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

SCIENTIFIC NAME: *Gila nigra*

COMMON NAME: Headwater chub

LEAD REGION: 2

INFORMATION CURRENT AS OF: April 2010

STATUS/ACTION

___ Species assessment - determined we do not have sufficient information on file to support a proposal to list the species and, therefore, it was not elevated to Candidate status
___ New candidate
_X_ Continuing candidate
    ___ Non-petitioned
    _X_ Petitioned - Date petition received: April 14, 2003, November 9, 2009
        X 90-day positive - FR date: July 12, 2005
        X 12-month warranted but precluded - FR date: May 3, 2006
        _ Did the petition request a reclassification of a listed species?

        FOR PETITIONED CANDIDATE SPECIES:
        a. Is listing warranted (if yes, see summary of threats below)? yes
        b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? yes
        c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.
        Higher priority listing actions, including court-approved settlements, court-ordered 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 the 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.

___ Listing priority change
    Former LP: ___
    New LP: ___

Date when the species first became a Candidate (as currently defined): May 3, 2006

___ Candidate removal: Former LPN: ___
    ___ A – 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.

____U – 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.

___ F – Range is no longer a U.S. territory.

___ I – Insufficient information exists on biological vulnerability and threats to support listing.

___ M – Taxon mistakenly included in past notice of review.

___ N – Taxon does not meet the Act's definition of "species."

___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Fishes - Cyprinidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: AZ, NM

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: AZ, NM

LAND OWNERSHIP: 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% Federal, all Forest Service (160 river kilometers (km), 99 river miles (mi), 588 hectares (ha) 1,452 acres (ac)); estimated 5% State - Arizona State Lands Department, Arizona Game and Fish Department, New Mexico Department of Game and Fish (12.5 river km, 7.7 river mi, 46 ha, 113 ac); 10% Tribal - San Carlos Apache Tribe (50 river km, 31 river mi, 184.4 ha, 455.7 ac); estimated 5% 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, p. 100-102; Sublette *et al.* 1990, p. 126-129; Propst 1999, p. 23-25; Minckley and Demaris 2000, p. 254-255; Voeltz 2002, p. 8-11). Minckley and Demaris (2000, p. 5-6) provided a key to the identification of Gila, headwater, and roundtail chub, and Dowling *et al*. (2008, p. 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 the 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, p. 37-38; Rinne 1969, p. 1-69; Holden and Stalnaker 1970, p. 409; Rinne 1976, p. 65-99; Smith et al. 1977, p. 613; DeMarais 1986, p. 111; Rosenfeld and Wilkinson 1989, p. 232; Dowling and DeMarais 1993, p. 444-446; Douglas et al. 1998, p. 163-165; Minckley and DeMarais 2000, p. 251-256; Gerber et al. 2001, p. 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 Society's 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 Demaris 2000, p. 255). Bestgen and Propst (1989, p. 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, p. 402-410; Barrett and Maughan 1995, p. 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, p. 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, p. 13-14). Neve (1976, p. 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, p. 100-104; Bestgen and Propst 1989, 405-406); Propst 1990, p. 23. Voeltz (2002, p. 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 and New Mexico.

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, p. 8-9), and may occupy lower Turkey Creek below a barrier and the Gila River below the forks area in New Mexico, although these fish have not been definitively identified (Stefferud *et al.* 2009, 10-11). In Arizona, headwater chub 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, Gun, Haigler, Horton, Marsh, Rock, Spring, Turkey creeks) (Voeltz 2002, p. 81-87; Stefferud *et al*. 2009, p. 11-23). Headwater chub may still occur in parts of the San Carlos River basin, although recent survey information for these streams is unavailable because San Carlos Tribal survey information is proprietary and confidential (Voeltz 2002, p. 81-87; Stefferud *et al.* 2009, p. 11). The taxonomic status of chub in West Clear Creek has still not been resolved, and either or both roundtail chub and headwater chub may occupy that stream (Stefferud *et al.* 2009; p. 14-15). 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, p. 41-43).

