# ROUNDTAIL CHUB (*GILA ROBUSTA*) STATUS SURVEY OF THE LOWER COLORADO RIVER BASIN

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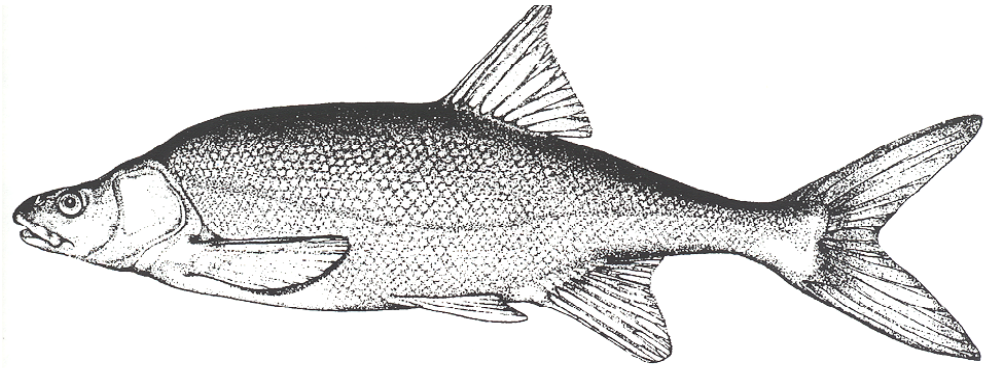

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# EXECUTIVE SUMMARY

*Purpose*. The roundtail chub (*Gila robusta*) has been a species of concern since the late 1970s due to dwindling distribution and abundance throughout its range. The U.S. Fish and Wildlife Service funded this project to: (1) assemble existing information on the species, (2) identify existing information gaps, and (3) conduct surveys to fill these information gaps and establish its current status. This information is necessary to determine the need for future management of the species. This report serves to identify the present status of the roundtail chub and the headwater chub (*Gila nigra,* formerly referred to as *Gila robusta grahami*) in the lower Colorado River basin, including summaries of taxonomy and life history (habitat, diet, reproduction, and age and growth) of both species.

*Historic Distribution*. Historically, the roundtail chub was found throughout the Colorado River and its tributaries. In the lower Colorado River basin, the roundtail chub has been documented in the Little Colorado, Bill Williams, Gila, Salt, and Verde rivers, and most of their perennial tributaries. The headwater chub was found in the middle to headwater reaches of middle sized-streams in the Gila River basin.

*Stream Survey Priorities*. Roundtail and headwater chub populations with no current information available were identified and used to develop a survey strategy to fill existing information gaps. Populations surveyed for this report were prioritized based primarily upon three criteria: (1) streams known to contain historic populations of roundtail or headwater chubs with no museum collections associated with those streams, (2) streams with historic populations of roundtail or headwater chubs that have not been surveyed within the last ten years, and (3) streams with historic populations of roundtail or headwater chubs that have been surveyed within the last 10 years but the population are deemed highly vulnerable to changes or impacts.

*Current Distribution*. Currently, roundtail and headwater chubs are known to occur in at least 30 streams in the lower Colorado River basin. Roundtail and headwater chubs are considered extirpated from 13 streams. Due to lack of recent survey data (mainly due to access restrictions) the population status for 14 streams that historically contained roundtail or headwater chubs is unknown.

*Species Status*. It is estimated that the roundtail chub currently occupies about 18% of its historic range in the lower Colorado River basin, and the headwater chub currently occupies about 40% of its historic range in the lower Colorado River basin. Of the 30 streams known to currently contain roundtail or headwater chubs, 17 are classified as Unstable-Threatened, 12 are classified as Stable-Threatened, and 1 is classified as Stable-Secure.

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Jeremy B. Voeltz

## INTRODUCTION

The roundtail chub (*Gila robusta*) is a member of the minnow family Cyprinidae, and is one of six recognized species in the genus *Gila* endemic to the Colorado River basin (Minckley et al. 1986; Minckley and DeMarais 2000; J. Nelson, pers. comm. [Table 1]). The roundtail chub is included on the Arizona Game and Fish Department's (AGFD) list of *Wildlife of Special Concern in Arizona* (in prep.), which will replace *Threatened Native Wildlife in Arizona* (AGFD 1988). It is also listed as endangered in New Mexico (Propst 1999) by the New Mexico Department of Game and Fish (NMDGF). The U.S. Fish and Wildlife Service (USFWS) listed *Gila robusta* "*grahami*" in the Gila River basin as a category 2 candidate species during the 1982, 1985, and 1989 notices of review of candidate species (Harlow 1999). In 1989, ongoing genetic work considered the subspecies "*grahami*" invalid, and the Desert Fish Recovery Team (DFRT) recommended listing of the entire *Gila robusta* binomial as a category 2 candidate species (DFRT 1989). It remained in category 2 through the 1991 and 1994 notices of review of candidate species. The DFRT recommended listing *Gila robusta* as threatened or endangered in 1992, 1993, and 1996 (DFRT 1992, 1993, 1996). In 1993, the DFRT renewed its recommendation for listing of *Gila robusta* and concluded that new genetic information supported separate listing of the lower Colorado River basin population (DFRT 1993). However, no listing action was initiated and in 1995-1996 the species was dropped from recognition as a candidate species when policy changes abolished category 2 species from the notice of review of candidate species (Harlow 1999).

This report fulfills contract number 1448-00002-96-0814, to provide the USFWS with a complete status report on the roundtail chub in the lower Colorado River basin, including all putative subspecies (*Gila robusta* "*grahami*") with the exception of *Gila robusta jordani* (*G. r. jordani* is protected under the Endangered Species Act with a completed Recovery Plan [USFWS 1985]). The USFWS funded this project to: (1) assemble existing information on the species, (2) identify existing information gaps, and (3) conduct surveys to fill these information gaps and establish its current status. This information is necessary to determine the need for future management of the species.

The name *Gila grahami* (Baird and Girard 1854) was applied by Rinne (1969, 1976) as a subspecies of *Gila robusta*. As detailed later, DeMarais (1992) and Minckley and DeMarais (2000) identified syntypes of *Gila grahami* as *Gila robusta*, relegating the name "*grahami*" as synonymous with "*robusta*" and invalid for use. The earliest replacement name for "*grahami*" is *Gila nigra* (Cope and Yarrow 1875), now recognized as a full species (Minckley and DeMarais 2000, J. Nelson, pers. comm.). At the inception of this project, *Gila robusta* "*grahami*" (=*nigra*) was considered a subspecies of *G. robusta*, and therefore the status of *Gila nigra* will also be included in this report, with distribution information for the roundtail chub (*G. robusta*) and the headwater chub (*G. nigra*) provided in Minckley and DeMarais (2000). This report will

summarize historic distribution, life history, taxonomy, current distribution, and current status of the roundtail chub and the headwater chub in the lower Colorado River basin.

Table 1. Currently recognized *Gila* species in the Colorado River basin.

| Latin Name | Common Name |
|---|---|
| *Gila cypha* | humpback chub |
| *Gila elegans* | bonytail chub |
| *Gila intermedia* | Gila chub |
| *Gila nigra* | headwater chub |
| *Gila robusta jordani* | Pahranagat roundtail chub |
| *Gila robusta* | roundtail chub |
| *Gila seminuda* | Virgin chub |

## METHODS

### MAPPING AND REPORTING METHODS

The scope of this survey covers the lower Colorado River basin, defined as the Colorado River basin from Glen Canyon Dam, Arizona, downstream to the Colorado River's confluence with the Sea of Cortez, Mexico. The mainstem Colorado River in the lower basin is reported on as a whole due to low abundance of specimens. To facilitate more efficient data summarization in this report the Gila River basin was divided into upper and lower reaches following the example of Minckley (1985). The upper Gila River basin is defined as the Gila River and its tributaries from Coolidge Dam upstream to its headwaters. The lower Gila River basin is defined as the Gila River and its tributaries from immediately below Coolidge Dam downstream to its confluence with the Colorado River.

Requests for historical data were submitted by posted letter, e-mail, or through collection database queries of museum collections via the Internet. Museum collection records queried included: The Academy of Natural Sciences Department of Ichthyology (ANSP); Arizona State University Collection of Fishes (ASU); Cornell University Ichthyology Collection (CU); Florida Museum of Natural History (FLMNH); Harvard Museum of Comparative Zoology (MCZ); Illinois Natural History Survey (INHS); Muséum National d'Histoire Naturelle (MNHN); Museum of Southwestern Biology Division of Fishes (MSB); National Museum of Natural History (NMNH); Oklahoma State University (OSU); Texas Natural History Collections (TNHC); Tulane University Museum of Natural History (TMNH); University of Arizona Fish Collection (UA); University of Michigan Museum of Zoology (UMMZ); and USGS Biological Survey Collection (USGS). Descriptions of collection localities are reported in the units provided with original collection data.

Despite best attempts by museums to assure accuracy of specimen identification, verification cannot be guaranteed and is the responsibility of researchers at the museums. Incomplete information gathered through database queries was supplemented by phone, e-mail, or postal mail requests for additional information.

For the purpose of this report, a collection record refers to a record where fish were preserved and accessioned into a museum. A sampling record refers to a record where fish were identified by qualified biologists but no specimens were preserved. Collection records for roundtail and headwater chubs are provided in Appendix D. Sampling records for roundtail and headwater chubs are provided in Appendix E. In Appendixes D and E, streams are listed in alphabetical order by drainage (Colorado River mainstem, Little Colorado River and tributaries, Bill Williams River and tributaries, upper Gila River and tributaries, lower Gila River and tributaries, Salt River and tributaries, and Verde River and tributaries). In text, streams are listed by drainage, with the primary river in the drainage listed first, followed by its tributaries in downstream progression.

Historic and current ranges of roundtail and headwater chubs were estimated using information from museum collections, agency databases, records found in literature, and consultation with experts. Using this information, estimated historic range was recorded in linear stream kilometers (km) using ARC View and ARC Info software. Estimated current range was recorded with the same methods using information from recent collection and sampling data. Streams known to contain historic populations, but not sampled recently due to access restrictions were measured to determine estimated km of streams in which the current status of the chub population is unknown. Percentage of historic range currently occupied by roundtail and headwater chubs was calculated by dividing the estimated km of current range by the estimated km of historic range. Percentage of historic range where current status of the population is unknown was calculated using the same methods (km of unknown range/km of historic range).

AGFD Native Fish Program and Heritage Data Management System (HDMS) specialists compiled land ownership maps, provided separately. Maps were constructed to depict current estimated ranges of roundtail and headwater chubs and land ownership status within a 1.6 km (1.0 mile [mi]) buffer zone around the streams. Upper and lower end points for each stream were selected in an attempt to include all perennial water or suspected distribution of roundtail or headwater chubs, based upon best estimate. Land ownership statistics for Arizona were calculated by HDMS based on the Arizona State Land Department (ASLD) land ownership database. Geographic Information System (GIS) covers for perennial water were originally developed by the AGFD Statewide Riparian Inventory. Land ownership statistics and perennial water GIS covers for New Mexico were developed and provided by the New Mexico Resource GIS Program, a cooperative program between University of New Mexico and the New Mexico Information Technology Commission.

While reviewing the New Mexico land ownership data it was clear that the area surrounding the upper Gila and San Francisco rivers is not 100% private lands as indicated the New Mexico GIS covers. According to topographical maps, the area is predominately managed by the Gila National Forest (U.S. Forest Service) with some private holdings. Because the data was provided to this project by the New Mexico Resource GIS program, the error could not be corrected. To avoid confusion on the maps, the error is noted and the area is given a different hue.

Recent records representing extant roundtail or headwater chub populations were identified on each map when survey locations could be determined based on available information. Many of the UTM coordinates for collections had already been identified and were provided to this project through the Arizona State University (ASU) Southwestern Fishes database, under the management of Peter J. Unmack at ASU. Information available for some records was not sufficient to accurately map survey locations and these records were not mapped. UTM coordinates provided (Appendixes D and E) with survey localities should be used with caution, as some of the coordinates were plotted after the surveys occurred, based upon descriptions of the survey locations. The coordinates are included to provide estimated historic and current ranges of the species and are not to be interpreted as finite locations of specific populations.

A list of abbreviations and names of fishes (common and scientific) used throughout this report are provided in Appendix B**.** Contact information for personal communication (pers. comm.) sources are listed in Appendix C. Materials cited specifically in text are provided in the Literature Cited section. Other materials examined, but not cited in text, are provided in Appendix F.

## SURVEY METHODS

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.

Information gathered was used to perform a "Gap Analysis" to identify streams with no current information on the status of roundtail and headwater chubs (Appendix A). Streams where current information was not available were identified and used to delineate information gaps to allow for development of a survey strategy. Streams surveyed for this report were prioritized using primarily three criteria. Highest priority was given to streams with known roundtail or headwater chub populations that did not have any chub collections in a museum associated with those streams. Second priority was given to streams with historic roundtail or headwater chub populations that had not been surveyed during the last ten years. Third priority was given to streams containing roundtail or headwater chubs that have been surveyed during the last ten years but the chub populations were deemed highly vulnerable to changes or impacts. Additional criteria were assessed (Appendix A), but (other than criterion for access availability) provided little input in determining priority.

AGFD personnel surveyed streams for this project during summers of 2000 and 2001 according to priorities established in the Gap Analysis. Surveys were qualitative, focusing on habitats considered likely to contain chubs (undercut banks, root wads, debris dams, large boulders and boulder complexes, pools, and eddies [Bestgen and Propst 1989, Ziebell and Roy 1989, Karp and Tyus 1990, Brouder et al. 2000]). Survey methods included the use of Smith-Root backpack electroshocking units, seines, experimental gill nets, trammel nets, hook and line, and visual

observation. A sub-sample of chubs and other fishes sampled were preserved using techniques in Minckley (1973) and accessioned into the ASU Collection of Fishes.

### METHODS USED TO DESCRIBE POPULATION STATUS

Stream-specific status designations for current roundtail and headwater chub populations were based upon the categories described by Weedman et al. (1996) and Girmendonk and Young (1997). Qualitative descriptors were used to describe estimated fish abundance (abundant, common, uncommon, rare, absent) due to a lack of quantifiable data. Using the most current information available, roundtail and headwater chub populations were placed into one of five categories:

| | |
|---|---|
| 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 nonnatives 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. |

## RESULTS

### TAXONOMY

The original description of *Gila robusta* was made by Baird and Girard from specimens collected in 1851 from the Zuni River (Baird and Girard 1853a). The original description of *Gila nigra* was made by E.D. Cope from specimens collected in 1874 from Ash Creek and the San Carlos River (Cope and Yarrow 1875).

Although full species status has not been questioned for *G. robusta* (Miller 1946), several generic and specific names have been applied to the species over the years. The following scientific names have been used in reference to the roundtail chub (*G. robusta*) and the headwater chub (*G. nigra*), and are based largely on the works of Rinne (1976), Sublette et al. (1990), and Minckley and DeMarais (2000):

*Gila robusta*, Baird and Girard 1853a: 369 (original description from Zuni River, New Mexico), 1853b: 148-149; Girard 1856: 205; Cope and Yarrow 1875: 663; Evermann and Rutter 1895: 483; Jordan and Evermann 1896: 227; Gilbert and Scofield 1898: 493; Cockerell 1908: 171; Snyder 1915: 581; Jordan et al. 1930: 114; Miller 1945: 104; Winn and Miller 1954: 273; Koster 1957: 58; LaRivers 1962: 392; Miller and Lowe, 1964: 140; Minckley and Deacon 1968: 1427; Holden and Stalnaker 1970: 409; Rinne and Minckley 1970: 16; Miller 1972: 242; Minckley 1973: 99; Rinne 1976: 89; Smith et al. 1979: 614; Bestgen 1985a: 1; Bestgen et al. 1985: 1; Propst et al. 1986: 2; Bestgen et al. 1987: 353; Propst et al. 1988: 45; Minckley and DeMarais 2000: 251-256.

*Gila gracilis*, Baird and Girard 1853a: 369 (original description from Zuni River, New Mexico); Girard 1856: 205; Cope and Yarrow 1875: 665; Jordan and Gilbert 1883: 228.

*Ptychocheilus vorax*, Girard 1856: 209, 1859: 301.

*Gila affinis*, Abbott 1860: 473-474 (original description from Kansas River in error, correct locality unknown).

*Lueciscus robustus*, Günther 1868: 241.

*Lueciscus zunnensis*, Günther 1868: 241.

*Gila nacrea*, Cope 1871: 441.

*Gila robusta robusta*, Miller 1946: 414, 1955: 131, 1961: 377-378; Simon 1951: 79; LaRivers 1952: 100, 1962: 392, 1994: 388-390; Beckman 1963: 45; Miller and Lowe 1964: 141; Uyeno and Miller 1965: 39; Barber and Minckley 1966: 317-319; Cole 1968: 471-472; Minckley and Alger 1968: 471-472; Rinne and Minckley 1970: 16-18; Minckley 1973: 100-101; Rinne 1976: 76-82, 87-91.

*Gila nigra*, Cope and Yarrow 1875: 663 (original description from Ash Creek and the San Carlos River, Arizona); Minckley and DeMarais 2000: 251-256.

*Gila grahami*, Baird and Girard 1854: 389; Girard 1856: 205, 1859: 61; Cope 1871: 441; Cope and Yarrow 1875: 665; Jordan and Gilbert 1883: 228.

*Lueciscus grahami*, Günther 1868: 242.

*Ptychocheilus lucius*, Evermann and Rutter 1895: 476 (misidentified).

*Richardsonius gibbosus*, Snyder 1915: 582.

*Gila robusta*: *robusta* x *intermedia*, Barber and Minckley 1966: 317-319.

*Gila robusta grahami*, Rinne and Minckley 1970: 16-17; Minckley 1973: 102-103; Rinne 1976: 76-82, 87-91; Deacon et al. 1979; DeMarais 1986.

**Taxonomic Status of Fishes in Genus *Gila***

Taxonomic status of fishes in the genus *Gila* has changed significantly over time. Closely related and even identical species were occasionally assigned to different genera by early taxonomists (Uyeno 1960). For example, the Gila chub (*Gila intermedia*) has at various times been placed in five separate cyprinid genera, namely *Tigoma*, *Squalius*, *Leuciscus*, *Richardsonius*, and *Gila* (DeMarais 1995). Miller (1946) assigned several currently recognized *Gila* species (*G. intermedia, G. robusta, G. seminuda*, and *G. elegans*) to the "*Gila robusta* complex", believing they comprised a series of ecological subspecies. Compounding the taxonomic problems associated with the genus *Gila* is a large degree of variation among populations, and in some cases overlap of morphological and meristic characters traditionally used to distinguish separate species. Following the example of DeMarais (1992), the name "*grahami*" is used for convenience in discussing populations to which the name has been previously applied in museum collections and in the literature reviewed, with no taxonomic validity implied.

Studies conducted by Rinne (1969, 1976) on populations of *Gila* from the Gila River basin used morphological and meristic characters to focus on taxonomic problems related to *G. intermedia* and *G. robusta*. He supported recognition of both species (*G. robusta* and *G. intermedia*), but also concluded that two subspecies of *G. robusta* were present in the Gila River basin (*G. r. robusta* and *G. r. grahami*).

Using morphological and meristic data, Holden and Stalnaker (1970) conducted a study of the genus *Gila* in the upper and lower Colorado River basins, which included 130 *G. robusta*; however, the study only included ten specimens of *G. robusta* from the lower Colorado River basin (all ten from the Black River). The authors concluded that *G. robusta* (which at the time, encompassed the problematic form, *G. r. grahami,* found in the Gila River basin) was morphologically uniform throughout the entire Colorado River basin. Lack of sufficient specimens from the lower Colorado River basin undoubtedly prevented recognition of the variability existing between many of the lower Colorado River basin populations identified as *G. robusta*.

DeMarais (1986) used morphological and meristic data to demonstrate that *G. r. grahami* populations spanned the entire morphological/meristic distance between *G. intermedia* and *G. robusta*, rather than forming a discrete unit. He proposed that the form referred to as *G. r. grahami* originated through hybridization between *G. robusta* and *G. intermedia* during the Miocene to early Pliocene.

Using protein electrophoresis, DeMarais (1992) examined genetic variation between *G. robusta*, *G. intermedia*, and *G. r. grahami*. Results identified a high degree of variation existing between populations of *G. r. grahami*. Examination of *G. robusta* populations (specimens representing four distinct sub-basins) indicated stronger genetic similarity between populations, relative to *G. r. grahami* and *G. intermedia*. DeMarais (1992) reported that syntypes of *G. grahami* examined by R.R. Miller and W.L. Minckley (cited as pers. comm. in DeMarais 1992) were actually

specimens of *G. robusta*, relegating the name *grahami* to a synonym of *robusta*, thus unavailable to be used as the name for the intermediate form.

Based upon the reidentification of syntypes, Minckley and DeMarais (2000) reiterated the synonymy of *grahami* with *robusta* and the unavailability of the name "*grahami*" to be used for the intermediate form. The authors identified the earliest replacement name available as *Gila nigra* (Cope and Yarrow 1875) described from specimens collected in Ash Creek and the San Carlos River in 1874. The authors proposed full species status for *Gila nigra*, considering it a species of hybrid origin, stating "species-level recognition acknowledges the widespread, parapatric, inter- and intraspecific geographic ranges of the three forms" (*G. robusta, G. nigra,* and *G. intermedia*). The American Fisheries Society will recognize *Gila nigra* in the 2002 edition of *Common and Scientific Names of Fishes from the United States, Canada, and Mexico* (J. Nelson, pers. comm.). A summary of taxonomic nomenclature assigned to populations of "*grahami*" (=*nigra*) by several authors and museums is provided in Table 2, as is the current nomenclature that will be followed in this report.

Colloquial names for *G. robusta* published in the literature are numerous, and include roundtail chub (Minckley 1973, Sublette et al. 1990, Girmendonk and Young 1997), Gila trout (Minckley 1973), Verde trout (Minckley 1973, Siebert 1980, Girmendonk and Young 1997), bonytail (Madsen 1935a, Gee 1938, Hemphill 1954), squawfish (Simon 1951), Colorado Gila (LaRivers 1994), Colorado chub (Vanicek and Kramer 1969), roundtail (LaRivers 1994), and in Mexico, charalito aleta redondo (Rinne and Minckley 1991).

## LIFE HISTORY

### Description of the Species

Roundtail chub (*Gila robusta*)

The roundtail chub is a member of the minnow family Cyprinidae, and is endemic to the Colorado River basin. It occupies mainstem and primary tributaries of the Colorado River in the upper Colorado River basin, and middle-sized and larger tributaries throughout much of the lower Colorado River basin. The following description is modified from Weedman (1998).

Individuals of this species are most commonly 250-350 mm (9.8-13.8 in.) in total length (Sigler and Miller 1963, Minckley 1973, Sublette et al. 1990), but are occasionally found as large as 500-600 mm (19.7-23.6 in.) in large river environments (Sublette et al. 1990). The body is thick, compressed, and moderately streamlined with a slender (but not pencil-shaped) caudal peduncle (Minckley 1973, Page and Burr 1991). The dorsal fin is weakly falcate and a little higher than it is long (Baird and Girard 1853a, Sublette et al. 1990, Sigler and Sigler 1996). The pectoral fins are pointed and the pelvic fins are triangular with a bluntly pointed apex. The anal fin is strongly falcate and the caudal fin is deeply forked with pointed lobes (Sublette et al. 1990). The angle along the anal fin base continues into the middle of the caudal fin (Page and Burr 1991).

Table 2. Taxonomic designations by authors for *Gila* populations morphologically intermediate between *G. robusta* and *G. intermedia*.

| Location | Minckley (1973) | Rinne (1976)[1] | DeMarais (1986)[2] | Current Designation (Minckley and DeMarais 2000) |
|---|---|---|---|---|
| Aravaipa Creek | "grahami" | "grahami" | *G. robusta* | *G. robusta* |
| Eagle Creek, upper<br>Eagle Creek, lower | "grahami" | "grahami" | *G. intermedia*<br>*G. robusta* | *G. intermedia*<br>*G. robusta* |
| East Verde River | "grahami" | "grahami" | intermediate | *G. nigra* |
| Fossil Creek | "grahami" | "grahami" | *G. robusta* | *G. nigra* (above the diversion dam)<br>*G. robusta* (below the diversion dam) |
| Fossil Springs | ----- | ----- | intermediate | *G. nigra* |
| Upper Gila River | "grahami" | "grahami" | intermediate | *G. nigra* (above confluence with Mangas Creek, New Mexico)<br>*G. robusta* (below confluence with Mangas Creek, New Mexico) |
| Lower Gila River | *G. robusta* | "grahami" | *G. robusta* | *G. robusta* |
| Oak Creek | *G. robusta*<br>*G. intermedia* | *G. robusta*<br>*G. intermedia* | ----- | *G. robusta* (lower)<br>*G. intermedia* (upper) |
| Rye Creek | ----- | ----- | intermediate | *G. nigra* |
| Salt River | *G. robusta* | *G. robusta* | intermediate | *G. robusta* |
| San Francisco River | ----- | "grahami" | ----- | ----- |
| San Pedro River, upper<br>San Pedro River, lower | *G. intermedia*<br>"grahami" | *G. intermedia*<br>"grahami" | intermediate | *G. intermedia*<br>*G. robusta* |
| Tonto Creek | "grahami" | "grahami" | ----- | *G. nigra* |
| W. Clear Creek, upper<br>W. Clear Creek, lower | ----- | ----- | intermediate<br>*G. robusta* | *G. robusta*<br>*G. robusta* |

[1] Rinne (1976) reported "grahami" in the Little Colorado River basin in East Clear, Clear, and Chevelon creeks, and possibly the Little Colorado River. However, DeMarais (1986) identified chubs from the entire Little Colorado River drainage as *G. robusta*.

