical range because many areas formerly occupied are now unsuitable due to dewatering (Miller 1961, p. 377; Miller 1972, p. 240;

Deacon et al. 1979, p. 32; Bestgen and Propst 1989, p. 407; Girmendonk and Young 1997, p. 49; Bezzerides and Bestgen 2002, pp. 25, 28; Voeltz 2002, p. 76; Carman 2006, p. 30). Water withdrawal is a threat in at least 8 of the 22 extant populations of headwater chub (Bestgen and Propst 1989, p. 407; Girmendonk and Young 1997, p. 37, 42; Propst 1999, p. 25; Voeltz 2002). Habitat for roundtail chub, a closely related species, is likely eliminated once surface flow drops below 0.3 cubic meters per second (10 cubic feet per second) because the stream lacks the depth and habitat features, such as deep pools, that the species requires (Service 1989, p. 32). Groundwater pumping and surface water withdrawal directly eliminate headwater chub habitat because they remove water. However, flowing water helps to create the habitat diversity that headwater chub require. Lack of flow often results in only pool habitat remaining, which can concentrate headwater chub with nonnative species and increase predation pressure of nonnative fishes on headwater chub, which has been documented in Marsh Creek and the East Verde River (Voeltz 2002, pp. 63, 76). The flows in the upper East Verde River are under imminent threat of reduction through the Arizona Water Rights Settlement Agreement which allows up to 3,500 acre-feet of the 9,000 to 12,000 acre-feet (4.3 million cubic meters (cms) of the 11 million cms to 15 million cms+) trans-basin diversion from East Clear Creek to the East Verde River to be diverted for use by the Town of Payson and other rim communities (USFS 2011, pp. 1-2). Flows in the upper East Verde River during the summer months can be quite low, and may limit the amount of available habitat for headwater chub in the occupied reach. The construction of the diversion pipeline is estimated to take 18 to 24 months (USFS 2011, p. 5)

The upper Gila River, in the vicinities of Cliff, Redrock, and Virden, New Mexico, has been entirely dewatered on occasion by diversions for agriculture (Bestgen 1985, p. 13). Development of Gila River water in New Mexico under the Central Arizona Project may also cause additional reductions in flow that increase adverse effects to fish habitat. Groundwater pumping in Tonto Creek regularly eliminates surface flows during parts of the year (Abarca and Weedman 1993, p. 2). Groundwater pumping in the East Verde River is a threat to many parts of the stream (Girmendonk and Young 1997, p. 42). Groundwater pumping in Webber Creek for municipal use, as well as at least one diversion for agricultural use, reduces flows in that stream (Voeltz 2002, pp. 77-78).

Livestock grazing. Improper livestock grazing has been documented to negatively impact native fish habitats. Improper livestock grazing is often cited as one of the most significant factors contributing to regional stream channel downcutting (the entrenchment of stream channels and creation of arroyos) in the late 1800s; profound effects from this period occurred throughout the watershed of Tonto Creek (Croxen 1926, pp. 1-11), which contains 70 percent of all extant headwater chub populations (Voeltz 2002, pp. 82-83); and these effects are still evident and compounded by ongoing grazing (Ganda 1997, pp. 5-3). Improper livestock grazing destabilizes stream channels and disturbs riparian ecosystem functions (Hereford 1992, p. 17; Tellman et al. 1997, pp. 88-89). It negatively affects headwater chub habitat through removal of riparian vegetation (Clary and Webster 1989, pp. 6-7; Clary and Medin 1990, pp. 2-3; Schulz and Leininger 1990, p. 296; Armour et al. 1991, p. 7; Fleishner 1994, pp. 630-631), which results in reduced bank stability, fewer pools, and higher water temperatures, creating habitats that are too extreme to support headwater chub (Meehan 1991, p. 91; Kauffman and Krueger 1984, pp. 430-433; Swanson et al. 1982, pp. 288-289; Minckley and Rinne 1985, pp. 151-152; Fleishner 1994, pp. 630-631; Belsky et al. 1999, p. 419). This activity also causes increased sediment in the stream channel, due to streambank trampling and riparian vegetation loss (Waters 1995; Pearce et al. 1998, p. 301). Livestock physically alter streambanks through trampling and shearing, leading to bank erosion (Trimble and Mendel 1995, p. 233) and remove canopy cover that can raise water temperatures (Platts and Nelson 1989, p. 455). In combination, loss of riparian vegetation and bank erosion alters channel morphology, including increased erosion and deposition, downcutting, and an increased width/depth ratio, all of which lead to a loss of deep pool habitats required by the headwater chub, and loss of shallow side and backwater habitats used by larval chub (Trimble and Mendel 1995, p.249; Belsky et al. 1999, pp. 26-28).

Poorly managed livestock grazing causes the structure and diversity of the fish community to shift due to changes in availability and suitability of habitat types (Rahel and Hubert 1991, p. 326). This loss of aquatic habitat complexity reduces the diversity of habitat types available to fish communities (Gorman and Karr

1978, p. 507). In the arid west, this loss of habitat complexity has been found to accelerate the displacement of native fish by nonnative species (Baltz and Moyle 1993, p. 246). Livestock grazing also contributes significantly to the introduction and spread of nonnative aquatic species through the proliferation of ponded water in stock tanks (Rosen et al. 2001, p. 24; Hedwall and Sponholtz 2005, pp. 15; Service 2008, pp. 4651).).

Stream channelization and irrigation. Sections of many Gila Basin's rivers and streams have been and continue to be channelized for flood control, which disrupts natural channel dynamics and promotes the loss of riparian plant communities. Channelization changes the gradient of the stream above and below the channel. It increases stream flow in the channelized section, which results in increased rates of erosion of the stream and its tributaries, accompanied by gradual deposits of sediment in downstream reaches that increase the risk of flooding (Emerson 1971, p. 325; Simpson et al. 1982, pp. 122-125). Channelization has affected headwater chub habitat by reducing its complexity, eliminating cover, reducing nutrient input, improving habitat for nonnative species, changing sediment transport, altering substrate size, and reducing the length of the stream (and therefore the amount of aquatic habitat available) (Gorman and Karr 1978, p. 507; Simpson 1982, pp. 122-125; Schmetterling et al. 2001, p. 6). Channelization occurs within at least 50 percent of extant populations as presented in the 12-Month Finding (71 FR 26007, May 3, 2006).

Irrigation water withdrawal from streams reduces or eliminates water in existing fish habitat. Fish can be carried into irrigation ditches, where they may die following desiccation (drying). Irrigation dams prevent movement of fish between populations, resulting in genetic isolation within species; small populations are subject to genetic threats, such as inbreeding depression (reduced health due to elevated levels of inbreeding) and to genetic drift (a reduction in gene flow within the species that can increase the probability of unhealthy traits; Meffe and Carroll 1994, p. 157). There are numerous surface water diversions in headwater chub habitats, including the upper Gila River, East Verde River, and Tonto Creek. Larger dams prevent movement of fish between populations, and dramatically alter the flow regime of streams through the impoundment of water behind the dam and alteration of the hydrograph below (Ligon et al. 1995, pp. 184-185). We do not have information however, as to whether any of the extant populations are at such low levels of abundance and isolation that they are experiencing inbreeding depression, and at this time we cannot quantify the risk of this or other genetic threats other than to recognize them as potential problems.