Population Estimates/Status

The decline of the headwater chub has been noted in both the scientific literature (Bestgen and Propst 1989, p. 404-407) and in State agency reports (Girmendonk and Young 1997, p. 49; Bezzerides and Bestgen 2002, p. 30-33; Voeltz 2002, p. 81-84), Paroz and Propst 2007, p. 20). The Arizona Game and Fish Department (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.

We received a petition to emergency list headwater chub and to change the listing priority number from an 8 to a 2 on November 9, 2009 (Stefferud *et al.* 2009). Because we had already made a determination that listing the headwater chub was warranted but precluded and added the species to our list of candidates, and we annually determine whether listing remains warranted and whether we need to use the emergency listing provisions of the Act (included in this candidate form), we informed the petitioners that we would take no further action on their request letter on December 28, 2010. The petitioners included extensive status information for all extant headwater chub populations, which we have utilized here. The petitioners also used a modified classification system from Voletz (2002, p. 5) that included an additional category, "imperiled threatened" to identify "populations of headwater chub where the trend is unremittingly downward with little fluctuation" and to "allow recognition of downward change from the 2002 status quo" (Stefferud *et al.* 2009, p. 7). Our review of the petitioners rationale for including this new category found no difference between it and the "unstable threatened" category of Voeltz (2002, p. 5), and we continue to use the categories described in Voeltz (2002, p. 5) to evaluate the species.

The petitioners provide a new assessment of the number of populations that are currently extant (Stefferud *et al.* 2009, p. 5-6). Their rationale is that some streams are connected, and genetic analysis indicates that these connected reaches, or in some cases reaches that are not necessarily connected but are close together geographically, should be considered a single population. Although this approach is logical in terms of management units, we do not have definitive information to indicate that these stream complexes are in fact currently functioning as separate populations from a population-genetics standpoint. For this reason, and to maintain consistency with past assessments of Gila River chub status (Weedman *et al.* 1996, Voeltz 2002, U.S. Fish and Wildlife Service 2005, 2006, 2009) we continue to assess status here by individual stream occupancy. We provide our 2010 assessment of headwater chub-occupied streams in Table 2.

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

Status	***Definition***
Stable-Secure	Chubs are abundant or common, data over the past 5-10 years shows a stable, reproducing population with successful recruitment; no impacts from nonnative aquatic species exist; and no current or future habitat altering land or water uses were identified.
Stable-Threatened	Chubs are abundant or common, data over the past 5-10 years shows a reproducing population, although recruitment may be limited; predatory or competitive threats from nonnative aquatic species exist; and/or some current or future habitat altering land or water uses were identified.
Unstable-Threatened	Chubs are uncommon or rare with a limited distribution; data over the past 5-10 years shows a declining population with limited recruitment; predatory or competitive threats from nonnative aquatic species exist; and/or serious current or future habitat altering land or water uses were identified.
Extirpated	Chubs are no longer believed to occur in the system.
Unknown	Lack of data precludes determination of status.

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 2010 assessment utilizes information from Voeltz (2002) and from Stefferud *et al.* (2009). We conclude that the headwater chub now occurs in 17 of 27 streams formerly known to be occupied. Of the 17 extant streams, one is stable-secure, nine are stable-threatened, and seven are unstable-threatened. Headwater chub have been extirpated from four streams, and the species status is unknown in an additional six streams. All of the 17 currently extant streams are fragmented, and many are small isolated stream segments. 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.

In general, we agree with much of the status assessment conducted in association with the petition discussed earlier, with some exceptions. We have retained the status assessment categories as described in Voeltz (2002, p. 5) for reasons described above, and thus we have not adopted the "imperiled threatened" category used in the petition (Stefferud *et al.* 2009, p. 7). We determined that the Spring Creek basin streams (Spring, Rock, Buzzard Roost, Turkey, and Dinner creeks) are "stable-threatened" because numerous threats occur to chubs in these streams, and repeated monitoring has indicated good recruitment and common to abundant numbers in these streams, thus meeting the standard of the "stable-threatened" category (survey data summarized in Stefferud *et al.* 2009, p. 13). Information from Paroz and Propst (2007, p. 20) summarizes the status of headwater chub in the Gila Forks area and documents declining populations, particularly in the East and Middle Forks. Paroz *et al.* (2009, p. 15) noted that the number of headwater chub in the East Fork was low with only one juvenile collected. They noted that the West Fork and Middle Fork had more robust populations and the lower West Fork was an important nursery area for headwater chub. Paroz *et al.* (2009, p. 27) recognized that the Forks area was the stronghold for headwater chub in New Mexico.