[2] intermediate refers to specimens determined to be phenotypically intermediate between *G. robusta* and *G. intermedia*.

The fatty nuchal hump is rare, and if present, weakly developed at 211-309 mm (8.3-12.2 in.) standard length (Sublette et al. 1990). Dorsal fin rays usually number nine with a range of 8-10, and the anal fin rays also number 9, ranging from 7-10 (Minckley 1973, Sublette et al. 1990, Page and Burr 1991). The scales are small and thin, and are only slightly imbricated. The basal radii are absent to weak on the scales (Minckley 1973). Lateral line series usually with more than 80 scales, but ranges from 75-99 (Minckley 1973, Page and Burr 1991). Vertebrae number 43-49 (Minckley 1973, Sublette et al. 1990). The head is depressed, sloping very rapidly from the nape to the snout and forming ¼ the total length (Baird and Girard 1853a, Page and Burr 1991). The mouth is moderate to large, with the posterior branch of the maxillary not reaching the vertical line of the pupil (Baird and Girard 1853a, Sublette et al. 1990, Page and Burr 1991). The eyes are

proportionally small and subcircular (Baird and Girard 1853a). Pharyngeal teeth number 2,5-4,2 (Minckley 1973, Page and Burr 1991). Coloration of *G. robusta* is dusky to green on the back and upper sides, but sometimes metallic blue, and silvery or white below (Baird and Girard 1853a, Sigler and Miller 1963, Minckley 1973, Sublette et al. 1990, Page and Burr 1991). Both sexes have orange-red coloration on the lower cheek, the ventrolateral surface, and on all fins except the dorsal (Muth et al. 1985, Karp and Tyus 1990, Sublette et al. 1990, Page and Burr 1991), however, females exhibit less intense breeding colors than the males (Rinne and Minckley 1991). The largest recorded roundtail chub caught by hook and line was taken from the lower Salt River in March 1984, a specimen measuring 469.9 mm (18.5 in) and weighing 1782.62 g (3.93 lb) (Girmendonk and Young 1997, AGFD 2002).

Headwater chub (*Gila nigra*)

The headwater chub is a cyprinid species endemic to the Gila River basin of Arizona and New Mexico, occupying middle and headwater reaches of middle-sized streams (Minckley and DeMarais 2000). It is similar in appearance to the roundtail chub, and individual specimens are difficult to identify to species. In general, headwater chubs have meristic and morphometric counts intermediate between *G. robusta* and *G. intermedia* (DeMarais 1992, Minckley and DeMarais 2000). Headwater chubs do not grow as large as roundtail chubs, most likely a result of the smaller habitats that they occupy. Bestgen (1985b) speculated that that variability of chub length was the result of local habitat conditions.

Minckley and DeMarais (2000) provided a key for distinguishing species of *Gila* occurring in the Gila River basin. Portions of the key pertinent to *G. intermedia, G. nigra*, and *G. robusta* are reproduced in tabular form (Table 3).

Table 3. Morphometric differences between *Gila robusta*, *Gila nigra*, and *Gila intermedia*.

| Characteristics | Species | | |
|---|---|---|---|
| | roundtail chub (*Gila robusta*) | headwater chub (*Gila nigra*) | Gila chub (*Gila intermedia*) |
| Head length/caudal peduncle depth | 3.25 or greater (based on population means) | 3.2 or less (based on population means) | 3.0 or less (based on population means) |
| Number of lateral line scales | 75-90 (extremes 71-99) | 73-83 (extremes 71-90) | 62-74 (extremes 51-83) |
| Number of dorsal and anal fin rays | 9 (rarely 8 or 10) | 8 (rarely 7 or 9) | 8 (rarely 7 or 9) |
| Fin interradial membrane pigmentation | Dark pigmented | Usually pigmented, often dark | Transparent to translucent |
| Body coloration | Dark overall, belly lighter; sometimes diffuse longitudinal stripes | Dark overall, silver laterally, white below; often with diffuse longitudinal stripes, rarely dark dorsolateral blotches | Silvery, especially on sides; rarely with diffuse longitudinal stripes, sometimes with dark dorsolateral blotches |

**Origins and Distribution**

Rinne (1976) concluded that the most plausible explanation for the present distribution of *G. robusta*, *G. r.* "*grahami*", and *G. intermedia* was through a series of invasions of the lower Colorado River. His explanation proposed: (1) drainages associated with the southern Colorado Plateau were occupied by an early form of *G. robusta* from the north which began to differentiate, followed by massive headward erosion and capture of southern Colorado Plateau waters by the ancestral Salt and Gila rivers; (2) invasion of *G. intermedia* (or its ancestor) from the south, which occupied waters south and west of the uplifting southern Colorado Plateau; (3) connection and integration of the Gila River basin with the lower Colorado River, allowing invasion by a more aggressive, large river form of *G. robusta*; and (4) ecological adjustments and displacements of the three forms, intergradations of the two forms of *G. robusta*, and attainment of present distributions.

DeMarais (1986) believed *G. r. grahami* to have originated through hybridization between *G. robusta* and *G. intermedia* during the Miocene to early Pliocene. Hybrid stocks (*G. r. grahami*) were replaced by invading *G. r. robusta* in suitable mainstem habitats, leaving isolated populations of *G. r. grahami* in a number of headwater habitats. In a later study, DeMarais (1992) proposed hybridization between *G. robusta* and *G. intermedia* (possibly multiple local events rather than a single event) as the most plausible explanation for the origin of "*grahami*," suggesting that restricted distribution of *G. intermedia* and "*grahami*" in small isolated tributaries effectively reduced migration and subsequent gene flow making them more susceptible to the effects of genetic drift or local selection. This likely accounts for the genetic subdivision between their respective populations. The preference of *G. robusta* for larger, better-integrated river systems allowed adequate gene flow in the species throughout the basin, reducing the opportunity for genetic drift or local selection to substantially change gene frequencies. DeMarais (1992) emphasized that selection of *G. robusta* for larger systems is likely a factor in its recent decline in the lower Colorado River basin, observing that habitat destruction and nonnative introductions have been greater in these relatively large systems.

Based on Minckley and DeMarais (2000), chub populations occupying the Little Colorado River and Bill Williams River drainages are *G. robusta*. In the Gila River basin, populations identified as *G. robusta* by Minckley and DeMarais (2000), and P. Unmack (pers. comm.) include:

- mainstem Gila River of Arizona New Mexico (below the confluence with Mangas Creek, New Mexico)
- Eagle Creek (except headwater populations comprised of *G. intermedia*)
- San Pedro River (tributary to the lower Gila River)
- Aravaipa Creek (tributary to the San Pedro River)
- Salt River mainstem
- Black River (tributary to the Salt River)
- East Fork Black River (tributary to the Black River)
- White River (tributary to the Salt River)

- North Fork White River (tributary to the White River)
- Carrizo Creek (tributary to the Salt River)
- Cedar Creek (tributary to Carrizo Creek)
- Corduroy Creek (tributary to Carrizo Creek)
- Cibecue Creek (tributary to the Salt River)
- Canyon Creek (tributary to the Salt River)
- Cherry Creek (tributary to the Salt River)
- Salome Creek (tributary to the Salt River)
- Verde River (tributary to the Salt River)
- Oak Creek (tributary to the Verde River)
- Beaver Creek (including Wet Beaver and Dry Beaver Creeks, tributaries to the Verde River)
- Lower Fossil Creek (tributary to the Verde River) below the diversion dam
- West Clear Creek (tributary to the Verde River)

With relatively few exceptions, chubs examined from the uppermost Gila River mainstem of New Mexico were attributable to *Gila nigra* (W.L. Minckley, pers. comm.). Populations in the Gila River basin recognized as *Gila nigra* by Minckley and DeMarais (2000) include:

- mainstem Gila River (above the confluence with Mangas Creek) in New Mexico including the West, Middle, and East forks of the Gila River
- San Carlos River (tributary to the upper Gila River)
- Ash Creek (tributary to the San Carlos River)
- Tonto Creek (tributary to the Salt River)
- Spring Creek (tributary to Tonto Creek)
- Upper Fossil Creek (tributary to the Verde River) above the diversion dam
- East Verde River (tributary to the Verde River)
- Deadman Creek (tributary to the Verde River)

The upper Fossil Creek population (above the diversion dam) is recognized as *G. nigra*, with *G. robusta* occupying the lower reaches of the stream (below the diversion dam) (Minckley and DeMarais 2000; P. Unmack, pers. comm.). The population in Turkey Creek (tributary to the upper Gila River in New Mexico) has been classified as *G. intermedia* (Minckley and DeMarais 2000).

**Habitat**

Roundtail chubs occur in cool to warm water, mid-elevation rivers and streams throughout the Colorado River basin, often occupying open areas of the deepest pools and eddies of middle-sized to larger streams (Minckley 1973, Brouder et al. 2000, Minckley and DeMarais 2000). They occasionally concentrate in relatively swift, turbulent waters below rapids, moving into less turbulent chutes in small groups, presumably to feed (Minckley 1973, Vanicek and Kramer 1969). Habitats occupied by roundtail chubs are often associated with adjacent cover in the form of boulders, overhanging cliffs, undercut banks, or vegetation. However, roundtail chubs are less

prone to using cover than other species of *Gila* in the Gila River basin (Minckley and DeMarais 2000). When uncommon in a system, roundtail chubs can be extremely localized in distribution, often occurring in a single pool when apparently suitable habitat occurs only a few meters away (Minckley and Clarkson 1979, Bestgen and Propst 1989, Propst 1999). Minckley (1973) described juvenile chubs utilizing quiet backwaters until they reached a size of 25 to 50 mm. Juveniles often occupy shallower and swifter habitats (glides and runs) associated with vegetated shorelines, undercut banks, and instream boulders (Propst 1999, Brouder et al. 2000, Bryan et al. 2000), while avoiding substrates of bedrock and boulders (Brouder et al. 2000). Carter et al. (1986) reported larval roundtail chubs (meso- and metalarvae) occurring in shoreline drift, comprising 6 to 13.1 percent of total catch. Bryan and Robinson (2000) found larval roundtail chubs in low velocity waters occupying the middle and bottom of the water column, using cobble and pebbles as cover.

Roundtail chubs in the upper Verde River were found most often associated with pool habitats (approximately 60%; n =1,271) and less often associated with glide habitat (approximately 18% [Stefferud 1996]). In Wet Beaver Creek, Barrett and Maughan (1995) found that roundtail chubs consistently used the deepest and slowest portion of their study reach. Substrates utilized were bedrock and large boulders with instream cover. Rinne (1992) describes roundtail chubs in Aravaipa Creek as utilizing pools of greater depth (> 30 cm) and lower velocity, often occupying "pools along canyon walls with undercuts" containing substrates of sand and gravel. Bryan and Robinson (2000) found the majority of roundtail chubs in the lower Verde River occupying glides, low gradient riffles, and lateral scour pools, while those in the lower Salt River were in main channel pools. In the upper Colorado River basin, Karp and Tyus (1990) most often found adult and juvenile roundtail chubs in eddies, pools, shoreline runs, and to a lesser extent in riffles and the lower portions of rapids.

Roundtail chubs have shown indications of seasonal movement into and out of the inner gorge of Aravaipa Creek (Siebert 1980). Roundtail chubs moved into waters of the inner gorge during warmer months and dispersed into the upper and lower reaches outside of the gorge during the cooler fall and winter months. The reach of stream within the gorge had higher flows, less direct light, and cooler air and water temperatures than upper and lower reaches outside the gorge. Siebert (1980) believed the seasonal movements served to take advantage of optimal thermal conditions in the system. Brouder et al. (2000) noted that movement of roundtail chubs in the upper Verde River was similar to movement observed by Siebert (1980) in Aravaipa Creek, with both studies observing the majority of movement by roundtail chubs to be less than 100 m. Brouder et al. (2000) also observed an apparent "site fidelity," with 25% (n=18) of the roundtail chubs recaptured during the study showing no movement at all, with a mean residence time of around 325 days.

Headwater chubs (*Gila nigra*) occur in middle to headwater reaches of mid-sized streams (Minckley and DeMarais 2000). In the upper Gila River basin, Bestgen and Propst (1989) found chubs occupying tributary and mainstem habitats at elevations from 1,325 m (4,347 ft) to 2,000 m (6,562 ft) with maximum temperatures ranging from 20 to 26.5 °C (68 to 79.9 °F). Adults

typically occupied deep, nearshore pools adjacent to swift riffles and runs. Cover consisted of root wads, boulders, undercut cliff walls, submerged organic debris, or deep water. Adult chubs were observed feeding in moderate-velocity pools and runs, retreating to deep pools and undercut stream banks when disturbed. Juveniles were found in shallow, low velocity habitats associated with overhead bank cover. Following a large flood that altered typical habitat, Bestgen and Propst (1989) reported young chubs occupying shallow midstream riffles without associated cover.

In the Gila River mainstem, Bestgen (1985a) found that 90% of the chubs occurring below Mogollon Creek in New Mexico were less than 110 mm total length (TL). Habitat in this reach consisted primarily of run and riffles, with pools rare and almost exclusively formed by undercuts beneath tree root systems. Scarcity of pool habitat was suggested as a potential reason for the lack of large adults. Lack of suitable habitat (mainly deep pools) was suggested as a limiting factor to downstream distribution of chubs in the mainstem Gila River of New Mexico.

Adult headwater chubs in Fossil Creek generally utilized waters >1.8 m deep with velocities of <0.10 meters per second (mps), occasionally entering shallow waters with higher velocities (Barrett and Maughan 1995). Substrates that they were most often associated with were gravel, small boulders, and large instream objects. Chubs were observed retreating to shadows of instream structures when disturbed. Juvenile chubs most often selected depths between 0.9 and 1.5 m and velocities of 0.15 mps, often over sand substrates. Neve (1976) observed larval chubs in Fossil Creek showing preference for stream margins with little detectable habitat selection by juvenile chubs; adult chubs preferred pool and backwater habitats.

**Diet**

Roundtail chubs are generally described as omnivores, consuming aquatic and terrestrial invertebrates, aquatic vegetation, and detritus (Propst 1999). Schreiber and Minckley (1981) listed a wide variety of food items in the diet of roundtail chubs in Aravaipa Creek, including aquatic and terrestrial invertebrates, fish, lizards, filamentous algae, and detritus. The roundtail chub's diet was considered unique, with 6 of 21 (28.6%) food items in the roundtail chub's diet not used by any other fish species (Schreiber and Minckley 1981).

Neve (1976) reported the principal food items of adult headwater chubs from Fossil Creek consisted of aquatic insects, ostracods, and plant material. Seasonal variation in adult headwater chub diet was evident with the highest diversity of food items utilized during spring months. Dominant food items consumed during spring months included various aquatic invertebrates, macrophytes, and algae. Diet was similar during summer months, with diatoms and terrestrial insects comprising additional major components. A decreasing trend in diversity of food items was documented during fall and winter months, with diatoms, *Potomageton*, and filamentous algae occurring frequently in the diet of adult headwater chubs. No fish remains were found in stomach contents of any of the headwater chubs examined from Fossil Creek; however, remains

of iguanid lizards were found in the stomachs of two headwater chubs. Diets of juvenile headwater chubs less than 50 mm consisted almost exclusively of filamentous algae and diatoms.

In chubs <100 mm TL in the mainstem Gila River in New Mexico, Bestgen (1985b) found algae to be the predominant dietary component with trichopterans and miscellaneous insect parts comprising the majority of additional food items. Algae were also a major dietary component in chubs between 100 mm and 170 mm with ephemeropterans, trichopterans, and unidentified insects also predominant food items. In chubs >170 mm, algae, trichopterans, and ephemeropterans were major dietary items, in addition to fish and crayfish.

Vanicek and Kramer (1969) described the feeding habits of roundtail chubs as opportunistic and sporadic. They reported a wide variety of food items utilized by roundtail chubs including filamentous algae, unidentified plant debris, aquatic and terrestrial insects, and fish. Stomachs of young roundtail chubs (<100mm TL) contained predominantly unidentified insect remains, with dipteran and ephemeropteran larvae comprising the bulk of identifiable food items. Fish were identified as part of the diet in roundtail chubs between 101 – 200 mm TL (n=8) and 201 – 370 mm (n=8). However, the authors reported an inability to distinguish between bonytail (*G. elegans*) and roundtail (*G. robusta*) chubs less than 200 mm as reason for combining specimens <200mm for analysis. They subsequently reported identifying all fish less than 200 mm containing fish remains as roundtail chubs, without elaborating on the means of distinction.

**Reproduction**

Roundtail chubs usually become reproductively active between the ages of 2-5 (Bestgen 1985a, Brouder et al. 2000). In reproductive condition roundtail chubs display breeding colors and tubercles over much of the body. Males develop bright red to orange coloration around the cheeks and ventro-lateral surfaces of the head, abdomen, and paired anal fins (Minckley 1973, Propst 1999). Females may also display color but when present it is usually restricted to the bases of the paired fins and is less intense than in males (Bestgen 1985a). Both sexes develop breeding tubercles prior to spawning. In males, tubercles cover most of the anterior body and fins occasionally extending posteriorly to include the caudal peduncle and anal fin. In females, tubercles develop to a lesser degree, primarily on the head, pectoral fins, and dorso-laterally between the dorsal fin and the head (Bestgen 1985a, Propst 1999). As females approach spawning condition the abdomen becomes noticeably enlarged, the vent distended, and the ovipositor considerably elongated relative to males; males remain relatively streamlined (Bestgen 1985a).

Gonadal development in adult roundtail chubs follows a seasonal cycle with spawning occurring in late-spring to early summer (Bestgen 1985b, Propst 1999). Neve (1976) reported that in adult headwater chubs from Fossil Creek gonadal weights increased to 4.5% and 8.5% of the total body weight for males and females (respectively) between January and March, while decreasing to less than 0.5% of total body weight during May. In females, increase in gonadal weight corresponded with an increase in ova size from 0.5 mm to 1.5 mm. Fecundity is size-dependant

(Propst 1999) and possibly exponentially related to length (Neve 1976). Females from Fossil Creek ranging from 100 – 260 mm TL were found to contain between 1,000 and 4,300 eggs, with egg diameter ranging from 1.2 – 2.1 mm (Neve 1976). One female weighing 321 gm was reported to contain 36,959 eggs. Mature eggs are adhesive and yellow in color. Brouder et al. (2000) reported females from the Verde River ranging from 270 – 427 mm TL containing between 7,267 and 26,903 eggs, with egg diameter ranging from 1.8 – 3.8 mm. The average reproducing female from the upper Verde River was age-5, 328 mm TL, and produced 13,948 eggs (Brouder et al. 2000).

Water temperatures associated with roundtail chub spawning in the upper Colorado River basin ranged from 14 to 24 °C (Kaeding et al. 1990). Data collected from the upper Salt and Gila rivers by Bestgen (1985b) suggests that high and late winter runoff may postpone spawning activities until lower flows and warmer water temperatures prevail. In upper Colorado River basin waters, presence of gravid and ripe chubs during surveys suggested spawning occurred between mid-June and early July when water temperatures reached approximately 18 °C (Vanicek and Kramer 1969). Gravid and ripe roundtail and bonytail (*G. elegans*) chubs were taken during the same time period, but never in the same net sets, suggesting temporal concurrence but spatial segregation in spawning activity between the two species. Brouder et al. (2000) witnessed spawning roundtail chubs in the upper Verde River during May 1998, with water temperature on both days averaging 18.3 °C. Bestgen (1985b) captured ripe headwater chubs that freely expressed gametes in the East Fork Gila River when afternoon water temperatures reached 22 °C, and he believed that water temperature is the predominant cue to spawning activity.

Studies also suggest that spawning may be associated with a descending hydrograph (Vanicek and Kramer 1969, Kaeding et al. 1990). In the Yampa and Green rivers of the upper Colorado River basin, Karp and Tyus (1990) found most roundtail chubs in breeding condition occupying shoreline eddies during the five to six weeks following the highest spring runoff. Chubs were found in these habitats from May to June during low to average flow years and as late as July in years with extended high flows.

In the lower Colorado River basin, spawning occurs from February through June in pool, run, and riffle habitats, with slow to moderate water velocities (Neve 1976, Minckley 1981, Bestgen 1985b, Propst 1999, Brouder et al. 2000). In the upper Verde River, studies conducted during 1997-1998 found that gonadosomatic index (GSI = ovary weight [g]/total body weight [g] * 100) for roundtail chubs reached its highest point in April followed by a sharp decline in May, indicating that spawning occurred during this period (Brouder et al. 2000). Preferred substrate appears to be clean gravel, although spawning over substrates of sand and silt have been reported as well (Neve 1976, Minckley 1981). Roundtail chub spawning has been described as conforming to a "generalized cyprinoid spawning behavior" (Minckley 1981) with several males aggregating in suitable spawning areas, being joined by a female when she is ready to spawn. The female is accompanied by two or more males that align themselves posterio-laterally to the female, releasing sperm simultaneously to the release of ova by the female (Minckley 1981). Spawning activity conforming to this description was also observed by Brouder et al. (2000)

with the release of gametes accompanied by a rapid quivering of the caudal region by both sexes. Minckley (1981) reported movement by aggregates of males over spawning sites prior to spawning which served to clear substrates of algae and debris, presumably enhancing egg placement. Brouder et al. (2000) observed spawning of roundtail chubs in the Verde River over substrates previously "cleaned" by the spawning activities of Sonora suckers (*Catostomus insignis*). Brouder (2001) speculates that restructuring of substrates during spring flooding provides clear interstitial spaces for eggs that may ultimately lead to increased spawning success.

**Age and Growth**

Muth et al. (1985) recorded developmental stages of roundtail chubs through the larval period. Development under laboratory conditions following fertilization and water hardening of the embryos *in situ* were reported as follows: 4 hours (hr.) – beginning of cleavage; 20 hr. – blastula; 36 hr. – late gastrula; 44 hr. – late neurula; 56 hr. – oval eyes; 60 hr. – early tail-bud; 92 hr. – finfold; 108 hr. – pigmented eyes; 126 – 156 hr. – hatching. Approximately 94% of the eggs hatched. Water temperature during development was maintained at 19°C. Snyder (1981) developed a guide for the identification of proto-, meso-, meta- larval, and juvenile roundtail chubs. Identification is based on ranges and means of selected morphometrics and myomere counts.

Propst (1999) reported the growth rate in chubs after the first year to be approximately 50 mm per year until the fourth year. After Age 4 growth rate slows and an Age 7 individual may achieve a length of 300 mm. Bestgen (1985b) found growth rates of Age 0 roundtail chubs were variable at different localities, speculating that differences were perhaps due to local habitat conditions. Differences in age and growth between chubs from Turkey Creek (Gila River tributary, Grant County, New Mexico) and the Gila River mainstem in New Mexico were observed (Bestgen 1985b). Chubs in Turkey Creek grew slower, matured at smaller size and younger age, were less fecund, and had a shorter life span than chubs found in mainstem habitats (5 years in Turkey Creek vs. 7+ years in Gila mainstem). Bestgen (1985b) speculated that this difference was attributable to earlier mortality in small habitats. However, chubs showed greatest incremental growth during their first summer, regardless of locality. Bestgen (1985b) also speculated that late runoff may retard time of spawning and influence growth rates of all age groups of fishes. W.L. Minckley (pers. comm.) has identified the Turkey Creek population to be *G. intermedia* while the majority of specimens examined from the upper Gila River in New Mexico (including East Fork Gila, Middle Fork Gila, and West Fork Gila rivers) have been identified as *G. nigra*. This may explain some of the inconsistencies noted by Bestgen (1985b) between the Turkey Creek and Gila River populations.

Brouder (2001) found a strong positive correlation between flooding events from one year and catch-per-unit-effort (CPUE) of age 1 fish the following year, concluding that late-winter/early-spring floods in the upper Verde River during 1998-1999 enhanced survival of age 0 roundtail chubs to age 1 the following year. CPUE for age 1 fish following years without late-winter/early-spring floods showed a significant decrease or remained low.

Analysis of age and growth using scales from roundtail chubs was attempted by Neve (1976), but results were unclear due to formation of annuli throughout the year, which made aging fish using this method "difficult if not impossible." Using otoliths (lapilli) to estimate ages of 18 roundtail chubs, Marsh (1997a) found no clear relationship between fish age and fish size, speculating that lack of a clear relationship between age and size in the study was perhaps due to a small sample size. Absorptions due to environmental stress and scale regeneration were identified as two confounding factors when attempting to use bony structures or scales to accurately age cyprinoid fishes. Brouder et al. (2000) sacrificed and extracted the otoliths of 280 roundtail chubs collected from the upper Verde River to determine if analyzing otoliths was a valid technique for aging roundtail chubs. Roundtail chubs were also hatched and reared at AGFD's Bubbling Ponds Fish Hatchery, and therefore were of known age when sacrificed, providing a control for analyzing the otoliths of wild fish. Otolith annuli were laid down around May, probably with the onset of spawning. Annuli on otoliths from wild-caught and hatchery raised chub were analyzed; ages assigned by three independent otoliths "readers" were in agreement 100% of the time on known-aged fish. Brouder et al. (2000) concluded that analyzing otoliths is a valid technique for determining the age roundtail chubs.