Mining activities. Mining activities were more widespread historically and likely constituted a greater threat in the past; however, the continued mining of sand, gravel, iron, gold, copper, or other materials remains a potential threat to the habitat of four headwater chub populations (Table 2). The effects of mining activities on populations include adverse effects to water quality and lowered flow rates due to dewatering of nearby streams needed for mining operations (ADEQ 1993, pp. 61-63).

Ongoing sand and gravel mining in Tonto Creek is eliminating headwater chub habitat (Abarca and Weedman 1993, p. 12; Voeltz 2002, p. 59). Sand and gravel mining removes riparian vegetation and destabilizes streambanks, which results in habitat loss for the headwater chub (Brown et al. 1998, p. 979). Mining occurs within at least one third of the extant populations as presented in the 12-Month Finding (71 FR 26007, May 3, 2006).

Roads and logging. Roads are considered a threat to 15 of the 22 extant populations. Roads have adversely affected headwater chub habitat by destroying riparian vegetation and by increasing surface runoff, sedimentation, and erosion (Burns 1971, p. 1; Eaglin and Hubert 1993, p. 844). Roads require instream structures, such as culverts and bridges, which remove aquatic habitat and can act as barriers to fish movement (Warren and Pardew 1998, pp. 642-3). All of these activities negatively impact headwater chub by lowering water quality and reducing the quality and quantity of pools, by filling pools with sediments, by reducing the quantity of large woody-debris necessary to form pools, and by imposing barriers to movement. Roads also cause the modification and destruction of habitat, facilitate the spread of nonnative species via human vectors, increase the likelihood of subsequent urbanization, and contribute contaminants to aquatic communities (Wheeler et al. 2005, pp. 145, 148149). Thus roads can ultimately deteriorate habitat for the

headwater chub. Roads are found in all drainages containing extant populations of headwater chub as presented in the 12-Month Finding (71 FR 26007, May 3, 2006).

Vehicular use of roads in creek bottoms, as has been documented in Tonto Creek (Voeltz 2002, p. 59), degrades headwater chub habitat and can result in headwater chub mortality. Such use inhibits riparian plant growth, breaks down banks, causes erosion and sedimentation, and increases turbidity in the stream, particularly where vehicles drive through the stream and immediately downstream of the vehicular activity. These effects result in wider and shallower stream channels (Meehan 1991, p. 52). This causes progressive adjustments in other variables of hydraulic geometry and results in changes to the configuration of pools, runs, riffles, and backwaters; levels of fine sediments and substrate embeddedness; availability of instream cover; and other fish habitat factors in the vicinity of vehicle crossings (Rosgen 1994, p. 183). Resultant changes to the stream channels alter the way in which flood flows interact with the stream channel and may exacerbate flood damage to banks, channel bottoms, and riparian vegetation. The breaking down of stream banks by vehicles reduces undercut banks and overhanging vegetation that chub use as cover. Fish fry and eggs could also be killed or injured if vehicles are driven through stream segments where these life stages occur. Vehicles driven rapidly through the stream could splash young fish or eggs onto the bank where they may desiccate. Larger fish are likely to swim away and avoid death or injury. Public vehicular use is also often associated with an elevated risk of human-caused fire, due to increased access of remote areas.

Adverse effects of stream sedimentation to fish and fish habitat have been extensively documented (Murphy et al. 1981, p. 469; Newcombe and MacDonald 1991, p. 72; Barrett et al. 1992, p. 437). Excessive sedimentation causes channel changes that are adverse to headwater chub habitat. These activities have direct impacts on headwater chub habitat because excessive sediment can fill backwaters and deep pools used by headwater chub, and sediment deposition in the main channel can cause a tendency toward stream braiding (e.g., the stream becomes wider, shallower, and has numerous channels as opposed to one channel), which reduces adult headwater chub habitat. Excessive sediment will smother invertebrates (Newcombe and MacDonald 1991, p.78), thereby reducing chub food production and availability, and related turbidity reduces the headwater chubs ability to see and capture food (Barrett et al. 1992, p. 441).

Although logging is a land use in many of the watersheds known to contain headwater chub populations (71 FR 26007, May 3, 2006), logging is largely a threat of the past, resulting from previous management practices no longer in place. The alteration of watersheds resulting from road-building and logging is deleterious to fish and other aquatic life forms (e.g., Burns 1971, p. 1; Eaglin and Hubert 1993, p. 844). Roads and logging increase surface runoff, sedimentation, and mudslides, and destroy riparian vegetation (Lewis 1998, p. 55; Jones et al. 2000, p. 76).

Recreation. Recreation was noted as a land-use in all of the watersheds containing headwater chub (71 FR 26007, May 3, 2006). The impacts of recreation are highly dependent on the type of activity, with activities such as bird-watching having little to no impact and activities such as off-road vehicle use potentially having severe impacts on aquatic habitats. Specific problems with recreation were noted in the Upper Gila River, and Tonto and Webber Creeks (Voeltz 2002, pp. 39, 59, 77). For example, Voeltz (2002, p. 59) noted that in-channel vehicular traffic was a threat to headwater chubs in Tonto Creek (also discussed above under Roads and Logging). The U.S. Forest Service is in the initial stages of development for a recreational management plan to address use along Fossil Creek as part of its designation as a Wild and Scenic River. Much of the current range of the headwater chub occurs on public lands administered by the U.S. Forest Service, and public use of these lands is high; such use creates an elevated risk of human-caused impacts such as off-road vehicle use.

Development activities. Headwater chub habitat is also threatened increasingly from urban and suburban development (Tellman et al. 1997, pp. 92-93). Urban and suburban development affects headwater chub and its habitat in a number of ways, such as direct alteration of streambanks and floodplains from construction of buildings, gardens, pastures, and roads (Tellman et al. 1997, pp. 92-93), or as mentioned above, diversion of water, both from streams and connected groundwater (Glennon 1995, pp. 133-139). On a broader scale,

urban and suburban development alters the watershed, which changes the hydrology, sediment regimes, and pollution input (Dunne and Leopold 1978, p.173; Horak 1989, pp. 41-43; Medina 1990, p. 351; Reid 1993, pp. 48-50; Waters 1995, pp. 52-53; Wheeler et al. 2005, pp. 149-155). Wheeler noted that roads and development increase the probability of nonnative species introductions (Wheeler et al. 2005, p. 154). Introduction of nonnative fishes species into headwater chub habitat has resulted in their extirpation in at least three streams, Christopher, Horton, and Rye Creeks, all in Arizona (Voeltz 2002, pp. 60-61, 67-68).