We also determined that Fossil Creek is now "stable-secure" because nonnative fishes have been eliminated from that system and the native fishes including headwater chub are thriving (Marks *et al.* 2009, p. 7-8). Although nonnative crayfish are still present and abundant in Fossil Creek, this does not appear to affect native fish in that system (Marks *et al.* 2009, p. 9). Although water in Fossil Creek must still be very attractive to nearby communities such as Strawberry and Pine, we are not aware of immediate plans to divert water from Fossil Creek or to add new wells to pump groundwater in the system. Intensive recreational use is present seasonally in Fossil Creek, however the effects of this use on headwater chub in the system is unknown, and do not appear adverse considering the abundance of the species in this system.

Table 2. Summary of headwater chub status and threats by stream reach (Voeltz 2002, Schwemm 2006, AGFD 2008).

Stream Reach	Status	Primary Threats
East Fork Gila River	UT	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest, wildfire. Factor C: Nonnative species. Factor E: Climate change.
Middle Fork Gila River	UT	Factor A: Improper livestock grazing, limited fuelwood harvest, wildfire. Factor C: Nonnative species. Factor E: Climate change.
West Fork Gila River	UT	Factor A: Improper livestock grazing, limited fuelwood harvest, wildfire. Factor C: Nonnative species. Factor E: Climate change.
Turkey Creek (NM) And Gila River below forks	U	Factor A: Improper livestock grazing, limited fuelwood harvest, wildfire. Factor C: Nonnative species. Factor E: Climate change.
San Carlos River	U	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest, limited agriculture, fisheries and wildlife management, and localized municipal, urban and rural development and associated water use. Factor C: Nonnative species. Factor E: Climate change.
Ash Creek	U	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest, limited agriculture, fisheries and wildlife management, and localized municipal, urban and rural development and associated water use. Factor C: Nonnative species. Factor E: Climate change.
Tonto Creek	UT	Factor A: Water diversions, groundwater pumping, dewatering, mining, contaminants, urban and agricultural development, improper livestock grazing, roads. Factor C: Nonnative species. Factor E: Climate change.
Christopher Creek	E	Factor A: Water diversions, groundwater pumping, dewatering, urban and agricultural development, improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Gun Creek	UT	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Horton Creek	E	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Rye Creek	E	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Sharp Creek	E	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Haigler Creek	ST	Factor A: Improper livestock grazing, recreation, limited

		fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Gordon Creek	ST	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Marsh Creek	ST	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Spring Creek	ST	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Buzzard Creek	ST	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Rock Creek	ST	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Dinner Creek	ST	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Turkey Creek (AZ)	ST	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
West Clear Creek	U	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Fossil Creek	SS	Factor A: Recreation.
East Verde River	UT	Factor A: Water diversions, groundwater pumping, dewatering, mining, contaminants, urban and agricultural development, improper livestock grazing. Factor C: Nonnative species. Factor E: Climate change.
The Gorge	U	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Pine Creek	U	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Deadman Creek	ST	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.
Wet Bottom Creek	UT	Factor A: Improper livestock grazing, recreation, limited fuelwood harvest. Factor C: Nonnative species. Factor E: Climate change.

E=extirpated; SS=stable-secure; ST=stable-threatened; U=unknown; UT=unstable-threatened

THREATS

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>. 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, p. 159-170; Propst 1999, p. 25; Voeltz 2002, p. 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, p. 159-170; Propst 1999, p. 25; Voeltz 2002, p. 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, p. 25, 28; Voeltz 2002, p. 76; Carman 2006, p. 30). Water withdrawal is a threat in at least 8 of the 17 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, p. 63, 76).

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, p. 77-78).