**Parasites**

A factor potentially retarding growth rate in chubs is parasitism. The condition factor ($K=\text{length}/\text{weight}^3 \times 10^5$) of roundtail chubs in the Verde River increased as abundance of *Gyrodactlyus* sp. infestation decreased (Robinson et al. 1998). Mpoame (1981) reported that roundtail chubs (101–364 mm TL) collected from Aravaipa, Canyon, and Oak creeks, were infected by protozoans (*Ichthyophthirius multifilis*), trematodes (*Ornithodiplostomum ptychocheilus, Clinostomum marginatum* and *Plagioporus* sp.) cestodes (*Isoglaridacris bulboocirrus*), and nematodes (*Dacnitoides* sp., *Rhabdochona decaturensis*, and other *Rhabdochona* sp.). The most prevalent parasite in roundtail chubs examined during the study was the cestode *Isoglaridacris bulboocirrus*, occurring in 7.14% of fish examined. Yellow grub (*Clinostomum marginatum*) was found in the skin, fins, musculature, peritoneum, oral cavity, and gills of infected fish from Canyon Creek.

Of three native fishes (*G. robusta, Catostomus insignis* [Sonora sucker], and *Pantosteus clarki* [desert sucker]) from the Salt River basin, roundtail chubs were found to be the most susceptible to infection by the copepod *Lernaea* (James 1968). Evidence of heavy blood loss from hemorrhagic and ulcerated areas surrounding the point of penetration by the copepod and high incidence of secondary fungal infection were reported. In the lower Verde and Salt rivers, Bryan et al. (2000) found *G. robusta* heavily infested with *Lernaea*, to a lesser degree with yellow grub (*Clinostomum* sp.), and an unidentified fungus. Vanicek (1967) reported anchor worms (*Lernaea* sp.) infecting the fins and gills of roundtail chubs in the Green River of the upper Colorado River basin.

Neve (1976) reported two species of trematodes (not identified to species) occurring occasionally in the digestive tracts of headwater chubs from Fossil Creek. Adult nematodes were also found,

occurring most frequently between the months of January and May, with percentage of occurrence ranging from 43–65% in chubs collected. Brouder (1999) examined juvenile roundtail chubs (mean TL 156 mm) infected by the Asian fish tapeworm, *Bothriocephalus acheilognathi*. The roundtail chubs had been raised under hatchery conditions and were inadvertently infected via mosquitofish (*Gambusia affinis*) that occupied the source springs supplying the hatchery. Forty-four of 52 fish examined were heavily infected. The majority of tapeworms were found to form a "clump" in the anterior portion of the gastrointestinal tract of infected chubs. Brouder (1999) detected a strong negative correlation between the total length of fish and number of tapeworms. Abdomens of infected fish were distended as if having recently fed and externally fish appeared healthy. Necropsy of the infected fish determined the distention was due to tapeworms. In upper Colorado River basin waters, Vanicek and Kramer (1969) found tapeworms in 23% of stomachs from roundtail chubs greater than 200 mm TL, but absent in chubs less than 200 mm.

## HISTORIC DISTRIBUTION

The historic range of the roundtail chub is poorly documented (Girmendonk and Young 1997), mainly due to the paucity of native fish surveys prior to habitat alterations and stockings (intentional and unintentional) of nonnative fish species. Based on museum collection records, agency database searches, literature (published and gray), and consultation with knowledgeable biologists, the estimated historic ranges of the roundtail chub and the headwater chub are depicted in Figure 1. Throughout much of its range, roundtail and headwater chubs were historically common in abundance (Minckley 1973, Holden and Stalnaker 1975, Propst 1999).

### Lower Colorado River

Historical occurrence of the roundtail chub in the lower Colorado River mainstem is limited to a small number of museum collections and several references in literature that document roundtail chubs as historically occupying the lower Colorado River. Mapped localities from Minckley (1973) show occurrences of roundtail chubs in the vicinities of Shinimu Creek and Paria River although no documented collections were found for those localities. Valdez and Carothers (1998) reported that roundtail chubs historically occupied the Colorado River between Glen Canyon and Separation Canyon; however, C. O. Minckley (1996) described the historic distribution of roundtail chubs in the mainstem lower Colorado River as rare or essentially absent. Minckley (1979) reported that roundtail chubs historically occurred in the lower Colorado River from the Arizona-Mexico border upstream to near the Cibola National Wildlife Refuge, also stating that roundtails were probably never very abundant in the lower Colorado River. Regardless, collection records from Lake Mohave, Imperial Dam, Davis Dam, and Glen Canyon Dam (Appendix D-2) indicate that roundtail chubs have occurred in the lower Colorado River mainstem, and it's likely that the small number of roundtail chub specimens identified is a result of sparse collections prior to habitat alterations on the Colorado River that likely reduced their distribution in the mainstem lower Colorado River.

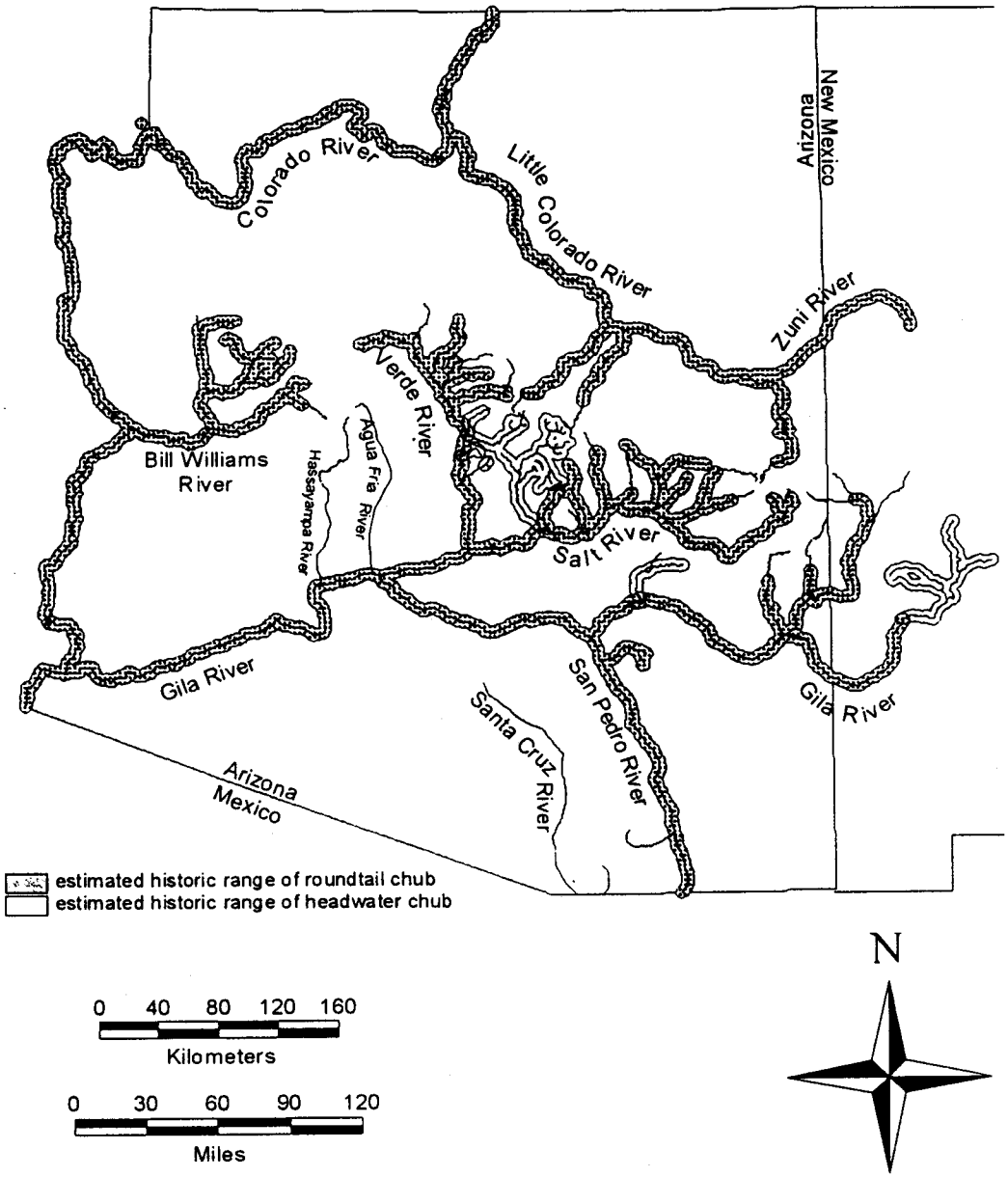


Figure 1. Historic distribution of roundtail and headwater chubs in the lower Colorado River basin (roundtail and headwater chubs' distribution from Minckley and DeMarais 2000).

**Little Colorado River and Tributaries**
Historically, roundtail chubs were found in the mainstem Little Colorado River (LCR) and at least three tributaries of the LCR: the Zuni River, Chevelon Creek, and East Clear Creek. Original description of the roundtail chub was by Baird and Girard (1853a), based on specimens collected in 1851 by S.W. Woodhouse (NMNH 000246, NMNH 047983), Surgeon and Naturalist to the Sitgreaves Expedition. The type specimens were reportedly from the Zuni River (tributary to Little Colorado River). Later work by Smith et al. (1979) reported the type locality (Zuni River) as incorrect. Smith et al. (1979) concluded the correct locality of the type specimen collection was most likely the site of Sitgreaves' last station in the LCR basin during the expedition, below Grand Falls; however, Sublette et al. (1990) suggests that the specimens may have been collected from the Rio Pescado (tributary to the Zuni River) and incorrectly cited as the Zuni River. During a search of the literature, one reference was found for a former population of chub in another tributary to the LCR, Silver Creek (Kobetich 1974), but no other record of this population has been found.

**Bill Williams River and Tributaries**
Based on Minckley (1973) and museum and agency database searches (see Appendix D-4, and Appendix E-3), roundtail chubs historically occupied the Bill Williams River and most of its perennial tributaries. Museum records containing chubs were found for 11 streams in the drainage (Big Sandy, Bill Williams, and Santa Maria rivers; Boulder, Burro, Conger, Francis, Kirkland, Sycamore, Trout, and Wilder creeks).

**Gila River and Tributaries**
Collection records indicate roundtail and headwater chubs historically occupied much of the mainstem Gila River, with specimens collected from mainstem portions in New Mexico (Propst 1999) to near the confluence with the Colorado River in Arizona (Snyder 1915). Chubs in the lower mainstem Gila River (from below Coolidge Dam to the confluence with the Colorado River) were probably locally common where river morphology provided suitable habitat.

Tributaries to the Gila River in which chub collections were found, or where historic range likely occurred include the San Francisco, San Carlos, and San Pedro rivers; and Ash (tributary to San Carlos River), Beaver (tributary to East Fork Gila River), Eagle, Taylor (tributary to East Fork Gila River), Aravaipa, Turkey (tributary to Aravaipa Creek), and Babocomari (tributary to the San Pedro River) creeks. Starnes (1992) reported collecting roundtail chubs from "Blue River, at Blue River Camp", an area of easy access and high recreational use. Specimens were reportedly deposited in the ASU museum (Starnes 1992), but a search of the ASU Museum database failed to find any record of them. Extensive sampling prior to, and following this collection failed to detect the presence of any species of chubs in the Blue River drainage (Silvey and Thompson 1978) and the reported locality is believed erroneous (P. Marsh, pers. comm.). Current native fish composition in the Blue River is identical to other streams in the Gila River basin that contain roundtail chubs, and it's likely that the lower reaches of the Blue River historically contained roundtail chubs before habitat alterations in the early 1900s removed most of the pool habitat preferred by roundtail chubs (S. Stefferud, pers. comm.).

**Salt River and Tributaries**

Distribution of chubs within the Salt River drainage of Arizona was extensive, with the Salt River mainstem and many of its tributary streams supporting large populations of chubs. Madsen (1935a) reported "bonytails" (= roundtail chubs) as abundant in the five miles of the Salt River sampled on the Tonto National Forest. Chubs have been found throughout the Black River mainstem, and as far upstream as Three Forks on the East Fork Black River (UMMZ 121651). Gee (1938) also recorded "bonytail" occurring in Boneyard Creek, tributary to East Fork Black River. No chub museum specimens were found from Boneyard Creek, but the chub encountered by Gee (1938) were likely *Gila robusta.* In the White River distribution of roundtail chubs in the system extended into the North Fork White River, upstream to above the confluence of Diamond Creek (ASU 11237). Additional tributaries to Salt River with historic roundtail chub collections include Canyon, Carrizo, Cedar, Cherry, Corduroy, and Salome creeks.

Headwater chubs were once widespread throughout the Tonto Creek (tributary to the Salt River) basin, occupying suitable habitats of Tonto Creek and its tributaries. Madsen (1935a) found "bonytails" (likely headwater chubs based on distribution information from Minckley and DeMarais [2000]) abundant in Christopher, Haigler, Marsh, and Spring creeks; common in Horton Creek; and rare in Sharp Creek (tributary to Christopher Creek). Other tributaries in the Tonto Creek basin that contained historic populations of headwater chubs included Gun and Rye creeks (tributaries to Tonto Creek), Buzzard Roost and Rock creeks (tributaries to Spring Creek), and Gordon Creek (tributary to Marsh Creek). Historical collections were not found for Gun, Rye, Buzzard Roost, Rock, and Gordon creeks, but recent surveys (1983-2001) indicate that headwater chubs currently occupy these streams (unpublished data from the AGFD Native Fish Database).

**Verde River and Tributaries**

Girmendonk and Young (1997) identified historical populations of chubs from the Verde River and eight tributaries (Wet Beaver, Dry Beaver, Oak, West Clear, East Verde, Webber, Fossil, and Deadman creeks). Roundtail chubs have been recorded from the headwaters of the Verde River near Sullivan Lake (Girmendonk and Young 1997) to its confluence with the Salt River (Bryan and Robinson 2000). Based on extensive collection and sampling records it is likely that roundtail chubs were abundant throughout the Verde River mainstem and its tributaries. In October 2001, a new population of chub was discovered in Wet Bottom Creek (Marsh 2001), but the current distribution of chubs in Wet Bottom Creek is unknown. Four specimens were preserved and deposited at the ASU Collection of Fishes, but have not been accessioned into the museum at the time of completion of this report (P. Unmack, pers. comm.). The population is likely *Gila nigra* due to Wet Bottom Creek's close proximity to the East Verde River and Deadman Creek (both identified as containing *G. nigra* [Minckley and DeMarais 2000; P. Unmack, pers. comm.]). See Appendix E-7i for location of the Wet Bottom Creek survey.

**Agua Fria River and Santa Cruz River basins**

Chub populations found within the Agua Fria and Santa Cruz river basins in Arizona are *G. intermedia*, with no evidence found to suggest that either roundtail or headwater chubs occurred

in either drainage. Lack of persistent surface flows from the Santa Cruz River to the Gila River confluence and unsuitable habitat (lack of deep pools and runs) within the lower portions of the Santa Cruz River may have prevented the successful invasion by either *G. robusta* or *G. nigra* into the Santa Cruz River basin.

**Mexico**

Outside of the Colorado River basin, Hendrickson et al. (1981) reported roundtail chubs as widely distributed in the Rio Yaqui system of Sonora, Mexico, where it occurs in rivers or smaller streams with well-developed, permanent pools. Propst (1999) described the distribution of roundtail in Mexico to include the rios Yaqui, Fuerte, and Sinaloa in northwestern Mexico. Minckley and DeMarais (2000) reported forms in coastal rivers southward to the State of Sinaloa, Mexico, as largely unstudied, and based on genetic differences from chubs of the Colorado River basin, W.L. Minckley (pers. comm.) believes chubs in Mexican waters represent a separate species.

SITE-SPECIFIC DISTRIBUTION AND STATUS

**Lower Colorado River Mainstem**

Site Description:

For the purpose of this report, the lower Colorado River mainstem is the Colorado River from Glen Canyon Dam, Arizona, downstream to the confluence with the Gulf of California, Mexico. The Colorado River mainstem is one of the most highly modified and controlled rivers in North America (Minckley 1985). Downstream of the Grand Canyon, nearly the entire volume is diverted or held in reservoirs, with progressively smaller downstream flows maintained by return of agricultural and domestic wastewaters, seepage and tributary flows, until little or no water reaches the Gulf of California in Mexico.

Land Ownership:

Due to the length of the lower Colorado River, and because roundtail chubs are no longer found in the lower Colorado River, land ownership data was not calculated.

Land and Water Uses:

Land uses within the lower Colorado River include municipal and urban development, recreation, livestock grazing, wildlife and fisheries management, and mining. Water uses include impoundment and storage for hydropower, diversion, agricultural irrigation, municipal and domestic water supplies, industry, groundwater pumping, and recreation.

Collection History:

The earliest collections of roundtail chubs from the mainstem Colorado River below Glen Canyon Dam were made in 1966 from the Glen Canyon Dam site area (ASU 7037, ASU 2490). The most recent collection of roundtail chub was made in 1984 from Lake Mohave, Mohave

County, Arizona (ASU 10423). Other roundtail chub collections were made in 1969 and 1973. See Appendix D-2 for complete collection history.

Results of Surveys Conducted for this Project:
The lower Colorado River was not surveyed for this project because the roundtail chub is extirpated from this river.

Population Status:
**Extirpated**. The roundtail chub is considered extirpated from the lower Colorado River mainstem (Minckley 1979, Valdez and Carothers 1998).

**Little Colorado River and Tributaries**

The Little Colorado River (LCR) basin occupies an area of approximately 70,160 $km^2$ within the Colorado Plateau Province of northeastern Arizona and western New Mexico. Elevation within the basin ranges from 3,850m at its highest point to 830m at the mouth of the LCR, where it joins the Colorado River (Young et al. 2001). Major tributaries to the LCR include the Zuni River and Chevelon, Clear, and Silver creeks.

Little Colorado River

Site Description:
Headwaters of the LCR originate on the northern slopes of the White Mountains in eastern Arizona, and the channel follows a northwesterly course to its confluence with the Colorado River. Perennial flows within the LCR mainstem typically disappear below the town of St. Johns (Young et al. 2001). The Lyman basin is delineated as the upper LCR drainage, from Lyman Lake Dam to the headwaters of the LCR. Lyman Lake is located approximately 10 km south of the town of St. Johns, Arizona. The drainage area of Lyman basin encompasses 2098 $km^2$, with elevation ranging from 3477–1811 m.

Land Ownership:
Land ownership within a 1.6 kilometer (km) (1.0 mile [mi]) buffer along the Little Colorado River is comprised of Navajo Indian Reservation (40%), private (38%), Arizona State Land Department (ASLD) (12%), Apache-Sitgreaves National Forest (4%), Bureau of Land Management (BLM) (3%), Zuni Indian Reservation (1%), Grand Canyon National Park (1%), Wapatki National Monument (1%), AGFD (<1%), and Fort Apache Indian Reservation (<1%) lands.

Land and Water Uses:
Land uses within the boundaries of the Lyman basin include agriculture, timber production, cattle grazing, mining, wildlife and fisheries management, recreation, and residential development. Young et al. (2001) reported 51 developed reservoirs and 2000 stock ponds within

the upper LCR watershed. The upper LCR sub-basin contains an estimated 14,600 irrigated acres under cultivation, with approximately 18,360 acre-ft. of water diverted for irrigation.

Collection History:
The earliest known collection of roundtail chubs from the LCR was made in 1873, with the location described as "Col. Chiquito, Arizona" (NMNH 015799). The LCR was often called "Colorado Chiquito" by old-timers (Young et al. 2001). The most recent collection of roundtail chubs from the LCR was from 1939 (UMMZ 137080) approximately 5–6 miles south of St. Johns and roughly 6 miles north of Lyman Lake. Other roundtail chub collections were made in 1934 and 1938 (See Appendix D-3c for entire collection history). A paper by Hemphill (1953, 1954) reported "3,000 lbs. of bonytail (*Gila robusta elegans*)" killed in Lyman Lake as a result of treatment with a toxicant to remove unwanted fish species. The lake was drained 48 hours after initiation of treatment and an additional count of 3,000 bonytail was reported. Identification of chubs from Lyman Lake as *G. robusta elegans* (Hemphill 1953, 1954) is likely erroneous, the correct designation most likely *G. r. robusta*. However, it has been proposed that the chubs reported by Hemphill (1953, 1954) were instead Little Colorado suckers (*Catostomus* sp.) (D. Dorum, pers. comm.). Chamberlain (1904) referred to flannelmouth suckers (*Catostomus latipinnis*) as "bonytail suckers" and Little Colorado suckers were once identified as *Catostomus latipinnis*; a species that was abundant in the upper Little Colorado River basin (Minckley 1973). It is possible that these fish were simply identified as "bonytail", referring to "bonytail suckers", then incorrectly reported as *Gila robusta elegans*. Hemphill (1953, 1954) does not report presence of any suckers salvaged at Lyman Lake, while other treatments in the area around the same time period reported suckers killed, without the presence of any chubs (D. Dorum, pers. comm.).

Results of Surveys Conducted for this Project:
The Little Colorado River was not surveyed for this project because the roundtail chub is extirpated from this river.

Population Status:
**Extirpated**. Intensive sampling within the Lyman sub-basin over the previous decade has failed to detect any roundtail chubs. The Silver Creek Fish Hatchery should be considered as a location to propagate roundtail chubs for reintroduction or augmentation stockings in the LCR basin. Roundtail chubs from East Clear Creek could be used as brood stock for the hatchery, and high priority translocation sites have been identified on the LCR between Springerville and Lyman Lake (M. Lopez, pers. comm.).

Zuni River

Site Description:
Headwaters of the Zuni River drainage in New Mexico are comprised of several perennial waters including Cebolla Creek, Nutria and Pescado rivers, and McGaffey, Nutria, Black Rock and Ramah lakes. Sublette et al. (1990) refers to oral accounts of present day residents of the Zuni

Pueblo indicating that during the time of their grandparents the Zuni River was a deep perennial stream with pools up to 3m deep. Although flow might cease during dry years, the pools would persist.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the Zuni River in Arizona is comprised of private (61%), ASLD (26%), BLM (5%), and Zuni Indian Reservation (7%) lands. In New Mexico, land ownership within a 1.6 km (1.0 mi) buffer along the Zuni River is comprised of 100% Zuni Indian Reservation lands.

Land and Water Uses:
Land and water uses along the Zuni River include livestock grazing, groundwater withdrawals, low-intensity and localized residential development, water storage reservoirs and diversions, agriculture, mining, and irrigation.

Collection History:
Type specimens of *Gila robusta* were collected from the Zuni River in 1851 by S.W. Woodhouse (NMNH 000246), but no specific locality information was provided. Other collections from the Zuni River were made in 1873 (NMNH 016635) and in 1874 (NMNH 015762). No roundtail chubs have been collected from the drainage since the late 1800s (Sublette et al. 1990). Based upon unsuitable size, flow and habitat, Smith et al. (1979) surmised that locality information for the Zuni River collection of 1851 is erroneous, with probable correct collection locality being the Little Colorado River below Grand Falls. However, Sublette et al. (1990) suggests that the specimens may have been collected from the Rio Pescado and incorrectly cited as the Zuni River. Regardless, no roundtail chubs have been collected from the Zuni River since the late 19$^{th}$ century, and are considered extirpated from the drainage in New Mexico (Sublette et al. 1990, Propst 1999) and Arizona. Within the boundaries of Arizona, waters are intermittent, providing no known habitat for chubs. See Appendix D-3d for complete collection history.

Results of Surveys Conducted for this Project:
The Zuni River was not surveyed for this project because the roundtail chub is extirpated from this river (Propst 1999).

Population Status:
**Extirpated**. The majority of the Zuni River may have supported only “an extremely limited and marginal fish fauna”, dependent upon periodic recruitment during high flows from the Rio Pescado (Sublette et al. 1990). Several piscivorous nonnative fishes have been introduced into the drainage in the past (Propst 1999). Sublette et al. (1990) found little evidence to suggest that the Zuni River was ever perennial except perhaps for small reaches below confluences with the rios Nutria and Pescado in New Mexico.

Chevelon Creek

Site Description:
Chevelon Creek is formed by the junctions of Woods and Willow Springs canyons at approximately 2,143 m elevation, atop the Mogollon Rim, and flows in a northeasterly direction to the confluence with the LCR. Runoff storage in the drainage is maintained in two headwater reservoirs (Woods Canyon and Willow Springs lakes) and one mainstem reservoir (Chevelon Lake). Area of the drainage encompasses 2,070 $km^2$, with elevation ranging from 2,410 – 1,494 meters.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Chevelon Creek is comprised of Apache-Sitgreaves National Forest (50%), private (36%), ASLD (12%), BLM (1%), and AGFD (1%) lands.

Land and Water Uses:
Land and water uses along Chevelon Creek include timber production, cattle grazing, mining, recreation, and residential and industrial development. Young et al. (2001) reported 4 developed reservoirs and 417 stock ponds within the Chevelon Creek sub-basin, with an estimated total cultural depletion of water within the sub-basin of 6,470 ac-ft·$yr^{-1}$, and an estimated undepleted flow of 35,740 ac-ft·$yr^{-1}$.

Collection History:
The earliest identified roundtail chub collection from Chevelon Creek was made in 1965 below Chevelon Dam (ASU 2185). The most recent roundtail chub collections from Chevelon Creek were made in 1991 (ASU 12861, ASU 12871, ASU 13261, ASU 13265). Additional roundtail chub collections for the stream were made in 1966 and 1973. Surveys where roundtail chubs were sampled from Chevelon Creek were conducted in 1991, 1992, 1995, 1997, and 1998. See Appendix D-3a for complete collection history, and Appendix E-2a for complete sampling history.

Results of Surveys Conducted for this Project:
Chevelon Creek was not surveyed for this project because information gathered was recent enough (unpublished data from the AGFD Native Fish Database [AGFD NFDB] from 1998) to determine population status.