Suburban and urban development have degraded and eliminated headwater chub habitat. The Phoenix metropolitan area, founded in part due to its proximity to the Salt and Gila Rivers, is a population center of 3.5 million people. Communities in the middle and upper Verde River watershed, such as the Prescott-Chino Valley, the Cottonwood-Clarkdale-Camp Verde communities, Strawberry, Pine, and Payson, are all seeing rapid population growth. Many of these communities are near headwater chub populations, and 25 percent of known headwater chub populations occur in areas of urban and commercial development (Voeltz 2002, p. 84). Suburban development continues in the East Verde River and Tonto Creek watersheds. On a broader scale, as of 2005, Arizona was listed as the second fastest in statewide population growth in the nation, and Arizona is projected to grow by 109 percent by the year 2030 (U.S. Census Bureau 2005, p. 1).

Human activities in the watershed have had substantial adverse impacts to headwater chub habitat. Watershed alteration is a cumulative result of many human uses, including timber harvest, livestock grazing, roads, recreation, channelization, and residential development. The combined effect of all of these actions results in a substantial loss and degradation of habitat (Burns 1971, p. 1; Reid 1993, pp. 1-12). For example, in Williamson Valley Wash, human uses (e.g., recreational use of off-road vehicles) in the highly erodible upper watershed have resulted in increased erosion and high loads of sediment. In 1993, flooding in Williamson Valley Wash carried enough sediment that the isolated pool where Gila chub, a related species to the headwater chub, were previously collected became completely filled with sand and gravel (Weedman et al. 1996, p. 33).

In summary, habitat loss and modification due to numerous human activities threaten the headwater chub. Water withdrawals from diversion and groundwater pumping, livestock grazing, and stream channelization are of particular concern; we recognize that road building and use, mining, recreation and development are also threats. The frequency and magnitude of these activities can be expected to increase with human population size as human populations in Arizona and New Mexico continue to grow.

B. Overutilization for commercial, recreational, scientific, or educational purposes:

The AGFD added headwater chub to its list of protected native fish in the 2007 to 2008 Commission Order 40 fishing regulations. Any headwater chub caught must be immediately released unharmed. Except for Fossil Creek, headwater chub are not legal sportfish in Arizona. Angler catch is considered light in Arizona (Warnecke 2004, pers. comm.). However, headwater chub populations in the East Verde River and Haigler Creek are in areas stocked with rainbow trout to create a sportfishing opportunity. Headwater chub are trout-like, and angler bycatch does occur (Youtz 2010, p. 1) in the East Verde River and is likely in Haigler Creek. These two streams are operated as a standard fishery allowing bait and barbed hooks. Hooked headwater chub must be returned alive to the stream, but there is some mortality related to capture and handling that occurs. Fossil Creek is a catch-and-release fishery with barbless hooks specifically for headwater and roundtail chub, but there is still a risk of mortality from the legal fishery and the illegal fishery. During surveys in 2009, an estimate of 7 percent of chub were observed with hoooking injuries (Rinker et al. 2009, p. 5). Most headwater chub populations in Arizona are not in stocked streams and have only limited, if any, exposure to anglers. Consequently we do not believe that overutilization is a threat to headwater chub in Arizona, although on a local level there may be more impacts.

In the upper Gila River in New Mexico, there are reports of anglers purposefully discarding chub species, which may be having a negative effect on populations of headwater chub locally (Voeltz 2002, p. 40). In New Mexico, catch is prohibited and headwater chub are listed as an endangered species under the New

Mexico Wildlife Conservation Act, which protects the species from any direct take, including angling. Originally, the headwater chub was included with the roundtail chub as a single species until it was listed as endangered in its own right in 2006, so no additional protection was derived from that adjustment. New Mexico has a recovery plan for headwater chub that identifies the need to also include that information in the New Mexico state fishing regulations (Carman 2006, p. 1). The current fishing rules and information booklet (2011-2012, NMDGF 2013, p. 8) identifies that endangered fish cannot be taken and must be returned to the water immediately. However, it does not list the species of fish this restriction refers to as this information is in other documents.

C. Disease or predation:

The introduction and spread of nonnative species has long been identified as one of the major factors in the continuing decline of native fishes throughout North America and particularly in the southwest (Clarkson et al. 2005, pp. 20-25; Mueller 2005, pp. 10-11). In the American southwest, Miller et al. (1989, p. 22) concluded that introduced nonnative species were a causal factor in 68 percent of the fish extinctions in North America in the last 100 years. For 70 percent of those fish still extant, but considered to be endangered or threatened, introduced nonnative species are a primary cause of the decline (ANSTF 1994, p. 11; Lassuy 1995, p. 391). In Arizona, release or dispersal of new nonnative aquatic organisms, is a continuing phenomenon (Rosen et al. 1995, p. 251; Service 2008, p. 64). Introduction of nonnative species has also been consistently cited as a threat to the native fish fauna of the Colorado River, and is listed as a factor in the listing rules of nine other fish species with historical ranges that overlap with headwater chub (bonytail chub (G. elegans) (45 FR 27710, April 23, 1980), humpback chub (G. cypha) (32 FR 4001, March 11, 1967), Gila chub (67 FR 51948, November 2, 2005), Colorado pikeminnow (Ptychocheilus lucius) (32 FR 4001, March 11, 1967), spikedace (Meda fulgida) and loach minnow (Tiaroga cobitis),(51 FR 23769, October 28, 1986), razorback sucker (Xyrauchen texanus) (56 FR 54957, October 23, 1991), desert pupfish (Cyprinodon macularius) (61 FR 10842, March 31, 1986), and Gila topminnow (Poecilopsis occidentalis) (32 FR 4001, March 11, 1967)). Aquatic nonnative species are introduced and spread into new areas through a variety of mechanisms, both intentional and accidental, and authorized and unauthorized. Mechanisms for nonnative dispersal in the southwestern United States include inter-basin water transfer, sport stocking, aquaculture, aquarium releases, bait-bucket release (release of fish used as bait by anglers), and for use in biological control (Courtney 1993, pp. 35-56).

Headwater chub evolved in a fish community with low species diversity and where few predators existed, and as a result developed few or no mechanisms to deal with predation (Clarkson et al. 2005, p. 21). In its habitats, the headwater chub was probably the most predatory fish and experienced little or no competition. Nonnative fishes known from within the historical range of headwater chub in the Gila River basin include channel catfish (Ictalurus punctatus), flathead catfish (Pylodictis olivaris), red shiner (Cyprinella lutrensis), fathead minnow (Pimephales promelas), green sunfish (Lepomis cyanellus), largemouth bass (Micropterus salmoides), smallmouth bass (M. dolomieui), rainbow trout (Oncorynchus mykiss), brown trout (Salmo trutta), western mosquitofish (Gambusia affinis), carp (Cyprinus carpio), warmouth (L. gulosus), bluegill (L. macrochiris), yellow bullhead (Ameiurus natalis), black bullhead (A. melas), and goldfish (Carassius auratus) (Minckley 1973, Voeltz 2002, Service 2008). All populations of headwater chub except for Fossil Creek contain one or more self-sustaining predatory nonnative fish species, particularly brown trout, rainbow trout, green sunfish, smallmouth bass, and yellow bullhead. Smallmouth bass were documented in Fossil Creek in July, 2011, but is it not clear they have established a population (Crowder 2011, p. 1). A review of literature does not indicate any new nonnative species from most headwater chub sites since 2006. Paroz et al. (2006, p 69-71) summarized survey data for the Upper Gila Forks populations and did not record the presence of red shiner or flathead catfish in their surveys from 1988 to 2005. Propst et al. (2009, pp. 7-13) included those data and extended the information through 2008 with no records of these species. However, during nonnative fish removal efforts in 2006 to 2009 in the West Fork, nine red shiner were found in November 2007 and flathead catfish were found in April 2006 (one), November 2007 (four), December 2008 (one), and June 2009 (one) (NMDGF et al. 2009, p. 3). Both these species are extant in lower portions of the Gila River and hopefully their range is not expanding. For sites in Arizona, there has been little to no change in nonnative

fish species present in the occupied habitats since green sunfish were documented in Deadman Creek in 2001 (Bagley 2002, pp. 17-18).