Livestock grazing. Improperlivestock grazing has been documented to negatively impact headwater chub habitat and is considered a threat to the species in many of the extant populations (Table 2). 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, p. 1-11), which contains 70 percent of all extant headwater chub populations (Voeltz 2002, p. 82-83); and these effects are still evident and compounded by ongoing grazing (Ganda 1997, p. 5-3). Improper livestock grazing destabilizes stream channels and disturbs riparian ecosystem functions (Hereford 1992, p. 17; Tellman *et al.* 1997, p. 88-89). It negatively affects headwater chub habitat through removal of riparian vegetation (Clary and Webster 1989, p. 6-7; Clary and Medin 1990, p. 2-3; Schulz and Leininger 1990, p. 296; Armour *et al.* 1991, p. 7; Fleishner 1994, p. 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, p. 430-433; Swanson *et al.* 1982, p. 288-289; Minckley and Rinne 1985, p. 151-152; Fleishner 1994, p. 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, p. 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 species by nonnatives (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. 1–5; Service 2008, pp. 46–51).).

Stream channelization and irrigation. Sections of many Gila Basin 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 streamflow 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, p. 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, p. 122-125; Schmetterling *et al.* 2001, p. 6). Channelization occurs within at least 50 percent of extant populations (Voeltz 2002).

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, p. 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, p. 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 (Voeltz 2002).

Roads and Logging. Roads are considered a threat to 15 of the 17 extant populations (Table 2). 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 (Barrett *et al.* 1992; Warren and Pardew 1998). 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, 148–149). Thus roads can ultimately deteriorate habitat for the headwater chub. Roads are found within every drainage containing extant populations of headwater chub (Voeltz 2002).

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 chub's 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 (Voeltz 2002), 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 (Voeltz 2002). The impacts of recreation are highly dependent on the type of activity, with activities such as birdwatching 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, p. 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*). 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, p. 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, p. 92-93), or as mentioned above, diversion of water, both from streams and connected groundwater (Glennon 1995, p. 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, p. 41-43; Medina 1990, p. 351; Reid 1993, p. 48-50; Waters 1995, p. 52-53; Wheeler et al. 2005, p. 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, p. 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). 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, p. 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 (*G. intermedia*), 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; although 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. <u>Overutilization for commercial, recreational, scientific, or educational purposes</u>.
Angler catch is considered light in Arizona (Warnecke 2004, pers. comm.), and consequently we do not believe that overutilization is a threat to headwater chub there. However, 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). 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, 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. New Mexico has a recovery plan for headwater chub (Carman 2006, p. 1) that identifies the need to also prohibit capture and possession in the New Mexico state fishing regulations, and New Mexico Game and Fish Department has included language that catch/take of endangered or threatened fish and the need to release them immediately back into the water in the 2010-2011 fishing proclamation (NMGFD 2010)..

AGFD recently established a fishery for roundtail chub in this stream; one roundtail chub greater than 33 cm) (13 in. is allowed via angling per day. The AGFD has also established a catch-and-release only, artificial fly and lure only, single barbless hook, 7-month fishing season for roundtail chub in Fossil Creek. A 7.2-km (4.5-mi) middle reach segment of Fossil Creek will be open to catch-and release fishing for roundtail chub from October 3, 2009, through April 30, 2010. The area is closed to all fishing for the remainder of the year,. It is likely that at least some chub caught via hook and line in Fossil Creek for sport will actually be headwater chub since these two species are quite difficult to distinguish from each other. However, angler use of roundtail chub is light (Cantrell 2009 pers. comm.), and we do not believe that overutilization from current levels of angling is a threat to the species in Arizona.

C. <u>Disease or predation</u>.

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, p. 20-25; Mueller 2005, p. 10-11). In the American southwest, Miller *et al.* (1989, p. 22) concluded that introduced nonnatives 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), humpback chub (*G. cypha*) (32 FR 4001), Gila chub (*G. intermedia*) (67 FR 51948), Colorado pikeminnow (*Ptychocheilus lucius*) (32 FR 4001), spikedace (*Meda fulgida*) and loach minnow (*Tiaroga cobitis*),(51 FR 23769), razorback sucker (*Xyrauchen texanus*) (56 FR 54957), desert pupfish (*Cyprinodon macularius*) (61 FR 10842), and Gila topminnow (*Poecilopsis occidentalis*) (32 FR 4001)). 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, p. 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 carpo*), warmouth (*Lepomis gulosus*), bluegill (*L. macrochiris*), yellow bullhead (*Ameiurus natalis*), black bullhead (*A. melas*), and goldfish (*Carassius auratus*) (Minckley 1973, , Voeltz 2001, Service 2008).