Population Status:
**Unstable – Threatened**. AGFD survey data from 1995-1998 indicates that roundtail are uncommon with an extremely limited distribution. At least 18 nonnative fish species have been recorded from the drainage. Stream evaluations within the watershed by ADEQ (1993) indicated water quality not meeting standards for sediments and turbidity, due to grazing and unknown sources. High channel erosion, habitat modification, and unsatisfactory watershed condition were reported for the watershed.

The perennial habitats in Chevelon Creek upstream of Chevelon Lake between Pony Canyon and McLaws Road bridge are suitable for roundtail chubs. All other areas of Chevelon Creek are currently unsuitable for sustainable chub populations due to lack of perennial water and pool habitat, and overabundance of nonnative predatory fish (M. Lopez, pers. comm.). Juvenile roundtail chubs should be translocated from areas of Chevelon Creek where they currently occur into areas of the creek identified as suitable for chubs, if the translocations will not adversely affect the population currently in Chevelon Creek.

East Clear Creek and Clear Creek

Site Description:
The East Clear Creek drainage encompasses an area of approximately 2,070 $km^2$, with elevation ranging from 2,410 – 1,494 m. Its headwaters originate from the Mogollon Rim, at roughly 2,194 m elevation, and East Clear Creek flows in a northeasterly direction to its confluence with Willow Creek. At this point, East Clear Creek becomes Clear Creek downstream to confluence with the LCR. For reporting purposes, and to avoid confusion with West Clear Creek, the entire creek will be referred to as East Clear Creek. Runoff from several watersheds within the drainage is stored in four reservoirs, Blue Ridge Reservoir, Knoll and Bear Canyon lakes in the upper drainage, and Clear Creek Reservoir near its confluence with the LCR.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along East Clear Creek is comprised of Coconino National Forest (39%), private (29%), Apache-Sitgreaves National Forest (12%), ASLD (19%), Tonto National Forest (1%), and BLM (<1%) lands.

Land and Water Uses:
Land uses within the East Clear Creek sub-basin include recreation, agriculture, livestock grazing, mining, timber production, and limited residential development. Blue Ridge Reservoir serves as a storage basin from which water is pumped to the East Verde River in the Gila River basin. The East Clear Creek drainage contains 147 developed stock ponds, and 1010 irrigated acres consuming approximately 6,210 ac-ft $\cdot yr^{-1}$. Total cultural depletions within the drainage are estimated at 19,520 ac-ft $\cdot yr^{-1}$ (Young et al. 2001).

Collection History:
The earliest identified collection of roundtail chubs from East Clear Creek was made in 1960 (UMMZ 178691), about 13 miles west of the Chevelon Ranger Station. The only other roundtail chub collection identified from East Clear Creek was made in 1991 (ASU 12856), south of East Sunset Mountain. Surveys where roundtail chubs were sampled from East Clear Creek were conducted in 1964, 1991, 1999, and 2000. See Appendix D-3b for complete collection history, and Appendix E-2b for complete sampling history.

Results of Surveys Conducted for this Project:
East Clear Creek was not surveyed for this project because information gathered was recent enough (AGFD NFDB 2000) to determine population status.

Population Status:
**Stable – Threatened**. Sampling during 1999 and 2000 by AGFD showed roundtail chubs common, although occurring primarily in reaches of the stream identified as intermittent. Potential threats by nonnative fish species exist. Stream evaluations within the watershed by ADEQ (1993), indicated water quality not meeting standards due to point source discharge in exceedance of permit discharge limitations. At one site, turbidity due to channel erosion from rangeland, off-road vehicles, and habitat modifications exceeded acceptable levels; at another site, biological oxygen demand, soluble solids, settleable solids, and fecal coliforms exceeded acceptable standards (ADEQ 1993).

**Bill Williams River and Tributaries**

The Bill Williams basin encompasses roughly 14,141 $km^2$ (5,460 $mi^2$), located entirely within the Basin-and-Range Province, north and west of the Gila River Basin. Primary drainages within the basin include the Santa Maria, Big Sandy (including Burro Creek and its tributaries), and the Bill Williams rivers.

Bill Williams River

Site Description:
The Bill Williams River is a tributary to the Colorado River, presently entering the Colorado River through Lake Havasu. The Bill Williams River was previously formed by the confluence of the Santa Maria and Big Sandy rivers, both of which now flow into Alamo Lake, formed following the completion of Alamo Dam in 1968. Alamo Lake is the only major impoundment in the system, constructed principally for flood control and desiltation of waters entering Lake Havasu through the Bill Williams arm (Minckley 1985). Flow of the Bill Williams River became regulated by Alamo Lake beginning March 2, 1969 (USGS 1998).

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the Bill Williams River is comprised of BLM (63%), private (19%), Havasu National Wildlife Refuge (7%), ASLD (6%), Army Corps of Engineers (3%), and Bureau of Reclamation (1%) lands.

Land and Water Uses:
Land and water uses around the Bill Williams River include mining, open-range livestock grazing, recreation, wildlife conservation, groundwater pumping, and water diversions.

Collection History:
Only one collection record of roundtail chub was found from the Bill Williams River (ASU 5896), collected above Alamo Dam in 1970 by J.E. Johnson (Appendix D-4b). Kepner (1980) reported roundtail chubs totally absent from the Bill Williams River below Alamo Dam, where they had reportedly occurred prior to impoundment. No survey records from the Bill Williams River reporting the occurrence of roundtail were found. During 1993, 384 roundtail chubs from Burro Creek were introduced into waters on the Bill Williams River National Wildlife Refuge (USFWS 1993), but all were believed lost due to desiccation of the system (C.O. Minckley, pers. comm.).

Results of Surveys Conducted for this Project:
The Bill Williams River was not surveyed for this project because the roundtail chub is extirpated from this river (Kepner 1980).

Population Status:
**Extirpated**. Kepner (1980) reported roundtail as entirely absent from the Bill Williams River below Alamo Dam.

Santa Maria River

Site Description:
The Santa Maria River is formed by the confluence of Sycamore and Kirkland creeks, and flows southwest for approximately 66 km into Alamo Lake (Kepner 1980). Area of the Santa Maria watershed encompasses approximately 3,937 $km^2$. The stream channel of the Santa Maria is typically broad, shallow and low gradient, with predominant substrates of sand and gravel. Kepner (1979) reported fish habitat in the Santa Maria as "marginal at best", with lack of fish diversity believed due to habitat homogeneity.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the Santa Maria River is comprised of BLM (49%), ASLD (34%), private (12%), and Army Corps of Engineers (5%) lands.

Land and Water Uses:
Land and water uses within the Santa Maria watershed include mining, livestock grazing, agriculture, groundwater pumping, recreation, locally heavy residential development, and dispersed residential development.

Collection History:
Roundtail chub collections from the Santa Maria watershed include those from Kirkland and Sycamore creeks (headwater tributaries), and the Santa Maria River. The earliest identified collection of roundtail chubs from the Santa Maria River was made in 1979 by W.G. Kepner (ASU 8865) below the Highway 96 bridge. The most recent collections of roundtail chubs from the Santa Maria River were made in 1999 at the confluence of Kirkland and Sycamore creeks

(ASU 18495), and at the end of the canyon above Highway 96 (ASU 18503). Additional collections were made in 1979, 1980, and 1991. Surveys where roundtail chubs were sampled from the Santa Maria were conducted in 1998. The earliest identified collection of roundtail chubs from Sycamore Creek was made in 1980 by Kepner (ASU 8654) above the confluence with Kirkland Creek. The most recent chub collection from Sycamore Creek was made in 1999 at Scott's Basin (ASU 18486). The only collection of roundtail chubs found for Kirkland Creek (ASU 8643) was made in 1980 by W.G. Kepner (Appendix D-4g). Examination of gray literature identified one survey record of "several" roundtail chubs sampled in Kirkland Creek (Young 1992). Roundtail chubs were found above a rock-masonry diversion dam, which supplied irrigation water to the Muleshoe Ranch in the lower reach of the stream. Locality of the survey site was given as "T14N, R7W, sec 35 (east) or 36 (west)". See Appendixes D-4g, D-4h, and D-4i for complete collection history of the Santa Maria River drainage. See Appendixes E-3e, E-3f, and E-3g for complete sampling history of the Santa Maria River drainage.

Results of Surveys Conducted for this Project:
The Santa Maria River was not surveyed for this project because information gathered was recent enough (surveys conducted in 1999 by ASU [P. Unmack, pers. comm.]) to determine population status.

Population Status:
**Unstable – Threatened**. Recent sampling by Arizona State University personnel during 1999 indicate chubs locally common in Sycamore Creek, absent in Kirkland Creek, and uncommon in the Santa Maria (P. Unmack, pers. comm.) where previously reported as numerous by Kepner (1980). Predatory and competitive nonnative species were common or abundant in all localities sampled. Lower reaches of the drainage exceeded acceptable standards for beryllium, cyanide and turbidity during sampling in the early 1990s (ADEQ 1996). Kepner (1979) reported the greatest threat to the Santa Maria watershed was the reopening of the Anderson Uranium Mine adjacent to the Santa Maria River downstream of the U.S. Highway 93 bridge, citing potential impacts from sediments, heavy metals, radionuclides, and water withdrawals from either surface or groundwater sources.

Big Sandy River

Site Description:
The Big Sandy River originates at the confluence of Knight and Trout creeks, and flows south 61 km into Alamo Lake. The Big Sandy River is primarily a broad, shallow, low gradient stream, comprised primarily of sandy runs, with few pools or riffles (Kepner 1980).

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the Big Sandy River is comprised of BLM (48%), private (42%), ASLD (8%), Army Corps of Engineers (<1%), and Hualapai Indian Reservation (<1%) lands, and other Indian allotments (<1%).

Land and Water Uses:
Land and water uses along the Big Sandy River include groundwater pumping for agriculture and domestic use, water diversion, mining, livestock grazing, burro management, wildlife management, limited recreation, and development.

Collection History:
The only roundtail chub collections identified from the Big Sandy River were four specimens collected in 1979 by W.G. Kepner (ASU 8984, ASU 11299, ASU 11632, ASU 8981). In the vicinity of the Burro Creek confluence, 26 roundtail chubs were sampled by Kepner (1979), but he attributed their presence in the stream as the result of outflow from perennial tributaries during flooding. Although sampling station localities were provided in the report by Kepner (1979), localities where roundtail were sampled, number per locality, and date of sampling were not provided. See Appendix D-4a for complete collection history, and Appendix E-3a for complete sampling history.

Results of Surveys Conducted for this Project:
The Big Sandy River was not surveyed for this project because the roundtail chub is extirpated from this river (Kepner 1979).

Population Status:
**Extirpated.** Four specimens were collected from the Big Sandy in 1979, and an additional 26 sampled, but Kepner (1979) believed their presence in the stream due to movement from perennial tributaries during flooding. His conclusion was based on the absence of suitable roundtail habitat in the main channel of the Big Sandy. Regardless, roundtail occurred in the mainstem river, if only intermittently, and movement of chubs between tributaries of the Big Sandy River and into the Bill Williams River likely occurred during wetter periods in the past.

Trout Creek

Site Description:
Trout Creek is a tributary to the Big Sandy River. Headwaters of Trout Creek drain the Aquarius and Mohon mountains in the northeastern portion of the Big Sandy drainage. No stocking records for any trout species were found for Trout Creek, so it is possible that the creek derived its name from a colloquial name for roundtail chub used by locals and old-timers; the Verde Trout. Kepner (1979) described the Trout Creek drainage as rugged, with moderate to steep slopes and deeply incised canyons. Aquatic habitats are much narrower, deeper, and heterogeneous than the Big Sandy River, with riffles, runs, and pools well represented. Stream banks are cut but stable, and substrates vary from gravel/cobble to small boulders.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Trout Creek is comprised of ASLD (78%), private (21%), BLM (<1%), and Hualapai Indian Reservation (<1%) lands, and other Indian allotments (<1%).

Land and Water Uses:
Land and water uses along the Trout Creek include livestock grazing, limited recreation, and residential development. Old cattle sign was seen in the drainage above and leading to Trout Creek but no sign was seen along the stream. Riparian areas and banks appeared in good condition. Lands on the upper slopes of the drainage to the south, and in the upper drainage are being developed for residential use.

Collection History:
The earliest identified collection of roundtail chubs from Trout Creek was made in 1947 by R.R. Miller (NMNH 146097) near Hubbard Ranch, Mohave County, Arizona. Additional roundtail chub collections were made in 1950, 1966, 1979, and 1984. Surveys where roundtail chubs were sampled from Trout Creek were conducted in 1966, 1977, 1978, 1982, 1985, 1988, 1990, 1992, and 1999. See Appendix D-4j for complete collection history, and Appendix E-3h for complete sampling history.

Results of Surveys Conducted for this Project:
Surveys conducted in the middle reaches of Trout Creek during March 2001 found no roundtail chubs. Green sunfish (*Lepomis cyanellus*) and black bullhead (*Ameiurus melas*) were the only species found and both were abundant. Available habitats appeared extremely well suited for roundtail chubs (deep pools, undercut banks, boulders), but were occupied exclusively by nonnatives; underneath one well-developed undercut boulder 35 black bullheads were sampled. Surveys conducted in upper reaches of Trout Creek during summer 2001 collected roundtail chubs (ASU 18344, ASU 18345), although they were rare (5 roundtail chubs collected in 2876 shocking seconds). Black bullheads and green sunfish were also abundant in upper Trout Creek.

Population Status:
**Unstable – Threatened**. Kepner (1979) reported upper reaches of Trout Creek occupied exclusively by natives, with roundtail chubs the second most abundant species throughout the stream. Lower reaches were occupied by both native and nonnative species, with native species predominant. A die-off of fish was reported in Trout Creek during 1997 (T19N, R11W, sec. 27-28). Specimens were examined and found heavily infested with black grub (*Neascus* sp.), which may have weakened the fish sufficiently to cause bacterial hemorrhagic septicemia (M.F. Kubacki 1997). Prior to 1997, roundtail had been commonly encountered during monitoring activities by AGFD.

Burro Creek

Site Description:
Burro Creek is formed by the confluence of Pine Creek and Cabin Wash, flowing about 92 km southwest to its confluence with the Big Sandy River (Kepner 1979). Burro Creek drainage encompasses approximately 1,779 $km^2$, receiving runoff from the Aquarius, Mohon and Santa Maria mountains. Major tributaries to Burro Creek include Francis, Boulder, and Conger creeks. Kepner (1980) describes aquatic habitats as heterogeneous, with riffle, run, and pool habitats

well represented in the system, but much of the stream is reduced to intermittent flows during drier months.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Burro Creek is comprised of BLM (52%), private (30%), and ASLD (18%) lands.

Land and Water Uses:
Land and water uses along Burro Creek include mining, livestock grazing, wild burro management, localized recreation, and groundwater pumping for industrial and domestic consumption.

Collection History:
The earliest identified collection of roundtail chubs from Burro Creek was made in 1947 by R.R. Miller (NMNH 146101) approximately 20 miles southeast of Wickieup, Mohave County, Arizona. The most recent roundtail chub collection was made in 1999 by W.L. Minckley and P. Unmack (ASU 18506) at Six Mile Crossing. Additional collections were made in 1965, 1966, 1974–1976, and 1978–1980. Surveys where roundtail chubs were sampled from Burro Creek were conducted in 1977, 1987, 1991–1996, and 1999. See Appendix D-4d for complete collection history, and Appendix E-3c for complete sampling history.

Results of Surveys Conducted for this Project:
Burro Creek was not surveyed for this project because information gathered was recent enough (Morgan et al. 1997; surveys conducted by ASU in 1999 [P. Unmack, pers. comm.]) to determine population status.

Population Status:
**Unstable – Threatened**. Kepner (1979) found introduced species increasing in abundance in the lower reaches of Burro Creek with the headwaters almost exclusively occupied by native species. Though roundtail numbers were comparable to those found by Kepner (1979), survey data provided by Morgan et al. (1997) indicated that native fishes in the system had declined while nonnatives had increased and possibly expanded in distribution. Morgan et al. (1997) believed that direct comparisons between the two surveys were not valid, due to sampling gear differences and indications of extreme differences in climatic and stream-flow conditions between the two periods. Several of the sites sampled during 1979 were dry during the 1996 sampling and fishes may have been concentrated in the only suitable habitats available during the 1996 surveys. Within Burro Creek, threats to roundtail chubs include release of toxic effluents into aquatic systems from mining operations, depletion of waters by withdrawal for mining and municipal use, degradation of riparian areas and aquatic systems through continued access by livestock and burros, and expansion in range and abundance of competitive and predaceous nonnative fishes.

Boulder Creek

Site Description:
Boulder Creek, a tributary to Burro Creek, flows in a southwesterly direction through Yavapai county until its confluence with Burro Creek about 2.5 km east of the Yavapai/Mohave county border. Boulder Creek consists of isolated pools between intermittent runs, with rubble and cobble substrates throughout (Morgan et at. 1997).

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Boulder Creek is comprised of ASLD (45%), Prescott National Forest (22%), private (21%), and BLM (12%) lands.

Land and Water Uses:
Land and water uses around Boulder Creek include mining, livestock grazing, wild burro management, localized recreation, and groundwater pumping for industrial and domestic consumption.

Collection History:
The earliest identified collections of roundtail chubs from Boulder Creek were made in 1978 by W.G. Kepner (ASU 8757, ASU 8758, ASU 8762, ASU 8771). The only other roundtail chub collection from Boulder Creek was made in 1999 by W.L. Minckley and P. Unmack (ASU 18505). Surveys where roundtail chub were sampled from Boulder Creek were conducted in 1993 and 1996. See Appendix D-4c for complete collection history, and Appendix E-3b for complete sampling history.

Results of Surveys Conducted for this Project:
Boulder Creek was not surveyed for this project because information gathered was recent enough (Morgan et al. 1997; surveys conducted by ASU in 1999 [P. Unmack, pers. comm.]) to determine population status.

Population Status:
**Stable – Threatened.** Roundtail chub was the most abundant species sampled in 1996 (Morgan et al. 1997), and based on a survey conducted during 1999 by ASU, roundtail remain abundant in Boulder Creek (P. Unmack, pers. comm.). Effluent from mining operations and the presence of green sunfish, red shiner, and yellow bullhead in Boulder Creek pose a threat to the native fish population (Morgan et al. 1997). Groundwater pumping for industrial and domestic use is a serious threat for all of the streams in the Burro Creek drainage.

Conger Creek

Site Description:
Conger Creek, a tributary to Burro Creek, flows in a westerly direction through Yavapai county before its confluence with Burro Creek about 11 km east of the Mohave/Yavapai county border.

Not surveyed since 1979 (Kepner 1979), Morgan et al. (1997) described difficult sampling conditions at Conger Creek due to rugged and remote terrain and private property restrictions.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Conger Creek is comprised of ASLD (94%) and private (6%) lands.

Land and Water Uses:
Land and water uses around Conger Creek include mining, livestock grazing, wild burro management, localized recreation, and groundwater pumping for industrial and domestic consumption.

Collection History:
Only two collections of roundtail chubs from Conger Creek were found. In 1966 L.H. Carufel collected chubs three miles above the confluence with Burro Creek (ASU 2353), and in 1979 W.G. Kepner collected chubs above the confluence with Burro Creek (ASU 8908). No survey records documenting roundtail chub occurrence in Conger Creek were identified. See Appendix D-4e for complete collection history.

Results of Surveys Conducted for this Project:
Conger Creek was not surveyed for this project due to remote, rugged terrain and private property restrictions (Morgan et al. 1997).

Population Status:
**Unknown.** Due to rugged, remote terrain, lack of collection history, and private property restrictions, the current status of the chub population in Conger Creek is unknown, although Kepner (1979) found only native species in Conger Creek during his survey.

Francis Creek

Site Description:
Francis Creek, a tributary to Burro Creek, flows in a southeasterly direction through Mohave and Yavapai counties before its confluence with Burro Creek about 8.2 km east of the Mohave/Yavapai county border and about 4 km south of the Burro/Conger creek confluence. Morgan et al. (1997) described Francis Creek as dominated by rubble and cobble substrates, with the presence of a variety of pool, riffle, and run habitats.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Francis Creek is comprised of private (57%), BLM (26%), and ASLD (17%) lands.

Land and Water Uses:
Land and water uses around Francis Creek include mining, livestock grazing, wild burro management, localized recreation, and groundwater pumping for industrial and domestic consumption.

Collection History:
The earliest identified collection of roundtail chubs from Francis Creek was made in 1950 by R.R. Miller and H.E. Winn (UMMZ 162659). Additional roundtail chub collections from Francis Creek were made in 1967, 1979, and 1991. Surveys where roundtail chubs were sampled from Francis Creek were conducted in 1991–1996 and 1998. See Appendix D-4f for complete collection history, and Appendix E-3d for complete samplings history.

Results of Surveys Conducted for this Project:
Francis Creek was not surveyed for this project because information gathered was recent enough (Morgan et al. 1997, AGFD Region 3 unpublished data from 1998) to determine population status.

Population Status:
**Stable – Threatened**. Morgan et al. (1997) reported a dominant native fish structure in Francis Creek, with natives representing 83% of the total catch. Roundtail chubs comprised 47% of the total catch, with 80% of the roundtail classified as juvenile fish, showing successful reproduction. However, impacts from nonnative green sunfish and black bullheads (species that comprised the remaining 17% of the total catch) could pose a serious threat to roundtail chubs and other native fish in the system.

Wilder Creek

Site Description:
Wilder Creek is a tributary of Boulder Creek, flowing in a southwesterly direction from its headwaters at Wilder Spring to the confluence with Boulder Creek near Hillside Mine. Hilwig (2000) describes Wilder Creek as a perennial stream with cobble/boulder substrate composed of small (3-10m long and 1-2 m wide) adjacent pools and very few riffles. The stream also contains small bogs and saturated root masses. The riparian area contains several storied stands of sycamore, ash, alder, walnut, and other riparian vegetation, with a 100% canopy cover.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Wilder Creek is comprised of ASLD (92%), private (5%), and BLM (3%) lands.

Land and Water Uses:
Land and water uses along Wilder Creek include livestock grazing, wild burro management, localized recreation, and groundwater pumping for industrial and domestic consumption. During both the 2000 and 2001 efforts, old cattle sign was noted but cattle use appeared light. Stock

ponds with water were available on mesas above the stream, and cattle present on the mesas appeared to be using only those resources during the time of the 2001 collection.

Collection History:
The earliest identified collection of roundtail chub from Wilder Creek was made in 1998 by J. Hinkle at Wilder Spring (ASU 16713). The only survey where roundtail chubs were sampled from Wilder Creek was conducted in May 2000, and reported roundtail chubs abundant in headwater reaches of the stream (Hilwig 2000). Over 250 roundtail of several size-classes were surveyed in approximately 0.8 km of stream. See Appendix D-4k for complete collection history, and Appendix E-3i for complete sampling history.

Results of Surveys Conducted for this Project:
Wilder Creek was surveyed at, and below, Wilder Spring during March 2001. Roundtail chubs were abundant and the only species sampled and collected (ASU 18301).

Population Status:
**Unknown.** Although the upper reach of Wilder Creek (near Wilder Spring) holds a stable, reproducing roundtail chub population without the presence of any nonnative species (roundtail were the only species sampled in 2000-2001), not enough temporal sampling data exists on the creek to determine population status. There are no mines in the Wilder Creek watershed and no nonnatives were sampled in 2000 or 2001, so immediate threats appear low. Over 90% of the land within a 1.0-mile buffer around Wilder Creek is managed by the Arizona State Land Department and developments or expansion from the Bagdad area could pose future threats.

The lower reach of Wilder Creek should be sampled to determine downstream range and abundance of chubs, and to identify why nonnative species have not invaded Wilder Creek from Boulder Creek. If a natural barrier exists or perennial water does not extend to Boulder Creek, Wilder Creek's chub population should not be threatened by nonnative species. Several large cattle tanks were noted on the mesa surrounding Wilder Creek. Sampling should be conducted on these tanks to determine if nonnative species (fish, crayfish, or bullfrogs) are present and could be flushed into Wilder Creek during a major flood. The Jeep trail on which the creek was accessed during the 2001 field season had a damaged fence through which livestock and burros could access the riparian area. Fences should be maintained to keep livestock and burros out of the riparian area. Contact the city of Bagdad and the ASLD and attempt to develop a management plan for Wilder Creek focusing on maintaining a secure roundtail chub population and a healthy riparian area.

**Gila River and Tributaries**

For purposes of this report, the upper Gila River basin is defined as the mainstem Gila River and its headwater tributaries in southwestern New Mexico to Coolidge Dam on the San Carlos Apache Indian Reservation in Arizona. Headwaters of the upper Gila River include the East, Middle, and West forks of the Gila River in southwestern New Mexico. Major tributaries of the

upper Gila River include the San Francisco, San Carlos, and San Simon rivers; and Bonita and Eagle creeks. The lower Gila River basin is the Gila River from Coolidge Dam to the confluence with the Colorado River. Major tributaries to this reach are the San Pedro, Salt, Hassayampa, Santa Cruz, and Agua Fria rivers. Major tributaries to the Salt River include White, Black, and Verde rivers, and Tonto Creek.