Direct predation by nonnative fishes on, and competition of nonnative fishes with, the headwater chub has resulted in rangewide population declines and local extirpations (Christopher Creek, Rye Creek, and Horton Creek). Nonnative aquatic organisms negatively affect native fish through predation, aggression and harassment, resource competition, habitat alteration, aquatic community disruption, introduction of diseases and parasites, and hybridization (Service 2008, p. 71). Based on survey information, nonnative species occur in every known population of headwater chub (71 FR 26007, May 3, 2006). As described below, nonnative fish that prey on and/or compete with headwater chub are a serious and persistent threat to the continued existence of this species.

Dudley and Matter (2000, pp. 24-29) found that nonnative green sunfish prey on, compete with, and virtually eliminate recruitment of Gila chub (a recently Federally listed species that is closely related to headwater chub) in Sabino Creek in Arizona. Similar effects of green sunfish on Gila chub have been documented in Silver Creek in Arizona (Unmack et al. 2003, pp. 86-87). In the Verde River, Bonar et al. (2004, pp. 5-7) found that largemouth bass, smallmouth bass, bluegill, green sunfish, channel catfish, flathead catfish, and yellow bullhead all consumed native fish. Roundtail chub (a closely related species to headwater chub) have been found in stomachs of largemouth bass in the lower Salt River (Schwemm and Unmack 2001, p. 54). Bestgen and Propst (1989, p. 406) reported that, of nonnatives present in New Mexico, smallmouth bass, flathead catfish, and channel catfish most impacted headwater chub via predation.

Carpenter (2005, pp. 338340) documented that crayfish may reduce the growth rates of native fish through competition for food and noted that the significance of this impact may vary between species. At least two species of crayfish (Procambaris clarki and Orconectes virilis) have been introduced into Arizona aquatic systems and one or both species co-occur with headwater chub in at least four streams (Inman et al. 1998, p. 3; Voeltz 2002, pp. 1588). Crayfish are the only nonnative aquatic species remaining in Fossil Creek.

River otters (Lontra canadensis) were introduced into the Verde River by AGFD in the 1980s and have established populations in the mainstem and in Fossil Creek. They have not been documented in the East Verde River or Tonto Creek. River otters are predators on fish and invertebrates, particularly crayfish. They have not been documented preying on headwater or roundtail chub in Fossil Creek; however, they did prey on naïve (recently stocked) razorback suckers in Fossil Creek (Avery et al. 2009, p. 1). The crayfish population in Fossil Creek survived the renovation that removed nonnative fish, and varies in distribution and abundance in the reach occupied by headwater chub (Marks et al. 2009, p. 1).

Of further concern for all four headwater chub populations in New Mexico (the three Forks populations and Turkey Creek) was the proposal to introduce river otters to the upper Gila River (NMDGF 2006). Otters prey on crayfish and fish, and may have significant effects to fish populations. Crayfish are rare in the Upper Gila River (NMDGF 2006, pp. 48-49, NMDGF et al. 2009, p. 3). In February 2012, the New Mexico Game and Fish Commission (NMGFC) voted to delay the release of river otters into the upper Gila River pending the completion of additional assessments (NMGFC 2012 p.1-2) and the proposal may be revived in the future.

Diseases, especially ones caused by parasites, are a threat. Asian tapeworm (Bothriocephalus acheilognathi) was introduced into the United States via imported grass carp in the early 1970s. It has since become well-established in the southeast and mid-south and has been recently found in the southwest. The definitive host in the life cycle of B. Asian tapeworm is cyprinid fishes, and, therefore, it is a potential threat to the headwater chub as well as to the other native fishes in Arizona. The Asian tapeworm affects fish health in several ways. Two direct impacts are by impeding the digestion of food as it passes through the intestinal track, and when large numbers of worms feed off of the fish they can cause emaciation and starvation. The Asian tapeworm is present in the Colorado River basin in the Virgin River (Heckmann et al. 1986, p. 665) and the Little Colorado River (Clarkson et al. 1997, p. 66), and has recently invaded the Gila River basin (Service 2008, p. 73).

Anchor worm (Lernaea cyprinacea) (Copepoda), an external parasite, is unusual in that it has little host specificity, infecting a wide range of fishes and amphibians. Severe Lernaea sp. infections have been noted in a number of chub populations. Hendrickson (1993, pp. 45-46) noted very high infections of Lernaea sp. during warm periods in the Verde River, and Voeltz (2002, p. 69) reported that headwater chubs found in Gun Creek in 2000, when surface flow was almost totally lacking, showed signs of stress, and many had Lernaea, black grub, lesions and an unidentified fungus. Increases in infection negatively affect headwater chub populations with Girmendonk and Young (1997, p. 19) concluding that parasitic infestations may greatly affect the health and thus population size of native fishes.

D. The inadequacy of existing regulatory mechanisms:

There are currently no specific Federal protections for headwater chub, and generalized Federal protections found in U.S. Forest Service plans, Clean Water Act dredge and fill regulations for streams, and other statutory, regulatory, or policy provisions have not been shown to be effective in preventing the decline and alleviating threats to this species. Presently, Federal, State, and Tribal statutes, regulations, and planning have not achieved significant conservation of headwater chub and its habitat.

As described above, introductions of nonnative fish are likely a significant threat to headwater chub. Fish introductions are illegal unless approved by the respective States. However, enforcement is difficult. Many nonnative fish populations are established through illegal introductions. Nine species of fish, crayfish, and waterdogs (tiger salamanders (Ambystoma pigrimum)) may be legally used as bait in Arizona, all of which are nonnative to the State of Arizona and several of which are known to have serious adverse effects on native species. The portion of the State of Arizona in which use of live bait is permitted is limited, and use of live bait is restricted in much of the Gila River system in Arizona (AGFD 2004, p. 26). The NMDGF allows use of only fathead minnows in the Gila River Basin for live bait (NMDGF 2011, p. 7). Goldfish (Carassius auratus), a nonnative formerly allowed for live bait use, is no longer allowed. Arizona and New Mexico also continue to stock nonnative fishes within areas that are connected to habitat of headwater chub.