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 (Voeltz 2002). 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, p. 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, p. 86-87). In the Verde River, Bonar *et al.* (2004, p. 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. 338–340) 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. 15–88).

Diseases, especially 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. acheilognathi* 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) and the Little Colorado River (Clarkson et al. 1997, p. 66), and has recently invaded the 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, p. 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. <u>The inadequacy of existing regulatory mechanisms</u>.
There are currently no specific Federal protections for headwater chub, and generalized Federal protections found in Forest 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 of 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 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). New Mexico Department of Game and Fish (NMDGF) allows use of only fathead minnows in the Gila River Basin for live bait (NMDGF 2010 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).

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.

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 now listed as an endangered species under the New Mexico Wildlife Conservation Act (discussed further below), which protects the species from any direct take, including angling. New Mexico has a recovery plan for headwater chub (Carman 2006, p. 56-59) that identifies the need to also prohibit capture and possession in the New Mexico state fishing regulations, and this was accomplished in the 2010-2011 fishing proclamation (NMDGF 2010).

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 new land and resource management planning regulation under NFMA (2008 rule, 36 CRF 219) was adopted on April 21, 2008 (73 FR 21467); the new 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 improving due to improvements in grazing management in recent years, 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.

NMDGF has adopted a wetland protection policy whereby the Department 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.

The State of New Mexico added headwater chub to its list of endangered species under the Wildlife Conservation Act in 2006 (New Mexico Wildlife Conservation Act 17-2-41(B)). A recovery plan for headwater chub in New Mexico was also completed in 2006 (Carman 2006). While the New Mexico Wildlife Conservation Act prohibits take of listed species and directs NMDGF to recover imperiled species, no habitat authority is provided. AGFD has created a conservation agreement and strategy for several native Arizona fishes including headwater chub. 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 (referred to as 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. <u>Other natural or manmade factors affecting its continued existence</u>.
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) that might further reduce their population sizes. Until recently, headwater chub were not considered secure in any of the stream segments where they occur (Voeltz 2002, p. 82-83); as a result of a recent renovation and construction of a barrier on Fossil Creek, that headwater chub population can now be considered secure, although other authors from a recent petition argued that this population should not be considered secure (Stefferud et al. 2009, p. 15-20). 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 recolonization 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, p. 129-162; Covington and Moore 1994, p. 39-46; Swetnam and Baison 1994, p. 11; Touchan *et al.* 1995, p. 269-272). We have information indicating that the intensity of forest fires has increased in recent times (Covington and Moore 1994, p. 39-46; National Interagency Fire Center 2009. 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). 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). Recently, several extreme summer fires, including the 2002 Rodeo-Chedeski Fire and the 2004 Willow Fire, may have resulted in losses of individuals and populations of headwater chub throughout Arizona. Carter and Rinne (unpubl. data) found that the Picture Fire both benefited and eliminated headwater chub from portions of Spring Creek. The fire eliminated chubs from Turkey Creek, a tributary to Spring Creek. In other parts of Spring Creek, however, headwater chubs initially declined, but later thrived after the fire, presumably because most of the nonnative fishes were eliminated. Additionally, several populations in the Mazatzal Mountains in central Arizona may have been eliminated in 2004 due to the Willow Fire (Robinson 2004, pers. comm.). Therefore, every extant population of headwater chub is at risk of experiencing effects from wildfire.

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 one 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 2021–2040 (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 by 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 2008b, 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. 1183–1184), 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. 521–522). 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 warmwater 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. Warmwater 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 et al. (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 *et al.* (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 *et al.* (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 25-30 °C (77-86 °F) (Granath and Esch 1983, p. 1116), and optimal anchorworm temperatures are 23-30 °C (73-86 °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. 1–4) provided streamflow 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 Arizona’s drought status through June 2008 in watersheds where the headwater chub occurs or historically occurred. They found that the Verde and San Pedro watersheds continue 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 have depleted recharge of aquifers and decreased baseflows 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

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 of 2007.