Upper Gila River

Site Description:
The upper Gila River flows in a southwesterly direction through southwestern New Mexico and enters Arizona near the town of Duncan. In Arizona, the upper Gila River flows in a westerly direction through the San Carlos Indian Reservation and into San Carlos Lake, formed by Coolidge Dam. Drainage area of the upper Gila River encompasses roughly 33,375 $km^2$, of which approximately 9,065 $km^2$ is in New Mexico. The West Fork and Middle Fork drain the Mogollon Mountains within the Gila National Forest, and the East Fork drains the Black Range, part of the continental divide.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the upper Gila River in Arizona is comprised of private (44%), BLM (28%), San Carlos Indian Reservation (20%), and ASLD (8%) lands. In New Mexico, land ownership within a 1.6 km (1.0 mi) buffer along the upper Gila River includes BLM (20%) and state (6%) lands. Due to an error in the New Mexico land ownership database (see the Mapping and Reporting Methods section) specific ownership for the remaining 74% could not be calculated for that area; however, topographical maps indicate that ownership along the upper Gila River in New Mexico is primarily Gila National Forest and private lands.

Land and Water Uses:
Land and water uses along the upper Gila River include agriculture, mining, livestock production, timber production, dispersed and concentrated recreation, localized municipal and urban development, and dispersed rural development. Irrigation diversions in the vicinities of Cliff, Redrock, and Virden, New Mexico often completely draw off surface flow (Bestgen 1985a). In Arizona, the upper Gila River is diverted for agricultural purposes throughout the Safford region.

Collection History:
The earliest identified collection of chub from the upper Gila River was made in 1938 by C.L. Hubbs at Cliff, Grant County, New Mexico (UMMZ 124744). Additional collections of chubs were made from the upper Gila River (including the West Fork Gila, Middle Fork Gila, and East Fork Gila rivers) in 1949–1953, 1965, 1966, 1971, 1974, 1977, 1980, 1983, 1984, 1987, 1991, and 1994. Only one collection record was found for the Arizona portion of the upper Gila River, collected by Lt. W.L. Carpenter at Fort Thomas (date unknown, NMNH 041173). Surveys where chubs were sampled from the upper Gila River (including the West Fork Gila, Middle Fork Gila,

and East Fork Gila rivers) were conducted in 1973, 1988–1992, 1995, 1996, and 1998. See Appendix D-5d for complete collection history, and Appendix E-4b for complete sampling history.

Results of Surveys Conducted for this Project:
The upper Gila River was not surveyed for this project because information gathered was recent enough (Propst 1999) to determine population status.

Population Status:
**Unstable – Threatened**. Chub populations occupying the headwaters and upper mainstem of the Gila River (above Mangas Creek) in New Mexico are headwater chubs, *Gila nigra* (W.L. Minckley, pers. comm.). In the mainstem upper Gila River, occurrence of chub is now rare where they were formerly common during and prior to the 1940s (Propst 1999). Headwater chub populations in the upper Gila River persist in three small populations in New Mexico; the upper East Fork of the Gila River, the lower Middle Fork of the Gila River, and lower West Fork of the Gila River. All three populations are small and face threats from competitive and predaceous nonnative fishes (D. Propst, pers. comm.). In the upper Gila River near the Cliff/Gila Valley roundtail chubs are incidental or absent (Propst 1999). The roundtail chub is likely extirpated from the Arizona portion of the upper Gila River. The population of *Gila* sp. existing above a barrier falls in the headwaters of Turkey Creek (a small tributary to the Gila River) has been identified as *G. intermedia* (Minckley and DeMarais 2000). Propst (pers. comm.) believes recreational angling has direct impact on the remaining populations, due to misperception by anglers that chubs don't belong in waters from which they are caught, often being killed as a result.

San Francisco River

Site Description:
The San Francisco River is a tributary to the Gila River. Its headwaters arise in the White Mountains of eastern Arizona, flowing in an easterly direction to enter New Mexico, then flowing south and west to re-enter Arizona approximately 29 km (18 mi) northeast of Clifton, Arizona. The San Francisco sub-basin encompasses an area of roughly 7,366 $km^2$ (2,844 $mi^2$), with approximately 4,921 $km^2$ (1,900 $mi^2$) in New Mexico, and 2,445 $km^2$ (944 $mi^2$) in Arizona.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the San Francisco River in Arizona is comprised of Apache-Sitgreaves National Forest (57%), BLM (19%), private (23%), and ASLD (2%) lands. Due to an error in the New Mexico land ownership database (see the Mapping and Reporting Methods section), ownership could not be calculated for the portions of the San Francisco River that flow through New Mexico, but according to topographical maps the majority of the land ownership around the San Francisco River in New Mexico consists of Gila National Forest and private lands.

Land and Water Uses:
Land and water uses along the San Francisco River include mining, localized residential and municipal development, agriculture, livestock grazing, timber production, wildlife management, and recreation. Anderson and Turner (1977) reported heavy cattle grazing in the river bottom in portions of the San Francisco downstream of the Arizona–New Mexico border.

Collection History:
The earliest identified collections of roundtail chubs from the San Francisco River were made in 1872 by E.D. Cope from the New Mexico portion of the river (ANSP 19458, ANSP 19578, ANSP 19110). Three other collections of roundtail chubs from the San Francisco River in New Mexico were made in 1948 by W.J. Koster and K. Rafferty Jr. (MSB 1730, MSB 1731, MSB 1738). A local rancher reported regularly spending Sundays during the Depression fishing for chubs as a source of food in the vicinity of the San Francisco Box in New Mexico (D. Propst, pers. comm.). No survey records identifying roundtail chubs in the San Francisco River were found for New Mexico or Arizona, though they likely occurred in the Arizona portion of the San Francisco River in the past. Surveys conducted between 1994 and 1998 by ASU and USFS personnel using a variety of sampling gear types failed to detect roundtail chubs in the Arizona portion of San Francisco River (T. Myers, pers. comm.).

Results of Surveys Conducted for this Project:
The San Francisco River was not surveyed for this project because the roundtail chub is extirpated from this river (Propst 1999; T. Myers, pers. comm.).

Population Status:
**Extirpated**. There have been no documented collections of roundtail from the San Francisco River in New Mexico since 1948 (Bestgen and Propst 1989, Propst 1999). No collections or sampling records have been found for roundtail chubs from the San Francisco River in Arizona. Minckley (1985) reported roundtail persisting in tributaries to this system, but was not specific. No collection of roundtail chubs has been identified from Blue River, although one record of occurrence was found; the record is believed erroneous.

Eagle Creek

Site Description:
Eagle Creek is a tributary to the Gila River, with its headwaters originating at approximately 2800 m (9,190 ft) on U.S. Forest Service and Indian Reservation lands immediately below the Mogollon Rim, and south of the Black River drainage. Headwaters of Eagle Creek include Dry Prong and East Eagle creeks. Eagle Creek flows southward for over 64 km (40 mi) before joining the Gila River a short distance below the confluence of the San Francisco and Gila rivers. Substrates in the system are dominated by cobble and boulder, with sand restricted to riffles and stream margins, and silt accumulating only locally in pools (Marsh et al. 1990).

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Eagle Creek is comprised of San Carlos Indian Reservation (33%), Apache-Sitgreaves National Forest (31%), private (16%), BLM (14%), and ASLD (7%) lands.

Land and Water Uses:
Land and water uses along Eagle Creek include livestock grazing, agriculture, mining, and limited recreation. Water is diverted by Phelps-Dodge Corporation from Black River roughly 0.5 miles below Freezeout Creek, and pumped into adjacent Willow Creek drainage, tributary to Eagle Creek. A major pumping station on lower Eagle Creek withdraws and transports water to mining operations in the Clifton-Morenci area. Eagle Creek often becomes intermittent in its lower reach below the pumping station during years of little precipitation, but flows are continuous in the upper reaches of the stream (Minckley 1985). The diverted water is used for mining, metal ore processing, and domestic consumption.

Collection History:
The earliest identified collection of chubs from Eagle Creek was made in 1934 by M.J. Madsen 100 yards above Honeymoon Ranch (UMMZ 216958) although these specimens may represent Gila chubs rather than roundtail chubs (Fig.1 in Minckley and DeMarais 2000). The most recent collection of roundtail chubs from Eagle Creek was made in 1992 (ASU 15986). Additional collections of roundtail chubs from Eagle Creek were made in 1950, 1964, 1977, 1978, 1980, 1982, 1983, 1985, 1987, and 1991. Surveys were roundtail chubs were sampled from Eagle Creek were conducted in 1964, 1986–1988, 1990, 1992, and 1993–1999. See Appendix D-5c for complete collection history, and Appendix E-4a for complete sampling history. Roundtail chub were sampled from Willow Tank Canyon in 1995 (see Appendix E-4d) and from Knight Canyon in 1996 (see Appendix E-4c); both canyons are tributaries of Eagle Creek. Both surveys were conducted close to the confluence with Eagle Creek, so the upstream range of chub in Willow Tank and Knight canyons is unknown. Due to rugged terrain and difficult access, neither canyon was sampled for this project.

Results of Surveys Conducted for this Project:
Eagle Creek was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown**. The population found in upper Eagle Creek (in the vicinity of Honeymoon Campground and above) is *G. intermedia*, and in lower reaches of the stream *G. robusta* (Minckley and DeMarais 2000). Current range of population is unknown, but specimens have been regularly sampled throughout the last decade. Nonnative aquatic species are present in the system, posing a threat to the population. Livestock freely range or encroach in portions of the riparian corridors in upper Eagle Creek, potentially degrading aquatic habitats. Eagle Creek flows along the eastern border of the San Carlos Indian Reservation and despite contacting the Tribe, access was not given to survey waters on Tribal lands.

San Carlos River

Site Description:
The San Carlos River is a tributary to the Gila River, now flowing into San Carlos Reservoir, an impoundment on the Gila River formed after the closing of Coolidge Dam in 1928. Drainage of the San Carlos River encompasses over 2,657 $km^2$ (1,026 $mi^2$), with elevations in the drainage ranging from approximately 1,768 m (5,800 ft) in the Natanes Mountains to 760 m (2,500 ft) at San Carlos Reservoir.

Land Ownership:
Land Ownership within a 1.6 km (1.0 mi) buffer along the San Carlos River is comprised of 100% San Carlos Indian Reservation lands.

Land and Water Uses:
Land and water uses along the San Carlos River include agriculture, livestock grazing, recreation, water diversions for irrigation, and inflow from sewage treatment plant. The lower reach of the San Carlos River is now impounded by San Carlos Reservoir.

Collection History:
Type specimens of *Gila nigra* were collected by H.W. Henshaw from "San Carlos" (MCZ 35963, and NMNH 16972) presumably near Camp San Carlos (established in 1873 and located roughly 1 mile north of the confluence of the San Carlos and Gila rivers [Nearing and Hoff 1995]). Other chub collections from the San Carlos River were made in 1968 and 1983. No survey records for the San Carlos River. See Appendix D-5e for complete collection history.

Results of Surveys Conducted for this Project:
The San Carlos River was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown**. The chub population in San Carlos River is currently recognized as *G. nigra*. Minckley and DeMarais (2000) reported: "The NMNH syntypes correspond in morphology to recent specimens from the San Carlos River (ASU 4644), excluding *intermedia* from a tributary named Blue River." Based on information provided in Minckley and DeMarais (2000), forms occupying Blue River (tributary to San Carlos River) are *G. intermedia*. Current status of population unknown; sampling was not conducted because access requests were not granted by the Tribe.

Ash Creek

Site Description:
Ash Creek, headwater to the San Carlos River, flows in westerly direction before its confluence with Kidde Canyon (forming the San Carlos River).

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Ash Creek is comprised of 100% San Carlos Indian Reservation lands.

Land and Water Uses:
Land and water uses along Ash Creek include agriculture, livestock grazing, and recreation.

Collection History:
J.T. Rothrock collected *Gila nigra* type specimens from Ash Creek (no specific locality information was included) in 1874 (NMNH 16987, NMNH 15991). Although there is no specific locality information associated with the Ash Creek collections and there are at least six Ash Creeks in Arizona, it is most likely that the collections (NMNH 15991, NMNH 16987) were made from Ash Creek, tributary to San Carlos River. Field activities of the Rothrock party were concentrated in eastern and southeastern Arizona during the field season of 1874 in the vicinity of Camp Apache to that of abandoned Camp Crittenden (near present day Patagonia, Santa Cruz County [Yarrow 1875a, Nearing and Hoff 1995]). H.W. Henshaw, the ornithologist attached to Rothrock's party, reported collections of fishes obtained by hook and line from Ash Creek, between Camp Apache and the Gila River, enroute to Camp Grant to the south (Henshaw 1875). Arrival of the party at Camp Grant was July 28 1874, three days following the date of collection of NMNH 15991 from Ash Creek. No survey records were found for Ash Creek. See Appendix D-5a for complete collection history.

Results of Surveys Conducted for this Project:
Ash Creek was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown.** The collections from 1874 represent the only known collections from Ash Creek. Current status of population unknown; sampling was not conducted because access requests were not granted by the Tribe.

Lower Gila River

Site Description:
The lower Gila River drains an area of approximately 116,550 $km^2$ (45,000 $mi^2$). The river once flowed through southern Arizona in a westerly direction until its confluence with the Colorado River near Yuma. Currently, flows in the lower Gila River are controlled through releases from Coolidge Dam, although seepage, springs, and the San Pedro River often help maintain perennial water between Coolidge Dam and Ashurst-Hayden Dam. Except under extreme flood conditions, all flow remaining in the Gila River is diverted at the Ashurst-Hayden Dam into a system of canals and reservoirs, supplying water for municipal and agricultural purposes to a number of small central Arizona communities. Near Gila Bend, Arizona, Painted Rock Reservoir serves as

flood control storage for floodwaters entering the Gila River from the Hassayampa, Agua Fria, and Salt rivers.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the lower Gila River is comprised of private (41%), BLM (23%), Gila River Indian Reservation (18%), ASLD (7%), Bureau of Reclamation (5%), San Carlos Indian Reservation (3%), AGFD (1%), regional or state parks (<1%), United States Military (<1%), Hohokam-Pima National Monument (<1%), Gila Bend Indian Reservation (<1%), and Fort Yuma Indian Reservation (<1%) lands.

Land and Water Uses:
Land and water uses along the lower Gila River include groundwater pumping, livestock grazing, agriculture, irrigation, municipal and domestic water supplies, mining, rural and urban development, industrial development, wildlife management, recreation, and municipal and agricultural water returns.

Collection History:
The earliest dated collection of roundtail chubs from the lower Gila River was made in 1929 below Gillespie Dam, roughly 32 km north of Gila Bend, Arizona (NMNH 094268). A collection that presumably occurred earlier (date unknown) was made by E.A. Mearns at Gila, Arizona (NMNH 075985). The most recent collection of chubs from the lower Gila River was made in 1943 by J.R. Simon below Winkelman (UMMZ 146666). See Appendix D-6c for complete collection history, and Appendix E-5b for complete sampling history.

Results of Surveys Conducted for this Project:
The lower Gila River was not surveyed for this project because the roundtail chub is extirpated from this river.

Population Status:
**Extirpated**. Lack of aquatic habitat over most of the reach and a diversity of nonnative species in habitats that do exist, preclude the occurrence of chubs in the lower Gila River. Annual surveys of the Gila River conducted since 1995 from the confluence of the San Pedro River to Ashurst-Hayden Dam have failed to detect any roundtail chubs (R. Clarkson, pers. comm.). The "Tres Rios" project, a cooperative plan between the City of Phoenix, Army Corps of Engineers, Bureau of Reclamation, the USFWS, AGFD, and other groups, is a project dedicated to restoring riparian habitats in the area near the confluence of the Gila and Salt rivers. Habitat may become suitable for native fish reintroductions in the future.

San Pedro River

Site Description:
The San Pedro River basin encompasses roughly 11,616 $km^2$, with 1,803 $km^2$ of the upper drainage in the state of Sonora, Mexico, and 9,813 $km^2$ in Arizona (USDA 1977). The highest

point in the basin occurs on Mt. Graham in the Pinaleno Mountains, at 3,265 m elevation. Though normally intermittent over much of its reach, the channel of the San Pedro extends north approximately 240 km from near Cananea, Sonora, to its confluence with the Gila River near Winkelman, Arizona (Minckley 1985). Indications are that perennial and continuous surface flows remained in the San Pedro as recently as the end of the 19th century (Minckley and Meffe 1987). Prior to the 20th century, chubs likely occupied extensive reaches of the river from near its headwaters to its confluence with the Gila River. Around 1890, a change in hydrological conditions along major watercourses in southern Arizona occurred, initiating a period of severe downcutting in river channels, and major impacts to local water tables, riparian habitats and biological communities along the San Pedro River (Minckley and Meffe 1987).

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the San Pedro River (the United States portion) is comprised of private (44%), ASLD (30%), BLM (25%), Ft. Huachuca (<1%), and Bureau of Reclamation (<1%) lands, and other Indian allotments (<1%).

Land and Water Uses:
Land and water uses along the San Pedro River include groundwater pumping, livestock grazing, agriculture, irrigation, municipal and domestic water supplies, mining, industry, rural and urban development, wildlife management, and recreation.

Collection History:
Type specimens of *Gila grahami* (Baird and Girard 1854) were collected from the San Pedro River by J.H. Clark in 1840 and 1851; however, R.R. Miller and W.L. Minckley reidentified those syntypes as synonymous with *G. robusta* (Minckley and DeMarais 2000). The most recent roundtail chub collection from the San Pedro was made in 1931 by B. Campbell from near Tombstone (NMNH 130207). Miller (1961) reported roundtail chub sampled in 1846 and 1904 from the San Pedro River between Benson and Fairbanks. See Appendix D-6d for complete collection history, and Appendix E-5c for complete sampling history.

Specimens collected from Babocomari Creek (tributary to San Pedro River) in 1950 (UMMZ 162696; Appendix D-6b) were originally identified as *G. robusta intermedia*, but approaching *G. r. robusta*, and may prove to be *G. nigra*. Other populations found within the Babocomari Creek drainage (O'Donnell Canyon, and T-4 Spring on Babocomari Ranch) are recognized as *Gila intermedia* (Weedman et al. 1996).

Results of Surveys Conducted for this Project:
The San Pedro River was not surveyed for this project because the roundtail chub is extirpated from this river.

Population Status:
**Extirpated.** The last reported collection of roundtail chubs from the San Pedro River was in 1931, near Tombstone. Growth and development by nearby communities, municipalities, and

industry can be expected to continue, placing additional demands on seriously limited water supplies. Pollution in the form of untreated sewage transported during flooding from Naco, Mexico, and acidified flows originating from mining operations in Cananea, Mexico have been documented in the past. The impacts to downstream riparian communities were severe and have the potential to occur again.

Aravaipa Creek

Site Description:
Described by Minckley (1985) as one of the most pristine native fish habitats remaining in Arizona, Aravaipa Creek is a perennial tributary of the San Pedro River, whose headwater reaches drain portions of the Pinaleno, Galiuro, and Santa Teresa mountains. The stream travels approximately 75 km from its headwaters near Klondyke, Graham County, Arizona, to its confluence with the San Pedro River, approximately 9 km south of Dudleyville, Pinal County, Arizona. Aravaipa Creek is one of the last streams in Arizona to maintain a relatively intact community of native fishes (seven native species), of which two are federally listed as threatened (spikedace, *Meda fulgida*; and loach minnow, *Tiaroga cobitis*). The central canyon of the creek is protected within the confines of the Aravaipa Canyon Wilderness Area (managed by BLM). The Nature Conservancy has established reserves on portions of land both upstream and downstream of the Wilderness Area.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Aravaipa Creek is comprised of BLM (52%), private (27%), and ASLD (21%) lands, as well as unidentified Indian allotments (1%).

Land and Water Uses:
Land and water uses along Aravaipa Creek include groundwater pumping, water diversions, livestock grazing, mining, limited rural development, road maintenance, and recreation.

Collection History:
The earliest identified roundtail chub collections from Aravaipa Creek were made in 1943 by S. Hendrickson (UMMZ 141721, UA 95-87). The most recent collection of roundtail chubs from Aravaipa Creek was made in 1992 by A. Anderson (ASU 15985). This is recognized as one of the most intensely monitored streams in Arizona, see Appendix D-6a for complete collection history, and Appendix E-5a for complete sampling history.

Roundtail chubs have been collected from Turkey Creek, tributary to Aravaipa Creek (ASU 16136, ASU 16139), but the collections were made near the confluence with Aravaipa Creek and probably represent a population supported from Aravaipa Creek.

Results of Surveys Conducted for this Project:
Aravaipa Creek was not surveyed for this project because information gathered was recent enough (AGFD NFDB 2000) to determine population status.

Population Status:
**Stable – Threatened**. One of the most systematically monitored streams in Arizona waters, roundtail chubs appear to be maintaining a stable population with limited recruitment; however, recent reinvasion by red shiner places roundtail and other native fishes in the system under threat. A fish barrier on lower Aravaipa Creek was completed in 2001, constructed to prevent non-native species from entering Aravaipa Creek from the San Pedro River.

Aravaipa Creek should be monitored quarterly above, below, and in-between the fish barriers to determine effectiveness of the barriers in preventing nonnative species from entering the Aravaipa Creek from the San Pedro River.

**Salt River and Tributaries**

Salt River

Site Description:
The Salt River is formed by the confluence of the Black and White rivers at the boundary of the Fort Apache and San Carlos Apache reservations. It flows in a southwesterly direction to its confluence with the Gila River, near the city of Avondale, Arizona. Major tributaries to the Salt River include the Black and White rivers, Carrizo, Cibecue, Canyon, Cherry, Coon, Salome and Tonto creeks, and the Verde River. Drainage area for the Salt River basin encompasses approximately 35,480 $km^2$. Lentic conditions prevail in the reach from upper Roosevelt Lake to Stewart Mountain Dam on Saguaro Lake, about 64 km downstream. Below Stewart Mountain Dam, the Salt River flows again for several miles, receiving regulated input from the Verde River. At Granite Reef Dam, all flows from the Salt and Verde rivers are diverted into two canals, supplying water to the Phoenix metropolitan area for agricultural, industrial and domestic consumption, as well as numerous urban lakes. The Salt River is generally dry from below Granite Reef Dam to the confluence with the Gila River, except following extreme flooding.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the Salt River is comprised of Tonto National Forest (52%), Fort Apache Indian Reservation (30%), San Carlos Apache Indian Reservation (16%), Salt River Indian Reservation (1%), and private (<1%) lands.

Land and Water Uses:
Land and water uses along Salt River include, urban and industrial development, mining, agriculture, recreation, surface water impoundments, diversions, and groundwater pumping for agricultural and domestic irrigation, municipal and domestic water supplies, wildlife management, and recreation.

Collection History:
The earliest identified collection of roundtail chubs from the Salt River were made in 1890 by G. Scofield at Tempe, Maricopa County, Arizona (NMNH 048120). The most recent collection of

roundtail chubs from the Salt River was made in 1996 by T. Gray at Gleason Flat (ASU 16719). Other collections of roundtail chubs from the Salt River were made in 1904, 1926, 1934, 1937, 1950, 1958, 1959, 1964–1967, 1969, 1972, 1974, 1976, 1977, 1979, 1980, 1982, 1984, 1985, and 1989. Surveys were roundtail chubs were sampled from the Salt River were conducted in 1890, 1935, 1943, 1981, 1983–1986, 1988, 1989, 1993, 1994, 1996, 1997, 1999, and 2000. Surveys conducted by Madsen (1935a) indicated "bonytails" (= roundtail chubs) were abundant and in good condition throughout a 5 mile reach of the Salt River above Roosevelt Lake. During surveys in the lower Salt River (below Stewart Mountain Dam) roundtail chubs have been found as recently as 2000, although no roundtail chubs have been sampled from the upper Salt River since 1997. See Appendixes D-7p (lower Salt River) and D-7q (upper Salt River) for complete collection history. See Appendixes E-6s (lower Salt River) and E-6t (upper Salt River) for complete sampling history.

Roundtail chubs appear to regularly enter canal systems through the Granite Reef Dam diversion, occasionally gaining access to urban lakes in the Phoenix metropolitan area. Collections of roundtail chubs were found for a number of canals and are provided in Appendix D-9a. Sampling records of roundtail chubs found in canals are provided in Appendix E-8a. Urban lake collection records are provided in Appendix D-9b and sampling records in Appendix E-8b.

One survey record from Coon Creek (tributary to the Salt River) was found, described as "Coon Creek, above Salt River" (Appendix E-6i). In spring 2001, upper and lower Coon Creek were sampled, but no roundtail were found. Chub habitat in Coon Creek was marginal, consisting mainly of shallow runs, and it is likely that the sample occurred at the confluence with the Salt River.

Results of Surveys Conducted for this Project:
The Salt River was not surveyed for this project because information was recent enough (Jahrke and Clark 1999, Bryan and Robinson 2000) to determine population status.

Population Status:
**Unstable – Threatened (Unknown)**. Surveys in the Salt River during the past decade show that roundtail chubs in the upper Salt River (above Roosevelt Lake) have become very rare, and may be extirpated in that reach (Creef and Clarkson 1993, Jahrke and Clark 1999). Data indicates that piscivorous flathead catfish (*Pylodictis olivaris*) and channel catfish (*Ictalurus punctatus*) comprise a predominant portion of the ichthyofaunal assemblage. Continued presence of flathead catfish in the upper Salt River will likely preclude the reestablishment of roundtail chubs in the system. The entire population of flathead catfish in the upper Salt River and Roosevelt Lake reportedly originated from a stocking above the Highway 288 bridge in the early 1970s by the Arizona Game and Fish Department (Jahrke and Clark 1999). In the upper Salt River between Horseshoe Bend and the 288 Highway bridge, sampling through 1999 found flathead catfish comprised 80% of all fish sampled. In a recent study on the lower Salt River, Bryan and Robinson (2000) observed a large number of roundtail chubs in main channel pools when low flows prevailed. With increased flows roundtail chubs appeared to move out of these habitats,

and subsequent sampling efforts to capture chubs in this reach were unsuccessful. Bryan and Robinson (2000) speculated that with increased flows and lowered water temperatures, roundtails may have moved into warmer waters of the Verde River to spawn. Chub population status in portions of the Salt River that flows through the Fort Apache and San Carlos Apache reservation lands is unknown. Sampling did not occur on the reservations because access requests were not granted by the Tribes.