Increasing restrictions of live bait use will reduce the input of nonnative species into headwater chub habitat. However, it will do little to reduce unauthorized bait use or other forms of bait-bucket transfer (e.g., dumping of unwanted aquarium fish, which may be invasive nonnative species) not directly related to bait use. In fact, those other bait-bucket transfers are expected to increase as the human population of Arizona increases and as nonnative species remain available to the public through aquaculture and the aquarium trade. The general public has been known to dump unwanted pet fish and other aquatic species into irrigation ditches such as the Central Arizona Project (CAP) aqueduct in the Phoenix metropolitan area (Service 2008, p. 57, 66).

The AGFD also regulates species of nonnatives that can legally be brought into the State. Prohibited nonnative species are put onto the Restricted Live Wildlife List (Commission Order 12-4-406). However, species are allowed unless they are prohibited by placement on the list, rather than the more conservative approach of prohibited unless specifically allowed, and this leaves a serious regulatory inadequacy that allows the opportunity for many noxious nonnatives to be legally imported and introduced into Arizona. New Mexico has adopted a more stringent approach; no live animal (except domesticated animals or domesticated fowl or fish from government hatcheries) is allowed to be imported without a permit (NMS 17-3-32). However, the majority of the headwater chub range occurs within Arizona.

In the 2007 to 2008 Commission Order 40, the AGFD recently added headwater chub to its list of protected native fish in the 2007-2008 commission order 40 fishing regulations. Any headwater chub caught must be immediately released unharmed. In New Mexico, headwater chub are listed as an endangered species under the New Mexico Wildlife Conservation Act, which protects the species from any direct take, including angling. While the New Mexico Wildlife Conservation Act prohibits take of listed species and directs NMDGF to recovery imperiled species, no habitat protection authority is provided.

The Federal Land Policy Management Act of 1976 (43 U.S.C. 1701 et seq.) and the National Forest

Management Act (NMFA) of 1976 (16 U.S.C. 1600 et seq.) direct Federal agencies to prepare programmatic-level management plans to guide long-term resource management decisions. The 1982 NFMA implementing regulation for land and resource management planning, under which all existing forest plans were prepared, requires the U.S. Forest Service to manage habitat to maintain viable populations of existing native vertebrate species on National Forest System lands (1982 rule, 36 CFR 219.19). A newer land and resource management planning regulation under NFMA (2008 rule, 36 CRF 219) was adopted on April 21, 2008 (73 FR 21467); the newer regulation does not include the requirement for managing habitat to maintain viable populations. Instead, it has provisions for social, economic, and ecological sustainability. The provision for ecological sustainability states an overall goal of providing a framework to contribute to sustaining native ecological systems by providing appropriate ecological conditions to support diversity of native plant and animal species in the plan area. The regulation also specifies: If the responsible official determines that provisions in plan components [in addition to that for ecosystem diversity] are needed to provide appropriate ecological conditions for specific threatened and endangered species, species-of-concern, and species-of-interest, then the plan must include additional provisions for these species, consistent with the limits of Agency authorities, the capability of the plan area, and overall multiple use objectives. (2008 rule, 36 CFR 219. 10(b)(2)). All of the existing Land and Resource Management Plans involving headwater chub habitat will eventually be revised using the new planning rule.

The U.S. Forest Service is the largest landowner and manager of headwater chub habitat, and lists the headwater chub as a sensitive species in the lower Colorado River basin in the southwestern region (Arizona and New Mexico). However, a sensitive species designation provides little protection to the headwater chub because it only requires the U.S. Forest Service to analyze the effects of their actions on sensitive species, but does not require that they choose environmentally benign actions. Voeltz (2002, p. 15-88) found that livestock grazing occurred in every drainage in which headwater chub occur and he considered this land use an ongoing threat. Improper livestock grazing continues to be a threat (see discussion under Factor A, above), because although in general most grazed areas in the range of the headwater chub are have not been addressed (with the exception of allotments in the Fossil Creek drainage) , livestock water use can eliminate headwater chub habitat in times of drought. Most of these areas where the majority of extant populations of headwater chub occur are managed by the U.S. Forest Service.

Wetland values and water quality of aquatic sites inhabited by the headwater chub are afforded varying protection under the Federal Water Pollution Control Act of 1948 (33 U.S.C. 1251-1376), as amended; Federal Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands); and section 404 of the Clean Water Act, which regulates dredging and filling activities in waterways.

The NMDGF has adopted a wetland protection policy so that it does not endorse any project that would result in a net decrease in either wetland acreage or wetland habitat values. This policy may afford some protection to headwater chub habitat; although, it is advisory only and destruction or alteration of wetlands is not regulated by State law.

The State of Arizona Executive Order Number 89-16 (Streams and Riparian Resources), signed on June 10, 1989, directs State agencies to evaluate their actions and implement changes, as appropriate, to allow for restoration of riparian resources. At this time, we have no monitoring information on the effects of this Executive Order, nor do we have information indicating that actions taken under it have been effective in reducing adverse effects to the headwater chub.

The National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 4347) requires Federal agencies to consider the environmental impacts of their actions. Most actions taken by the U.S. Forest Service and other Federal agencies that affect the headwater chub are subject to NEPA. NEPA requires Federal agencies to describe the proposed action, consider alternatives, identify and disclose potential environmental impacts of each alternative, and involve the public in the decision-making process. However, Federal agencies are not

required to select the alternative having the least significant environmental impacts. A Federal action agency may select an action that will adversely affect sensitive species provided that these effects were known and identified in a NEPA document.

Status of headwater chub on tribal lands is not well known. Any regulatory or other protective measures for the species on tribal lands would be at the discretion of the individual Tribe and non-Tribal entities would not likely be privy to information on the adequacy of such measures. The San Carlos Apache Tribe has developed a fisheries management plan that provides protection to headwater chub; however, there are only two populations of the species that occur on San Carlos Apache lands and there are no surveys to document the status of those populations.

A recovery plan for headwater chub in New Mexico was completed in 2006 (Carman 2006). The AGFD has created a conservation agreement and strategy for several native Arizona fishes including headwater chub (AGFD 1006). The conservation strategy and agreement was finalized and signed by the AGFD in 2007; AGFD has added several signatories to the agreement and is in the process of adding additional signatories. AGFD has also implemented conservation actions that have benefited the species, including assisting with restoration of headwater chub habitat in Fossil Creek. We are working with both Arizona and New Mexico to ensure that these efforts will be as effective as possible. However, at this time, no funding has been committed to ensure complete execution of these efforts, and their future effectiveness is uncertain. Under our Policy for Evaluation of Conservation Efforts When Making Listing Decisions (PECE) (68 FR 15100; March 28, 2003), conservations efforts for which there is not sufficient certainty of effectiveness cannot contribute to a decision that listing a species is unnecessary.