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

NMDGF has completed a recovery plan for headwater chub (Carman 2006) that includes a list of management issues, strategies, and implementation tasks. 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.

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 impact of 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

AGFD (2006) and Carman (2007) 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.

LISTING PRIORITY

THREAT			
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	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude:
This 2010 assessment utilizes information from Voeltz (2002), Paroz and Propst (2007), Paroz *et al.* (2009) and Stefferud *et al*. (2009). We conclude that the headwater chub now occurs in 17 of 27 streams formerly known to be occupied. Of the 17 extant streams, one is stable-secure, nine are stable-threatened, and 7 are unstable-threatened. Headwater chub have been extirpated from four streams, and headwater chub status is unknown in an additional six streams. All of the 17 currently extant streams where headwater chub now occur are fragmented, and many are small, isolated stream segments. We estimate 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 (Voeltz 2002).

Although the remaining populations are fragmented and isolated, and threatened by a combination of factors, the remaining headwater chub populations have exhibited long-term persistence, and existing data indicate that 10 of the 17 currently extant populations are now considered stable. Recent surveys indicate that all 17 populations are persisting at this time, although some populations have declined since Voeltz (2002) summarized the condition of the populations. That decline is of concern, and more information is needed to identify the causes of those declines. A primary threat to these species is predation and competition from non-native aquatic organisms, which, once established, are extremely difficult to eradicate. As human population density increases in Arizona, demands on local water sources can be expected to increase to the detriment of aquatic habitats, further threatening native fish faunas, including the headwater chub. The fragmented nature and rarity of existing populations also makes them vulnerable to extinction from other natural or manmade factors such as drought and wildfire. In our 2009 review of the status of the headwater chub, we identified that the threat of nonnative species and habitat destruction appeared to be of a lower magnitude than previously thought. We have not located any new data that confirms or denies that assumption. The changes in status of the headwater chub populations over time indicate some are declining and others are maintaining recruiting populations in the face of existing threats. The long-term prognosis for the headwater chub is unclear; however, in the short term addressed in this review, the loss of any one population is unlikely.. Although existing regulatory mechanisms do not appear to be adequate for addressing the impact of nonnative fish and also have not removed or eliminated the threats that continue to be posed in relation to habitat destruction or modification, a recently completed statewide conservation agreement (AGFD 2006) should begin to address and minimize these threats and protect habitat. Several projects are currently planned by the signatories of the agreement that will help conserve the species (AGFD 2008). Therefore, because many of the populations are not in immediate danger of elimination from extant threats, we find that the effects of the threats facing this species over at least the short term are of a moderate magnitude. Before the next review, we need to review those assumptions, the progress of the conservation actions and if possible, the current status of the populations.

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. 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. 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.

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No. Given the information we currently have on the status of thespecies, including a thorough review of the information we received in a petition to emergency list the species (Stefferud *et al.* 2009), we do not believe emergency listed 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. We are working with AGFD and various landowners on implementation of the conservation strategy. We believe that the current status of the species combined with these efforts to conserve the species preclude emergency listing at this time. We anticipate that implementation of this conservation agreement will conserve the species. The conservation agreement has already resulted in better monitoring that is improving assessments of headwater chub status, and efforts to install barriers and remove nonnative fishes from headwater chub habitats are in the planning stages.

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 a semi-annual basis. Completion of the status review in 2002 (Voeltz 2002) 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. Likewise, the NMDGF's implementation of their recovery plan continues to improve monitoring.

COORDINATION WITH STATES

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

Indicate which State(s) did not provide any information or comments: N/A

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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: ______________________________ May 21, 2010
Acting Regional Director, Fish and Wildlife Service Date

Concur: ______________________________
ACTING
Director, Fish and Wildlife Service Date: October 22, 2010

Do not concur: ______________________________ ____________
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: April 2010
Conducted by: Glen Knowles