White River

Site Description:
The White River, a tributary to the Salt River, arises in the White Mountains of eastern Arizona and is formed by the confluence of the North Fork White River and the East Fork White River. Area of the White River drainage basin encompasses roughly 1650 $km^2$.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the White River (including the North Fork and East Fork) is comprised of Fort Apache Indian Reservation (99%) and San Carlos Apache Indian Reservation (1%) lands, although the White River lies completely within the Fort Apache Indian Reservation (only a portion of the buffer falls within the San Carlos Apache Indian Reservation).

Land and Water Uses:
Fort Apache Indian Reservation lands are used for recreation, livestock grazing, agriculture, mining, timber production, fisheries and wildlife management, localized municipal, and urban and residential development.

Collection History:
The earliest identified collection of roundtail chub from the White River was made in 1874 by J.M. Rutter (NMNH 017078). The most recent collection of roundtail chub from the White River was made in 1985 by W.G. Kepner (ASU 11237). Other roundtail chub collections from the White River were made in 1950, 1954, 1966, and 1967. Surveys for loach minnow during 1988 (Western Technology and Engineering, Inc. 1988) sampled roundtail chub in the White River below the confluence of the North Fork White and the East Fork White rivers. Roundtail chubs represented 3% of all fish collected from White River during surveys (WESTECH 1988); however, sampling effort was concentrated on riffle habitat, which is not primary habitat for roundtail chub. See Appendix D-7t for complete collection history, and Appendix E-6x for complete sampling history.

Results of Surveys Conducted for this Project:
The White River was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown**. Current status of the population is unknown. Surveys did not occur because access requests were not granted by the Tribe.

Black River

Site Description:
The Black River, a tributary of the Salt River, is formed by the confluence of the East Fork Black and the West Fork Black rivers. Area of the Black River drainage encompasses 3,243 $km^2$ (1,252 $mi^2$). Headwaters of the East and West forks of the Black River arise primarily in the White Mountains of east-central Arizona on U.S. Forest Service (Apache-Sitgreaves National Forest) and Fort Apache Indian Reservation lands, draining the south and southeast portions of Mt. Baldy in the White Mountains. Additional tributaries of Black River arise on lands of the Fort Apache Indian Reservation, traversing Tribal lands to flow into Black River.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the Black River (including the East Fork Black and West Fork Black rivers) is comprised of Apache-Sitgreaves National Forest (38%), San Carlos Apache Indian Reservation (31%), Fort Apache Indian Reservation (31%), private (<1%), and AGFD (<1%) lands.

Land and Water Uses:
Land and water uses along the Black River include livestock production, timber production, mining, recreation, and water diversion for municipal, agricultural, and mining purposes. Water is diverted by Phelps-Dodge Corporation from the Black River roughly 0.8 km below Freezeout Creek and pumped into an adjacent drainage (Willow Creek, tributary to Eagle Creek). The diverted water is used for mining, ore processing, and domestic consumption in the vicinity of Morenci.

Collection History:
The earliest identified collection of roundtail chubs from the Black River was made in 1935 by M.A. Gee, in the East Fork Black River at Buffalo Crossing (UMMZ 110438). The most recent collections of roundtail chubs in the Black River were made in 1977 by W.G. Kepner, 0.5 miles above the Fort Apache Indian Reservation boundary (ASU 7459, ASU 7557). Additional collections of roundtail chub from the Black River were made in 1936, 1937, and 1964–1968. Surveys where roundtail chubs were sampled from the Black River were conducted in 1937, 1993, 1996, 1997, and 2000. Marsh (1997b) initiated a general fisheries survey of the Black River on lands administered by the U.S. Forest Service. Discovery of loach minnow during this survey redirected efforts towards specific habitats preferred by loach minnow (mainly riffles) in an attempt to determine the extent of loach minnow distribution within the drainage. Surveys determined roundtail to be locally abundant between Forest Service Road (FR) 25 and the Fort Apache Indian Reservation boundary (Marsh 1997b). Although roundtail have also been previously recorded from the Three Forks area of the Black River, surveys in the vicinity of

Three Forks during the 1996 survey failed to detect the presence of chubs. Chubs were caught by hook and line in 2000 from the Black River at the confluence with Beaver Creek, near the Fort Apache Indian Reservation boundary (M. Lopez, pers. comm.). See Appendix D-7a for complete collection history, and Appendix E-6a for complete sampling history.

Results of Surveys Conducted for this Project:
The Black River was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown**. Although Marsh (1997b) sampled chubs in the vicinity of FR 25 and the Fort Apache Indian Reservation boundary, distribution may be limited. Minckley (1973) reported suppression of reproductive success by roundtail chubs in Black River following a population explosion by smallmouth bass (*Micropterus dolomieu*). Current status of the population is unknown. Surveys did not occur on the Reservation because access requests were not granted by the Tribe.

Carrizo Creek

Site Description:
Tributary to the Salt River, Carrizo Creek flows in a southeasterly and southerly direction, entering Salt River roughly 15 km below the confluence of the Black and White rivers. Carrizo Creek has two major tributaries, Corduroy and Cedar creeks. The drainage is bounded to the north by the Mogollon Rim, and to the east by the White River drainage.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Carrizo Creek is comprised of Fort Apache Indian Reservation (98%) and San Carlos Apache Indian Reservation (2%) lands.

Land and Water Uses:
Fort Apache Indian Reservation lands are used for recreation, livestock grazing, agriculture, mining, timber production, fisheries and wildlife management, localized municipal, and urban and residential development.

Collection History:
The earliest identified collection of roundtail chubs from Carrizo Creek was made in 1950 by R.R. Miller and H.E. Winn at the U.S. (Highway) 60 crossing (UMMZ 162773). The most recent collection of roundtail chubs from Carrizo Creek was made in 1986 by J. Brooks, also at the U.S. 60 crossing (ASU 11967). Additional roundtail chub collections from Carrizo Creek were made in 1965–1967, 1973, 1974, and 1985. Surveys where roundtail chubs were sampled from Carrizo Creek were conducted in 1984, 1985, and 1987. See Appendix D-7d for complete collection history, and Appendix E-6e for complete sampling history.

Results of Surveys Conducted for this Project:
Carrizo Creek was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown**. Current status of the population is unknown. Surveys did not occur because access requests were not granted by the Tribe.

Corduroy Creek

Site Description:
Corduroy Creek, a tributary of Carrizo Creek, flows west-southwest through the Fort Apache Indian Reservation before its confluence with Carrizo Creek.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Corduroy Creek is comprised of 100% Fort Apache Indian Reservation lands.

Land and Water Uses:
Fort Apache Indian Reservation lands are used for recreation, livestock grazing, agriculture, mining, timber production, fisheries and wildlife management, localized municipal, and urban and residential development.

Collection History:
The earliest identified collection of roundtail chubs from Corduroy Creek was made in 1965 by G. Kobetich near the inflow of Big Spring (MSB 2691). The only other collection of roundtail chubs from Corduroy Creek was made in 1966 by W. Barber at the Highway 60 crossing (ASU 2459). The only survey where roundtail chubs were sampled from Corduroy Creek was conducted in 1991, and roundtail chubs were abundant at all 6 sampling stations (P. Marsh, pers. comm.). See Appendix D-7h for complete collection history, and Appendix E-6j for complete sampling history.

Results of Surveys Conducted for this Project:
Corduroy Creek was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown**. Current status of the population is unknown. Surveys did not occur because access requests were not granted by the Tribe.

Cedar Creek

Site Description:
Cedar Creek, a tributary of Carrizo Creek, flows in a southwesterly direction through the Fort Apache Indian Reservation before its confluence with Carrizo Creek, approximately 2.5 km above Carrizo Creek's confluence with the Salt River.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Cedar Creek is comprised of 100% Fort Apache Indian Reservation lands.

Land and Water Uses:
Fort Apache Indian Reservation lands are used for recreation, livestock grazing, agriculture, mining, timber production, fisheries and wildlife management, localized municipal, and urban and residential development.

Collection History:
The only identified collection of roundtail chubs from Cedar Creek was made in 1986 by J. Brooks at the road 14 crossing (ASU 11974, Appendix D-7e). The only survey where roundtail chubs were sampled from Cedar Creek were conducted in 1987 by AGFD at the road 14 and road 18 crossings (Appendix E-6f).

Results of Surveys Conducted for this Project:
Cedar Creek was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown**. Current status of the population is unknown. Surveys did not occur because access requests were not granted by the Tribe.

Cibecue Creek

Site Description:
Cibecue Creek, a tributary to the Salt River, enters the Salt River between Carrizo and Canyon creeks. The Cibecue Creek drainage is bounded to the north by the Mogollon Rim and to the west by the Canyon Creek drainage.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Cibecue Creek is comprised of Fort Apache Indian Reservation (99%) and Tonto National Forest (1%) lands.

Land and Water Uses:
Fort Apache Indian Reservation lands are used for recreation, livestock grazing, agriculture, mining, timber production, fisheries and wildlife management, localized municipal, and urban and residential development.

Collection History:
The earliest identified collection of roundtail chubs from Cibecue Creek was made in 1950 by R.R. Miller and H.E. Winn at the confluence with Salt River (UMMZ 162777). The most recent collections of roundtail chubs from Cibecue Creek were made in 1967 by J. Rinne (ASU 3127, ASU 3152). Other collections of roundtail chubs from Cibecue Creek were made in 1964–1966. See Appendix D-7g for complete collection history. No roundtail chub sampling records for Cibecue Creek were found.

One collection of roundtail chub from Salt Creek Draw (tributary to the Salt River) was found from 1967 (ASU 3165). This is the only known chub collection from Salt Creek Draw, but the township, range, and section description indicates the collection may have been made from an unnamed tributary to Cibecue Creek (Appendix D-7o).

Results of Surveys Conducted for this Project:
Cibecue Creek was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown**. Current status of the population is unknown. Surveys did not occur because access requests were not granted by the Tribe.

Canyon Creek

Site Description:
Canyon Creek, a tributary to the Salt River, flows in a southerly direction from the Mogollon Rim on the Tonto National Forest, entering lands belonging to the White Mountain Apache Tribe just east of the Gila/Navajo County border. Major tributaries include Ellison, Oak, and Willow creeks.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Canyon Creek is comprised of Fort Apache Indian Reservation (85%), Tonto National Forest (13%), Apache-Sitgreaves National Forest (2%), and private (<1%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging mining, and fuelwood cutting. Fort Apache Indian Reservation lands are used for recreation, livestock grazing, agriculture, mining, timber production, fisheries, and wildlife management. AGFD operates a

fish hatchery on upper Canyon Creek, mainly producing rainbow trout. The upper reaches of Canyon Creek are managed as a blue-ribbon trout fishery.

Collection History:
The only identified collection of roundtail chubs from Canyon Creek was made in 1967 by J. Rinne 18 miles NNW of Seneca (ASU 3168, Appendix D-7c). Surveys where roundtail chubs were sampled from Canyon Creek were conducted in 1987 and 1988 (Appendix E-6d). All of the identified collection and sampling records took place on the Fort Apache Indian Reservation.

Results of Surveys Conducted for this Project:
Canyon Creek was not sampled for this project because AGFD did not receive access approval to survey streams that flow through Reservation lands.

Population Status:
**Unknown**. Current status of the population is unknown. Surveys did not occur because access requests were not granted by the Tribe. No roundtail chub records were found for portions of the stream not on White Mountain Apache tribal lands.

Cherry Creek

Site Description:
Cherry Creek, a tributary to the Salt River, drains the eastern slopes of the Sierra Anchas, and is bounded to the north by the Naegelin Rim, northwest of Young, Gila County, Arizona. Major tributaries to Cherry Creek include Crouch, Walnut, and P B creeks.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Cherry Creek is comprised of Tonto National Forest (99%) and private (1%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging and fuelwood cutting. Land and water uses along Cherry Creek include mining, groundwater pumping, water diversions, recreation, localized and dispersed rural development, and limited agriculture.

Collection History:
The earliest identified collection of roundtail chubs from Cherry Creek was made in 1950 by R.R. Miller and H.E. Winn (UMMZ 162794). The most recent collection of roundtail chubs from Cherry Creek was made in 1993 by D. Hendrickson above Ellison Ranch (ASU 15973). Other collections of roundtail chubs from Cherry Creek were made in 1965, 1967, 1980, 1981, 1983, and 1988. Surveys where roundtail chubs were sampled from Cherry Creek were conducted during 1987, 1988, 1990, 1993 - 1995, and 1998. See Appendix D-7f for complete collection history, and Appendix E-6g for complete sampling history.

Results of Surveys Conducted for this Project:
Cherry Creek was not surveyed for this project because information gathered was recent enough (AGFD NFDB 1995, 1998) to determine population status.

Population Status:
**Stable – Threatened**. Surveys conducted between 1990-95 indicate chubs still occur throughout much of Cherry Creek. Eight nonnative fish species were sampled in the 1990s (unpublished AGFD data), including predatory flathead catfish, yellow bullhead, smallmouth bass, channel catfish, green sunfish, and red shiner. Nonnative crayfish have removed much of the instream vegetation in the area at and below Horse Camp (A. Clark, pers. comm.). Private lands in the immediate vicinity of Young continue to develop, and water demands in the area can be expected to increase.

Ash Creek, a tributary of the Salt River downstream of Cherry Creek, has been identified as a suitable location for native fish to be stocked (D. Weedman, pers. comm.); roundtail chubs and other native fish should be translocated from Cherry Creek to Ash Creek.

Salome Creek

Site Description:
Salome Creek, a tributary to the Salt River, rises on the western slopes of the Sierra Ancha, roughly 21 km SSW of Young, Gila County, Arizona. Salome Creek flows in a southerly direction for nearly 30 km, where it enters Roosevelt Lake. In dry years surface flow in the lower reaches may be intermittent or entirely dry. Extensive reaches of the stream are canyon-bound and in the Salome Wilderness, making access difficult throughout much of the stream.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Salome Creek is comprised of Tonto National Forest (99%) and private (1%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging and fuelwood cutting. Signs of cattle grazing were apparent above the reach sampled on upper Salome, but impacts appeared moderate. Cattle sign was also present at lower Salome Creek, but all sign appeared old. Accessing Salome Creek is difficult; extensive reaches of the stream are canyon-bound, resulting in low recreational use.

Collection History:
No collections of chubs were found during the search of museum records. Surveys where roundtail chubs were sampled from Salome Creek were conducted in 1979 and 1997 (Appendix E-6r). Cooper (1979) reported collecting chubs during a general species survey on June 27, 1979, but final disposition of the specimens is unknown. The locality sampled was reported as "an area below the falls, which is approximately 3 miles north of Roosevelt Lake", and described as "…

deep pools (up to 30 feet), to fast flowing, shallow rocky areas". Duncan (1997b) accessed the portion of the stream known as "The Jug", to perform a Spot Check Survey using fishing gear. A ten meter barrier fall exists at the location where accessed, with roundtail chub, rainbow trout (*Oncorhynchus mykiss*), an unidentified sucker occurring below the fall, and only green sunfish found above the falls. Edwards (1973) collected brown trout (*Salmo trutta*) from upper Salome Creek and noted that the population had diminished following a flood in 1970.

Results of Surveys Conducted for this Project:
Roundtail chubs were not found in the upper reaches of Salome Creek during sampling in June 2000, but specimens were obtained in the lower drainage. Access was gained to the upper stream via Indian Camp Canyon. There was no surface flow in the streambed of Indian Camp Canyon for several hundred meters below the road from which access was gained. There were a number of potholes in the bedrock of the channel that held water, and green sunfish were present in several of them. Natural downstream barriers (over 2 m high) suggest the origin of the fish in this portion of Indian Camp Canyon is likely from upstream sources. Green sunfish were abundant throughout the upper reach of Salome Creek. An unidentified species of salmonid was also present, but was rare and not successfully sampled. Edwards (1973) collected brown trout in upper Salome Creek, documenting the occurrence of a salmonid in upper Salome Creek. Edwards (1973) noted that prior to a flood in 1970, upper Salome Creek supported a large population of brown trout. Based on previous occurrence in the system it is likely that the salmonids seen during the 2000 surveys were brown trout. In the lower reach of Salome Creek the stream was accessed from A-Cross Road. Most of the lower channel south of Dutch Woman Butte was dry. Large pools of fresh water were found in canyon narrows adjacent to Dutch Woman Butte from which roundtail were collected (ASU 18304). Green sunfish were abundant, with yellow bullhead collected as well, but appearing uncommon.

Population Status:
**Unstable – Threatened**. The chub population in Salome Creek has been identified as *G. robusta* (P. Unmack, pers. comm.). The roundtail chub population in the Salome Creek is very localized in distribution due to the rarity of suitable habitat. Impacts of grazing within the drainage, although not recent, appeared moderate during summer of 2000.

Tonto Creek

Site Description:
Tonto Creek, formerly a tributary to Salt River, but now when surface flows are present in lower reaches of the stream, Tonto Creek flows into Roosevelt Lake. The basin encompasses roughly 2,473 $km^2$. Headwaters of Tonto Creek originate at the base of the Mogollon Rim in northern and western Gila County, at an approximate elevation of 2,072 m. It flows south approximately 80 km into the western arm of Roosevelt Lake at approximately 650 m elevation. Tonto Creek is perennial throughout much of its upper reach, becoming seasonally intermittent below Gun Creek, at which point the stream channel enters a broad alluvial basin, becoming shallow, wide

and braided. Tonto Creek has numerous tributary streams. During dry periods, surface flow may be absent in lower reaches of many of the tributaries.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Tonto Creek is comprised of Tonto National Forest (93%), private (6%), Coconino National Forest (<1%), and Apache-Sitgreaves National Forest (<1%) lands.

Land and Water Uses:
Land and water uses along Tonto Creek include timber production, livestock grazing, in-channel sand and gravel mining, groundwater pumping, irrigation, urban and rural development, and dispersed and locally intense recreation, in-channel use by off-road vehicles. Groundwater discharge, evapotranspiration, and groundwater pumping from wells regularly lower water level in the alluvium to below streambed levels during part of the year (Abarca and Weedman 1993). The upper portions of Tonto Creek are managed as a put-and-take trout stream. National Forest lands are used for recreation, cattle grazing, logging, and fuelwood cutting. AGFD operates a fish hatchery on upper Tonto Creek, producing mainly rainbow trout.

Collection History:
The earliest identified collection of chubs from Tonto Creek was made in 1926 by C.L. Hubbs midway between Roosevelt Dam and Payson (UMMZ 094880). The most recent collection of chubs from Tonto Creek was made in 1992 by D.A. Hendrickson at Hells Gate, near the confluence with Haigler Creek (ASU 15989). Additional collections of chubs were made in 1936, 1937, 1950, 1967, 1970, 1979, 1983, 1987, and 1991. Surveys where chubs were sampled from Tonto Creek were conducted in 1935, 1987, 1988, 1991, 1992, and 1995. Madsen (1935a) surveyed approximately 49 miles of Tonto Creek on the Tonto National Forest, reporting "bonytails" (= headwater chubs) as occurring throughout the survey reach, abundant and in excellent condition. Abarca and Weedman (1993) found a fish community predominated by native species, however headwater chubs comprised less than 1% of the total fish captured in the survey. In 1993, headwater chubs were locally common in Tonto Creek at the confluence of Gun Creek, at 1.5 mi above Gun Creek, at 1.7 mi East of Jakes Corner, and at Hells Gate. See Appendix D-7s for complete collection history, and Appendix E-6w for complete sampling history.

Results of Surveys Conducted for this Project:
Tonto Creek was not surveyed for this project because information gathered was recent enough (Abarca and Weedman 1993) to determine population status.

Population Status:
**Unstable – Threatened.** Minckley and DeMarais (2000) identified chub populations found in Tonto Creek and its tributaries as *Gila nigra*. Threats to chubs in Tonto Creek include widespread distribution of competitive and predaceous nonnative fishes, water diversions and groundwater pumping, in-channel sand and gravel mining operations, habitat degradation due to

cattle grazing and in-channel vehicular traffic. Distribution of chubs in Tonto Creek currently appears restricted to canyon bound reaches above Gun Creek (Abarca and Weedman 1993). Tonto Creek was dry at the Gun Creek confluence during the summer of 2000. Upper portions of Tonto Creek and some of its tributaries have been managed since the early 1930s as trout sportfisheries, with rainbow trout the predominant species stocked.

Horton Creek

Site Description:
Horton Creek, a tributary to Tonto Creek, begins at Horton Spring below the Mogollon Rim and to the northwest of Promentory Butte. Flow is in a southwesterly direction for approximately 5 km where the creek enters Tonto Creek near the U.S. Forest Service Tonto Creek Campgrounds. Lower portions of Horton Creek are often dry.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Horton Creek is comprised of Tonto National Forest (96%), private (3%), and Apache-Sitgreaves National Forest (1%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging, and fuelwood cutting. Recreational use, primarily camping and hiking, in the vicinity of Horton Creek is heavy especially during the summer months. Horton Creek is currently managed as a self-sustaining brown trout fishery.

Collection History:
No collections of chubs from Horton Creek were identified. Madsen (1935a) surveyed approximately 5 km of Horton Creek on the Tonto National Forest, reporting “bonytails” as occurring throughout the survey reach, common and in excellent condition (Appendix E-6n). The “bonytails” reported by Madsen (1935a) were likely *Gila nigra* although no museum specimens were found.

Results of Surveys Conducted for this Project:
Horton Creek was not surveyed for this project because the *Gila* sp. reported by Madsen (1935a) is extirpated from this stream.

Population Status:
**Extirpated**. Horton Creek is currently managed as a brown trout sportfishery. Other than Madsen (1935a), no survey records or collections reporting chubs in Horton Creek were found.

Christopher Creek

Site Description:
Christopher Creek is tributary to Tonto Creek, with its waters originating below the base of the Mogollon Rim and flowing in a southerly and westerly direction to its confluence with Tonto Creek.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Christopher Creek is comprised of Tonto National Forest (78%), Apache-Sitgreaves National Forest (17%), and private (6%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging, and fuelwood cutting. Other land and water uses in the vicinity of Christopher Creek include ground water pumping, localized residential development.

Collection History:
No collections of chubs from Christopher Creek were identified. Madsen (1935a) surveyed approximately 11 km of Christopher Creek on the Tonto National Forest, reporting "bonytails" as occurring throughout the survey reach, abundant and in excellent condition (Appendix E-6h). Madsen (1935a) also surveyed a two-mile reach of Sharp Creek (tributary of Christopher Creek) and reported catching very few "bonytails". No other records for chubs from Christopher or Sharp creeks were found. The "bonytails" reported by Madsen (1935a) were likely *Gila nigra* although no museum specimens were found.

Results of Surveys Conducted for this Project:
Christopher Creek was not surveyed for this project because the *Gila* sp. reported by Madsen (1935a) is extirpated from this stream.

Population Status:
**Extirpated**. Christopher Creek has been managed as a trout fishery for most of the previous century, and it is unlikely that chubs persist in this system. Crayfish are abundant in and around the recreation areas at Christopher Creek. Educational materials should be displayed at high-use recreation areas around Christopher Creek to educate the public about the negative effects of transporting crayfish to new locations.

Haigler Creek

Site Description:
Haigler Creek, a tributary to Tonto Creek, flows westerly from below the Mogollon Rim to its confluence with Tonto Creek roughly 19 km northwest of Young, Gila County, Arizona. Major tributaries to Haigler Creek include Gordon and Marsh creeks.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Haigler Creek is comprised of Tonto National Forest (98%) and private (2%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging, and fuelwood cutting. The lower reach of Haigler Creek flows through the Hellsgate Wilderness Area.

Collection History:
No collections of chubs from Haigler Creek were identified. Madsen (1935a) surveyed approximately 14 km of Haigler Creek on the Tonto National Forest, reporting "bonytails" (likely headwater chubs based on distribution from Minckley and DeMarais [2000]) as abundant throughout the survey reach. Surveys conducted in 1993 sampled chubs in Haigler Creek downstream of the Marsh Creek confluence. See Appendix E-6m for complete sampling history.

Results of Surveys Conducted for this Project:
A single survey conducted during the summer of 2000 found no chubs present in the portion of Haigler Creek sampled; about one mile upstream of the Marsh Creek confluence. The only native species found was speckled dace (*Rhinichthys osculus*), which were rare. Nonnative species collected included rainbow and brown trouts, which were common. Crayfish were abundant throughout the reach sampled. Water was turbid, and silt deposits heavy, which made sampling difficult and may have resulted in an under-representation of species present.

Population Status:
**Stable – Threatened**. Although no museum collections of chubs exist from Haigler Creek, the population is likely *Gila nigra* based on distribution information provided in Minckley and DeMarais (2000). Surveys conducted in 1993 by AGFD personnel found chubs in Haigler Creek in the vicinity of the Marsh Creek confluence and below. Chubs were caught by hook and line in and around the vicinity of the Gordon Creek confluence during the late 1990s (A. Clark, pers. comm.). Nonnative rainbow trout and brown trout are well established in Haigler Creek. Much of Haigler Creek is protected by the Hellsgate Wilderness Area.