E. Other natural or manmade factors affecting its continued existence:

The rarity of headwater chub increases its extinction risk associated when partnered with stochastic events such as drought, flood, and wildfire. Headwater chub populations have been fragmented and isolated to smaller stream segments and are thus vulnerable to natural or manmade factors (drought, groundwater pumping, wildfire) that might further reduce their population sizes. In general, Arizona is an arid State; about one-half of Arizona receives less than 10 inches of rain a year. As described above in factor A, dewatering and other forms of habitat loss have resulted in fragmentation of headwater chub populations, and water demands from a rapidly increasing human population could further reduce habitat available to these species, and further fragment populations. In examining the relationship between species distribution and extinction risk in southwestern fishes, Fagan et al. (2002) found that the number of occurrences or populations of a species is less significant a factor in determining extinction risk than is habitat fragmentation. Fragmentation of habitat makes the headwater chub vulnerable to extinction from threats of further habitat loss and competition from nonnative fish and other threats because immigration and re-colonization from adjacent populations is not likely. Thus, the risk of extinction of this species, based on their degree of fragmentation alone, is high and is predicted to increase with increasing fragmentation and rarity (Fagan et al. 2002, p. 3250).

The probability of catastrophic stochastic events that could eliminate isolated populations of this species is exacerbated by a century of livestock grazing and fire suppression that has led to unnaturally high fuel loadings (Cooper 1960, pp. 129-162; Covington and Moore 1994, pp. 39-46; Swetnam and Baison 1994, p. 11; Touchan et al. 1995, pp. 269-272). We have information indicating that the intensity of forest fires has increased in recent times (Covington and Moore 1994, pp. 39-46; National Interagency Fire Center 2005). Fires in the Southwest frequently occur during the summer monsoon season. As a result, fires are often followed by rain that washes toxic, ash-laden debris into streams and adversely affects the fish populations (Rinne 2004, p. 151; Carter and Rinne 2005, p. 1). Extreme summer fires, such as the 1990 Dude Fire, and corresponding ash flows have decimated some fish populations including headwater chub populations in the East Verde River (Voeltz 2002, p. 77). The 2009 Water Wheel Fire on the East Verde River also resulted in fish kills within the occupied reach for headwater chub. The 2003 Picture Fire affected headwater chub populations in Spring, Rock, and Turkey Creeks in the Tonto Creek drainage. Significant declines in

headwater chub numbers were documented (Carter and Rinne 2005, p. 11) and while the Spring and Rock Creeks populations appear to have survived, the low numbers of headwater chub recorded in Turkey Creek raises concerns about that population remaining extant, and there are no post 2003-surveys. Similarly, the Deadman Creek and South Deadman Creek populations were affected by the 2004 Willow Fire (A. Robinson, AGFD, pers. comm. 2004), and there have been no surveys to assess the status of that population. Surveys of Deadman Creek were scheduled for 2012 to assess population status but were not completed and are expected to occur in the future. Information from the Tonto National Forest documents other wildfires in headwater chub drainages that may have affected populations in Tonto Creek (Dude, Promontory 2007), Haigler Creek (Haigler 2007), and East Verde River (Dude, Packrat 2002, Webber 2004, February 2006, Rim 2009, and Water Wheel 2009). There is no recent fire history for Fossil Creek. In New Mexico, fires on the Middle Fork and West Fork in 2000, 2002, 2003, 2006, and 2007 did result in some ash flows into the creeks but headwater chub are still present and recruiting (Paroz et al. 2009, p. 11). The 2011 Miller Fire also affected the Gila Forks and Turkey Creek (Gilbert 2012a, pers. comm.) and the 2012 Whitewater/Baldy fire burned in the West Fork drainage. It is also important to visualize the distribution of headwater chub populations within their range. A single population (Deadman Creek, Fossil Creek, and Wet Bottom Creek) in a drainage is rare, with populations clustered in subdrainages. For example, Gordon/Haigler/Marsh/Tonto forms one cluster that could be affected by one large fire. The Spring Creek cluster (Buzzard Roost, Dinner, Rock, Spring, and Turkey Creeks) has already experienced one fire that affected three of the five streams, and only narrowly missed the other two. The three Gila Forks populations are a third cluster and have been affected by several wildfires, most recently the Whitewater/Baldy Fire in the West Fork Gila River drainage. With the continuing drought, we believe there has not been a reduction in the magnitude of threat from wildfires and all populations are at risk where there has not been a wildfire in the last 10 to 15 years. Fossil Creek has not had a wildfire within this period, and as the only SS population and possessing a unique lineage, the results of a wildfire in the upper elevations of the drainage could be catastrophic.

Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms climate and climate change are defined by the Intergovernmental Panel on Climate Change (IPCC). Climate refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term climate change thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 814, 1819). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Several recent studies predict continued drought in the southwestern United States due to global climate change, and in particular in the lower Colorado River basin. Seagar et al. (2007, pp. 1181 1184) analyzed 19 different computer models of differing variables to estimate the future climatology of the southwestern United States and northern Mexico in response to predictions of changing climatic patterns. All but 1 of the 19 models predicted a drying trend within the Southwest (Seager et al. 2007, p. 1181). A total of 49 projections were created using the 19 models and all but three predicted a shift to increasing aridity (dryness) in the southwest as early as 2021 to 2040 (Seager, et al. 2007, p. 1181). Recently published projections of potential reductions in natural flow on the Colorado River Basin by the mid-21st century range from approximately 45 percent by Hoerling and Eischeid (2006, p. 20) to approximately 6 percent (Christensen and Lettenmaier 2006, p. 3748). The U.S. Climate Change Science Program (CCSP) recently completed a report; regarding the southwest United States, the summary and findings concluded: Climate model studies over North America and the global subtropics indicate that subtropical drying will likely intensify and persist in the future due to greenhouse warming. This drying is predicted to move northward into the southwestern United States. If the model results are correct, the southwestern United States may be beginning an abrupt period of increased drought (CCSP 2008, p. 2).

If predicted effects of climate change result in persistent drought conditions in the Colorado River basin similar to those seen in recent years, a primary water source for central Arizona, the Colorado River water delivered by the Central Arizona Project canal system will be further taxed by the lower Colorado River basin states, placing increased demand on other surface and groundwater supplies within Arizona. Clearly, permanent water is crucial for the continued survival of native fish in the region, including headwater chub. Essentially the entire range of the headwater chub in the lower Colorado River basin is predicted to be at risk of becoming more arid (Seager et al. 2007, pp. 11831184), which has severe implications to the integrity of aquatic and riparian ecosystems and the water that supports them.