Marsh Creek

Site Description:
Tributary to Haigler Creek, headwaters of Marsh Creek originate along the southwestern slopes of the Naegelin Rim, north of Young, Gila County, Arizona. It flows from its headwaters at an elevation of roughly 2,070 m to its confluence with Haigler Creek, at an elevation of approximately 1,370 m. Marsh Creek enters Haigler Creek roughly 13 km northwest of Young.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Marsh Creek is comprised of Tonto National Forest (98%) and private (2%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging, and fuelwood cutting. No sign of recent grazing in the Marsh Creek channel, though recent browsing on young alders was noted. Evidence of heavy grazing was seen above a fence in a side-drainage leading into Marsh Creek.

Collection History:
One collection of chub was identified from Marsh Creek, collected in 1992 (ASU 15989). Madsen (1935a) surveyed approximately 4 miles of Marsh Creek on the Tonto National Forest, reporting "bonytails" (= headwater chub) as occurring throughout the survey reach, abundant and in good condition. Abarca and Weedman (1993) reported five chubs collected as specimens from an unnamed tributary to Marsh Creek, 0.2 mi West of Marsh Creek Ranch, and chubs were abundant throughout pools in the drainage with no other species of fish observed or collected. See Appendix D-7k for complete collection history, and Appendix E-6o for complete sampling history.

Results of Surveys Conducted for this Project:
Headwater chubs were collected in the middle reach of Marsh Creek during surveys conducted in summer of 2000 (ASU 18312) and were abundant in pools, runs, and riffles (109 chub sampled in 1774 shocking seconds). The majority of chubs ranged between 80 and 150 mm. Green sunfish were also abundant, rainbow trout were common, and brown trout were rare. Stream flow was low and drought conditions during 2000 may have served to concentrate fishes in available habitats. No crayfish were found in the area sampled.

Population Status:
**Stable – Threatened.** The chub population in Marsh Creek is *Gila nigra* (Minckley and DeMarais 2000). Headwater chubs were abundant during surveys in 2000, with several age classes present. The most imminent threat to the headwater chub population in Marsh Creek is the presence of nonnative fish species.

Gordon Creek

Site Description:
Gordon Creek, a tributary to Haigler Creek, flows in a southwesterly direction through the Tonto National Forest, before its confluence approximately 1.6 km downstream of the Marsh/Haigler confluence.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Gordon Creek is comprised of Tonto National Forest (98%) and private (2%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging, and fuelwood cutting. Public access to the stream across private property is no longer available, and according to the current residents livestock grazing is no longer practiced on the property. No evidence of recreation or livestock use was observed along the reach sampled.

Collection History:
No collections of chubs were identified from Gordon Creek. Surveys where chubs were sampled from Gordon Creek were conducted in 1993 (Appendix E-6k).

Results of Surveys Conducted for this Project:
Headwater chubs were collected from Gordon Creek during surveys in summer of 2000 (ASU 18307, Appendix D-7i). Water in the stream was turbid with fine silt covering bedrock and boulder substrates. Sampling covered approximately 0.4 km of stream and found 19 chubs (including six juveniles) during 1950 seconds of electroshocking. Water turbidity may have resulted in an under-representation of numbers of individuals per species, or number of species present. Longfin dace were also present but appeared rare. No other fishes were sampled, but according to locals brown trout occur further up the drainage. No algal growth was present on substrates and crayfish were abundant throughout. Riparian vegetation appeared in good condition and stream banks appeared stable.

Population Status:
**Stable – Threatened.** The chub population in Gordon Creek is *Gila nigra* (Minckley and DeMarais 2000). The most imminent threat to the headwater chub population in Gordon Creek is the abundance of nonnative crayfish.

Spring Creek

Site Description:
Spring Creek, a tributary to Tonto Creek, flows in a northwesterly direction to its confluence with Tonto Creek roughly 22 km northwest of Young, Gila County, Arizona, in the Hellsgate Wilderness. Spring Creek and its tributaries drain the northwestern slopes of the Sierra Anchas.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Spring Creek is comprised of Tonto National Forest (99%) and private (1%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, mining, logging, and fuelwood cutting. A spring fed impoundment exists on private property on upper Spring Creek, providing recreation and irrigation. An abandoned mine (Spring Creek mine) is immediately upstream of the locality sampled during 2001.

Collection History:
The earliest identified collections of chubs from Spring Creek were made in 1934 in the lower and upper portions of the creek (UMMZ 217026, UMMZ 216964). Additional collections of chubs were made in 1950 and 2000. Madsen (1935a) surveyed approximately 13 km of Spring Creek in the Tonto National Forest reporting "bonytails" (= headwater chubs) occurring throughout the survey reach, abundant and in good condition. Additional surveys where chubs were sampled from Spring Creek were conducted in 1992 and 1993. See Appendix D-7r for complete collection history and Appendix E-6v for complete sampling history.

Results of Surveys Conducted for this Project:
Chubs were abundant in the uppermost reaches of Spring Creek in 2001 (ASU 18309). Speckled dace were also abundant; brown trout were common, desert sucker uncommon, and mosquitofish and fathead minnow were rare. Chubs were common at the site surveyed in the middle reach of Spring Creek (ASU 18310); green sunfish and yellow bullhead were abundant, and brown trout were rare.

Population Status:
**Stable – Threatened**. The chub population in Spring Creek is *Gila nigra*. The most imminent threat to the headwater chub population in Spring Creek is the presence of nonnative fish species. A local informed the sampling crew in spring of 2001 that he had transplanted green sunfish from Spring Creek into several stock tanks in the Young area to provide angling opportunities for children.

The current land manager of Spring Creek Ranch is considering stocking rainbow trout into the pond, but during survey conducted in 2000-2001 the manager was interested in discussing other management options for the pond. Stocking rainbow trout into the pond would not likely have a negative effect on the native fish population occurring in Spring Creek (nonnative fish species are already established), but the pond could be used as a refugium for headwater chub, speckled dace, and other suitable native aquatic species.

Rock Creek

Site Description:
Rock Creek, a tributary to Spring Creek, forms at the confluence of Turkey Creek and Bearhead Canyon on the northeastern side of the Sierra Ancha mountains. Rock Creek flows in a north-northeasterly direction until it reaches Spring Creek about 2 km upstream of Spring Creek mine. During surveys conducted in spring of 2001 the stream channel was comprised primarily of scoured cobble and boulder; channel down-cutting and streambank collapse was noted.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Rock Creek is comprised of Tonto National Forest (99%) and private (1%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, mining, logging, and fuelwood cutting. Cattle were observed in the stream channel immediately above and outside of the J/X Ranch property fence on Turkey Creek (headwater tributary to Rock Creek).

Collection History:
No collections of chubs from Rock Creek were identified. Surveys where chubs were sampled from Rock Creek were conducted in 1993 (Appendix E-6p).

Results of Surveys Conducted for this Project:
Collections of chubs were made on lower and upper Rock Creek during 2001 (ASU 18311, ASU 18303; Appendix D-7l). The upper sample site included the lower portion of Turkey Creek (headwater tributary to Rock Creek) and the upper portion of Rock Creek. The lower site sampled was approximately 2 km downstream of the confluence with Buzzard Roost Creek. Chubs were found to be abundant at both localities on Rock Creek. In lower Rock Creek, chubs and brown trout were abundant, while speckled dace and desert sucker were rare.

Population Status:
**Stable – Threatened.** The chub population in Rock Creek is *G. nigra*. No nonnative species were sampled in upper Rock Creek; however, brown trout were abundant in lower Rock Creek and are possibly affecting the native fish community.

AGFD has been approached by a realtor from Tonto Basin who would like to sell property on the headwaters of Rock Creek (identified on Tonto National Forest map as "J/X", T7N R12E Sec. 3. Purchasing this property would be beneficial to all aquatic and terrestrial species in the area.

Buzzard Roost Creek

Site Description:
Buzzard Roost Creek, a tributary of Rock Creek, flows in a northerly direction until its confluence with Rock Creek about 1.6 km downstream of Buzzard Roost Creek Ranch. Stream channel is primarily bedrock with cobble and gravel, and a low sediment load (D. Weedman, pers. comm.).

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Buzzard Roost Creek is comprised of 100% Tonto National Forest lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, mining, logging, and fuelwood cutting.

Collection History:
No collections of chubs from Buzzard Roost Creek were identified. Surveys where chubs were sampled from Buzzard Roost Creek were conducted in 1993 (Appendix E-6c).

Results of Surveys Conducted for this Project:
A single specimen of headwater chub (ASU 18321, Appendix D-7b) was collected in June 2001 just downstream of Buzzard Roost Ranch. Chubs were visually observed to be abundant in deep canyon-bound pools near the Rock Creek confluence, but were not sampled because of deep water (D. Weedman, pers. comm.).

Population Status:
**Stable – Threatened.** Flow is intermittent from Buzzard Roost Ranch upstream and it is unlikely that a sustainable chub population exists above the ranch. During surveys of Spring Creek, a local reported catching and releasing brown trout up to 8lbs. in the deep pools of Buzzard Roost Creek, but stated that "Verde trout" (= headwater chub) were the most common fish in the stream, followed in abundance by "warmouth" (= green sunfish), and brown trout.

The lower reach of Buzzard Roost Creek should be surveyed using a variety of gear types (experimental gill nets, trammel nets, angling) to determine the distribution and abundance of the fish community in the deep pools near the confluence with Rock Creek.

Rye Creek

Site Description:
Rye Creek is a tributary to Tonto Creek, draining the northeastern slopes of the Mazatzal Mountains and entering Tonto Creek roughly 10 km southeast of Rye, Gila County, Arizona. Drought conditions prevailed during the period of sampling in 2000 and surface flows were restricted to a short distance above the FR 184 crossing to the confluence with Tonto Creek.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Rye Creek is comprised of Tonto National Forest (95%) and private (5%) lands.

Land and Water Uses:
Land and water uses along Rye Creek include livestock grazing, mining, recreation, limited commercial, urban, and rural development, limited agriculture, and groundwater pumping. Most cattle sign within the stream channel appeared several weeks old but one bull was observed in the stream channel during the sampling. Beaver sign was seen through most of the reach sampled.

Collection History:
The earliest identified collections of chubs from Rye Creek were made in 1983 by B.D. DeMarais and K. Aitkin in 1983, from approximately 0.5 km above the confluence with Tonto

Creek (ASU 10408, ASU 10409, ASU 10410). One additional collection of chub was obtained from the same location in 1995 (ASU 14282). Surveys where chubs were sampled from Rye Creek were conducted in 1995. See Appendix D-7m for complete collection history, and Appendix E-6q for complete sampling history.

Results of Surveys Conducted for this Project:
In 2000, a survey was conducted from 100 m above Forest Road 184 bridge to 100 m above the confluence with Tonto Creek. Surface flow a short distance above Forest Road 184 was absent. Records suggest localized presence of chubs in lower drainage in 1983. Examination of the upper drainage and Rock Creek (tributary to Rye Creek) found no water. There were later reports, however, of a pond on private property west of Highway 87 that may have still held water. Nonnative fish and crayfish were abundant throughout the reach sampled. Native fishes found during the survey included longfin dace (common), Sonora sucker (uncommon), and desert sucker (rare).

Population Status:
**Extirpated.** The headwater chub population in Rye Creek is likely extirpated. Lack of suitable habitat and presence of nonnative fish and crayfish are the main threats to native fish in Rye Creek.

Gun Creek

Site Description:
Gun Creek is a tributary to Tonto Creek, flowing off the northern and western slopes of the Sierra Ancha Mountains. The upper half of the drainage flows in a northerly direction and the lower half in a southwesterly direction. Gun Creek enters Tonto Creek approximately 4 km southeast of Jakes Corner, Gila County, Arizona. During the time of the survey in 2000 general drought conditions prevailed throughout most of Arizona. No surface flow was found in any portion of the drainage sampled; however, bedrock pools did persist in some canyon-bound reaches. There were no stream banks throughout much of this reach, just scoured cobble and boulder between canyon walls, with an occasional strand of soil in the channel bottom. There were also no surface waters in Tonto Creek at the confluence with Gun Creek during the time of the survey.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Gun Creek is comprised of Tonto National Forest (99%) and private (1%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, mining, logging, and fuelwood cutting. Recent cattle sign was observed, but the majority of sign appeared several weeks old.

Collection History:
No collections of chubs from Gun Creek were identified. Surveys where chubs were sampled from Gun Creek were conducted in 1993 and 2000. See Appendix E-6l for complete sampling history.

Results of Surveys Conducted for this Project:
Headwater chubs were collected from lower Gun Creek during surveys in 2000 (ASU 18305, Appendix D-7j). A survey in middle reach of Gun Creek during summer 2000 found only speckled dace. Chubs in the lower portion of the drainage were found in three of eight small bedrock pools, roughly one mile above the confluence with Tonto Creek. All chubs were relatively small (< 175 mm TL); many showed signs of stress and many had *Lernaea*, black grub, lesions, and an unidentified fungus. Green sunfish were also present further down the drainage but were restricted to two pools downstream from a boulder barrier approximately 4 m high. In the lower reach of the stream, no sign of cattle or recreation were seen. Intermediate reaches of the drainage were dry for roughly 3.2 km upstream of Forest Road 894. Leopard frogs (*Rana* sp.) were seen at all of the pools in this reach.

Population Status:
**Unstable – Threatened.** The chub population occurring in Gun Creek is *Gila nigra*. Lack of perennial flow is the biggest threat to the headwater chub population in Gun Creek. All of the headwater chubs sampled from Gun Creek were found in small bedrock pools with very little surface flow connecting the pools.

**Verde River and Tributaries**

Verde River

Site Description:
The Verde River originates at Sullivan Lake in Chino Valley (Yavapai County, Arizona) at an elevation of 1,325 m, following a southeasterly and southerly direction for approximately 300 km to its confluence with Salt River (Maricopa County) at an elevation of approximately 402 m. In the upper drainage, surface flow decreases dramatically in the reach below the Arizona Power Company (TAPCO), an abandoned coal-burning power plant, as the river passes through the towns of Clarkdale, Cottonwood, Bridgeport, and Camp Verde. Water withdrawals and diversions for agricultural, municipal, and domestic consumption are substantial in this portion of the river. Surface flows increase downstream from urbanized areas as a result of tributary inflow and water returns from upstream diversions (Girmendonk and Young 1997). Perennial flows are supplemented along much of the Verde by a number of tributaries and springs. Perennial flows on the lower Verde River are controlled via releases from two water storage facilities; Bartlett and Horseshoe reservoirs.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the Verde River is comprised of Tonto National Forest (46%), private (18%), Coconino National Forest (14%), Prescott National Forest (8%), Fort McDowell Indian Reservation (9%), Salt River Indian Reservation (<1%), AGFD (<1%), Yavapai Apache Reservation (<1%), and National Park Service (Tuzigoot National Monument) (<1%) lands, as well as other Indian allotments (<1%).

Land and Water Uses:
Land and water uses along the Verde River include mining; livestock grazing; recreation; water diversion for agricultural, municipal, and industrial use; groundwater pumping for agriculture, urban, and municipal uses; and increasing municipal, urban, and rural development. Treated wastewaters from domestic use are passed into the system from Prescott, Sedona, Cottonwood, and smaller communities (Minckley 1985).

Collection History:
The earliest identified collections of roundtail chubs from the Verde River were made in 1888 by E. A. Mearns at Fort Verde (NMNH 076305, NMNH 039576). The most recent collection of roundtail chubs from the Verde River was made in 1993 by D. Weedman at Burnt Corral Ranch (ASU 14205). Additional collections of roundtail chubs from the Verde River were made in 1905, 1937, 1938, 1950, 1963, 1965, 1966, 1967, 1970, 1974, 1975, 1978, 1981, 1984–1989, 1992, and 1993. Surveys where roundtail chubs were sampled from the Verde River were conducted in 1892 and 1985–2001. Roundtail chubs remain common in the upper reaches of the Verde River (Brouder et al. 2000, A. Clark, pers. comm.) Monitoring summaries of the Verde River between Childs and Horseshoe Reservoir indicates chubs have become rare in that reach (Jahrke and Clark 1999). Sampling conducted in 1999-2000 on lower reach of the Verde River (below Bartlett Dam) indicates that roundtail chubs are common to abundant (Bryan and Robinson 2000). See Appendix D-8g for complete collection history, and Appendix E-7f for complete sampling history.

Collections of chubs from Sycamore Creek (tributary to the Verde River below Perkinsville and north of Clarkdale; UMMZ 216974, ASU 4963) have been limited to the lowermost perennial reaches with connection to the Verde River, suggesting that chubs may enter Sycamore Creek and be maintained from the mainstem Verde River(Girmendonk and Young 1997).

Results of Surveys Conducted for this Project:
The Verde River was not surveyed during this project because information gathered was recent enough (Brouder et al. 2000, Bryan et al. 2000, Stefferud et al. 2000) to determine population status.

Population Status:
**Unstable – Threatened.** Roundtail chubs are reported to remain fairly common in the upper Verde River above Sycamore Creek (Brouder et al. 2000), and in the lower river from below Bartlett Reservoir to the confluence with the Salt River (Bryan and Robinson 2000). Based on

mark-recapture data, the lower Verde River population has been estimated at over 6000 fish, although documented recruitment is very low (S. Bryan, pers. comm.) However, data collected by United States Forest Service (USFS) during the last seven years at fixed stations in the upper river suggests an alarming decline in abundance in the reach of river above Sycamore Creek (Stefferud 2000). Recruitment of young roundtail in these reaches appears sporadic and limited. Reproducing populations of nonnative fish species (especially red shiner, smallmouth bass, channel catfish, and flathead catfish) are well established throughout most of the river and continue to pose a threat to the native fish assemblage. Crayfish throughout the system pose an additional threat. Flow records from the Verde indicate that water withdrawals are negatively impacting the system (Girmendonk and Young 1997). The City of Prescott is working on mitigation plans to offset possible reductions in base flows caused by ground water pumping in the Big Chino aquifer that is set to begin in the next five years (P. Sponholtz, pers. comm.). Bureau of Reclamation predicts that groundwater pumping may completely eliminate flows in up to 20 miles of the upper Verde River unless current trends are reversed (Harlow 1999).

Oak Creek

Site Description:
Oak Creek is a tributary to the Verde River in Coconino and Yavapai counties, Arizona, flowing south from Sterling Springs Fish Hatchery for roughly 82 km to its confluence with the Verde River. Oak Creek joins the Verde River near Cornville, Yavapai County. Portions of the western drainage in upper Oak Creek are contained within the boundaries of Red Rock Secret Mountain Wilderness Area. Oak Creek is the largest perennial Verde River tributary.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Oak Creek is comprised of Coconino National Forest (73%), private (22%), ASLD (4%), Coconino County (1%), AGFD (<1%), and Prescott National Forest (<1%) lands. Private lands are found primarily in the Sedona, Cornville, and Oak Creek Canyon areas.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging, and fuelwood cutting. Land and water uses along Oak Creek include ground and surface water withdrawals for municipal, agricultural, and industrial uses, and domestic consumption. Urban development within the drainage continues to increase, and water demands can be expected to increase as well. Recreational use along Oak Creek is high and seasonally intense in localized areas. Hiking trails occur along much of the stream's length. Three Arizona Game and Fish Department hatcheries operate within the Oak Creek drainage: Page Springs, Bubbling Ponds, and Sterling Springs.

Collection History:
The earliest identified collection of roundtail chubs from Oak Creek was made in 1936 by M.A. Gee at the Sedona Ranger Station (UMMZ 113523). The most recent collection of roundtail chubs from Oak Creek was taken in 1995 approximately 2.5 miles southwest of Sedona (INHS

37457). Additional collections of roundtail chubs from Oak Creek were made in 1950, 1963, 1965, 1967, 1970, 1979, and 1981. Except for the 1995 collection, all of the other collections identified consisted of only one or two specimens. Surveys where roundtail chubs were sampled from Oak Creek were conducted in 1986 and 1987. Other collection and sampling records summarized in Girmendonk and Young (1997) indicated at least 13 sampling efforts expended in Oak Creek between 1970 and 1995 in which no chubs were found. Minckley (1973) reported a suspected undocumented introduction of Gila chubs into Oak Creek, but more recent studies from the Oak Creek basin suggest that Gila chubs are native to the watershed and are present in at least one tributary, Spring Creek (Weedman et al. 1996, Girmendonk and Young 1997). See Appendix D-8e for complete collection history, and Appendix E-7e for complete sampling history.

Results of Surveys Conducted for this Project:
Efforts to find roundtail chubs in Oak Creek during 2000 were unsuccessful. Sonora and desert suckers were common in an area sampled upstream of Sedona (at Huckaby Trail, east of Midgley Bridge), but downstream at Chavez Crossing, Sonora suckers were rare and desert suckers were absent. Additional surveys conducted in Oak Creek (above and below the Highway 179 bridge) during 2001 found three roundtail chubs, indicating that they still exist in the system but their occurrence is rare. Two of the chubs were in possession by an angler but were released (L. Luedeker, pers. comm.).

Population Status:
**Unstable – Threatened.** Recent collection efforts during 2000-2001 indicate that roundtail are rare in Oak Creek. Reproducing populations of nonnative fish species (especially red shiner, rock bass [*Ambloplites rupestris*], and channel catfish) are well established throughout most of the river and continue to pose a threat to the native fish assemblage. Water quality data provided by ADEQ (1996) indicate that water quality within the drainage exceeded standards for arsenic, iron, and turbidity during the 1990s.

Beaver Creek (Wet and Dry Beaver creeks)

Site Description:
Headwaters of Wet Beaver Creek originate in Coconino County, Arizona, on the Mogollon Rim south of Apache Maid Mountain. Most of the upper canyon-bound reach of Wet Beaver Creek is within the Wet Beaver Wilderness. The stream flows approximately 39 km to its confluence with Dry Beaver Creek in McGuireville (Yavapai County), at which point the two form Beaver Creek. Much of the upper Dry Beaver Creek drainage is found within Munds Mountain Wilderness. Except for intermittent waters near spring sources and runoff flows during periods of high precipitation, much of upper Dry Beaver Creek has little or no surface flow. In Wet Beaver Creek, aquatic habitat consists of pools separated by rocky drops. Dry Beaver Creek extends about 29 km to the confluence with Wet Beaver Creek in McGuireville (Girmendonk and Young 1997). Beaver Creek enters the Verde River above Camp Verde.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Wet Beaver Creek (including Beaver Creek) is comprised of Coconino National Forest (74%), private (23%), National Park Service (Montezuma Castle National Monument) (2%), National Park Service (Montezuma Well) (1%), Yavapai Apache Indian Reservation (<1%), and ASLD (<1%) lands. Land ownership within a 1.6 km (1.0 mi) buffer along Dry Beaver Creek is comprised of Coconino National Forest (50%) and private (50%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging, and fuelwood cutting. Beaver Creek is perennial from the confluence of Wet and Dry Beaver creeks to the Montezuma Castle National Monument. During the summer months most of the water at this point is diverted for irrigation purposes (Girmendonk and Young 1997). The Wet Beaver Wilderness Area protects much of upper Wet Beaver Creek from human impacts resulting from land uses.

Collection History:
Collectors have referred to Wet Beaver and Beaver creeks synonymously (Girmendonk and Young 1997). Collection site data for either stream may have been recorded as "Beaver Creek", and for that reason, reference to these collections should be made with caution. Dry Beaver Creek collection and sampling records will be referred to separately. See Appendix D-8a for complete collection history, and Appendix E-7a for complete sampling history.

The earliest identified collection of roundtail chubs from Beaver Creek was made in 1937 by E. Jackson near Montezuma Castle (UMMZ 120101). The most recent collection of roundtail chubs from Oak Creek was made in 1964 by W.L. Minckley, 0.5 miles above Montezuma Castle (ASU 783). Additional collections of roundtail chubs from Beaver Creek were made in 1937, 1938, and 1956. All of collections identified consisted of between one and three chubs. Surveys where roundtail chubs were sampled from Beaver Creek were conducted in 1962, 1988, 1995, 1998, and 1999. Sampling conducted by AGFD personnel in the upper, canyon-bound reaches of Wet Beaver Creek in 1998 reportedly found roundtail chubs common throughout the reach sampled (unpublished data from AGFD Research Branch; Rick Peebles, pers. comm.).

Three collections of roundtail chubs from Dry Beaver Creek were identified, the first in 1966 collected by L. Carufel at "Dry Beaver Creek at Beaverhead Springs" (ASU 2429), a second in 1970 by W. Kepner and R. Engrad at the same locality (ASU 7585), and the most recent in 1972 by C.O. Minckley at "Dry Beaver Creek, 15 miles NE of Camp Verde" (MNA 2740 Z5.36; inquiries to the Museum of Northern Arizona [MNA] for any collections of *Gila robusta* did not detect this collection, but the record was reported in Girmendonk and Young [1997]). In a survey conducted during 1995, the majority of upper Dry Beaver Creek was dry (Dorum et al. 1996). Where water was found in the upper drainage (one of six sites examined in Wood Canyon), green sunfish and black bullhead were the only species encountered. Flow was nearly continuous from Beaverhead Spring to approximately 9.5 km downstream. Three sites below the spring, and a pool immediately upstream of the spring were sampled, but no chubs were found. Of the 476

fishes sampled, only two natives were sampled, both of them Sonora sucker. Five species of nonnatives were sampled, with green sunfish the most abundant at all sites (Dorum et al. 1996).

Results of Surveys Conducted for this Project:
Wet Beaver and Beaver creeks were not surveyed for this project because information was recent enough (unpublished data from AGFD Research Branch 1988) to determine the population status AGFD personnel sampled Dry Beaver Creek in June 2001; no chubs or suitable chub habitat (deep pools, undercut banks) was encountered in the survey, and green sunfish were abundant (C. Benedict, pers. comm.).

Population Status:
**Unstable – Threatened (Beaver and Wet Beaver creeks).** Beaver Creek was treated with rotenone in 1962 (Bassett 1962). Barrett and Maughan (1995) found the roundtail chub population in Beaver Creek comprised entirely of large adults, with no juveniles found, during surveys conducted from 1988 –1990. Presence of smallmouth bass may have displaced roundtail chubs from preferred habitats, resulting in a subviable roundtail population below canyon-bound reaches. Surveys noted a simultaneous increase in abundance of all size classes of smallmouth. Numerous other species of competitive and piscivorous nonnative fish and crayfish have been recorded from the stream. Montgomery et al. (1994) did not find chubs during spring and fall 1993 surveys near Montezuma Castle National Monument, indicating their rarity in the system. One roundtail was found during surveys during 1995 at Davis Hole on Montezuma Castle National Monument (L. Montgomery, pers. comm.). Surveys conducted by AGFD personnel during July 1998, found roundtail common in canyon-bound reaches above the gauge station in the upper reaches of the stream. In the stream reach above a barrier waterfall, brown trout, desert sucker and roundtail chub were common, with smallmouth bass first being sampled below the fall, and increasing in abundance with distance traveled downstream. Cumulatively, this suggests that the occasional roundtail sampled in lower Wet Beaver Creek may be moving down from the population remaining in the upper portions of the drainage.

**Extirpated (Dry Beaver Creek).** Intermittent water and invasions by nonnative predatory fish have likely caused extirpation of the chub population in Dry Beaver Creek. A complete and thorough survey is needed before chub populations should be declared extirpated. Except for a pool in the vicinity of Beaverhead Spring, Dry Beaver creek was believed entirely dry during drought conditions of summer 2000 (C. Benedict, pers. comm.). Green sunfish were reportedly abundant in the pool.

West Clear Creek

Site Description:
West Clear Creek is a tributary to the Verde River, flowing approximately 60 km in a westerly and southwesterly direction through Coconino and Yavapai counties, to its confluence with the Verde River. The West Clear Creek basin encompasses approximately 262 $km^2$. The headwaters of West Clear Creek are formed by Clover Creek and Willow Valley Spring, Coconino County,

Arizona. Much of this creek is a high gradient stream with numerous deep pools, coursing between high, sheer cliff walls. West Clear Creek enters the Verde River just upstream of Beasley Flat in Yavapai County.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along West Clear Creek is comprised of Coconino National Forest (92%), private (7%), Prescott National Forest (1%), and ASLD (<1%) lands.

Land and Water Uses:
Land and water uses along West Clear Creek include livestock grazing, agriculture, water diversion, timber production, and recreation. During summer months, the creek often runs dry near its confluence with the Verde River due to irrigation diversions (Girmendonk and Young 1997). The upper reach of West Clear Creek flows through the West Clear Creek Wilderness Area.

Collection History:
The earliest identified collection of roundtail chubs from West Clear Creek was made in 1937 by Tarzwell, approximately 1 mile above its confluence with the Verde River (UMMZ 120081). Additional collections of roundtail chubs from West Clear Creek were made in 1967, 1970, 1974, 1975, 1977, 1978, 1982, 1983, and 1992. Surveys where roundtail chubs were sampled from West Clear Creek were conducted in 1988, 1992, 1995, 1996, 1998 2000. See Appendix D-8i for complete collection history, and Appendix E-7h for complete sampling records.

Results of Surveys Conducted for this Project:
Roundtail chubs were common during surveys conducted in summer of 2001 (ASU 18343) in upper West Clear Creek, upstream of Tramway Trail (C. Benedict, pers. comm.). Lower West Clear Creek was not surveyed for this project because information gathered was recent enough (Brouder et al. 2000) to determine population status.

Population Status:
**Stable – Threatened.** Information provided in Minckley and DeMarais (2000) indicate the West Clear Creek population is *Gila robusta*. Brouder (pers. comm.) found roundtail chubs common during 1998-1999 at Bullpen Campground (approximately 16 km upstream of the confluence) on lower West Clear Creek. During this period roundtail chubs were the most abundant species sampled. A USFS employee reported catching chubs by hook and line in lower Willow Creek (headwater tributary) in 2001 (C. Benedict, pers. comm.). Brouder et al. (2000) found multiple cohorts present during sampling in 1998 and 1999, with no age-0 chubs found during sampling in 1999. In the lower drainage, the suitability to support aquatic species may be reduced due to residential development, grazing, and sand and gravel activities on private lands within one mile of the confluence with the Verde River (Girmendonk and Young 1997). Rainbow trout are stocked by AGFD near the Bullpen Campground from April to June each year. Threats include nonnative fishes, crayfish, and water depletion at the extreme lower end of the creek.

East Verde River

Site Description:
The East Verde River is perennial for much of its length, originating north of Payson below the Mogollon Rim in Gila County, Arizona. The river maintains about 64 km of perennial stream, flowing in a southwesterly and westerly direction. Flow varies greatly, and is supplemented by water pumped from Blue Ridge Reservoir on East Clear Creek (Little Colorado River basin), down from the Mogollon Rim and into the headwater reaches of the East Verde, near Washington Park, north of Payson. The East Verde River enters the Verde River roughly 7 km below Fossil Creek.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along the East Verde River is comprised of Tonto National Forest (97%), private (3%), and Coconino National Forest (<1%) lands.

Land and Water Uses:
Land and water uses within the East Verde drainage include groundwater pumping, recreation, residential development, municipal development, livestock grazing, agriculture, water diversion, timber production, and recreation.

Collection History:
The chub population in the East Verde River is *Gila nigra* (Minckley and DeMarais 2000). The earliest identified collection of chubs from the East Verde River was made in 1904 by F.W. Chamberlain at a site identified as "Angora", roughly 13 km north of Payson (NMNH 130020). The most recent identified collection of chubs from the East Verde was made in 1999 (ASU 18465). Additional collections of chubs from the East Verde River were made in 1926, 1937, 1950, 1963–1965, 1967, 1969, 1970, 1981, 1982, 1986, 1988, 1991, and 1992. Surveys where chubs were sampled from the East Verde River were conducted in 1935, 1966, 1970, 1979, 1987–1989, 1991, 1992, 1995, and 1997. Madsen (1935a) reported "bonytails" (=headwater chubs) as abundant and in excellent condition throughout a 25-mile reach of the river. See Appendix D-8c for complete collection history, and Appendix E-7c for complete sampling history.

Results of Surveys Conducted for this Project:
Surveys during 2000 found chubs common in a 0.3 km reach of the East Verde River above Webber Creek (ASU 18306). Flows in the East Verde were very low at the time of sampling, and habitats sampled in the upper reach were marginal. The largest chub taken was 131mm, suggesting successful reproduction in the years prior to 2000. Sampling was also conducted in the middle reach of East Verde River, above and below the confluence of Pine Creek. Surface flow was also very low in this area, except within the canyon-bound reach below the confluence, where extensive pools were formed in excess of 2 m depth. Nonnatives were predominant in this area, with no chubs found. In pools within the canyon, large smallmouth bass and green sunfish were seen in abundance.

Population Status:
**Unstable – Threatened.** Fish populations within the East Verde drainage were heavily impacted following the Dude Fire in 1990. Runoff from storms following the fire washed ash and sediments off of the burned slopes into the system, reducing or eliminating fish populations in many of the small tributary streams in the area of the fire.

Increased groundwater pumping along the drainage can be expected to impact flows within East Verde River. Habitat maintenance is important in efforts to preserve and recover headwater chubs in the East Verde River. Records indicate that when water importation from Blue Ridge Reservoir is not occurring, the upper reach of the river from the headwaters to around Crackerjack Mine Road sometimes ceases to flow (Girmendonk and Young 1997). Water storage at Blue Ridge Reservoir and interbasin transfer into the East Verde River are the subject of water settlement discussions and may be modified in the future, possibly reducing flows into the East Verde River (K. Young, pers. comm.). Increased water withdrawals from the river could severely impact aquatic and riparian communities. Potential diversions from the river could occur by Payson, the Tonto-Apache Indian Community, and a possible joint diversion by the towns of Pine and Strawberry (USFWS 1989).

Webber Creek

Site Description:
Tributary to the East Verde River, Webber Creek has intermittent flows for approximately 19 km, from its headwaters at the base of the Mogollon Rim in Gila County (approximate elevation 2304 m) to its confluence with the East Verde River. Webber Creek is formed by the confluence of West Webber Creek and Patton Spring Draw. Webber Creek enters the East Verde River north of Payson near Sunflower Mesa on the Tonto National Forest at an elevation of 1402 m.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Webber Creek is comprised of Tonto National Forest (97%) and private (3%) lands.

Land and Water Uses:
Land uses along Webber Creek include the Camp Geronimo Boy Scout Camp in the upper reaches of the stream and limited residential development on private in-holdings along the middle and lowermost reaches of Webber Creek. National Forest lands are used for recreation, cattle grazing, logging, and fuelwood cutting. Water uses along lower Webber Creek include groundwater withdrawals for domestic consumption and at least one diversion for limited agricultural use. Residential developments on the middle and lowermost portions of the drainage continues to increase, but are limited, as are sources of water in this area. Water demands can be expected to increase. Recreational use along Webber Creek is seasonally high in the uppermost reaches of the stream, but work projects annually undertaken by the Boy Scouts appear to have beneficial results in the surrounding areas. Trails occurring in the upper watershed are regularly maintained and trail use is light. Litter was common in the lower reach implying at least limited

recreational use. In the lowermost reach, vegetation appeared heavily grazed and browsed, but did not appear recent. Elk sign was heavy in the vicinity of Webber Spring in the lower reach. Surface flow was low during sampling in June 2000. Surface water was absent a short distance above Webber Spring and the spring was dry. During sampling in July 2000, precipitation in the drainage had been sufficient to return surface flow to Webber Spring. A water diversion exists (apparently on USFS property) less than 1/4 mile upstream from private property boundary.

Collection History:
The only identified collection of chubs from Webber Creek was made in 1979 by R. Clarkson 1/4 mile above the confluence with the East Verde River (ASU 12104). Surveys where chubs were sampled from Webber Creek were conducted in 1979 and 2000. See Appendix D-8h for complete collection history, and Appendix E-7g for complete sampling history.

Results of Surveys Conducted for this Project:
In June 2000, chubs were collected from Webber Creek above Flowing Springs (ASU 18300). In July 2000, chubs were collected from Webber Creek 0.3 km upstream of the confluence with the Verde River (ASU 18302). During sampling in 2000, the stream channel along FR64 and FR440 were entirely dry. Headwater tributaries contained water, but no chubs were found. Chub were uncommon in the lower reach of the stream. Where chubs were found, they were associated with undercut banks and large boulders. Trout were collected in headwater tributaries (West Webber Creek and Patton Spring Draw), which are believed to be a strain of cutthroat (*Oncorhynchus clarki* ssp.), or cutthroat hybrid (*O. clarki* x *O. mykiss*). Stocking records indicate stocking of "native" trout in 1939, but at that time, cutthroats were commonly referred to as "speckled natives" or "spotted natives" by old timers (B. Silvey through L. Riley, pers. comm.). In the upper drainage, crayfish were abundant in Webber Creek on Camp Geronimo property, and for a short distance above, but appeared to be absent or rare in waters of West Webber Creek and Patton Spring Draw. Crayfish were abundant throughout the lower reach from Webber Spring to private property boundary. Surface flow during summer 2000 was found only in the uppermost and lower Webber Creek, but rock pools in the reach between the two are likely to exist.

Population Status:
**Unstable – Threatened.** The chub population in Webber Creek is *Gila nigra* (Minckley and DeMarais 2000). The largest threat to the headwater chub population in Webber Creek is the abundance of nonnative crayfish.

Fossil Creek

Site Description:
Fossil Creek is a tributary to the Verde River, originating at an elevation of 1690 m approximately 7 km west of Strawberry in Gila County, Arizona. The creek is a large, spring-fed stream, with several perennial springs at its source, and a consistent base flow of 1.2 cms (43 cfs). Fossil Creek flows in a southwesterly direction to its confluence with the Verde River (Yavapai County) approximately 23 km downstream. The waters are saturated with calcium

salts, which begin to precipitate shortly after emergence from the spring source. Prior to its diversion in 1908 for hydropower generation, the stream deposited spectacular travertine formations throughout much of its upper course. The Childs hydropower plant was completed on the Verde River in 1908. Shortly after, the completion of a dam below the springs diverted virtually the entire flow into a flume system leading to the plant. A second power generating station, the Irving power plant, was built approximately 12 km upstream from the Childs plant in 1915. Talks are currently underway for decommissioning of the Childs and Irving power plants, with a tentative target date for the return of flows to Fossil Creek in December 2004. Hardscrabble Creek joins Fossil Creek roughly 3 km upstream of the Verde River confluence.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Fossil Creek is comprised of Coconino National Forest (52%), Tonto National Forest (48%), and private (<1%) lands.

Land and Water Uses:
National Forest lands are used for recreation, cattle grazing, logging and fuelwood cutting. Water is diverted from upper Fossil Creek into flumes for energy production at the Childs and Irving power plants.

Collection History:
Chamberlain (1904) recorded taking "*Lueciscus*" (identified in Minckley [1999] as headwater chub) in 1904 from Fossil Creek downstream of the springhead (NMNH 130017). The most recent collection of chubs from Fossil Creek was made in 1992 (ASU 15990). Additional collections of chub from Fossil Creek were made in 1937, 1950, 1966, 1967, 1970, 1972, 1975, 1979, 1981, 1983, 1988, and 1989. Surveys where headwater chubs were sampled from Fossil Creek were conducted in 1935, 1988–1992, and 1994–1999. Madsen (1935a) reported "bonytails" (= headwater chub) as common and in good condition throughout a 1.2 km reach of Fossil Creek surveyed. See Appendix D-8d for complete collection history, and Appendix E-7d for complete sampling history.

Results of Surveys Conducted for this Project:
Fossil Creek was not surveyed for this project because information gathered was recent enough (AGFD NFDB 1999) to determine population status.

Population Status:
**Unstable – Threatened.** Chubs in Fossil Springs above the diversion dam and in upper portions of the stream are currently identified as *G. nigra* (Minckley and DeMarais 2000). Chubs found in the lower portions of the stream (below the diversion dam) are *Gila robusta* (B. DeMarais through P. Unmack, pers. comm.). Nonnative fishes currently prove to be the greatest threat to chubs in Fossil Creek. During February 1995 the largest flood since 1921 was observed in Fossil Creek, destroying the only apparent natural fish barrier in the lower reaches (Girmendonk and Young 1997). Jones et al. (1999) reported on surveys conducted during 1994, 1996, and 1998 at two sites below Irving Dam, noting the decline and disappearance of roundtail chubs and the

concurrent increase in smallmouth bass at their study sites through 1998. Currently, smallmouth bass appear well established in pool habitats of Fossil Creek from the Verde River confluence to at least 16 km upstream. Flathead catfish were found in Fossil Creek approximately 1.6 km upstream from the Verde River confluence, in 1996. Crayfish currently inhabit the lower 19 km of Fossil Creek (P. Sponholtz, pers. comm.).

Expansion of the nearby communities of Strawberry, Pine, and Payson are limited by the availability of water to support such growth, and one or all of these communities can be expected to explore the potential for obtaining water from Fossil Creek, following decommissioning of the power plant. Indications are that the communities want to secure 10% of the base flows from Fossil Creek (P. Sponholtz, pers. comm.).

Deadman Creek (South Fork)

Site Description:
Deadman Creek is a Verde River tributary in Yavapai County, Arizona. The creek is fed by Maverick Basin, and is formed by flows from the North and South forks of Deadman Creek. The creek begins at a headwater elevation of 1219 m in the Mazatzal Wilderness Area, and terminates at its confluence with Horseshoe Reservoir at an approximate elevation of 616 m. The South Fork enters Deadman Creek at an elevation of about 1097 m, with flows reported at 50 to 60 percent of that in Deadman Creek itself (Lister 1991). Deadman Creek is generally perennial only along the upper one-third of the creek.

Land Ownership:
Land ownership within a 1.6 km (1.0 mi) buffer along Deadman Creek is comprised of 100% Tonto National Forest lands.

Land and Water Uses:
Land and water uses along Deadman Creek include limited livestock grazing and light recreation.

Collection History:
The only identified collection of chubs from Deadman Creek was made in 1993 by K. Young in the South Fork of Deadman Creek, one mile above the confluence with Deadman Creek (ASU 12993). AGFD and USFS personnel conducted the survey in the South Fork in October 1993 from Deadman Creek confluence to about 4 km (3 mi) upstream and chubs were common (Young 1994). In June and August 1989, USFS and AGFD personnel surveyed the South Fork of Deadman Creek from Club Trail crossing downstream. Approximately 20 years earlier, observation of an unidentified trout species had been reported from this drainage (Duncan 1997a). During April 1991, USFS and AGFD personnel surveyed upper Deadman Creek, specifically the South Fork of the drainage. The survey was conducted to verify reports of the unidentified trout species. Four chubs were caught from the first pool above the confluence of the South Fork. Specimens were preserved in formalin (Lister 1991). Current location of

specimens is unknown. See Appendix D-8b for complete collection history, and Appendix E-7b for complete sampling history.

Results of Surveys Conducted for this Project:
Deadman Creek was not surveyed for this project because information gathered was recent enough (Girmendonk and Young 1997) to determine population status.

Population Status:
**Stable – Secure.** The population in Deadman Creek has been identified as *Gila nigra* (Minckley and DeMarais 2000). Headwater chubs are common and there are no immediate apparent threats to the South Fork or uppermost reaches of Deadman Creek. No nonnative fishes have been sampled or observed in the South Fork of Deadman Creek. Deadman Creek has been identified as a potential reintroduction site for the endangered Gila trout, *Oncorhynchus gilae* (Warnecke 2000). The creek is protected by isolation and difficult access, therefore, no habitat threats were identified. Leopard frogs and mud turtles have been observed along upper Deadman Creek (Lister 1991).

**Agua Fria River and Tributaries**
No known populations or collections of *G. robusta* or *G. nigra* were found from within this drainage. Previous reports (Bettaso and Young 1994, Weedman et al. 1996) point out collections identified as *G. robusta* from Sycamore and Little Sycamore creeks in the Agua Fria drainage as attributable to misidentification of *G. intermedia*.

**Hassayampa River and Tributaries**
No known populations or collections of *G. robusta* or *G. nigra* have been reported from this drainage.

**Santa Cruz River and Tributaries**
No known populations or collections of *G. robusta* or *G. nigra* have ever been reported from this drainage. Lack of persistent surface flows from the Santa Cruz River to the Gila River confluence, and unsuitable habitat within the lower portions of the Santa Cruz, may have prevented the successful invasion by either species into the Santa Cruz basin.

## SUMMARY AND CONCLUSIONS

### PRESENT DISTRIBUTION

Roundtail and headwater chubs are currently known to occur in at least 30 streams in Arizona and New Mexico (Fig. 2).The population status for 14 streams that historically contained chubs is unknown (Fig. 3). Roundtail and headwater chubs are considered extirpated from 13 streams known to historically contain chubs. Table 4 provides the list of streams that historically contained roundtail or headwater chubs, the current status of the chub population in the streams, and a number that coincides with the stream location on figures 2 and 3.

Table 4. Roundtail and headwater chub population status in the lower Colorado River basin.

| Stream | Current Taxonomic Designation | Current Population Status | Stream number (Fig. 2 and Fig. 3) |
|---|---|---|---|
| lower Colorado River mainstem | | | |
| Colorado River | *Gila robusta* | Extirpated | 1 |
| Little Colorado River drainage | | | |
| Chevelon Creek | *Gila robusta* | Unstable-Threatened | 2 |
| East Clear Creek | *Gila robusta* | Stable-Threatened | 3 |
| Little Colorado River | *Gila robusta* | Extirpated | 4 |
| Zuni River | *Gila robusta* | Extirpated | 5 |
| Bill Williams River drainage | | | |
| Big Sandy River | *Gila robusta* | Extirpated | 6 |
| Bill Williams River | *Gila robusta* | Extirpated | 7 |
| Boulder Creek | *Gila robusta* | Stable-Threatened | 8 |
| Burro Creek | *Gila robusta* | Unstable-Threatened | 9 |
| Conger Creek | *Gila robusta* | Unknown | 10 |
| Francis Creek | *Gila robusta* | Stable-Threatened | 11 |
| Kirkland Creek | *Gila robusta* | Unstable-Threatened | 12 |
| Santa Maria River | *Gila robusta* | Unstable-Threatened | 13 |
| Sycamore Creek | *Gila robusta* | Unstable-Threatened | 14 |
| Trout Creek | *Gila robusta* | Unstable-Threatened | 15 |
| Wilder Creek | *Gila robusta* | Unknown[1] | 16 |
| upper Gila River drainage | | | |
| Ash Creek | *Gila nigra* | Unknown | 17 |
| Blue River | *Gila robusta* | Extirpated | 18 |
| Eagle Creek | *Gila robusta* | Unknown[1] | 19 |
| San Carlos River | *Gila nigra* | Unknown | 20 |
| San Francisco River | *Gila robusta* | Extirpated | 21 |
| Upper Gila River | *Gila robusta* and *Gila nigra* | Unstable-Threatened | 22 |
| lower Gila River drainage | | | |
| Aravaipa Creek | *Gila robusta* | Stable-Threatened | 23 |
| Lower Gila River | *Gila robusta* | Extirpated | 24 |
| San Pedro River | *Gila robusta* | Extirpated | 25 |
| Salt River drainage | | | |
| Black River | *Gila robusta* | Unknown[1] | 26 |
| Buzzard Roost Creek | *Gila nigra* | Stable-Threatened | 27 |
| Canyon Creek | *Gila robusta* | Unknown | 28 |
| Carrizo Creek | *Gila robusta* | Unknown | 29 |
| Cedar Creek | *Gila robusta* | Unknown | 30 |
| Cherry Creek | *Gila robusta* | Stable-Threatened | 31 |
| Christopher Creek | *Gila nigra* | Extirpated | 32 |
| Cibecue Creek | *Gila robusta* | Unknown | 33 |
| Corduroy Creek | *Gila robusta* | Unknown | 34 |
| Gordon Creek | *Gila nigra* | Stable-Threatened | 35 |
| Gun Creek | *Gila nigra* | Unstable-Threatened | 36 |
| Haigler Creek | *Gila nigra* | Stable-Threatened | 37 |
| Horton Creek | *Gila nigra* | Extirpated | 38 |
| Marsh Creek | *Gila nigra* | Stable-Threatened | 39 |

Table 4 (continued). Roundtail and headwater chub population status in the lower Colorado River basin.

| Stream | Current Taxonomic Designation | Current Population Status | Stream number (Fig. 2 and Fig. 3) |
|---|---|---|---|
| Salt River Drainage (continued) | | | |
| Rye Creek | *Gila nigra* | Extirpated | 40 |
| Rock Creek | *Gila nigra* | Stable-Threatened | 41 |
| Salome Creek | *Gila robusta* | Unstable-Threatened | 42 |
| Salt River | *Gila robusta* | Unstable-Threatened | 43 |
| Salt River (on Reservation) | *Gila robusta* | Unknown | 44 |
| Spring Creek | *Gila nigra* | Stable-Threatened | 45 |
| Tonto Creek | *Gila nigra* | Unstable-Threatened | 46 |
| White River | *Gila robusta* | Unknown | 47 |
| Verde River drainage | | | |
| Deadman Creek | *Gila nigra* | Stable-Secure | 48 |
| Dry Beaver Creek | *Gila robusta* | Extirpated | 49 |
| East Verde River | *Gila nigra* | Unstable-Threatened | 50 |
| Fossil Creek | *Gila robusta* and *Gila nigra* | Unstable-Threatened | 51 |
| Oak Creek | *Gila robusta* | Unstable-Threatened | 52 |
| Verde River | *Gila robusta* | Unstable-Threatened | 53 |
| Webber Creek | *Gila nigra* | Unstable-Threatened | 54 |
| West Clear Creek | *Gila robusta* | Stable-Threatened | 55 |
| Wet Beaver Creek | *Gila robusta* | Unstable-Threatened | 56 |
| Wet Bottom Creek | *Gila nigra* | Unknown[1] | 57 |

[1] Although the current statuses of these populations are unknown, chubs are still found in these streams. See Site-Specific Distribution and Status section for more information.

It is estimated that roundtail and headwater chubs historically occupied approximately 5000 km of streams in the lower Colorado River basin. Roundtail and headwater chubs no longer occur in approximately 3300 km of their historic range. The current population status of chubs in 700 km of historic range is currently unknown (mainly due to access restrictions on Reservation lands). It is estimated that roundtail and headwater chubs currently occupy approximately 1000 km of streams in the lower Colorado River basin (Table 5).

Table 5. Estimated historic and current ranges (in linear stream km) of the roundtail and headwater chubs in the lower Colorado River basin.

| Species of chub | Estimated historic range | Estimated range with an unknown current population status (km & % of historic range) | Estimated current range (km and % of estimated historic range currently occupied) | Estimated reduction in range (km and % of estimated historic range that no longer contains chubs) |
|---|---|---|---|---|
| *Gila robusta* | 4500 km | 650 km (14%) | 800 km (18%) | 3050 km (68%) |
| *Gila nigra* | 500 km | 50 km (10%) | 200 km (40%) | 250 km (50%) |
| Both Species | 5000 km | 700 km (14%) | 1000 km (20%) | 3300 km (66%) |