Changes to climatic patterns may warm water temperatures, alter stream flow events, and may increase demand for water storage and conveyance systems (Rahel and Olden 2008, pp. 521522). Warmer water temperatures across temperate regions are predicted to expand the distribution of existing aquatic nonnative species by providing 31 percent more suitable habitat for aquatic nonnative species, which are often tropical in origin and adaptable to warmer water temperatures. This conclusion is based upon studies that compared the thermal tolerances of 57 fish species with predictions made from climate change temperature models (Mohseni et al. 2003, p. 389). Eaton and Scheller (1996, p. 1,111) reported that while several cold-water fish species in North America are expected to have reductions in their distribution from effects of climate change, several warm-water fish species are expected to increase their distribution. In the southwestern United States, this situation may occur where the quantity of water is sufficient to sustain effects of potential prolonged drought conditions but where water temperature may warm to a level found suitable to harmful nonnative species that were previously physiologically precluded from occupation of these areas. Species that are particularly harmful to headwater chub populations such as the green sunfish, channel catfish, largemouth bass, and bluegill are expected to increase their distribution by 7.4 percent, 25.2 percent, 30.4 percent, and 33.3 percent, respectively (Eaton and Scheller 1996, p. 1,111). Rahel and Olden (2008, p. 526) expect that increases in water temperatures in drier climates such as the southwestern United States will result in periods of prolonged low flows and stream drying. These effects from changing climatic conditions may have profound effects on the amount, permanency, and quality of habitat for the headwater chub. Warm-water nonnative species such as red shiner, common carp, mosquitofish, and largemouth bass are expected to benefit from prolonged periods of low flow (Rahel and Olden 2008, p. 527).

Climate change could also provide conditions that benefit nonnative species, increasing their proliferation, and increase the threat from nonnative fish predation and competition to headwater chub. Rahel and Olden (2008, p. 551) examined climate change models, nonnative species biology, and ecological observations, and concluded that climate change could foster the expansion of nonnative aquatic species into new areas, magnify the effects of existing aquatic nonnative species where they currently occur, increase nonnative predation rates, and heighten the virulence of disease outbreaks in North America. Many of the nonnative species have similar, basic ecological requirements as our native species, such as the need of permanent water. Rahel and Olden (2008, pp. 554-555, and from Carveth et al. 2006) found that climate change will likely favor nonnative fish species such as largemouth bass, yellow bullhead, and green sunfish, over headwater chub, in part because they have higher temperature tolerances. Drying of stream channels will intuitively create less habitat and greater competition for limited space and habitat.

Rahel and Olden (2008, p. 555) also noted that climate change could facilitate expansion of nonnative parasites. This could be an important threat to headwater chub. Optimal Asian tapeworm development occurs at 25 to 30 °C (77 to 86 °F) (Granath and Esch 1983, p. 1116), and optimal anchorworm temperatures are 23 to 30 °C (73 to 86 °F) (Bulow et al. 1979, p. 102). Cold water temperatures in parts of the range of the headwater chub may have prevented these parasites from completing their life cycles and limited their distribution. Warmer climate trends could result in warmer overall water temperatures, increasing the prevalence of these parasites.

The effects of the water withdrawals discussed above may be exacerbated by the current, long-term drought facing the arid southwestern United States. Philips and Thomas (2005, pp. 14) provided stream flow records that indicate that the drought Arizona experienced between 1999 and 2004 was the worst drought since the

early 1940s and possibly earlier. The Arizona Drought Preparedness Plan Monitoring Technical Committee (ADPPMTC) (2008) assessed Arizonas drought status through June 2008 in watersheds where the headwater chub occurs or historically occurred. They found that the Verde and San Pedro watersheds continued to experience moderate drought (ADPPMTC 2008), and the Salt, Upper Gila, Lower Gila, and Lower Colorado watersheds were abnormally dry (ADPPMTC 2008). Ongoing drought conditions depleted recharge of aquifers and decreased base flows in the region. While drought periods have been relatively numerous in the arid Southwest from the mid-1800s to the present, the effects of human-caused impacts on riparian and aquatic communities may compromise the ability of these communities to function under the additional stress of prolonged drought conditions.

Conservation Measures Planned or Implemented :

The AGFD has finalized a conservation agreement and strategy for the headwater chub. The plan includes a comprehensive list of conservation measures, including: 1) establishing a statewide team to implement the plan; 2) compiling existing information on existing status, management, threats, and research; 3) securing, enhancing and creating habitat (includes addressing threats of habitat loss and predation and competition from nonnative species); 4) establishing and enhancing populations (includes addressing threats of habitat loss and predation and competition from nonnative species); 5) monitoring extant populations; 6) developing research on knowledge gaps in species biology and threats; and 7) incorporating adaptive management in plan implementation. The conservation strategy and agreement was finalized and signed by the AGFD in 2007, and a number of signatories, including most of the land management agencies with authority on lands occupied by the species, have now signed the agreement. The Service signed the conservation agreement in August 2007.

The Bureau of Reclamation (USBR) has begun planning a project, in coordination with the U.S. Forest Service (Tonto National Forest) and AGFD to erect barriers to prevent the introduction of nonnative fish and renovate nonnative fishes from headwater chub habitat, which would enhance and protect the four headwater chub populations (Buzzard Roost, Rock, Spring and Turkey Creeks). The project is only in the initial stages, and has not received the support of all existing stakeholders.

The NMDGF has completed a recovery plan for headwater chub that includes a list of management issues, strategies, and implementation tasks (Carman 2006, entire). The implementation tasks provide a comprehensive list of conservation measures, including: compiling information on status and potential habitat; improving knowledge of historical and current populations dynamics; creating refuge populations of chub lineages; restoring and securing habitats; if necessary, augmenting populations; if possible, establishing additional populations; restricting angling take of headwater chub; controlling nonnative species; identifying and reducing information gaps; establishing agreements and partnerships to implement the recovery plan.

The Arizona Ecological Services Office (AESO) completed section 7 consultation with the Wildlife and Sport Fish Restoration Program (WSFR) on the effects to listed, proposed, and candidate species from Federal funding of the sportfish stocking grant to AGFD beginning in 2011 and continuing through 2021, to the next 10-year period. Headwater chub populations in the East Verde River, Webber Creek, Tonto Creek, Haigler Creek, and Marsh Creek are potentially affected by the stocking of rainbow trout under the grant. As part of the proposed action, AGFD and WSFR will implement a Conservation and Mitigation Program (CAMP) to address adverse effects to federally-listed species from the sportfish stocking program. The headwater chub is a priority species in the CAMP, and has specific conservation measures associated with it, as well as benefits from the more generic measures. The particular measures for headwater chub are:

- The AGFD commits to provide for three populations of headwater chub either through securing existing but threatened populations or establishment of new conservation populations.
- Headwater chub habitats in the East Verde River and Tonto Creek are priority areas for use of triploid rainbow trout to avoid augmentations to existing wild populations.
- The AGFD will implement actions to increase angler awareness that headwater chub is not a legal

sportfish at the East Verde River and Haigler Creek stocking sites.

- In order to obtain information needed to implement conservation actions, AGFD will undertake an assessment of headwater chub populations in the Verde River, East Verde River, Tonto Creek, and the Haigler Creek drainages to determine population structure and extent, nonnative species present as stressors, sites for potential reestablishment, and identification of specific research needs. This assessment should tier off the Arizona Statewide Conservation Agreement and Strategy (AGFD 2006) for headwater chub and five other native fish species, as that document contains considerable information on the conservation needs and a strategy to address those needs. The assessment will serve as a guidance document for implementing conservation actions for the headwater chub.
- The AGFD will review and update existing outreach programs on the risks to native aquatic species from the transport of nonnative aquatic species (sportfish, baitfish, other fish species, amphibians, invertebrates, and plants) to ensure they are adequately informing the public of the harmful nature of such actions, and means they can take to reduce or prevent inadvertent transport of such nonnative species.

Because the CAMP must be implemented in order for AGFD to continue to use Federal funds to stock sportfish, we are sufficiently certain that the conservation measures for headwater chub will be implemented during the 10-year period covered by the consultation. Implementation of the CAMP began in 2011 and the new surveys reported for 2011 and 2012 were the result of gathering information to define conservation needs. In addition, in 2012, four streams in the East Verde River drainage were surveyed for their potential value to establish headwater chub populations. Chase Creek (Jaeger 2012a, p. 2) and Deer Creek/South Deer Creek (Jaeger 2012b, p. 2) were found to have some potential as reintroduction sites while Dude Creek did not (Jaeger 2012c, p. 2). Thre re-treatment of Fossil Creek to remove smallmouth bass may be considered as a threat reduction to headwater chub resulting from the CAMP. A report describing hatchery culture procedures for roundtail chub, headwater chub, and Gila chub was completed in 2011 (Bonar et al. 2011, entire). This report will guide hatchery operations to produce these chub for repatriation purposes.

Summary of Threats :

Headwater chub currently occupy only 40 percent of their estimated historical range in the Gila River Basin in Arizona and New Mexico, and the remaining populations are fragmented and isolated, and threatened by a combination of factors. Headwater chub are threatened by introductions of nonnative fish that are predators on them and/or compete with them for food, and these nonnative fish are difficult to eliminate and thus pose an on-going threat. Habitat destruction and modification has occurred, and continues to occur, as a result of dewatering, impoundment, channelization, and channel changes caused by alteration of riparian vegetation and watershed degradation from mining, grazing, roads, water pollution, urban and suburban development, groundwater pumping, and other human actions. Existing regulatory mechanisms do not appear to be adequate for addressing the impacts from nonnative fish and also have not removed or eliminated the threats that continue to be posed in relation to habitat destruction or modification, or predation by nonnative fish. The fragmented nature and rarity of existing populations makes them vulnerable to other natural or manmade factors, such as drought and wildfire. Thus, we find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

We find that the headwater chub is warranted for listing throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

For species that are being removed from candidate status:

_____ Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions(PECE)?

Recommended Conservation Measures :

The AGFD (2006) and Carman (2006) documents described above provide comprehensive lists of conservation measures for headwater chub. Briefly, the key conservation measures include:

- Establish agreements and partnerships to achieve headwater chub conservation;
- Improve survey information to better establish population trends;
- Create and maintain refugia for management units;
- Protect and improve habitat (instream flow, physical properties, chemical properties);
- Implement control of nonnative species;
- Reestablish headwater chub into formerly occupied habitats;
- Improve knowledge of the species and its needs through research;
- Improve public knowledge of the species and the need for its conservation.

Priority Table

Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/Population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/Population	6
Moderate to Low	**Imminent**	Monotypic genus	7
		Species	**8**
		Subspecies/Population	9
	Non-Imminent	Monotype genus	10
		Species	11
		Subspecies/Population	12

Rationale for Change in Listing Priority Number:

Magnitude:

In this 2013 assessment, we have incorporated new information on headwater chub populations, and have not detected any significant declines in overall population status; in fact, new survey information has enabled us to increase our knowledge on several populations as described above and revise their status accordingly. Further, the implementation of the Multi-District Litigation (MDL) Settlement Agreement provides that all species that were candidates as of 2010 will be evaluated for listing within six years and either a withdrawal of candidate status due to not-warranted or a proposed rule would be developed. The headwater chub and roundtail chub are scheduled for consideration in FY2015.

Imminence :

Habitat destruction and modification has occurred, and continues to occur, as a result of dewatering, impoundment, channelization, and channel changes caused by alteration of riparian vegetation and watershed

degradation from mining, grazing, roads, water pollution, urban and suburban development, groundwater pumping, and other human actions. Catastrophic wildfire remains a significant concern for all populations. Pressures to withdraw water in the Verde River basin for human use are on-going and increasing. The threat of wildfire to the species continues to be imminent. The Gila River drainage is in the midst of a long-term, on-going drought, causing stream flows to be at record lows which further reduces available habitat for the headwater chub. In addition, water development pressures in the upper Gila River in New Mexico may have effects to flows that support the current population, and diversions from East Clear Creek that will adversely affect headwater chub habitat in the East Verde River will begin within 2 to 3 years. Current land management practices continue to degrade the habitat of headwater chub by contributing sediment to the streams. Thus, these threats are on-going and therefore, imminent. The presence of nonnative fish species in all but one headwater chub population is a significant and imminent threat to this species due to predation and competition. While the magnitude (in terms of degree of effect) of this threat is subject to scrutiny, there is no question that it is happening and continues to happen.
__Yes__ Have you promptly reviewed all of the information received regarding the species for the purpose of determination whether emergency listing is needed?

Emergency Listing Review

__No__ Is Emergency Listing Warranted?

Given the information we currently have on the status of the species, including a thorough review of the information we received in a petition to emergency list the species (Stefferud et al. 2009, entire) and other information cited in this assessment, we do not believe emergency listing is warranted. While the situation is serious, we do not believe that it rises to the level of requiring emergency listing. The long-term effect of the on-going drought on the headwater chub is unknown, and the continuing risk from wildfire and nonnative species is of concern. We have not documented significant declines in most populations, and no new threats have been identified that affect a majority of the populations. We are working with AGFD, NMDGF, and various landowners on implementation of the conservation actions for the headwater chub. Our knowledge of population status of headwater chub in Arizona will be improving due to implementation of the CAMP program that began in 2011. Information gained through new surveys will assist in identifying needed conservation measures for future implementation, or identify a need to take immediate proactive measures.

Description of Monitoring:

Monitoring is on-going by the AGFD, NMDGF, and U.S. Forest Service. We coordinate with the U.S. Forest Service and the States to track the status of headwater chub on an annual basis. Completion of the status review in 2002 (71 FR 26007, May 3, 2006) resulted in new surveys and the identification of gaps in existing survey information. Implementation of the AGFD conservation strategy is improving monitoring for the species, and the implementation of the CAMP will expand upon that baseline. Likewise, the NMDGFs implementation of their recovery plan continues to improve monitoring.

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:

Arizona,New Mexico

Indicate which State(s) did not provide any information or comment:

none

State Coordination:

The AGFD and NMDGF have both provided information used in this assessment. Both Arizona and New

Mexico have identified the headwater chub as a Species of Greatest Conservation Need in their Comprehensive Wildlife Conservation Strategy. We also met with AGFD on May 4, 2011, to begin the initiation of the CAMP that resulted in survey commitments for 2012. Both AGFD and NMDGF provided information through personal contacts or published reports.

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Approval/Concurrence:

Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: Jay E. Nicholopoulos 06/19/2013
Date

Concur: 10/28/2013
Date

Did not concur: _____
Date

Director's Remarks: